550 VOLT MEGOHMMETER

by B. V. Lamb

THE PAST few years have seen more and more householders tackling home wiring installation work. When the work is completed and before the mains can be permanently connected certain safety checks have to be made. This article and project deal with a very useful instrument that will measure the insulation resistance of the wiring.

Poor insulation causes current to flow between the line and earth or neutral. This current in turn will generate heat in the wiring, which if of sufficient temperature could cause fuse blowing or, more seriously, a fire.

Unfortunately, most do-it-yourself wiring enthusiasts do not possess the means for measuring leakage currents at high voltage. Commercially available instruments are expensive and secondhand units are not cheap either. The traditional instrument consists of a hand driven generator that causes a high voltage to appear across a lead terminating in a couple of croc clips, a meter registers the insulation resistance. More recently, electronic testers have tended to replace the hand driven types.

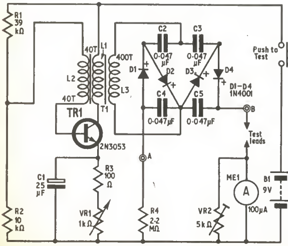

Fig. 1. Circuit diagram of the Megohmmeter

DESIGN CONSIDERATIONS

The a.c. voltage in the United Kingdom is 240 volts r.m.s.. Since we are interested in peak voltage, and $V_{peak} = V_{r.m.s.} \times 1{\cdot}414$ the test voltage generator will need to be at least 340 volts. In practice, however, regulations require that a minimum of 500 volts be used.

The 550 volt megohmmeter here described satisfies the twin requirements of the home electrican; it is easy to build and the price is low compared to commercially available units. Push button operation is employed as this prevents inadvertent battery run down due to a switch being left on. All of the components are readily available.

As to the choice of a suitable transistor high voltage generator; the demands made by the Megohmmeter dictate that a sine wave oscillator type d.c. convertor be used. There are three broad types of d.c. convertor that could be used, namely: ringing choke, multivibrator and sine wave.

Each of these circuits produce an oscillating voltage that is stepped up to a higher voltage by means of a transformer and then rectified to give a d.c. voltage at the required level.

Although the least efficient of the three, the sine wave oscillator is the first choice in favour of the ringing choke method when it comes to ease of starting. In economy of components it beats the multivibrator circuit. Since the Megohmmeter does not need to produce more than about 170 microamps under short circuit conditions, a low efficiency high voltage generator does not matter in the least.

CIRCUIT OPERATION

Transformer T1, TR1 and the associated circuitry form a sine wave oscillator whose period of oscillation is determined by the inductance and self capacitance of T1 (Fig. 1).

The feedback winding of T1 sustains the oscillation and is connected to the junction of R1 and R2 which together with R3 and VR1 set the d.c. bias for TR1. C1 prevents a.c. degeneration. VR1 allows for variation in voltage developed across the collector winding of T1.

The diodes, D1, D2, D3 and D4 plus the capacitors, C2, C3, C4 and C5 comprise a voltage quadrupler circuit. This circuit rectifies the a.c. voltage appearing across L3 and multiplies by four its equivalent d.c. value.

By varying VR1 over its whole range the open circuit output at the test leads can be varied from approximately 300 to 650 volts. In practice however, the voltage will be set at 550 for normal use. The wide range does allow for increased versatility and the constructor will be able to make use of this from time to time.

CONSTRUCTION

Dismantle the Ferroxcube core and carefully mount the bobbin on a suitable arbor — the author used a wheelbrace which had a gear ratio of 3·75 : 1 clamped in a bench vice and a 2BA screw as the arbor.

Strip a 2in length of thin pliable plastic sleeve from some spare wire and thread this onto some 41 s.w.g. enamelled copper wire (L3).

Carefully wind 400 turns and finish off L3 by insulating with one turn of Scotch Tape.

Next wind 40 turns of 41 s.w.g. for L2 and similarly insulate. Finally wind 40 turns of 28 s.w.g. for L1 and complete the transformer with a layer of tape.

The rest of the construction is quite straightforward (Fig. 2). The only caution is that building the circuit on inferior leaky tagboard is bound to cause difficulty in getting an infinity reading since leakage current will cause a standing error. The ideal case is plastic although metal can be used if care is taken with insulation.

SETTING UP

Once the circuit has been built, it is first of all necessary to establish the working of the oscillator.

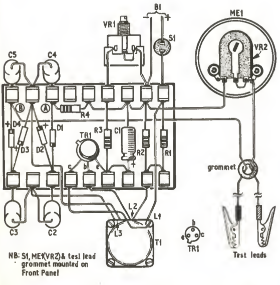

Fig. 2. Layout of the components on the tagboard and interconnections to the transformer, potentiometer, pushbutton and meter.

COMPONENTS . . .

Resistors
R1 39k Ω
R2 10k Ω
R3 100 Ω
R4 2·2M Ω
All ¼W 10% carbon

Potentiometers
VR1 1k Ω
VR2 5k Ω preset

Capacitors
C1 25μF 6·4V electrolytic
C2, 3, 4, 5 0·047μF 400V polyester (4 off)

Semiconductors
TR1 2N3053
D1, 2, 3, 4 1N4004 *or* any 400 p.i.v. low current diode (4 off)

Miscellaneous
S1 Miniature pushbutton
ME1 100μA f.s.d.
T1 Ferroxcube core type LA1 *or* equivalent
9 way Tagboard
Crocodile Clips (2 off)
9V Battery. PP7 or similar
Metal case 4in × 2½in × 2in
41 and 28 s.w.g. enamelled copper wire

Short the test clips together and the meter should indicate some value. If no movement is seen the oscillator feedback winding (L2) has to be reversed. Once the circuit is working, the output should be set to 550 volts.

Connect a high resistance voltmeter between points A and B then adjust VR1 for 550 volts. During this operation the test clips must of course be open circuited. The meter can now be calibrated in terms of megohms.

Remove the meter from its case and place it on the working surface having previously cleaned up and dusted down. Carefully remove the scaleplate and paint the reverse side matt white with emulsion paint.

When dry place the scaleplate — with its original markings uppermost—on a piece of cardboard. With a compass find the radius of the scale line and the maximum and minimum positions. Transfer these lines to the blank side. Screw the scaleplate back on the meter.

Short out the test clips and mark the scale with a soft pencil at this point. Now connect 1, 3, 10 and 50 megohm resistors and mark these equivalent points in. A professional job can be done by using plastic film ink for the scale lines and Letraset for the letters and numbers.

CONCLUSION

The 550 volt insulation tester that has been described should prove to be a valuable addition to the electricians tool kit. There are of course other uses to which it can be put, insulation tests for the electronic engineer being one example.

By making a simple twin pointed probe, relative dampness in wood and plaster can be measured. ★