# CHAPTER 1

## TESTMETERS, Types C, D, E, F, AND H

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### Introduction

1. Testmeters, types C, D, E, F, and H are self-contained instruments, providing the means of measuring wide ranges of voltage, current, and resistance values, and although light and easily portable they are reliable and robust. The instruments are dust and weatherproof and are suitable for both temperate and tropical climates. They are housed in suitable weatherproof cases and the ranges covered are controlled by switches and/or sockets mounted on the front of the instrument. A scale, protected with glass, and appropriately marked, is mounted on the front of the case, and these, together with the necessary terminals, comprise the complete testmeter control equipment. All screws and detachable parts are secured against looseness due to vibration.

### Types available

2. The testmeter and accessories available for use are given in table 1.

TABLE 1

| *Stores Ref.* | *Type* | *Remarks* | *Weight* |
|---|---|---|---|
| 10S/10610 | D | With leads | 5 lb. 5 oz. |
| 10S/10613 | E | With leads and case | 1 lb. 12 oz. |
| 10S/1 | F | With leads | 6 lb. |
| 10S/46 | H | With leads and case | 1 lb. 2 oz. |
| 10S/78 | C | With leads and case | 1 lb. 2½ oz. |
| 10S/10612 | D | Connecting leads No. 4 | |
| 10S/10616 | E | Connecting leads No. 5 | |
| 10S/10611 | 15 | Fuse testmeter, type D | |
| 10S/10615 | 16 | Fuse testmeter, type E | |
| 5J/2000 | D | Battery | |
| 5J/1723 | E | Battery | |
| 10S/10614 | E | Leather carrying case | |

## DESCRIPTION

### Testmeter, type F

3. The instrument consists of a moulded panel on the inside of which are mounted the whole of the switching apparatus, resistances, shunts, transformer, rectifier and the moving coil. The panel fits into an aluminium or moulded case, the joint being dust-proof, and a leather carrying strap held by two studs on each side of the case is provided for portability. The overall size of the meter is 8 in. by 7¼ in. by 4⅜ in.

4. The entire switching of the testmeter is accomplished by means of two switch knobs on the panel, each being plainly marked so that the range in use appears opposite an arrowhead. The left-hand switch knob governs the D.C. ranges and the right-hand the A.C. ranges, and they are so interlocked that it is only possible to obtain D.C. readings by setting the D.C. switch to a range and rotating the A.C. switch to the position marked D.C. A similar procedure is necessary when making an A.C. measurement, and the instrument is therefore protected from damage in the event of both switches being left on ranges when making a test, as, while in this condition, there is no circuit through the meter.

5. The movement is of the moving coil type, and consists of an aluminium former wound with copper wire supplemented with constantan in order to reduce temperature error. The coil, pivoted on hardened, polished steel points, swings in a gap energised by an artificially aged cobalt steel magnet, two phosphor-bronze hair springs being fitted to convey current to and from the moving coil, and torsionally for the return of the pointer to zero. The movement is electrically damped to prevent undue oscillation and to ensure the pointer coming quickly to rest, and the resistance of the electrical circuit of the testmeter is approximately 500 ohms per volt on normal ranges, or 1000 ohms per volt on press-button ranges.

6. The scale plate has six scales each approximately 5 in. in length. The top scale is for resistance measurements, the second for both A.C. and D.C. current and voltage measurements, and the third is used in conjunction with the 400-volt range marked on the switch knob. The three lower scales are provided for capacity, power, and decibels respectively. The dial is fitted with an untarnishable mirror to prevent errors due to parallax. With the exception of the 400-volt A.C.–D.C. range and its associated 200-volt range obtainable by use of the press button, each successive range, as indicated by the switch knobs, is ten times the value of the previous one, thus avoiding the use of awkward multiplying constants.

7. The press button is situated in the centre of the panel and is only intended for use when measuring voltage and current. By pressing the button the normal full scale deflection, as shown by the switch knob, is halved, and consequently twice the normal length of pointer deflection is produced with a given input, the meter resistance being unchanged. A control marked P, situated on the left-hand side of the panel directly beneath the scale, is used in conjunction with the control R positioned below the centre of the scale to compensate for voltage loss in the dry cell when measuring resistance. Below the control R is the zero adjuster, slotted for screwdriver operation and designed for zero adjustment of the AMPS and VOLTS scale. The control Q, on the right-hand side of the panel in line with P, is used for pointer adjustment when using the 1-megohm resistance range or when measuring capacity. The cut-out reset knob is mounted in the centre of the lower edge of the panel, and should an overload be applied to the instrument, the knob springs from its normal position in the panel thus breaking the circuit.

8. Two terminals marked + and −, affording attachment for the connecting leads, are mounted on the bottom of the panel. The two leads are coloured red and black respectively, each lead being fitted with a flat hook connection at one end for connection to the testmeter. The free end is fitted with a threaded ferrule, into which a crocodile clip or pointed prod can be screwed. The leads are 2 ft. 6 in. in length, are of ample cross-sectional area to carry the current for which they are to be used and are insulated to withstand 1500 volts. Three rubber feet, on which the instrument rests when in use, are fitted at the back of the case.

*Ranges covered*

9. The following table gives the ranges covered by the testmeter, type F.

TABLE 2

| *Stores Ref.* | *Type* | *Voltage* | | *Current* | | *Resistance* |
|---|---|---|---|---|---|---|
| | | *D.C.* | *A.C.* | *D.C.* | *A.C.* | |
| 10S/1 | F | 0–50 mV | 0–5 V | 0–1 mA | 0–5 mA | with internal battery |
| | | 0–100 mV | 0–10 V | 0–2 mA | 0–10 mA | 0–10,000 ohm |
| | | 0–500 mV | 0–50 V | 0–5 mA | 0–50 mA | 0–100,000 ohm |
| | | 0–1 V | 0–100 V | 0–10 mA | 0–100 mA | 0–1 megohm |
| | | 0–5 V | 0–200 V | 0–50 mA | 0–500 mA | with A.C. or D.C. mains |
| | | 0–10 V | 0–400 V | 0–100 mA | 0–1 A | 0–10 megohms |
| | | 0–50 V | 0–500 V | 0–500 mA | 0–5 A | 0–40 megohms |
| | | 0–100 V | 0–1,000 V | 0–1 A | 0–10 A | capacity |
| | | 0–200 V | | 0–5 A | | 0–20 mFd |
| | | 0–400 V | | 0–10 A | | first indication |
| | | 0–500 V | | | | 0·01 mFd. |
| | | 0–1,000V | | | | |

*Power and Decibels*

| *Impedance* | *Range* | *First Indication* | *0 = 50 mW* |
|---|---|---|---|
| 500 ohms | 0–200 mW | 0·1 mW | −25 to + 6 db |
| 5,000 ohms | 0–2 W | 1 mW | −15 to + 16 db |
| 50,000 ohms | 0–200 mW | 0·1 mW | −25 to + 6 db |

With the older type instruments, having aluminium cases, there is only one range for power and decibels from 0–4 watts of 4000 ohms impedance with a minimum indication of 1 mW. The decibel limits are −10 to +15 decibels to a reference level of 50 mW.

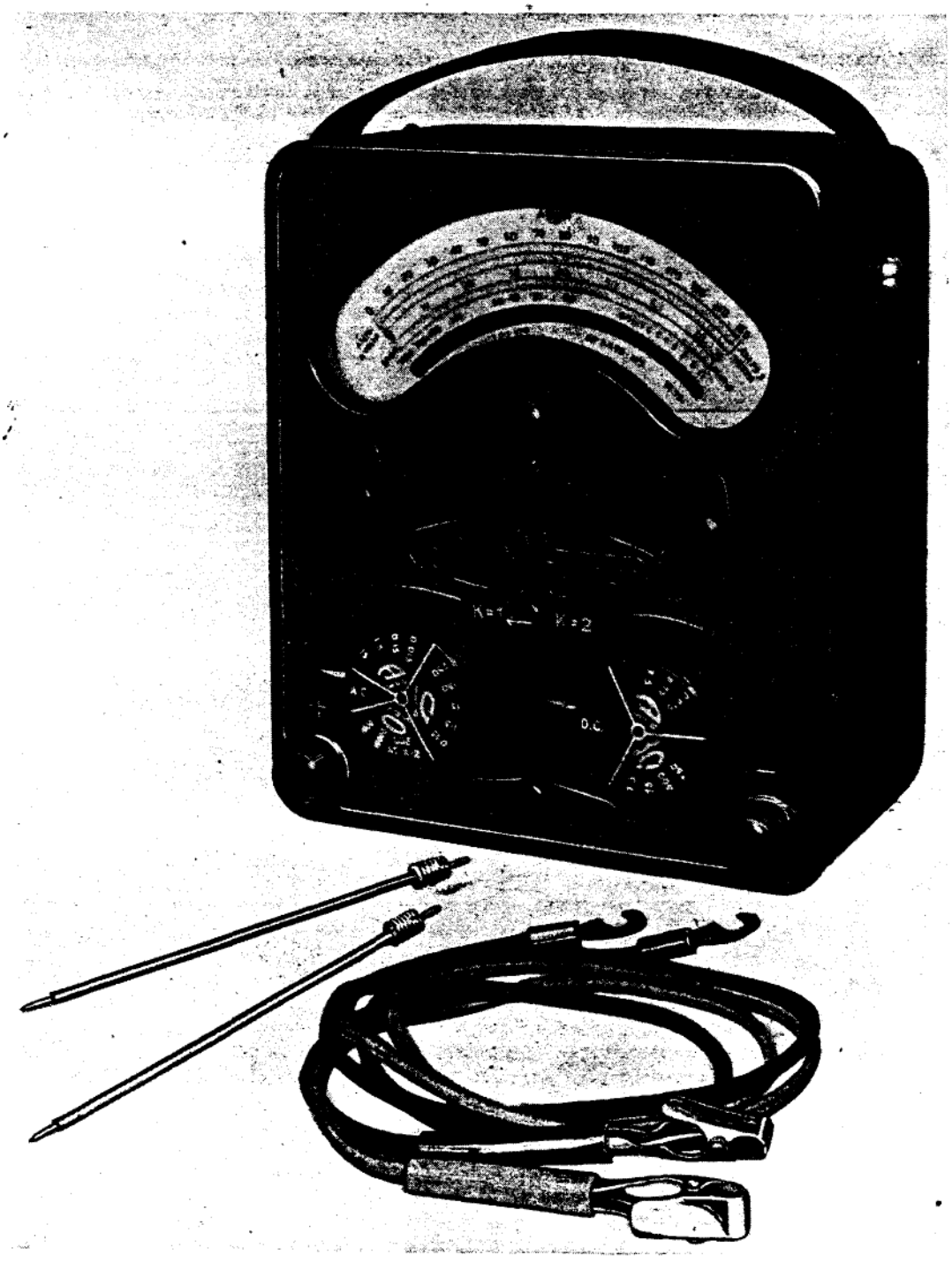


**Fig. 1.—Testmeter, type D**

**Testmeter, type D**

10. Although similar in design to the testmeter already described, testmeter, type D, which is illustrated in fig. 1 has slightly differing controls. Instead of the press button, a multiplier switch knob is situated in the centre of the panel. It is engraved with a white indicating arrow, the designation K = 1 appearing on the left, and the designation K = 2 appearing on the right-hand side of the control. By use of this control the voltage indications, with the knob in the K=2 position, are doubled. The control Q at the right of the panel below the scale is a dummy. The scale is white and has three sets of calibrations marked on it in black, the markings being in sub-divisions of amps, volts, and ohms. When used as a voltmeter, the resistance of the electrical circuit of the instrument is 400 ohms per volt on K=1 and 200 ohms per volt on K=2.

*Ranges covered*

11. The ranges covered by the testmeter, type D, are given in table 3.

TABLE 3

| *Stores Ref.* | *Type* | *Voltage* | | *Current* | | *Ohms* |
|---|---|---|---|---|---|---|
| | | D.C. | A.C. | D.C. | A.C. | |
| 10S/10610 | D | 0–150 mV | 0–7·5 V | 0–15 mA | 0–75 mA | 0–1,000 |
| | | 0–300 mV | 0–15 V | 0–30 mA | 0–150 mA | 0–10,000 |
| | | 0–1·5 V | 0–75 V | 0–150 mA | 0–750 mA | |
| | | 0–3 V | 0–150 V | 0–300 mA | 0–1·5 A | |
| | | 0–15 V | 0–300 V | 0–1·5 A | 0–7·5 A | |
| | | 0–30 V | 0–600 V | 0–3 A | 0–15 A | |
| | | 0–150 V | 0–750 V | 0–15 A | | |
| | | 0–300 V | 0–1500 V | 0–30 A | | |
| | | 0–750 V | | | | |
| | | 0–1500 V | | | | |

**Testmeter, type E**

12. The testmeter, type E, is depicted in fig. 2. It is constructed of black moulded insulating material, is approximately 4¾ in. by 3¾ in. by 2 in. overall, weighs 1 lb. 12 oz. and has four rubber feet located on the back upon which it should rest when in use. Also at the back is a hinged instruction plate secured by two spring clips, and beneath it a loose plate clamped by a rubber buffer, covering a compartment in which is housed a dry battery.

13. The front of the instrument is also the control panel, and contains eleven protected sockets disposed four on the left-hand side, five on the right-hand side, and two on the bottom of the panel. These sockets, in conjunction with the range selector switch, provide the range selection for which the testmeter is designed. On the left-hand side, reading from the top downwards, the sockets are labelled 1,000 V, 200 V, 20 V, and 2 V, respectively. On the right-hand side reading from the top they are labelled 20 A, 2 A, 200 mA, 100 mA, and 20 mA, respectively. The bottom left-hand socket is marked NEG. and that on the right 10,000 ohms. A detachable fuse cartridge engraved E, which screws into a brass bush in the panel, is situated at the bottom left-hand corner, whilst centrally in the panel is the screwdriver slotted zero adjuster Z. The three-position range selection switch, located below the adjuster Z, has an arrow indication moulded upon the switch handle, and the switch indications are moulded immediately above it. The three positions, reading from left to right are, VOLTS, K = 1, AMPS and OHMS, and VOLTS K = 2. The scale has three sets of calibrations marked in sub-divisions of amperes, volts and ohms, and the pointer is fitted with a locating disc. The zero adjuster, designed for use when measuring resistance, is directly in line with the range switch and is mounted on the bottom edge of the instrument. An accurate moving coil movement is employed, motion limiting stops are provided, the meter is electrically damped, approximately dead beat and the zero adjustment is sufficiently tight to prevent creeping. In order to prevent high voltage occurring between the line wire and the magnet system or other metal parts the electrical

connections are made in such a way that no metal parts are isolated. The connecting leads are similar to those supplied with testmeter, type F, but plugs for making connection with the sockets in the testmeter are provided in place of the terminal connections. A leather carrying case with a shoulder strap enables the testmeter to be carried slung from the shoulder. The resistance of the electrical circuit of the testmeter is approximately 400 ohms per volt on K=2 and 800 ohms per volt on K=1.

*Ranges covered*

14. . The ranges covered by the testmeter, type E, are given in table 4.

TABLE 4

| *Stores Ref.* | *Type* | *Voltage* D.C. | *Current* D.C. | *Resistance* |
|---|---|---|---|---|
| 10S/10613 | E | 0–2 V | 0–20 mA | 0–10,000 ohms |
| | | 0–4 V | 0–100 mA | |
| | | 0–20 V | 0–200 mA | |
| | | 0–40 V | 0–2 A | |
| | | 0–200 V | 0–20 A | |
| | | 0–400 V | | |
| | | 0–1000 V | | |
| | | 0–2000 V | | |

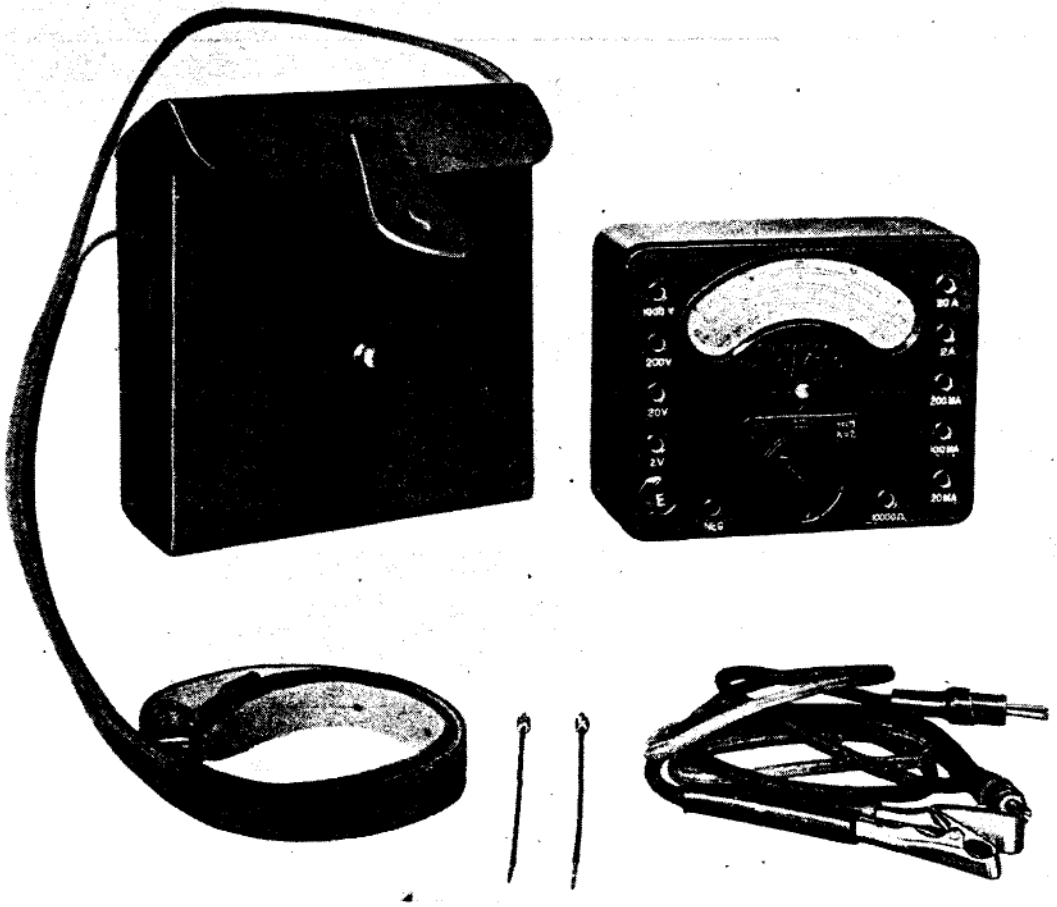


**Fig. 2.—Testmeter, type E**

**Testmeter, type H**

15. The testmeter, type H, is similar in appearance to the type E but there are twelve range selection sockets, which together with the range selection switch give the appropriate ranges covered by the meter. The socket indications on the left-hand side reading from the top downwards are 500 V, 250 V, 100 V, 25 V, and 5 V A.C. or D.C. Those on the right-hand side reading from the top downwards are 500 mA, 100 mA, 25 mA, and 2·5 mA D.C. only. The bottom left-hand socket is engraved COM. NEG. and the bottom right-hand socket 20,000 ohms. The range selection switch has two positions and is marked A.C.—VOLTS on the left and D.C.—OHMS on the right-hand side.

*Ranges covered*

16. The ranges covered by the testmeter, type H, are given in Table 5.

TABLE 5

| *Stores Ref.* | *Type* | *Voltage* | | *Current* D.C. | *Resistance* | |
|---|---|---|---|---|---|---|
| | | D.C. | A.C. | | | |
| 10S/46 | H | 0–75 mV | 0–5 V | 0–2·5 mA | 0–20,000 ohms (internal cell) | |
| | | 0–5 V | 0–25 V | 0–5 mA | 0–100,000 ohms | using external voltage |
| | | 0–25 V | 0–100 V | 0–25 mA | 0–500,000 ohms | |
| | | 0–100 V | 0–250 V | 0–100 mA | 0–2 megohms | |
| | | 0–250 V | 0–500 V | 0–500 mA | 0–5 megohms | |
| | | 0–500 V | | | 0–10 megohms | |

**Testmeter, type C**

17. Designed for use with D.C. only, the testmeter, type C has a $2\frac{1}{2}$ in. scale calibrated from 0 to 60 for voltage and current readings, and 0 to 10,000 for resistance in ohms. A total resistance of 100,000 ohms enables a full scale deflection of 300 volts to be obtained for a current consumption of 3 mA, and an ohms adjuster is fitted to provide compensation for voltage change in the internal battery. The control panel contains eight protected sockets, that at the top left-hand side being marked + and that at the top right-hand side OHMS. Reading from the left, the centre row of sockets are designated 6 mA, 30 mA and 120 mA, whilst the bottom row are marked 6 volts, 120 volts and 300 volts, respectively. The instrument is contained in a case, the lid of which houses the test leads, clips, and prods, the weight of the meter and case being $18\frac{1}{2}$ oz. and the overall size $4\frac{3}{4}$ in. by $3\frac{3}{4}$ in. by $2\frac{5}{8}$ in.

*Ranges covered*

18. The ranges covered by the testmeter, type C, are given in Table 6.

TABLE 6

| *Current* | *Voltage* | *Resistance* |
|---|---|---|
| 0–6 milliamps | 0–6 V 0–12 V | With internal cell 0–10,000 ohms |
| 0–30 milliamps | 0–120 V 0–240 V | With external supply 0–60,000 ohms |
| 0–120 milliamps | 0–300 V 0–600 V | 0–1,200,000 ohms |
| | | 0–3 megohms |

## OPERATION

19. The testmeters are not magnetically screened and should not be employed near steel or electro-magnetic circuits. As a safety measure, when the instrument is not in use the range selection devices should be set so that the top range is in circuit, or with testmeters, types D and F the two range selection switches should be set, one to the A.C., and the other to the D.C. position, as, when in

this position, there is no circuit through the meter. Should A.C. be passed through the meter when it is set to a correct range of D.C. or *vice versa*, no pointer indication will be produced, and no damage will result. It is thus possible to determine whether a supply is A.C. or D.C. since pointer deflection can only be produced with switches set for the same type of measurement as the source. When in use the testmeters should be laid flat, face upwards, on the rubber feet provided at the back. The pointer should be set to zero by means of the zero adjustment and the leads attached to the appropriate terminals, clips or prods being used on the free ends of the leads according to the nature of the test to be made.

**Types D and F**

*Voltage*

20. When measuring voltage, the switches should be set to the appropriate range, and the leads connected across the source of voltage to be measured. If the approximate value of the quality to be measured is not known, the range switch should first be set to the highest range, and then rotated until the correct range is found. When using the testmeter, type D, with the multiplier switch in the K=2 position, full scale deflection is produced with twice the value shown on the switch knob. With the testmeter, type F, by using the press button, twice the normal length of pointer deflection is produced with a given input.

*Current*

21. To measure current with testmeters, types D and F, the switches should be set to a suitable range, and the instrument connected in series with the apparatus being tested. With the testmeter, type D, the range may be increased by setting the multiplier switch in the K=2 position, and with the testmeter, type F, the press button may be employed to increase the length of pointer indication on lesser loads.

*Resistance*

22. When used as an ohmmeter for the measurement of resistance it is advisable to check, and, if necessary, to adjust for any change in the battery voltage or resistance. The leads should be connected together, the D.C. range control set to the 10,000-ohm position and the control P adjusted so that the pointer indicates zero ohms. With the range control set in the 1,000-ohm position the control R should be used to adjust the pointer to a similar position, which position must be maintained with the switch in either the 1,000 or 10,000-ohm position. The pointer should then again be set to the zero position by a further adjustment of the control P, with the switch in the 10,000-ohm position. With the testmeter, type D, the range multiplier switch should be set in the K=2 position when making these adjustments, and when the adjustments are completed, with the D.C. range control set to the appropriate range, the leads should be connected across the article under test and its resistance will be indicated on the OHMS scale.

23. When measuring resistance with the testmeter, type F, the 1½-volt cell furnishes the current for making the test on the two lower resistance ranges, and, after checking, and if necessary, adjusting to compensate for battery exhaustion, it is only necessary to connect the leads across the article under test and its resistance will be indicated on the top scale. The one megohm range involves the use of two 4½-volt batteries which are housed in the battery compartment. Before testing on this range the leads should be connected together and the control Q withdrawn from the panel and rotated in a clockwise direction until the pointer indicates zero ohms. When set, resistance measurements can be made by connecting the leads across the article under test. Always reset control Q to its normal position in the panel before resuming tests. Extension of resistance ranges can be effected with the aid of A.C. or D.C. mains or other source of voltage used in conjunction with the 100 or 400-volt ranges. Adjustment for supply voltage is carried out by connecting the leads to the source and using the knob Q as before. This gives compensation from two thirds to two-and-a-half times the voltage range employed and it is safe to use the 100-volt range even when the testing voltage is as high as 250 volts. When set, the unknown resistance is connected in series with the meter and the supply, its value being that shown on the ohms scale multiplied by 1000 or 4000 respectively. Always reset control Q after use. Special care should be exercised when using the mains, the article under test should not be handled while the voltage is switched on and it should be realised that resistance tests must not be attempted on apparatus already carrying current.

**Type F only**

*Capacity*

24. Three further scales are provided with the testmeter, type F, for measuring capacity, power, and decibels. Capacity from 0·01 $\mu$F to 20 $\mu$F can be measured directly with the aid of an A.C. supply after a preliminary setting of voltage. With the switch set for capacity, the leads

should be connected to an A.C. supply of between 65 and 250 volts, 50 cycles, when the control Q can be used to bring the pointer to the infinity capacity mark. When set, the condenser under test is connected in series with the supply and the meter and its capacity can be read direct within commercial limits. Frequencies other than 50 cycles can be used, but the voltage limits will be affected, and it is important that 250 volts is not exceeded. The control Q must be returned to normal after use and the internal condenser should be discharged by joining the leads together. Electrolytic condensers must not be tested as the necessary polarising voltage cannot be applied.

*Power*

25. The power output scale, which is calibrated from one milliwatt to four watts, has an internal load resistance of 4000 ohms, and the readings obtained are a measure of audio-frequency power absorbed in this resistance. If the optimum load of the output valve is in the neighbourhood of 4000 ohms, the output transformer secondary should be disconnected and the meter connected across the primary, the power being indicated directly on the scale. Should the load impedance of the valve be different, a matching transformer to match 4000 ohms to the output impedance of the valve should be inserted in place of the existing output transformer, the meter being connected to the appropriate terminals. Rough indications of power output can be obtained simply by disconnecting the speaker and connecting the meter, set at its power range, across the output transformer primary terminals.

*Decibels*

26. There is a further range in conjunction with which there is a scale calibrated in decibels, the reference power level being taken as 50 milliwatts. Details of this range appear in the second part of TABLE 2, para. 9.

**Types E and H**

27. When in use, the testmeters should rest upon the four rubber feet provided at the back. The pointer should, if necessary, be set to zero by screwdriver adjustment of the control Z, and the leads plugged into the appropriate sockets, the blue lead into the socket marked NEG. and the red lead into the socket corresponding to the measurement to be taken. Crocodile clips or prods may be used on the free ends of the leads according to the nature of the apparatus under test. When the approximate value of the current or voltage to be measured is not known it is advisable to start with the highest range gradually reducing by changing to another socket until the correct range is found.

*Voltage*

28. When taking voltage measurements with the testmeter, type E, the multiplier switch may be set to either K = 1 or K = 2 according to the measurement to be made. The top current and voltage scale is calibrated with two sets of figures, the top set reading from 0 to 40 and the other from 0 to 20. The lower current voltage scale has one set of figures from 0 to 10. These scale markings are multiples of the actual measurements, governed by the range of the socket into which the red lead is plugged. Thus, with the multiplier switch in the K=1 position, the red plug in the 1000-volt socket, and a reading of 8 on the lower amps and volts scale, the actual voltage measured will be 800 volts. With the multiplier switch in the K=2 position, the red plug in the 1000-volt socket and a reading of 8 on the underside markings of the top amps. and volts scale, the actual voltage measured will be 1600. It will be seen that as this scale is calibrated from 0 to 20 a reading of 2000 volts can be obtained on this range.

29. When making A.C. voltage measurements with the testmeter, type H, the centre switch should be turned to the left-hand position marked A.C.—VOLTS. The negative lead may be plugged into the socket marked COM.—NEG. the positive lead in to the appropriate socket on the left-hand side of the instrument, and the free ends connected across the source of voltage to be measured. The milliamp and voltage scale is uniformly divided and marked with 50 divisions, a special scale being provided for the 5-volt A.C. range only. The figures on these scales are multiples of the voltage measured, governed by the markings on the socket into which the positive lead is plugged. For the measurement of D.C. voltage the procedure will be the same, but the centre switch should be turned to the D.C. AND OHMS position.

*Current*

30. When using the testmeter, type E, current measurements should be made with the control switch in the mid position marked AMPS. AND OHMS, the negative lead inserted in the NEG. terminal, and the positive lead plugged into the appropriate terminal on the right-hand side of the instrument. With the apparatus to be tested connected in series with the instrument, the scale readings will be found to be multiples of the socket markings. The procedure when using the testmeter, type H, is similar to that for the type E, but the current measurement should be made with the switch in the D.C. AND OHMS position.

*Resistance*

31. For the measurement of resistance when using the testmeter, type E, the control switch should be set in the mid position marked AMPS. and OHMS. With the negative lead plugged into the NEG. socket and the positive lead plugged into the socket marked 10,000 OHMS the testmeter should be set to allow for the condition of the cell by joining the free ends of the leads together and rotating the compensator control on the bottom edge of the panel until zero ohms is indicated by the pointer. Tests can then be made by connecting the leads across the resistance to be measured, the values being indicated on the OHMS scale on the dial. When using the testmeter, type H, the control switch should be set in the right-hand or D.C. AND OHMS position and the positive lead in the socket marked 20,000 OHMS, the remaining procedure being as for type E.

**Type C**

*Voltage*

32. When taking voltage measurements with the testmeter, type C, the positive lead should be plugged into the socket marked + and the remaining lead into the socket appropriate to the range to be measured, when a reading may be taken in the normal manner, using clips or prods as may be desired. With the positive lead plugged into the 6 mA socket all the voltage ranges are doubled, the resistance of the instrument remaining unaffected.

*Current*

33. When taking measurement of current the positive lead must be plugged into the common positive socket and the negative lead into the appropriately marked socket on the control panel and the instrument connected in series with the apparatus under test.

*Resistance*

34. When used as an ohmmeter, the meter should be checked and adjusted for any change in the battery voltage or resistance, by plugging the negative lead into the OHMS socket and the positive lead into the socket marked +, joining the free ends together, and rotating the compensator control until zero ohms is indicated by the pointer. Tests can then be made by connecting the leads across the resistance to be measured and inserting the plug at the end of the positive lead into the correct socket in the voltage series at the bottom of the panel.

**General care**

35. These instruments have been rendered proof against corrosion by anodic treatment, plating, or varnish on the metal parts, and they have been thoroughly tested at temperatures beyond the normal limits in which they will be required to function, as well as for overload, vibration, insulation and conditions of continuous load. It should be realised, however, that rough handling or misuse may cause harm to the meters and seriously affect their accuracy. In the past, damage has been caused to equipment through the use of meters that have been inaccurate, and wherever possible a standard instrument should be kept in a wooden case, padded with rubber, so that it can be used to verify the accuracy of the meters in general use.

## SERVICING

36. Very few repairs can be effected whilst the instruments are in service, as they are sealed, and the seals should not be broken. It should be remembered that whilst care has been exercised to see that the testmeters are reasonably strong, they are delicately adjusted and must be handled with discretion. If any accidental damage be done to the glass covering the scale, the instrument should be returned to the appropriate depot for repairs.

37. When replacing prods or crocodile clips care should be taken to see that a good connection is made. The leads may be required to carry comparatively high voltages, the insulation should therefore be good, and periodical inspection should be made for damage. These leads are standard and cannot be repaired in service, and if faults develop new leads may be requisitioned and the old ones returned to stores. The terminal connections should be kept clean, and where plugs are employed on the ends of the leads, they should be a good fit in their respective sockets.

38. Testmeter, type E, and some of the earlier models of type D employ fuses to protect the movement. In the event of a fuse blowing, it can be replaced by unscrewing the entire fuse from the brass bush in which it is screwed and replacing it by a new one, care being taken to see that the correct type of fuse is employed. Before replacement the leads should be disconnected from the source of supply and, if possible, the cause of the blowing ascertained and corrected. Blown fuses may be returned to the appropriate depot for repair.

39. The cells used for resistance measurement must be replaced when they become exhausted. With the testmeter, type D, the replacement is effected by slackening the two wood screws located at the top or back of the case and removing the plate. The two nuts on the top of the cell should then be unscrewed, the wire removed, the old cell lifted out and a new one inserted, care being taken to see that the connections from the cell to the central spring clip and the wire, the tightening of both nuts, and the wire connections are correctly carried out, and the top plate replaced and secured.

40. When replacing the cells in testmeters, types E and H, the replacement is effected by lifting the hinged instruction plate at the back of the instrument, and removing the oblong insulated cover plate, thus exposing the cavity in which the cell is held between two spring clips. The old cell should be lifted out and replaced by a new one, the negative end being inserted first. Care should be taken to see that the polarity is correct, the positive connector being marked with red paint and located at the right-hand end of the cell housing. After replacing the cell cover the instruction plate should be snapped under its two fasteners. It will be found necessary, whenever cell replacements have been made, to adjust for zero on the ohms scale.

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