OPERATING INSTRUCTIONS

FOR

TEST SET, TYPE D-30-A

314448

MUIRHEAD

MUIRHEAD & CO. LTD.
ELMERS END
BECKENHAM, KENT

OPERATING INSTRUCTIONS

FOR

TEST SET TYPE D-30-A

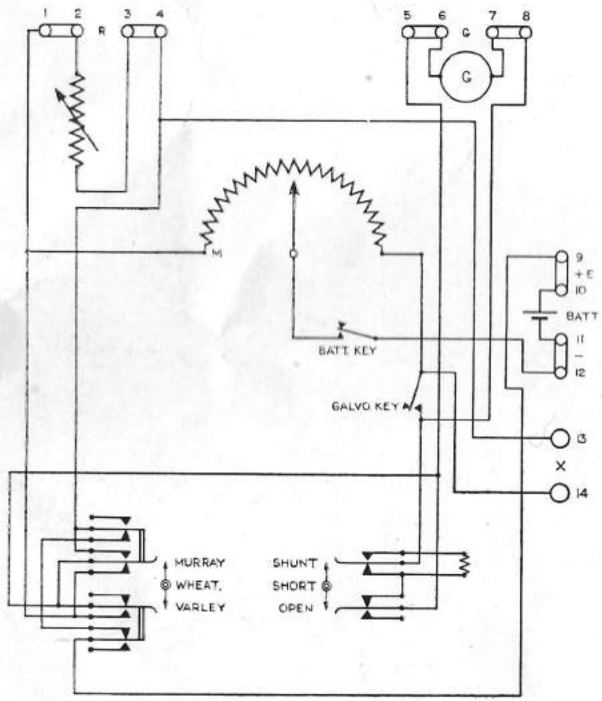
MUIRHEAD & CO. LTD.

ELMERS END

BECKENHAM, KENT

TELEPHONE:

TELEGRAMS AND CABLES:



INTRODUCTION

The Type D-30-A Test Set is a portable multi-purpose measuring set.

The fundamental circuit is that of the Wheatstone bridge but facilities are provided which enable this circuit to be adapted to many specialised measurements such as fault location on power and telephone lines.

THE WHEATSTONE BRIDGE

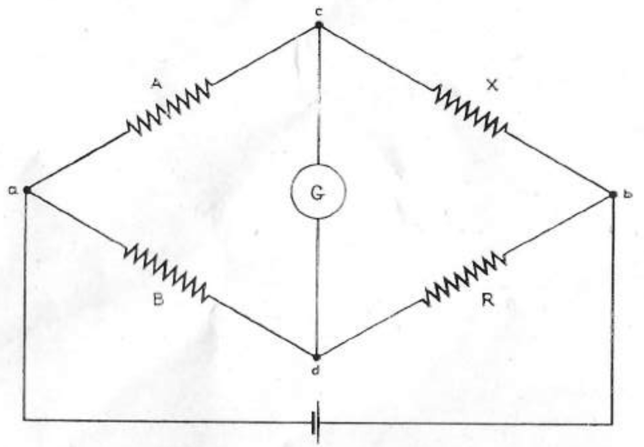


FIG. 1.

The Wheatstone bridge comprises four sets of resistance coils, a battery and a galvanometer. Two of the resistance groups are joined together and form the bridge proper, each set being known as an 'arm' of the bridge. It is only necessary to know the ratio that exists between the resistance of these two arms, the actual resistance being immaterial, hence, they are generally known as the 'ratio arms' of the bridge.

The third set of resistances is usually referred to as the 'rheostat' and should be capable of adjustment in small steps over a wide range of values.

The fourth resistance is the unknown whose value it is required to determine.

Fig. 1 shows the complete Wheatstone bridge circuit where :—

A and B are the ratio arms,
R is the rheostat and
X is the unknown resistance.

BRIDGE BALANCE

The bridge is said to be balanced when the points c and d are equi-potential which condition obtains when the four resistances have the relation,

$$\frac{A}{B} = \frac{X}{R}$$

$$\text{from which, } X = \frac{A}{B} R$$

The Type D-30-A Test Set has the basic circuit of Fig. 1 and the above fundamental equations must be satisfied.

The loop tests to be described later are based on the same principle and only differ in circuit arrangement.

DESCRIPTION OF TEST SET

RESISTANCE ARMS

The ratio arms of the bridge are variable and are controlled by a single switch which selects multiplying factors, $\frac{A}{B}$ of 0.001, 0.01, 0.1, 1, 10, 100 and 1,000.

The rheostat arm consists of a four dial decade resistance totalling 11,110 ohms in steps of 1 ohm.

CIRCUIT SWITCHING

By means of a three-position key switch the circuit is altered so that the instrument may be used as a normal Wheatstone bridge and also for fault location using the Murray or the Varley loop tests.

Another three-position key switch provides a sensitivity control for the galvanometer. Tapping keys are provided for closing the battery and galvanometer circuits.

Other facilities consist of a pair of link connections which, when opened, enable the galvanometer to be used externally to the bridge or to permit of some other form of detector being included in the bridge. The rheostat may also be used externally to the instrument by making use of terminals 2 and 3 engraved 'R,' having previously opened the associated links.

GALVANOMETER

The galvanometer is built into the bridge and is a sensitive moving coil instrument having a centre zero which may be accurately set by means of a zero setting device.

When the 'GALVO' switch is thrown to 'SHORT' the damping of the moving system is sufficient to render the galvanometer safe for transport.

BATTERY

The battery supplied with the instrument is a three volt cylindrical flash-lamp type, fitted into a compartment inside the box. An external battery may be connected by means of terminals 9 and 12, after opening the link connections. The internal battery may be used separately by taking connections from terminals 10 and 11.

Use of Set as a Wheatstone Bridge

First ascertain that the internal battery is in good condition and that the galvanometer pointer is accurately positioned on the zero mark. Connect the unknown resistance to the terminals marked 'x.' Throw the bridge switch to 'WHEATSTONE' and the 'GALVO' switch to 'SHUNT.' As a preliminary adjustment set the multiplier switch to 1 and make sure that some resistance is included in the rheostat arm. The circuit shown in Fig. 1 is now set up.

Depressing the 'BATT' and 'GALVO' keys will now cause the galvanometer pointer to deflect. Always depress the battery key *first* and release *last*.

Failure to observe this rule will result in a damaged GALVO.

Adjust the rheostat dials in conjunction with the multiplier switch until the galvanometer is restored to zero, i.e., midscale deflection. Now throw the 'GALVO' switch to 'OPEN.' This increases the sensitivity of the galvanometer and permits a more accurate balance to be made.

The value of the unknown resistance is given by the product of the rheostat and multiplier settings.

Example :—Rheostat setting 1,234
Multiplier setting 10
Resistance value $= 1{,}234 \times 10 = 12{,}340$ ohms.

In order to obtain a reading of resistance to the greatest number of significant figures a setting of the multiplier switch must be chosen which requires the use of all four dials of the rheostat to obtain balance.

It is important that the preliminary balance be made with the 'GALVO' switch in the 'SHUNT' position thus avoiding the possibility of damage to the galvanometer due to the heavy out-of-balance currents which are likely to occur when searching for the balance condition.

As a general rule the battery key should be depressed only for the short time necessary to observe whether it is required to increase or decrease the resistance of the rheostat in order to approach balance. The key should then be released while effecting the necessary adjustment. The observance of this procedure is particularly important when using uneven ratios in order to limit the comparatively heavy current through the bridge coils to the shortest possible period.

To obtain the required sensitivity for accurate measurement of high resistance values it may be necessary to increase the voltage applied to the bridge. This necessitates the use of an external battery.

Use of Set for Fault Localization on Cables

Faults may be divided into three classes, viz., earths, disconnections and contacts. In each of these classes the faults may differ in degree and the terms full and partial are used respectively to describe the very pronounced and the slight faults in the case of earths and contacts.

The disconnection faults range from a total disconnection to a partial disconnection or even a slight increase in line resistance which might be caused by a defective connection or 'dry' joint. Any of the above faults may be either continuous or intermittent.

Preliminary localization tests are made by the use of a sensitive galvanometer and an earthed battery. The galvanometer in the Type D-30-A Test Set is eminently suitable for this purpose.

Earths

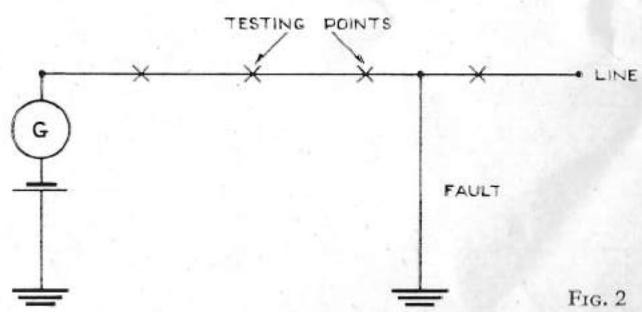


Fig. 2

In order to localize an earth fault a continuity test has first to be made in order to ascertain in which section of the line the fault is located. For this purpose an earthed battery and a galvanometer are joined to the line as shown in Fig. 2.

The line is then disconnected at the far end and the degree of the fault judged.

Leaving the line open at the far end a disconnection is then made at the next convenient testing point in the direction of the near end.

This procedure is carried on until a point is reached where no deflection of the galvanometer is observed indicating that the line is clear up to this point.

Disconnections

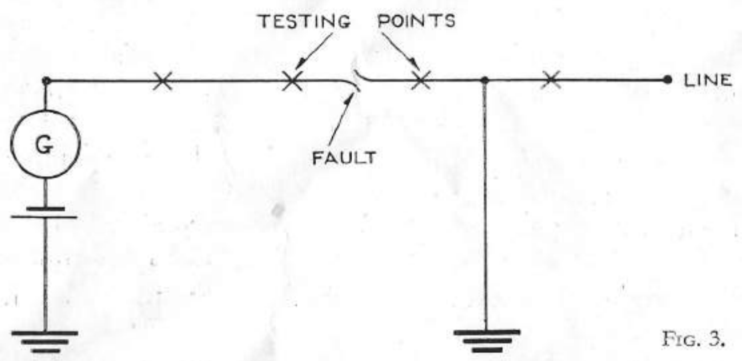


Fig. 3.

This test is carried out with the same apparatus and the procedure is similar to that used for localizing an earth fault. In the present instance, however, the presence of a deflection indicates the continuity of the circuit between the testing points whilst the absence of a deflection denotes the presence of a disconnection in the section under test. Fig. 3 indicates these conditions.

Contacts

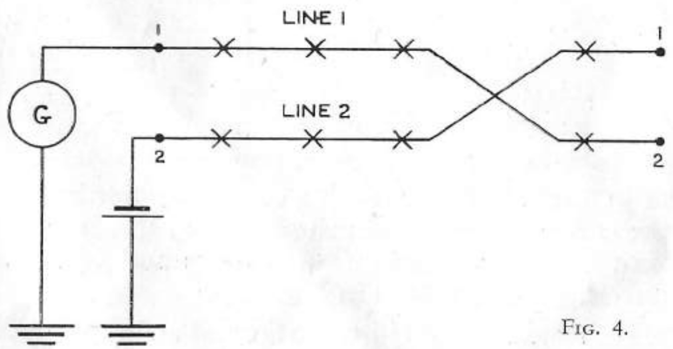


Fig. 4.

To test for a contact an earthed battery is connected to one line and an earthed galvanometer to the other. If the two wires are in contact the galvanometer is deflected. This is shown in Fig. 4.

It will be seen that localization tests are of an extremely simple character, but the utmost care must be taken in order to avoid a mis-test with the consequent delay in clearing the fault.

Varley Loop Test

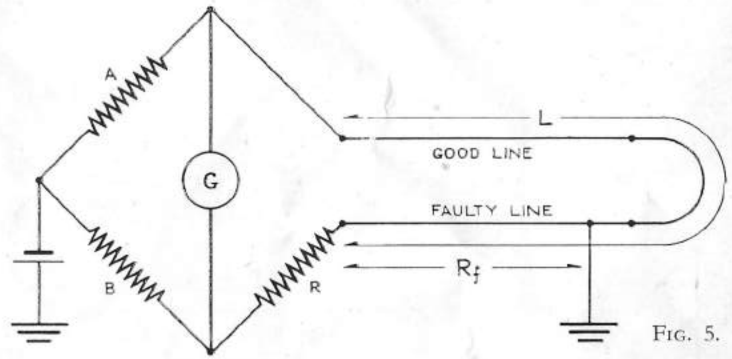


Fig. 5.

The Varley Loop test is best adapted to fault location in high resistance loops. The faulty wire is looped at the far end to a line known to be good and the resistance of this loop measured with the bridge set up in the 'WHEATSTONE' condition, the faulty wire being connected to terminal 13 and the good wire to terminal 14, The bridge key is then thrown to 'VARLEY', terminal 9 connected to a good earth and the ratio switch set to 1. The circuit then becomes that shown in Fig. 5.

When the rheostat is adjusted to give balance, the resistance from the testing end to the fault is given by :—

$$R_f = \frac{L - R}{2}$$

where L = resistance of the loop,
R = resistance of the rheostat, and
R_f = resistance to fault.

Where it is necessary to set the multiplier switch to some position other than unity in order to get a sufficiently accurate reading, the resistance to the fault is given by :—

$$R_f = \frac{L - MR}{M + 1}$$

where L = resistance of the loop,
R = resistance of rheostat,
M = the indication on the multiplier dial, and
R_f = resistance to fault.

The results obtained by the Varley Loop test are very accurate where the resistance of the fault is low and the insulation is high but the results tend to become meaningless when the resistance of the fault approximates to the insulation resistance of the circuit.

Murray Loop Test

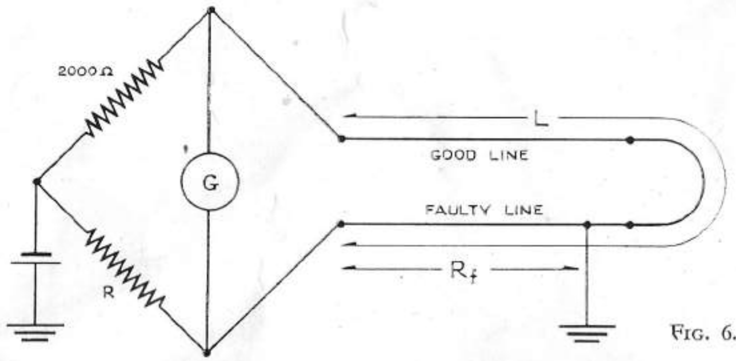


Fig. 6.

When the looped circuit has relatively low resistance as in short lengths of communication lines and cables, the Murray Loop test should be applied.

To make this test it is necessary first to measure the resistance of the loop as in the case of the Varley Loop test. The bridge key is then thrown to 'MURRAY' and the multiplier switch turned to 'M.'

The bridge circuit is then arranged as in Fig. 6.

Balance is again obtained by adjusting the rheostat. Since the value of the fixed ratio arm M is 2,000 ohms, the resistance of the line from the testing office to the position of the fault is given by :—

$$R_f = \frac{R\,L}{2{,}000 + R} \text{ where}$$

R = resistance of rheostat
L = resistance of loop
R_f = resistance to fault.

Pomeroy's Method of Testing Earths

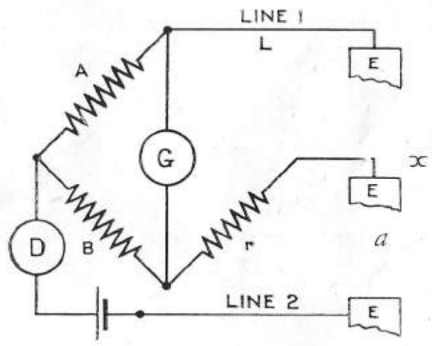


Fig. 7a

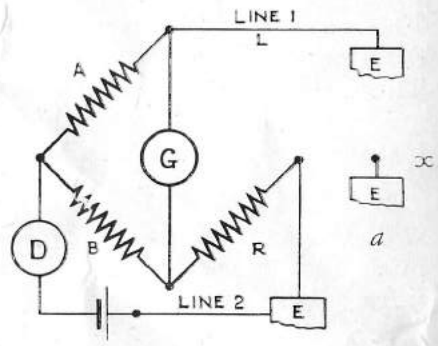


Fig. 7b.

It is often necessary to know the resistance of an earth connection and this can be accomplished by making the two tests shown in Figs. 7a and 7b. Two lines connected to two independent earths are required for the tests and are first joined up as in Fig. 7a. It is necessary that the value of the current passing the earth plate should be approximately equal in both cases, and the battery power required for the second test should therefore be increased accordingly.

This may best be judged by including a detector in series with the battery as indicated. The connections are rearranged as in Fig. 7b for the second test, the battery connections being reversed so that the direction of the current from the plate at *a* may be the same in both tests. (L includes the resistance of the earth upon line 1).

The balance conditions for both tests are :—

1st test $\quad A\,(r+x) = B\,L$

2nd test $\quad A\,R = B\,(L+x)$

whence $\quad x = \dfrac{A\,(R-r)}{A+B}$

and where $A = B$ $\quad x = \dfrac{R-r}{2}$

A.C. MEASUREMENTS

All the resistance elements of the instrument are non-reactively wound and are suitable for use at frequencies up to at least 10 Kc/s. Full details of their characteristics are given in the description of the Type A-5 Resistance Units in our catalogue. These characteristics coupled with the fact that the bridge arms may be isolated from the battery and galvanometer, enable the instrument to be used as a basis for alternating current bridges.

It is beyond the scope of this pamphlet to deal with the very wide range of A.C. measurements possible and reference should be made to the many standard text-books on the subject, notably, " A.C. Bridge Methods " by B. Hague, D.Sc.

CARE OF INSTRUMENT

Used with reasonable care the instrument will give reliable service for very long periods without attention apart from the occasional renewal of the internal battery.

Should the bridge at any time show signs of instability not traceable to external components or connections, it is probable that the switch contacts require cleaning.

The top panel should be lifted by first removing the fixing screws around the outer edge and disconnecting the leads to the battery. The panel can then be inverted to expose the switches.

The contacts of the rotary stud switches are self-cleaning and self-lubricating, and should not require any attention. However, if the instrument has not been used recently, it is advisable to rotate the switches several times before making any measurements.

The contacts on the key switches can be cleaned with a contact file or if this is not available, a piece of very fine emery paper may be used. No lubricant is required.

The internal battery is G. E. C. type BA 6123 which is leakproof; when replacing the battery, ensure that this type is used - or an equivalent which is leakproof.

RAY-O-VAC. Type 2LP., obtainable from Instrument Room.