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BULLETIN

JOURNAL OF THE RADIO SOCIETY OF GREAT BRITAIN

- COMMUNICATION ON CENTIMETRE WAVES
- DIVERSITY RECEPTION

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THE FUTURE OF CIVILIAN WIRELESS RESERVES

IT is perhaps too early to expect the Government, through its Service Departments, to give an indication regarding the future of civilian wireless reserves but undoubtedly a statement—however brief—would be welcomed at the present time. In view of the outstanding work achieved by amateurs during recent years, it is fairly safe to assume that all three Services will take steps after the war to form reserves similar to the Royal Naval Volunteer (Wireless) Reserve and the Royal Air Force Civilian Wireless Reserve. These two pre-war Reserves were instituted primarily for the purpose of training amateurs to become Naval telegraphists or R.A.F. wireless operators, but when war came the authorities concerned quickly recognised that many of the reservists were capable of performing other tasks which their training as radio experimenters had fitted them to undertake. Those tasks were concerned with the maintenance and installation of special radio equipment, much of which was brand new, both in design and in principles of operation.

Bearing these points in mind it is of interest to attempt to forecast the part which will be played in post-war years by civilian wireless reserves.

The necessity for training a nucleus of wireless operators, signalmen and telegraphists, additional to those serving full-time in the Armed Forces of the Crown, will be obvious. These reservists will be trained in procedure and will operate to pre-determined schedules on special frequency bands. But what equipment will they use? In pre-war days the R.N.V.(W.)R. and R.A.F.C.W.R. depended for their success upon the readiness of reservists to use their amateur-built equipment for training purposes. Under the then existing conditions that arrangement was satisfactory, but when the post-war reserves recommence we should like to see every qualified station provided with a standard Service transmitter and receiver complete with all accessories. In the case of the R.A.F. Reserve what better set could be used for training purposes than the new G-P? By adopting this suggestion many advantages would be gained. First, every qualified reservist would train on a standard set which he would quickly learn to operate on reserve frequencies at maximum efficiency. Second, his Reserve equipment would be separate and distinct from his experimental equipment. The latter point is important as it would overcome many of the difficulties that confronted pre-war Naval and Air Force reservists. True the equipment would ultimately become obsolescent but surely it will be better to use it in the way indicated than to allow dealers to buy it up to resell at a large profit!

Assuming that some such suggestion can be adopted what other steps could be taken to ensure that reservists derive the maximum benefit from their training? Clearly the most satisfactory plan would be to arrange for them to spend a week or more each year at a Service training centre. In the case of the R.A.F. Reserve no particular difficulty should arise in attaching groups of reservists to their nearest Radio School. Here they would be brought up-to-date with the newest equipment, whilst lectures on procedure, with perhaps refresher Morse tests, would add to the interest of the course.

These suggestions are mainly concerned with the training of reservists capable of maintaining a communications network, but in view of what has been written earlier we believe that many amateurs will prefer to continue the work begun during the war.

Christmas Greetings and Best Wishes
for the New Year
to All Members Abroad

For obvious reasons we cannot be explicit but we have little doubt that the majority of those now serving in the Armed Forces would be more ready to join a reserve which would keep them up to date say with "radar," than one designed only to produce operators. Training difficulties could be overcome by continuing to make use of existing centres.

The problem of the young radio enthusiast, who to-day is in his early teens and who will wish to join a Reserve, can be solved by training him first as a wireless operator, signalman or telegraphist. It is here that the Sea Cadet Corps, Army Cadet Force and Air Training Corps could be brought into the picture.

All three organisations will be able to call upon the services of qualified amateurs who, if we guess correctly, will be only too glad to "teach their business" to the new generation with the aid of experimental equipment and later with standard Service transmitters and receivers.

There are no doubt difficulties in the way of carrying out all of the suggestions put forward—which incidentally are those of the writer and not of the Council of the Society—but if they provoke some discussion a useful purpose will have been served.

J. C.

COMMUNICATION ON CENTIMETRE WAVES

PART IV

By J. H. SHANKLAND, B.Sc., Grad. I.E.E. (GM8FM)*

Wave Guides

AT centimetre wavelengths the distance between two components in a piece of apparatus may be a large number of wavelengths so the problem of transmitting energy from one point to another, without radiation loss, becomes very important. Here again, completely enclosed transmission lines must be used. The co-axial line is the commonest type of non-radiating transmission line and this may be used down to very short wavelengths provided that there is an appreciable thickness of metal in the outer conductor, and that the system is closed at each end. There is one other requirement when using a co-axial line at very short wavelengths—that is, to make sure that the dimensions of the line do not become comparable with the wavelengths transmitted. The reason for this will become apparent when the hollow tube transmission line has been discussed later in this section. If these conditions are observed then the co-axial line will behave as it does at lower radio frequencies and its operation in this manner need not be further discussed.

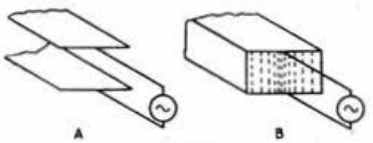

Fig. 17.
Derivation of a wave guide transmission line from a conventional two-wire line.

The fact that electro-magnetic energy may be transmitted along the inside of a single hollow conductor is perhaps not so familiar to the radio engineer although the phenomena was demonstrated and studied theoretically in the 1890's, when radio communication was no more than a scientific plaything. Such a hollow tube transmission line is known as a "wave guide" and assumes great importance at wavelengths of a few centimetres since it has been found that with certain propagation modes the attenuation in a wave guide is much lower than in a co-axial cable. The absence of any insulating material in a wave guide is also a point to be noted, as in the co-axial line insulating spiders must be inserted at intervals which still further increases the attenuation.

Let us now see how the wave guide may be evolved from the well-known twin wire transmission line. A twin wire line may take the form of two flat parallel metal strips (Fig. 17A). Now let us decrease the wavelength of the energy applied to the end of the line until the width of the metal strips forming the line becomes an appreciable fraction of the wavelength. As the wavelength is reduced the intensity of the electric field across the width of the strips, which was more or less uniform at the higher wavelengths, will become more and more concentrated at the centre of the strips. A point will ultimately be reached where the electric field will be very weak at the edges of the strips and very intense at the centre (Fig. 17B). When this condition has been attained then the edges of the strips may very well be connected together so as to form a long rectangular hollow box and energy will still be propagated along the line in spite of the short-circuiting sides of the box. The need for insulators has now been removed as no radio frequency voltages will appear on the outside of the wave guide if the metal used in the construction is thick enough. Note that there will be a "critical" wavelength above which the wave guide will not transmit energy. The cross-sectional dimensions of the guide must be of the order of a half wavelength or more, *i.e.* the wave must "fit into" the guide if transmission is to take place. Wave guides may have rectangular, circular, or elliptical cross-sections. Various modes of propagation are indicated in Fig. 18. Where there is a component of electric force along the axis of the tube in the direction of propagation the waves are termed "E-waves." Similarly, if there is an axial component of magnetic force in the direction of propagation, the waves are termed "H-waves."

There is an alternative nomenclature for the two types of wave, which is used by some American authors and which has been more widely adopted in recent literature on the subject. The types of wave are distinguished by referring to the transverse field in a cross-section of the guide, and the waves are called TE (transverse electric) and TM (transverse magnetic) waves. Thus the TE-wave which has an entirely transverse electric field and an axial component of magnetic force is equivalent to an H-wave, and a TM-wave having a magnetic vector in a plane at right angles to the direction of propagation and an axial component of electric force is equivalent to an E-wave.

In both systems the designating symbols may be given suffixes (which are either zero or positive integers). These suffixes indicate the mode which is being propagated in the tube. In the case of the

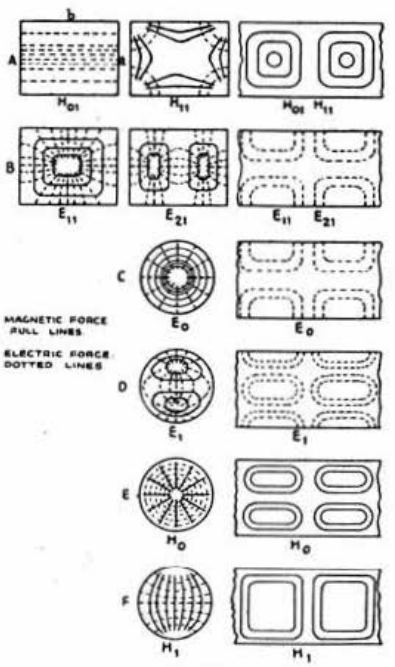

Fig. 18.
Modes in wave guides of circular and rectangular section.

* 23 Richmond Road, Rugby.

rectangular-section guide, the subscripts m, n, denote the number of half-periods of electric field distribution along the two sides of the rectangle.

In Fig. 18 (A) and (B), are shown four modes of excitation of a rectangular guide. The H_{01} mode is is seen to be the simplest, having a sinusoidal electric field distribution across the side a only and the critical wavelength depends only on the length of the side a. The other dimension b may be of any length for this mode. In order to transmit the longest possible wavelength for a given rectangular section the guide is usually operated with the transverse electric field across the longer sides of the rectangle. The other three modes illustrated are more complex. Each has its own critical wavelength. In general only the simpler modes of excitation are of importance, although when harmonics are present higher order modes may have to be considered.

When considering the field patterns in Fig. 18, it should be remembered that the lines of magnetic and electric force are everywhere at right angles, this being a fundamental characteristic of an electro-magnetic field.

In the case of the wave guide of circular section (Fig. 18C, D, E, F) there is a similar series of modes and the various excitation modes are again distinguished by suffixes m and n. They are, however, interpreted slightly differently from the previous case. The first subscript m shows the number of half-period variations of the angular component of the electric field when passing along a radius, and the second n, indicates the number of full period variations of the electric field when passing around the circumference. If there is no variation in the distribution along either of these paths then the value of the subscript is zero. In circular section wave guides the subscript m is often omitted and m is then understood to be equal to unity.

As in the case of the rectangular guide, there is also a simple mode for the cylindrical guide, the H_1 mode (Fig. 18F) in which the transverse electric field is more or less parallel to a diameter. This mode corresponds to the H_{01} mode for a rectangular guide. Other similar modes for rectangular and circular section wave guides may be seen by considering Fig. 18.

It is now apparent that the simpler types of cavity resonators which were discussed in Part III are really short sections of wave guides closed at the ends by metal plugs just as in the case of the half-wave concentric resonator, although in the case of the wave guide resonator a half wavelength measured in the guide is not necessarily equal to half of the free-space wavelength.

The modes of oscillation of such types of cavity resonators may also be classed as E- or H-waves and given distinguishing subscripts. The suffix will now consist of a number triplet, the first two numbers referring to the cross-section of the cavity as in a wave guide, and the third indicating the number of half-period variations in field intensity along a longitudinal section of the resonator.

Wave guides are usually excited by small probes carrying high frequency currents, inserted along a line of electric force, the probes being fed from a co-axial cable. The probes should run at right angles to the wall of the guide or to the end wall, and must be so positioned to fall in a region of maximum electric field intensity for the desired mode. Where more than one probe is employed, attention must be paid to the phasing of the probe currents. A movable metal piston is usually situated behind the exciting rods, and its position is varied so as to obtain the maximum transfer of energy from the rods to the guide. Fig. 19 shows the location of the probes for the excitation of a guide in various modes. Energy may be transferred to a co-axial system at the far end of the guide by a similar arrangement of probes. As an alternative to the probes, coupling may be effected by introducing small loops into the guide, the loops being positioned in a region of maximum magnetic field intensity.

In all wave guide systems there is an axial component of either magnetic or electric force, hence, if boundary conditions are to be satisfied there will be a maximum wavelength above which no transmission of energy will take place. There is no axial component in a co-axial transmission line (Fig. 13) and so energy at any wavelength may be transmitted, but at very short wavelengths the diameter of the outer conductor must be kept small with respect to the wavelength to ensure that there is no spurious wave guide action in the co-axial line. The co-axial line is really a type of wave guide consisting of two co-axial surfaces, and if the diameter of the outer is large compared with the wavelength to be transmitted, the line may respond to a higher type of mode in which there are axial components of electric or magnetic force. For these

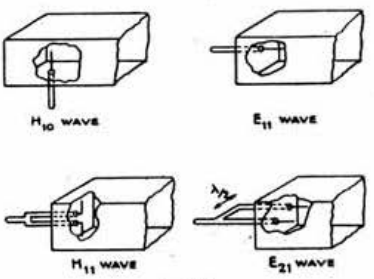

Fig. 19.

Excitation of wave guides by means of probes or exciting rods.

higher modes the co-axial line will have critical wavelength and will behave as a wave guide. Thus, if a tunable section of co-axial line of large diameter is used as a resonator, there may be several tuning positions for a given wavelength, as a half-wavelength for a " wave guide " mode will not correspond to a half-wavelength for the principal " transmission line " mode. Now if the diameter is reduced so as to avoid the excitation of the line in a " wave guide " mode, at very short wavelengths the diameter of the inner line will become very small, giving rise to corona discharges between the conductors when high power is being transmitted along the line. This disadvantage and the fact that the hollow pipe system has a lower attenuation and requires no insulators makes the wave guide unequalled as a transmission line at wavelengths under 10 cms. (3,000 Mc/s.).

The velocity of propagation of energy in a co-axial line is the same as the velocity of propagation in free space and hence the wavelength measured in a concentric line is the same as the wavelength in free space, but in a wave guide system the velocity of propagation in the guide is no longer equal to the velocity in free space, but depends on the frequency of the energy transmitted. At wavelengths much smaller than the critical wavelength the velocity in the guide is approximately equal to the velocity in free space, and the wavelength as measured in the tube approaches the value of the exciting wavelength. As the exciting wavelength approaches the critical value of the guide, the wavelength measured in the guide tends towards infinity.

All the above remarks refer to wave guides filled with air, but it may be noted that for a given tube cross-section the critical wavelength may be increased

by filling the guide with some suitable dielectric such as oil, but the losses in the guide will be very much increased and so the system is little used.

An important property of conventional transmission lines is the characteristic impedance—being the ratio of voltage to current at any point in an infinite line. When a wave guide is considered, however, there is no return conductor and the usual concept of characteristic impedance must be revised. The "wave impedances" are defined as ratios of electric and magnetic field components. This involves the solution of the wave equations. For an E-wave in a uniform tube of any cross-section the wave impedance Z in the direction of the propagation is given by :—

$$Z = \left(\frac{\mu}{\varepsilon}\right)^{\frac{1}{2}} \left\{1 - (f_0/f)^2\right\}^{\frac{1}{2}} = \left(\frac{\mu}{\varepsilon}\right)^{\frac{1}{2}} \frac{\lambda}{\lambda_t}$$

and for H-waves :—

$$Z = \left(\frac{\mu}{\varepsilon}\right)^{\frac{1}{2}} \frac{1}{\left\{1 - (f_0/f)^2\right\}^{\frac{1}{2}}} = \left(\frac{\mu}{\varepsilon}\right)^{\frac{1}{2}} \frac{\lambda_t}{\lambda}$$

where μ is the permeability of the dielectric

ε is the dielectric constant

f is the frequency transmitted

f_0 is the cut-off frequency of the wave guide,

which may be calculated for the mode desired from the cross-sectional dimensions of the tube, and λ_t is the wavelength measured in the tube.

From the above equations it is seen that for E-waves, the wave impedance increases from zero at the cut-off wavelength up to the value $\left(\frac{\mu}{\varepsilon}\right)^{\frac{1}{2}}$. For H-waves the wave impedance decreases from infinity at the cut-off wavelength down to the value $\left(\frac{\mu}{\varepsilon}\right)^{\frac{1}{2}}$.

Relations between the critical wavelength and the cross-sectional dimensions of the guides for various modes are given in the table. The figures apply for air-filled guides. In practice it has been found that wave guides need not be straight, but may be bent into any desired shape, without any appreciable amount of energy being lost at bends in the guide. Bad joints between sections of the guide also do not seem to cause any great loss of energy.

Tube Section	Mode	Critical Wavelength
Circular (Diam. 2a) ..	E_0	2·61a
	E_1, H_0	1·64a
	H_1	3·41a
Square (Side a) ..	E_{11}, H_{11}	1·414a
	H_{01}*	2a
	E_{21}	0·894a

* Note that for this mode the guide may be of rectangular section as the critical wavelength depends only on the dimension of one side.

Wavelength Measurement

In the neighbourhood of 100 cms., wavelengths may be measured fairly accurately by measuring the standing waves on Lecher wires as is done at higher wavelengths. As the wavelength is decreased, the spacing between the rods or wires must also be decreased due to the increasing inductance of the shorting link. A better form of wavemeter consists of an odd number of quarter wavelengths of concentric line with the inner conductor adjustable in length by means of a micrometer lead screw, and the conductors shorted at one end. Resonance is indicated by means of a crystal detector (or diode) and microammeter coupled to the low impedance end of the line. The input to the wavemeter is also connected at this point. The distances between maxima as measured on the micrometer scale give half-wavelengths directly.

Wavemeters of this type may be employed down to wavelengths of the order of 10 cms. with fairly good accuracy provided that the diameter of the outer line is sufficiently reduced in order to avoid "false" maxima due to wave guide resonances in the line.

It will be remembered that in a wave guide operating near its critical wavelength, the wavelength measured in the guide may be much greater than the free space value. This property may be used to measure very short wavelengths with much greater accuracy than can be obtained using a concentric line wavemeter. The relation between λ_g, the wavelength in the guide, and the free space wavelength, may be be calculated from the field equations. A conversion chart for a circular section guide is shown in Fig. 20. As the critical wavelength is approached the wavelength measured in the guide (λ_g) may be several times the actual wavelength and hence a small variation in the wavelength to be measured will give a very much larger variation in the wavelength measured in the guide. The guide should be operated near its critical wavelength to obtain accurate measurements. It should be noted that it is important to know the type of mode being propagated in the wave guide, as different modes have different critical wavelengths.

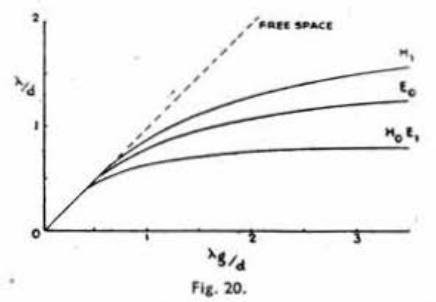

Fig. 20.

Relation between the free space wavelength and the wavelength measured in a guide of circular section.

In a practical set-up of this type, the resonance indicator again consists of a crystal detector and microammeter coupled to the guide. The end of the guide is closed by a movable piston driven by a micrometer lead screw. This piston is adjusted to give several maximum readings on the microammeter. The difference between successive micrometer readings then gives $\frac{1}{2}\lambda_g$. Knowing the diameter of the guide and the mode being propagated, the actual free-space wavelength may be obtained from the chart (Fig. 20). With a wavemeter of this type, good accuracy can be obtained at wavelengths below 1 cm. (30,000 Mc/s.).

(To be continued.)

News from the Kriegies

Information is to hand that Sig. J. B. Kay, **G3CO** and Sig. R. M. Garrett, **G3BP** have been transferred from Italy to Germany. In a communication dated July 30, A.C.1 "Snowy" Campbell, **VK3MR** reported the formation of a S.W.L. Club at PG. 52 Italy. VK3MR has been appointed organising Chairman and all parts of the Empire are represented.

Missing

We record with much regret that Tel. R. Frew, GM8FR has been reported missing, believed killed.

DIVERSITY RECEPTION *

By H. V. GRIFFITHS†

This article considers the various efforts which have been made to reduce the effect of short-wave fading by using more than one receiving-system and combining the signals received by two or more systems of receivers.

THE phenomenon known as "fading" of radio signals is not confined to the shorter wavelengths, but the frequency and severity of fading is greatest in the band between 300 metres and 12 metres (1·5 and 25 Mc/s.). It is in this band that communication is usually effected by means of indirect ray signals. There are two or more reasons for the fluctuations of signal voltage which are so commonly experienced in this band. The first reason is that slow changes are continually occurring in the medium through which such signals are propagated, particularly in the ionosphere in which the waves are refracted and from which they are returned to the earth's surface. These changes in absorption and refraction are comparatively slow and are, in most cases, less troublesome than the wave-interference effects produced by the interaction of waves which have taken different paths between transmitter and receiver; different paths in both the horizontal plane and, more particularly, in the vertical plane.

The fact that short-wave signals do not necessarily follow the great-circle path between transmitter and receiver is well demonstrated by short-wave direction-finding and by the phenomenon known as "scattering." What is perhaps more serious, in general reception, is that they do not follow the same path in the other plane: the waves may leave the transmitting aerial at various vertical angles and thus be differentially refracted in the F or E layers. As propagation conditions are usually such as to permit more than one refracted-ray reaching the receiving point, signals may arrive after having traversed any one of a number of paths, and the multiple signals thus received will have phase and amplitude relationships which are both variable. The total received voltage will thus be subject to changes from moment to moment. The most difficult problem of all arises when two main signals are momentarily in equal amplitudes and opposite phase, when the total voltage will momentarily be zero. As this effect will be selective in frequency, affecting carrier and sideband frequencies differentially, it is known as "selective fading."

The principal technical devices designed to reduce the effects of fading are: Automatic Gain Control, Directional Aerials, Diversity Reception, "Steered" Aerials in combination (the M.U.S.A. system) and Single-Sideband Transmission. Each one of these devices can be used to improve short-wave reception, singly or together. The last two mentioned are in use only by the largest undertakings concerned with commercial point-to-point transmissions. It is anticipated that single sideband working may be extended in the future as it is particularly effective in combating the problem of selective fading. In this paper, we shall confine our main consideration to Diversity Reception—used in conjunction with simple directional aerials and automatic volume control. Fig. 1 gives an example of the improvement which may be expected by this means, using only two receivers. The signal voltage scale in the diagram is a linear one.

"Diversity reception" may be defined as the separate reception and combination of two or more composite signals which have been subject to different mean-path conditions of propagation and may thus be expected to have differential fading. It is *not* a panacea for all the ills of short-wave signalling but has been proved to be a useful and comparatively simple improvement upon the basic single-receiver-and-aerial system. Although some of the examples given later may not appear to be as simple, as easy to erect or as low in cost as one might wish, a reduction of apparatus to a bare minimum may still retain the main virtue of the Diversity scheme and bring it within easy possibility, which a more elaborate scheme might defeat. The limits of simplification must be governed by the individual conditions to be met; apparatus described here will be within practical limits at a comparatively small receiving station of a commercial or public-service organisation.

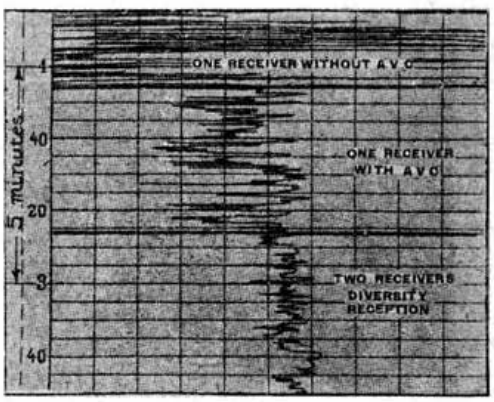

Fig. 1.

An example of the improvement which may be expected by using two receivers only, arranged for diversity reception.

The "Diversity" effect was first observed in the early 1920's, both here and in the U.S.A. Experiments, with which the Author had the pleasure of being associated, were commenced in England by the B.B.C. and the Marconi Company jointly, in 1927, at Terling, Essex. Similar experiments were undertaken by R.C.A. Communications Inc., at Riverhead, N.J. (1). Experiments by the American Telegraph and Telephone Co. were undertaken later in developing the M.U.S.A. system (2).

The British experiments first used "spaced aerials" which were separated 1¾ miles across the wavefront. These have been described in the "Marconi Review" (3) q.v., and in *Wireless World* (4). The large aerial spacing was found to give little advantage when compared with smaller spacing which is much simpler and less costly in land and in receiver interlinking. In this respect, it may be interesting to mention that the receivers used in the Marconi–B.B.C. experiments at Terling had pre-tuned R.F. stages at the remote aerial sites, where there was also the 1st Detector and 1st I.F. valves. The local oscillator and I.F. signals were "piped" forth and back about two miles in each direction, over open-wire lines. With reduced aerial spacing, this problem does

* *A lecture delivered to the Society by the author at the Institution of Electrical Engineers, London, on February 27, 1943.*

† *Engineer-in-Charge, B.B.C. Measurement and Receiving Station.*

not arise although, if it did so, the advent of screened low-loss high-frequency cables and of wideband R.F. Amplifiers, would make it less difficult to solve nowadays than it was in 1927.

There are several types of circuit arrangement capable of producing some form of Diversity effect and which can thus be used to reduce fading. The principal arrangements are generally known as Space Diversity, Frequency Diversity and Polarisation Diversity. It is proposed to consider these systems as well as Vertical-Angle Diversity, although as this is part of the M.U.S.A. system, reference should be made to the publications of the Bell System Laboratories for fuller details.

The question of cost should not be neglected. It will obviously be less important as the size and service importance of the receiving station increases. The economics of traffic and revenue will limit the most elaborate apparatus to the very largest commercial stations. This limit applies at present to the M.U.S.A. system, though it is in use in England by the Post Office, as well as in America.

Space Diversity.—The Spaced Aerial Diversity system takes account of the fact that the fading of the composite signal on aerials spaced by several wavelengths is not usually synchronous but normally occurs at random intervals without noticeable periodicity. Thus, although signals from two such aerials may sometimes fade simultaneously, they do not usually do so. Combining the outputs from these aerials will give a substantial reduction in the number of fades experienced. (Fig. 2.)

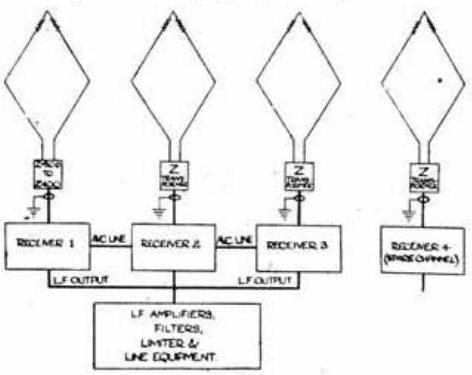

Fig. 2.
Space diversity reception.

To produce a fair degree, probably the maximum possible degree, of diversity of fading between any two aerials, it has been found that the spacing should not be less than four wavelengths and need not be greater than 10 wavelengths. If a band of frequencies has to be covered by the same aerials, it can best be done by making the spacing of the aerials four or five wavelengths at the lowest frequency end of the band, thus a ratio between upper and lower limits of frequency of at least $2\frac{1}{2}$ to 1 can be accommodated. At Terling, the spacing was 100λ at 20 metres wave, but as mentioned this large spacing showed no appreciable advantage compared with 10λ. The lay-out of aerials is not critical; with three aerials the most convenient arrangement is generally a triangle with one side across the wavefront, with four aerials a square is usual, with the station building located at its centre. Other arrangements, dictated by the lie of the available land, have proved quite satisfactory in England and in South Africa, in which places the Author has been in charge of the installation of Space Diversity equipment.

Frequency Diversity is not always a possible arrangement, as it depends upon the availability of more than one transmitter carrying the required signal on different frequencies, which must of necessity be in the same band or in adjacent bands in order to obtain similar propagation conditions overall. (Fig. 3.) Further difficulties may arise if the transmitters themselves are spaced, as the phase relationship of the modulation may be very different from the two

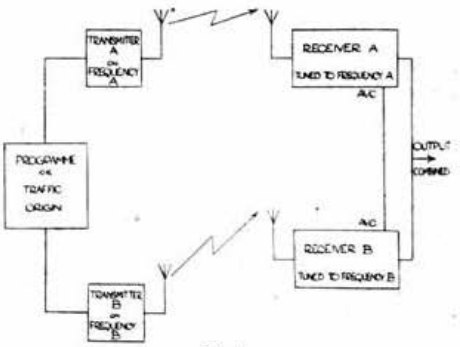

Fig. 3.
Frequency or transmitter diversity.

transmitters—it may, indeed, be so different that they cannot be combined without the use of L.F. delay networks at the receiving end, to compensate for the difference in line delay at the transmitting end. This difference will not, of course, arise if the two or more transmitters being received are installed at a common site but, even in this case, a simple phase reversing switch should be included in each receiver output, in order to compensate for accidental phase-reversal in the modulation circuits of one or other of the transmitters.

Polarisation Diversity.—This depends upon the presence of differential fading of waves arriving horizontally and vertically polarised. Changes in the polarisation of waves tend to take place during their passage through the ionosphere. The polarisation of waves on arrival at the receiving aerial by this cause may have a large horizontal component or may be so complex as to introduce circular polarisation. (Fig. 4.)

Sometimes, the degree of "diversity" obtainable by using two receivers connected to vertical and horizontal aerials respectively may not be pronounced and this simple diversity arrangement will not always be useful. There are, however, occasions when conditions are abnormal and there may be good differential fading on receivers so connected. Thus, if Space or other Diversity connections do not give good

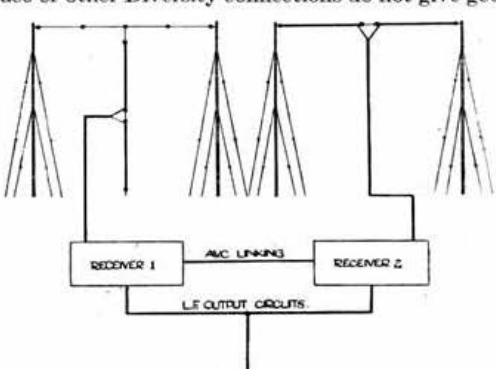

Fig. 4.
Simple polarisation diversity.

results on any occasion, the effect of using differently polarised aerials should be tried as a final resource. It can, obviously, be used in conjunction with Space Diversity, using—for example—two horizontal spaced aerials and one **adjacent** vertical aerial.

Horizontal and Vertical Angle Diversity.—Reflected-ray signals do not always take the most direct (great circle) path in the horizontal plane. Conditions sometimes arise when, for a considerable period of time, perhaps several hours, a stable signal—comparatively speaking—may arrive at the receiving point after having traversed a " skew " path, following refraction from a scatter-area well off the great-circle path. Some degree of scattering is very often present and, on infrequent occasions, the difference in angle between the great circle signal and the skew or scattered signal may be as much as 60°. Since propagation conditions and path-lengths will in these cases be largely different, we may expect a fair degree of differential fading and this could be realised and used for " Diversity Reception " by using aerials sharply directional in the horizontal plane with their directions of maximum reception adjusted to the separate angles of arrival of the different paths. (Fig. 5.)

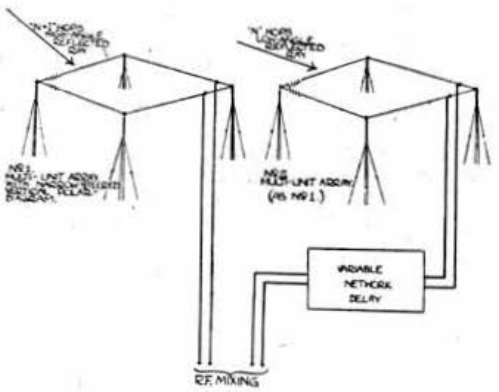

Fig. 5.

Simplified diagram of path or vertical-angle diversity.

Horizontally steered aerials have been used most successfully and, in particular cases, the skew signal obtained (using only one steered array) has given a good signal, whereas nothing was audible when the array was oriented on the great-circle bearing of the transmitter. An example of this has been published in U.S.A., whereby the best reception of a British signal was obtained by steering the receiving array so that it faced away from the direction of the British Isles, toward the South Atlantic !

The size and cost of steered arrays, with polar diagrams providing the required discrimination, limits the possibility of using this type of diversity reception apparatus to the very largest commercial receiving stations.

Diversity circuits based upon discrimination of vertical angle are similarly limited in their use, mainly by financial considerations. It is, nevertheless, interesting to consider their possibilities briefly, although the subject of the " Multiple Unit Steerable Antenna " system has been described fully in American publications of the I.R.E. and the Bell System, by engineers of the A.T. & T. Co. Let us take a simple example of what is involved in the consideration of vertical-angle " diversity," from a transmission originating from the U.S.A., received in England.

Confining ourselves to signals which have experienced two and three refractions in the " F " layer—two and three " hops "—we see that the two-hop signal will have a mean path length of approximately 3,416 miles during daylight and 3,456 miles during darkness, this difference being accounted for by the diurnal variation in layer-height. The corresponding lengths for the 3-hop signal will be about 3,504 and 3,576 miles respecitvely and the corresponding angles of the downcoming-rays will be, roughly, $7\frac{1}{4}°$ and $9\frac{1}{2}°$ for 2-hops and $15\frac{1}{2}°$ and 18° for three hops. With the daylight signal, there will be a difference in path length of approximately 88 miles. At night time, this difference will increase to about 120 miles and the 3-hop signal will thus be delayed by about 472 micro-seconds during daylight and 645 micro-seconds during darkness conditions, compared with the 2-hop signal arriving by the shorter path.

These two different paths, passing through different positions in the ionosphere, will experience unlike conditions of absorption, etc., and thus may be expected to fade differentially, so that two receiving chains could finally be combined in " Diversity." But, since the two sets of arrays designed and adjusted for the appropriate angles of downcoming ray will require to discriminate very sharply against reception at other vertical angles, the phase-relationship of the composite signal in either of the aerial output circuits will be a comparatively stable one—very much more stable than would be the case with a simple aerial system with a wide polar diagram in either plane. Thus signals from the two special arrays, corresponding with two and three hops, could be combined at *radio* frequency by the use of a suitable delay-network. The important point to remember is that, using simple aerials, radio-frequency combination is out of the question because of the unstable R.F. phase-relationship of the composite, multi-path derivation of the voltages from the separate aerials. With simple aerials or arrays, we must have recourse to *L.F.* combination when attempting diversity reception. The phase-relationship of the L.F. signals—speech modulation or tone-telegraphy—will vary over only small limits and, from two or more separate aerial and receiver systems will be closely similar. The human ear is tolerant toward small changes of phase, which may occur in the combined output from the receivers. Even these small changes may largely be prevented by avoiding the simplest method of linking the receivers in parallel so that, apart from perhaps infinitesimal periods of time, the " combined " output from the diversity system is actually contributed by one receiver alone. This can be achieved in various ways which will be discussed later. We may now consider in some detail what are the prime requirements of apparatus necessary to make best use of the method of diversity

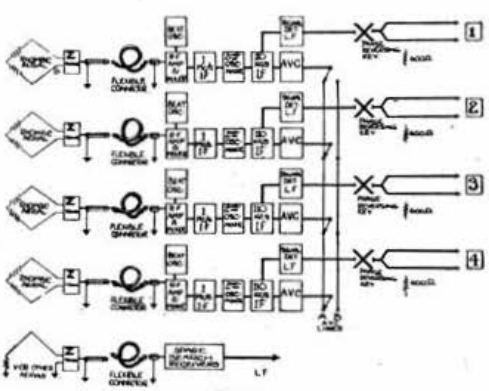

Fig. 6.

Simplified diagram of typical space diversity apparatus.

reception in moderately simple form, such as can be attained without the very complex aerial arrays used in the M.U.S.A. system.

Aerials. — At a receiving point, it is usually uneconomic to erect separate aerials for receiving signals on different frequencies. The receiver itself is generally able to cover a wide band of frequencies, the best frequency of reception from any particular part of the world will vary widely throughout the day and the number of aerials of the " resonant " type, required to obtain the proper coverage of wavelength and direction might be very large indeed, besides which the aerials would have to be duplicated or triplicated to obtain space-diversity effects. It is, therefore, almost essential to choose a type of directional aerial which is non-resonant and which can thus be used over the whole of the frequency band likely to be used. Aerials of this type can be designed to have a working range of more than three to one in the ratio of frequencies over which they will give a substantial improvement compared with the standard dipole, i.e. in " gain factor " and in directional characteristic.

Two such types of aerials are known as the " Bruce Rhombic " and the " R.C.A. Beverage." Experience with the former and with the simpler versions of it—all developed from the tilted wire aerial theory of E. Bruce and his co-workers (4)—has shown very satisfactory results. Such aerials are in constant use in England, India, South Africa and other places for diversity reception of broadcasting from overseas. The number of aerials required depends, naturally, on the number of different directions from which reception is expected. By taking account of the possibility of using the aerial with reversed connections of feeder and termination, thus obtaining reciprocal directional characteristics, the total number of separate aerials needed can sometimes be reduced considerably.

For diversity reception from one single direction, the minimum number of aerials required will obviously be two, each with similar directional properties. A worthwhile improvement in overall diversity can be obtained by adding a third. More than three aerials and receivers, tuned to any single transmitter, will not generally give sufficient improvement to justify the extra cost but there may be alternative transmitters carrying the required signal which will provide a useful stand-by in case of breakdown. For this reason, the typical " diversity unit " consists usually of four recivers or multiples of four. Four similar spaced aerials will thus be required for each direction of reception and the total requirements will be quite large in terms of numbers of aerials and the land needed for their accommodation, if reception is to take place at different times from transmitters with different great-circle bearings from the receiving point. Twelve or 14 aerials, some with reversible connections, with at least six or eight receivers, will be the average requirement for relaying broadcast programmes from overseas.

Feeders and Impedance Transformers.—To connect the aerials—some of them quite remote from the receiving building—to the receivers, some form of non-resonant feeder-line is required. Open wire lines have been used quite successfully for this purpose, but two-wire lines are difficult to balance and to maintain in perfect symmetry over long runs. Four wire lines, although easier to balance, generally require straining heavily, besides being mechanically tricky at bends or corners. The co-axial type of cable, which provides perfect screening, can be installed underground. As this cable requires the minimum of attention it is the best, although not necessarily the cheapest, solution of the feeder problem. Types of this cable, developed for carrier-telephony and for television distribution, have attenuation characteristics such that the loss at 20 Mc/s. does not exceed 12 db per 1,000 yards, which enables well-spaced aerial systems to be connected without the need for intervening " repeaters." Even the use of such repeaters would not be prohibited, if the size and spacing of aerials necessitated it. Losses of about 10 db in feeder circuits can be tolerated, because the signal and received-noise will be attenuated in equal proportions. Greater loss than this would probably justify the use of repeaters as, otherwise, the signal voltage at the receiver-input on the higher frequencies and with weak signals, would not be much greater than thermal-agitation voltages in the first circuits of the receiver and the overall signal-to-noise ratio would be degraded.

Having decided to use co-axial concentric feeder, an impedance-transforming network will have to be inserted between the balanced rhombic aerial—or the simpler but less effective inverted V aerial which is unbalanced to earth—and the feeder. Large rhombic aerials, designed for the 20 metres band and built with No. 14 S.W.G. wire, will present a terminal impedance of approximately 800 ohms, whilst the terminal impedance of the inverted V aerial will be about half this figure. The impedance of typical co-axial feeder is about 75 ohms. Impedance-transforming networks, the design of which is based upon band-pass filter theory, can be produced to match this 10 to 1 impedance ratio. In structures of the coupled-coil type, the " mutual " between the two windings mainly governs the band width of frequency over which the loss introduced by the impedance-transformer will be very small. The Author has employed two versions of this circuit, one using air-core coils with a coupling factor as low as 0·57, the other with dust-core coils with k = 0·85. In both cases, the insertion loss in the " pass band " does not exceed 2db. The advantage of this type of network is that it can be designed to have this low loss over a frequency range comparable with—or greater than—the frequency range over which non-resonant aerials, such as the rhombic, have a fairly constant gain-factor and front-to-back ratio. Thus, one part of the system is not spoiled by the other.

Both the aerial and the impedance-transformer can be easily designed to have an effective band width of more than 3 to 1 in frequency—say, from 16 to 50 metres or 19 to 6 Megacyles/sec—and there will be very little falling-off in performance at 21 Megacycles/sec. Allowing for feeder loss, this aerial system shows an overall gain factor, assessed in terms of the improvement in signal-to-noise ratio compared with the standard dipole, of between 16 db and 12 db. The average front-to-back ratio as checked by simple comparisons of interference levels between the rhombic and a non-directional aerial, appear to be of the order of 20 db at least.

To enable rapid inter-connections between various receivers and the required directional aerials, it is convenient to terminate the aerials, *via* their co-axial feeders, on one panel of a relay-rack mounting. Short feeders connecting to the receivers are then terminated upon a panel immediately below. Using plugs and sockets and screened flexible connectors, the input circuits of the receivers can quickly be linked with whatever aerial system is required, depending upon the direction of the transmitter. It is also convenient, particularly when aerials are remote and not easily seen from the receiver building, to arrange that the basic impedance transformer circuit is modified to permit sending direct-current through the feeder and transformer, through one limb of the aerial, the termination resistances and back by the other limb, returning *via* the outer conductor of the feeder and

earth. A suspected fault in aerial or termination can rapidly be verified by this means.

The Receiver.—There is only one primary specification about receivers which are to be used for diversity reception of telephony signals. There must be some provision whereby the A.G.C. circuits, normally separated in individual receivers, are so combined that the A.G.C. voltage fed to the appropriate stages of the receivers is common to each chain. This can be arranged, if considered necessary, by designing the diversity receivers to have an A.V.C. circuit which is common to all the receivers. But this is often inconvenient, as it specifies that the receivers —three or four of them—must always be used together. For this reason, it is usually preferable to employ separate A.V.C. circuits for each diversity-chain, arranging that they may be linked together at will in any arrangement so that three or four receivers may all be linked together or they may be linked in two pairs separately or with three linked and one separate. (Fig. 6.)

The method of linking A.G.C.s may be the simple one whereby the output circuits of the A.G.C.s from each unit can be connected at will to either one of two bus-bars. There are more complex ways of effecting this linkage, through intermediate valve circuits. But, however it be done, it is an essential requirement that it *shall* be done, otherwise the internally-produced noise from the receiver momentarily carrying a weak signal will appear on the combined output, even if another of the receivers has, at that moment, a strong signal and a corresponding low noise-ratio because the A.G.C. of that receiver is in full operation. Thus, absence of A.G.C. linking would cause a higher value of noise to be contributed to the combined-output, even though the diversity-system had effected an improvement in freedom from fading.

In the simplest and most easily-tuned arrangement for diversity reception, it is possible to use a single beat-oscillator, feeding the mixer valve of each receiver in the diversity chain. Another advantage of this arrangement is the obvious freedom from the possibility of any trouble caused by the interaction of *different* intermediate-frequencies, such as might happen if the individual I.F. amplifiers were poorly screened or insufficiently decoupled. There is, however, one disadvantage of this otherwise economical scheme of using a single beat-oscillator, and that is that the two, three or more receivers must always be used as one unit, tuned to one frequency. They can never be used as individual, separate receivers, tuned to different frequencies and are in this way of more limited use. There may, however, be circumstances where the economical arrangement is justified, on account of a limited requirement, invariably calling for space-diversity. Then, the simplicity of tuning will be a most valuable asset.

A compromise could be made, by some form of switching, each receiver being a separate unit with its own beat-oscillator, switched out when the common-oscillator circuit is required. This compromise is not easy to arrange and itself has the drawback that the I.F. amplifiers must necessarily be each tuned to the same frequency. Whereas, it is often convenient, to avoid any possibility of mutual interference between them, to stagger the frequencies of the I.F. amplifiers, so that each differs by, say, 25 kc /s. from its neighbour.

It is not necessary to consider here the question of design of short-wave receivers. Much can be—and already has been—written on this subject. Whether one chooses a high intermediate-frequency or a low one, or whether one chooses both and changes frequency twice; whether one or two R.F. stages be used; these and many other interesting questions have been asked by all engaged in short-wave reception and have their pros and cons. Receivers of modern design may well have two R.F. stages, the circuits of which are ganged but are provided with front-of-panel trimmer controls to ensure maximum efficiency. The first beat-oscillator is separately tuned and fed to the triode-hexode frequency-changer *via* a buffer-valve. There is also a meter-valve for setting up the correct voltage from the oscillator into the mixer valve, the output of the beat oscillator being adjustable to obtain the correct transfer voltage, normally about 10–11 volts.

The first intermediate frequency of approximately 1,000 kc /s. is followed by a second frequency-changer and second I.F. amplifier at approximately 110 kc /s. which has band-pass filter characteristics and provides about 80 db attenuation of unwanted signals 10 kc /s. off the midband frequency. There is a diode detector in the signal circuit. The separate A.G.C. detector and D.C. amplifier applies the A.G.C. voltage to the first and second I.F. amplifiers and to the linking switches. Delayed A.G.C. can be applied to the R.F. stages but these are normally operated at full gain to obtain maximum signal-to-noise ratio, a manual R.F. gain control being provided in case the signal input should be strong enough to cause overloading.

It will often be quite satisfactory to arrange that the L.F. outputs are, like the A.G.C. voltages, paralleled quite simply to one or other of two " bus-bars " or output lines. This combination of L.F. outputs and of A.G.C.s can even be affected on a single multi-contact key, although it is better to use two keys because it will often be interesting and useful to common the A.G.C.'s without paralleling the outputs, in order to check the diversity-adjustments. The more pretentious bridge-circuits shown in the drawing, Fig. 7—which has been simplified to exclude warning-lamp circuits, for the sake of clearness—are used only to avoid the output impedance of the combined diversity system or systems being dependent upon the number of receivers linked together. With the circuit shown, the impedance remains 600 ohms whatever the combination of receivers used.

The use of the phase-reversing key will be appreciated if it is remembered that " Frequency " or " Transmitter " Diversity may be in use and that the two distant transmitters may have their modulation components in opposite phase-relationship. In this connection, the provision of a variable delay-network in the output of one receiver would be justified if, as may happen in broadcasting, two transmitters with different delays on their programme lines, but carrying the same programme, are required to be momentarily or otherwise mixed. Without this

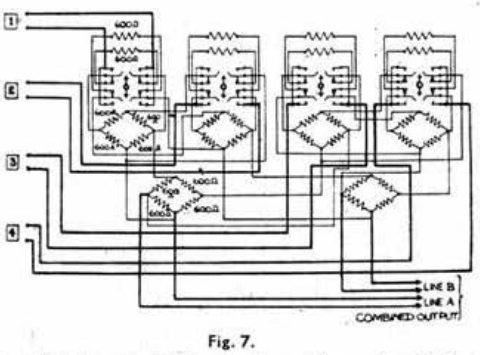

Fig. 7.

Simplified diagram of bridge circuits used for receiver linking.

provision at the receiving end, there would be an objectionable echo produced on the combined output.

Operational Details

Before concluding, it may be interesting to consider some of the operational details of diversity reception. There will first be the tuning of two receivers, having made connection to the required directional aerials. This tuning operation will not usually be hurried and will include a final trimming of R.F. circuits—best done by momentarily disconnecting the flexible plug connectors on the Aerial Selector panel and tuning on first circuit noise-maximum, to avoid the difficulty of exact tuning of fading signals. For this operation, A.G.C. will be " off " and the receiver gain manually controlled.

Next, the operator must decide whether there is effective " diversity " between the two signals and whether the arrangement used shall permit each receiver to make a fair proportion of the total time-contribution in the combined output, or whether it will be possible to let one receiver do most of the work and call on the others only to contribute during deep fades. This is the preferred arrangement as it entails only short, infrequent periods of mixing.

The third receiver may now be lined up, watched for a few moments and linked in with the others. But, before this, the manual control of maximum overall gain, at minimum A.G.C. voltage, must have been set on each receiver to be such that, if a complete signal-dropout occurs on all receivers, the receiver noise in the combined output does not rise to an audio level greater than, say, 20 db *lower* than the peak output level of the L.F. signal. This adjustment will prevent the most objectionable form of " fading hiss " on the output signal.

There are several other useful devices which can be used. A " limiter " is one of them and its virtue is obvious in suppressing those occasional bursts of excessive L.F. signal which occur during moments of selective fading.

Some automatic control of L.F. gain, operated in conjunction with the normal A.G.C. circuits, will assist greatly in confining the period of time of " mixing " of receiver outputs to a few milliseconds only. The ideal of reception is to have the output contributed by only one receiver at any moment of time, the other receivers being " cut off " until there is a fade on this first receiver and then one of the others must " take over." Normal A.G.C. circuits, with a linear second detector in the signal chain, will not provide sufficient " cut-off," *i.e.*, the idle receivers with reduced gain will still contribute an appreciable signal to the combined output. Some improvement can be obtained by using a square law 2nd detector to exaggerate the drop in output level with rising A.G.C. volts. There will be other objections to this—although not for exclusively telegraphic reception. The provision of " A.V.C." on the L.F. outputs of the separate receivers, before combination, is one method of attacking this difficulty.

A modification of the same basic idea, to avoid a mixed L.F. signal, can be visualised in the form of a differential bridge circuit similar to that used in V.O.D.A.S. (echo-suppressor) technique.

Finally, it may be of interest to mention briefly other directions in which there is considerable promise of better reception. In conjunction with other workers, the problem of " selective fading " has been investigated and promising results were obtained by providing a locally supplied carrier from a steered oscillator. But the difficulties of phasing and synchronisation are very great when dealing with normal sidebands-and-carrier types of input signal at the receiver. These difficulties are reduced to simpler proportions if the transmission is effected by " single sideband and pilot carrier " (6). For long distance high quality short-wave reception, in conjunction with " Diversity " or " M.U.S.A." at central receiving stations, this type of transmission will largely be able to overcome the bugbear of fading, when it comes into more general use.

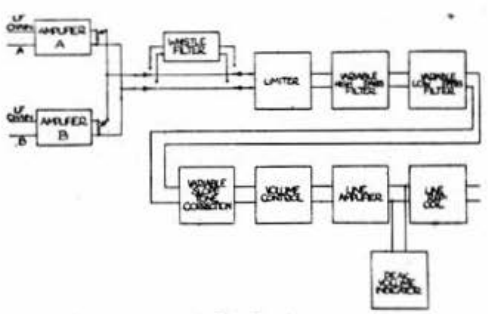

Fig. 8.

Block diagram of typical L.F. circuits used for radio telephony diversity reception.

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The Long Arm

BRS5909 in a letter to GM6ZV enclosed a QSL card—nothing remarkable in that you say—but behind this lies a story of coincidence. BRS5909 found the card—that of FT4AF—in the ruins of a bombed house at Sfax. FT4AF is a YL and we hope she is safe and well, despite the destruction of her home.

Congrats

● To Cfn. P. E. Murphy, R.E.M.E., **BRS6640,** of Roehampton, who has been notified that at the City and Guilds Institute examinations held in May he obtained 1st Class passes in Radio Communication, Grades I and II, and in Radio Servicing, Parts I and II.

● To C.S.M. C. A. Bradbury, **BRS1066,** who was married to Miss Florence M. Moscrop on Saturday, September 25, 1943.

● To Mr. and Mrs. N. A. Richardson, **G5HJ** of Bletchley on the arrival of a daughter.

KHAKI AND BLUE

● Latest news from The Rock is given by Sgm. Moseley, **2CIW,** of Grays, Essex, who reports visiting G2KQ and GM3TD in company with 4046. Not until the August BULL. arrived did he discover that P./O. Viney, whom he had met in the course of his duties, was G2VD.

● L.A.C. R. F. H. Nicholson, **2DOH,** seeks news of pre-war members of the Medway Amateur Transmitters Society. In particular he would like to hear from G5FN, 2AFT and 2BOL. His address is 35 Wireless Unit, R.A.F., M.E.F.

● In an airgraph letter from Ceylon, A.C.1 Ryley (S.E.C.E.) reports that Sgt. Richardson has now left the island. His attempts to organise meetings have not proved successful due to postings. In connection with the recent BULLETIN questionnaire he writes: " The District notes feature is the first one I look at. It keeps us in touch with home."

● Cfn. Evans, operator of **GW8WJ,** reports that meetings of the newly-formed Tripoli Amateur Radio Society are held at 17.00 hours each Sunday. The following have attended recent meetings: G4BB, 5ZA, 2DHV, 2FVK and 4023. Lt. Tann, R.E.M.E. has been elected President, Sgt. Barnes is Secretary, with 2DHV, 2FVK and two others forming the Committee.

● Sgt. Douglas McDonald, **4877,** who is with 114 Squadron, R.A.F., sends greetings to Cpl. George Parker, R.A.F. and other old friends. He has met no members since arriving at his present destination.

● Scottish friends of D. M. Harrower, **GM6NX,** will be interested to hear that he has been granted a commission as P./O. in Tech. Sigs. R.A.F. (Radar Air). He reports having spent a very enjoyable leave as the guest of Mr. J. S. Nicholson, VU2JP, of B.E.R.U. Contest fame. The contact was made through the good offices of two Sergeant W./Ops. billeted with " Nic " who told him that an amateur was at their station.

● One o. our new members, Cfn. Beaven, with the R.E.M.E. in B.N.A.F., recently borrowed a collection of technical books (including back issues of THE BULLETIN) from an American Staff Sergeant. Before he had time to return them, his unit was moved to another part of the front, and it was not until some time had elapsed that he found in one of the pages of a magazine an R.S.G.B. membership certificate issued last year to his American friend—Staff Sergeant Harry Klingener, W2GXC. The certificate has now been returned to its rightful owner.

● J. D. Gillies, **2FZT** has had a varied war experience. In 1940 he was in the Army as a " D.R." Tiffy on " ack ack " duties connected with R.D.F. Later he joined the M.N., only to be torpedoed shortly afterwards, whilst 200 miles from Brest. He has been ashore for the past six months, but as the call of the sea is in his bones he is trying to join the R.N.R. Rescue tug service.

● Writing from Algiers under date of August 21, Radio Officer G. A. Raeburn, **GM2KP,** reports meeting G3WZ and W5HQH. He wishes to be remembered to G3WZ, 6GQ, GM6ZV and 2FZT, and all old GM friends. Like other members serving abroad he appreciates reading District Notes but prefers theoretical rather than constructional articles. He is anxious to join the Micro-wave Group.

● Yet another member of the M.N. comes along with news, this time, 1st Radio Officer H. F. Burtoft, **G8LO.** He has been in the Service for three years, serving first as a Junior R.O. and then, on passing for a peace-time commercial ticket, as 1st R.O. which position he has held for two years .He has been in action against the enemy 12 times, but except on one occasion the luck has been with his particular ship. He is at present on a Norwegian vessel with all-bands transmitters running at 1 kW. Some months ago he met SU1AX, 1RD, 1SG, 2DTQ, G3GU and GI3VQ (the latter also M.N.). G8LO wishes to be remembered to G2XC, 3WZ, 4FA, 6NZ, 8BD, 8WC and to all friends in South Hants and Alexandria. He mentions that Ray Baldwin, **G3WZ** is a 1st R.O. and that he has been torpedoed at least twice. And they call these lads civvies!

● A spate of airgraphs and airmails have been received recently from members serving abroad. L.A.C. Desmond Alimundo, **G4HK,** R.A.F. Indian Command, reports meeting G2UQ of Whittlesey; Ldg. R./Mech. W. H. Hodgson, **G3BW,** Naval Base, Kilindini, Mombasa, has met VS1AO of Cables and Wireless; Cpl. Montague, **2ANR** R.A.F., Malta, sends greetings to S./Ldr. Jack Sutton, GW2NG and inquires whether the " Monopoly " set has proved useful to him in his travels; P./O. Peter Spary, **2FVU,** Telecoms Centre, R.A.F., M.E., has been in hospital recovering from typhoid. He writes " How sweet is the cathode follower after weeks of thermometers and bedpans!" F./Lt. Howard Brabrook, **G5ZG** R.A.F., C.M.F., gives his views regarding the " make up " of the BULLETIN. He thinks " K. and B." should be enlarged, an opinion shared by many Service members.

● S./Ldr. John Curnow, **G6CW** writing from Advanced Desert Air Force, Central Mediterranean Forces during August, reports having taken part in the Eighth Army's advance from Egypt to Tunisia and in the invasion of Sicily. During his travels he ran across an Italian prisoner of war who was identified as an amateur by means of the " diamond " he was wearing on his tunic! John would like to hear from Dave Price Jones, G5SA and Ernie Dedman, G2NH.

Our President and Secretary again visit No. 1 Radio School

The special R.S.G.B. meeting held on Sunday, September 12, in the Radio Block Cinema, East Camp, was marked by the presence of Mr. A. D. Gay, G6NF, and F./O. John Clarricoats, G6CL, President and General Secretary respectively.

S./Ldr. Newnham, G6NZ, after opening the meeting invited Mr. Gay to take the Chair. In a much appreciated address G6NF gave an account of the development of amateur radio and spoke of the wonderful opportunities which the R.A.F. offers to young men. He also expressed his keen interest in the work of the young apprentices who are members of the R.A.F. Amateur Radio Society. During the course of an address lasting for nearly an hour the General Secretary referred to the various activities of the Society. He thanked S./Ldr. Hibbins, BRS3887, and the organisers of the meeting for the hospitality extended to him during his visit to the school.

S./Ldr. Hibbins in reply emphasised that many new tasks will confront the post-war radio amateur. He expressed the hope that the Society would take full advantage of war-time radio developments and that close attention would be paid to micro-wave technique and Television.

Mr. Gay voiced his thanks to all who had co-operated in making the meeting possible, and mentioned in particular Cpl. H. S. Chadwick, G8ON, who has for several years assumed responsibility for arranging R.S.G.B. functions at the School.

Present at the meeting, which was supported by more than 100 members and friends, were Mr. Arthur Simons, G5BD (Representative for District 17) and F./O. Frank Robb, GI6TK, of Belfast. A fountain pen and pipe kindly donated by G5BD were offered as prizes for a raffle which produced £4 6s. for the R.S.G.B. Prisoners of War Fund.

Earlier in the week GI6TK and G6CL attended a meeting of the R.S.G.B. Section, to hear a discourse by the Hon. Secretary of the Manchester Inter-planetary Society on " Space Ships."

(It is regretted that pressure on our limited space prevents a more detailed account being published of recent Cranwell activities. We would, however, urge all newcomers to the school to get in touch on arrival with Cpl. Chadwick, at the Corporals Club, East Camp.—ED.)

Calling Old Timers

S./Ldr. A. Hibbins, **BRS3887** who is forming an exhibition of early R.F.C. and R.A.F. radio equipment, is in urgent need of a Mark III or Mark III Star Tuner, a Wilson Transmitter and a TWAII and TWAIII transmitter-receiver combination as used in France during 1918. Can any member loan or donate one or more of these items? Offers should be made via headquarters.

Recording over Berlin

Listeners to the B.B.C. Home and Overseas news services were recently thrilled to hear records made in a bomber during an R.A.F. raid over Berlin. The commentator was Vaughan Thomas and the recording engineer Reg Pidsley, G6PI, of Potters Bar, Herts, and a well-known member of District 12.

A standard set of B.B.C. mobile disc recording equipment was installed in the plane especially for the trip. This gear made it possible to record from any one, or from a mixture, of three channels; the " inter-comm," the commentator or " effects."

G6PI had an exciting few moments over the target when the dropping of the four thousand pounds bomb tore a large piece out of the disc!

He was glad to have the assistance of Flying Officer Clark, 2BIB in installing the gear whilst the success of the recordings is a magnificent tribute to the skill and efficiency of the crew.

The photograph, shows Vaughan Thomas and Reg Pidsley in front of the Lancaster which made the trip. RX.

BRITISH ISLES NOTES AND NEWS

DISTRICT 2 (North Eastern)

D.R.: C. A. Sharp (G6KU), 316, Poplar Grove, Gt. Horton, Bradford. Bfd. 10772. Scribe: H. Beadle (G8UO), 13, Chandos St., Keighley.

2BMC is pleased to see Huddersfield coming to the fore and says that interest seems greater than in pre-war days. 6PL has obtained an Eddystone 4-valve receiver and finds it very satisfactory. 3KF is welcomed to membership. 3KB who reports fit and well from the M.E. has contacted SU1AX; the latter hopes to arrange monthly meetings in Alexandria. 3XX has constructed two bug keys from information given in THE BULL. His eldest son is a Sgt. W./Mech., with the R.A.F. in India. 4CL reports that only one member attended the meeting at his home on September 1. 4976 is kept busy writing to Service members who have visited his home and who are now overseas. 5VD held a meeting at his house on August 28, when the following were present: BRS2481, 6268 and 2HIK (all R.Sigs.), 3CD, 8VF, 2DUX and 6225. The next meeting, at 12 Langley Terrace, Oakes, Huddersfield, will be held on Saturday, October 23, from 7 p.m. onwards. Some of the letter budgets seem to be held up, keep them moving please. G6PJ (R.A.F.) writing from India reports fit and well and sends 73 to all who knew him. He would like to hear from local members. Address from 2LT. G8UO.

DISTRICT 3 (West Midlands)

D.R.: V. Desmond (G5VM), The Chestnuts, Gilbert's End, Worcs. Scribe: E. J. Wilson (2FDR), 48 Westbourne Road, Olton, Birmingham.

Birmingham.—The annual general meeting of M.A.R.S. was held on Sunday, September 12, at the "Hope and Anchor" Hotel, when the following officers were elected:—President: C. Naylor-Strong, F.R.C.S.; Secretary: E. J. Wilson; Treasurer: B. George; Committee: Messrs. Follis, Vincent, Young, George, Watson, Kirlew, and Shaler. Mr. George Brown, G5BJ, was awarded the Naylor-Strong Cup for the best lecture of the year. The next meeting will be held on November 14. 2FDR.

DISTRICT 4 (East Midlands)

Deputy D.R.: A. E. Clipstone (G8DZ), 14 Epperstone Road, West Bridgford, Notts.

Derby.—G2OU reports visits from 2CUL and 8SI, both of whom are building multi-range meters. 2OU has just finished a signal generator and has started a push-pull audio amplifier.

Leicester.—A meeting was held at 6VD on September 26, for the purpose of electing a T.R. Sgt. K. G. Chapman, BRS5605, was elected by the unconventional method of drawing a name from the hat. It is hoped that local members will give him full support.

G2XD brought along an oscillator of unusual design. This excellent piece of gear has great possibilities and we hope to see and hear more of it in the near future. Mr. Bruce is considering an article for THE BULLETIN.

The next meeting will be at the new T.R.'s home, 292 Gwendolen Road, Leicester, on October 24, at 2.30 p.m. A junk sale will be held. *Via* G6VD.

Nottingham.—Radio Quiz No. 2 was very well received and quite a lot of useful information was revealed. A team comprising 3DG, 2AOO, 5406, 6414 and 6748 beat 5639, 6053, 6574 and 6781 by 6 points in 10. 6748 is well on the way with his new 'scope which shows signs of being a fine piece of test gear. 2AOO is completing a new audio amplifier and has also designed a multi-range test meter. 6053 is still having negative feed-back troubles and seems stuck with his B.F.O. 5383 is to be married on October 23; we wish him much happiness. 3BV is in the R.A. somewhere in the Middle East and is fit and doing well. The next meeting and Radio Quiz will be held on October 24 at 14 Epperstone Road, West Bridgford, at 6.30 p.m. G8DZ would like to hear from those members who could attend a Dinner or Supper on the Sunday before Christmas. G8DZ.

DISTRICT 5 (Western)

D.R.: R. A. Bartlett (G6RB), 31 King's Drive, Bishopston, Bristol. Bristol 46960.

Bristol.—The usual monthly meeting was held in September but the attendance was again small. We were, however, very pleased to welcome 2BDA of Bolton and also G5KT home on leave.

Swindon.—A further letter is to hand from 3JO who is now stationed near Wem, Shropshire. He hears occasionally from 3HS who is also in the R.A.F.

The D.R. was pleased to receive an airgraph from 3849 serving with the Navy. He has visited Capetown and Alexandria and is now in a rest camp at Malta. He was recently operator on a U.S. liberty ship, the other operator being W1KXL. G6RB.

DISTRICT 6 (South Western)

D.R: W. B. Sydenham, B.Sc. (G5SY), Sherrington, Cleveland Road, Torquay. Torquay 2097.

As news has been very scarce for the last few months, the D.R. has followed his usual policy of not wasting valuable BULLETIN space by inserting useless padding. Nevertheless, will members still living in the District please remember that the D.R. is still here, ready and willing to report on anything of interest and value?

We learn with regret that our old friend Harold Webber, G5YR, of Tiverton, is lying seriously ill in the Royal Masonic Hospital, London. We feel sure that all members will join us in expressing the hope that he will soon be restored to full health.

North Devon.—In a recent airgraph to the T.R., G3AM states that his term of overseas service will terminate soon, he expects to be home some time during the coming winter. (Thank you very much G3BO for the report. You are most helpful in trying to keep things going.—D.R.) G5SY.

DISTRICT 7 (Southern)

D.R.: W. E. Russell (G5WP), Milestones, Mayford, Woking, Surrey. Woking 1589.

Bournemouth.—Welcome to Mr. Herbert, G2KU, who has come to live in the town. 2NS has acquired an Eddystone One-Ten receiver. 4MY spent a recent holiday in London. As 2HNO will be in London for the next few months 2NS has agreed to look after the Bournemouth contribution to these notes.
(*Via* 2HNO.)

Croydon.—G2RD who has been on leave reports that his oscilloscope is completed and working nicely. 5XH has met many fellow amateurs in his travels. He wishes to be remembered to all old friends.

See "Forthcoming Events" for the date, time and details of the next meeting. (*Via* G2DP.)

Coulsdon.—4458 has taken up a civilian radio course in preparation for post-war activities. A welcome is extended to 2AXG and 6666, both new members. (*Via* 3003.)

Reading.—Are there any members left in Reading who would have the time to attend and run meetings in the town? At long intervals letters arrive complaining of lack of activity. Please write the D.R. who will circulate a list of those answering this appeal. G5WP.

DISTRICT 8 (Home Counties)

Deputy D.R.: L. W. Jones (G5JO), 16 Leys Road, Cambridge. Cambridge 3406.

Owing to the fact that only four members intimated they would be attending the meeting fixed for Saturday, September 25 at the Milton Arms Hotel, Cambridge, this had to be cancelled. It is not possible to hold meetings for such a small number. If any enthusiasm is shown for a meeting at a later date efforts will be made to organise one.

An interesting letter has been received from 5274 who is serving with the R.A.F. in Sicily. Sgt. J. Edwards has also written, he seems to be seeing the world as he mentions visiting a number of places; at the time of writing he was in the Bahamas. He sends best wishes to all at 2SS and asks to be remembered to Cpl. Turner. L.A.C. Bampfield, 6819, has also written. G5JO.

DISTRICT 9 (East Anglia)

D.R.: H. W. Sadler (G2XS), The Warren Farm, South Wootton, Kings Lynn, Norfolk. Castle Rising 233.

G8DD now residing in District 4 seeks the present address of G5QO. 2MN states that 2UX is now in the district working with 8JO.

Reports are still scarce; what about it local members? Are we to write R.I.P. to these notes when so many of our friends abroad look here for items of home news. G2XS.

DISTRICT 10 (South Wales & Monmouthshire)

Deputy D.R.: H. H. Phillips (GW4KQ), 82 Cottrell Road, Roath Park, Cardiff. Cardiff 2697 during business hours.

A recent airmail letter from India brings news of 4467 (Port Talbot); latest advices report 5BI in the same area and 5VX in the M.E. A cordial welcome is extended to 6JL upon rejoining and to 6626, 6720 on their election.

Cardiff.—Amongst those who attended the August meeting were G2UH, 4KQ, 8UH, 4476, 5753 and Mr. Pugh. Pre-war field-day activities were discussed. 8UH intends demonstrating a suggested receiver for post-war use at the meeting to be held at 3 p.m. on November 7 at 29 Ladysmith Road—off Penylan Hill—Roath Park, Cardiff. GW4KQ recently met 2FP who is stationed in the area.

Newport.—G2JL asks that his 73 be conveyed to all friends in the District. Ron Owen (5643) has had to relinquish his recent appointment as T.R. for Newport upon joining the R.A.F. No support is yet forthcoming for the proposed meetings in this town. GW4KQ.

DISTRICT 11 (North Wales)

Deputy D.R.: C. Spillane (BRS1060), "Woodside," Meliden Road, Prestatyn.

Owing to no report of the September meeting having been received details of the next meeting are lacking. Any member who wishes to know the arrangements should write to BRS2731, "Wayside," Middlewood Road, Poynton, Cheshire.

Congrats. to James Starkey, GW6KY, on his promotion to Sq./Leader. L./Cpl. Aldrich, writing from the M.E., reports that he is building some new receivers. He sends 73 to local members.

GW4CK has met a number of amateurs at his station in

Wiltshire, including W8SCW, G5JD and G4DR. BRS5770, Coventry, in a recent air mail reports having arrived in India after a trip via South Africa.

DISTRICT 12 (London North and Herts)

D.R.: S. Buckingham (G5QF), 41 Brunswick Park Road, New Southgate, N.11. Enterprise 3112.

At our September meeting held at " The Cock," Cockfosters, we were pleased to welcome Lieut. Cassey, ZL2IQ and Reg Pidsley, G6PI, " hot " from his trip over Berlin with the B.B.C. recording gear. Difficulty is being experienced in finding a suitable meeting place where the ladies can attend and where tea can be provided on a Sunday. Any member who can help is asked to write or telephone the D.R. The location should be within easy reach of the Piccadilly Line in order to facilitate travel.

The next meeting will be held at the home of Capt. A. Phillips, 390 Camden Road, London, N.7 (opposite Holloway gaol !) at 3 p.m. on Sunday, October 24. G5QF.

Forthcoming Events

Oct. 23	District 15, 3 p.m., at The Excelsior Hotel, 1 Ladbroke Gardens, Ladbroke Grove, Notting Hill, W.11. (Buses 7, 15 and 32, or Met. Railway.)
,, 24	District 7 (Croydon Section), Sale of Apparatus, 3 p.m., at 6 Dunheved Close, Thornton Heath.
,, 24	District 4 (Nottingham Section), 6.30 p.m., at 14 Epperstone Road, West Bridgford.
,, 24	District 12, 3 p.m., at BRS4486, 390 Camden Road, Holloway, N.7 (opposite Holloway Gaol).
,, 24	District 14 (Chingford Section), 3 p.m., at BRS6599, 8 Valance Avenue, N. Chingford. (Bus 145.)
,, 30	London Meeting, 2.30 p.m., at I.E.E. " Radio and its Relationship to Kindred Sciences." By W. A. Scarr, M.A., G2WS.
,, 31	District 5, 3 p.m., at 17 Colston Avenue, Centre, Bristol.
,, 31	District 15 (Aylesbury Section), 6.30 p.m., at " The Bulls Head," Aylesbury. (A p.c. to 8BW, 165 Park Street, if attending.)
,, 31	Scotland " A " District, 3 p.m., at Royal Technical College, George Street, Glasgow. (Enter by Montrose Street.)
Nov. 7	Districts 7 and 13. Combined Meeting, 3 p.m., at the Y.M.C.A., North End, West Croydon.
,, 7	District 10, 3 p.m., at GW8UH, 29 Ladysmith Road, off Penylan Hill, Roath Park, Cardiff. (No. 4A or B tram from Town Centre.)
,, 14	Scotland " C " District. 2.30 p.m., at 7 Airlie Place, Dundee. Lecturette, " L.F.A.C. Theory," by T. Reay.
Dec. 12	Scotland " C " District, 2.30 p.m., at 7 Airlie Place, Dundee. Lecturette, " Electrical Chemistry," by R. P. McConway.

DISTRICT 13 (London South)

South Eastern and Central, S. E. Langley (G3ST), 62 Dumbarton Road, S.W.2.

South Eastern and Central.—The September meeting was attended by G2DP, 2HP, 2VB, 3DF, 3RU, 3ST, 8TN, 2FWA, 2HMV, BRS, 1545, 3003, 3868, 4324, 4814, 5545, 6064, 6426, 6446. We were particularly pleased to see 8TN again after such a long time.

Another air mail letter has arrived from L.A.C. Glass, M.E.F., who reports that 3HG is well, but slightly haywire, as the sight of green grass after two years of sand has caused his heart to ache for a real London fog ! He states there may be another Cairo meeting about the middle of November. G2GZ writes to say that he is about to attend a special course as Signal Instructor.

It has recently come to the knowledge of 3ST how valuable the Red Cross and P.O.W. Funds can be to prisoners of war, so please give generously and be thankful that you are on the business side of the barbed wire. G3ST.

DISTRICT 14 (Eastern)

Scribe: L. J. Fuller (G6LB), 167 Galleywood Road, Chelmsford, Essex. Telephone: Chelmsford 3929.

Chelmsford.—Eight members were present at the September meeting when a discussion on the BULLETIN left no doubt as to the popularity of District Notes. It was thought that much of the " Khaki and Blue " column could be transferred to this section thus avoiding considerable overlapping. The lists of new members were thought to be unnecessary, providing D.R.'s and T.R.'s could be advised of new elections to their areas. This could be done quarterly *via* the D.R.'s or their deputies.

Chingford.—The bright spot of the District. An excellent attendance for war-time, of eleven was recorded at the September meeting held at G8DG when 2ABC demonstrated his home-made bug key. Congrats. to 6303 on obtaining a City and Guilds Radio Communication Grade 1. G8DG has had an airgraph from 6365, who is training with the R.A.F. in Ontario. He bemoans the fact that the Service kit-bag is not large enough to hold an RME70 and other amateur gear easily obtainable " over there." He also says that during several trips to the States, the W's gave him a grand time.

All District 14 members and others stationed in the area are asked to look out for an announcement in the November BULLETIN regarding a Sunday meeting which it is proposed to hold in the Romford area. G6LB.

DISTRICT 15 (London West, Middlesex and Buckinghamshire)

D.R.: H. V. Wilkins (G6WN), 539 Oldfield Lane, Sudbury Hill, Greenford, Middlesex. Byron 3369.

The highlight of the past month was the District dinner which is reported elsewhere in this issue. We regret that we had to disappoint a few members and their ladies but this was due entirely to catering difficulties. We hope everyone will be lucky next time.

West London.—G8VM is now with Coastal Command. Since G6ZY returned to this country from Gib. he has flown to America *via* VO and VE3 and back, then to Casablanca and Tunis and finally back to Britain. He is now a captain. 2FUX is congratulated on making the grade of Pilot Officer. 2BMY is in India ; 8PD has his address. 8KZ has heard from 8FA who also is in India.

Aylesbury.—Congrats. to 6019 on his engagement and to 6357 on his forthcoming marriage. The local group send greetings to Miss Hollingsworth 6022 who is now in District 7. 6024 is to give a lecture at the next meeting on the subject of " Plastics, as applied to Radio Engineering." G6WN.

DISTRICT 16 (South Eastern)

Deputy D.R.: W. A. Scarr, M.A. (G2WS), 8 Beckenham Grove, Shortlands, Bromley, Kent. Beckenham 1131.

Correspondence has become very scanty of late with the result that BULLETIN notes are necessarily brief. Two interesting airgraphs have, however, arrived from George Haylock, Sidcup, who tells of the formation of a " local " radio club in North Africa with a membership which had reached 32 in August. F./O. Peter Halliday, Sgt. F. Barnes and Sgt. L. Huntley are amongst the members.

G. R. N. Naish (6448), of Church Causeway, Shipley, Horsham, is anxious to hear from any member living within a few miles of Horsham, with whom he could make contact. G2WS.

DISTRICT 17 (Mid East)

D.R.: A. C. Simons (G5BD), Admiralty Road, Mablethorpe. (Phone 69.)

Interest in the district appears to be at very low ebb, the only news received being from G5LL who reports fit from Sicily. Our newest member, Sgt. N. Wright, is W./Op. on a Catalina with Coastal Command. The D.R. had a very good time at Cranwell, meeting many friends, old and new. G5BD.

Scotland

Scottish Records Officer: J. Hunter (GM6ZV), 51 Camphill Avenue, Glasgow, S.1. Langside 237.

There is a little more news this month and special mention must be made of the efforts being made by " C " District who have been very active with a go-ahead publicity scheme which has already achieved good results.

" *A* " *District.*—At the September meeting, David Macadie, GM6MD, the newly appointed D.O. gave a very interesting talk

on pre-selectors and displayed several specimens. It is suggested that members may have components not in use and that they bring along to the next meeting a list of such items and a note of components desired. Probably an exchange could be arranged. Next meeting will be on October 31.

"*C*" *District.*—At the August meeting J. Gouck lectured on "A.F. Amplifiers" and gave demonstrations on sample gear. The attendance of 25 members was a record for a war-time meeting.

The September meeting was devoted to the subject of "Simple Formulæ" which was capably dealt with by J. H. Prince. GM3LU has heard from GM4NR who is in Egypt.

The District's publicity campaign includes the issue of a bi-annual duplicated circular to all members, the display of a post-card size notice on all Service notice-boards in the district (particulars from the D.O.), and the insertion of a local press notice two days prior to each meeting. This campaign has brought the district 37 new members in the last 12 months (Heartiest congrats.—Ed.)

"*H*" *District.*—We have pleasure in extending a cordial welcome to our new members—D. Dunsire, 6523, and Lieut. D. Wemyss, 6629. 6JJ reports that he has visited the new H.Q., and has met 2OA during his travels. 8MQ states that 8KQ is now back in this country after three years in India and elsewhere. 2761, while on a course, contacted GM3BZ. 4AN received a visit from 3LO last month, and regrets not seeing 4GK when the latter was on leave. 2DBX is still busy in the Home Guard signal section. The D.O. would be glad to hear from the missing "H" links—GM3ND, 8SQ, 8KQ, 8FB, 4MQ, 2AVN, 2DVV, 2FWN, 3611, 3525, 2806, 2736.

"*The Far North.*"—Members here welcome the return of 5598 who is once more on the "active" list after his long illness. D. Craig, BRS4046, and now in ZB2, sends his 73 to all old friends. He reports meeting 2845, and will by this time have contacted GM3TD. 2NQ had the unexpected pleasure of meeting GM6VH last month. A recent visitor was Lieut. G. Ramsden, G6BR, and we regret that opportunity was lacking for a closer contact which might have made his stay less lonely. GM6ZV.

Northern Ireland

D.R.: J. N. Smith (GI5QX), 19 Hawthornden Drive, Belmont, Belfast. Telephone: Belfast 63323. T.R.: R. Holden (GI5HU), 260 Grosvenor Road, Belfast.

F./O. Frank Robb, GI6TK, just back from England, reports meeting no less than 59 members during visits to Cranwell and Scarborough. He also visited new H.Qs. Ron Jenks, 2DYZ, is at present in hospital, we wish him a speedy recovery. Congrats to R. Cowden, 2DZV, and J. Davidson, 4730, on their recent promotions.

By the time these notes appear in print the Belfast Y.M.C.A. Radio Club A.G.M. will have been held. A full report of the proceedings will be published next month, meanwhile, the D.R. and T.R. extend a warm welcome to any visiting amateur to attend Club Meetings. W9EEZ is still a constant visitor at the Club.

The D.R. recently received a visit from GI3VQ who is now recovering from his illness. He hopes to put to sea again shortly.
GI5QX.

WEST LONDON KEEPS UP THE TRADITION

The first Dinner and Social held in District 15 since the beginning of the war took place on Sunday, September 26, at Ealing Broadway. From 4.30 p.m. onwards the Palladium Cinema witnessed a steady stream of members and their friends winding their way up to the Oak Room for the beginning of the social activities of the evening. After an informal rag-chew, Mr. Peter Bradley, G8KZ, introduced a novel feature entitled "My Greatest Thrill in Amateur Radio," in which those whose names were drawn from a hat were asked to relate their pet "fisherman's yarn"! "Lucky Dip" prizes were awarded at intervals during the evening and the ladies were not forgotten. Prizes were donated by Headquarters, G8KZ, G6WN, and others. Mr. A. D. Gay, G6NF (President), Mr. H. A. M. Clark, G6OT (Hon. Secretary), Mr. F. Charman, G6CJ (a member of Council), and the General Secretary, Mr. John Clarricoats, G6CL, arrived during the early part of the evening. The latter was immediately called upon to relate his greatest thrill!

Just before 7 o'clock the D.R., Mr. Harold Wilkins, G6WN, announced that dinner would be served at the Forum Cinema Cafe, a few yards down the road. As the party left the Palladium a collection amounting to £4 2s. 6d. was taken for the P.O.W. Fund. The dinner went by, as dinners do—a succession of soup, roast pork, fruit tart and coffee. Orangeade was served, and a bottle of whisky, for which we are indebted to G8KZ, was seen to roam the table.

After the loyal toast, Ft./Lt. Thorogood, G4KD, proposed a toast to the R.S.G.B. which was replied to by the President. Mr. Freeman proposed a toast to the visitors and the ladies and, in their replies SP1HA and LA1GA related a little of the sufferings of amateurs at the hands of the Gestapo in their unhappy countries. Mrs. Bradley aptly replied on behalf of the ladies. G6CL in replying to the toast "Amateur Radio," proposed by Ft./Lt. Ted Fowler, VE5VO, spoke of the great part played by the radio amateur in the war effort. "Big Ben minute" was kept in silence. A final toast to the District was proposed by G8KZ. G6WN in reply mentioned that there were now between 400 and 500 members in the district compared with about 250 prior to the war. The proceedings at the Forum ended with the taking of a photograph by LA1GA.

The seventy odd members and friends who attended this function were very grateful to G6WN, G8KZ and 2ADL for their sterling work in making the necessary arrangements. Unfortunately some applications for tickets had to be turned down owing to lack of accommodation. Here's to the next time!
G8PD.

Letters to The Editor

The Light Receiver

DEAR SIR,—Mr. Nisbet (GM3SW) and those who considered the proposals set forth in his article on The Light Receiver, might be interested in some experiments carried out here about eight years ago.

The immediate object of the experiments was the conversion of light of varying intensity into sound. A selenium cell was used as a variable resistance controlling a two stage straight amplifier. As the reception of flashes of light with a comparatively long interval between them was not contemplated there was no audio oscillator brought into play as suggested by 3SW. A flash of light would merely have caused "clicks" in the 'phones and so the arrangement would have been of little use for reading the Aldis lamp signals unless one were prepared to read the "umpty iddies" but when many pulses in close succession, as, for example, those produced by light from a lamp lit by A.C., fell upon the cell the mains hum was heard. A disc with holes punched round the circumferences of four concentric circles of different radii (like a siren disc) was placed between a steady source of light and the cell. When this disc was rotated a chord was heard in the 'phones, because the numbers of holes in the four circles had been arranged to be in proportion to the relative frequencies of the notes d, m, s, d.

The next step was to try to modulate the beam of light by sound instead of chopping it up mechanically. This was done by employing a sensitive flame. A box, having a thin rubber diaphragm dividing it into two compartments was used. Gas was led by a tube into one compartment and out of the same compartment by a jet, while a conical funnel was fastened to the other compartment. The arrangement is known as a manometric capsule.

Sounds entering the funnel cause the diaphragm to vibrate, which, thus, by altering the pressure of the gas passing through the other compartment, causes the flame to become bigger and smaller but at a rate not visible to the unaided eye. It was the light from this flame which was allowed to fall upon the selenium cell. Speech and music were both transmitted and received in this manner, but due to lack of space no DX records are claimed, as the maximum distance covered was about six feet!

Coal gas was tried first, then coal gas to which had been added certain illuminants and finally acetylene. Nothing further was done with the idea and I cannot recall what led up to the experiments. 3SW's suggestions seem quite sound and much more convenient. I hope the time will not be long distant when he himself will be able to put his ideas into practice. If I may, I should like to send him greetings from a fellow member of "H" district.

Yours sincerely,
K. M. FRASER (GM4FK).

6 McDuff Crescent,
Kinghorn.

Applied D.C. and Mixed Heater Circuits

DEAR SIR,—With reference to the article in the September BULLETIN entitled "Applied D.C., Part I," I would like to refer to the dangers attached to the use of mixed heater circuits and point out that this matter has to be dealt with cautiously, unless one is only attempting, as inferred, to use up odd valves as repairs for receivers of no great consequence.

The difficulty is caused by the fact that the apparent resistance of a valve heater does not obey Ohm's law but has a positive temperature co-efficient similar to that of a metal filament lamp; also there is a tolerance on the heater current at a specified voltage or on the voltage at a specified current, depending upon whether the valve is intended for parallel or series operation. Hence, unless the valve in question is designed for series operation the cathode will run too hot or too cold if used in a series circuit unless, by accident, the heater characteristics are "on bogey." Further, unless this latter accident occurs, it is impossible to calculate from Ohm's law the value of any parallel resistance required, as Fig. 2B. Any change in the applied mains voltage will result in disproportionate changes in the heater current of a valve used in parallel with a resistance, because the valve will change in apparent resistance, whereas the resistance will stay constant.

This also applies when two valves of different makes or types are used in parallel in a series circuit (*e.g.* a 0.15 amp. and a 0.3 amp. in a 0.45 amp. chain), because different types of heater obey different laws.

Readers may like to try a few experiments using various valves and a low resistance ammeter and high resistance voltmeter, and ascertain for themselves what does happen, particularly when the circuit is switched on from cold. I think they will agree that the resistance values can only, with safety, be determined by measurement, using the valves in question.

D. N. CORFIELD (G5CD).

HEADQUARTERS CALLING

August Council Meeting

Resume of the Minutes of a Meeting of the Council held at New Ruskin House, London, W.C.1, on Monday, August 30, 1943. *at 6 p.m.*

Present.—Messrs. A. D. Gay (President), A. E. Watts, H. A. M. Clark, A. J. H. Watson, D. N. Corfield, F. Charman, G. R. Scott Farnie, S. K. Lewer, W. H. Matthews, W. E. Russell, W. A. Scarr and J. Clarricoats (General Secretary).

Apologies for absence were received from Messrs. E. L. Gardiner, E. H. Simmonds, G. A. Jessup and J. Hunter.

1. It was unanimously resolved to accept 176 applications for membership. It was recorded that 40 applications had been supported by references and that the remainder had been sponsored by Corporate members. One Life member, Mr. H. Arnfield, G3LX, was elected.

2. The monthly Balance Sheet and Statement of Account was considered and adopted.

3. A letter was read from the China Amateur Radio League thanking the President for his broadcast on May 5, which was perfectly received in China. Thanks were also expressed to those members of the Society who contributed to the C.A.R.L. Convention.

4. It was agreed to approach the City and Guilds Institute London regarding the G.P.O. suggestion of preparing technical examination papers for post-war applicants for amateur experimental transmitting licences.

5. A lengthy discussion took place regarding the post-war re-organisation of the Society, with special reference to improving District representation on Council. Pre-war Councils frequently lacked Provincial Representation owing to the inability of provincial members, due to business commitments, to travel to London. Ways of overcoming this difficulty were explored.

6. Honoraria were awarded to BULLETIN contributors as per the list published in the September issue.

The meeting closed at 8.20 p.m.

Subscription Renewals

Members are reminded that due to paper rationing and limitation of supplies it is now impossible to supply back issues of THE BULLETIN to those who allow their subscription to become overdue. In order to prevent disappointment and to avoid additional clerical work at Headquarters, members are requested to renew promptly when their subscription becomes due. The Statement of Account should always be returned.

I.E.E. Meeting

There was an attendance of about 40 members to hear Mr. S. K. Lewer, G6LJ, lecture on "The Development of Amateur Radio" at the opening meeting of the 1943/4 session held on September 25 at the Institution of Electrical Engineers. The chair was taken by Mr. A. D. Gay, G6NF (President), who was supported by Mr. E. L. Gardiner, G6GR (President Elect). Those who contributed to the discussion included Messrs. Corsham, Milne, Starr and Clarricoats. A vote of thanks to the lecturer was proposed by Mr. E. L. Gardiner. It is hoped to publish a résumé of Mr. Lewer's lecture in a future issue of the Society's Journal.

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Mr. W. A. Scarr, M.A. (G2WS) will open a discussion on "Radio and its Relationship to Kindred Sciences" at the meeting to be held on Saturday, October 30th, 1943, at the Institution of Electrical Engineers, Savoy Place, London, S.W.1. The meeting will commence at 2.30 p.m.

It is hoped that all members in the London area will support this function.

U.H.F. Group

Mr. H. H. Phillips, GW4KQ, 82 Cottrell Road, Roath Park, Cardiff, Manager of the Experimental Section, U.H.F. Group, regrets that due to lack of contributions, coupled with pressure of private business, he has been unable for some months to issue a Group Letter Budget. No. 8 Budget is now being prepared and will be distributed at an early date. Members interested in U.H.F. work are invited to communicate with Mr. Phillips.

NEW MEMBERS

Home Corporates

G2HK J. F. LUCAS, Glenmore, Redhoods Way E., Letchworth
G2XD D. J. BRUCE, 26 Dorchester Road, Leicester.
G2YK *A. E. MARKWICK, 13 Dunstable Rd., Richmond, Surrey.
G3FR A. W. FOWLER, c/o Scott & Slack, Station Road, Sutton-in-Ashfield.
G3HM L. E. HARRIS, 22 Baliol Road, Hitchin, Herts.
G3HS D. T. BOFFIN, 44 High Street, Winslow, Bucks.
G4LD C. A. THORNTON, 119 Rastrick Common, Brighouse.
G5MW S. THACKRAY, Gas Works House, Valley Road, Morley, Leeds.
G5NU *CAPT. W. B. H. LORD, M.E.F.
G8KM *S. S. D. JONES, c/o Barclays Bank, Cornmarket Street, Oxford.
G8UK *J. TURNBULL, 12 The Avenue, Monkseaton.
2AAR T. PLANT, 1 Park Avenue North, London, N.8.
2AFX E. J. HARRIS, 26 Queensberry Road, Salisbury.
2AJH J. T. THORNTON, 11 George Av., Birkby, Huddersfield.
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2AXH *H. A. WOODS, 34 Blackpool Rd., Ribbleton, Preston.
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2BQV E. H. RITCHINGS, Links View, Croft Street, Bacup.
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2DHB J. J. HARGAN, 8 Epworth St., Park Av., Londonderry.
2DLL A. H. HILLMAN, 128 Union Street, Dunstable, Beds.

(Home Corporates) B.R.S.

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6787 J. S. ELLIS, 51 Raffles Road, Birkenhead, Cheshire.
6788 J. WEADEN, 40 St. Dunstans Road, Bristol, 3.
6789 R. F. A. HOPES, 25 Cairnfield Avenue, London, N.W.2.
6790 D. J. CLARKE, Hatch Pk., Hatch Beauchamp, nr. Taunton.
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6792 A. W. BURGOYNE, 10 Arlington Road, London, W.13.
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6794 W. A. SIMCOCK, Avondale, Sandsend Road, Davyhulme, Urmston.
6795 E. D. ABRAMS, 41 Charlotte Road, Birmingham, 15.
6796 C. WILSON, 13 Brocklehurst St., Moston, Manchester, 9.
6797 C. L. ORSBORNE, 3 Green Lane, Peterborough.
6798 W. H. HACKNEY, B.Sc., 4 Burnham Close, Enfield, Mdx.
6799 S./Ldr. W. H. GEORGE, D.F.C., 8 Collingham Road, London, S.W.5.
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6812 D. J. HARVEY, 135 Bearwood Road, Smethwick, 41.
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6814 R. C. WATKINS, 56 Park View Road, London, S.E.9.
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6816 E. WARREN, 255 Thornton Road, Carshalton, Surrey.
6817 W. E. CARTWRIGHT, 18 Harris Road, Bexley Heath.
6818 R. J. ROGERS, 14 Gonville Avenue, Croxley Green, Rickmansworth.

A CORDIAL WELCOME IS EXTENDED TO THE

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NEW MEMBERS WHOSE NAMES ARE LISTED

6819 T. A. BAMPFIELD, 114 Elsenham Road, Grimsby.
6820 I. E. ATTWOOD, St. Andrews, Worcester Rd., Malvern Link.
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6839 R. MCGOWAN, 7 St. Leonards Drive, Woodlands Park, Timperley.
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6841 A. J. RAWLINGS, 20 Melbourne Rd., Bishopston, Bristol, 7.
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6843 G. I. WILSON, 2 Springwell Av., North End, Durham City.
6844 W. D. BOTTOMLEY, 68 Barassie Street, Troon, Ayrshire.
6845 F. J. G. STOCKWELL, 27 Homestead Road, London, S.W.6.
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6847 J. P. EVANS, c/o Roberts Bunneys, Ltd., Mostyn Street, Llandudno.
6848 E. OLDHAM, 14 Longwood Av., Nangreave Rd., Stockport
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6851 R. W. N. MASON, 22 Broughton Avenue, Aylesbury.
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6855 A. HUBBARD, Old Barn Farm, Cinderford Lane, Hailsham.
6856 A. J. ROLFE, 9 Manor Crt., Gunnersbury Av., London, W.3.

* *Denotes Re-elected to Membership.*

R.S.G.B. Prisoners of War Fund

DONATIONS.—The General Secretary acknowledges with thanks on behalf of Council, receipt of donations from :—G. R. Scott Farnie, GW5FI, £3 3s. ; J. J. Shaw, 5319, 10s. ; R. B. Holman, 2DYM, 10s. ; A. C. Bryant, 3999, 2s. 6d. ; G. Trotter, 4461, 5s. ; R. E. Cawkell, 4072, £5 ; A. B. Hodgson (Archbishop Holgates Grammar School, York) 15s. ; C. Coates, G5CS, £1 1s. ; "The Two of Us"—"H" District, 10s. ; F. W. Cole, G4GX, 5s. ; J. Ellis, G3GM, 10s. ; Miss M. Butters (daughter of G6UB), 10s. ; A. Hine, 4438, £1 1s. ; Mrs. K. D. Ayers, 5s. ; Anon, 6s. 2d. ; E. L. Wright, G3SI, £2 2s. ; Cranwell Meeting, £4 6s. ; W. P. Mitchell, G2TM, 5s. ; G. V. Catt, G4FV, 10s. ; J. P. Blair, GM5FT, 10s. 6d. ; A. E. Ashfold, GW5AB, 5s. ; E. Fowler, VE5VO, 5s. ; District 15 Dinner, £4 2s. 6d. ; Anon, 8s. 6d. ; District 13 (per G3ST), 13s. 6d. ; R. N. Lawson, G5ZK, £1 1s. ; H. Arnfield, G3LX, 10s. **Receipts to date £921 16s. 0d. Expenditure to date, £467 17s. 9d. Balance in hand as at September 30th, £453 18s. 3d.**

BOOKS AND GAMES.—Mr. C. H. L. Edwards, G8TL, Speedways, Bartholomews Lane, Sudbury, Suffolk (Hon. Administrator of the R.S.G.B. P.O.W. Fund) again appeals to members for books and games. Gifts should be sent to him at the above address.

PARCELS.—Due to the Italian situation no parcels were sent in September to members known to have been in Italian prison camps up to the time of the Armistice. Those who were transferred to Germany will receive parcels as soon as their new addresses are known. Parcels were sent in July to 23 members and 5 non-members, in August to 24 members and 5 non-members, and in September to 17 members and 5 non-members.

A DELIGHTFUL GESTURE.—Little Marguerite Butters (aged 11), daughter of G6UB, sent the Fund a donation of 10s. which represented the proceeds received from the sale of milk jug covers and iron holders which she made herself. Thank you, Marguerite.

Book Reviews

WORKED RADIO CALCULATIONS. By Alfred T. Witts, A.M.I.E.E. Pitman ; 6s. 6d.

This new publication will prove of much value to Radar and Wireless Mechanics, as well as to those students who find that the most difficult part of their *ab initio* course is the mastering of mathematical equations. Most of the important formulæ met with in radio servicing and wireless operator-mechanic courses are included and several examples are given of each formula, especially the fundamental ones.

The book contains eight chapters which deal with Current, Voltage, Resistance, Meters, D.C. Power ; Batteries ; Electromagnetism, Inductance, Transformers ; Condensers and Capacity ; Reactance, Impedance, Resonant Frequency ; A.C. and Power ; Thermionic Valves ; Receiver Circuits and Gain.

There are no less than 302 worked examples, many of which are illustrated by diagrams.

The arrangement, style of presentation and practical treatment will appeal to all interested in radio calculations.

TESTING RADIO SETS. By J. H. Reyner, B.Sc., A.C.G.I., D.I.C., A.M.I.E.E. Chapman and Hall ; 15s.

This fourth edition of Mr. Reyner's standard work, is really deserving of a new title to differentiate it from earlier editions. The complete change in radio technique which has taken place during the twelve years since the book was first written, has necessitated a major operation in preparing the new edition. As the author points out in his preface the testing of receivers is now a highly specialised business usually carried out in well-equipped workshops. Even the individual service-man who locates, and possibly rectifies, faults on the spot, has, to-day, to be equipped with a wide variety of instruments, such as Signal Generators and Output meters, if he is to operate efficiently.

In previous editions Fault Finding and Laboratory Testing have been treated as separate and distinct functions, but now that modern test equipment is more generally available Mr. Reyner has very wisely abandoned the division between the work undertaken by the service-man and that carried out by the laboratory worker.

The author introduces his subject by stressing the need for system. General testing methods are described and reference is made to signal generators, C.R.O.'s and audio oscillators. Later chapters deal with Meters, Generators and Indicators, A.F. tests, Tuning tests, R.F. tests, Superhet tests, mains apparatus, short-wave tests, Receiver tests, and Component tests. The C.R.O. is dealt with at greater length in Chapter XII whilst the last chapter, and one of the most interesting, describes some curious faults noted by the author. The Appendices deal with Time Constant, Resistance Condenser Networks and Negative Feedback. The book contains ten pages of plates depicting modern test gear and a large number of line diagrams. J.C.

Hospitality Offered

S./Ldr. and Mrs. H. W. Simpson, **G8DI**, will be glad to welcome members at their new home "The Green," Chipping Warden.

Crowded Out

We regret that due to pressure on our limited space, Part II of "D.C. Supplies," Part III of "Valve Vade Mecum," as well as the names of a further 150 members recently elected, have been crowded out from this issue. We hope to include these features next month.

EXCHANGE & MART—ADVERTISEMENT RATES

MEMBERS' private advertisements 2d. per word, minimum 3s. TRADE advertisements 4d. per word, minimum 6s. Box Numbers: 6 words, plus 1s. TERMS: Cash with order. All copy and payments to be sent direct to Advertisement Managers, Parrs Advertising Ltd., 121 Kingsway, London, W.C.2, by the 30th of the month for following month's issue.

ALL KINDS OF PRINT.—Send your enquiries to G6MN, Castlemount, Worksop.

BULLETINS.—118 copies, 1929–1940 ; *Q.S.T.*, 35 copies, 1935–1938 ; R.S.G.B. two-valve receiver chassis with valves ; six oak cabinets ; SG215 valve, new. Offers to Box 230, PARRS, 121 Kingsway, London, W.C.2.

FOURTEEN numbers *Electronic Engineering*, 1941–2 ; 10 numbers *Radio*, 1942–3 ; *P.O.E.E.J.*, 1940 to 1943 complete. Over 10s. secures lot.—WALSBY, Henstridge, Templecombe, Somerset.

G6HP disposing all equipment ; unused three years due absence overseas. Best cash offers accepted. BULLETINS since March 1934 to date. Television since Jan. 1936. Eddystone E.C.R. and speaker. Frequency meter. (Jan.–Feb. 1940 "BULL"). Pre-selector (Jan. 1941 "BULL"). U.S.W. Convertor. High voltage transformers, condensers, meters, Brown's "A" 'phones, tools, keys, components. Enclose S.A.E. for reply.—F./O. WIMBUSH, "Staybrite," Grange Road, Bishopsworth, Nr. Bristol, Somerset.

SALE.—"Radiolab" set tester and analyser, £12 10s. Everett Edgecumbe 28 rage A.C./D.C. multimeter (1000 O.P.V.), £12 10s. "Radiometers" condenser and resistance bridge (with valves, no instructions), £3. "Wearite" A.C. valve tester and analyser (used with separate multimeter), £10. Wanted : Oscillator, communications receiver, automatic changer.—BRS 4630, 2 Meads Road, N.22. Bowes Park : 2140 (after 9 p.m.).

SALE.—1939 Hallicrafters SX18, 9 valves, crystal filter, bandspread, BFO. etc. ; in working condition but needs slight attention. Dollond students microscope, rack focussing, 1 eyepiece, 3 objectives, wooden case and 65 biological slides. Thirty-four *Wireless Worlds*, 1938–9 and 1940, and 41 indexes. Wanted. July 1941 *Wireless World*, 1942 index. Tel/Elect Engs 1940–41. Offers and details to 2BVH, Sandwycke, Sandpit Lane, St. Albans.

WANTED.—Choke and swinging choke 250 milliamps ; 2, type 131 T.C.C. condensers, or similar ; transformer 2.5 volts 10 amps. Details please.—PENTELOW, Finedon, Northants.

WANTED.—Type 83 valve ; metal chassis, 17½" × 10½" ; 0–100 or 0–200 m/a meter, flush pattern. Adjustable insulated brackets, Eddystone type, or other good make.—G6TC, TED ROWLEY, 29 Leason Lane, The Scotlands, Wolverhampton.

WANTED.—Service manuals, any make, for use by Service Engineer. Genuine need. Good price paid.—MYERS, 17 Rockcliff Road, Rawmarsh, Rotherham.

WANTED.—Clean copy of Johnson and Phillips *Transformer Book*, Lacey and Stigant.—WELCHMAN, 5 Leighwood, The Folly, Chippenham, Wilts.

WANTED.—100 K.C. crystal ; 0–1 M.A. meter. State make, condition and price.—G8WN, 30 Ransome Road, Ipswich.

PATENTS AND TRADE MARKS

KING'S Patent Agency Ltd. (B.T. King, G5TA, Mem. R.S.G.B., Reg. Pat. Agent), 146a Queen Victoria Street, London, E.C.4. Handbook and Advice on Patents and Trade Marks free. Phone: City 6161. 50 years' refs.

NEW VALVES. First grade, leading makes, at Pre-War Prices.

PHILCO Components. Fixed condensers and resistors. Mains transformers. Parcels of assorted components. See our adverts, June and August issues.—**E. H. ROBINS TRADING CO., LTD.**, 44 Kyle Crescent South, Whitchurch, Glam.

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