OHMMETER

By K. RAYMOND

MANY commercial instruments are available that will measure most common resistance values down to about 5 ohms with reasonable accuracy. When it comes to lower values, such as may be found in switch contacts, transformer windings, and radio tuning coils, such an instrument may be of only limited value.

What is required is a low resistance meter. This article sets out to explain the difference between the conventional resistance meter and one that will measure low resistance, and is followed by a practical circuit with constructional information.

It is also possible to measure the resistance of soldered joints so giving an indication of their electrical efficiency. It is well known that "dry" joints, caused by the flux intervening between the terminations, can give rise to mysterious oscillatory effects in some parts of audio and r.f. circuits. Here the low ohmmeter will be an asset in detecting the location of such a fault.

SERIES OHMMETER

Most medium to high resistance meters use a circuit based on that shown in Fig. 1. The zero resistance mark is usually found on the right hand end of the scale as meter current f.s.d. is calibrated with the test clips short circuit. As resistance is increased the current at the meter is reduced, causing the meter pointer to be deflected to a position left of full scale.

From these basic principles it is a simple matter to insert in series with the meter a variable resistance (potentiometer) to control the current to the meter. At a preset value of VR1, with terminals X1 and X2 short-circuited, the voltage across the meter will cause the meter to register full scale deflection. This control is called "set zero".

Having established a given reference zero at f.s.d., the scale can now be calibrated over the resistance range suited to both the battery voltage and the meter coil resistance. The current through the meter varies inversely with the value of resistance in the circuit. If the circuit is broken at some point so that an unknown resistance can be inserted (i.e. at terminals X1 and X2) the current flowing through the meter would be

$$I = \frac{V}{R_1 + R_X + R_M}$$

where V is the battery voltage,

R_1 is the preset value of the set zero control,

R_X is the unknown resistance to be measured, and

R_M is the coil resistance of the meter.

PARALLEL OHMMETER

For low resistance measurements a low value of resistance is shunted across the meter as in the circuit in Fig. 2. This circuit is called a "slide back" ohmmeter in which the meter current is reduced by shunting it with a fixed low resistance and the unknown resistance.

Front view of the ohmmeter clearly showing the new calibration of the dial

The fixed resistance is so much lower than the meter resistance (about 75 ohms) that any small change in the total shunt resistance will show as a well defined deflection on the meter.

This circuit will provide considerable expansion of the low resistance range; in the practical circuit 0 to 1 ohm occupies more than 50 per cent of the scale.

In the case of the series type ohmmeter (Fig. 1) the calibration reference is zero ohms, or meter f.s.d. obtained by varying potentiometer VR1. In the shunt type (Fig. 2) the f.s.d. reference will give the same reading as the fixed shunt—a resistor which will represent the maximum on the scale, in the case of this particular model the value chosen was 5·6 ohms. However, the scale can be extended by increasing the value of the shunt resistor.

PRACTICAL EXAMPLE

The circuit employed is shown in Fig. 3, which includes a ballast series resistor and a push button (*normally open*) to calibrate the meter with R2.

The meter circuit is built into an aluminium chassis, the dimensions and drilling details of which are given in Fig. 4. Wiring is straightforward, but read the calibration notes first as the meter will need re-calibrating before final assembly. To do this remove the cover of the meter and take off the scale plate. On a piece of

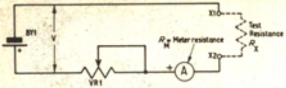


Fig. 1. Basic series ohmmeter for measuring medium and high resistance

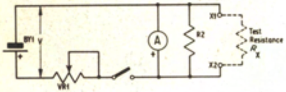


Fig. 2. Basic parallel ohmmeter for measuring low resistance

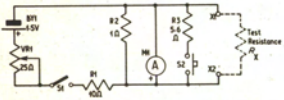


Fig. 3. Practical circuit of the low ohmmeter

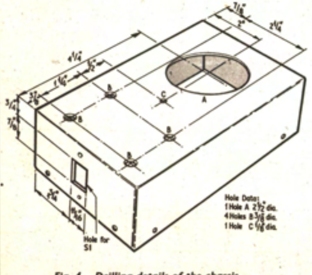


Fig. 4. Drilling details of the chassis

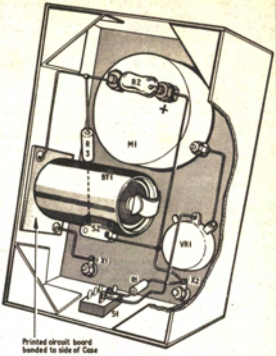


Fig. 5. Wiring of the ohmmeter

COMPONENTS . . .

Resistors

R1 10Ω, ½W, 10% carbon
R2 1Ω 1% wirewound
R3 5·6Ω, ½W, 1% wirewound

R2 and R3 are selected from 5% types

Potentiometer

VR1 25Ω preset wirewound

Meter

M1 0–1mA f.s.d.

Switches

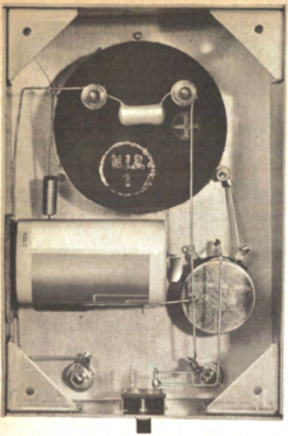
S1 Single-pole, on/off, slide switch
S2 Single-pole, on/off, push to make release to break

Battery

BY1 1·5V cell

Miscellaneous

Tinned copper wire 20 or 18 s.w.g.
Aluminium chassis 6in × 4in × 2½in
Screw terminals (2 off)
Spring clip for holding battery (see Fig. 5)



Rear view of the finished instrument

white card, mark the curved part of the scale the same size as the scale already on meter dial. Stick the card onto the old scale with an impact adhesive.

No difficulty should be encountered in making the instrument. The components aren't very critical other than the calibrating resistors. All leads however should be as short as possible and of fairly thick copper wire 20 s.w.g. or even thicker. The shunt resistors should be 1 per cent types if possible or selected from 5 per cent resistors.

CALIBRATION

Probably the simplest and most accurate way of calibrating the meter, that is if a precision resistance box is not available, is to use ordinary copper wire. Reference to a table of wire gauges provides the resistance in ohms per nominal length for most standard wire gauges. In this instance 38 s.w.g. wire was chosen, it having a resistance of 0·8503 ohms per yard. With the meter carefully removed from its case, the 5·6 ohm f.s.d. reference is established by applying the press switch and varying the 25 ohm potentiometer until the meter needle reads full scale. The 1 ohm calibration mark is established by connecting a length of wire equal to 36/0·8503in (or approximately 42·5in) plus sufficient to wind round the screw terminals. Now the fractional and multiple values of resistance can be marked by connecting proportional lengths of wire. For example, 4·25in for 0·1 ohm, 21·25in for 0·5 ohm, 85in for 2 ohms, and so on.

Having completed calibration, replace the meter in its case and remove the calibration wire. The instrument is now ready for use. ★