THE BATTERY “MEGGER” TESTER

Design Considerations and Features of the new Transistorised Insulation, Continuity and Voltage Tester.

The advent of the transistor has created the possibility of completely new approaches to the further development of conventional instruments. To infer that a transistor merely replaces a thermionic valve does much less than justice to the transistor, as it permits, in fact, new designs which, due to the supply voltage requirements of thermionic devices, would have been totally impracticable in the past.

The Battery “MEGGER” Tester described in this article differs in a number of ways from other “MEGGER” Insulation Testers, as the generation of the test voltage is performed by a battery driven d.c. converter. The new instrument also utilises a milliammeter type of movement for the actual resistance measurements in place of the cross coil movement which one has come to associate with “MEGGER” Testers.

By replacing the hand driven generator of other instruments with a transistorised test voltage source, one hand push button operation without handle effort has been achieved. Moreover, the use of a milliammeter movement has made possible the inclusion of both a.c. and d.c. voltage measuring facilities covering the ranges most useful to the electrician.

The power requirements of the new instrument are provided by a rechargeable nickel cadmium cell so that the use of the Battery “MEGGER” Tester is not dependent on the availability of a suitable battery. A mains operated charging circuit is embodied in the instrument which will recharge the battery during the night or during a period when the instrument is not in use. In view of the high capacity of the nickel cadmium cell (225 mA/H), very long periods between charges can be expected.

In common with the hand operated “MEGGER” Tester, Series 3, Mark 3, the Battery “MEGGER” Tester includes a continuity range

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which at its lower end is calibrated in units as small as 0·1 ohm, and which extends to a maximum scale value of 20 ohms.

The transistorised test voltage source (or d.c. converter), is, of course, of particular interest as it must, as far as possible, meet all the requirements with regard to output and voltage stability expected of the hand driven generator in conventional instruments, yet derive its power from a low voltage source of limited capacity. This capacity is a function of the physical size of the battery which must be small enough to be accommodated in a truly portable instrument. Thus the design of the converter has to take into consideration various conflicting requirements.

The principle of transistorised d.c. converters is identical with electro-mechanical d.c. to d.c. converters which utilise a vibrator to act as interrupter of the low voltage d.c. input current. The mechanical vibrator is replaced by the transistor, or transistors, which, through suitable "on/off" biasing, will interrupt or modulate the current from the d.c. source. The approximately square wave interrupted current is then fed into a step up transformer, and the high potential output so obtained in the secondary of the transformer is rectified and applied to a voltage doubler circuit to yield the required d.c. output potential. (An alternative system is the use of a blocking oscillator in conjunction with a ringing choke). The operating frequency and wave form of converters of this type can usually be adjusted to meet a required function, but are not, in themselves, critical in the instrument described in this article.

The main performance criteria as far as portable insulation testers are concerned, are low battery drain, relative independence of the output voltage from changes in the input voltage, and the best possible stability of the output potential with respect to load conditions varying widely in resistance and capacity.

Transistor converter circuits may be divided into two basic types each of which offers further alternative possibilities of circuit configuration. The first type makes use of the same transformer for both oscillation and voltage step-up, whilst the second type uses separate components for these two duties. As the operating parameters for the oscillator transformer will frequently involve saturation levels, it does not operate under efficient conditions, whilst on the other hand the step-up transformer is not subject to the same considerations and will be able to provide a relatively large power output despite small physical dimensions. The basic efficiency obtainable from two transformer converters is thus greater than the performance expected from single transformer types, yet despite this, the cost, space and weight of the two-transformer design prevent this type of converter from being the obvious choice for small portable insulation testers. The performance of single transformer converters can be increased by using two transistors in a push/pull circuit, and this circuit configuration also offers certain advantages in the secondary circuit of the transformer which are discussed later. The relative dependence of the operating frequency of single transformer converters on the output load is not of great importance in insulation testers if kept within reasonable limits.

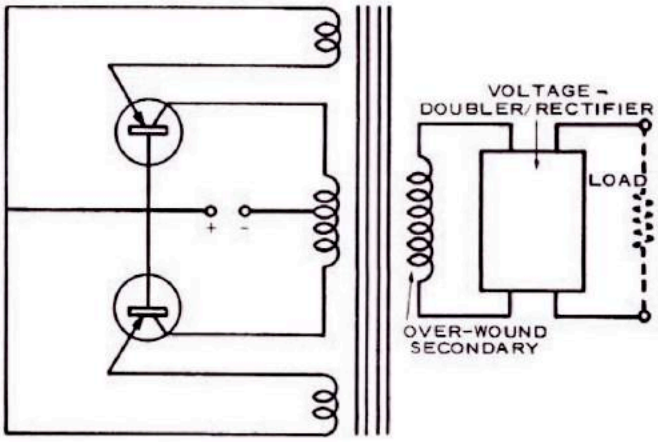

Figure 2.

Thus in the Battery "MEGGER" Tester, a single transformer design has been chosen in which the recurring saturation period of the transformer is used to produce the bias conditions necessary for the actual transistor switching. In making the transistor switching largely a function of the primary transformer current, considerable independence is achieved from changes in the input voltage as a result of gradual battery discharge. From this stems a further advantage as the actual switch-off point becomes less dependent on the actual transistor characteristics. In principle transistors used in such a circuit are not critical and do not require matching. Similarly, the choice of transistor operation, i.e. the use of common collector, common emitter, or common base circuits, is not very critical, and satisfactory performance can be achieved by any of these arrangements.

In the Battery "MEGGER" Tester, a common base circuit is employed, the simplified circuit arrangement of which is shown in Figure 2.

The design of the transformer is the factor largely determining converter performance. To keep the current necessary to achieve saturation low, a mumetal core transformer is employed. The core size also influences the choice of the optimum operating frequency of the converter which, in this instance, lies in the region of 500 cycles.

All these considerations must be equated with a primary/secondary turns ratio high enough to yield the desired output voltage. If, however, a very large turns ratio is employed, coupling between primary and secondary windings becomes increasingly difficult, and large winding capacitances which will result may also produce certain ill effects.

The use of a voltage doubler in the secondary circuit of the transformer permits the turns ratio to be kept to reasonable proportions. It also tends to reduce the effects of the load applied to the secondary circuit on the operation of the converter as a whole. A symmetrical voltage doubler circuit is used in the Battery "MEGGER" Tester which, in conjunction with the push/pull input circuit, will equalise the power drawn from both halves of the circuit. This also constitutes an inherent protection against ill effects caused through the unlikely event of unequal ageing of the transistors.

The excellent overall performance obtained from this d.c. converter and voltage doubler arrangement is shown in Figure 4 where the converter output voltage is plotted against load resistance for input voltages representing "fully charged" and "in need of charge" conditions of the 9 volt supply battery contained in the instrument.

The circuit for insulation tests is shown in Figure 3. This is an entirely conventional circuit, the converter being connected in series with the meter movement and the insulation to be tested. By employing a meter movement with a basic sensitivity of 1 mA. F.S.D., a high maximum calibrated insulation resistance value becomes possible, whilst the advantages of a robust movement are still maintained. The scale shape is so adjusted that the important value of 1 megohm falls into the centre of the insulation testing range, i.e. the area where maximum readability is inherent.

For continuity tests, the converter is not connected in the circuit, and the battery is used directly as the test voltage source. The resistance to be measured is connected in parallel with an internal resistor and with the meter movement, the whole of this parallel circuit being series connected with the battery and the pre-test setting up resistor. An interesting feature here is the provision of a warning neon lamp which will light up if the tester is inadvertently connected to the mains potential whilst being switched to the continuity or insulation range. Lighting of the neon lamp will then warn the operator not to depress the "test" push button which is arranged concentrically with the range switch. The facility of reading clearly calibrated resistance values as low as $\frac{1}{10}$th of an ohm, and a range spread of 1″ between 0 and 1 ohm (the latter value being mid-scale), greatly enhances the versatility of the instrument.

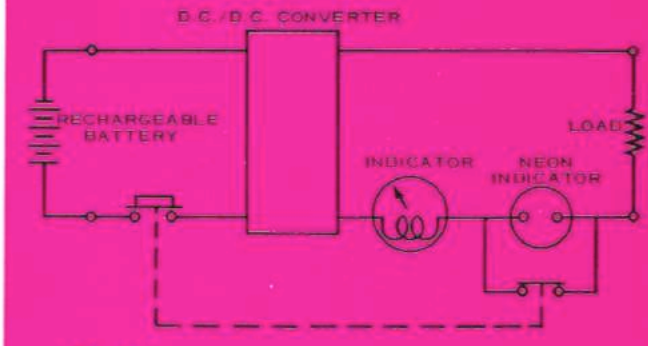

Figure 3.