AVO

Electronic TESTMETER

WORKING INSTRUCTIONS

THE AUTOMATIC COIL WINDER &
ELECTRICAL EQUIPMENT CO. LTD.
LONDON, S.W.1. ENGLAND.

THE
"AVO"
ELECTRONIC TESTMETER

INSTRUCTIONS FOR USE

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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 unexcelled accuracy, 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 use. 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 meet 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.

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ELECTRONIC
TESTMETER

THE

ELECTRONIC TESTMETER

INSTRUCTIONS FOR USE

INTRODUCTION

The field of electrical development has today become so vast that the time has passed when one type of multi-range testmeter would handle all requirements. It is now necessary for most engineers to be equipped to cover both power and electronic fields, the two having become closely allied, and it is to meet the demand of those who have been hitherto ill-equipped to undertake the higher grades of electronic work, that the "AVO" Electronic Testmeter has been developed. The instrument is based fundamentally upon the general principles appertaining to valve-volt meters, but its high degree of performance is due to ingenious design coupled with the various patented departures not found in any other make of meter. Whilst it is compact in size, several years of research in the laboratory and in the field were necessary to produce this instrument, which, although electronic in design, presents all the advantages of portability, range selection, a large number of ranges, and stability, only found hitherto in multi-range moving coil testmeters.

The high input resistance/impedance of the instrument renders it particularly suitable for use upon electronic circuits which are usually capable of supplying very little energy indeed, certainly not enough to drive directly a general purpose moving coil instrument without causing a serious volts drop in the power source. When working with R.F. it is usually particularly important that the circuit under test should not be loaded by the measuring instrument, or losses introduced into the circuit by virtue of capacity and leakage in the instrument. By the use of a novel type of probe, this testmeter overcomes these and other problems hitherto associated with R.F. testing.

The full capabilities of this instrument could hardly be described within the scope of this publication, and it is only intended to give in the following pages, concise details relating to the various functions of the Testmeter. For the reader who requires more detailed information on applications of the valve volt-meter type of instrument, many excellent books have already been published.

WORKING INSTRUCTIONS

Power Supply to Instrument

The Testmeter is designed to operate from 100-130V and 200-260V A.C. 50/60 c/s mains (some Home Market models operate from 190-250V A/C 50 c/s mains only). Upon receipt, the instrument should be opened up and the instructions set out upon page 17 followed to ensure that the tappings on the transformer are correctly set for the power source to which the instrument is to be connected. If it is intended to operate the instrument from a 50 c/s A.C. rotary converter the user must ensure that a reasonably good wave form is given by the converter, for otherwise errors may be introduced in the readings shown by the instrument. The testmeter is substantially independent of quite wide variations of mains voltage, within the voltage excursions of the transformer tap selected.

Power Consumption

The power consumed on 230V 50 c/s mains is approximately 17 watts.

Instructions to be followed upon Receipt of the Testmeter

Check mechanical zero of instrument pointer and adjust, if necessary, by means of the small screw located in the "AVO" sign upon the escutcheon of the indicating instrument. Connect mains lead to a 3-pin plug, red and black leads being phase and neutral, the green or yellow lead being earthed. Where connection is to be made to a 2-pin socket, the green or yellow zero lead (which is connected to the instrument case) should, if possible, be connected to earth in accordance with the normal safety regulations relating to metal cased apparatus.

Note.—Upon some home market models due to the form of stabilisation used, there will not necessarily be D.C. continuity between line and neutral leads.

General Instructions

Having connected the instrument to the supply, ensuring that the earth lead is used correctly, switch on the instrument by means of the mains switch to the left of the indicating meter, and note that the indicating instrument dial and range switch indicating panel become illuminated.

The instrument needle will rapidly move across the scale, hitting either or both end stops before coming to rest at some point upon the meter scale. With the Electronic Testmeter set to one of its D.C. current ranges, the meter needle should now be set to zero by means of the control marked "Instrument Set Zero." (Do not initially set instrument zero on A.C. volts capacity or power ranges.)

The instrument is now ready for use and should be operated in accordance with the detailed instructions which follow. No serious drift of zero should be noted after the first few minutes following switching on, when any small variation that does occur can be corrected by the use of the "Instrument Set Zero" control before taking a reading. Note that the resetting of the zero control should only take place when the meter is set to a D.C. current range.

Inasmuch as the testmeter contains valves and a transformer it will run at a fairly high temperature, but no concern need be felt on this account, for the circuit has been so designed as to minimise long term drift due to temperature rise. The design of the instrument renders it free from range to range zero drift, except upon the 250mV range, but it should be noted that the zero on the 1V A.C. range is automatically set at approximately 0·07V when the meter reverse switch is set to "normal," in order to overcome the non-linearity of the diode rectifier. This offsetting of the zero is proportional on all A.C. ranges and will be seen to be negligible above 10V A.C. Since the power and capacity ranges use the A.C. volt section of the instrument, this offsetting of zero is also noticed when those ranges are used.

For normal D.C. and A.C. voltage ranges, D.C. current ranges, power, resistance and capacity ranges, the measuring leads are connected to the two terminals L.P. and H.P., the L.P. terminal being earthy and normally positive for D.C. voltage and current ranges. D.C. voltage and current measurements may be made with the L.P. terminal negative by operating the meter reverse switch, which reverses the polarity of the moving coil indicating instrument. (See notes which follow.)

The selection of ranges is made by the range and multiplier switches, the range in use being shown in the illuminated window, all unwanted indications being automatically masked.

The Reverse Meter Switch and Safety Precautions to be take when making Measurements at High Voltages

In the interest of safety, and to ensure stability of high frequency measurements, the case of the Electronic Testmeter has been earthed, the L.P. terminal being connected to the case *via* a condenser and leak. (See Fig. 1.)

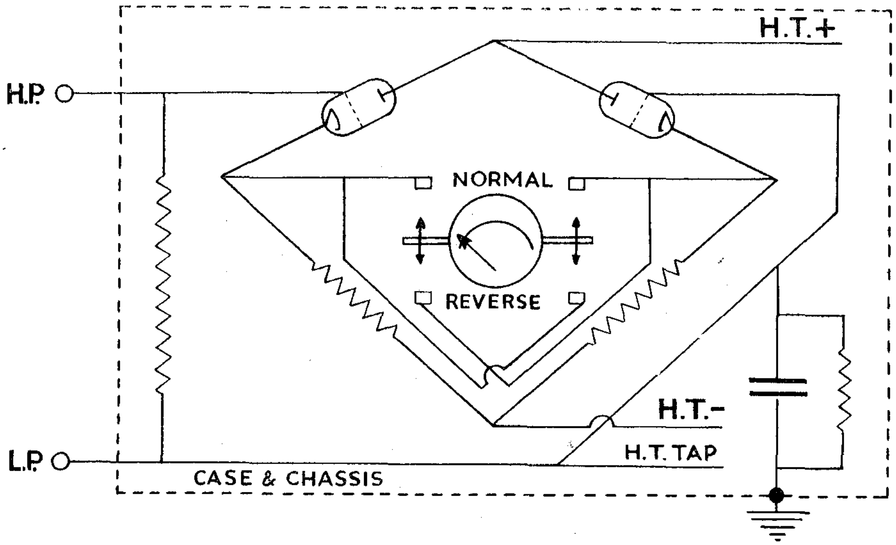
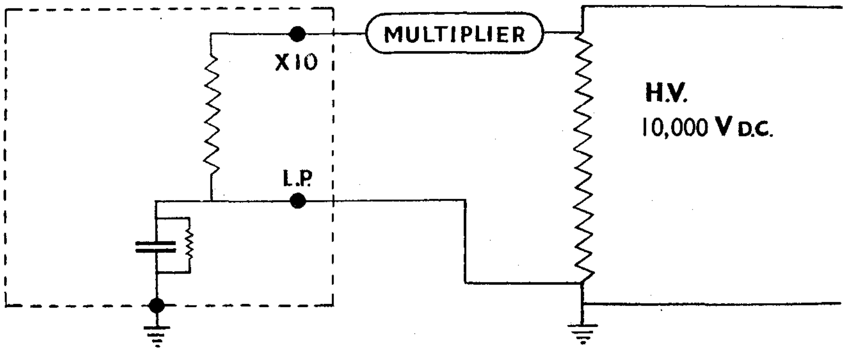


Fig. 1

It is essential that no high potential difference shall exist between the L.P. terminal of the Electronic Testmeter and the adjacent chassis of the apparatus under test or earth. Thus the L.P. terminal should always be connected as near as possible to the earthy side of the high voltage circuit being measured, the high potential lead being connected to the high voltage point with respect to earth. (See Fig. 2.) In no case should the voltage existing between the L.P. terminal of the Electronic Testmeter and its case or earth exceed 1,000V D.C. or 250V A.C.



Always ensure that L.P. Terminal is Connected before Commencing Tests

Fig. 2

It is therefore obvious that the low potential terminal (normally positive) may have to assume either positive or negative polarity dependent on the polarity of the earthy connection of the voltage being measured. If the internal polarity of the Electronic Testmeter low potential terminal was fixed with respect to the Electronic Testmeter circuit, this could result in the meter giving a backward reading under certain conditions. To overcome such a difficulty, the meter reverse switch is provided to enable the Electronic Testmeter to give a forward meter reading. For the measurement of A.C. voltages, the meter reverse switch should always be in its "normal" position. The switch is also obviously useful in avoiding the continuous changing of lead connections when making a succession of D.C. voltage or current measurements having varying polarity with respect to a common circuit point (e.g., H.T. and G.B. measurements with respect to the chassis or zero potential line in radio apparatus). When making current measurements in high tension circuits the Electronic Testmeter *must always* be connected at the low potential end of the circuit with respect to earth. (See Figs. 3 and 4.)

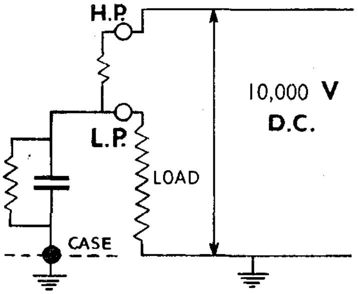


Fig. 3

WRONG

Never insert any type of Testmeter into a supply thus, when measuring current. In this instance, we have 10,000 volts likely to break through the 1,000 volt working condenser to the instrument case.

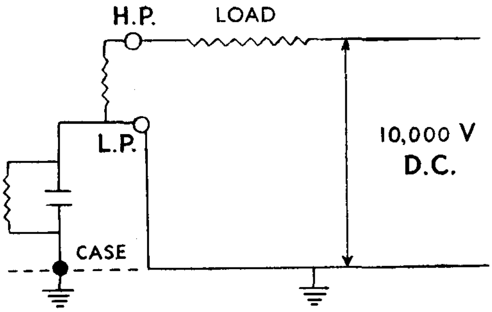


Fig. 4

CORRECT

Now the meter is placed at the earthy end of the supply. Practically no voltage appears across the condenser and the arrangement is perfectly safe.

Measurement of D.C. Volts

Turn the range Selector Switch to volts D.C. and the multiplier switch to a convenient range high enough to cover the expected voltage measurement. When measuring voltages up to 1,000V the leads should be connected to the L.P. and H.P. terminals, the instrument resistance being 11 Megohms on all ranges. When measuring voltages higher than 1,000V D.C. the multiplier lead and external voltage multiplier should be used plugged into the high voltage socket (marked X10). When using the external multiplier, the D.C. voltage range indicated by the multiplier switch will be multiplied by 10, whilst the input resistance of the instrument will be 110 Megohms. The linear scale is used on all D.C. voltage ranges and accuracy is within ±2 per cent. of full-scale deflection.

Note.—It is particularly important that where it is suspected that R.F. is super-imposed upon a D.C. level, that the external multiplier shall be used. The multiplier in this instance acts as an R.F. stopper in addition to multiplying by ten the D.C. range set on the instrument.

The external multiplier also enables an input resistance of 110 Megohms to be obtained with a full scale value of 2·5V upwards. (See Table on p. 20.)

Measurement of A.C. Volts

Turn the range selector to volts A.C. and set the multiplier switch to a voltage range sufficiently great to cover the expected magnitude of the voltage to be measured. (*Note.*—The 250mV and 1,000V positions marked in red upon the switch are for use upon D.C. only.)

The first A.C. voltage range is 1·0V. When the instrument is set to this range it will be noticed that the indicating needle, although having been correctly set to Zero on a D.C. current range, now shows a reading of approximately 0·07V. (This reading may vary from 0·05V to 0·085V, depending upon the particular characteristics of the instrument.) As mentioned above, this zero shift is deliberately introduced to compensate for the non-linearity of the diode rectifier. From this point onwards all A.C. voltage measurements are read on the linear scale, the first effective reading being 0·1V. Since this zero shift is proportional on all A.C. ranges, it is only readily apparent on the 1V and 2·5V ranges, and is therefore scarcely noticeable.

Owing to the high input impedance of the testmeter, stray readings may appear upon the movement due to pick up at the input terminals when using low voltage ranges. The 0·07V zero shift on the 1V A.C. range should therefore be checked with the input leads shorted together. A.C. voltage measurements up to 250V are measured from the normal terminals, whilst higher voltage readings up to 2,500V R.M.S. are measured by means of the high potential lead plugged into the X10 socket. The A.C. voltage ranges indicated upon the instrument will now be multiplied by 10. This multiplication function only operates with the probe housed internally. With the probe internal using the normal measuring terminals there will be negligible error up to 2Mc/s, the instrument having an input impedance of 250,000 ohms in parallel with 30pF. With the X10 measuring terminal in use, negligible error can be expected up to 1·5Mc/s, the input impedance being 2·5 Megohms in parallel with 15pF.

Accuracy of A.C. ranges is within $\pm$ 3 per cent. of full scale indication, and this degree of accuracy is reasonably maintained up to 1Mc/s at the normal measuring terminals. The Valve Bridge responds to the peak voltage value of the waveform under test, but since this value is rarely required, the movement is scaled in R.M.S. values, proportional to the peak input voltage. The R.M.S. calibration on the movement will therefore only be correct when sinusoidal voltages are being measured. The peak measurement obtained by multiplying the scale reading by 1·414 will, however, hold for voltages of distorted waveform.

For normal measurements at high frequency the probe may be withdrawn from the probe box and measurements made between the unmarked terminal on the insulated end of the probe, and the terminal on the probe casing which is made movable to allow very short connections to be used at V.H.F. With the probe withdrawn the ranges are selected as for normal A.C. ranges up to 250V. Above 50Mc/s, however, the voltage measurements should be kept below 100V, and if possible should be further restricted at frequencies of the order of 200Mc/s. Where it is not possible to limit the applied voltage in this manner, the probe should only be connected to the circuit under test sufficiently long to make a measurement. This will avoid undue heating in the diode internal insulation.

When making measurements at H.F. and V.H.F. the connection between the probe terminals and the voltage test points should be kept as short as possible. Ensure that the case terminal of the probe is connected *via* the shortest possible path to "true" R.F. earth when making tests upon Radio or H.F. equipment. The input impedance of the diode probe (measured at 1Mc/s) when used externally is approximately 1·75 Megohms in parallel with 7pF. The maximum frequency at which reasonable measurements can be made is 200Mc/s.

It is important to note that when measuring A.C. voltages the indicating needle will read in the correct direction irrespective of which line is connected to the two terminals L.P. and H.P. Before making tests, particularly when measuring mains circuits, it is important to ascertain which, if either, of the two lines is earthy. It will be remembered that the instrument case is earthed and if the unearthed line is applied to the L.P. terminal, then the whole of the applied voltage will be developed across the internal condenser and resistive network which exists between L.P. terminal and case. The correct connections to be used are shown in Fig. 5, and should always be employed to obtain accurate readings.

It is most important that the peak value of the voltage supply should not exceed 350V if applied to the meter in the reverse manner to that stated. It is always desirable to connect the earthy line to the L.P. terminal wherever circuit arrangements will permit. When using mains supplies upon which the neutral line is earthed, it is possible to distinguish which is the earthy line, provided that the case of the instrument is earthed correctly *via* the third core of the lead, by

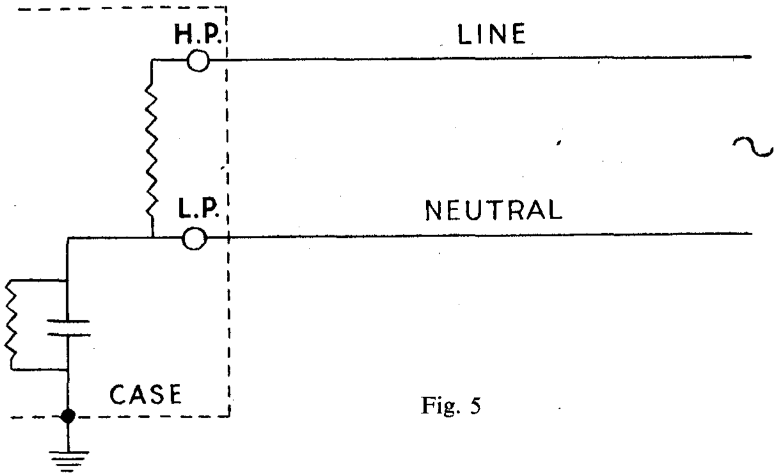


Fig. 5

connecting the H.P. terminal first to one line, then the other, and noting which produces an indication upon the instrument. The line which does produce the indication should be left connected to the H.P. terminal, the other line then being connected to the L.P. terminal. This practice must be limited to lines less than 350V above earth.

THE USE OF THE PROBE (20Kc/s—200Mc/s)

To use the probe externally it is removed from its compartment by unplugging from the octal socket immediately inside the case. Care should be taken to ensure that the connecting wires at the rear of the socket are not strained during this operation. The extension cable is now plugged into the octal socket situated in the probe box and the probe inserted in the octal connector at the remote end of the cable. This probe cable may be remade if desired, with any continuous length of cable similar to that already in use.

It will be noted when removing the probe from the case that the terminal marked "D" is connected to the instrument by a short length of wire. This wire is to be detached when removing the probe from its compartment and reconnected when the probe is replaced. Measurements between 20kc/s and 200Mc/s can now be made between the unmarked terminal upon the end of the probe and its sliding terminal on the side of the casing.

SPECIAL USES OF PROBE

If it is necessary to make measurements of voltages up to 250V A.C. at frequencies below, say, 30c/s, the impedance of the diode coupling condenser used with the probe housed internally (having a value of 0·05μF) may become appreciable in comparison with the parallel diode lead resistance of approximately 10 Megohms at these frequencies. In such circumstances the time-constant of the input circuit may be increased by using the probe externally and connecting a good quality condenser of suitably high value to the probe terminal marked "D." The voltage to be measured is then applied between the free end of this condenser and either the L.P. terminal or the sliding terminal on the diode casing.

Similarly, when making high audio frequency measurements where a reasonably high value of input condenser is required, and where the input capacitance with the probe internal (approximately 30pF) may cause losses, the probe should again be used externally with an input condenser of suitable value (0·05μF) connected to the probe terminal marked "D." The voltage to be measured is then applied between the free end of the condenser and the probe sliding terminal. These methods of procedure thus provide the following advantages:—

(1) It enables measurements to be made below the normal low operating frequency of 30c/s.

(2) It enables measurements to be made at audio and upper-audio frequency with input capacity of only approximately 8pF.

(3) It enables measurements to be made with fully screened leads to the point of application without the normal high capacity associated with screened leads.

For convenient measurements at power and audio frequencies where the above limitations do not apply and for wattage or capacity measurements, the probe should be reinserted in the probe box.

Note.—If D.C. is present when using the probe, the sum of D.C. voltage and the peak A.C. voltage across the diode terminal and probe case should not exceed 350V.

Measurement of Capacity

(Probe must be Internal)

Two ranges of capacity are provided when the Range Selector Switch is turned to "μF" and "μF × 100" respectively. The scale is marked directly in μF from 0·0001μF to 0·5μF. To obtain the higher range the scale readings are multiplied by 100 and thus cover a range of 0·01μF to 50μF. Measuring leads are connected to the normal terminals for these tests. After having set the Selector Switch to the appropriate capacity range, the leads should be shorted and the "R" and "C" zero control adjusted until the meter needle reads full scale deflection. If the leads are now open circuited and the unknown condenser connected between them, the capacity of the condenser will be directly indicated upon the instrument. When measuring condensers with one terminal earthy, this should be connected to the lead going to the L.P. terminal of the instrument. Full scale adjustment should be made in this instance with L.P. terminal already connected to earthy terminal of condenser. The maximum voltage impressed across a condenser in this measurement is 10V R.M.S.

Electrolytic condensers can be checked by either of two methods:

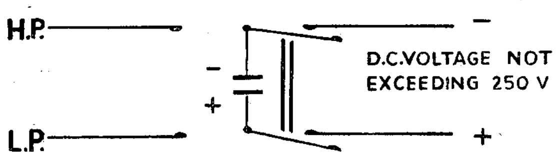


Fig. 6

(1) Double-pole double-throw switch enables condenser to be polarised from D.C. source and then immediately transferred to Testmeter leads. (See Fig. 6.)

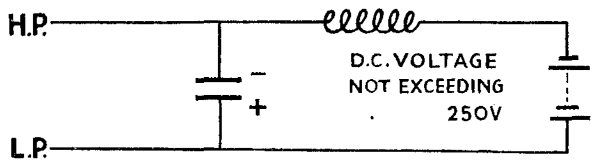


Fig. 7

(2) Condenser is connected in parallel with choke of value greater than 30H. D.C. polarising voltage is applied from battery and Electronic Testmeter leads are then connected across the condenser. (See Fig. 7.)

It should be noted that this method may give rise to considerable error if used to check condensers of less than 4μF.

Measurement of Resistance on the Ohms Ranges

Three ohms ranges are provided when the Selector Switch is turned to "ohms ÷ 100," "ohms," and "ohms × 100" respectively. Readings are taken from a scale graduated to correspond to the range and calibrated from a first indication of 20 ohms to a maximum reading of 100,000 ohms, the centre scale reading corresponding to 1,500 ohms. With the range Selector Switch turned to the "ohms ÷ 100" range, the scale readings then give a first indication of 0·2 ohms, with 15 ohms at mid-scale, whilst with the range selector switch set to "ohms × 100," the first indication is 2,000 ohms, mid-scale corresponding to 150,000 ohms and the maximum being 10 Megohms. With the range selector at the appropriate range the "R and C set zero" control should be turned until full scale deflection (i.e., 100 on black A.V. scale) is obtained with the leads open, zero readings being shown when the leads are shorted. Having selected a suitable range in accordance with the foregoing instructions, the insertion of the unknown resistance between the test leads will directly indicate the value of the unknown resistance upon the scale. The L.P. and H.P. terminals are used to make these measurements, the voltage across the resistance varying from 0—·25V D.C. whilst measurements are being made.

Measuring Resistance on the Megohms Range

With the range selector turned to "Megohms" a special high resistance range gives readings from a fraction of a Megohm to 1,000 Megohms. The range is set up by rotating the "R and C set zero control" until the instrument reads full scale deflection (zero Megohms) with the leads, connected to the H.P. and L.P. terminals, shorted together. With the leads open, the pointer should be at the normal instrument zero, but it should be noted that upon humid days it is possible that this zero reading may rise slightly due to leakage existing between the L.P. and H.P. terminals. The maximum voltage across the resistance under test is only 2·5V D.C. whilst measurements are being made.

Measurements of Audio Watts and db

The output power ranges are provided by turning the range Selector Switch to "5 watts" or "500mW" respectively. These ranges cover "5mW" to "500mW" and "50mW" to "5 watts." There are six load resistances which may be used with either of these ranges, selection being made by reading the load switch, the resistance value in use being indicated in the right-hand indicator window. It will be noted that on both power ranges, which utilise low A.C. voltage ranges, the instrument pointer does not fall to zero, this function being deliberately introduced as described earlier when speaking about the A.C. voltage ranges. The instrument should not therefore be set to zero when in use upon the wattage ranges.

When using the power ranges to check output power, any D.C. component present in the circuit being measured should be removed by the insertion of a suitably large capacitor in series with instrument. The limitation of the size of paper capacitors will usually make it impossible to satisfactorily measure power in loads below 1,000 ohms when D.C. is present. This, however, should not cause difficulty since most cases of lower loadings occur in secondary circuits of transformers in which there is usually no D.C. component. Having selected a suitable range and load upon the instrument and connected the leads to terminals H.P. and L.P., the internal load resistance in the Electronic Testmeter should be inserted in place of the normal load in the circuit being measured, for example, in place of the speaker coil or in series with a suitable large capacity across the primary of an output transformer (with speech coil disconnected).

The Electronic Testmeter will now directly indicate the watts developed in the load in question. Readings of watts are made on the scale printed to correspond with the 0·05—5 watts range. On the 500mW range the scale readings in watts should be divided by 10.

Immediately below the watts scale is a db scale so arranged that when taking measurements of watts the corresponding db figures can be read directly, the zero db mark corresponding with 500mW on the 5W range and 50mW on the 500mW range. Readings obtained on the 5W range can be referred to a zero level of 50mW by adding 10 db to the db scale readings. It should be noted that readings greater than 3 watts should not be maintained for long periods in order to avoid excessive heat dissipation in the internal load resistance.

Instructions for Replacement of Lamps, Valves, etc.

Replacement of Diode in Probe

When this diode fails it must be replaced by an Osram D77 or American type 6AL5 valve. Valves taken from stock will generally be found to be perfectly satisfactory after having been aged for a period of 50—100 hours to reduce the initial instability of contact potential within the valve. It is, however, preferable that a specially selected valve should be obtained from the Automatic Coil Winder & Electrical Equipment Co. Ltd., upon payment of the list price of the valve plus a very small charge for the selection and ageing work involved. When replacing this component some slight adjustment of the 1V A.C. Zero setting may be necessary. (See notes on p. 16.)

To open the probe, take out the three screws situated around the centre ring upon the end nearest the octal plug and withdraw the tube carefully. The diode valve may now be easily removed, a new diode inserted and the silvered tube replaced.

Replacement of Bridge Valve and Lamps

The instrument should be opened by placing it carefully upon its face and removing the four self-tapping screws around the side of the casing. The six screws around the perimeter of the back of the instrument should be withdrawn, the probe removed from its box and the rear half of the casing lifted off, taking care not to damage the probe box which fits into two slots on the inner side of this half of the casing.

Note.—When replacing the back of the instrument, ensure that the probe lead is correctly positioned in the slot in the probe box, and check that the probe box is correctly retained by the brackets inside the instrument casing. Replace the six screws upon the back of the instrument, the four self-tapping screws around the sides of the case and replace tube.

Upon a few models this procedure will have to be slightly modified owing to a variation in the construction in the casing.

Having thus opened the instrument, it is now possible to remove and replace the valve and lamps. (See Fig. 8.) Only lamps of the following (or equivalent) suggested types should be used: On the movement GEC 6·5V ·3 amp. radio panel lamps, under dials GEC 3·5V ·3 amp. lamps. Inasmuch as these lamps are commercially standard, replacements are not supplied by the Automatic Coil Winder & Electrical Equipment Co. Ltd.

The Bridge Valve, 6SN7 will be found mounted in a special sponge rubber and can be removed by unscrewing two 4BA screws in the paxolin sheet adjacent to the two controls. The valve base is of floating construction and care should be taken to ensure that the leads connected to the base are not strained whilst the valve is removed.

Valves giving rise to the following defects should not be used.

(1) *Loose Electrode Assembly.*

This will cause a shift of zero when the instrument is subjected to either knocking or jolting.

(2) *Gas Current.*

This will cause a shift of zero when, with the instrument leads open circuited, the range switch is changed from 25 microamps D.C. to 250mV D.C. The change of zero should not exceed one division, that is 2 per cent. full scale.

It may be necessary to try several valves in order to obtain the best results, and it should be noted that valves having gas current will often considerably improve after having been aged in the instrument continuously for a period of approximately 48 hours.

If required, The Automatic Coil Winder & Electrical Equipment Co. Ltd. can supply selected and aged valves at the list price of the valve, plus a small charge for the selection and ageing work involved.

Replacement of Fuse

A small 1-amp. fuse will be found located upon a paxolin board as shown in Fig. 8. This is a 1-amp. Belling & Lee fuse No. L.562/1.

Instructions for Setting the Coarse Zero and A.C. Zero Controls

If the instrument is turned on its face, with the probe box towards the observer, two small caps will be observed which are practically covered by the instrument stand when inserted in its stowed position. These two caps can easily be removed by prising the end of a screw-driver beneath the cap lips. Removal of the caps will reveal preset controls (see Fig. 8) which should be re-covered with the caps when the necessary adjustments have been made.

Important Note

The small screw immediately to the right of these two preset controls is a trimming adjustment and must not be touched.

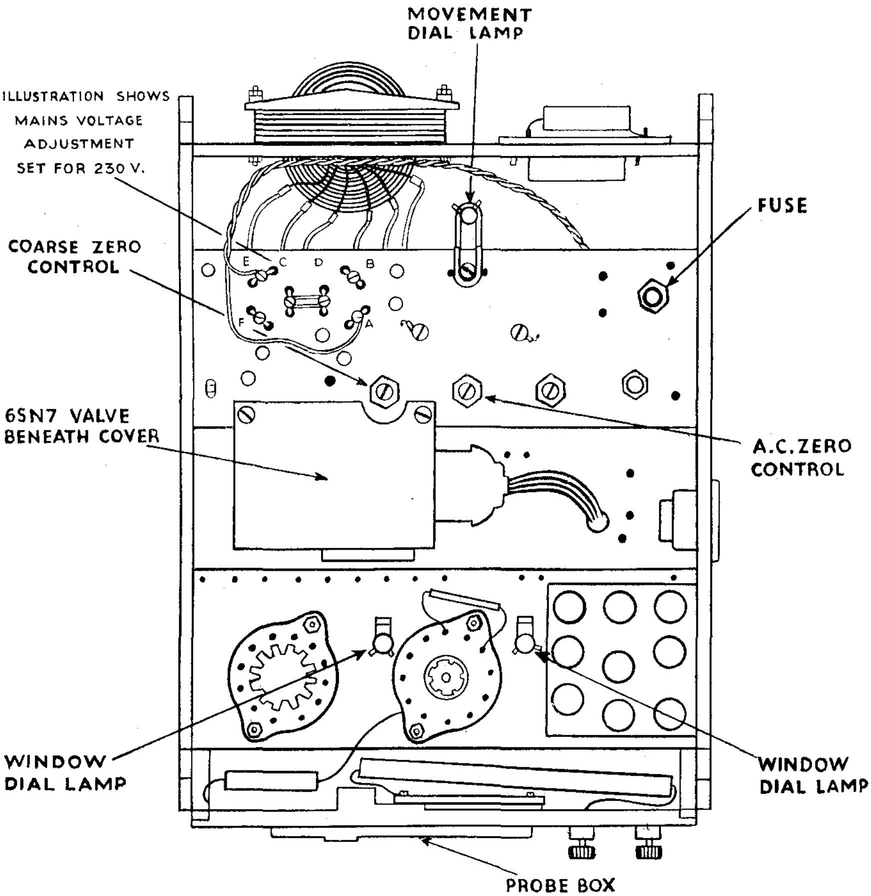


Fig. 8.

SETTING THE COARSE ZERO CONTROL

(1) Set the testmeter to "amps. D.C."

(2) Adjust the "Set Zero Instrument Control' on the front of the instrument half-way round its traverse.

(3) Adjust the "Coarse Zero Control" upon the back of the instrument until the movement pointer is at zero.

ADJUSTMENT OF A.C. ZERO

(1) With the probe internal place finger on H.P. terminal with instrument set to 1V A.C. range and note that the meter reverse switch is positioned to produce a forward deflection of the movement, as the terminal is touched.

(2) With the probe internal and the L.P. and H.P. terminal shorted or with the probe external and the unmarked probe terminal shorted to the probe case terminal, set the instrument to its 1V D.C. range.

(3) Set movement needle to zero by means of "Set Zero Instrument" Control.

(4) Change to 1V A.C. range and set movement needle to 0·07V (3·5 divisions) by means of "A.C. Zero" control, with H.P. and L.P. terminals shorted.

Adjustment of Instrument for Operation upon Various Power Supplies

The instrument is suitable for mains voltages between 100 and 130 volts, 50/60 cycles and 200/260 volts 50/60 cycles. Should it be necessary to alter the mains voltage tapping, the back of the instrument should be carefully removed (refer to p. 14). The mains voltage connections for different values of voltage are made as in the table below.

Mains Voltage 100/110V R.M.S.—connect mains leads to tags D. and E. Link tags B and D, link tags C and E.

Mains Voltage 110/130V R.M.S.—connect mains leads to tags D and E. Link tags A and D, link tags C and F.

Mains Voltage 200/220V R.M.S.—connect mains leads to tags B and E. Link tags C and D.

Mains Voltage 220/240V R.M.S.—connect mains leads to tags A and E. Link tags C and D.

Mains Voltage 240/260V R.M.S.—connect mains leads to tags A and F. Link tags C and D.

SERVICE NOTES AND ADJUSTMENTS

Symptoms	*Possible Fault*	*Procedure*
1. Failure of illumination.	1. Mains connecting lead faulty 2. Fuse open circuited. 3. Failure of lamps.	1. Check connections and cable. 2. Check fuse. (See p. 15.) 3. Replace lamps. noting that two associated with Selector switches are wired in series, the failure of one therefore causing both lamps to be extinguished.
1. Meter needle failing to move.	1. Dirty contacts on toggle re-reverse switch. 2. Faulty 6SN7 valve. 3. Faulty movement or associated circuits.	1. Operate meter reverse switch several times. 2. Replace valve. (See p. 15.) 3. Return Testmeter to manufacturer.
1. Meter fails to zero correctly when H.P. and L.P. terminals are shorted with probe internal and range selector switch set to "amps" or "volts" D.C.	1. Incorrect setting of coarse zero control. 2. Faulty 6SN7. 3. Circuit faults.	1. See notes for setting coarse zero control. (P. 17.) 2. Replace valve. 3. Return Testmeter to manufacturer.
1. Large changes of zero when changing multiplier on "amps" or "volts" D.C.	1. Gassy 6SN7. 2. Open circuited multiplier chain.	1. Replace valve. (See p. 15.) 2. Return instrument to manufacturer.
1. Steady movement of needle away from zero on "amps" or "volts" D.C.	1. Faulty 6SN7. 2. Open circuited multiplier chain.	1. Replace valve. (See p. 15.) 2. Return instrument to manufacturer.
1. Instrument zero is satisfactory on D.C., but fails to zero on A.C. with probe internal. (Note on offset voltage of approximately 0·07V is deliberately introduced upon the A.C. ranges (see p. 9).	1. Input leads not shorted. 2. Incorrect setting of A.C. zero control. 3. Probe diode faulty. 4. Circuit fault.	1. Short leads together. 2. Reset A.C. zero control. (See p. 17.) 3. Replace diode (see p. 14). 4. Return instrument to manufacturer.

SERVICE NOTES AND ADJUSTMENTS

(Continued)

Symptoms	*Possible Fault*	*Procedure*
1. As above but with probe external.	1. Unmarked probe terminal not shorted to probe case terminal. 2. A connection to the probe terminal marked "D." 3. Fault in extension cable for probe.	1. Short unmarked probe and probe case terminals. 2. Remove. 3. Check probe lead and sockets.
1. Failure to obtain a deflection on D.C. ranges when endeavouring to make a measurement.	1. Faulty measuring leads. 2. Internal circuit fault.	1. Check leads. 2. Return instrument to manufacturer.
1. Failure to obtain a deflection on A.C. ranges when endeavouring to make a measurement (probe internal) and assuming that instrument works correctly on D.C. ranges.	1. Faulty measuring leads. 2. Flying lead in probe box normally connected to terminal marked "D" on probe, either disconnect or connected to unmarked terminal on probe. 3. Faulty probe diode valve.	1. Check leads. 2. Check connection. 3. Replace probe diode.
1. Random needle deflection usually accompanied by excessive brilliance of lamps.	1. Arc in series with mains supply to instruments.	1. Check input lead and connections to 3-pin plug. 2. Check mains switch for bad make and break.

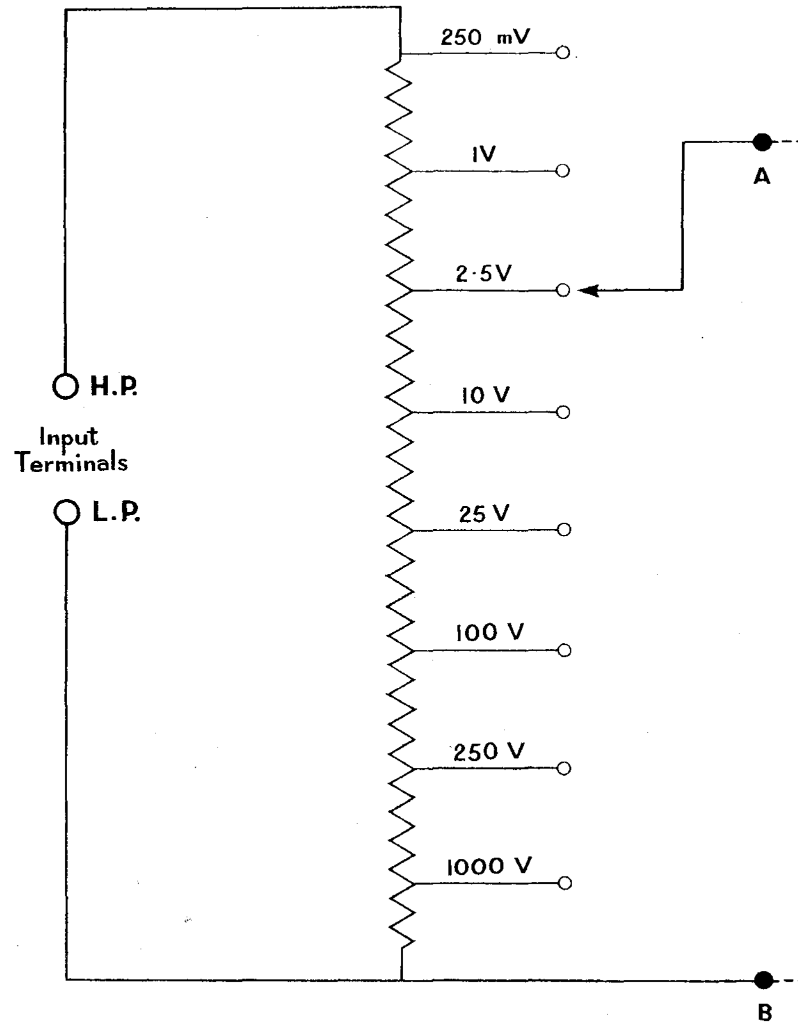
Return of Instrument to Manufacturer

If, after having studied the foregoing notes, it is quite clear that the instrument should be returned to the manufacturer for attention it should be accompanied with a clear and concise report of the fault(s) which have been found. The instrument should be adequately packed to ensuie that it is not damaged in transit.

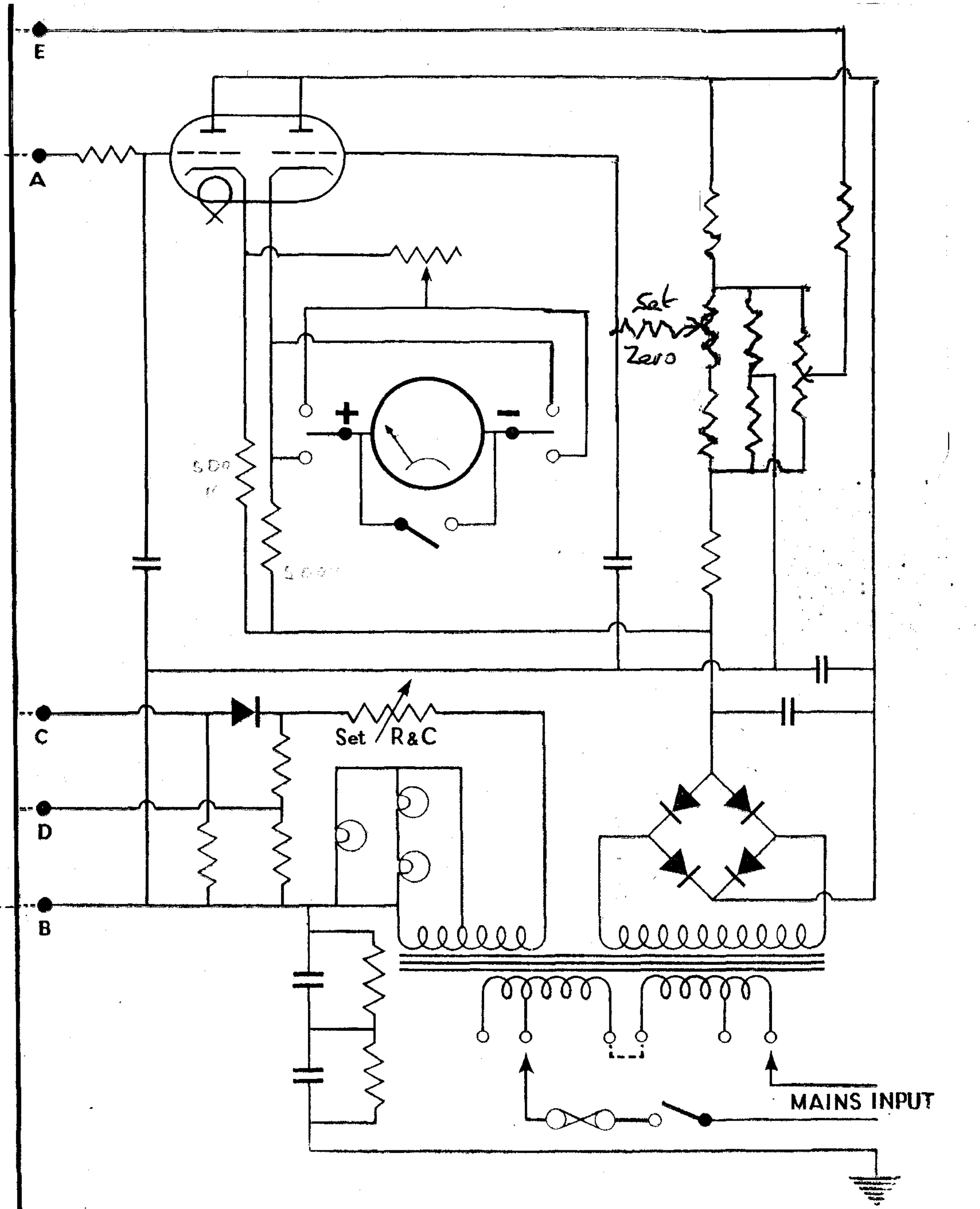
TABLE OF RANGES

Type of Measurement to be made.	Scale Reading.	Multiplier Switch Setting.	Range Switch Setting.	Load Switch Setting.
D.C. Volts.	250·0mV full scale	250·0mV D.C.	Volts D.C.	
Using H.P. and L.P. Terminals (Input Resistance 11MΩ)	1·0V ,, ,,	1·0V	,, ,,	
	2·5V ,, ,,	2·5V	,, ,,	
	10·0V ,, ,,	10·0V	,, ,,	
	25·0V ,, ,,	25·0V	,, ,,	
	100·0V ,, ,,	100·0V	,, ,,	
	250·0V ,, ,,	250·0V	,, ,,	
	1000·0V ,, ,,	1000·0V D.C.	,, ,,	
D.C. Volts	2·5V full scale	250·0mV D.C.	Volts D.C.	
Using L.P. Terminal with External Multiplier plugged into X10 Socket (Input Resistance 1·10MΩ)	10·0V ,, ,,	1·0V	,, ,,	
	25·0V ,, ,,	2·5V	,, ,,	
	100·0V ,, ,,	10·0V	,, ,,	
	250·0V ,, ,,	25·0V	,, ,,	
	1000·0V ,, ,,	100·0V	,, ,,	
	2500·0V ,, ,,	250·0V	,, ,,	
	10,000·0V ,, ,,	1000·0V D.C.	,, ,,	
A.C. Volts	1·0V R.M.S. full scale	1·0V	Volts A.C.	
Using L.P. and H.P. Terminals with Probe Internal	2·5V ,, ,, ,,	2·5V	,, ,,	
	10·0V ,, ,, ,,	10·0V	,, ,,	
	25·0V ,, ,, ,,	25·0V	,, ,,	
	100·0V ,, ,, ,,	100·0V	,, ,,	
	250·0V ,, ,, ,,	250·0V	,, ,,	
Measuring between unmarked Probe Terminal and Earth Clip with Probe External	1·0V R.M.S. full scale	1·0V	Volts A.C.	
(See page 10 for notes on Voltage Limitation at High Frequencies.)	2·5V ,, ,, ,,	2·5V	,, ,,	
	10·0V ,, ,, ,,	10·0V	,, ,,	
	25·0V ,, ,, ,,	25.0V	,, ,,	
	100·0V ,, ,, ,,	100·0V	,, ,,	
	250·0V ,, ,, ,,	250·0V	,, ,,	
A.C. Volts	10·0V R.M.S. full scale	1·0V	Volts A.C.	
Using L.P. Terminal with Probe Internal and High Potential Lead Plugged into X10 Socket	25·0V ,, ,, ,,	2·5V	,, ,,	
	100·0V ,, ,, ,,	10·0V	,, ,,	
	250·0V ,, ,, ,,	25·0V	,, ,,	
	1000·0V ,, ,, ,,	100·0V	,, ,,	
	2500·0V ,, ,, ,,	250·0V	,, ,,	

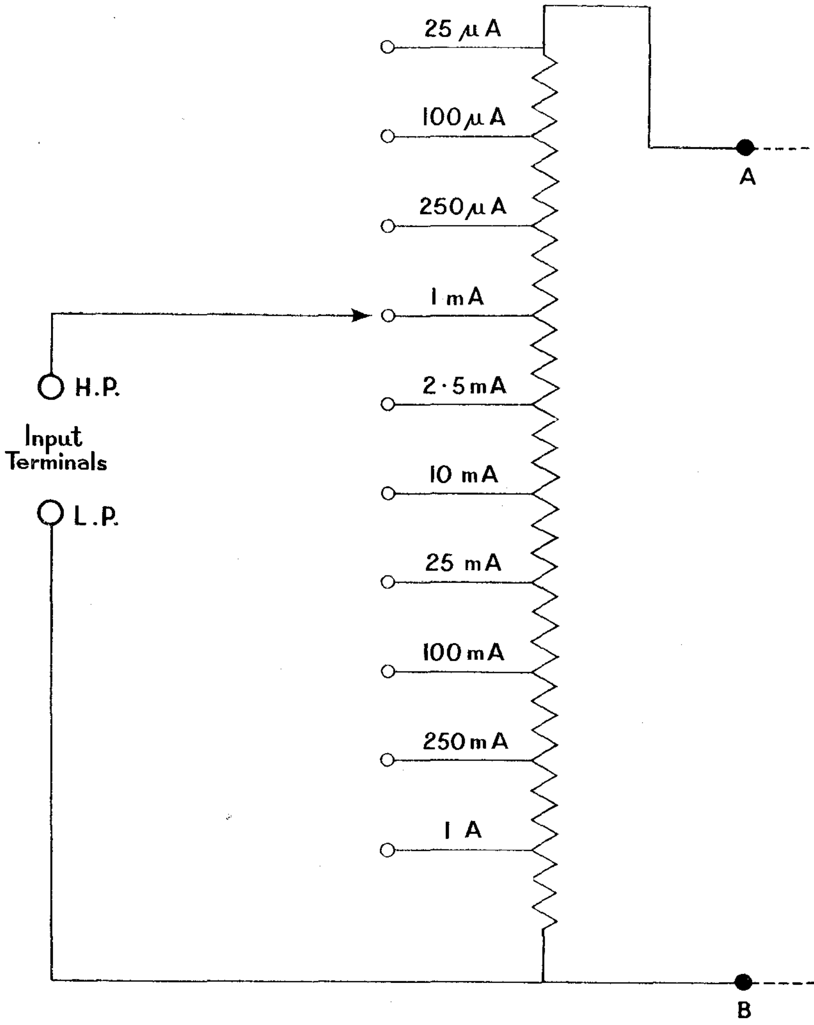
Type of Measurement to be made.	Scale Reading.	Multiplier Switch Setting.	Range Switch Setting.	Load Switch Setting.
D.C. Current 250mV Drop at Full Scale on all Ranges. Using L.P. and H.P. Terminals	25μA full scale 100μA ,, ,, 250μA ,, ,, 1mA ,, ,, 10mA ,, ,, 25mA ,, ,, 100mA ,, ,, 250mA ,, ,, 1A ,, ,,	25μA 100μA 250μA 1mA 10mA 25mA 100mA 250mA 1A	Amps. D.C. ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,, ,,	
Decibels Reference level of 50mW	−10 to +10db add 10db to scale reading	—	50mW 5 Watts	5Ω 200Ω 10Ω 600Ω 25Ω 5000Ω Select any load above as required
A.C. Power Output	500mV full scale 5·0W ,, ,,	—	500mW 5 Watts	5Ω 200Ω 10Ω 600Ω 25Ω 5000Ω Select any load above as required
Capacitance —	·0001μF—0·5μF ·01μF— 50μF	—	μF μF×100	
Resistance —	0·2Ω—1000Ω 20Ω—100,000Ω 2000Ω—10MΩ	—	Ω÷100 Ω Ω×100	
Insulation —	0·1MΩ—1000MΩ	—	MΩ	See notes on p. 13, *re* test voltage



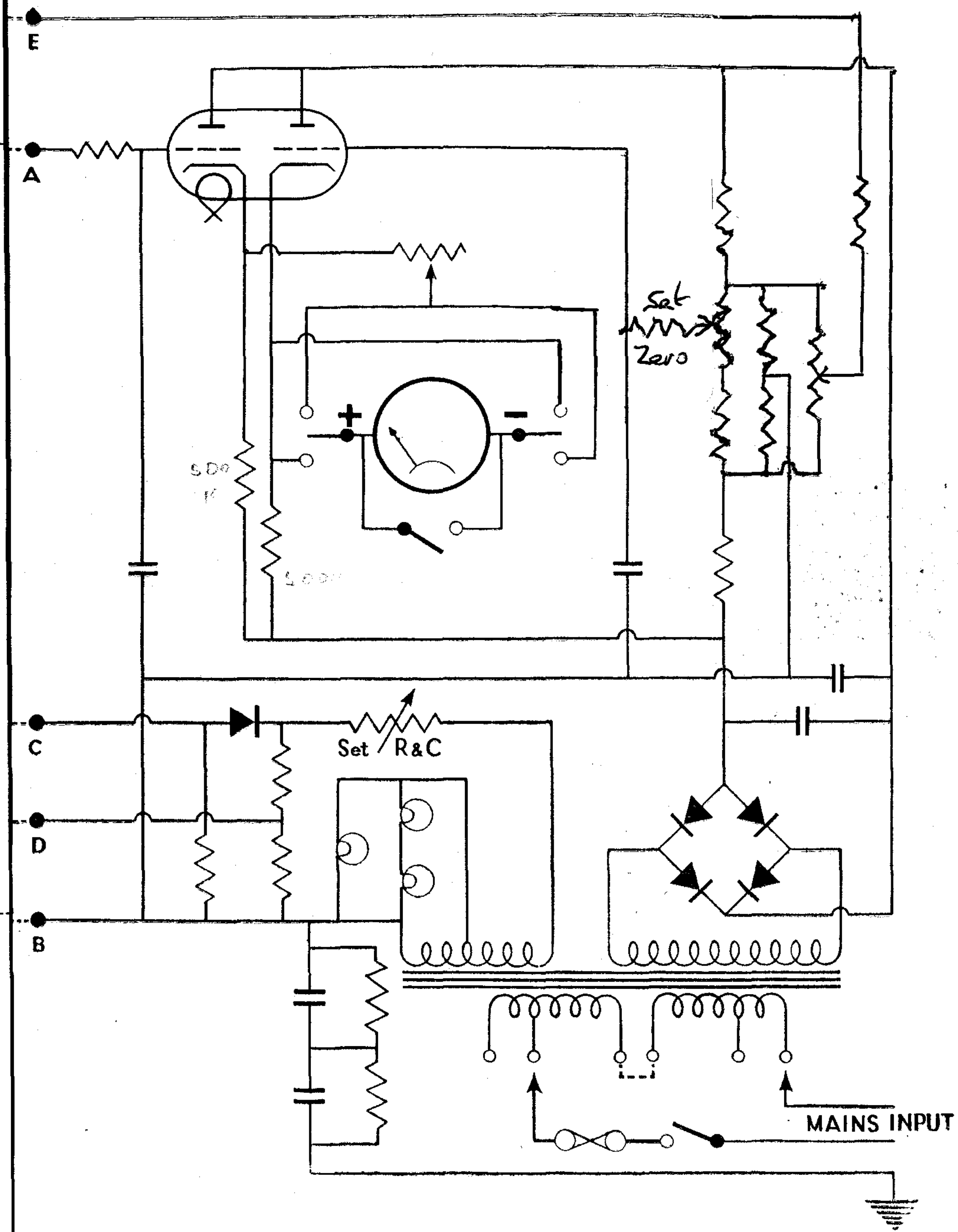
D.C. VOLTS MEASURING CIRCUIT



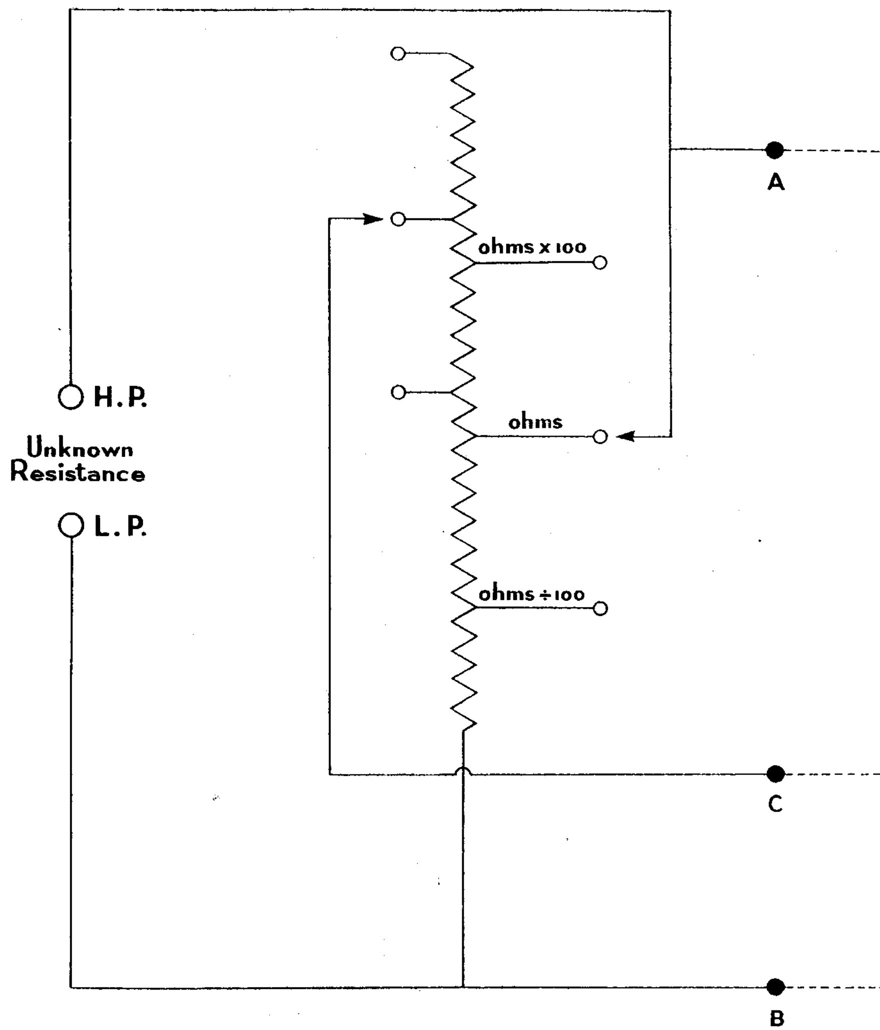
BASIC D.C. MILLIVOLTMETER DIAGRAM



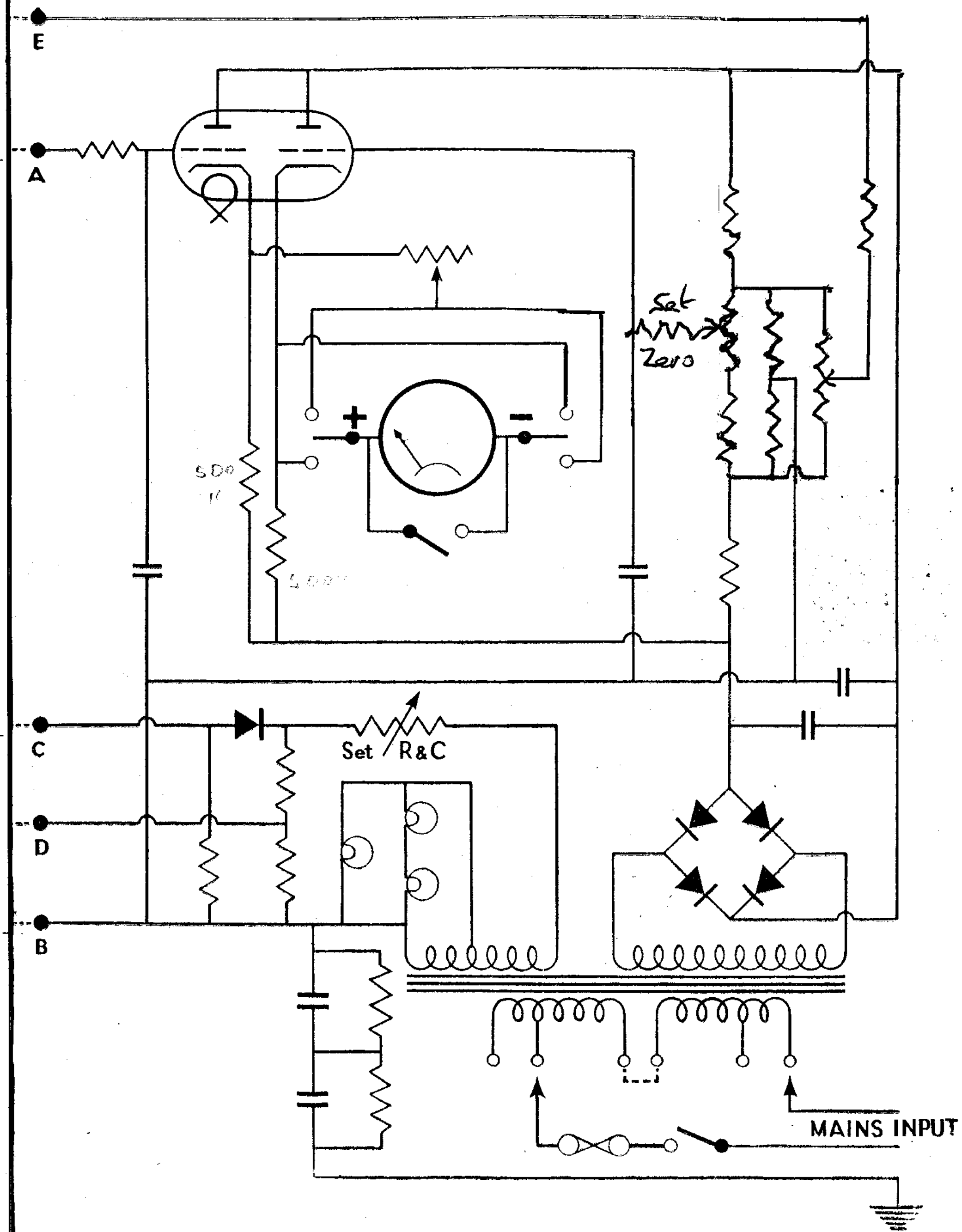
D.C. CURRENT MEASURING CIRCUIT



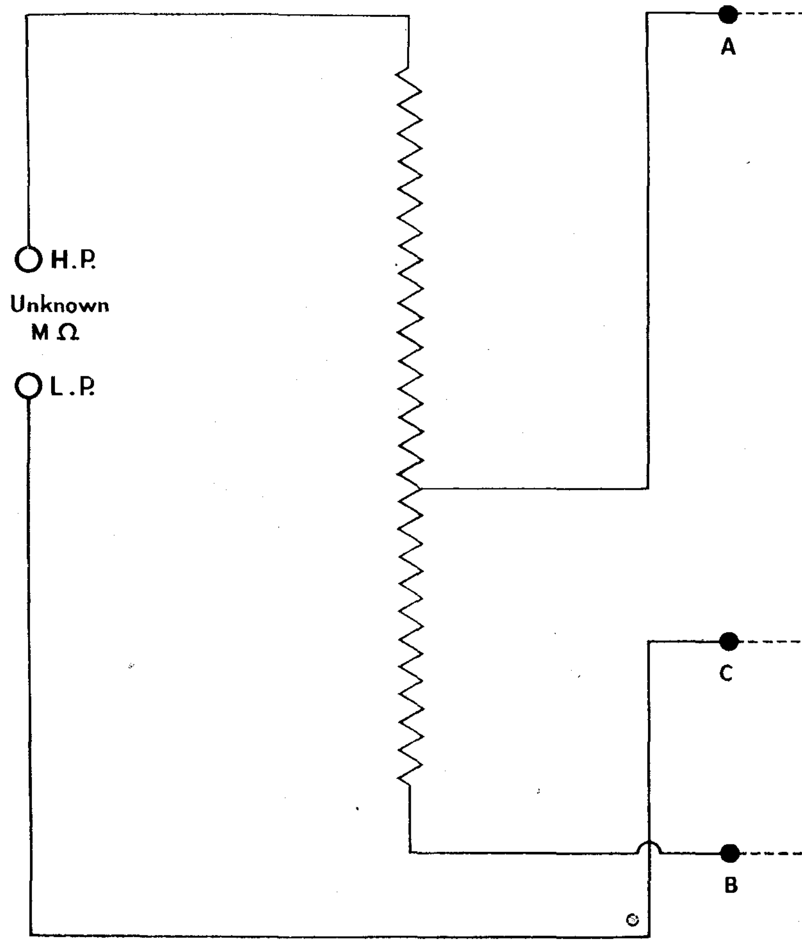
BASIC D.C. MILLIVOLTMETER DIAGRAM



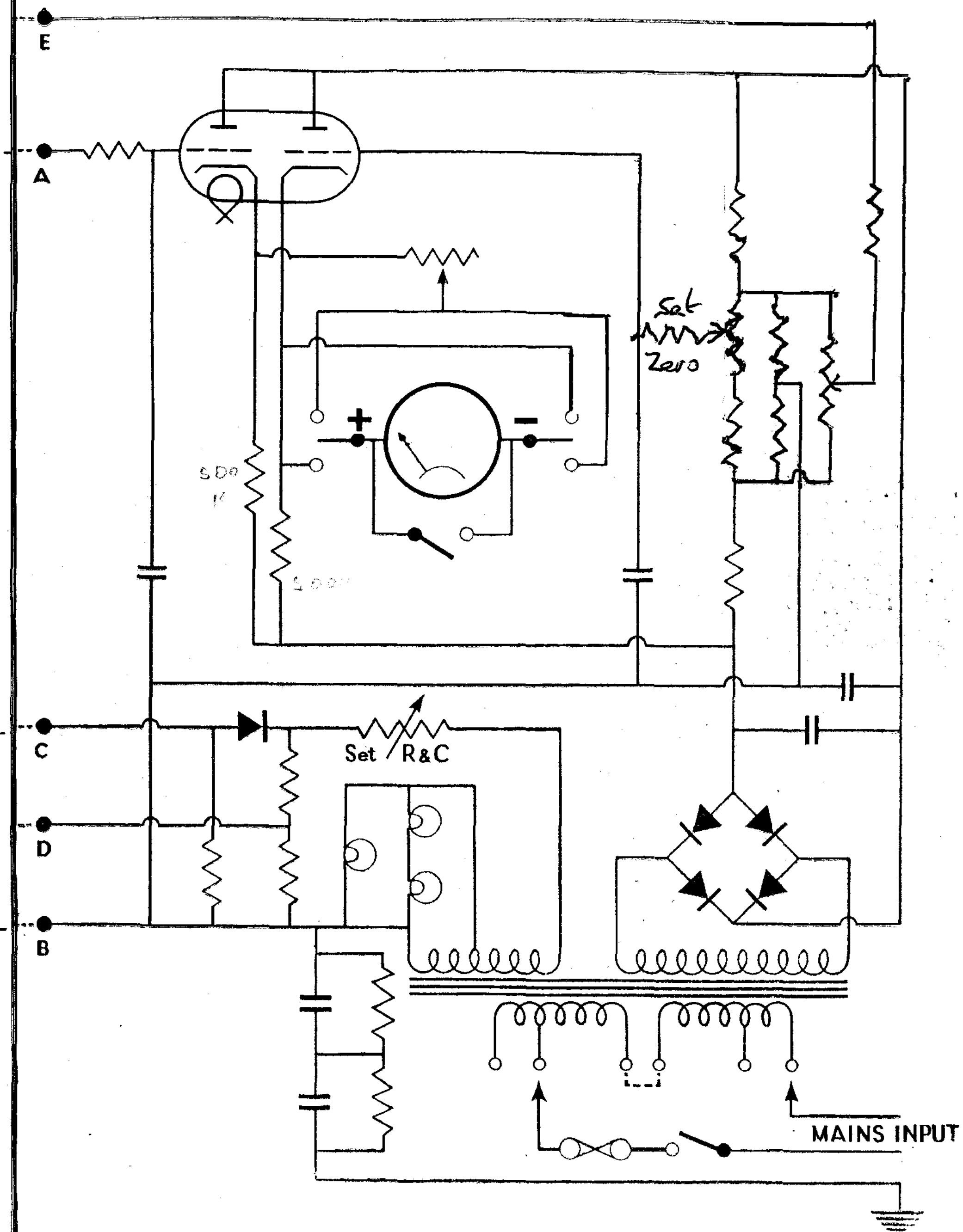
OHMS MEASURING CIRCUIT



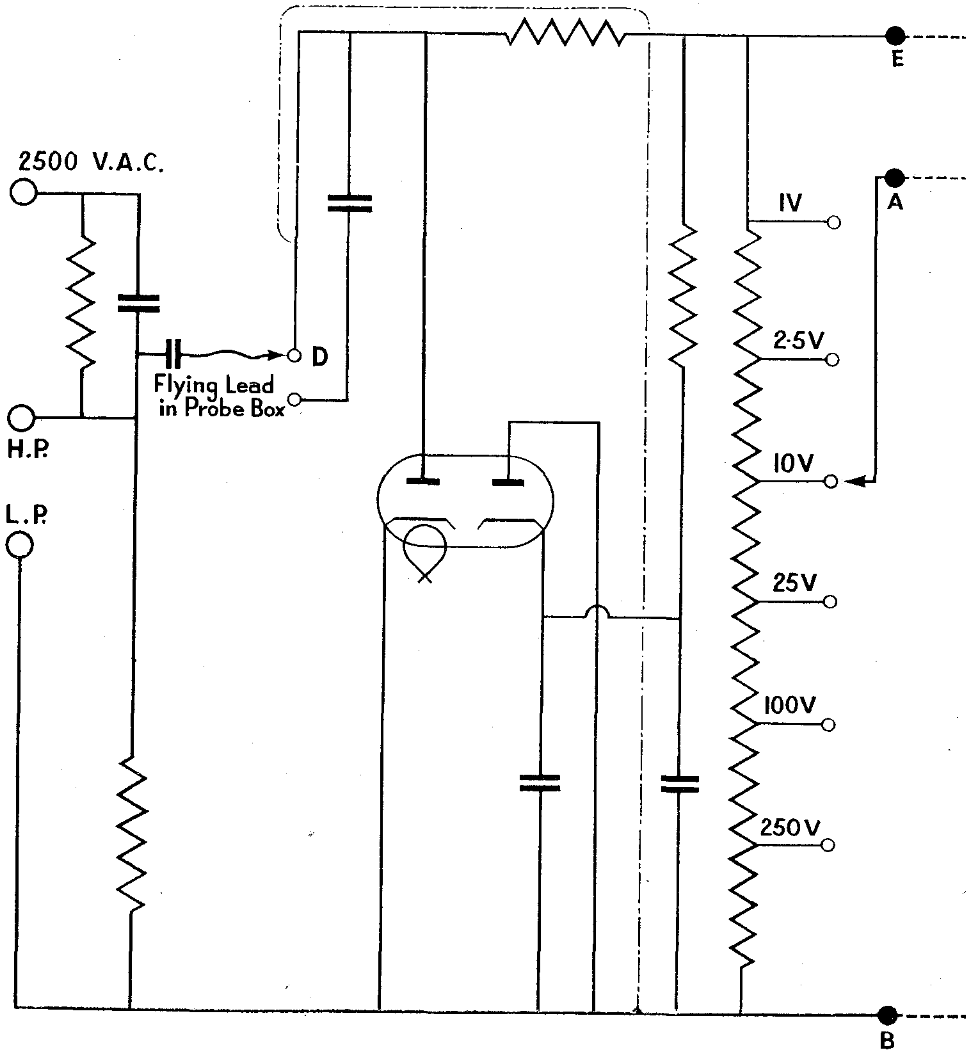
BASIC D.C. MILLIVOLTMETER DIAGRAM



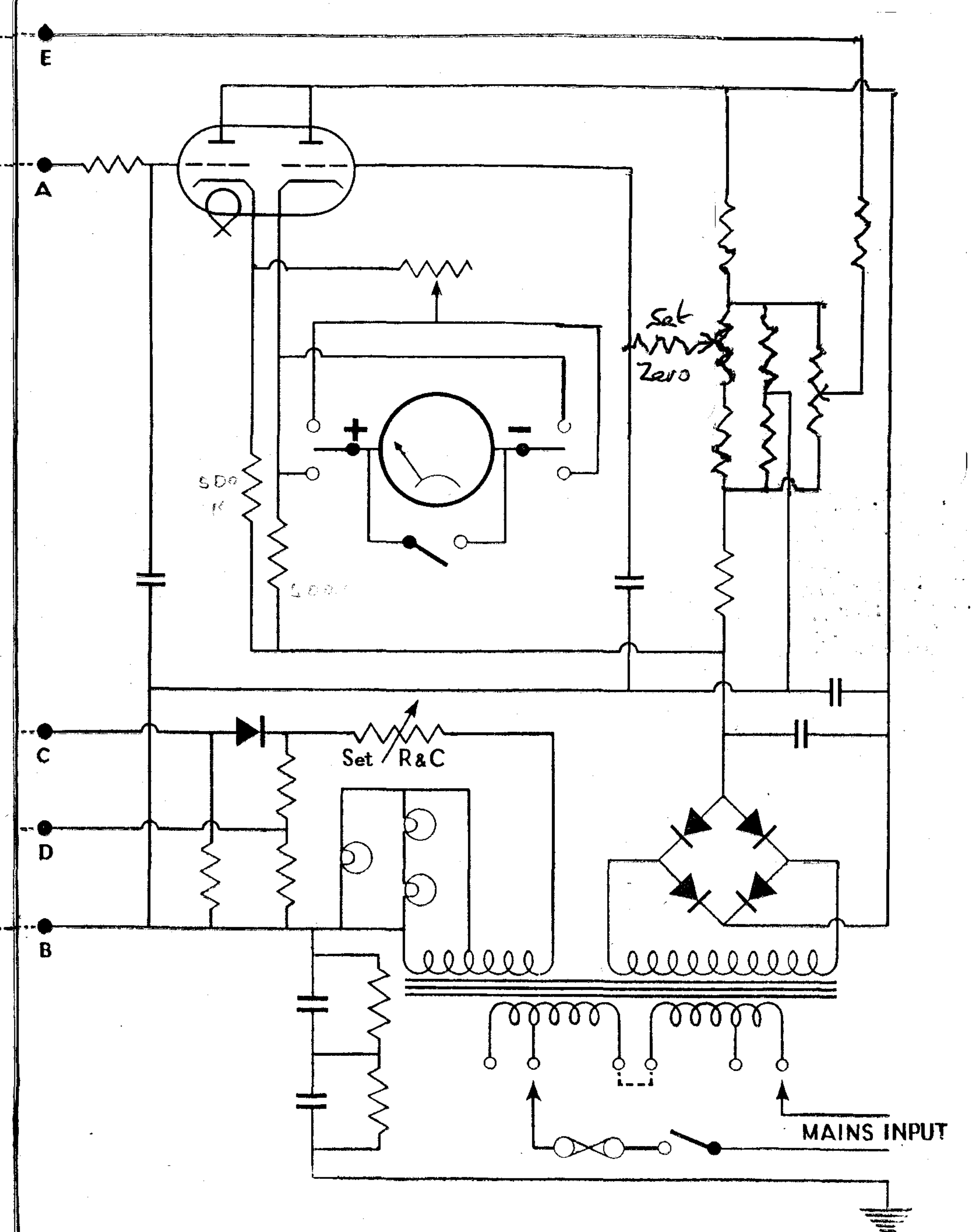
MEGOHMS MEASURING CIRCUIT



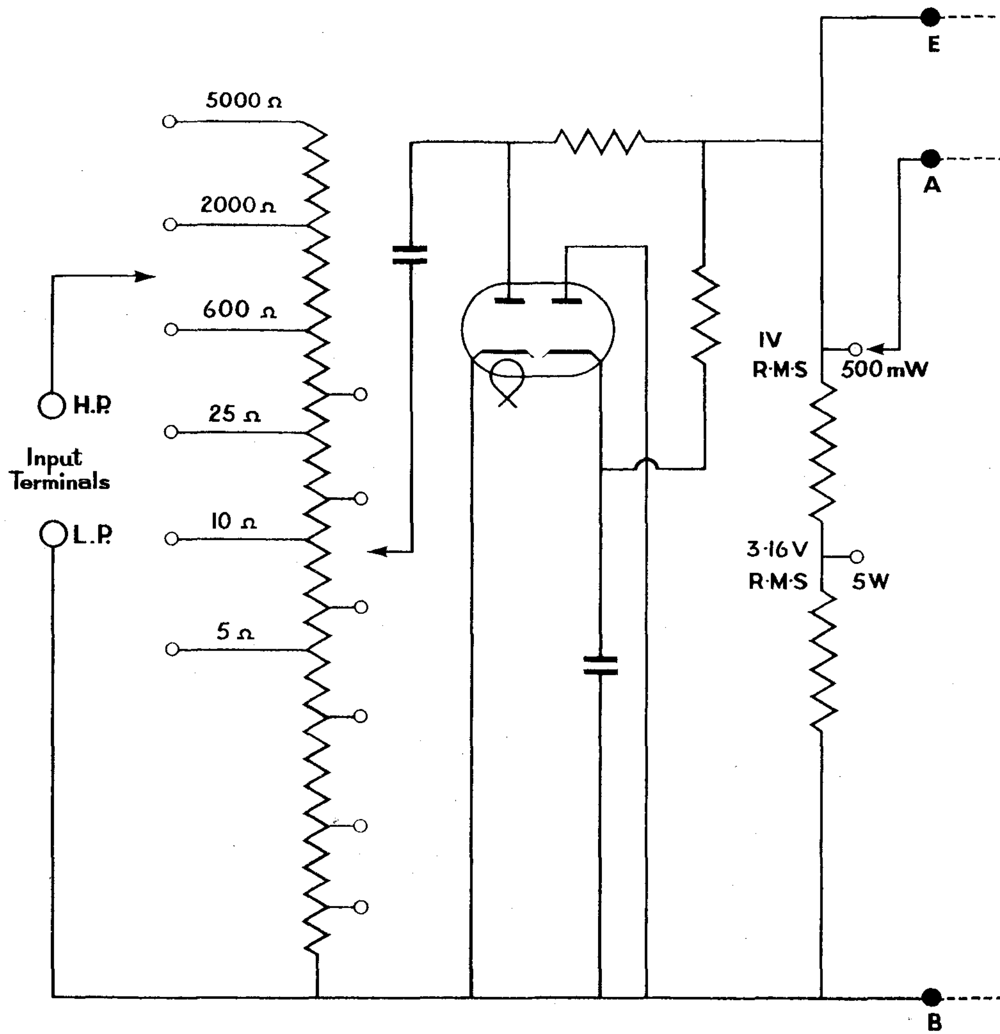
BASIC D.C. MILLIVOLTMETER DIAGRAM



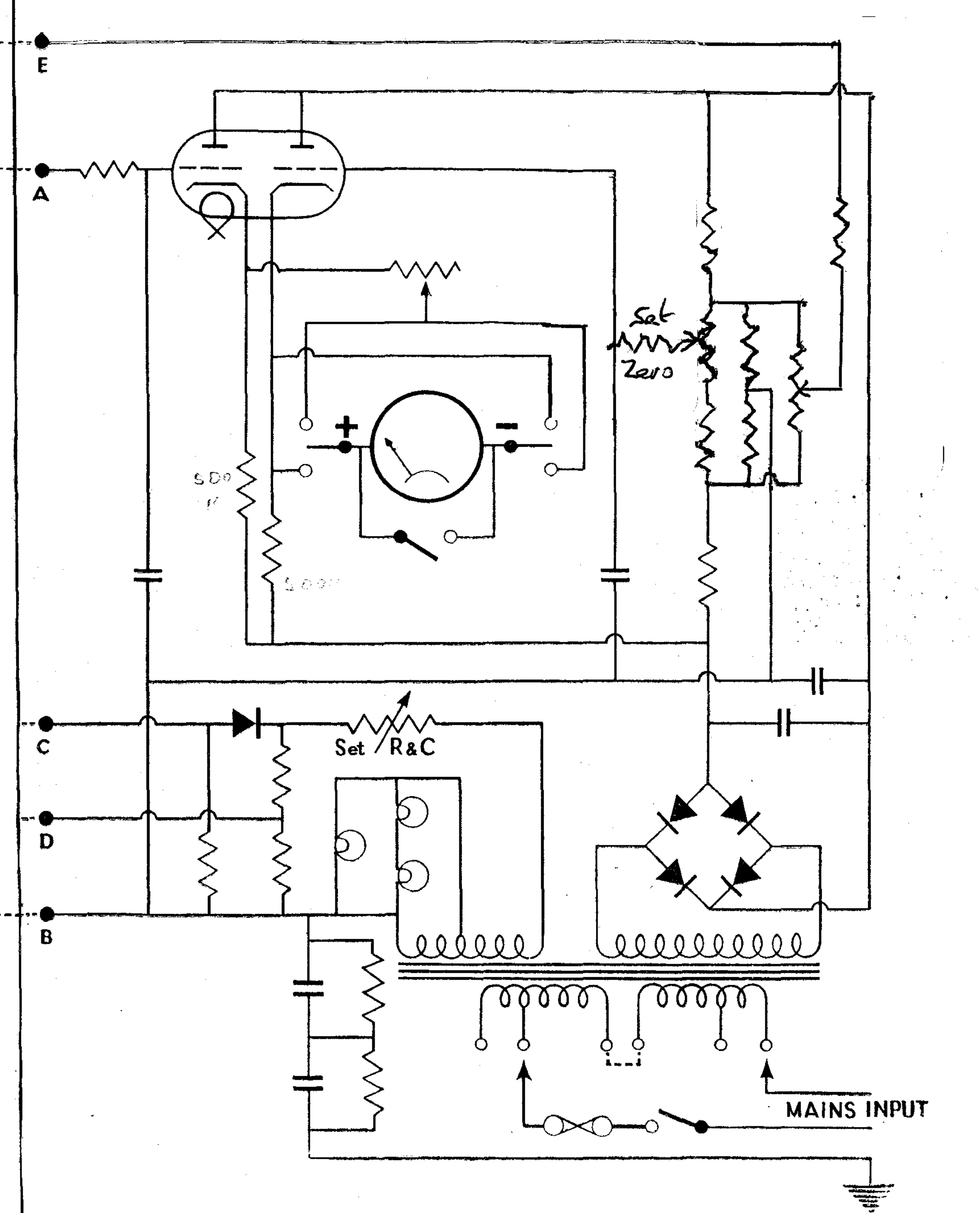
A.C. VOLTS MEASURING CIRCUIT



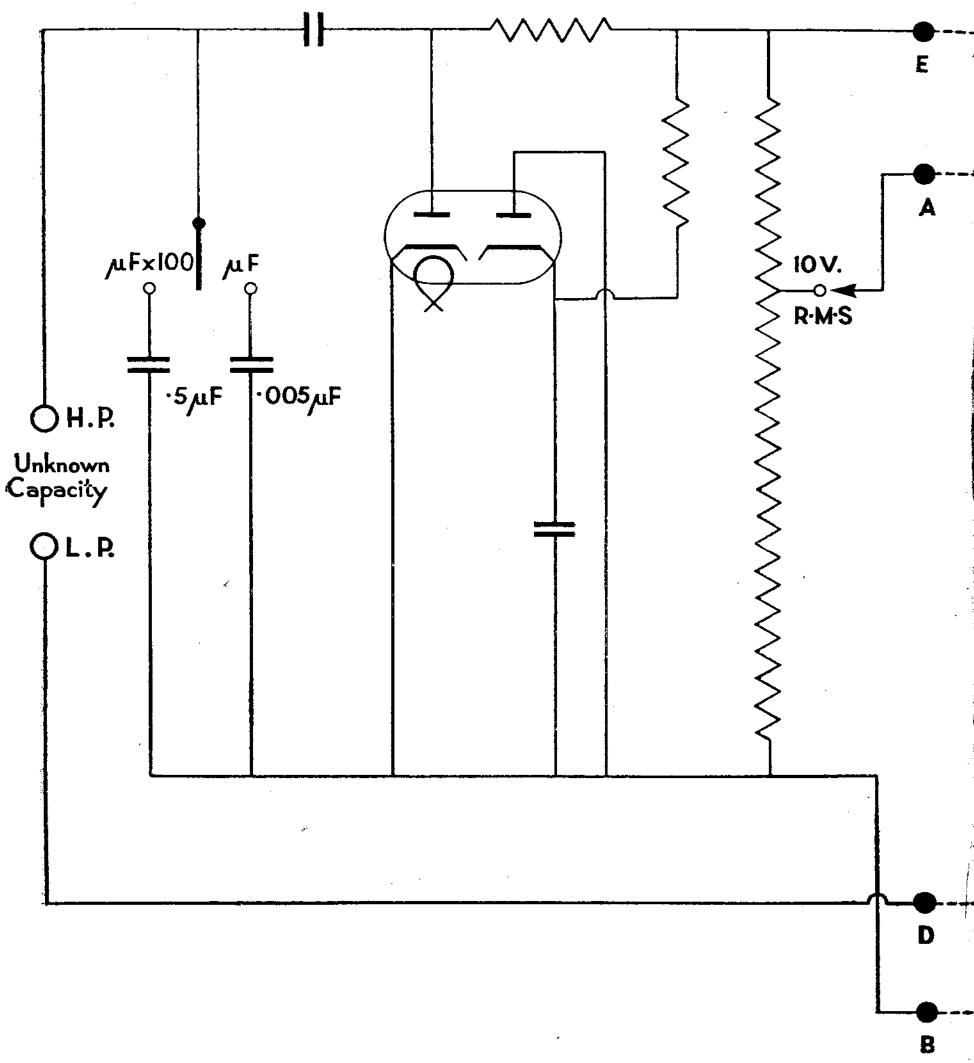
BASIC D.C. MILLIVOLTMETER DIAGRAM



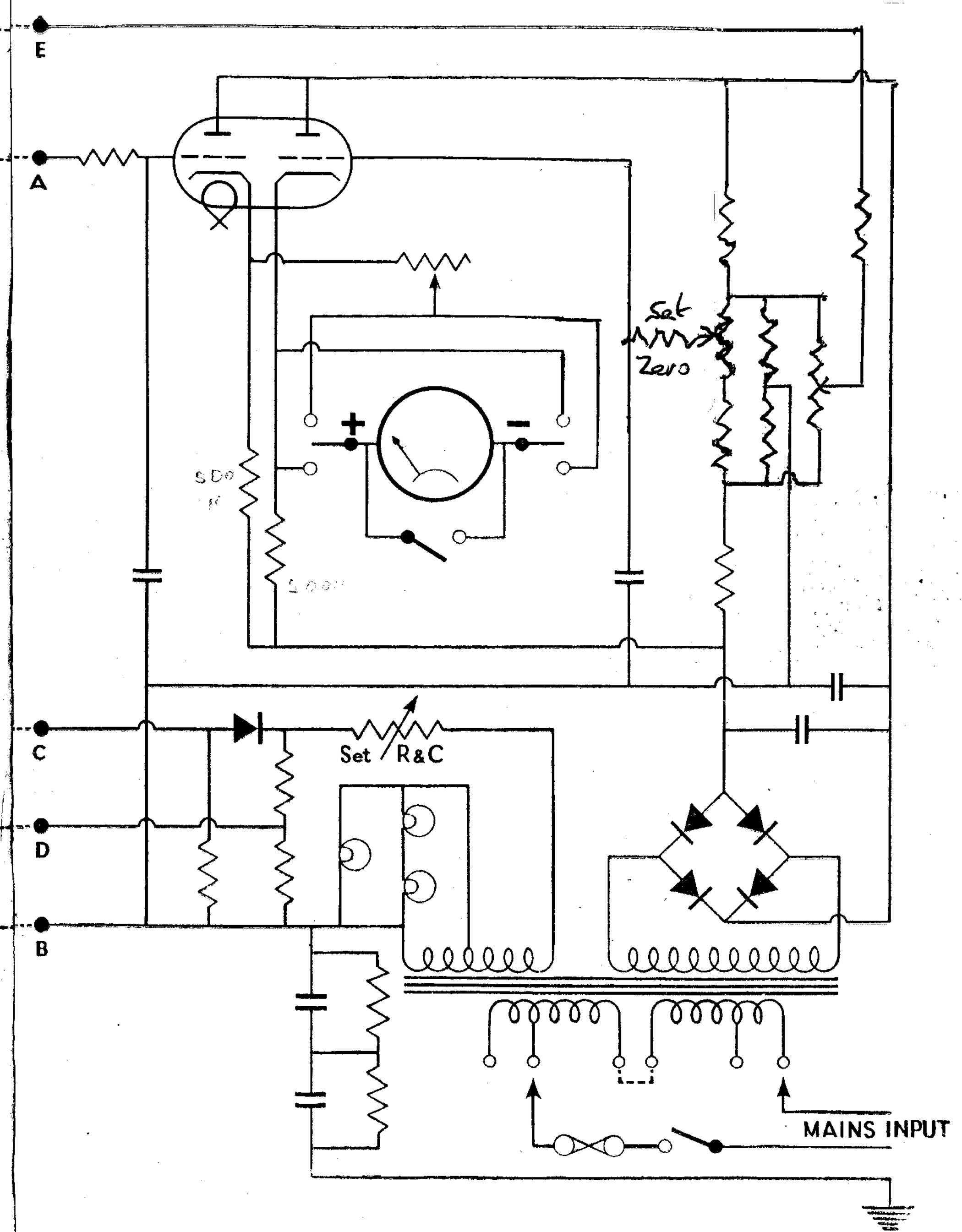
WATTS MEASURING CIRCUIT



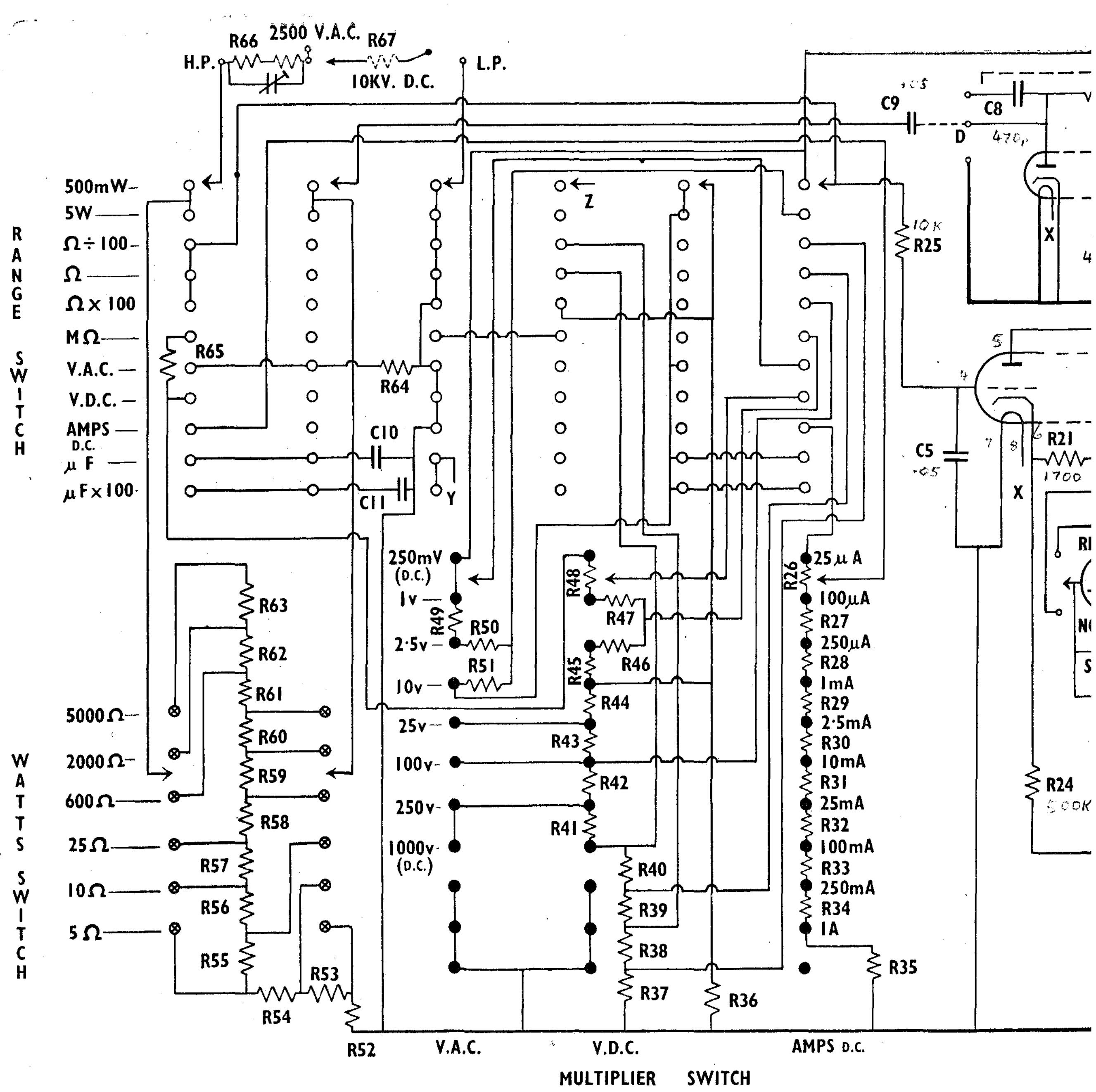
BASIC D.C. MILLIVOLTMETER DIAGRAM



CAPACITY MEASURING CIRCUIT



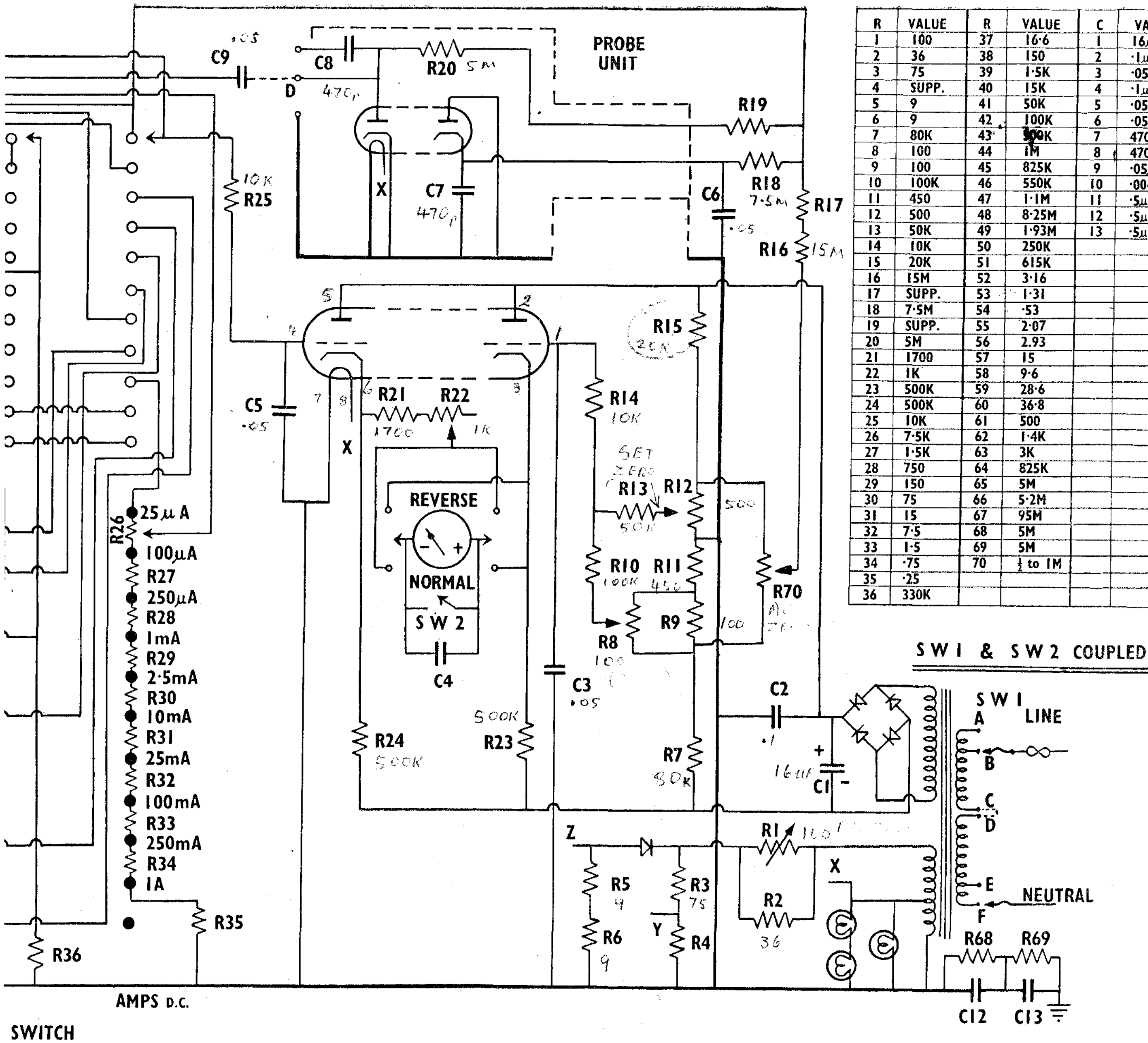
BASIC D.C. MILLIVOLTMETER DIAGRAM



CIRCUIT DIAGRA

THE "AVO" ELECTRONIC T

Instruments made to this circuit have a letter "U" in the serial number



R	VALUE	R	VALUE	C	VALUE
1	100	37	16·6	1	16μF
2	36	38	150	2	·1μF
3	75	39	1·5K	3	·05μF
4	SUPP.	40	15K	4	·1μF
5	9	41	50K	5	·05μF
6	9	42	100K	6	·05μF
7	80K	43	500K	7	470pF
8	100	44	1M	8	470pF
9	100	45	825K	9	·05μF
10	100K	46	550K	10	·0045μF
11	450	47	1·1M	11	·5μF
12	500	48	8·25M	12	·5μF
13	50K	49	1·93M	13	·5μF
14	10K	50	250K		
15	20K	51	615K		
16	15M	52	3·16		
17	SUPP.	53	1·31		
18	7·5M	54	·53		
19	SUPP.	55	2·07		
20	5M	56	2.93		
21	1700	57	15		
22	1K	58	9·6		
23	500K	59	28·6		
24	500K	60	36·8		
25	10K	61	500		
26	7·5K	62	1·4K		
27	1·5K	63	3K		
28	750	64	825K		
29	150	65	5M		
30	75	66	5·2M		
31	15	67	95M		
32	7·5	68	5M		
33	1·5	69	5M		
34	·75	70	½ to 1M		
35	·25				
36	330K				

SW 1 & SW 2 COUPLED

CIRCUIT DIAGRAM

"AVO" ELECTRONIC TESTMETER