OHMMETER NO. 18A

(This is a NEW Instruction)

1 GENERAL This Instruction describes the Ohmmeter No. 18A and the circuit arrangements for each of its functions. This instrument is suitable for the measurement of conductor insulation and loop resistances and for the location of earth, contact, and disconnexion faults. It is intended primarily for use on local lines, but it may also be used for certain tests on trunk and junction cables. It is portable and includes a headgear receiver which is required when locating disconnexion faults. Test leads and clips are also provided. Operating instructions for the instrument are given in F1056.

2 DESCRIPTION The instrument is shown in Fig 1. It is housed in an impact-resistant plastic case and weighs approximately 4.1 Kg (9 lb). An internal compartment houses the 9V Battery (Battery, Dry No. 29) which supplies power,

(a) directly to the test circuits, or

(b) to the d.c. convertor which gives a nominal output of 500V d.c. or

(c) to the 1 kHz transistor oscillator.

The panel of the instrument mounts the following items,

2.1 **PRESS ON pushbutton** This is a non-locking ON-OFF switch. The non-locking feature helps to avoid waste of battery power. In addition to controlling the battery supply, this switch maintains a 10K ohm resistor across the BAD WIRE and EARTH terminals whilst in the unoperated position, so ensuring that the line is discharged after testing.

2.2 **TEST FUNCTION switch** This is a five-position switch controlling the following functions:-

2.2.1 Check Battery and 1 Megohm

2.2.2 Insulation Resistance measurement

2.2.3 Loop Resistance measurement

2.2.4 Earth/Contact Fault tests

2.2.5 Disconnexion Fault tests

2.3 **RHEOSTAT VALUE switch** This is a five-position switch. Three positions control the multiplying factors of the bridge ratio arms during loop resistance measurements. The fourth position provides for calibrating the bridge circuits during fault-locating tests, while the fifth position provides for measuring after the bridge has been calibrated.

2.4 **BRIDGE VOLTS switch** This is a two-position switch which connects the 9V battery direct to the bridge circuit when set to the LOW position, and connects the d.c. convertor to the bridge circuit when set to the HIGH position. The switch is effective on Loop Resistance measurements and on Earth/contact Fault tests only.

2.5 **BAD WIRE, RETURN and EARTH terminals** These provide the means of connexion to the item or circuit being tested. They are screw terminals, but the stems are hollow to accept 4 mm plugs. The BAD WIRE terminal is coloured BLACK, the RETURN terminal RED, and the EARTH terminal GREEN.

2.6 **The RHEOSTAT BALANCE moving coil meter** This meter serves as a galvanometer for bridge tests, and is also calibrated for use as a battery voltage indicator. To cater for the galvanometer function the scale has a centre balance line, and the two halves of the scale are labelled INCREASE RHEO and DECREASE RHEO to denote the action required to balance the bridge. For the voltmeter function the scale has two markings, (i) NORM BATT corresponding to approximately 9V on load, and (ii) REPL BATT corresponding to approximately 6V on load, at which point the battery should be replaced.

The needle is set to rest at the centre balance mark. An external adjustment screw is provided.

2.7 **The INSULATION RESISTANCE moving-coil meter** This meter serves as an ohmmeter for insulation resistance measurements. The needle is set to a position marked INF at the beginning of the scale, and can be adjusted by an external screw. screw.

2.8 **A 4-dial rheostat for bridge measurements** The rheostat is adjustable in steps of 0.1 ohm, giving values from 0 to 999.9 ohm.

2.9 A CALIBRATE knob which operates a helical potentiometer requiring ten turns over its complete range.

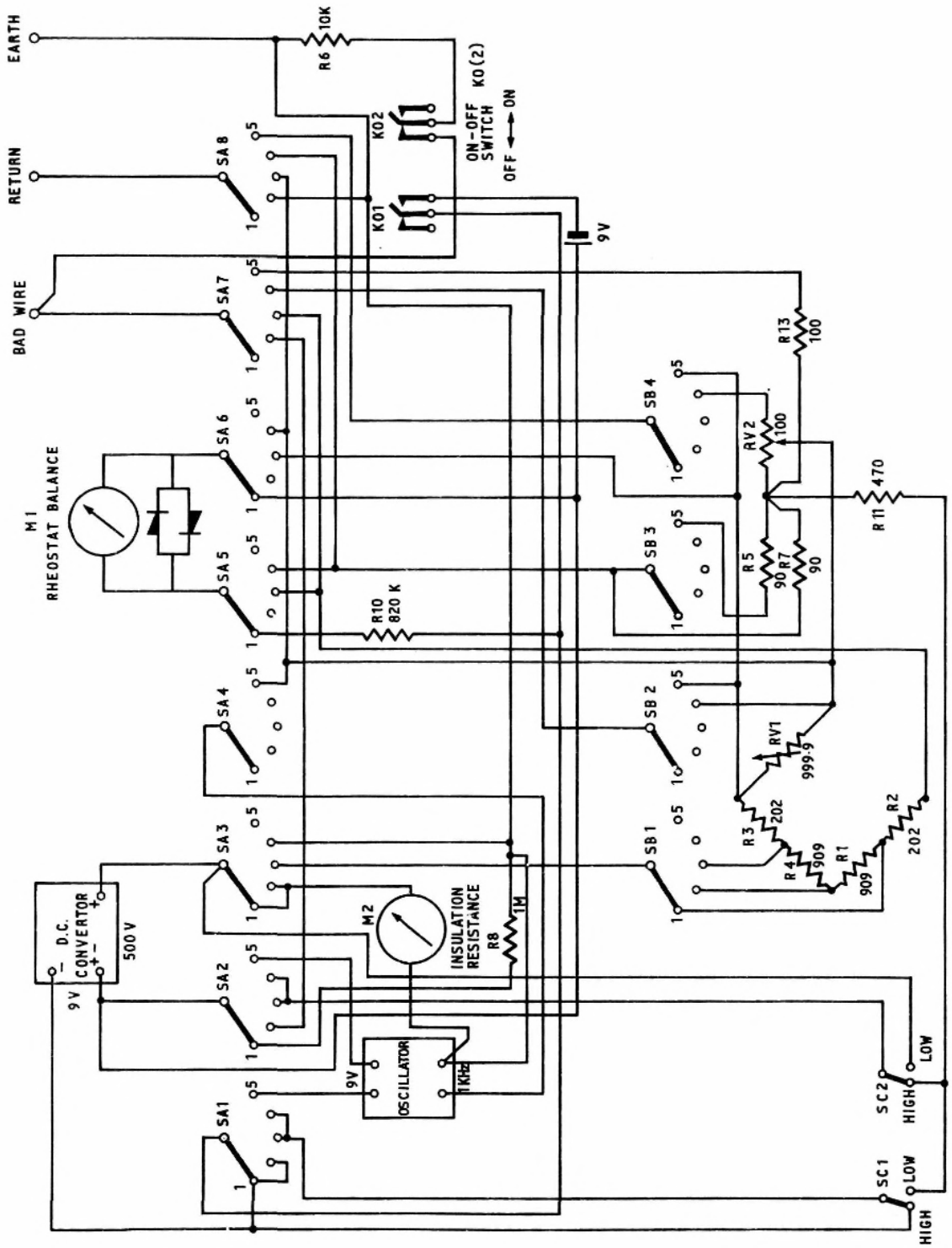

FIG. 2. OHMMETER 18A. DIAGRAM OF CONNEXIONS.

SA (8)
TEST FUNCTION SWITCH
1. CHECK BATTERY & 1MΩ
2. INSULATION
3. LOOP RESISTANCE
4. EARTH/CONTACT FAULTS
5. DISCONNEXION FAULTS

SB(4)
RHEOSTAT VALUE SWITCH
1. ÷ 10 } LOOP TEST
2. × 1 }
3. × 10 }
4. CALIBRATE } FAULT TESTS
5. MEASURE }

SC (2)
BRIDGE VOLTS SWITCH
HIGH — 500 VOLTS
LOW — 9 VOLTS

RV. 1.
4 DIAL RHEOSTAT
RV. 2.
10 TURN POTENTIOMETER

3 **PRINCIPLES OF OPERATION** A diagram of connexions is shown if Fig 2. The circuits operative during the different test functions are as follows.

3.1 Check battery and 1 Megohm TEST FUNCTION switch in position 1. PRESS ON button ON. Position of other switches immaterial. Connexions to terminals immaterial.

The connexions are shown in Fig 3. The RHEOSTAT BALANCE meter is connected to the 9V battery in series with a 820K ohm resistor and indicates the condition of the battery. The d.c. convertor is connected to the battery, and the 500V output is connected across the INSULATION RESISTANCE meter in series with a 1 Megohm resistor. If the instrument is functioning correctly the meter reads approximately 1 Megohm. If the reading is less than 0.5 Megohm or greater than 2.0 Megohm with the battery in good condition, the instrument is faulty.

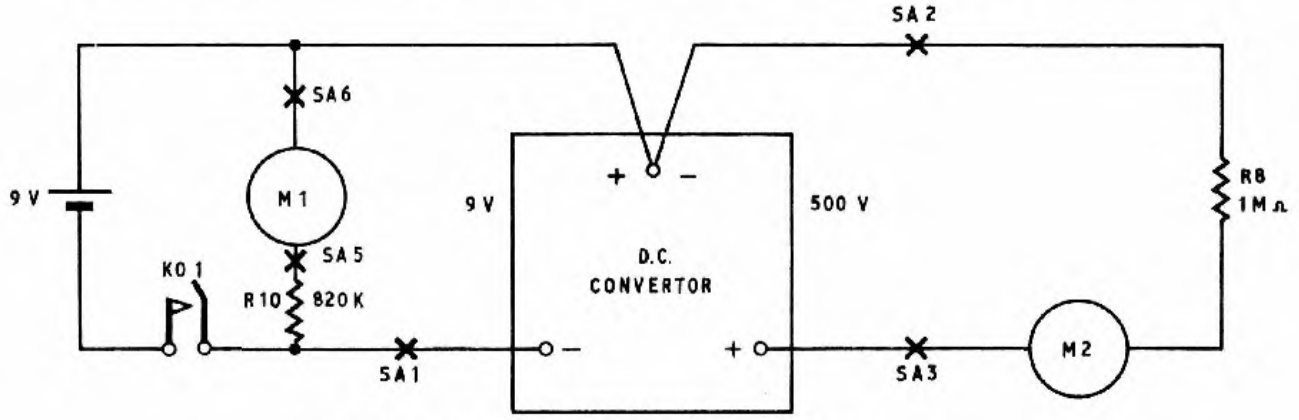

FIG. 3 CHECK BATTERY AND 1MΩ CONNEXIONS.

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3.2 Insulation Resistance measurement TEST FUNCTION switch in position 2. PRESS ON button ON. Position of other switches immaterial.

3.2.1 For insulation between wire and wire, the BAD WIRE and RETURN terminals are used.

3.2.2 For insulation between wires and earth, the wires are connected to the BAD WIRE terminal and an earth connexion to the EARTH terminal.

3.2.3 For insulation between one wire and another wire when connected to earth, the first wire is connected to the BAD WIRE terminal, the second to the RETURN terminal, and an earth connexion to the EARTH terminal.

The connexions are shown in Fig 4. The d.c. convertor is connected and the 500V output is fed through the INSULATION RESISTANCE meter and the item whose insulation resistance is to be measured. The meter gives a direct reading. Its scale is calibrated from 0.01 to 1,000 megohms.

3.3 Loop Resistance measurement TEST FUNCTION switch in position 3. PRESS ON button ON. RHEOSTAT VALUE switch in position 3 for x 10 ratio. BRIDGE VOLTS switch at LOW, or exceptionally at HIGH (see below). The item under test is connected across the BAD WIRE and RETURN terminals.

The power supply arrangements for 9V and 500V feeds are shown in Figs 5 and 6 respectively.

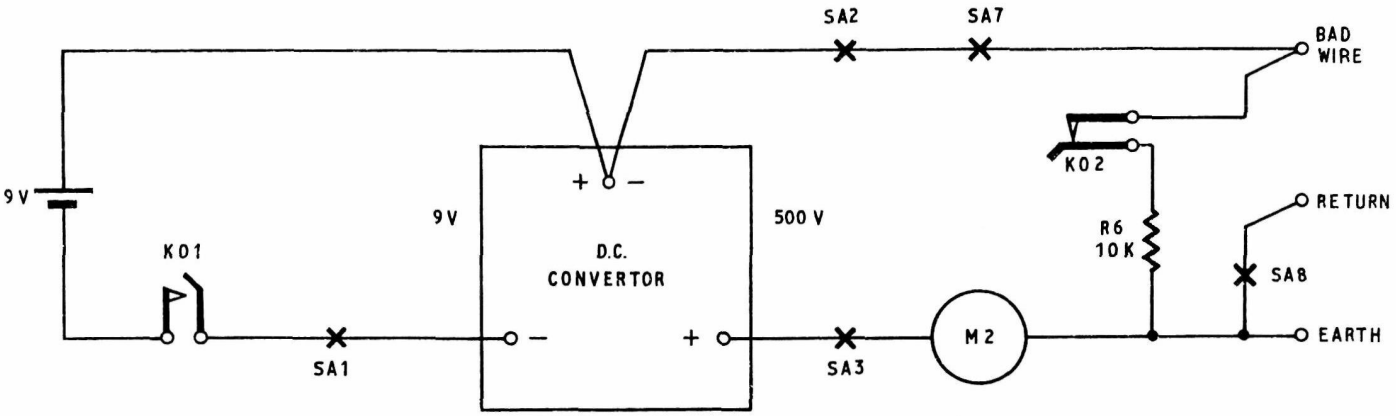

FIG. 4. INSULATION RESISTANCE MEASUREMENT.

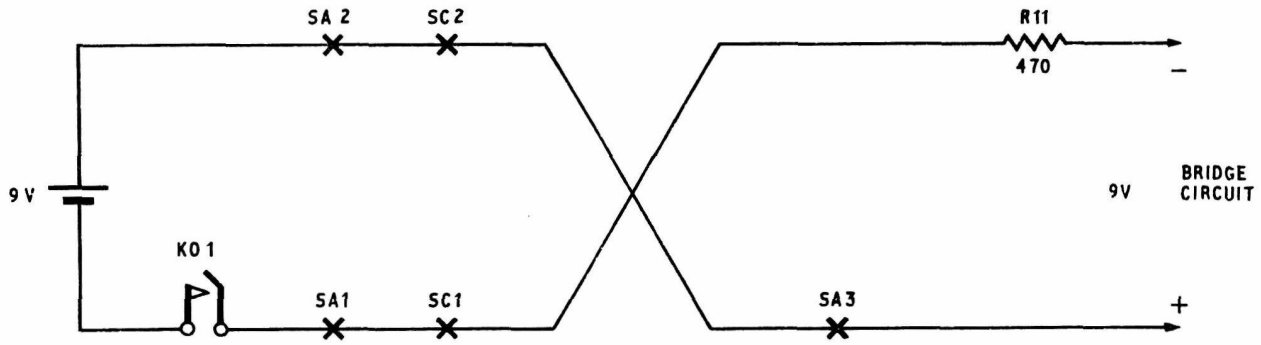

FIG. 5. CONNEXIONS FOR 9V SUPPLY TO BRIDGE CIRCUITS

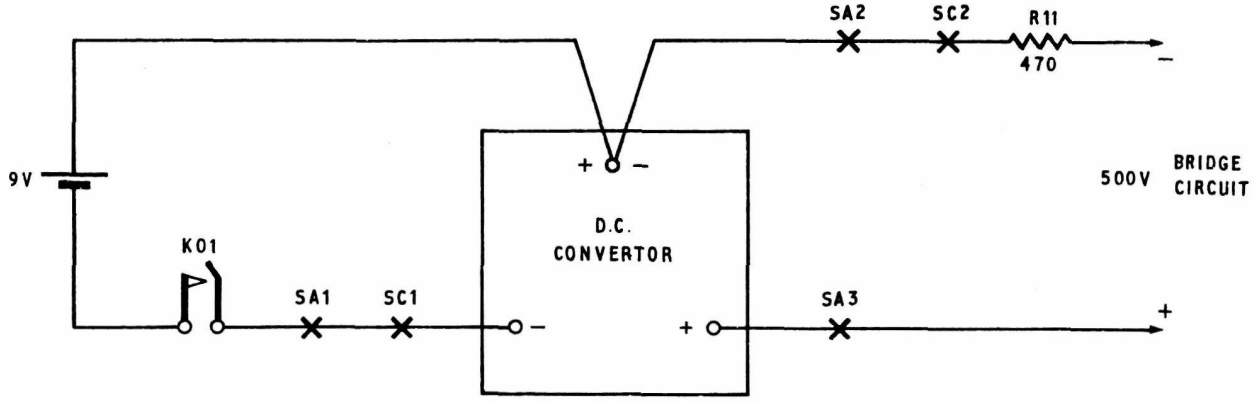

FIG 6. CONNEXIONS FOR 500 V SUPPLY TO BRIDGE CIRCUITS.

The bridge connexions are shown in Fig 7. The 470 ohm resistor R11 is included to limit the current drawn from the battery or d.c. convertor; the 100 ohm potentiometer RV2 is included for circuit convenience, it plays no essential part in the operation of the bridge.

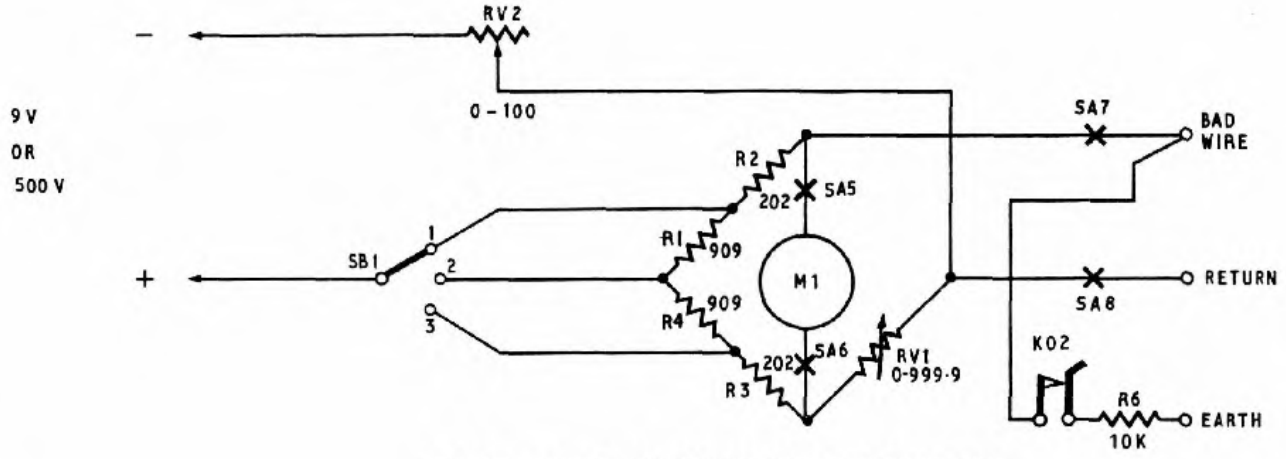

FIG. 7. CONNEXIONS FOR LOOP RESISTANCE MEASUREMENT.

When the RHEOSTAT VALUE switch is in position 1, the ratio of the bridge arms is R2 : (R1 + R4 + R3), ie 202 ; (909 + 909 + 202) = 1 : 10. Similarly when the switch is in position 2, the ratio is 1 : 1, and when in position 3 it is 10 : 1.

The bridge is balanced by adjusting the RHEOSTAT, balance being indicated by the RHEOSTAT BALANCE meter indicating the centre balance mark on its scale. When the 1 : 10 ratio is used, the range of measurement is 0 - 99.99 ohms, with the 1 : 1 ratio it is 0 - 999.9 ohms, and with the 10 : 1 ratio it is 0 - 9999 ohms.

The 9V supply is normally used for Loop Resistance measurements. If the BRIDGE VOLTS switch is set at HIGH, the load on the 500V supply presented by the bridge network reduces the available voltage to a very low value, with no increase in the sensitivity of the bridge. The load on the battery is very high under these conditions, so that the 500V supply should be used only exceptionally, and then for short periods of time. The main use is to check whether the testing voltage causes any change in the conditions of balance such as might occur if there were any spurious voltage present in the circuit under test.

The RHEOSTAT BALANCE meter is shunted by a pair of diodes. When the pd is very low the diodes have high impedances and do not materially reduce the sensitivity of the meter. The impedances fall to low values when the pd is increased, thus protecting the meter from overload.

3.4 Earth/Battery/Contact Fault Tests TEST FUNCTION switch in position 4. PRESS ON button ON. RHEOSTAT VALUE switch in position 4 for CALIBRATE, and position 5 for MEASURE. BRIDGE VOLTS switch at LOW for 9V supply and at HIGH for 500V supply. Faulty wire is looped to good wire at distant end. Faulty wire connected to BAD WIRE terminal and good wire to RETURN terminal. Earth connexion or contacting wire connected to EARTH terminal.

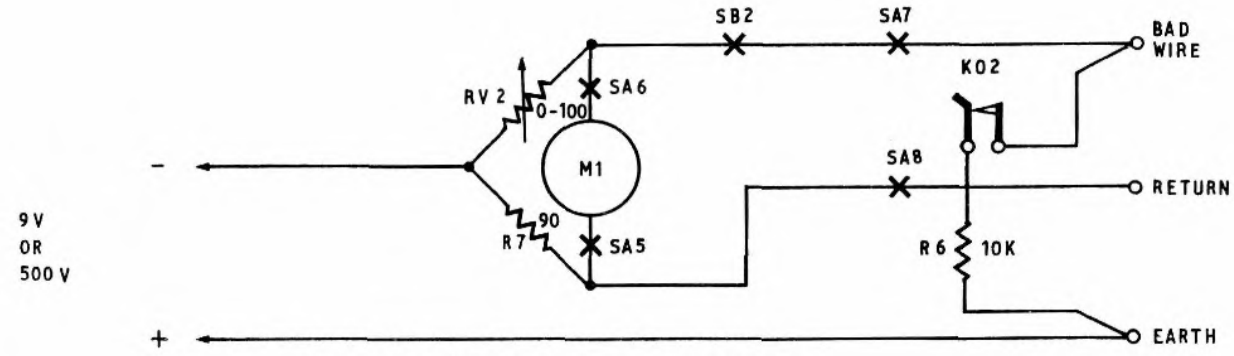

FIG.8. EARTH/CONTACT FAULT TEST - CALIBRATE

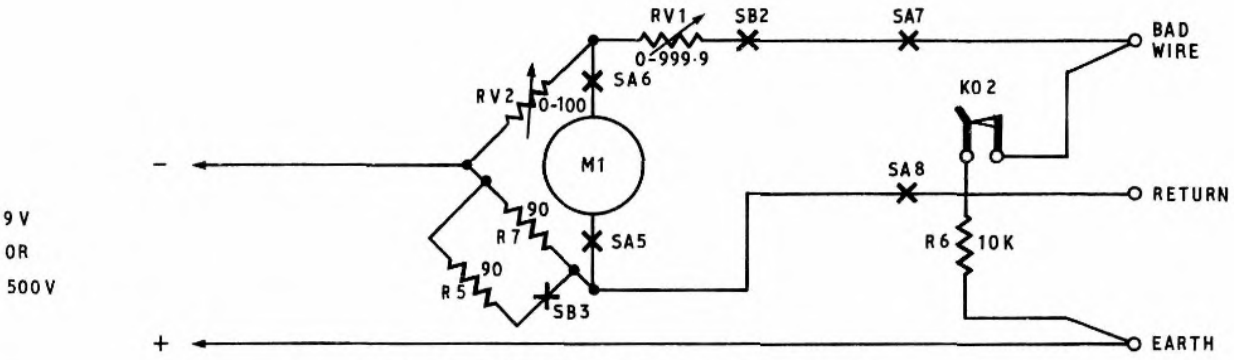

FIG. 9. EARTH/CONTACT FAULT TESTS – MEASURE

The power supply arrangements are similar to those for the Loop Resistance test and are shown in Figs 5 and 6. The bridge connexions are shown in Fig 8 for CALIBRATE and in Fig 9 for MEASURE. To calibrate the bridge, the CALIBRATE knob (10-turn potentiometer RV2) is adjusted until the RHEOSTAT BALANCE meter reads to the centre balance mark on its scale. (Taking L as the loop resistance of the good faulty wire, and X as the resistance along the faulty wire to the fault the conditions for balance are $\frac{R7}{RV2} = \frac{L - X}{X}$). When the RHEOSTAT VALUE switch is turned to the MEASURE position, R7 is shunted with a resistor of the same resistance value, thereby halving the resistance of this arm of the bridge. To restore balance a resistance equal to X is inserted in series with the faulty wire. This is accomplished by adjusting the RHEOSTAT, RV1 in Fig 9, until balance is restored. The resistance value registered on the RHEOSTAT thus equals the resistance to the fault. No measurement of the loop resistance of the pair, or application of formula is necessary.

If the fault is a low-resistance earth contact the 9V supply should be used, for a high-resistance fault the 500V supply will be necessary.

In the case of a contact with a circuit carrying exchange battery voltage, better results may occasionally be obtainable by removing the battery from the tester and connecting the battery connexion leads together, thus using the spurious battery connexion as the testing voltage. For such testing the BRIDGE VOLTS switch should be set to the LOW position. Under these conditions the deflections of the RHEOSTAT BALANCE meter are in the opposite directions to normal and the INCREASE RHEO and DECREASE RHEO scale markings must be read in the opposite sense.

3.5 Disconnexion Fault tests TESTS FUNCTION switch in position 5. PRESS ON button ON. RHEOSTAT VALUE switch in position 4 for calibrate, and position 5 for MEASURE. BRIDGE VOLTS switch position immaterial. A headgear receiver is connected between the BAD WIRE and RETURN terminals. Three modes of connexion of the faulty circuit are possible.

3.5.1 If one or both wires of a pair have disconnexion faults and a good pair exists over the same route either in the same cable or same cable type, the wires of the faulty pair may be looped to the corresponding wires of the good pair at the far end. At the testing end the faulty wire (or one of the faulty wires if both have disconnexion faults) is connected to the BAD WIRE terminal and the corresponding wire of the good circuit is connexted to the RETURN terminal. The remaining wires of the good and faulty pairs are connected together and to the EARTH terminal.

3.5.2 If one or both wires of a pair have disconnexion faults and a good pair exists over the same route either in the same cable or of same cable type, but it is not possible to loop the two pairs to one another, it is still possible to make a test, but with a lower degree of accuracy. At the testing end the pairs are connected as under 3.5.1 above.

3.5.3 If one wire has a disconnexion fault and no good pair exists over the same route, the pair is looped at the distant end. At the testing end the faulty wire is connected to the BAD WIRE terminal and the good wire to the RETURN terminal. An earth connexion is made to the EARTH terminal.

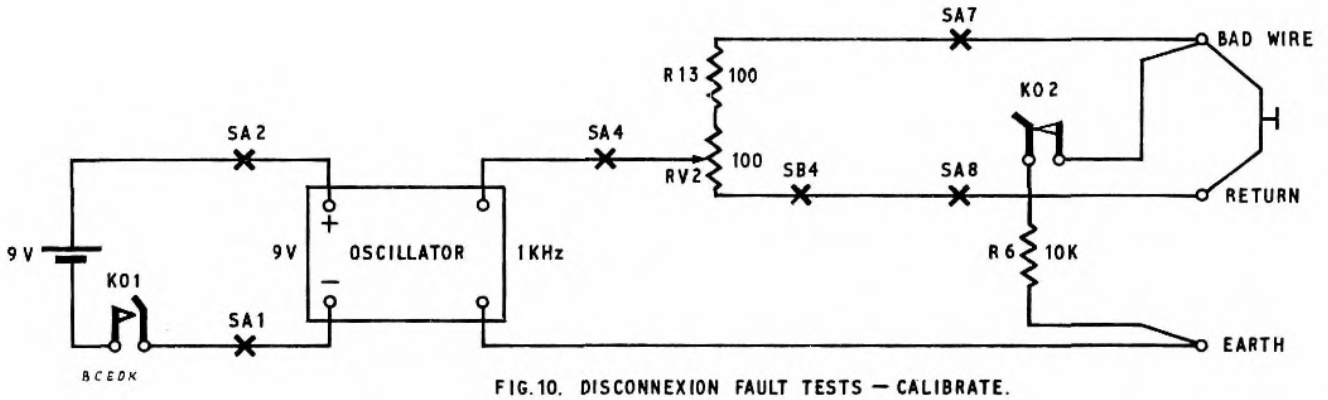

FIG.10. DISCONNEXION FAULT TESTS — CALIBRATE.

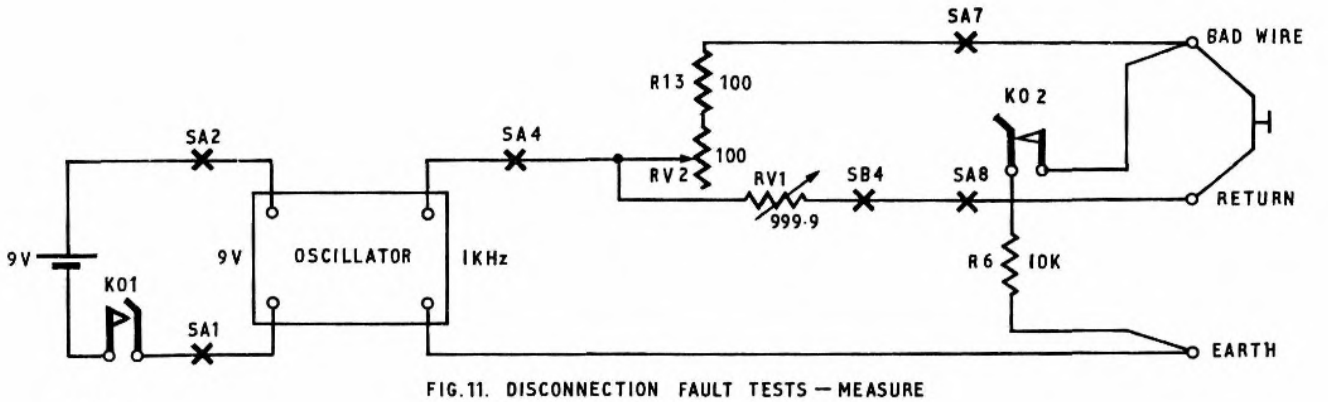

FIG.11. DISCONNECTION FAULT TESTS — MEASURE

The connexions are shown in Fig 10 for CALIBRATE and in Fig 11 for MEASURE. To calibrate the bridge, the CALIBRATE knob (10-turn potentiometer) is adjusted until there is minimum volume of tone in the headgear receiver. Under these conditions the ratio of the impedance between the BAD WIRE and EARTH terminals and the impedance between the RETURN and EARTH terminals corresponds to the ratio of the resistances in the other two arms of the bridge. The line impedances referred to are proportional to the reciprocals of the conductor capacitances, and thus of the conductor lengths. The 10-turn potentiometer has no calibrated dial, but when the RHEOSTAT VALUE switch is turned to MEASURE, the lower section of the potentiometer RV2 in Fig 10 is substituted by the 4-dial RHEOSTAT, which is adjusted to give minimum tone in the headgear receiver.

If the lengths of conductor connected to the BAD WIRE and RETURN terminals are L1 and L2 respectively, the ratio of the impedances associated with the conductors is $\frac{L2}{L1}$ corresponding to the ratio $\frac{R13 + (RV2 - RV1)}{RV1} = \frac{200 - RV1}{RV1}$. This gives solutions in the terms of simple formulae for each mode of connexion quoted above. For connexions (a) and (c),

$$\frac{L2}{L1} = \frac{200 - RV1}{RV1}$$

but L2 = 2 (distance to far end) - L1

$$\therefore \frac{2 \text{ (distance to far end)} - L1}{L1} = \frac{200 - RV1}{RV1}$$

$$\text{Hence, distance to fault } L1 = \frac{RV1}{100} \times \text{(distance to far end)}.$$

For connexion (b),

$$\frac{L2}{L1} = \frac{200 - RV1}{RV1}$$

but in this case, L2 = distance to far end,

$$\therefore \text{ distance to fault } L1 = \frac{RV1}{200 - RV1} \times \text{(distance to far end)}$$

4 MAINTENANCE Before use the rest positions of the meter needles should be checked and adjusted as necessary using the adjusting screws associated with the meters. The battery condition should also be checked using the test described in 3.1, and when it has fallen to the minimum voltage acceptable it should be replaced. The battery should be removed if the ohmmeter is to be stored for more than a week. More serious faults on the ohmmeter should not be rectified locally. The faulty instrument should be replaced under the normal procedure.

5 SUPPLY ARRANGEMENTS The Ohmmeter 18A and its accessories are obtainable from Supplies Division under the normal supply procedure.

It is supplied complete with the accessories listed below with exception of the battery which should be requisitioned separately. The accessories are available individually for maintenance replacements.

5.1 Ohmmeter No. 18A, 500V.

5.2 Battery, Dry No. 29.

5.3 Receiver, Headgear No. 16T, Black.

5.4 Cord, Test No. 2/54A. One supplied. The cord is terminated at one end with 4 mm plugs.

5.5 Cord, Test No. 1/36H) One of each supplied. The cords are similar but
" " No. 1/36J) are coloured Black, Red and Green respectively
" " No. 1/36K) to denote use with BAD WIRE, RETURN, and EARTH terminals. Each cord terminates in a 4 mm plug at each end.

5.6 Adaptor No. 25A. Two supplied. The adaptor is a spade terminal with a 4 mm socket for use with Cord Test No. 1/36....

5.7 Clips, Test No. 38A. Three supplied. The clip is a crocodile clip with a 4 mm socket for use with Cord Test No. 1/36....

5.8 Spike, Testing No. 10. One required. The spike is an insulated test probe with a 4 mm socket for use with Cord, Test No. 1/36....

Sv5.1.1 E N D