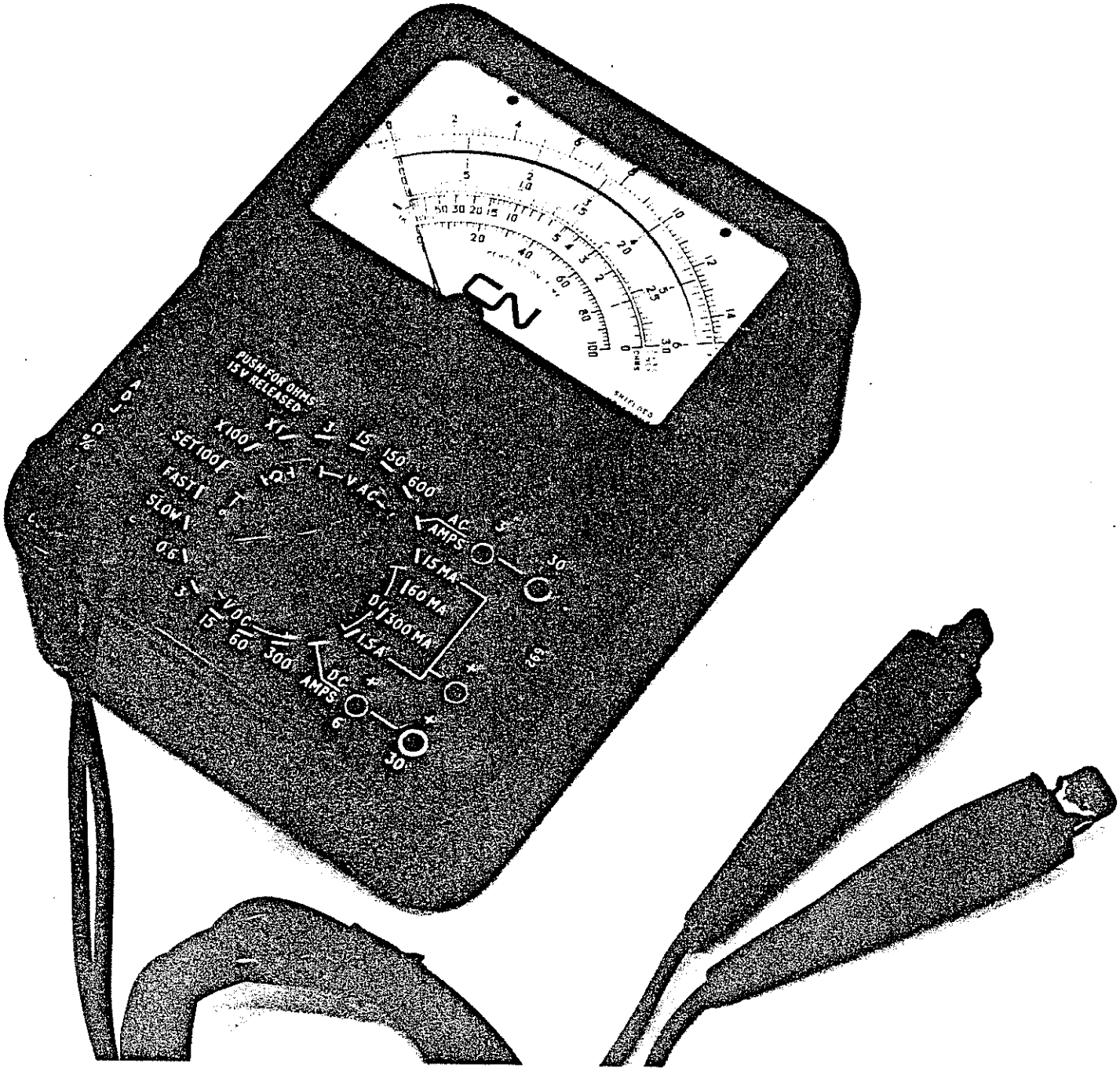
Southern Pacific
Transportation Company

SIGNAL TRAINING

VOLUME 1 CHAPTER 3

# MULTIMETER



Southern Pacific
Transportation Company

SIGNAL TRAINING

VOLUME 1 CHAPTER 3

# MULTIMETERS

## General

The most important fact to know, when filling an automobile tire, is the air pressure. This pressure is measured by a meter called a tire gauge. The gauge is required to measure the invisible force of air and if the eye were relied on to make this measurement the tire would likely be too hard or too soft. The gauge takes the place of the eye and in a sense, all meters are eyes specially designed to see and measure invisible forces and quantities.

The speed of a car is measured by a speedometer. The car generator charging rate is measured by an ammeter. All meters collect data inside a system and deliver it to the outside where it may be seen. Meters answer the question, "how much"?

In electrical Signal circuits "how much" is asked about three quantities - Current, Voltage and Resistance and the three meters used to measure these quantities are ammeters, voltmeters, and ohmmeters respectively.

Every circuit of any kind has a rated current load and if this rated load is exceeded heat develops, connections melt, and insulation may be set afire. Ammeters tell you exactly how much current is flowing and are used to make the periodic checks necessary to fore-warn of overloads.

Like current ratings all circuit components have voltage ratings. Should the voltage of a circuit exceed the rating it will force too much current through the components again causing overheating, etc. Too little voltage in a circuit will render the components useless as they require a certain amount of current to function. To cause current flow you must have voltage. Voltmeters are used to test that voltage is being maintained at the required levels.

Having meters that read current and voltage provides enough information to calculate the resistance of a circuit, using Ohms law. However, ohmmeters, which read the value of resistance directly are handier, as they do away with the need to divide the current into the voltage to calculate the resistance. $(R = \frac{E}{I})$.

Meters are very delicate devices and should be treated with as much care as a watch. Meter failures can usually be traced to negligence on the part of the handler. Either the meter has been placed in a circuit which has too much voltage or current which effects the meter in the same way excess current or voltage effects a circuit, that is, components are burnt out. Or the meter has been dropped or jarred so severely that internal connections or components are broken

rendering the meter useless.

The Bach-Simpson TS-111B illustrated on the cover page is widely used by the Railway Signalling forces and is specially designed to give nearly all the electrical measurements required, within the one meter, and is referred to as a multi-meter.

Among its features are provision for:-

- Measuring A.C. and D.C. current.
- Measuring A.C. and D.C. voltage.
- Measuring Resistance.
- Measuring percent "on-time" at any rate in excess of 30 pulses per minute.
- Simple, accurate selection of function and range using a single switch.
- An adjustable "Pointer Stop" which facilitates observation of "peak" readings of pulsating voltage or current on coded track.

(To take peak readings slowly rotate the Pointer Stop Knob clockwise. The point where motion of the meter pointer can no longer be detected indicates the peak value of the pulsating energy).

- An "OHMS" range safety device which indicates the presence of A.C. or D.C. voltage in a curcuit in which resistance is to be measured.
- A mechanical adjustment for positioning the needle on scale zero prior to taking readings. (This adjustment is made by turning the screw beneath the Pointer Stop Knob either right or left as required).

Note - to obtain accurate readings this meter should lay flat on its back.

Instructions for reading the A.C. and D.C. ammeter and voltmeter as well as the ohmmeter were covered completely in Programmed Learning sets 7, 8 and 10 of the electrical fundamentals course. The summaries covering these sets are included in this article to facilitate easy review.

The one feature of the multimeter that was not covered in the programmed course is the method of measuring percent "on-time" and this now follows the summaries.

## Summary 7

The multimeter is an electrical meter that can measure current, voltage and resistance. It can measure current when the range switch is in one of the current positions. Each current range indicates the highest value of current that can be applied to that range.

To measure current, you must connect the ammeter in series (never in parallel or across) with the circuit in such a way that the current enters the positive jack and leaves the -or common jack. Connecting the ammeter in series requires that you first open the circuit.

How to use the multimeter to measure current.

1) Set the range switch to the highest current position.

2) Connect the black lead to the - or common jack and the red lead to the appropriate jack.

3) Open the circuit and connect it in series. The black lead goes to the negative side and the red lead goes to the positive side.

4) Read the current from the D.C. scale.

5) Change to lower current scales until one is found that reads close to mid-scale.

Do not select a scale which overloads that scale or damage to the meter will result.

## Summary 8

The multimeter can operate as a D.C. voltmeter. It has five voltage ranges; the lowest range is .6 volts and the highest range is 300 volts. The black lead is plugged into the (-) or common jack and the red lead is plugged into the (+) jack. The voltmeter must always be connected in PARALLEL (never in series). The D.C. scales are used to indicate valves of D.C. voltage.

The D.C. voltmeter can be used to test battery voltage, but the battery must be under load otherwise it may test good when it is actually weak.

The multimeter can also operate as an AC voltmeter when the range switch is in an A.C. position. The test leads are plugged into the same jacks as if you were measuring D.C. The A.C. voltmeter must also always be connected in parallel. The A.C. scales are read the same as the D.C. scales with the exception of 0-3V which has a separate scale labelled (0-3V AC only).

How to measure voltages with the multimeter.

1) Set the range switch to either an AC or DC voltage range.

2) Plug the black lead into the jack marked (-) or common.

3) Plug the red lead into the (+) jack.

4) Connect the meter in parallel with the circuit.

5) Read the voltage on the appropriate scale.

REMEMBER: NEVER SELECT A RANGE THAT WILL OVERLOAD THE METER OTHERWISE DAMAGE WILL RESULT TO THE METER.

## Summary 10

The multimeter can operate as an ohmmeter when the range switch is set to one of the resistance positions. The ohmmeter test jacks are the - and + jacks. The ohmmeter is connected across the component to be measured (resistor, wire, lamp). Always turn OFF the power in a circuit before measuring its resistance. The value of resistance is the indication on the Ohms scale multiplied by the range switch position.

## HOW TO MEASURE RESISTANCE WITH THE MULTIMETER

1. Set the range switch to the RX100 position.
2. Plug black (-) lead into the - or common jack and red (+) lead into the + jack.
3. If measuring a component in a circuit, turn the power OFF.
4. Zero the meter by shorting the test leads and adjusting the zero ohms knob.
5. Connect test leads across component to be measured.
6. Set range switch to lower range positions for a meter indication closest to mid-scale; and remeber to ZERO THE METER each time the range switch is changed.

Percent "On-Time"

This is a new feature on the meter which can be used to test code transmitters. When a transmitter is coding, the "on" period is the time that the front contacts are made. This time is dependent on whether the contact gap is per specification and whether the transmitter is coding at the correct rate. The percent on time can be read directly on this meter.

This reading taken in the field tells whether the contacts of the code transmitter are worn. When the contacts are worn, the gap increases, therefore, decreasing the "on-time" of the relay. When the "on-time" reading drops below the specified minimum the relay should be shopped for inspection and repairs.

- Set range selector to "Set 100" position.

- Connect black lead to (-), red to (+) jack.

- set meter pointer to full scale deflection with the adjust Ω %knob.

- Switch to "FAST" or "SLOW" and connect leads to coded circuit. Observe correct polarity.

- Read percent "on-time" on the lowest black (0-100%) scale.

"On-time" readings in general are taken by reading the values at the upper and lower extremes of the pointer swing, as the coding contact is repeatedly made and broken, and determining the average or centre reading.

Use of the "FAST" or "SLOW" position is a matter of personal preference. In the "FAST" position the centre value stabilizes quickly but the spread between upper and lower readings will be wider, particularly with low pulse rates. In the "SLOW" position, time must be allowed for the reading to "settle", but, except for the lowest pulse rate, there will be virtually no pointer oscillation, and percent "on-time" can be read directly from the scale. Service specifications give the readings that apply to particular relays and should conform to the specifications for contact gap, code rate, and percent "on-time".

One important precaution to be taken is that the range selector switch should never be left on "Set 100" as it will discharge the mercury batteries through the meter movement and over a short period of time they will be completely dead.