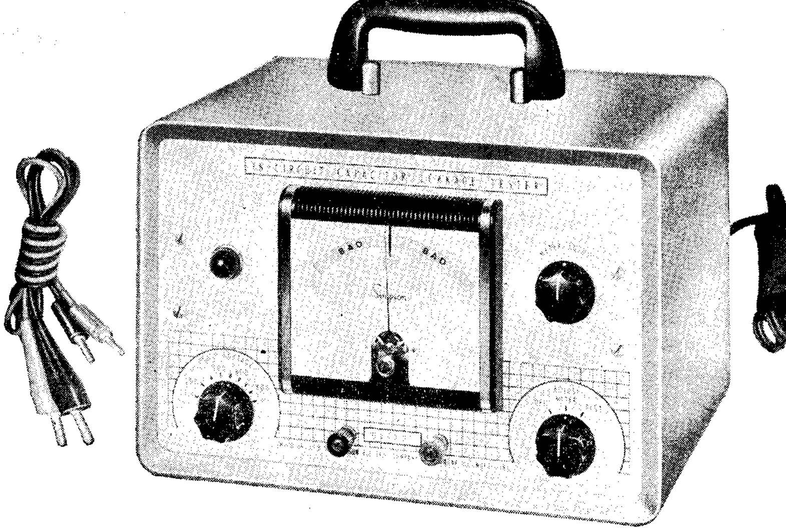

AN "IN-CIRCUIT" CONDENSER CHECKER

New Principles of Condenser Checking Are Employed In The "In-Circuit" Checker

by **GEORGE READE**

THE problem of checking the condition of condensers has always been a thorn in the side of most servicemen. The "open" condenser presents no great problem, since it may be detected by bridging with a similar condenser. The "shorted" condenser, unless it is shunted by a low resistance circuit, is also easy to find by ohmmeter tests. The headaches begin when we run into leaky condensers, intermittent condensers, and condensers which break down only when voltage is applied. The procedure at this point usually involves the tedious process of unsoldering or clipping one end, testing or substituting another condenser, resoldering, etc., etc. This can become exasperating, particularly when working where components are closely packed.

The Simpson Electric Company has recently developed a new test instrument called the Model 383 "In Circuit Capacitor Leakage Tester." As its name implies, it has been designed to check the condition of a condenser without disconnecting it in any way from the circuit in which it is used. As such, it should prove to be a boon to the trade. *Fig. 1* is a photograph of the instrument, and *Fig.* 2 its schematic.

What It Can Do

According to the manufacturer, the instrument has the following capabilities:

1. Checks paper, mica, and ceramic fixed condensers for leakage, shorts, breakdown and intermittents. It does this with the capacitor in the circuit, without disconnecting either end.
2. Checks horizontal drive and similar trimmer condensers for leakage and breakdown at rated working voltage.
3. Checks variable tuning condensers for leakage and breakdown points.
4. Checks vertical oscillator transformers and similar transformers for interwinding leakage, winding to core leakage, and for interlayer arcing at voltages up to 900 peak volts.
5. Checks for leakage between wires in wiring harnesses.
6. Checks rotary and toggle switches for leakage and for voltage breakdown up to 900 peak volts.
7. Checks terminal boards, sockets, mike connectors etc., for leakage and breakdown.
8. Tests coaxial cable and twin lead for leakage and breakdown.
9. Checks resistors for instability.

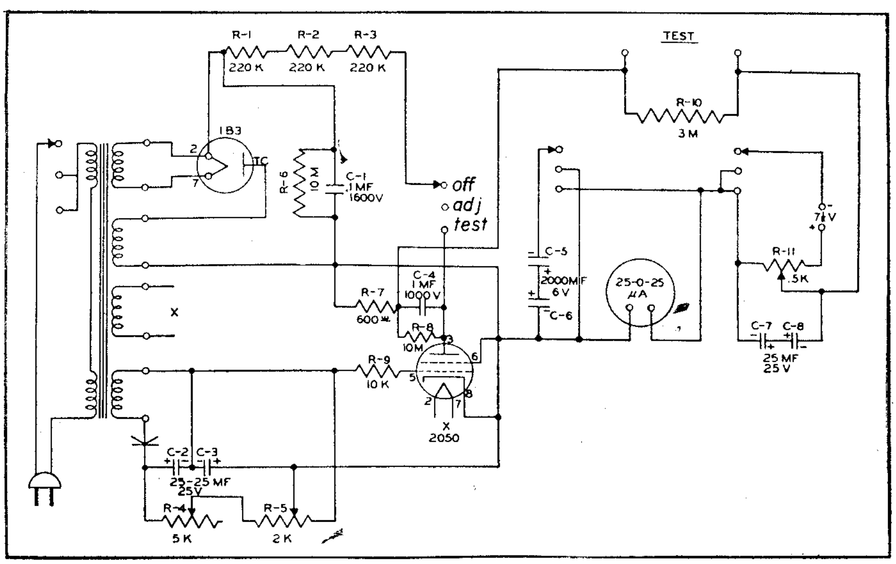

Fig. 2—Circuit diagram of Model 383 tester.

What It Cannot Do

1. It does not check the condition of electrolytic condensers.
2. It does not check an open condenser. Bridging a suspected open condenser is still a quick and sure test.
3. If a condenser is shunted by a circuit having a resistance of less than about 500 ohms, it cannot be checked in the circuit. One end of the condenser must then be freed before proceeding. This must also be done if the condenser is shunted by an electrolytic condenser or a low resistance circuit containing an electrolytic.

Principle of Operation

To illustrate the operation of this instrument refer to *Fig.* 3, which is a schematic of a typical vertical integrator circuit. Suppose *C4* were suspected of being leaky. An examination of the circuit indicates that the many resistors around *C4* form a series chain which shunts *C4* and any leakage resistance it may have. This amounts to a shunt resistance of from about 1 to 2.5 megohms, depending on the setting of *R6*, the vertical hold control. If the leakage resistance of the condenser were of the order of 10 megs, the *ordinary* condenser checker could not distinguish between leakage resistance and the circuit shunt resistance, unless one end of *C4* were unsoldered. In a similar way, *C1* is shunted by 24.2K and again one end would have to be disconnected to check for leakage.

This instrument however operates on a radically new principle, which enables it to distinguish between the leakage resistance and the circuit resistance, and because of this, the check may be made without disconnecting either condenser from the circuit.

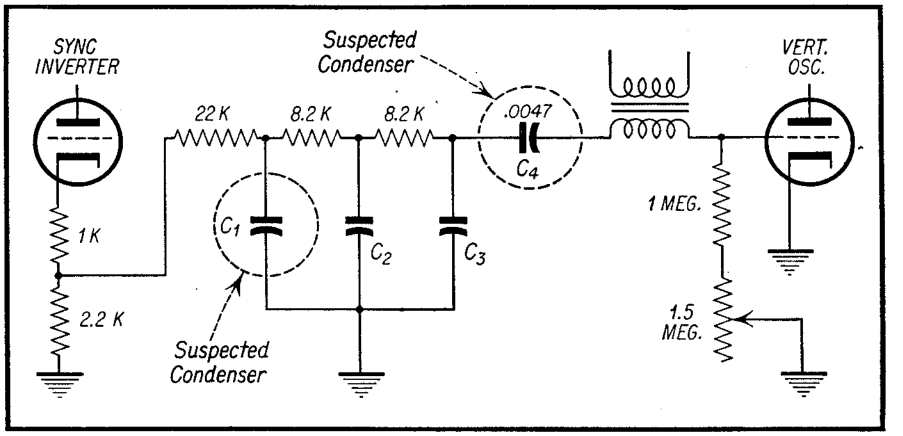

Fig. 3—Partial schematic of a typical vertical integrator circuit. Condenser C4 is shunted by the series string resistors comprising the 8.2K, 8.2K, 22K, 2.2K, 1.5 meg, and 1 meg resistors shown.

Servicemen have probably long been aware of the erratic readings often obtained on an ohmmeter when checking a condenser for leakage. Simpson engineers have made a study of this leakage resistance, and have come up with findings showing that there are a number of important differences between ordinary circuit resistance and leakage resistance. These may be summarized as follows:

1. Leakage resistance usually varies with the applied voltage. In most instances as the voltage across the condenser increases, the leakage resistance decreases. This is indicated in *Fig. 4*. If the leakage resistance remained unchanged, the leakage current would follow the straight line (B). However, as indicated by (A), the leakage current exceeds the normally expected ohms law current by greater and greater amounts as the applied voltage decreases. This indicates a lower and lower value of leakage resistance as the applied voltage increases. Less frequently, the change is in the opposite direction, and the leakage resistance increases with increased voltage.

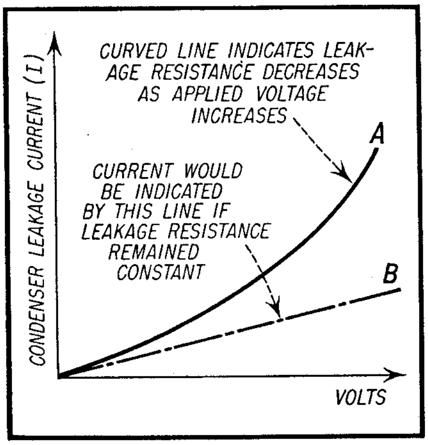

Fig. 4—Variation of leakage resistance with applied voltage is shown in the above illustration.

2. Leakage resistance is usually unstable. It frequently acquires a new value after the passage of a heavy current.

3. When the polarity of the voltage applied to a condenser reverses, the leakage resistance is often much greater (even infinite) for one polarity than it is for the reverse polarity.

4. Leakage resistance is often least stable when the applied voltage is in the form of sharp pulses.

The Model 383 utilizes these characteristics in the "in circuit" testing of capacitors. By employing a pulsed voltage across the condenser, two purposes are accomplished. First, a condenser may be charged to its rated breakdown value without injuring other circuit components in parallel with it. Thus a short duration 600 volt pulse with a comparatively long interval between pulses could be used to check a condenser for breakdown at 600 volts without overloading a parallel circuit as would be the case if a steady 600 volt *dc* source were used.

Secondly, a weak or intermittent condenser will break down more readily when a pulsed voltage is applied than when the voltage is steady.

Basically the instrument provides both a steady *dc* and a pulsed voltage to the condenser under test. After the test clips are placed in position across the suspected condenser, the function switch (see photograph, *Fig. 1*) is placed in the "Adjust Meter" position. This applies *dc* from an internal 7½ volt battery to the circuit. The "Meter Adjust" control is then rotated to bring the needle to the center line or "Good" position. Next, after making sure that the "Pulse Voltage" control is set at minimum, the function switch is turned up to the rated working voltage of the condenser. A good condenser produces no movement of the needle, whereas a leaky condenser will cause the needle to move either to the left or right in the meter sections marked "Bad."

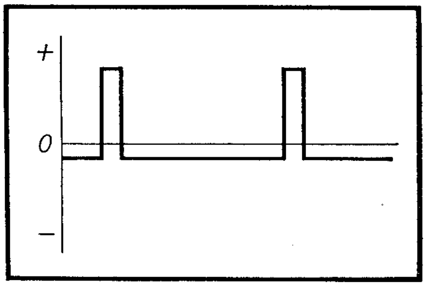

Fig. 5—The average value of the pulse is zero around the zero line.

If the pulse voltage is considered independently, it may be represented graphically by *Fig. 5*. Notice that the average value of such a pulse is zero, since the short duration high level pulse in the positive direction is balanced by the long duration low level pulse in the negative direction. If such a pulse were

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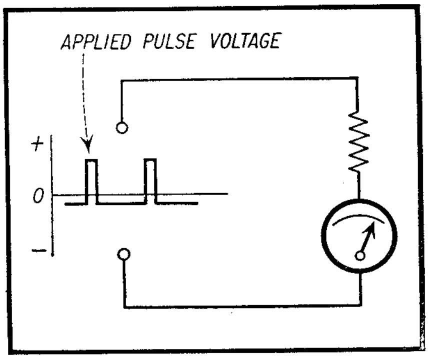

Fig. 6—Average current flow in resistor due to pulse is zero.

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fed into the resistive circuit of *Fig. 6*, the average current would be zero and the meter needle would not deflect. Of course the pulse repetition frequency would have to be high enough to prevent the needle from following the positive and negative excursions of each cycle.

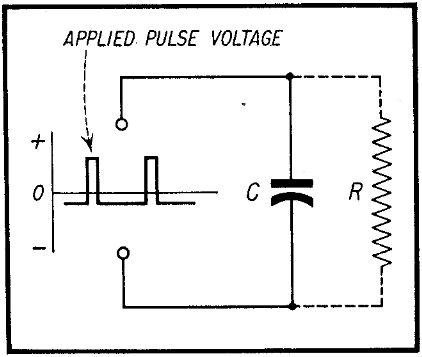

Fig. 7—If the condenser is good the action is same as in resistor.

Figure 7 shows similar circuit with a condenser taking the place of the resistor. If the condenser is good, the action is similar to that described for a resistor. If ordinary leakage resistance is present, however, the current flow will be greater in one direction that the other because of the third characteristic of leakage resistance previously mentioned. The needle will now swing off the zero mark since the average current is no longer zero. Thus, a leaky condenser causes the needle to deflect to one side or the other when the pulse voltage is applied. If the condenser is good, the needle remains stationary.

It was pointed out previously that leakage resistance is usually unstable. As a result of this instability a further check may be made on the condition of the condenser. After the pulse voltage test described above is completed, the function switch is turned back to the "Adjust Meter" position. We are now back to the position where only *dc* from the internal 7½ volt battery is being applied to the circuit. Unstable leakage resistance will cause the meter needle to come to rest at a position off the "Good" line, to which it had been adjusted in the first step described above.

The condenser may also be checked for breakdown in the following manner. With the test leads clipped across the condenser, and the function switch in the "Adjust Meter" position, the "Meter Adjust" control is rotated to center the needle on "Good" as before. The function switch is then turned to the "Test" position and the "Pulse Voltage" control is then advanced to deliver a voltage 50% higher than the rated working voltage of the capacitor. If the needle remains stationary, the condenser is good. A kicking needle or an off scale deflection indicates that the condenser dielectric is breaking down. This is often accompanied by a crackling sound from within the condenser.

Occasionally, we run across an unstable resistor, that is, a resistor whose value changes during operation. Such a resistor may be responsible for noisy or intermittent operation. The model 383 may be used to detect such a resistor by employing the following two tests.

1. Static Test—(Steady *dc* applied to resistor.) With the test leads clipped across the resistor, and function switch set to "Adjust Meter" turn the "Meter Adjust" control to bring the needle to the good line. Tap the resistor gently with a pencil watching the meter at the same time. If the needle moves off the "Good" line, even momentarily, an unstable resistor is indicated.

2. Dynamic Test—(Pulse Voltage Applied.) After completing the static test, turn the function switch to the "Test" position and advance the "Pulse Voltage" control to 300 volts. Repeat the tapping process, watching the meter. Any movement of the meter away from the "Good" line again indicates an unstable resistor.

Precautions

1. Be sure to remove any detector or converter crystals, or transistors from any circuit across which the test leads are placed. The higher values of pulse

voltage will burn out such components.

2. After each use of the instrument get into the habit of turning the "Pulse Voltage" control completely counter clockwise. If the test clips are touched while a high voltage pulse is being delivered, an annoying shock will be received.

3. Electrolytic capacitors in any branch circuit across the test points will result in fake "Bad" readings. If the electrolytic is isolated by a resistance of 1000 ohms or more it may simply be shorted out during the test. Otherwise, one end of the electrolytic should be disconnected.

In conclusion it might be pointed out that this condenser checker is truly an important advance in the art of checking condensers without removing them from the circuit. In light of its already proven effectiveness in the field it does merit consideration as a standard piece of equipment in the shop.