PHILCO SERVICE

PHILCO Factory-Supervised Service

Shop Practices and Service Techniques

RADIO

APRIL, 1951

THE REPAIR OF TEST EQUIPMENT

Philco maintains in Philadelphia a service for the repair of test equipment. This service was originally planned to perform, on such equipment as might require it, calibration, precision alignment and repair beyond the scope of field practice. We are constantly amazed at the test equipment returned to Philadelphia which require only minor repairs, such as the replacement of a tube. These minor troubles could have been successfully taken care of in the serviceman's own shop. Thus the equipment would be returned to immediate service. By doing the work himself the serviceman does not suffer the loss of a money making price and time saving piece of equipment, for while repairs are done speedily in Philadelphia there is considerable time consumed in transportation and handling.

We, therefore, hope in this and succeeding articles to take some of the mystery out of test equipment. We further intend to enable repair men to successfully perform many services to test equipment that will be of help to them.

This and future articles are not intended as blueprints for specific repairs but rather to give hints, ideas, and general procedures. It is hoped that these articles will present this one principle; that test equipment, while appearing quite complicated, can be serviced by the same sectionalization that has been applied to radio servicing for years.

THE SERVICING OF MULTITESTORS

The multitester is one of the most useful and versatile of the commonly used test instruments. This type of tester is primarily designed for portability and ease of operation. They are therefore, inherently rugged, being made to withstand mechanical abuse and considerable electrical overload. It should be remembered however, that 99% of all meter troubles are *caused* by accidental overload or neglectful operation.

The multitester performs many functions and appears quite complicated, in reality it is very simple. Overall there are many parts and a multisection—multitap switch that lends an air of confusion. Taking a given function and range into consideration and disregarding the switch, which is only a means of choosing one of many circuits, the complexity disappears. The section now in use consists of only the meter movement and several parts in a very simple circuit. The following illustrations are of the complete Philco Model 7002 and circuit breakdowns of two meter functions and two ranges. These schematics serve as an example of the individual circuit simplicity as opposed to the intricate system as a whole. It will be seen that the DC voltage circuit, shown in figure 2, is a simple series; the number of resistive components decreasing in proportion to a decrease in range. Figure 3, shows the current measuring circuit. This circuit uses a multisection shunt; the only change taking place when switching range is to move the position of the positive input.

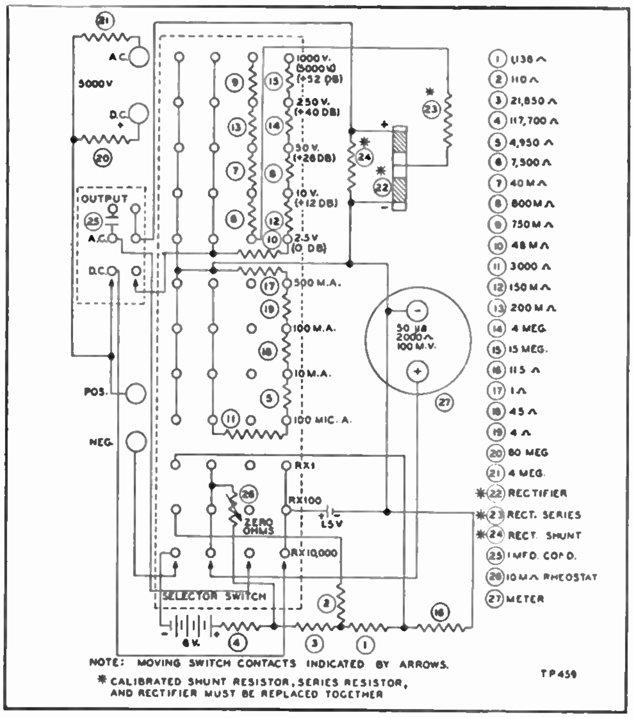

FIGURE 1

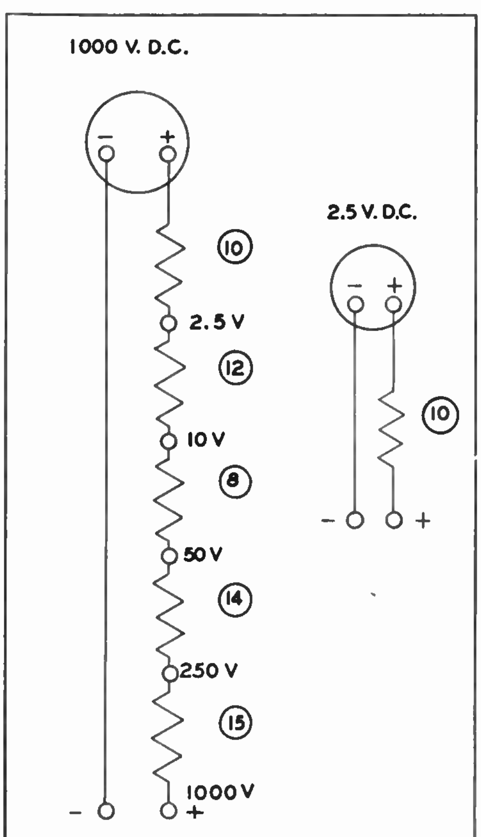

FIGURE 2

The fact that a multitester is not one but many test instruments and that the switch and meter are the only common parts to all its functions, readily lends this instrument to trouble shoot itself. As mentioned earlier most tester troubles are caused. The finding of a trouble is very simple if it is known which function and range was in use at the time of damage. Also, most damage will be obvious and show up as burned resistors (open) and burned switch contacts (open or intermittent). It is suggested that a visual inspection be made before proceeding.

To demonstrate this ability of a multitester to trouble-shoot itself we shall attempt to find the damage caused in several hypothetical cases. Let us assume that the meter was set to read DC volts on the 0-250 scale. Accidently the leads are put across several thousand volts, the needle swings wildly once and then no reading. The first step would be to switch to the low ohms scale and short the leads. If the meter is operating properly it will indicate 0 ohms. Since the meter is all that is common between the DC volt section and the ohm-meter and that we have now established that the movement itself is undamaged the trouble must be in the DC voltage circuit. Referring back to Figure 2, it is seen that there are four resistors in series with the meter. Switch to the low, 2.5 volt, DC scale and attempt to measure the voltage of an "A" cell. If this reading can be made advance to the next higher range. Repeat this procedure until the meter becomes inoperative. The trouble is then either a burned switch contact or the multiplier for that range is open. The next step would be to inspect the aforementioned resistor and switch. If there is no apparent damage check for continuity from the positive terminal to the multiplier of the highest operable range.

Let us now assume that the meter will not operate on any of the AC ranges. A quick check in ohms position proves that the meter is undamaged. By referring to Figure 4, it can be seen that there are only two possibilities; an open

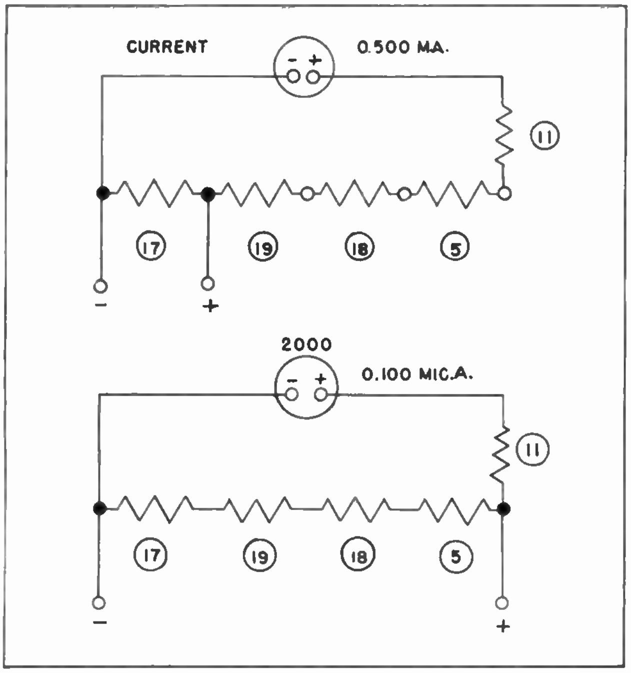

FIGURE 3

rectifier series resistor or a shorted rectifier. This trouble can readily be found by simple resistance checks. The rectifier, if shorted, will read 0 ohms regardless of polarity of ohm meter leads. A good rectifier, in this circuit, should measure 0 ohms when the negative lead is connected to the positive rectifier lead and approximately 300 ohms when connected in proper polarity. These resistance readings should be taken with the meter out of the circuit, i.e., meter switched to another function. If the rectifier, or its shunt or series resistors have to be replaced, it is important that all three units be replaced at the same time.

This principle of isolation of trouble by the meter itself is ideally demonstrated in the current section. As long as the meter movement is normal, the following procedure will immediately locate the faulty resistor. Referring to Figure 3, we shall assume that resistor number 5 is open. If a current is measured using the 0-100 microampere range the indication will be twice normal, since the shunt is open. When the range is changed to 10 milli-ampere, there will be no reading since the series meter circuit is open. It is advised that a current just sufficient to give an indication be used since, if the shunt is open, the meter will conduct a considerably heavier current than normal. Erroneous reading may be caused by these resistors lowering in value. These shunts are wire wound bobbins and when heated by overload they may char the cotton covering of the wire and short across turns rather than opening. A resistor in this state is easily spotted by visual check and can also be isolated in the same manner that an open is found. In a range position in which this burned resistor is the first shunt there will be a lowered reading. In the next higher range where this resistor is the first series there will be a slightly higher reading.

The most common trouble in the ohm meter section is changing values of resistors. The low resistance bobbins may partially short out as explained under the current section. The carbon

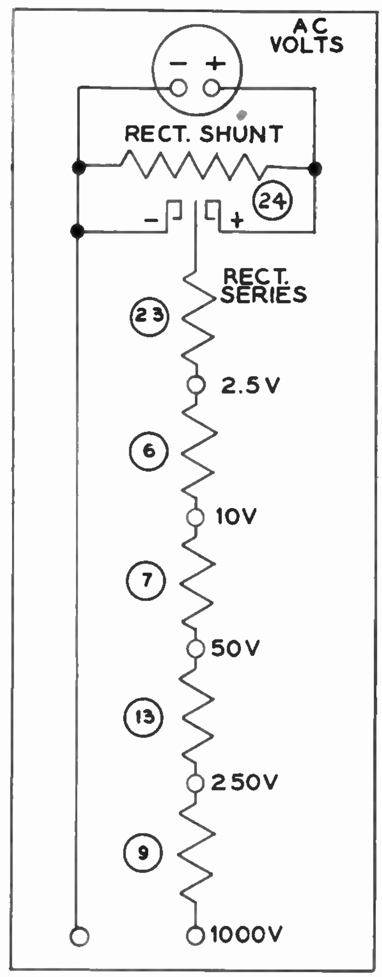

FIGURE 4

types may increase in value. An open resistor is easily found by merely checking continuity while the values should be checked with a resistance bridge.

The circuits shown in Figure 5 coupled with the causes (damage) and effects (meter indication) tabulated below give a good idea of how to trouble shoot the ohmmeter section.

16 open - Won't zero on any scale (reading less than zero)

1 open - No reading on R x 1
Won't zero (reading less than zero) on R x 100 and R x 10,000

3 open - No reading on R x 1 or R x 100
Won't zero (reading less than zero) on R x 10,000

26 open - No reading on any scale

2 open - No reading on R x 100
Normal operation on R x 1 and R x 10,000

4 open - No reading on R x 10,000
Normal operation on R x 1 and R x 100

A word is, perhaps, in order concerning the replacement of batteries in the multitester for the proper operation of the ohmmeter sections. It is obvious from the circuits shown in Figure 5 that if the meter will not zero in the R x 1 or R x 100 ranges, the $1\frac{1}{2}$ volt battery must be replaced, and if zero cannot be attained in the R x 10,000 range, the two 3-volt batteries (series connected) must be replaced. However, in the interest of accuracy, the batteries should be replaced when the zero control must be rotated completely, or nearly so, clockwise to obtain zero. Under this condition, the batteries are becoming weak and both the zero setting and resistance readings will fluctuate. This drift will cause readings to be higher than proper; the degree of inaccuracy will be dependent upon the length of time the leads are connected. When replacing batteries, it is good policy to pay strict attention to the connection of the old ones and not rely on color code to determine the positive and negative sides. If, after replacing the batteries, the ohmmeter will not zero, this is an indication that the batteries are not connected in proper polarity; they will have to be reversed.

It is of utmost importance when replacing components in testers that an exact replacement be used. Not only should the value be identical but the wattage, type, and temperature coefficient should also be the same as the original.

While it is the purpose of this article to convince servicemen that testers can be repaired in the field we strongly recommend that any damage to the movement itself be referred to your Philco Distributor. When shipping a meter for repair, ship the entire instrument as the movement should be calibrated with the individual instrument.

Next article will cover Signal Generators.

Service information for all recent test equipment will appear in the forthcoming 1950-51 Radio Year Book.

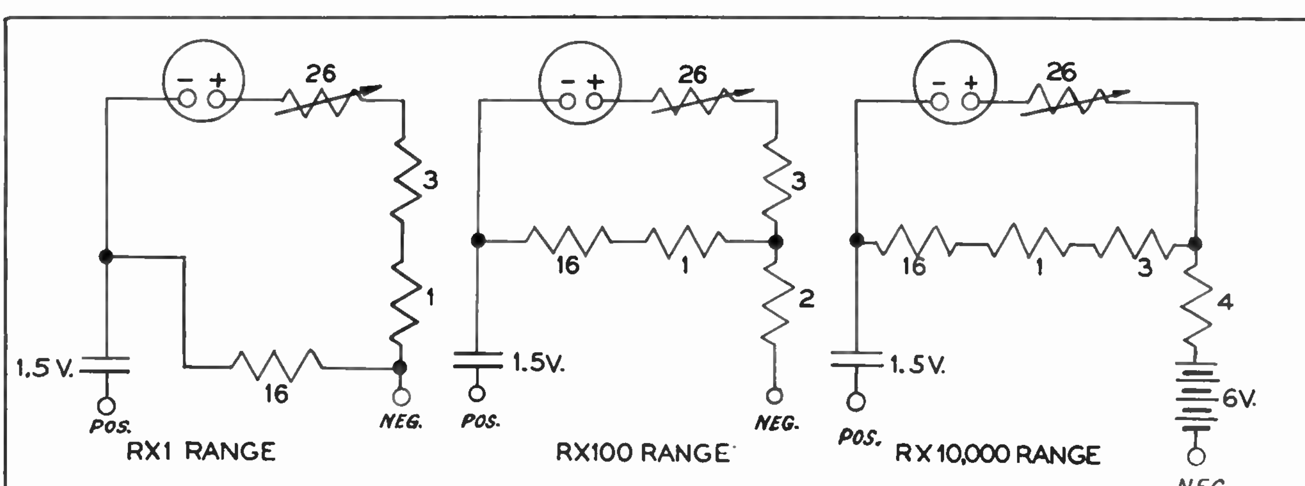

FIGURE 5