Model 8 Universal AVOMETER

REGD. TRADE MARK

MK II

WORKING INSTRUCTIONS

AVO LTD

THE
MODEL 8 UNIVERSAL
AVOMETER
Mk II

INSTRUCTIONS FOR USE

AVOCET
TRADE MARK

AVO LTD.

FOREWORD

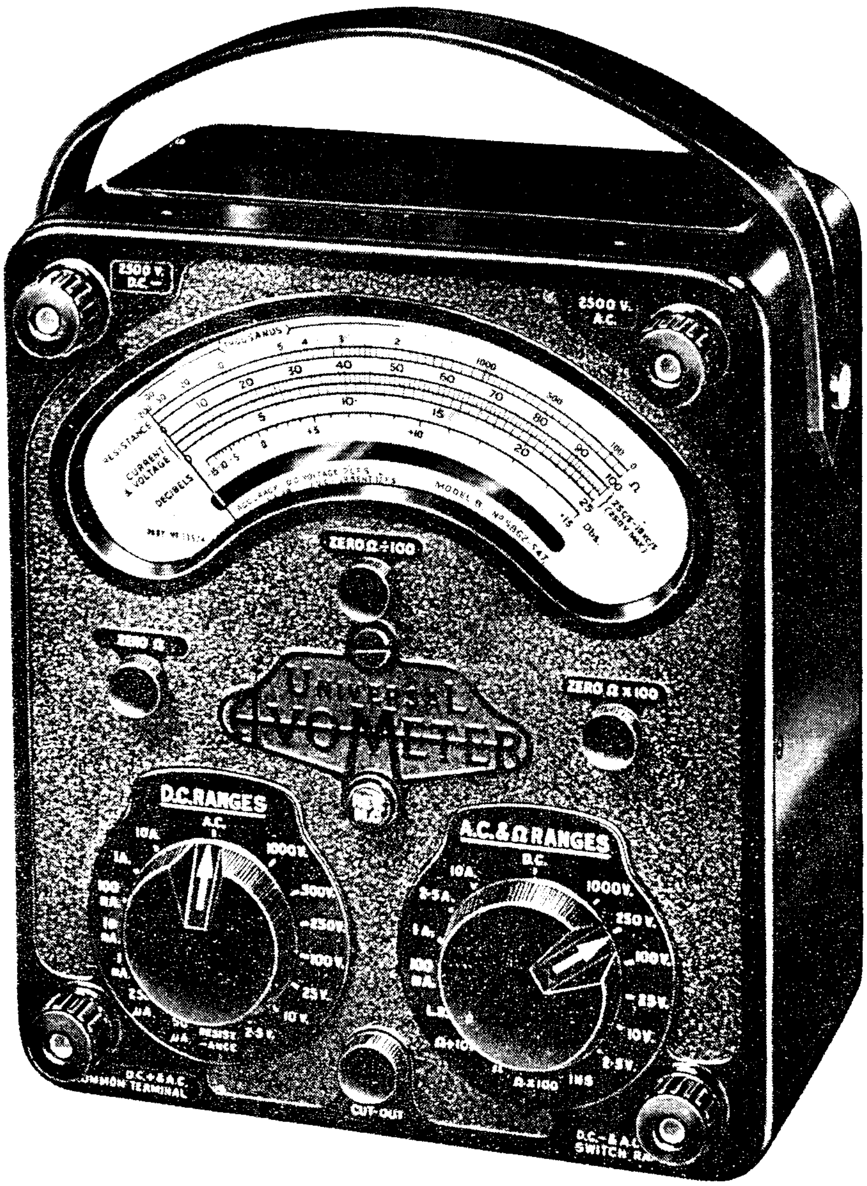
For more than a quarter of a century we have been engaged in the design and manufacture of " AVO " Electrical Measuring Instruments. Throughout that time we have consistently pioneered the design of modern multi-range instruments and have kept abreast of, and catered for, the requirements of the epoch-making developments in the fields of radio and electronics.

The success of our steadfast policy of maintaining high standards of performance in instruments of such wide versatility, and making such instruments available at reasonable cost, is reflected in the great respect and genuine goodwill which " AVO " products enjoy in every part of the world.

It has been gratifying to note the very large number of instances where the satisfaction obtained from the performance of one of our instruments has led to the automatic choice of other instruments from the " AVO " range. This process, having continued over a long period of years, has resulted in virtual standardisation on our products by numerous Public Bodies, The Services, Railway Systems, and Post Office and Telegraph Undertakings throughout the world.

Our designers have thereby been encouraged to ensure that new instruments or accessories for inclusion in the " AVO " range fit in with existing " AVO " apparatus and serve to extend the usefulness of instruments already in being. Thus, the user who standardises on " AVO " products will seldom find himself short of essential measuring equipment, for, by means of suitable accessories, his existing equipment can often be adapted to most unusual demands.

It is with pleasure that we acknowledge that the unique position attained by " AVO " is due in no small measure to the co-operation of so many users who stimulate our Research and Development staffs from time to time with suggestions, criticisms, and even requests for the production of entirely new instruments or accessories. It is our desire to encourage and preserve this relationship between those who use " AVO " instruments and those who are responsible for their design and manufacture, and correspondence is therefore welcomed, whilst suggestions will receive prompt and sympathetic consideration.



THE MODEL 8 AVOMETER MK. II

CONTENTS

INTRODUCTION

Since its conception in 1923, the AvoMeter has maintained a distinct lead upon all its competitors, and can today quite rightly be termed the most popular instrument of its type in the world, for in no other instrument can one find such a unique combination of ranges and comprehensive automatic overload protection, in addition to a high degree of accuracy, reliability and simplicity of use.

Much time and thought is continually devoted by our design department to the improvement of our products and it is for the Electronic Radio and Television Engineer that this new instrument has been primarily produced. The Model 8 AvoMeter Mk. II has the high d.c. voltage sensitivity of the High Resistance AvoMeter Models 1 and 2, but in addition, provision is made for the measurement of a.c. current. A further useful feature which has been incorporated is a push button change-over switch which enables the direction of the current through the moving coil to be reversed, thus obviating the necessity of changing leads when working with d.c. voltages and currents which may be either positive or negative in respect to a basic test position. The excellent qualities of previous models including the "AVO" automatic cut-out have been retained, and we have great confidence that given a reasonable amount of care and attention, not forgetting the removal of exhausted batteries, this instrument will give lasting satisfaction.

TABLE OF RANGES

D.C. Voltage	D.C. Current	A.C. Voltage	A.C. Current
2,500 V.	10 A.	2,500 V.	10 A.
1,000 V.	1 A.	1,000 V.	2·5 A.
500 V.	100 mA.	250 V.	1 A.
250 V.	10 mA.	100 V.	100 mA.
100 V.	1 mA.	25 V.	
25 V.	250μA.	10 V.	
10 V.	50μA.	2·5 V.	
2·5 V.			

Resistance

0—200 megohms (2 megohms mid-scale) with external voltage
0—20 meghoms, (200,000 ohms mid-scale)
0—200,000 ohms (2,000 ohms mid-scale)
0—2,000 ohms (20 ohms mid-scale)
0—2·5 ohms (with external unit)

The
Model 8 Universal AvoMeter
Mk II

WORKING INSTRUCTIONS

General Description

The meter is supplied complete with a pair of special rubber-covered leads which are intended for attachment to the AvoMeter by means of its non-loss terminals. The remote ends of the leads are fitted with spring clips, which may be interchanged with the " AVO " Prodclips supplied with the instrument.

" AVO " Prodclips have been introduced to enable connections for test purposes to be made at what are normally inaccessible points on a chassis. Examination will show that they are completely insulated with the exception of the jaws at one end, which can be opened by compressing the stem into the body of the clip. Rigid connections to wiring can thus be made by this insulated device in complicated wiring systems where other types of larger clip could not be attached, or if fixed might cause short circuits.

All tests, except those on the 2,500V. ranges, make use of the pair of terminals at the base of the instrument.

The meter is extremely simple to use, range selection in general being accomplished by means of two switch knobs.

A clearly marked 5″ scale has uniformly divided graduations to match 100 and 250 scale markings, and in addition there is an ohms scale and one for decibels. An anti-parallax mirror permits readings of the knife edge pointer to be made with great precision.

Limits of Accuracy

Generally speaking, the highest percentage accuracy on current and voltage ranges is obtainable at the upper end of the scale, but on resistance ranges it is better towards the centre of the scale. In the case of voltage measurements, which are more frequently taken than those of current, successive ranges have been closely chosen to obviate the need for taking readings on very small deflections.

The instrument will produce its highest accuracy when used face upwards, in which position it has been calibrated.

D.C. Voltage. 2% of indication between full-scale and half-scale deflection. Below half-scale deflection, 1% of the full-scale value.

D.C. Current. 1% of full-scale value over effective range.

A.C. Voltage. Up to 250V. 2.25% of full-scale value over effective range (25-2000 c/s).

A.C. Current. 2.25% of full-scale value over effective range.

The definition of " effective range " set down in the British Standard Specification 89/1954 is as follows, when related to the AvoMeter:—

D.C.—from 0·1 of scale-range to full-scale value.

A.C.—from 0·25 of scale-range to full-scale value.

It will be noted that with the exception of the d.c. voltage ranges, the instrument meets the requirements laid down in Section 6 of the British Standard Specification 89/1954 for 5″ (127mm.) scale-length Industrial Portable Instruments. In practice, the Model 8 is well within the above limits, due to the great care taken in the manufacture of its various components, and to the fine initial calibration.

Inasmuch as rectifier moving coil instruments give readings on " a.c." proportional to the mean and not the R.M.S. value of the wave form with which they are presented, they depend for their accuracy not only upon their initial calibration, but also upon the maintenance of a sinusoidal wave form. Since the form factor (R.M.S. value divided by mean value) of a sine wave is 1·11, this has been taken into account in calibrating the meter which does, therefore, indicate R.M.S. values on the assumption that the normal sine wave will be encountered. Generally speaking, considerable wave form distortion can occur without appreciably affecting the form factor and resulting accuracy of measurement, but the user should recognise the possibility of some error when using distorted wave forms, squarish wave shapes producing high readings, and peaky ones, low readings.

Design and Construction

The instrument consists of a moulded panel on the inside of which are mounted the whole of the switching apparatus, resistances, shunts, transformer, rectifier, etc., together with the movement. The panel fits into a robust moulded case, the joint being rendered completely dust proof, whilst a carrying strap is provided to facilitate portability. The main switching is accomplished automatically by means of two knobs which indicate on the engraved panel, the range in use. These switches are of generous and robust design, the contacts being arranged to " make " before " break " on adjacent ranges; a feature which provides a factor of safety in use.

When the instrument is set for operation on d.c., the moving coil is associated with a universal shunt and series multipliers, whilst on a.c., a full-wave rectifier and transformer are also introduced.

Range Controls

The left-hand knob provides all the d.c. current and voltage ranges (except 2,500V.) and the right-hand knob the a.c. ranges (except 2,500V.) and also the resistance ranges. These knobs are electrically interlocked so that d.c. readings can only be made after the right-hand switch has been set to d.c., and the left-hand switch to the range selected. a.c. readings call for the left-hand switch to be set for a.c. (it must not be left at RESISTANCE) and the right-hand switch at the range required Resistance tests require the left-hand switch to be set to RESISTANCE and the right-hand one to the desired range.

If the switches are inadvertently left to actual ranges simultaneously, there is no circuit through the meter, and it is thereby safeguarded against accidental damage or misleading readings.

It is possible to determine whether a source is a.c. or d.c., since a.c. will not produce pointer indication when the meter is set for d.c. measurement. A small pointer indication, however, may result if d.c. current is passed through an a.c. range, but no harm can be done to the meter provided it is not at the same time grossly overloaded.

The main ranges are engraved on the panel around the switches, and arrow heads on the knobs indicate the actual range selected. In the case of voltage, successive ranges are built up on the ratios of 2 : 1, 2·5 : 1 and 4 : 1, but in the case of current, a wide coverage has been chosen instead and the 10 : 1 ratio in general is followed. The 2,500V. a.c. and d.c. ranges are available by means of the two special terminals so marked.

Extremely wide coverage in resistance has been achieved by having a fundamental range as marked on the scale, together with ranges of × 100 and ÷ 100 to supplement it. Before carrying out resistance tests, the meter should be adjusted for the state of the batteries. It is merely necessary to join the leads together and adjust to zero in the following sequence: ohms, ohms ÷ 100, followed by ohms × 100, using in each case the adjuster to match the range.

In addition, a 200-megohm range marked " INS " is available, using an external d.c. voltage source.

The Movement

The moving coil consists of an aluminium former wound with copper wire and supplemented with Constantan in order to reduce temperature error. It is pivoted on hardened and highly polished steel pivots between conical spring-loaded jewels, and swings in a gap energised by two powerfully magnetised and aged ' Alcomax ' blocks associated with mild steel pole pieces. Two phosphor bronze hair springs are fitted for the purpose of conveying current to the moving coil, and to provide controlling torque. A knife edge type of pointer is fitted enabling very fine readings to be taken, whilst the whole movement is perfectly balanced and reasonably damped so that the pointer quickly comes to rest.

Scaling

The scale plate has three main sets of markings, each of approximately 5″ length, the outermost being for resistance measurement and is marked 0–200,000 ohms. The second is for current and voltage (both a.c .and d.c.) and is marked 0–100, with divisions approximately 1¼ mm. apart. The third scale, calibrated 0–250, has 50 divisions, and is so used for current and voltage measurements. In addition, there is a decibel scale marked from −15 dB. to +15 dB., which can be used with any of the a.c. ranges.

Replacement of Internal Battery and Cell

Inside the cover, under the carrying strap is mounted a 15V. battery and a 1½V. cell. These batteries should be examined from time to time to ensure that the electrolyte is not leaking and damaging the instrument. This condition will generally occur only when the cells are nearly exhausted. If it is known that the meter is going to stand unused for several months, it is preferable that these batteries should be removed to prevent possible damage.

When replacing batteries, the $1\frac{1}{2}$V. cell and the 15V. battery must be inserted with the poles to match the markings of polarity inside the battery box.

Replacements: 1·5V. cell, $1\frac{3}{8}''$ dia. $\times 2\frac{3}{8}''$, such as Ever Ready (or overseas, Berec) U.2.
15V. battery, $1\frac{1}{32}'' \times \frac{5}{8}'' \times 1\frac{1}{2}''$, such as Ever Ready B.121.

Movement Reverse Control

It sometimes happens that d.c. voltages may be required both positive and negative to a reference point, or the direction of flow may be reversed. In order to simplify the matter of lead alteration, a movement reverse press button (REV. M.C.) is provided. It should be noted that the polarity marked on the terminals is for normal use and does not apply when the button is pressed.

Overload Protection

Apart from the ability to do its job, one of the most attractive features of the instrument is the provision of an automatic cut-out which gives a very high degree of overload protection to the whole of the instrument. The incorporation of this device will be found to be of particular value when conducting experimental work, for it imparts to the user the feeling of mental ease and confidence. When conducting experimental work with conventional moving coil meters, these can be easily ruined by inadvertently applied overloads, whereas the AvoMeter is so well protected that it can withstand considerable mishandling.

If an overload is applied to the meter, the cut-out knob springs from its normal position in the panel, thus breaking the main circuit, and this knob has only to be depressed to render the instrument again ready for use. It is important to note that the cut-out should never be reset when the instrument is connected to an external circuit, whilst the fault which caused the overload should be rectified before the meter is reconnected.

The mechanism is brought into operation by the moving coil coming into contact with a trigger just beyond its full-scale position. There is, in addition, a second release at the zero end, so that the cut-out is tripped if the meter is overloaded in reverse.

Although the overload mechanism gives almost complete protection to the meter, it cannot be guaranteed to fulfil completely its function in the very worst cases of misuse, such as the mains being connected across the meter when set to a current range. It should be noted that mechanical shock to the instrument will sometimes trip the cut-out mechanism. The cut-out should be reset, using direct pressure and without twisting the button, the instrument lying face upwards.

WARNING

Special care must be taken when using the instrument to service television receivers or other apparatus employing capacitors of large capacity, for the inclusion of such components in a circuit may mean that **very heavy peak currents** *may flow when the apparatus is switched on. Such surges produce a peaky wave form, and although these peaks are of only a few milli-seconds duration, they may, never-the-less, puncture the instrument rectifier. It is impossible to guard against this cause of damage by means of any form of cut-out mechanism, but instruments manufactured since July 1954 have been fitted with a surge suppression rectifier (SAI) across the main rectifier, to give the maximum protection which can be devised.*

OPERATION OF INSTRUMENT

The meter is intended for use horizontally. Should it happen by any chance that the pointer is not on zero, it may be so set by means of the screw head on the panel.

The leads fitted with Prodclips or clips, as required, should be connected to the lower pair of meter terminals in all cases except when measuring voltages over 1,000V. (see next paragraph).

When measuring current or voltage, ensure that the instrument is set to match the type of source to be measured (either a.c. or d.c.) and then choose a suitable range before connecting up to the circuit under test. When in reasonable doubt, always switch to the highest range and work downwards, there being no necessity to disconnect the leads as the switch position is changed. *Do not, however, switch off by rotating either of the knobs to a blank position.* If the voltage should exceed 1,000V., the instrument should be set to measure 1,000V. as described above, but the negative lead should be transferred to the appropriate 2,500V. terminal.

The instrument is flash tested at 6,000V. a.c., but should the meter be used with accessories on circuits in excess of 2,500V., it should be kept at the low potential end of the circuit (near earth potential). If this procedure cannot be adopted other suitable safeguards must be applied.

CURRENT MEASUREMENT

To measure current, the instrument should be set to a suitable a.c. or d.c. range, and then connected in series with the apparatus to be tested.

Generally speaking, the power absorbed in the instrument is negligible, but in cases of low voltage heavy current circuits, the inclusion of a meter may reduce the current appreciably below the value which would otherwise prevail. The potential drop at the meter terminals is in the order of ½V. on all d.c. ranges, except the 50 microamp range which has a drop of 125 milli-volts. In the case of a.c., it is less than ¼V. on all ranges.

Standard meter leads have a resistance of 0·02 ohms per pair.

In certain cases, care should be taken to ensure that the circuit is " dead " before breaking into it to make current measurements.

VOLTAGE MEASUREMENTS

When measuring voltage, it is necessary to set the appropriate range of " a.c." or " d.c." and connect the leads across the source of voltage to be measured. If the expected magnitude of the voltage is within the range of the meter, but its actual value is unknown, set the instrument to its highest range, connect up and if below 1,000V. rotate the appropriate selector switch, decreasing the ranges step by step, until the most suitable range has been selected. Great care must be exercised when making connections to a live circuit, and the procedure should be entirely avoided if possible.

On d.c. ranges, the meter consumes only 50 microamps at full scale deflection, this sensitivity corresponding to 20,000 ohms per volt. In the case of a.c. ranges from 100V. upwards, full scale deflection is obtained with a consumption of 1mA. (1,000 ohms per volt). The 25V., 10V., and 2·5V. a.c. ranges consume 4, 10 and

40mA. respectively at full scale deflection. The meter maintains a high degree of accuracy for audio frequency tests up to 10 kc/s on ranges up to 250V. a.c.

Whilst discussing the problem of measuring voltage, it would be well to draw attention to the fact that in certain circuits where the current is limited because of the presence of a resistance between the scource and the point at which a measurement is to be made, it is possible for the actual voltage to be higher normally than when the meter is connected. All current consuming voltmeters, however sensitive, draw current to varying degrees from the circuit under test, thus causing a higher volts drop in the resistances mentioned, and thereby causing the voltage to fall at the point of measurement.

Owing to the high sensitivity of the Model 8 on its d.c. ranges, this effect is unlikely to be of importance except in a very few instances. A practical example of where it might be taken into account is in the measurement of EHT voltage on a television set or the tapping on a potential divider, where the resistances are so high as to be comparable with the resistance of the meter on the range in use. It is generally possible to use a meter on a higher range than absolutely necessary, and in such a case the higher meter resistance causes less disturbance than would otherwise be the case. At the same time adequate pointer deflection for reasonable accuracy should be attained.

When it is essential to obtain an accurate indication of the voltage developed across a high resistance it is sometimes preferable to insert the meter in series with it, and to measure the current flowing. The reading given upon the meter, in milliamps, multiplied by the value of the resistance in thousands of ohms, will give the developed voltage.

RESISTANCE MEASUREMENT

There are three self-contained ranges covering from 0·5 ohms to 20 megohms, and provision is also made for both upward and downward extension of these limits. The self-contained ranges make use of the usual series circuit, and successive ranges are on 100 : 1 ratio, which permits of very wide coverage with three ranges.

On resistance ranges, the meter must not merely start from its normal instrument zero, but must have, in addition, a resistance zero corresponding to the full scale deflection of the meter. Before carrying out tests for resistance a check and, if necessary, adjustment should be carried out to ensure that when the leads are joined together the meter actually indicates zero ohms, irrespective of the condition of the battery (within the limits of adjustment). The method of adjustment is described later

Owing to the nature of the scale, it is not easy to define the accuracy, but it should be within 3% of the reading about centre scale, increasing up to about 10% of the indication around deflections corresponding to 10% and 90% of full scale deflection.

Resistance test should never be carried out on components which are already carrying current.

On three ranges which utilise the internal source of voltage, it should be remembered that a positive potential appears at the negative terminal of the instrument when set for resistance tests. This fact may be important because the resistance of some components varies according to the direction of the current through them, and readings, therefore, depend upon the direction in which the test voltage is applied, quite apart from its magnitude. Such cases include electrolytic condensers and rectifiers.

When measuring the leakage resistance of an electrolytic capacitor, the negative lead from the meter should be connected to the positive terminal of the capacitor, and the ohms × 100 range employed.

Before making resistance tests the pointer should be adjusted to zero in the following sequence:—

1. Set left-hand switch at " RESISTANCE ".
2. Join leads together.
3. On the Ω range, adjust to zero by means of the knob marked " ZERO Ω ".
4. On the " Ω ÷ 100 " range, adjust to zero by means of the knob marked " ZERO Ω ÷ 100 ".
5. On the " Ω × 100 " range, adjust to zero by means of the knob marked " ZERO Ω× 100 ".

To test a resistance, set the right-hand switch at the range required, the leads being connected across the unknown component.

Resistance is read directly on the " Ω " range, but indications should be divided or multiplied by 100 on the other two ranges.

If on joining the leads together it is impossible to obtain zero ohms setting, or if furthermore the pointer position will not remain constant, but falls steadily, the internal battery or cell concerned should be replaced. It is important that a discharged unit should not be left in the instrument, since the electrolyte might seep through and cause damage to the meter.

NOTE. It can so happen that a 15-volt battery may age in such a manner that although it indicates a potential of 15 volts, its internal resistance has increased so much that some loss of accuracy can occur on the high resistance range (Ω×100). If the battery has been in use for some time, or if errors are suspected on the high resistance range, it is worth while *removing* the battery and checking its short circuit current on the 100mA. d.c. range. If the battery fails to give a reading greater than 5mA. it should be discarded.

INSULATION RESISTANCE MEASUREMENT

Two courses are open, the first merely calling for a battery or other source of d.c. voltage in the order of 130V. to 160V. The left-hand switch should be set at " RESISTANCE " with the right-hand switch at " INS " and the meter leads should be connected to the battery. The pointer should be brought to zero on the ohms scale by means of the adjuster marked " ZERO Ω × 100 ". To test, connect the unknown resistance in series with the meter and its value will be that shown on the ohms scale multiplied by 1,000. Resistances up to 200 megohms can, therefore, be read on this range.

The alternative method makes use of the " Model 8 Resistance Range Extension Unit," described later.

LOW RESISTANCE MEASUREMENT

The meter setting marked L.R. is for use with the Model 8 Resistance Range Extension Unit. The method of use is described in the section upon accessories.

DECIBELS

The decibel scale can be used with any of the a.c. current or voltage ranges. It has a logarithmic scale shape and is useful in so far that it gives a measurement closely related to the impression of aural intensity in sound reproduction apparatus. A difference of one decibel is about the minimum difference which can be appreciated when comparing two intensities. For convenience, the scale is marked in decibels both positive and negative from a reference point. The difference in level between a negative value on the dB. scale and a positive one is the sum of the two, i.e. the difference between −5 dB. and +6 dB. is 5 + 6 = 11 dB.

It will be appreciated that when changing from one current or voltage range to the next higher, the pointer indication will fall, although input is kept constant. For a current or voltage range ratio of $2\frac{1}{2}$: 1 this corresponds to a reduction of 8 in the indication on the dB. scale. It follows, therefore, that 8 should be added to the reading every time an increase of $2\frac{1}{2}$ times takes place on the range. In the same way, 12 should be added for an increase of 4 times on the range, or 8 + 12 = 20 dB. for an increase of $2\frac{1}{2} \times 4 = 10$ times in the range ratio.

The following might serve as an example: Suppose that the meter is connected on the 25V. a.c. range across the primary of an output transformer and that a reading of +9 dB. is indicated (corresponding to 12·5V. on this range). If now the output increases to say 40 volts, necessitating a change to the 100V. a.c. range, the pointer will indicate +7 on the dB. scale.

The 4 : 1 increase in the voltage range calls for an addition of 12 to the dB. indication, so that its true value represents +19 dB. The increase over the original reading is 19−9=10 dB.

ACCESSORIES

D.C. Voltage Multipliers

10kV D.C. Multiplier

A 10kV. d.c. Multiplier has been developed mainly to enable tests to be carried out in television circuits. The multiplier should be connected in series with the meter on its 2,500V. d.c. range, in which state maximum consumption on measurement cannot exceed 50 microamps, and may be considerably less. It is recommended that the meter is kept as near earth potential as possible, and the multiplier used at the high potential end, e.g., when measuring an E.H.T. voltage where the negative line is earthy, the multiplier should be connected between the point of positive potential and the positive terminal of the meter, the negative lead being connected to the terminal marked 2,500V. d.c.−. We do not recommend, in such cases, connecting the multiplier to the 2,500V. d.c.− terminal and pressing the moving coil reverse button, notwithstanding the fact that the meter is at the earthy end of the circuit.

25kV D.C. Multiplier

A 25kV. d.c. Multiplier is available for use in series with the meter set to its 10V. d.c. range, readings being made direct in kV on the 0-25 scale. It is *most* important to ensure that the meter is kept in the earthy end of the circuit and the multiplier connected to either the positive or negative terminal whichever is at high potential. This method of connection to get forward pointer indication with the meter earthy is recommended as we do not think it desirable to use the moving coil reverse button when measuring high voltage.

In general we recommend that neither the meter, multiplier nor leads are handled whilst high voltage tests are in progress, and a special lead is provided with the multiplier for connection to the high potential point.

NOTE. The 2,500V d.c. range is not employed when using this multiplier.

Resistance Range Extension Unit

This device enables the meter to be used for both high and low resistance measurements. It is complete with batteries (except in some instances) and switching to facilitate tests. The device should be connected to the lower terminals on the meter.

For high resistance the meter is set to the " $\Omega \times 100$ " position, the Unit switch at the " SET " position and the unknown resistance should then be connected to the " High " terminals. Adjustment to full scale deflection should be performed by means of the " ZERO $\Omega \times 100$ " knob. The Unit switch should then be rotated to " TEST ", and the reading on the ohms scale noted. Its value is that shown multiplied by 1,000 corresponding to a range of 200 megohms.

On the low range the Unit switch should be placed at " SET ", the unknown resistance connected to the " Low " terminals and adjustment to full scale deflection carried out by means of the " ZERO Ω " knob. The Unit switch should then be moved to position marked " TEST " and the pointer deflection on a uniformly divided scale noted. Full scale deflection corresponds to $2\frac{1}{2}$ ohms.

In order to avoid discharging the batteries, immediately tests have been completed the test leads and resistance should be removed from the unit, its switch set to the " low set " position, and the unit disconnected from the meter.

Replacements: 1·5V. Cell—$1\frac{3}{8}''$ dia. $\times 2\frac{3}{8}''$, such as Ever Ready (or overseas, Berec) U.2
Four 30V. batteries—$1\frac{1}{32}'' \times \frac{5}{8}'' \times 2\frac{9}{16}''$, such as Ever Ready B.123.

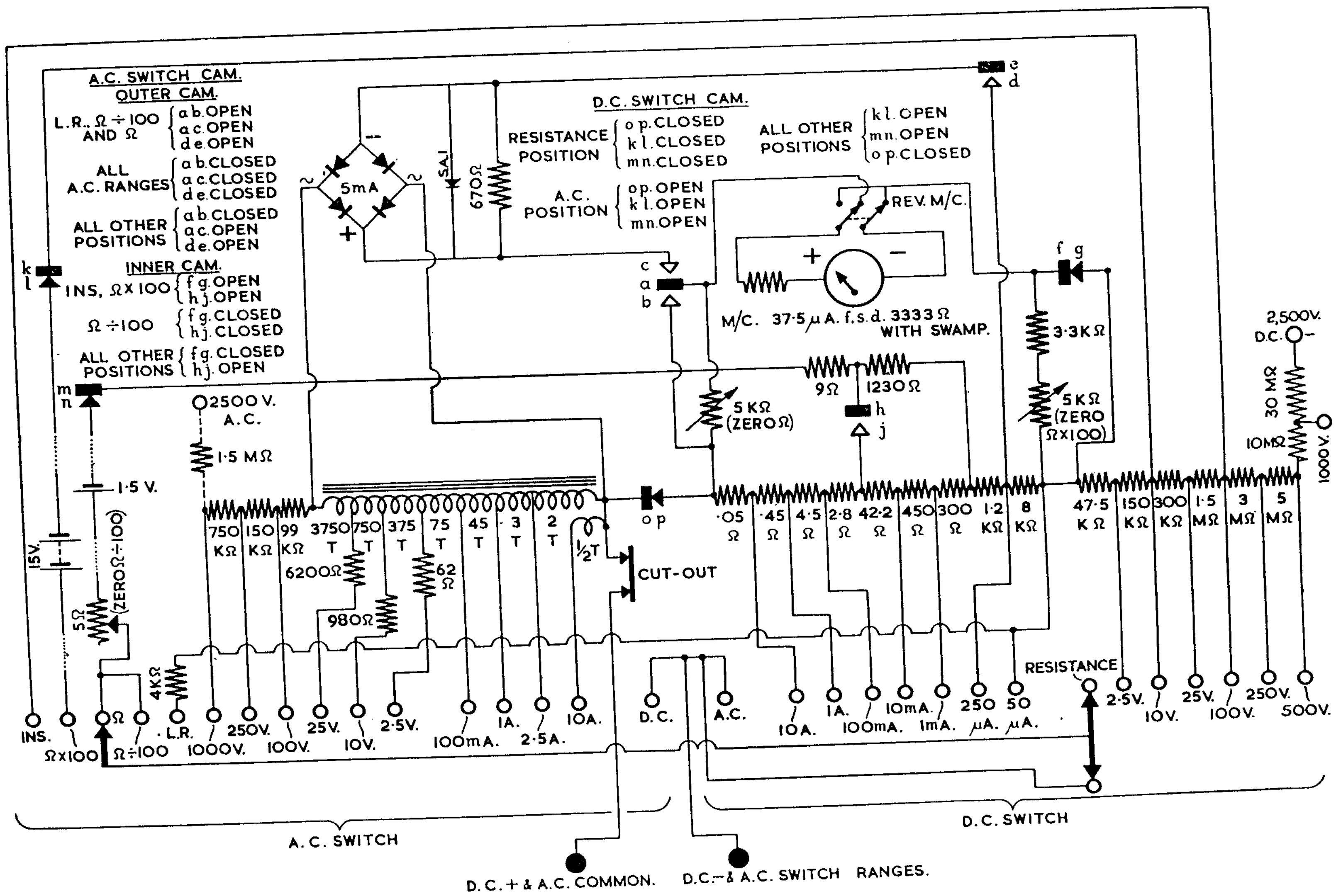
Transformers

Transformers as used on the Model 7 AvoMeter are equally applicable for use with the Model 8, when set to 100mA. a.c. It is necessary to connect the meter up to the secondary of the transformer before current is passed through the primary, and care should be taken that the cut-out is in position. If this course is not followed, quite a considerable voltage will appear at the secondary terminals, if current passes through the primary. Transformers for 50 amp., 100 amp., 200 amp. and 400 amp. are available.

CONCLUSION

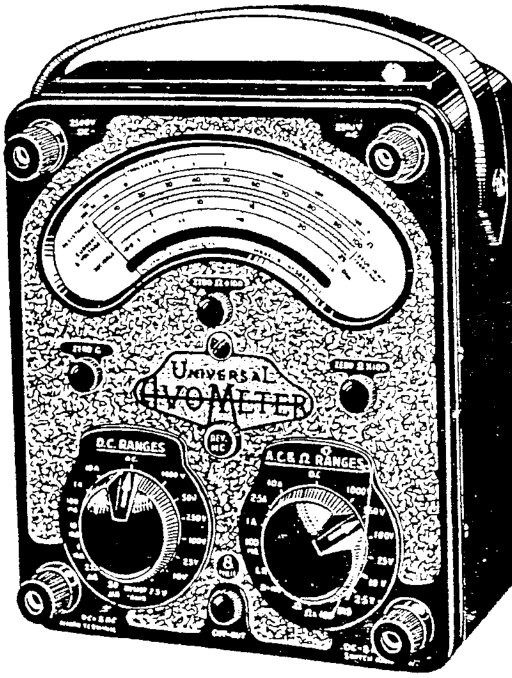
Due to the high operational standards maintained throughout our organisation, and the close limits within which we work, breakdowns are comparatively rare, and can often be traced to transit damage or careless handling, for which the Company cannot be held responsible. Should you at any time have to return your instrument to the Company for repair, pack it carefully and enclose a note informing our engineers of the faults which you have found.

E. & O. E.



CIRCUIT DIAGRAM OF THE MODEL 8 AVOMETER MK. II

Model 8 Avometer Marks 1 & 2



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SECTION

POSSIBLE FAULTS AND USEFUL SERVICING INFORMATION

PHOTOGRAPHIC PLATES AND PARTS LISTS

AVOMETER MODEL 8   MARKS 1 & 2

Through the years, the Avometer has built for itself an unrivalled reputation for reliability and service. It is, however, inevitable that instruments fail from time to time, mainly due to accidental misuse, and when they do we are most anxious to ensure that they are repaired to the highest possible standard It is hoped that this publication will form a useful guide to the trained engineer who has the task of servicing Avo products. The instrument has not been dealt with in absolute detail, but it has been assumed that the reader has a good knowledge of the principles of moving coil multi-range instruments.

The Model 8 Avometer has been 'broken down' in such a manner that an engineer with a limited amount of test-gear and tools, can take factory pre-calibrated parts and fit them into the instrument, which will then only require a minimum degree of calibration and test.

Please note particularly the advice which is given throughout this booklet on the use of complete sub-assemblies. Avo strongly advise you to keep in stock a number of key items, in order that they can be immediately available when required (certain sub-assemblies marked '†' in the parts list, can be returned to your stock for a moderate charge

Procedure for Ordering Spare Parts

If you will kindly follow the procedure set out below, delays will not occur due to the exchange of unnecessary correspondence:-

1. Study this manual carefully, and identify the part(s) required from the illustrations.
2. State the reference number of the part(s), also the quantity required, e.g. if 3 complete Model 8 Avometer transformers of the type shown on Plate 3, item 2 are required, your order should read 'quantity 3-3/2/8'.
3. State the Serial Number of your instrument, if known. This will be found either on the instrument scaleplate, or upon a label on the exterior of the instruments.

White figures against a black background on the photographic plates (occasionally shown in a rectangle) refer to complete sub-assemblies. Letters in italics against reference numbers on the photographic plates cross-reference the physical position of resistors with their position of resistors with their position in the theoretical circuit diagram shown on Plate 8.

Overseas users should send their requirements to their local Avo agents. In the United Kingdom, application should be made direct to Avo Limited in Dover.

AVOMETER MODEL 8 MARKS 1 & 2

1. Suggested Repair Procedure.

When the instrument arrives for repair, examine it carefully, and note any signs of damage which might have been caused whilst the instrument was in course of transit to you (we assume here that the instrument has not been brought to you by hand). Do not proceed with any repairs apart from internal inspection until, (a) you have received your customer's observations regarding the failure of the instrument, and (b) you are quite sure that the instrument has not suffered damage since it left your customer. Severe transit shocks can sometimes damage instruments internally, although externally they appear to be perfect. Always give your customer full details of any suspected transit damage, particularly when the damage to the instrument is more serious than that reported by him. Your customer may wish to claim financial damages from the carrier who shipped the instrument, and in order to assist him you should retain the packing materials in which the instrument arrived. It is also most important that the carriers should be informed of the damage without delay.

If your customer has not told you specifically to go ahead with the repair, irrespective of your charge, we strongly advise that you should examine the instrument and submit a quotation before any work is carried out. (Do not overlook the condition of the leads, prods, clips, cell and batteries when quoting). This procedure, and the acceptance of your quotation, will safeguard you against disputes arising over your charge for the work, after the necessary repairs have been completed.

2. Consideration of the Customer's Report, and the Opening of the Instrument.

If the customer has complained about trouble on the resistance ranges only, examine the batteries before opening the instrument, for testmeters requiring no more than the replacement of batteries, are often returned for repair. Take particular note of Section 17 which deals with the state of the 1.5 volt battery and cell. If the battery or cell is found to be exhausted, the instrument should nevertheless be tested throughout before being returned to its owner (see Section 5).

Before opening a meter to perform work, ensure that you are located in a dust free room, cover the bench with white paper or some other light material, have a number of small receptacles available into which parts can be placed, and ensure that you have adequate light in which to work. We have set out below, a short list of tools and test gear which will form your minimum requirements, assuming that you adopt our suggestion to fit new sub-assemblies. If you decide to undertake the more complicated tasks, then very much more equipment will be required.

Instruments and Test Gear.

- Suitable precision voltmeters A.C. and D.C.
- Suitable precision ammeters A.C. and D.C.
- An ohmmeter or a spare AvoMeter.
- A Resistance box.
- A wheatstone bridge.
- Controlled voltage and current supplies.

Tools.

- A small soldering iron.
- Tweezers suitable for light work on moving coil hairsprings etc.
- A set of BA box spanners.
- A set of open-ended BA spanners.
- A pin or tack hammer.
- An eye glass.
- A set of watch maker's screwdrivers.
- A hand drill.
- A set of twist drills from approximately $\frac{1}{4}$" (6.4mm) diameter downwards.
- One of each of the following taps:— 2 B.A., 4 B.A., 6 B.A. and 8 B.A.
- Pliers (various sizes)
- A pair of side cutters.
- Camel's hair pencil brushes.
- A pair of Duck-Bill pliers.

Spare Parts.

- A stock of AvoMeter spares.
- A stock of recently manufactured appropriate cells and batteries.

Miscellaneous Items.

A reel of good quality 60% tin, 40% lead, 16 S.W.G. (·064", 1·6256 mm.) cored solder such as "Ersin Multicore".
A reel of good quality 60% tin, 40% lead, 16 S.W.G. (·064", 1·6256 mm.) solid solder wire for soldering hairsprings.
A mapping pen and Indian Ink.
A bundle of pith.
Some small sticks of orange wood.
A stick of Chatterton's compound.
A tube of "Bostick" glazing compound.
Supplies of various gauges of insulated copper wire.
A number of steel needles and non-ferrous pins.
Thin mineral oil. White cellulose paint.
Methylated spirit. Cellulose thinners.
Carbon Tetrachloride. Trichlorethylene.
Cleaning cloths.

Having assured yourself that the instrument does require opening (see the notes which follow for your guidance in fault finding), it should be placed on the bench before you, and the "AVO" seal removed from its side. The head of the sealing screw is located beneath the wax seal.

During manufacture, the front panel is inserted into the case under pressure, and therefore, when removing the panel retaining screws, slight pressure on the panel will not only simplify and speed up this task, but will also avoid the case being cracked as the screws are being removed. Since some meters are fitted with screws not all the same length, it is advisable to place them on the bench in such a manner that they may be returned to their original positions when the instrument is reboxed. The panel may now be removed vertically from the case, turned on its face and examined. Since this is the position which the instrument will occupy for some time on the work bench, it is advisable to place small pieces of cotton or cellophane adhesive tape over the switch and terminal knobs to avoid their becoming defaced.

The fault may at once be apparent by signs of scorched windings, burnt contacts etc., but intermittent contact trouble and component failure may be a little more difficult to locate. One should, therefore, with the aid of the circuit diagram, trace through the suspected part of the circuit wiring by means of an Ohmmeter or another AvoMeter until the fault is located.

3. The supply of Interchangeable Parts.

Reference to the parts lists facing the photographic illustrations and modification sheets, will show that the instrument has been "broken down" in such a manner that all parts which may suffe. electrical or physical damage can be replaced. We have not shown every small component, pillar, nut, and bolt, for such items seldom suffer damage. Components such as leaf switches, which are uneconomical to rebuild, have been supplied as complete sub-assemblies.
We would ask you to take particular note of the following sub-assemblies :—

(a) The Bottom Resistance Board (Plate 3, Item 1).
(b) The Top Resistance Board (Plate 3, Item 17).
(c) The Movement (Plate 2, Item 2).
(d) The Cut-out Table Mechanism (Plate 6, Item 9).

The first two items (a) and (b) incorporate numerous resistors which have been carefully calibrated well within the limits shown in this publication. If any of these resistors become damaged and you have the necessary measuring apparatus available to check carbon resistors, wound bobbins or windings, individual components can be replaced, but *if you have not the necessary test gear, or are in any way in doubt, replace the whole board.* The original board should then be returned to us for repair and subsequent return to your stock for future use.

The latter two items (c) and (d) are not only carefully made (and precision calibrated in the case of the Movement), but they contain many matched parts which may present mechanical, as well as electrical problems if individually replaced. Again, *if you have not all the necessary apparatus at your disposal to carry out repairs to either assembly, replace the whole unit. Item (c) may be sent to the factory for repair and return to your stock.* We cannot stress too strongly the advisability of using factory set-up sub-assemblies, and we do in particular, urge you to replace a faulty movement with a new one, for so many difficulties can arise if you are not fully equipped and skilled in this delicate work. The factory employs special jigs, fixtures and tools for the assembly of the two sub-assemblies enumerated above, and without their aid, some repair tasks become most difficult. The notes which follow regarding these particular components will enable you to decide how to proceed.

NOTE

When carrying out repairs to an instrument, it is good practice to remove the movement from the panel, put it carefully to one side where it will not be damaged, and only return it to the panel when all soldering and mechanical work has been completed.

Instruments for use in a temperate zone are usually calibrated at an ambient temperature of 20°C. (68°F.), whilst instruments for use in hotter climates are normally calibrated at an ambient temperature of 35°C. (95°F.).

4. The Bottom Resistance Board (Plate 3, Item 1).

This board, details of which are shown on Plate 5, carries the various shunt windings, and some A.C. voltage multiplying resistors (the reader will notice that the physical location of the windings and the resistors throughout the meter are cross-referenced with the circuit diagram).

Where windings are burnt, they can either be re-wound, or the whole board replaced. Replacement parts supplied by the factory are pre-calibrated, except resistors "h" & "i" which should be adjusted when wired into the instrument. If part of the universal shunt (total value 10,000Ω comprising resistors "m̄,n,o,p,q,r,s,t", and "u") across the movement is burnt, and you are quite sure that neither the movement nor any other part of the instrument has been damaged, (or if there was damage, it has been repaired), then proceed as follows :—

The damaged shunt section should be re-wound and calibrated to the value stated, or the whole board replaced. After this has been carried out the instrument sensitivity should be checked by switching the meter to its 50μA D.C. range, passing 50μA D.C. through the instrument, (or if exactly 50μA cannot be obtained, a metered value near to it will suffice), and making slight adjustment if necessary to the magnetic shunt, (Plate 3, Item 8) until the AvoMeter agrees with the calibrating instrument.

If movement of either the " Ohms " or " Ohms x 100 " control varies the pointer indication when the instrument is carrying 50μA on this test, the leaf contacts a,b,f, and g, should be adjusted since these are not operating correctly. If the 10A and 1A ranges have been rewound or the whole board has been replaced adjustment to these windings will be required. Set the instrument to its 10 amp D.C. range, pass 10 amp D.C. (or near) through it and adjust the tapping of the 10 amp winding (m. Plate 5, Item 11) until the AvoMeter agrees with the calibrating instrument. The instrument should now be set to its 1 amp D.C. range, and the 1 amp D.C. tapping (n. Plate 5, Item 10) adjusted in the same way, using a current of 1 amp D.C. (or near). The adjustment of these tappings does not alter the total 10,000Ω resistance of the whole shunt, for we are merely tapping in upon the shunt with pieces of copper wire at the appropriate points. Where a complete board has been replaced, resistors " h " and " i " Plate 5, Items 2 & 3 (which are supplied slightly overwound) should now be adjusted. This is done by setting the instrument to its 10 volts A.C. range, connecting a 10 volts A.C. metered source across the instrument, and removing some of the wire from resistor "h" (decreasing the resistance of the winding increases the AvoMeter reading) until the AvoMeter agrees with the calibrating instrument. In a similar manner the instrument should now be set to its 2.5 volts A.C. range, connected across a 2.5 volts A.C. metered source and the resistor "i" adjusted until the AvoMeter agrees with the calibrating instrument. The windings should finally be brushed with shellac.

5. The Top Resistance Board (Plate 3, Item 17).

This board, shown in detail on Plate 4, carries most of the voltage multipliers, and the rectifier(s). The mulipliers employ high-stability carbon resistors, brought up to the required value by means of low value, lower tolerance resistors. Damage in this multiplier network can be made good either by replacing the whole board, or by the insertion of factory pre-calibrated resistors or bobbins.

Some instruments incorporate a bridge rectifier (Plate 4, Item 9) rated at 5mA, whilst others embody a smaller unit rated at 1mA. These two types of rectifier are interchangeable provided that use is made of spare rectifiers supplied from the factory. The rectifiers supplied as spares are specially selected, and the instruments will normally not require re-calibration following the replacement of a rectifier. All instruments arriving for repair should be checked to ensure that the voltage limiting rectifier (Plate 4, Item 11) is fitted. This component is a surge absorbing rectifier, which offers additional protection to the bridge rectifier which might otherwise be punctured by peaky voltage transients which sometimes occur in circuits under test.

6. The Cut-out Table Mechanism (Plate 6, Item 9).

Spare contacts for the cut-out are available and present no difficulty in fitting. Do however, ensure that all contacts are clean and seat correctly. The contacts are arranged in such a manner that when the cut-out is re-set, the outer contacts make first, and the gold-silver contacts last. When the cut-out trips, the inner contacts should move from their static position by $\frac{1}{32}$" (0.79 mm.) before breaking thus transferring the current to the outer contacts which should break after a further movement of $\frac{1}{32}$" (0.79 mm.). The arcing therefore takes place between the outer contacts and safeguards the inner gold-silver contacts which must always maintain low contact resistance when the cut-out is closed.

Individual mechanical spare parts for the cut-out mechanism can be fitted if the necessary skill and facilities to carry out the work are available, but it must be stressed that the rebuilding of this mechanism is not as easy as it would at first appear to be, and it is often more economical to purchase a new assembly, and to discard the old.

Where a completely new cut-out assembly is supplied, some difficulty may be experienced in fitting the screw, Plate 6, Item 24, and the cut-out guide pillar, Plate 6, Item 18. Modern assemblies use 6BA threads in these positions, whereas, older models use 8BA threads. If the original pillar and screw have been retained, they can usually be fitted to the new assembly, but if they have been lost or damaged, then the holes in the panel will have to be drilled and tapped 6BA before the new assembly can be fitted. In the same manner, when a new panel 7/1/8 is ordered, you should also request Part Nos. 6/18/8 and 6/24/8, in order to ensure that the existing cut-out table mechanism can be fitted to the new panel.

7. The Movement (Plate 2, Item 2).

The movement is hand calibrated after its final assembly, and *any* replacement parts added to it are likely to upset its performance. Spare hairsprings and pivots can be supplied if required, but we would stress that both these items are difficult to fit, and such work should not be attempted unless adequate facilities, tools, jigs, fixtures and the necessary skill are all available. The moving coil complete with hairsprings and pivots can also be supplied, but the replacement of such a unit in the movement will demand not only adjustment of sensitivity to 37.5μA, but recalibration of the swamp resistance and probable rewriting of the scale plate, in order to obtain the original accuracy. The fitting of a new moving coil will also necessitate the re-balancing of the movement whilst the magnet may have to be remagnetised and aged before the sensitivity of 37.5μA can be set.

If it is decided to build new parts into the movement assembly, ensure that the two nuts (Plate 3, Item 16) holding the magnetic system together are never removed. If this direction is ignored, much of the magnetic flux will be lost, and the assembly will require re-magnetisation.

In view of the difficulties set out above the desirability of fitting a complete replacement movement is self-apparent. When a movement is changed, always ensure that the serial number (if any) marked on its scale plate is transferred to the scale plate of the replacement movement.

To remove the movement, unsolder the connection on the magnetic system (Plate 3, Item 15), and the connection to the swamp bobbin (Plate 3, Item 11), mounted on the movement itself. Remove the two holding screws (Plate 3, Item 13), one at either side of the movement.

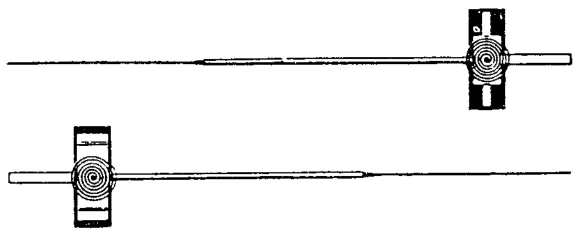
NOTE.

Be most careful to ensure that ferrous objects such as screwdrivers are not allowed to touch the magnetic system, which also must never be knocked or tapped. Failure to observe these precautions may result in a loss of magnetic flux. The magnetic shunt is only capable of introducing a maximum adjustment of ten divisions on the 100 division scale, and if loss of strength occurs, it may be impossible to make adjustments to the magnetic system as given in Section 4.

Once the movement has been removed from the panel, the frame carrying the moving coil can be removed from the magnetic system in order that the moving coil itself can subsequently be extracted from the assembly for any necessary attention. The 10BA screw (Plate 2, Item 7) on the back of the magnetic assembly should be carefully removed together with the leaf spring (Plate 2, Item 6). Unsolder the lead from the bottom hairspring adjustor (Plate 3, Item 10), remove the two 8 BA screws securing the frame to the pole pieces, turn the bottom hairspring adjustor into line with the bracket holding the bottom jewel screw, and withdraw the frame complete with the moving coil still mounted in its jewels. If the hairsprings (Plate 2, Item 14) are now unsoldered, the bottom jewel screw and locking nut slackened, and the two screws (Plate 2, Item 5) securing the bridge-piece which carries the top jewel screw slackened off considerably but not removed, the moving coil can now be taken away from the frame.

The reversal of this procedure will enable the movement to be rebuilt, but the following points should be observed. Before re-mounting the moving coil, the pivots and jewel screws should be cleaned as recommended in Section 10. If new hairsprings have been fitted, it is most important that they are orientated correctly, and the illustrations below give the information required for this to be done.

Moving coil assembly viewed from above.



Moving coil assembly viewed from below.

When refitting, great care must be taken to ensure that the hairsprings and pivots are not damaged. The coil should be correctly positioned as the jewel screws are tightened, the final setting being such that a minute looseness remains. The position of the coil about the concentrator should be such that on depressing the coil in either direction it cannot leave the spring jewels.

After replacing a movement in the panel it is always necessary to reset the cutout mechanism (see sections 11, 12 and 13). Great care must also be taken to ensure that the movement does not touch the resistor "x" item 35 plate 6.

NOTE.

Hairsprings should always be tinned at their ends and de-greased before mounting. *Never use a flux paste, resin or resin cored solder* since flux deposits will eventually cause hairspring turns to stick together in service. If trouble due to sticky hairsprings does make itself apparent they can be cleaned with Trichlorethylene or Carbon Tetrachloride, using a fine camel's hair brush.

POSSIBLE FAULTS AND USEFUL SERVICING INFORMATION

8. Moving Coil Will Not Move.

If the instrument is subjected to most severe shock, it sometimes happens that the moving coil is thrown completely out of its jewels. When this happens, the instrument must be opened, the movement removed, and the pivots and jewels examined for possible damage as set out in Sections 7 and 10.

9. The Movement Needle Tends to Stick at One Point on the Scale.

This symptom usually indicates that a small piece of iron or some other foreign body has found its way into the magnetic gap, and is fouling the moving coil former. The movement should be withdrawn from the meter, examined in a good light against a white background, and any non-metallic bodies removed with a small non-magnetic pin, or iron dust carefully drawn out by means of a thin steel needle. Iron dust in the gap will adhere to the needle, and with a little patient effort, an iron particle can usually be withdrawn.

This "stick" can also be due to the pointer fouling the scale plate. In such instances, the scale plate should be bent away from the pointer to give it adequate clearance.

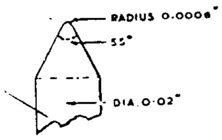
10. The Movement Needle Tends to Stick at All Points Across the Scale.

However well an instrument is constructed, there will always be some measure of friction between its pivots and jewels. If this friction is increased by damage due to impact, it may assume notable proportions, and it sometimes happens that an instrument will give slightly different consecutive readings upon the same test, although tapping the glass makes all readings more or less agree. Such a suspected fault can be found by carrying out the following procedure :—

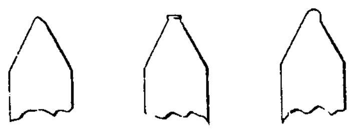
(a) Pass a known current through the instrument, and note its reading.
(b) Reduce the current considerably, and then bring it slowly back to its original value and take a second reading.
(c) Increase the current well beyond its original value, and then slowly reduce it to the value fixed under item (a).

If the differences between the readings are too great to be ignored, the movement will require attention. The trouble is usually due to increased friction in the movement bearings caused by dirt, a blunted pivot or a damaged jewel. Dirt can be removed by cleaning the pivots with pith, and gently inserting the sharp point of a small stick of orange wood into jewel recesses, or by washing the jewel screws in Trichlorethylene. If a pivot is damaged, it will either have to be replaced with a new one, or be given suitable treatment on a watchmaker's lathe. A damaged jewel must always be replaced.

The moving coil should be removed from the magnetic system (as directed in Section 7), and the pivots examined beneath a powerful magnifying glass or microscope. A good pivot will always look like this when rotated, and will have an approximate radius at the tip of .0006" :—



but one that is damaged may look like this :—



Pivots are most difficult to replace, for the coil assembly can easily be broken during this operation, unless suitable pivot extraction equipment is available. Where replacement is necessary, consider the replacement of the movement as a whole rather than its repair.

Following examination of the pivots, and their rectification if required, the jewels should now be checked. Remove each jewel screw in turn, and if a microscope is available (having a magnification of X 50 or better still X 100, if it is at any time to be used for the examination of pivots), mount the jewel screw in a jig with the jewel uppermost, illuminate it well and examine. Cracks and depressions can now be detected, but the operator must be skilled in the interpretation of what he sees. If the jewel appears to be faulty in any way, it should be discarded. Another means of detecting a faulty jewel is to take a fine needle ground to the sharpest possible point, and with it, feel gently around the jewel recess using a circular motion, *virtually no pressure whatever must be placed on the needle during this test, for it should be so sharp that the slightest pressure from the fingers will blunt its point.* The recess in a good jewel is conical and rounded at its extreme base, and therefore, no resistance to the needle point will be felt if the jewel is in good order. If, however the jewel is cracked, or the polished surface shattered, these symptoms will be detected quickly by the sensation of roughness transmitted to the fingers.

11. The Cut-out Mechanism Fails to Operate.

This mechanism should act when the instrument is subjected to a suddenly applied ten times forward overload, (this figure will be higher on a reverse overload). If the instrument has been subjected to an overload beyond the capacity of the circuit breaker, the cut-out contacts may have become very badly burnt, and these will have to be replaced. Whilst mentioning badly burnt instruments may we remind you to thoroughly clean any soot deposits from meters so damaged. Soot (carbon) is an electrical conductor and a film of soot anywhere within the instrument may so reduce its insulation that incorrect readings will be produced.

If the cut-out mechanism fails to operate when a 10 : 1 overload is suddenly applied, then the cut-out mechanism is probably set too coarsely. Remove the panel from the case, place it on the bench before you with its components uppermost, and slacken the screw (Plate 6, Item 24) and the pillar (Plate 6, Item 18,). Turn the cut-out table (Plate 6, Item 25) clockwise by a minute amount until the push rod (Plate 6, Item 15), is near enough to be actuated by the spring (Plate 2, Item 6) when a 10 : 1 overload occurs. The screw and the pillar should then be securely tightened down once again.

Occasionally, a customer will return a damaged instrument with a note to the effect that the cut-out mechanism failed to operate. In many instances however, the instrument has not only been overloaded as regards range, but has had A.C. applied when set to D.C. or vice versa. It can however, happen that a sustained overload less than ten times full scale deflection applied to one of the higher current ranges for a prolonged period, or alternatively, a slowly increasing overload which may exceed ten times full scale deflection, can cause overheating of the shunts.

One further instance where damage can occur is when an extremely high overload is applied to the meter on A.C. (current ranges in particular). In such an instance, the rectifier is sometimes punctured before the cut-out has had a chance to operate. A sudden D.C. discharge (such as would be obtained from a condenser) passing through the meter when it is set to A.C. can have the same effect. (See Section 5 regarding the incorporation of a surge limiting rectifier).

It is sometimes possible to check the accuracy of the customer's statement that the cut-out did not function by the examination of soot deposits caused by severe arcing. The range upon which the overload actually occured can sometimes also be checked by observing the position of soot deposits in relation to where arcing took place.

12. The Cut-out Mechanism is too Sensitive.

The cut-out mechanism of an instrument will sometimes be found to be so sensitive that it flies out whenever the instrument is touched, This symptom can also occur when making the adjustments mentioned in Section 11, and is usually due to the cut-out table (Plate 6, Item 25) having been turned too far clockwise. The fault may usually be removed by following the procedure outlined in Section 11, but in this instance, the cut-out table must be turned in an anti-clockwise direction.

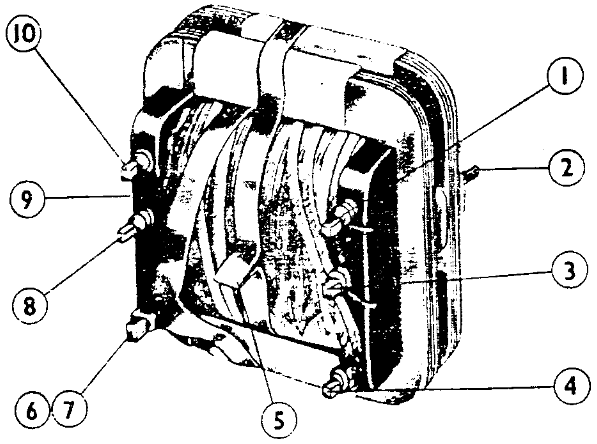
13. The Cut-out Button Refuses to Stay Set.

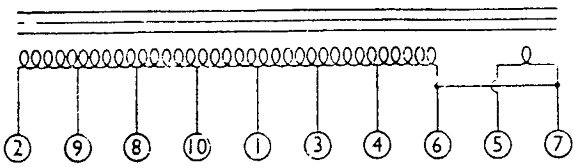
This trouble may be due to the cut-out mechanism having been set too sensitively, or alternatively the pallet stone fitted into the crank (Plate 6, Item 16), may have been broken. In the latter case, either the whole cut-out table mechannism will have to be replaced, or a new crank fitted, provided that adequate facilities are available for its final adjustment. Do not presume that the observations of your customer are necessarily correct. The mechanism will only satisfactorily re-set when the instrument is lying face uppermost, and before steps are taken to make adjustment, always place the instrument in this position and carry out tests of your own.

14. The Instrument Fails to Read, or is Low on All A.C. Ranges, but is Correct on D.C. Ranges.

This fault may be due to insufficient pressure on the leaf contacts (Plate 6, Item 34), which should be checked, cleaned and re-set if necessary (See Section 20). (Under no circumstances must abrasive material be used to clean contacts. The shape of the contacts must not be altered). If the contacts are in order, the rectifier should be replaced by another, (See section 5) and if this action fails to cure the trouble, the transformer may need replacement. This component can be removed by unsoldering its connections, and removing the bolt which runs through its centre. The installation of either of these two components may necessitate the recalibration of the 2.5 V and 10 V A.C. ranges as set out in section 4.

Connections to transformer tags are given below :—





1. Connected to 100mA contact " A.C. and Ω ranges " Switch.
2. Connected to 99KΩ Resistor.
3. Connected to 1A Contact on " A.C. and Ω ranges " Switch.
4. Connected to 2.5A contact on " A.C. and Ω ranges " Switch.
5. Connected to 10A contact on " A.C. and Ω ranges " Switch.
6. Connected to dead side of cut-out. } one tag carrying two leads.
7. Connected to rectifier. }
8. Connected to 950Ω winding (h).
9. Connected to 6.2KΩ resistor (g).
10. Connected to 62Ω winding (i).

15. Intermittent Fault.

One sometimes meets an instrument which the customer claims is reading inaccurately, yet when it is placed on the test bench no fault can be found. This symptom can be caused by a dry joint (a badly soldered joint) and calls for patient examination of the circuit. Due to special precautions taken in our factory, this fault does not often occur in new instruments, but is sometimes found in meters which have already been repaired where the components have been displaced during fault finding. If the fault is not obvious, it can sometimes be made apparent by applying a sideways pressure to the switch knobs, and pressure applied to the panel whilst taking different types of readings. This procedure will enable you to ascertain whether fluctuation of the pointer occurs.

16. Intermittent Fault Cured by the Operation of the Reversal Switch.

Poor contact may cause intermittent open circuit conditions when the changeover switch is in its normal position. The fault can sometimes be cured by pressing very hard upon the moving coil reverse button, this will bow the contacts in such a manner that they seat down more firmly when the button is replaced. If this action fails to clear the fault the movement must be removed from the instrument, the changeover contacts withdrawn, cleaned and replaced.

17. Errors on Resistance Ranges due to Abnormal Battery or Cell.

It can so happen that the 15 volt battery which energises the "Ω x 100 " range, may age in such a manner that although it has an E.M.F. of 15 volts, its internal resistance has increased so much that some loss of accuracy can occur. If the battery has been in use for some time, or if errors are suspected on the high resistance range, it is worth while *removing* the battery, and momentarily checking its short-circuit current on the 100mA D.C. range. With a good battery, up to 200mA may be obtained, which will not harm the 100 mA range of the instrument. If the battery fails to give a reading greater than 5 mA, it should be discarded. If the instrument fails to hold its " ohms zero " for a resonable period with the leads shorted together on the low resistance range, the 1.5 V cell requires replacement.

18. Instrument Reads Low on all Ranges

When an instrument is subjected to severe shock, (such as it may receive during transit), it sometimes happens that individual turns of the hairsprings become caught up upon one another causing the instrument to read low. Upon opening the instrument, the confused appearance of the hairspring(s) will at once be apparent. A non-ferrous pin should be inserted between the turns of the hairspring nearest its centre, and guided to follow the turns outwards in a rotary motion towards the periphery of the spring. The turns will be automatically released unless the hairspring has been badly deformed. A slightly damaged hairspring can sometimes be renovated with the aid of a small pair of tweezers, but a really badly deformed spring will have to be replaced. (See Section 7).

The same symptom may be caused by hairs on the hairsprings, or individual turns of a hair-spring sticking together, due to the presence of dirt or some viscous substance. The offending deposit should be removed by Trichlorethylene or Carbon Tetrachloride, care being taken to ensure that drops of the liquid do not fall upon the scale plate where they may cause discoloration.

19. Indicating Pointer out of Balance.

The moving coil is perfectly balanced when the instrument leaves the factory, but very severe overload or mechanical shock may cause it to become unbalanced. The balance can be regarded as being satisfactory if the needle moves from its position of rest by less than 1% of the maximum scale value, when the instrument is held in any position within 45° from horizontal. If the pointer moves outside this limit, withdraw the movement and re-adjust the balance weights, first for horizontal and then for vertical balance. It may be necessary to soften the old shellac securing the balance weights, and pressure from a small, moderately heated soldering iron wiped clean of solder, will usually enable the weights to be moved. Fresh shellac may be required to re-lock the balance weights, but only a minimum amount should be employed, and all spirit evaporated by the application of gentle heat from the soldering iron. If the moving coil assembly has been changed, the new assembly will require balancing as set out above. (It is important to note that abnormal balance behaviour can be due to damaged pivots), whilst errors in vertical balance are often due to a bent pointer. In the latter case correct balance can be restored by bending the pointer from its " root " back to its correct position.

The balancing of an instrument movement calls for a high degree of skill, and once again, we advise that whenever trouble is experienced with the movement, the whole assembly (Plate 2, Item 2) should be replaced, and the original unit returned to the factory for servicing.

20. Resetting Leaf Switches.

The individual springs of these switches some-times fail to make contact correctly. Leaves can be adjusted by bending their extremities up or down by means of a pair of duck bill pliers. The adjustment of these leaf switches sometimes proves to be rather difficult, and in some cases it is more economical to replace the whole contact assembly rather than to spend time on the adjustment of the old one.

21. Removal and Replacement of the Main Switch Assemblies.

Remove the 4BA screw from the A.C. switch cam (Plate 7, Item 12) which can then be removed from the spindle. Set the " A.C. and Ω Ranges " Switch to its 100V position and push pin shown in the brush arm carrier in the photographic illustration of Item 8 on Plate 7. Turn the switch through 180° and if the pin was not dislodged by the initial push remove it with a pair of pliers.

Lay the panel on the bench with its face uppermost. If the "A.C." switch knob is now gently lifted, the click ball will remain supported on its spring (Plate 7, Item 6) whilst the cam and brush arm assembly will fall away from the inside of the meter towards the bench.

To replace the switch, place the cam and brush arm assembly loosely in the correct position within the instrument in the centre of the switch ring, and place the meter on the bench with the panel uppermost. Place a little mineral jelly on the click ball spring and insert it into its hole in the panel. Place a similar piece of jelly into one of the slots on the underside of the switch knob and press the click ball into the jelly. Turn the panel again face downwards holding it in one hand, and push the spindle of the knob up into the panel ensuring that the click ball seats down on its spring and compresses it correctly. Turn the switch knob to its " 100mA " position and place the panel face downwards on the bench with the cut-out assembly towards you. Turn the brush arm until the contacts which run around the switch ring contacts are pointing away from you. Take the carrier pin, and place it in the hole in the brush arm carrier and press it home. The cam and its locking screw should be replaced and set as detailed in Section 22.

The procedure for the removal of the " D.C. Ranges " Switch is similar to that outlined for the " A.C. and Ohms Ranges " Switch, but when replacing the switch assembly the rotary contacts should be pointing towards you when the switch has been set to its " 100mA " position. The carrier pin should now be inserted and the cam replaced as explained in Section 22.

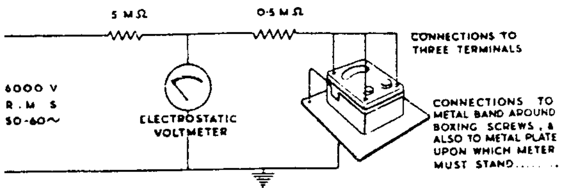
22. Setting the Main Switch Cams (Plate 7, items 3 and 12).

When the " A.C. and Ohms Ranges " Switch is set to " Ω÷100 " both contacts, of the set of leaf contacts nearest to the cut-out, should be lifted to their fullest extent. The cam should be turned until this occurs and the cam locking screw tightened."

When the "D.C. Ranges" Switch is set at "Resistance" the set of contacts nearest the cut-out contacts should be in the lifted position. The cams should be turned until the contacts are in this desired position and the screw in the top of the cam tightened.

23. Flash Testing

Before leaving the factory every Model '8' AvoMeter is subjected to a flash test by applying 6,000 volts r.m.s. 50 c/s, for one minute between the terminals and the case fixing screws. It is advisable that a corresponding test should be given to the instrument after repair, and a suitable circuit which will not cause damage in the event of failure is given below :—



The test voltage should be applied and removed gradually. Indication of breakdown will be given by the failure of the needle of the Electrostatic Voltmeter to rise, or its falling whilst a fixed voltage is applied. It is essential to ensure that the Electrostatic Voltmeter is of the type which draws negligible current.

When reboxing the instrument after repair, particular care must be taken to ensure that the screws used are no greater in length than those which were originally supplied. The use of incorrect screws can cause the breakdown of an instrument on flash test.

24. Limits of Accuracy.

When repairing an instrument your object should be to make it meet the same electrical specification as a new instrument. The limits are as follows :—

D.C. CURRENT RANGES ARE TO THE LIMITS LAID DOWN IN SECTION 6 OF THE BRITISH STANDARD SPECIFICATION 89/1954 FOR 5" (127 mm.) SCALE-LENGTH INDUSTRIAL PORTABLE INSTRUMENTS i.e.,

1% of full-scale value over effective range, i.e. from 10% to 100% of scale.

D.C. VOLTS.

2% of the indication from full-scale to half-scale.

1% of full-scale value below half-scale deflection.

A.C. CURRENT AND VOLTAGE ARE TO THE LIMITS LAID DOWN IN SECTION 6 OF THE BRITISH STANDARD SPECIFICATION 89/1954 FOR 5" SCALE-LENGTH INDUSTRIAL PORTABLE INSTRUMENTS i.e.,

2.25% of full-scale value over effective range, i.e., from 25% to 100% of scale.

Although only the above accuracy is claimed, a new meter comes well within these limits, and maintains a high degree of accuracy at audio frequencies up to 10Kc/s (See the note regarding voltage limitation in the Instruction Manual supplied with instrument).

RESISTANCE

Owing to the nature of the scale it is difficult to define the accuracy over its whole range. It may however, be taken as being within 3% of the reading at the centre of the scale increasing to 10% of the reading at deflections corresponding to 10% and 90% full scale deflection.

25. The Appearance of the Repaired Instrument.

Having ensured that the instrument is perfect electrically and mechanically, do not be content to return it to the customer in a dirty condition. Thoroughly clean the components, and wipe out the inside of the case, taking particular care that no small particles of iron or other foreign substances are left within the instrument. Fit the case to the panel using the original screws, and place your own seal in the recess provided. It is so important that ranges are clearly marked that should the white fillings be defaced, they should be removed and replaced with white cellulose paint applied by means of a very fine brush or mapping pen. The paint should be left to dry, and then rubbed off with a rag slightly damped with methylated spirit. The surplus paint will then be removed without destroying the surface of the fillings, but care must be taken to ensure that surplus paint is not deposited in the "crackle" finish of the moulding.

Take a small stiff bristle or hair brush, give it a very slight dressing of thin mineral oil, and brush out the dirt from the indentations in the mouldings. Place a little thin mineral oil on a piece of clean rag, and thoroughly wipe over the whole of the black mouldings.

This general "brightening up" of an instrument will usually have a most profound psychological effect on the owner of the instrument and immediately conveys to him the correct impression that his meter has received careful and pains-taking attention.

26. FAULT FINDING TABLE

SYMPTOMS	PROBABLE FAULT
No reading on any range.	Leads open circuit, or intermittent; circuit fault. It is useful in diagnosis to note whether current flows in the circuit on current or voltage ranges when no pointer indication is given. Another instrument will of course be required for this test.
Low reading on all ranges.	Hairspring turns caught up or stuck together (see Sections 7 and 18). This fault is sometimes associated with change of zero.
Ohms ranges inoperative, irregular or intermittent.	Battery or cell not making satisfactory contact. "Zero $\Omega \div 100$" rheostat winding tarnished. Faulty carbon potentiometers. Intermittent connection on leads can be diagnosed on a resistance range (preferably the lowest).
No reading on voltage ranges above a determined value.	An open circuit in a resistor beyond the last working range. Note that the three lowest A.C. voltage ranges have independent resistors.
No reading on an isolated current, voltage or resistance range.	Suspect a faulty connection between the switch contact and the shunt, multiplier or transformer concerned.
Pointer checked in its movement at one particular point on the scale.	Piece of dust or other foreign body fouling the movement. It may possibly be in the gap, or on the scaleplate or glass window. (See section 9.)
Small pointer stick which is about the same degree irrespective of the length of pointer deflection.	Blunted pivots, or possibly damaged jewels. (See section 10.)
Movement out of jewels.	Excessive shock has depressed one of the jewels. The moving coil should be removed and the pivots and jewels examined for possible damage. The coil should then be re-swung, and both jewel screws lowered (see section 8) a minute amount in order that further shock will cause the moving coil former to touch the concentrator before either pivot can leave its jewel. (See section 10).
Instability of reading.	Examine leaf switch contacts, main switch contacts, and reverse moving coil switch contacts.
Ohms zero varies shortly after being set.	Examine cell and batteries. (See section 17.)
Correct readings on D.C., but low on A.C.	Suspect faulty rectifier, or transformer. Determine which component is faulty by substitution. (See section 14.)
Cut-out fails to re-set.	Mechanism set too finely, or jewel in bell-crank chipped. (See section 12.)
Cut-out fails to operate.	Cut-out mechanism set too coarsely, operating rod bent, or plunger rod dirty. Do not use oil. (See section 11.)

PLATE 1

Similar item appears on plate number	Item No.	Description	Part No.	Drawing No.
	1	" Zero $\Omega \times 100$ " Control Knob	1/1/8	11207/3
	2	" Zero Ω " Control Knob (identical to item 1)	—	11207/3
10	3	Connecting Lead, Hook ended (black)	1/3/8	20913/A
10	4	Connecting Lead, Hook ended (red)	1/4/8	20913/B
	5	Clip	1/5/8	12381/B
	6	Prod (red) (not illustrated)	1/6/8	11588/A
	7	Prod (black) (not illustrated)	1/7/8	11588/B
	8	Connecting Lead, Plug-in Type (black) (not illustrated)	1/8/8	20913/F
	9	Connecting Lead, Plug-in Type (red) (not illustrated)	1/9/8	20913/E
	10	Set of Hook-ended Leads, Prods and Clips (not illustrated)	1/10/8	16103/N
	11	Set of Plug-in Leads, Prods and Clips (not illustrated)	1/11/8	16103/P

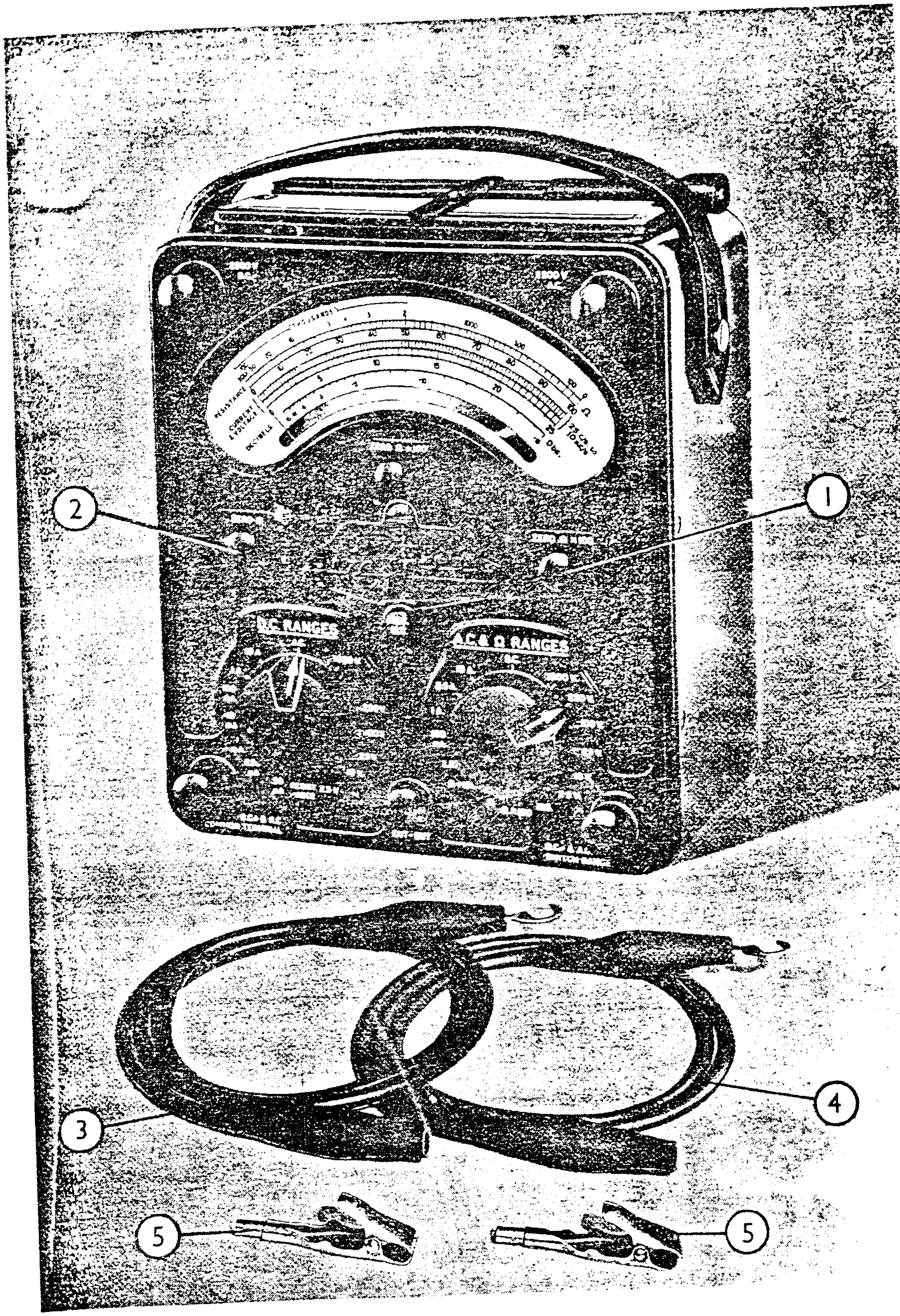

D.C. RANGES
A.C. & Ω RANGES
1
2
3
4
5
5

PLATE 2

SIMILAR ITEM APPEARS ON PLATE NUMBER	Item No.	Description	Part No.	Drawing No.
	1	Window Glass	2/1/8	11215/1
	† 2	Movement Assembly complete (bridged and calibrated)	2/2/8	40638/L
	3	Scaleplate (supplied uncalibrated, i.e. radial lines only)	2/3/8	13574/3
	4	Jewel Screw complete (top). Comprises screw fitted with sprung jewel	2/4/8	20673/B
	* 5	Screws securing bridge-piece	—	
	* 6	Leaf Spring	—	
	* 7	Leaf Spring retaining screw (8 B.A.)	—	
	8	Jewel Screw complete (bottom). Comprises screw fitted with sprung jewel	2/8/8	20673/C
	9	Movement Frame	2/9/8	40289/B
	10	Scaleplate Mirror	2/10/8	12679/1
	11	Moving Coil complete with hairsprings, pivots, pointer and balance weights	2/11/8	20672/A
	12	Pointer	2/12/8	16103/Y
	13	Pivots (pair)	2/13/8	10158/1
	14	Hairsprings with collets (matched pair)	2/14/8	10309/E
	15	Sealing Ring	2/15/8	12382/1
	16	Battery Box resistor Board assembly complete. Old and new assemblies are interchangeable.	2/16/8	20665/A
	17	1.5M Ω resistor calibrated (comprises 2—750K Ω resistors plus supplementary resistor if required)	2/17/8	16103/Q
	18	30M Ω resistor calibrated (comprises 2—14.7M Ω resistors plus supplementary resistor if required)	2/18/8	16103/R
	19	Battery Box Assembly, less resistor board (item 16), batteries and spring (item 31)	2/19/8	40300/D
	20	15V Battery (Ever Ready B/121 or equivalent. Obtain locally if possible)	2/20/8	12379/8
	21	Moulded Case Bare	2/21/8	40396/2
	22	Instrument Carrying Strap	2/22/8	10476/1
	23	Metal Stud for carrying strap	2/23/8	10324/4
	24	Three rubber feet with washers, screw and rivets	2/24/8	
	25	Instruction Plate. (Illustration shows blank side of plate). (English version)	2/25/8	20670/8
10	26	Battery Box Cover	2/26/8	40368/A
	27	Battery Box Prod Retaining Clip	2/27/8	13647/2
	27a	Battery Box Prod Retaining Screw	2/27a/8	13765/4
10	28	Long Reach Safety Clip (Obsolete Replaced by Mk.2 version)	2/28/8	21509/A
10	29	Pair of Prods (red and black)	2/29/8	11588/AB
	30	Moulded Case complete with two metal studs (item 23)	2/30/8	40397/D
	31	Cell Retaining Spring	2/31/8	13341/2
	32	1.5V. Cell (Ever Ready type U.2 or equivalent. Obtain locally if possible)	2/32/8	12379/9
	33	Complete case assembly (less battery and cell) ready to receive front panel	2/33/8	40328/D
	34	Sealing Screw (not illustrated)	2/34/8	S601
	35	Boxing Screws (not illustrated)	2/35/8	S646

* Not supplied as a spare part.

† Damaged assemblies removed from instruments under repair will be accepted for servicing at the factory.

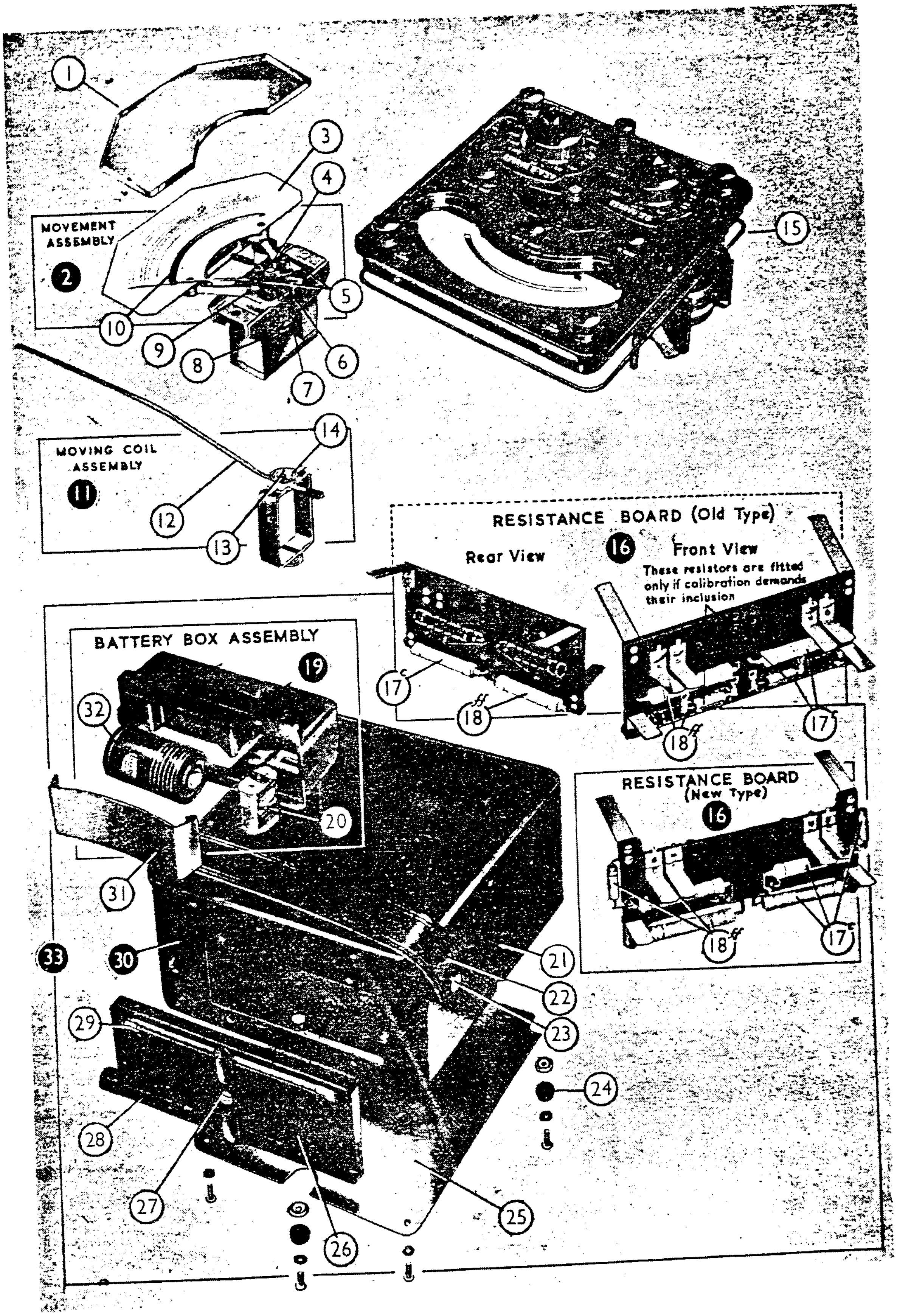

MOVEMENT ASSEMBLY
MOVING COIL ASSEMBLY
RESISTANCE BOARD (Old Type)
Rear View
Front View
These resistors are fitted only if calibration demands their inclusion
BATTERY BOX ASSEMBLY
RESISTANCE BOARD (New Type)

PLATE 3

Similar item appears on plate number	Item No.	Description	Part No.	Drawing No.
	† 1	Bottom resistance board assembly complete (calibrated as far as possible. See Section 4.)	3/1/8	20606/A
	2	Transformer complete	3/2/8	20252/E
	3	Insulating board located beneath transformer	3/3/8	12674/2
	4	750K Ω resistor (calibrated . Incorporates series resistor located beneath potentiometer board)	3/4/8	12049/221/C
	5	Potentiometer, ¼ Watt, 5,000 Ω for " Zero Ω " and " Zero $\Omega \times 100$ " controls	3/5/8	10311/2
	6	Potentiometer board assembly fitted with potentiometer (" Zero $\Omega \times 100$ ") control	3/6/8	20666/A
	6a	Potentiometer Board	3/6a/8	20906/1
10, 9	7	Terminal complete for 2,500V ranges. Comprises knob, stem, washer and pin	3/7/8	13243/A
	* 8	Magnetic shunt	—	
	9	Movement swamp bobbin (uncalibrated)	3/9/8	30006/W
	*10	Lead to bottom spring adjustor	—	
	*11	Swamp bobbin connection	—	
	12	Potentiometer board assembly fitted with potentiometer (" Zero Ω ") control	3/12/8	20666/B
	12a	Potentiometer Board	3/12a/8	20906/2
	*13	Movement fixing screws (one at either side of the movement)	—	
10	14	15M Ω resistor (calibrated). Incorporates series resistor located beneath potentiometer board	3/14/8	12049/222/C
	*15	Connection to movement assembly	—	
	*16	Magnetic system retaining nuts	—	
	†17	Top resistor board assembly (calibrated). See section 5	3/17/8	20607/A
	†18	Ohms strip (calibrated). This board carries two windings: 9 $\Omega \pm 0.05\%$ 32 s.w.g. (0.2743mm.; 0.0108") eureka D.S.C. 20 turns approximately; 1230 $\Omega \pm 3$ Ω 46 s.w.g. (0.0610 mm.; 0.0024") eureka D.S.C. 150 turns approximately	3/18/8	13074/A

* Not supplied as a spare part.

† Damaged assemblies removed from instruments under repair will be accepted for servicing at the factory.

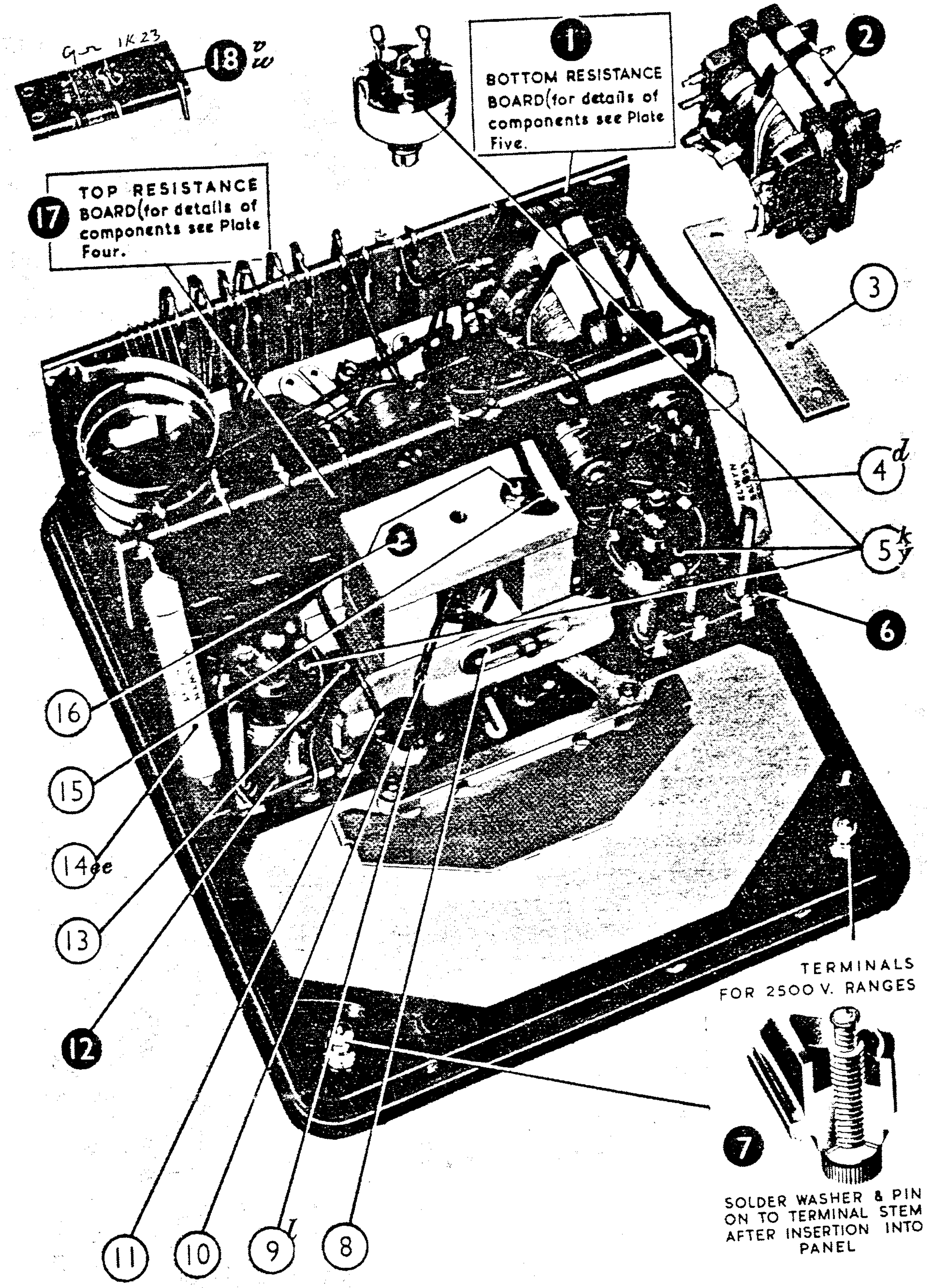
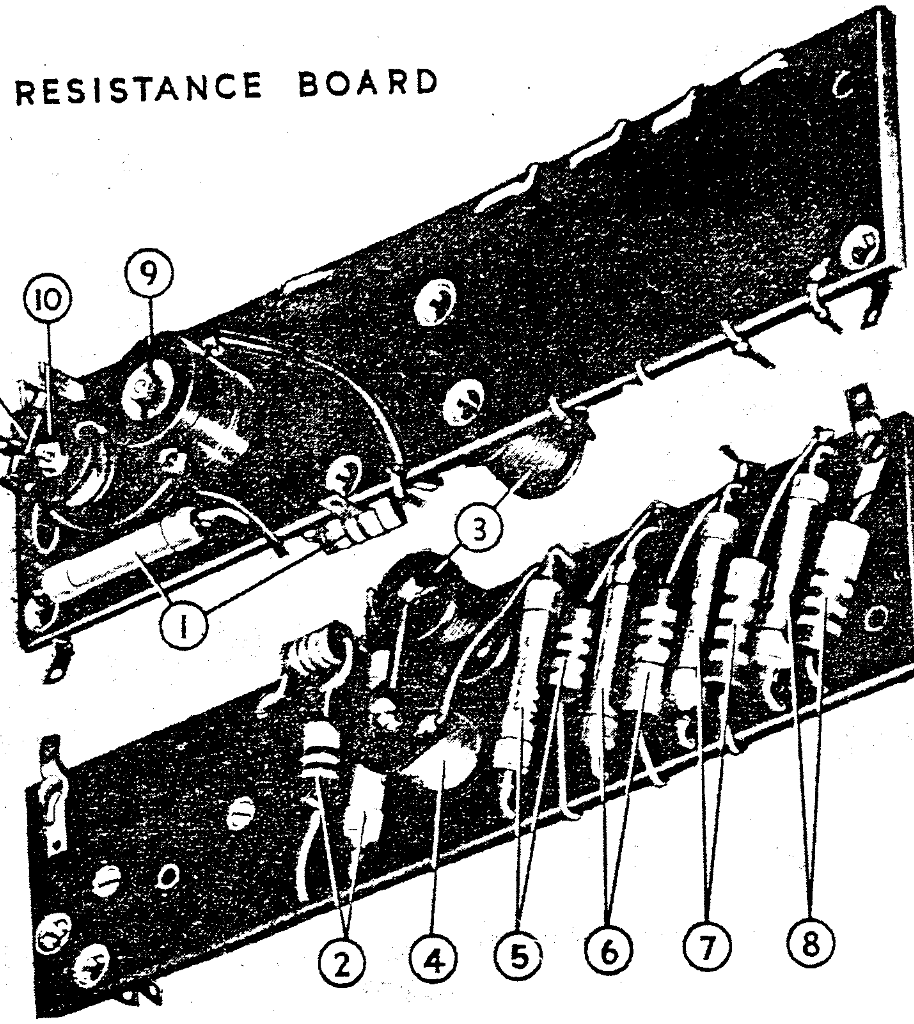
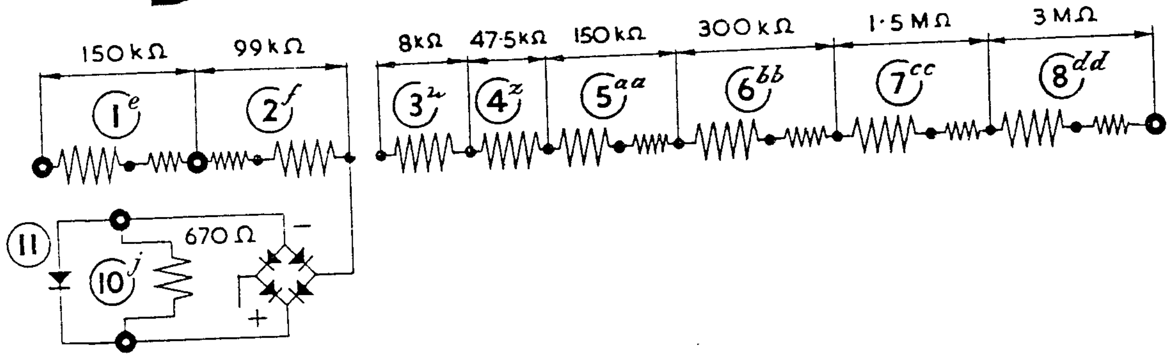

1
BOTTOM RESISTANCE BOARD (for details of components see Plate Five.
2
3
4
5
6
7
TERMINALS FOR 2500 V. RANGES
SOLDER WASHER & PIN ON TO TERMINAL STEM AFTER INSERTION INTO PANEL
8
9
10
11
12
13
14
15
16
17
TOP RESISTANCE BOARD (for details of components see Plate Four.
18

PLATE 4

SIMILAR ITEM APPEARS ON PLATE NUMBER	*Item No.*	*Description*	*Part No.*	*Drawing No.*
	1	150K Ω Resistor + 0.2% — 0.8% (calibrated with series resistor) ..	4/1/8	12049/220/C
	2	99K Ω Resistor + 0.2% — 0.8% (calibrated with series resistor) ..	4/2/8	12049/215/C
	3	Wound Bobbin (8KΩ ± 0.3%)	4/3/8	30006/TD
10	4	Calibrated Resistor 47.5KΩ ± 0.3% (Formerly Wound Bobbin) ..	4/4/8	12049/449/C
	5	150KΩ Resistor ± 0.5% (calibrated with series resistor)	4/5/8	12049/220/C
	6	300KΩ Resistor ± 0.5% (calibrated with series resistor)	4/6/8	12049/219/C
	7	1.5MΩ Resistor ± 0.5% (calibrated with series resistor)	4/7/8	12049/214/C
	8	3MΩ Resistor ± 0.5% (calibrated with series resistor)	4/8/8	12049/198/C
	9	Rectifier (1mA or 5mA selected. See Section 5)	4/9/8	12049/255
	10	Wound Bobbin (670 Ω ± 0.2%)	4/10/8	30006/UD
	11	Voltage limiting rectifier	4/11/8	12049/411

TOP RESISTANCE BOARD





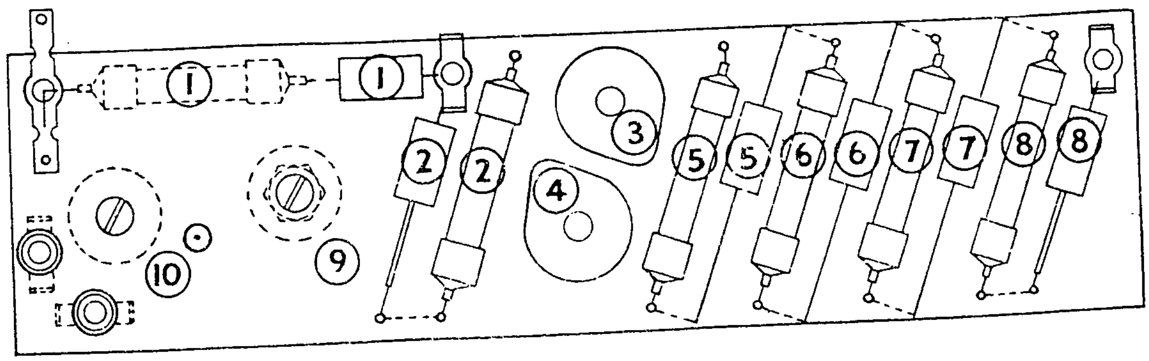
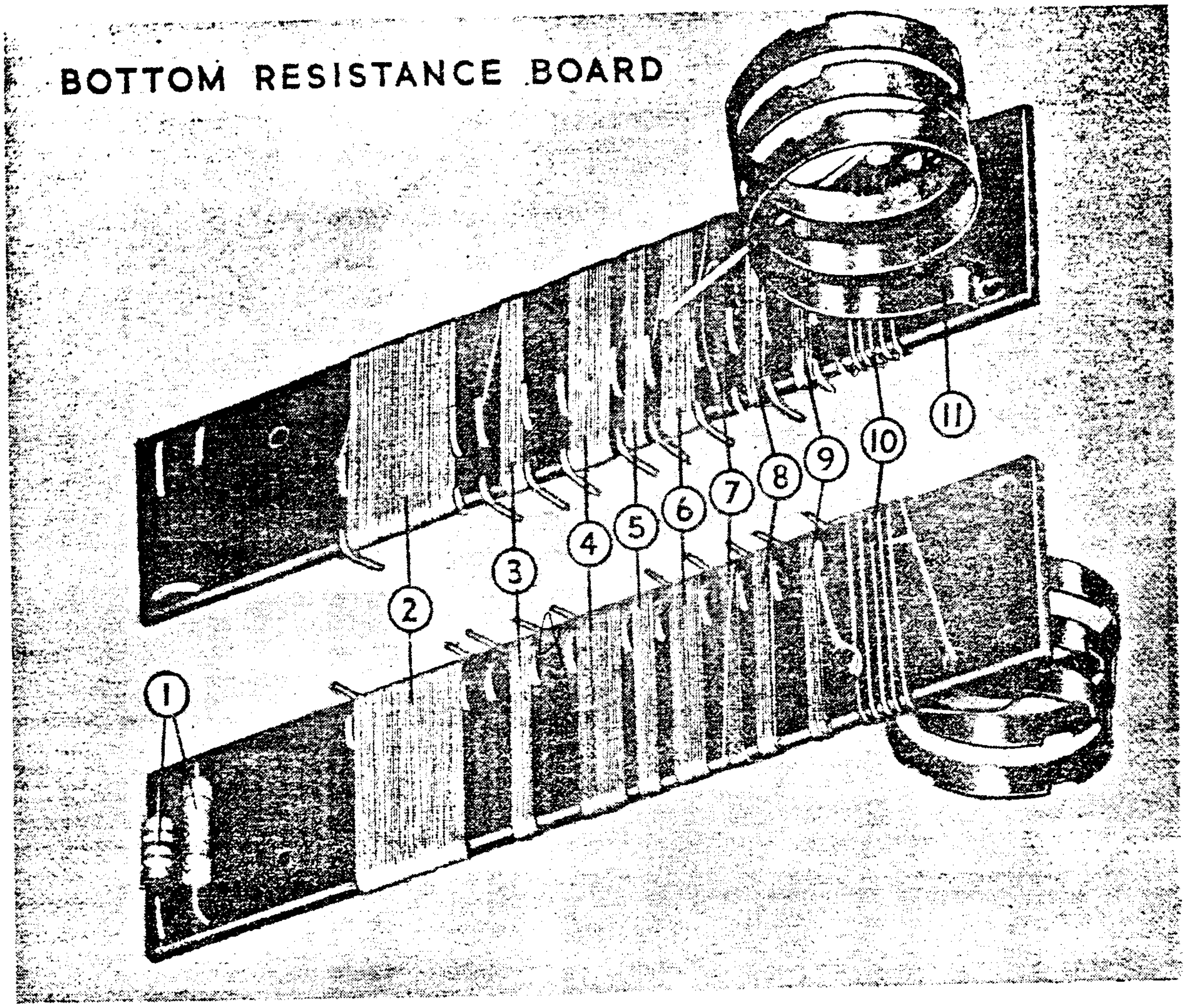


PLATE 5

SIMILAR ITEM APPEARS ON PLATE NUMBER	*Item No.*	*Description*	*Part No.*	*Drawing No.*
	1	6,200 Ω Resistor ± 0.5 Ω (calibrated with series resistor)	5/1/8	12049/216/C
	* 2	980 Ω 44 s.w.g. (0.0813 mm.; 0.0032″) eureka D.R.C. 140 turns approximately (resistance of winding is high to allow for calibration) ..	—	
	* 3	64 Ω 40 s.w.g. (0.1219 mm.; 0.0048″) eureka D.R.C. 20 turns approximately (resistance of winding is high to allow for calibration) ..	—	
	* 4	1200 Ω ± 0.3% 46 s.w.g. (0.0610 mm.; 0.0024″) eureka D.R.C. 120 turns approximately	—	
	* 5	300Ω ± 0.3% 46 s.w.g. (0.0610 mm.; 0.0024″) eureka D.R.C. 30 turns approximately	—	
	* 6	450Ω ± 0.3% 46 s.w.g. (0.0610 mm.; 0.0024″) eureka D.R.C. 50 turns approximately	—	
	* 7	42Ω ± 0.3% 40 s.w.g. (0.1219 mm.; 0.0048″) eureka D.R.C. 14 turns approximately	—	
	* 8	3Ω ± 0.3% s.w.g. (0.3150 mm.; 0.0124″) eureka D.R.C. 7 turns approximately	—	
	* 9	4.5Ω ± 0.3% s.w.g. (0.3150 mm.; 0.0124″) eureka D.R.C. 10 turns approximately	—	
	*10	0.45 Ω ± 0.3% 22 s.w.g. (0.7112 mm.; 0.028″) manganin bare 6 turns	—	
	*11	0.05 Ω ± 0.3% .020″ (0.5080 mm.) × 7/32″ (5.556 mm.) manganin in spiral form	—	

* Not supplied as a spare part.


BOTTOM RESISTANCE BOARD
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11

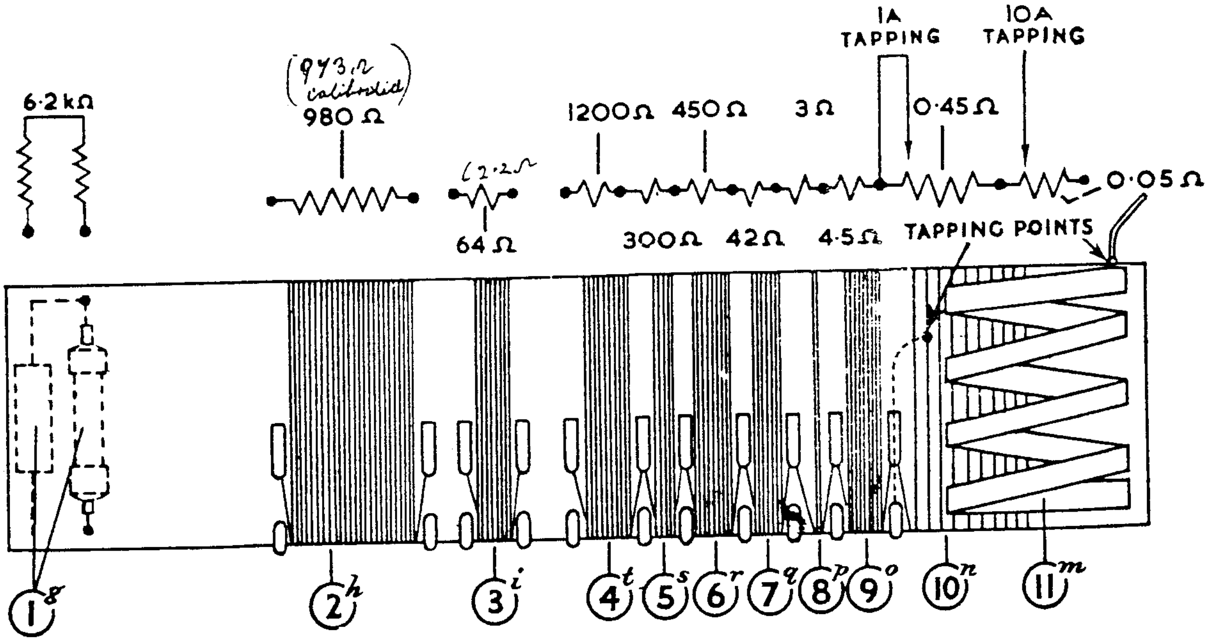
6·2 kΩ
(973 Ω calibrated)
980 Ω
64 Ω
1200 Ω
450 Ω
3 Ω
1A TAPPING
10A TAPPING
0·45 Ω
0·05 Ω
300 Ω
42 Ω
4·5 Ω
TAPPING POINTS
1 g
2 h
3 i
4 t
5 s
6 r
7 q
8 p
9 o
10 n
11 m

PLATE 6

SIMILAR ITEM APPEARS ON PLATE NUMBER	Item No.	Description	Part No.	Drawing No.
	* 1	Contact wiper for " Zero Ω ÷ 100 " control assembly, complete with washers and screw	6/1/8	10210/1
	2	Contact arm for " Zero Ω ÷ 100 " control assembly	6/2/8	11577/2
	3	Resistor strip for " Zero Ω ÷ 100 " control assembly	6/3/8	11562/A
	* 4	Moulded knob for " Zero Ω ÷ 100 " control assembly	6/4/8	11155/A
	5	Resin bonded paper tube complete with two split pins	6/5/8	13234/2
	6	Spring washer	6/6/8	30008/40
	7	Cut-out push button (knob, sleeve and spindle)	6/7/8	**16103/AT**
	8	Cut-out compression spring	6/8/8	13327/1
	9	Cut-out table complete. Comprises:—disc, pawl, lever spring, lever, screws, and washers less items 17 and 18	6/9/8	16103/G
9, 10	10	Cut-out fixed contact assembly (left-hand)	6/10/8	10696/B
9, 10	11	Cut-out fixed contacts mounted on board	6/11/8	20668/A
9, 10	12	Cut-out fixed contact assembly (right-hand)	6/12/8	10696/A
	13	Collar with fixing screw	6/13/8	10698/1
9	14	Cut-out moving contact complete	6/14/8	14157/A
	15	Push Rod	6/15/8	10387/1
	16	Cut-out pawl	6/16/8	12418/A
	17	Cut-out guide pillar stop spring	6/17/8	12419/1
	18	Cut-out guide pillar (threaded 6 B.A.)	6/18/8	12404/2
	19	Set of screws and washers for cut-out table	6/19/8	16103/T
	20	Supplied with Item 19.	—	
	21	Lever spring	6/21/8	14308/1
	22	Supplied with Item 19.	—	
	23	Lever	6/23/8	12392/1
	24	Cut-out disc locking screw (threaded 6 B.A.)	6/24/8	13802/2
	25	Cut-out table	6/25/8	14158/A
10	26	Switch contact assembly (for " D.C. ranges " switch)	6/26/8	40294/D
10	27	Terminal nut	6/27/8	13328/4
	28	Moving coil reversal switch moving contact (right-hand)	6/28/8	13354/B
	29	Moving coil reversal switch fixed contacts with insulation pieces (moulded)	6/29/8	**6/29/8**
	30	Moving coil reversing button	6/30/8	13384/1
	31	Moving coil reversal switch moving contact (left-hand)	6/31/8	13354/A
10	32	Terminal for switched ranges complete with pin and washer	6/32/8	13243/A
	33	Control knob for " Zero Ω × 100 " and " Zero Ω " controls (also shown on Plate 1, Part number 1/1/8)	—	
10	34	Switch contact assembly (for " A.C. and Ω ranges " switch)	6/34/8	40294/C
	35	3.3KΩ Resistor ± 5%	6/35/8	12049/218
	36	Zero adjuster (moulding and spiral)	6/36/8	15539/C

* Items 1 and 4 are supplied assembled. Part No. 6/37/8, Drawing No. 15534/A

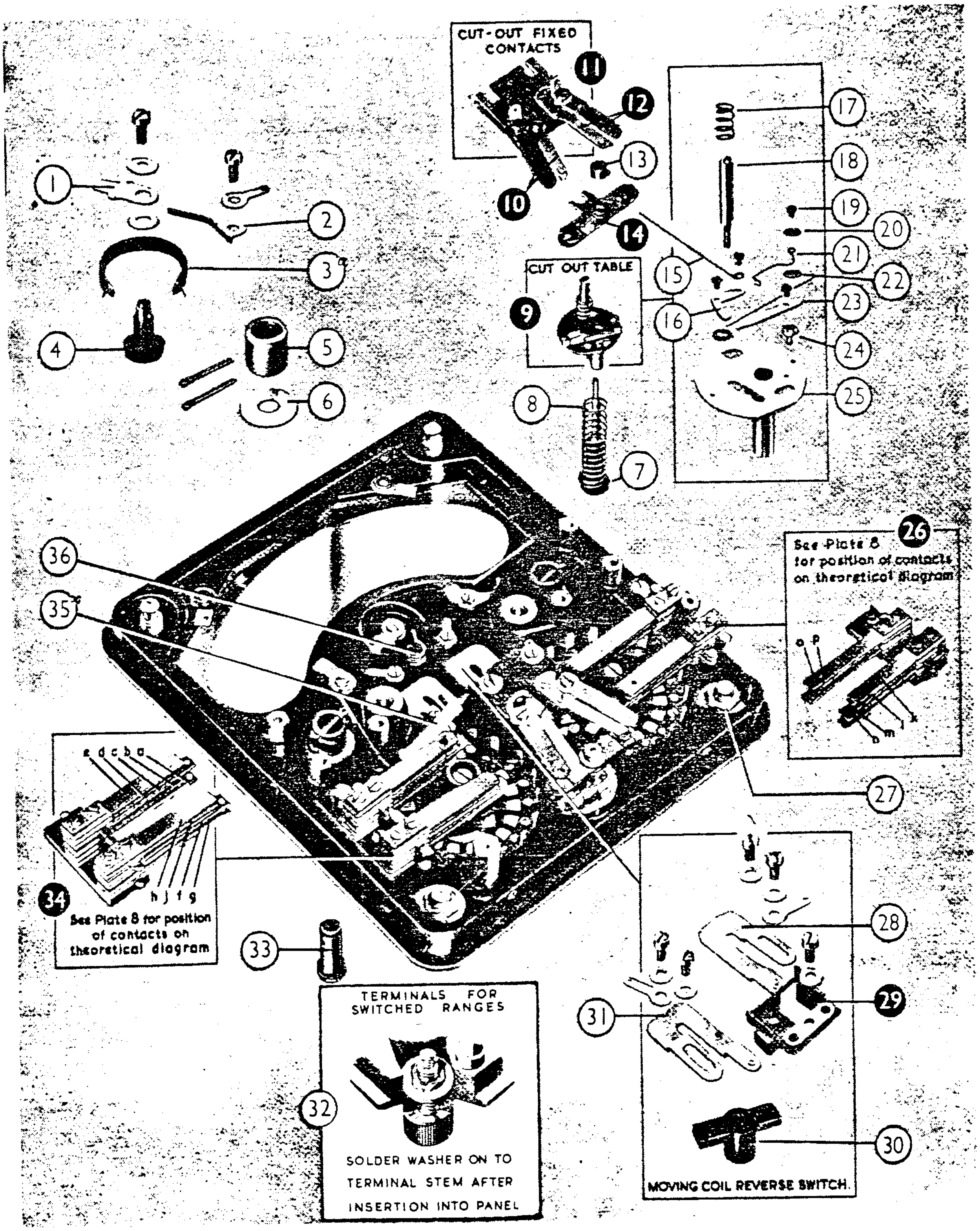
CUT-OUT FIXED CONTACTS
CUT OUT TABLE
See Plate 8 for position of contacts on theoretical diagram
e d c b a
h j f g
See Plate 8 for position of contacts on theoretical diagram
TERMINALS FOR SWITCHED RANGES
SOLDER WASHER ON TO TERMINAL STEM AFTER INSERTION INTO PANEL
MOVING COIL REVERSE SWITCH.
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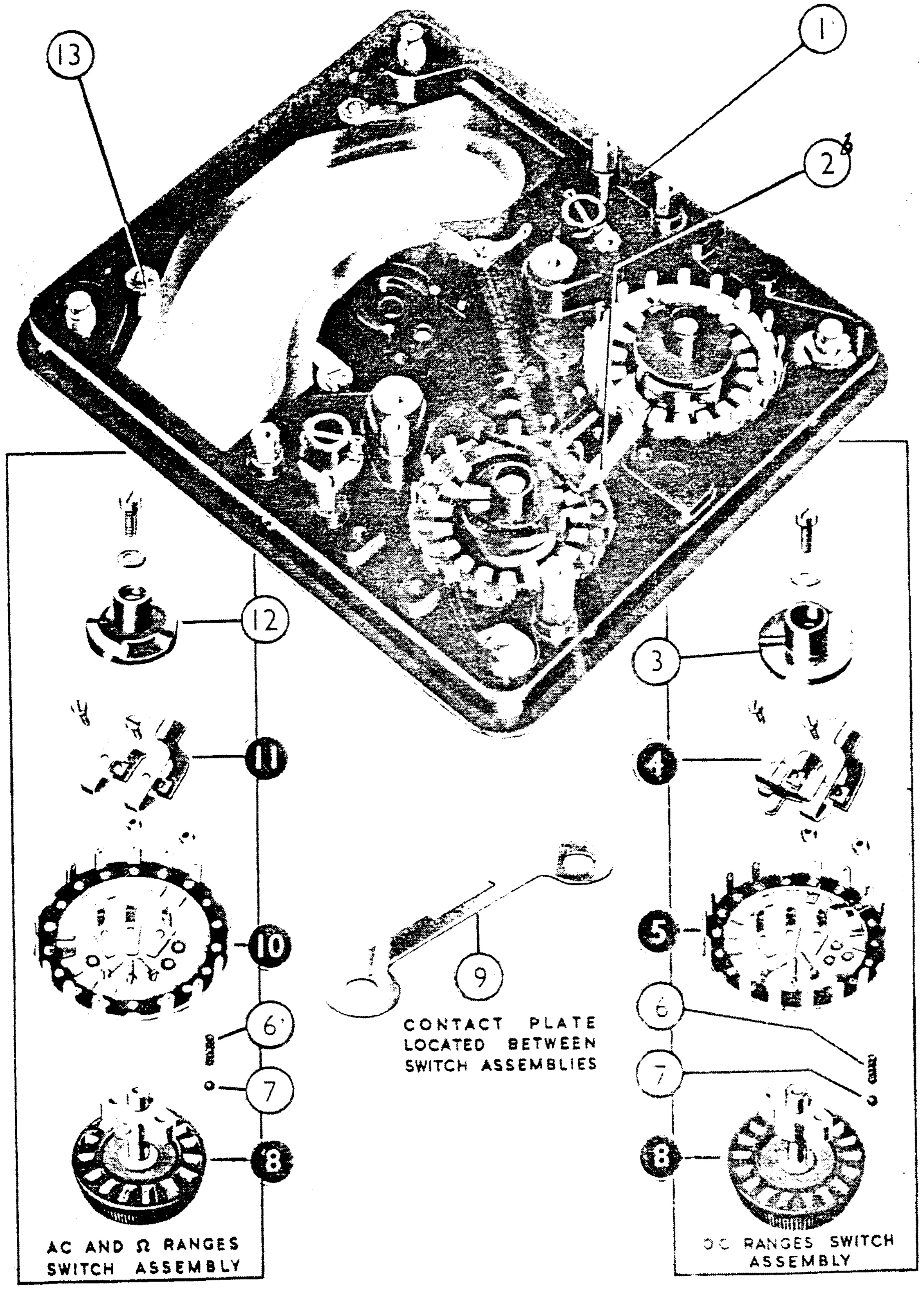
PLATE 7

Similar item appears on plate number	Item No.	Description	Part No.	Drawing No.
9, 10	* 1	Front panel moulding. (See Section 6. Parts 6/18/8 and 6/24/8 may also be required)	OBSOLETE	
	2	Resistor 4K Ω + 0% — 5% (calibrated)	7/2/8	12049/217
	3	Switch cam (for " D.C. ranges " switch)	7/3/8	14037/1
	4	Switch brush arm assembly (for " D.C. ranges " switch), complete with spacing pieces, nuts and bolts	7/4/8	16103/D
10	5	Switch ring assembly complete with loose contacts, screws and washers (for " D.C. ranges " switch). This item is now moulded	7/5/8	10913/3
	6	Click ball spring	7/6/8	11046/1
	7	Click ball	7/7/8	12422/1
	8	Switch knob and carrier for brush arm	7/8/8	12554/E
	9	Contact plate	7/9/8	10898/2
10	10	Switch ring assembly complete with loose contacts, screws and washers (for " A.C. and ohms ranges " switch). This item is now moulded	7/10/8	40584/B
	11	Switch brush arm assembly (for " A.C. and ohms ranges " switch), complete with spacing pieces, nuts and bolts	7/11/8	16103/C
	12	Switch cam (for " A.C. and ohms ranges " switch)	7/12/8	40273/1
10	13	Set of glass window clips	7/13/8	16103 AP

* Obsolete. For replacement see Plate 9.


13
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12
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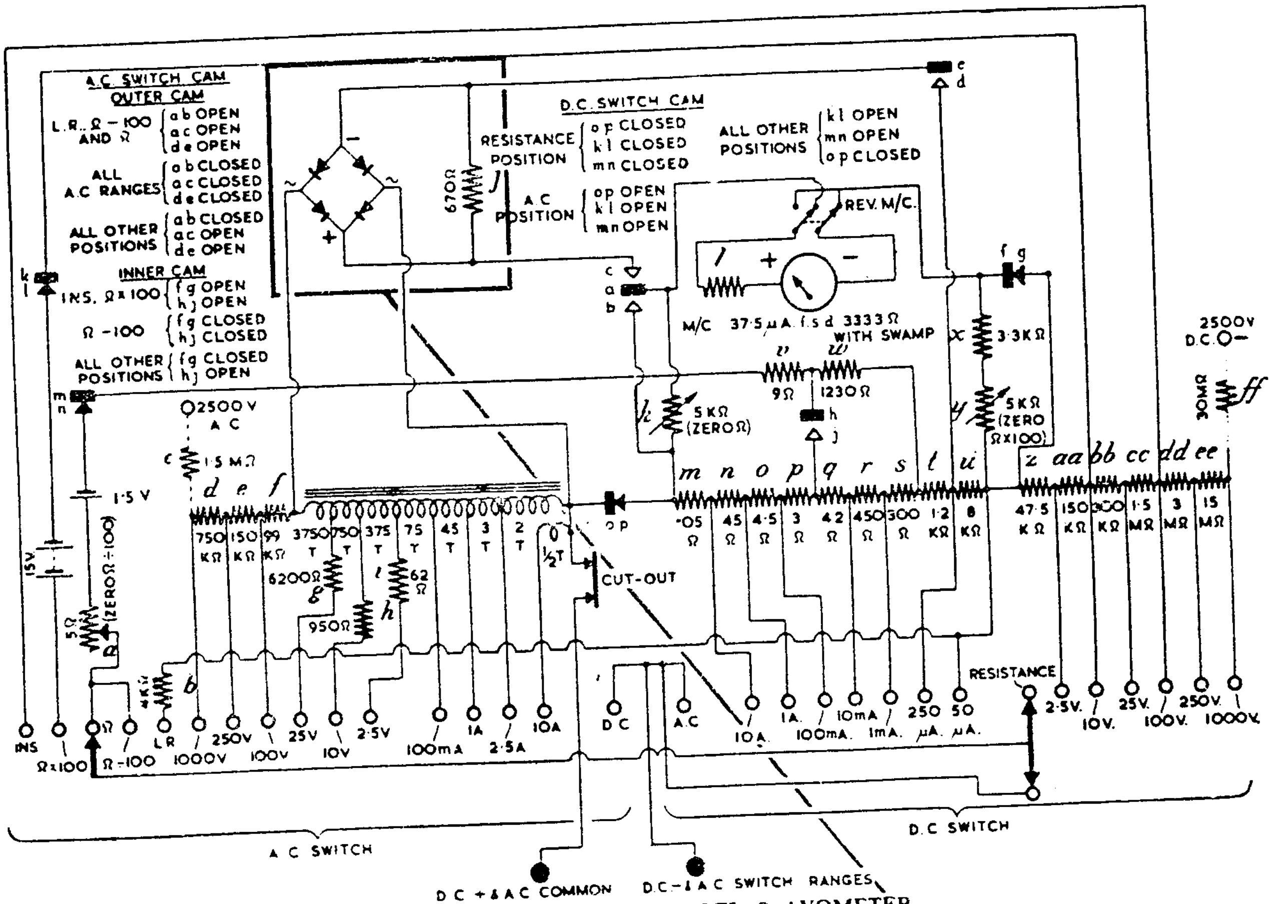
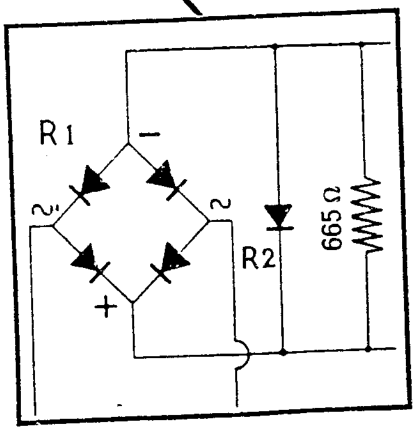
9
CONTACT PLATE
LOCATED BETWEEN
SWITCH ASSEMBLIES
6
7
8
AC AND Ω RANGES
SWITCH ASSEMBLY
RANGES SWITCH
ASSEMBLY

PLATE 8



CIRCUIT DIAGRAM OF THE MODEL 8 AVOMETER

SEE PLATE 6 FOR PHYSICAL LOCATION OF CAM CONTACTS

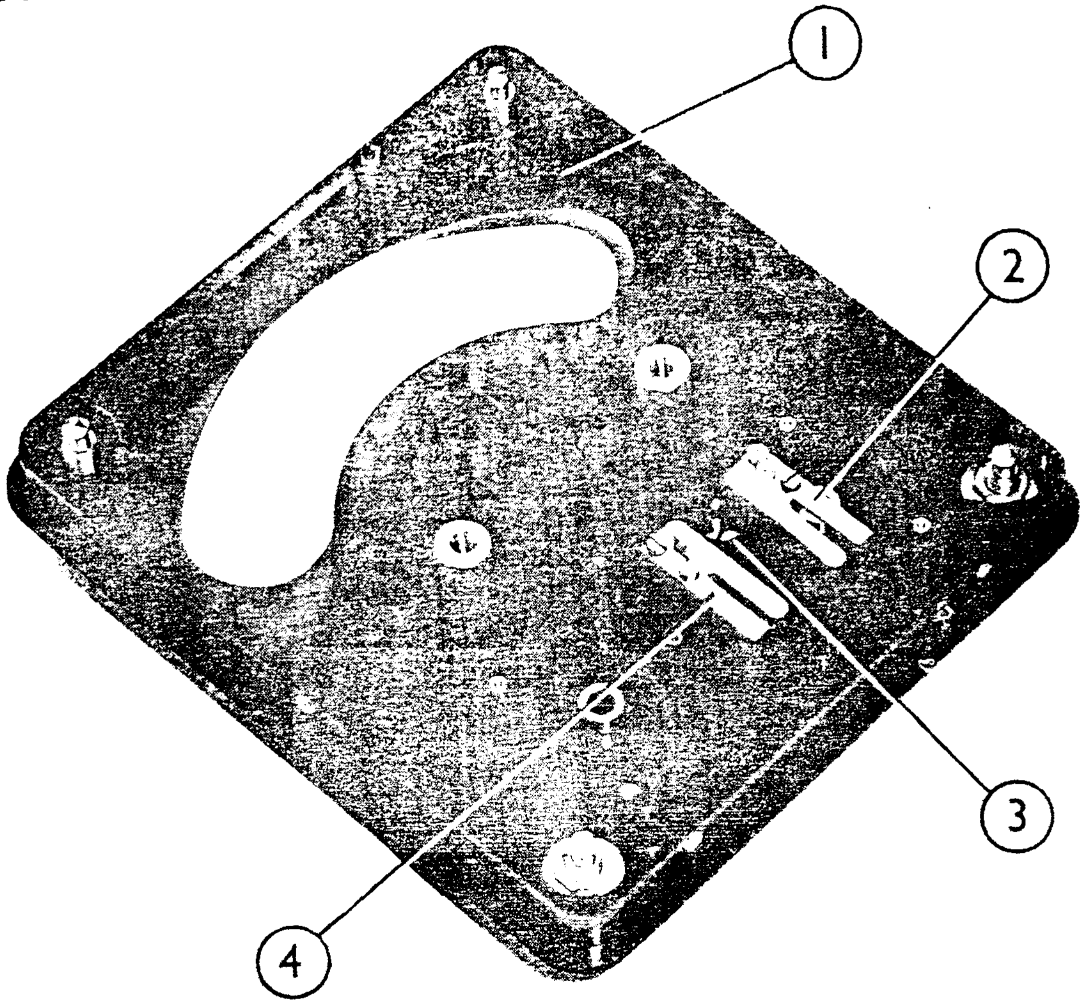


Resis-tor	Plate No.	Item No.	Resis-tor	Plate No.	Item No.
a	6	3	*q*	5	7
b	7	2	*r*	5	6
c	2	17	*s*	5	5
d	3	4	*t*	5	4
e	4	1	*u*	4	3
f	4	2	*v*	3	18
g	5	1	*w*	3	18
h	5	2	*x*	6	35
i	5	3	*y*	3	5
j	4	10	*z*	4	4
k	3	5	*aa*	4	5
l	3	9	*bb*	4	6
m	5	11	*cc*	4	7
n	5	10	*dd*	4	8
o	5	9	*ee*	3	14
p	5	8	*ff*	2	18

CIRCUIT MODIFICATION

Instruments not fitted with rectifier R2 (Plate 4, Item 11) should be modified, care being taken to ensure that R1 and R2 are connected positive to positive. R2 is a voltage (surge) limiting device, and offers additional protection to R1 (see Sections 5 and 11).

PLATE 9



Certain instruments have been modified to incorporate a new cut-out contact assembly. The Panel (Item 1) shown above, is not interchangeable with Part No. 7/1/8, whilst the contacts (Items 2, 3, 4 and 5) are not interchangeable with Part Nos. 6/10/8, 6/11/8, 6/12/8 and 6/14/8.

Item No.	*Description*	*Part No.*	*Drawing No.*
1	Front Panel Moulding	9/1/8	50080/AVO
* 2	Cut-out fixed contact assembly (right-hand)	9/2/8	16103/F
* 3	Moulded Carrier for fixed cut-out contacts	9/3/8	14624/1
* 4	Cut-out fixed contact assembly (left-hand)	9/4/8	16103/E
5	Cut-out moving contact complete (not shown,but similar in appearance to Item 6/14/8).	9/5/8	14157/A

* Items 2, 3 and 4 plus 10/17/8 and 10/5/8 completely assembled replace items 7/1/8 and 9/1/8. This assembly is Part No. 9/6/8, Drawing No. 50070/F.

PLATE 10

Amendment Nos. **2 &**

Model 8 Avometer Mk. II.

This instrument is very similar to the Mk. I instrument, and plates 1—7, can still be used for identification of spares. Alterations to plates are as follows:

SIMILAR ITEM APPEARS ON PLATE NUMBER		*Description*	*Part No.*	*Drawing No.*
1	Plate 1	Item 3 is now a plug-in type lead	10/1/8	20913/F
1		Item 4 is now a plug-in type lead	10/2/8	20913/E
2	Plate 2	Items 28, 29. These are now replaced by a pair of Long Reach Safety Clips	10/3/8	21509/A
2		Item 26. This is replaced by a metal plate	10/4/8	15532/E
		Plug-in type terminal (black)	10/5/8	15536/B
3 9	Plate 3	Item 7 plug-in type of terminal complete (red)	10/5/8	15536/A
		Terminal cap (black)	10/6/8	14963/1
		Terminal cap (red)	10/7/8	14963/2
3		Item 14 has been changed to 10MΩ the remaining 5MΩ being located on plate 4	10/8/8	12049/5..
	Plate 4	5MΩ resistor added	10/9/8	12049/546
4		47.5K bobbin (Item 4) replaced by carbon resistor	10/10/8	12049/449/C
	Plate 5	Unchanged		
6 9	Plate 6	Item 10 new type contact } See Plate 9	10/11/8	
6 9		Item 11 new assembly } See Plate 9	10/12/8	
6 9		Item 12 new contact } See Plate 9	10/13/8	
6		Item 26 moulded board and contacts	10/14/8	40294/D
6		Item 27 new nut	10/15/8	14962/2
3		Item 32 new terminal assembly (see note re plate 3 item 7 above		
6		Item 34 moulded board and contacts	10/16/8	40294/C
7 9	Plate 7	Item 1 new panel	10/17/8	50080/A2
7		Item 5 new switch ring	10/18/8	10913/J
7		Item 10 new switch ring	10/19/8	40584/B
7		Item 13 new window clips	10/20/8	16103/AP