New Type SIGNAL TRACER

Serviceman employing the CA-11 signal tracer to check receiver.

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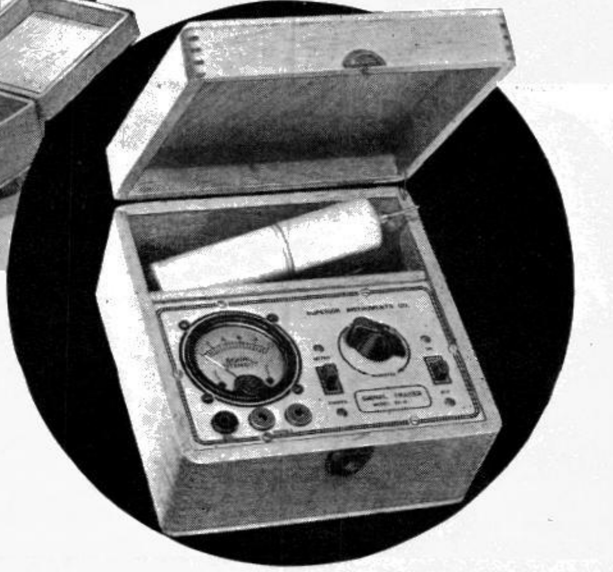
Superior Instruments Co.

Design of a highly sensitive and portable signal tracer. Simplicity of operation makes this tester ideal for home receiver repair—an important factor to servicemen.



Commercially constructed unit.

IN THE design of an efficient signal tracer, several points must be borne in mind. It must be sensitive, small, portable if possible, and not load or detune a circuit. In the past, signal tracers consisted of diode-vacuum tube voltmeter combinations with additional amplifiers (often tuned for radio frequencies) that were quite efficient, but bulky. It would take almost as long to set up one of these signal tracers with its maze of special cables as it did to find the trouble in a receiver. Because of the tuned amplifiers, these signal tracers would also require tuning. While a tuned amplifier is very efficient, a slight shift in signal frequency would mean retuning and sometimes actually losing the signal. For these reasons, signal tracers never did enjoy the amount of popularity that they should have.

Most of the objections to the older type signal tracer are eliminated by the new model CA-11 signal tracer manufactured by the *Superior Instruments Co.* and described herein. No tuned circuits are used and there is only one connecting cable.

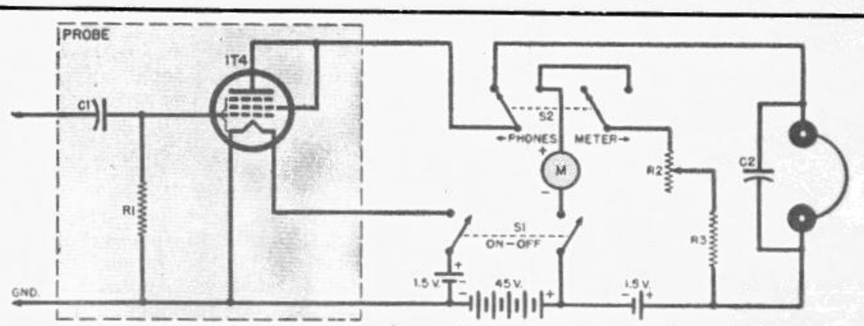
The circuit used is a 1T4 tube in a grid-leak vacuum tube voltmeter circuit, with provisions for insertion of phones.

The detector probe is composed of the 1T4 tube connected as a triode (screen grid and plate tied together) and a .0003 μfd. condenser and 20 megohm resistor. Both the .0003 μfd. condenser and 20 megohm resistor serve a dual purpose. D.c. is prevented from being applied to the grid of the 1T4 tube by the capacitor, which acts as a blocking condenser, while the resistor acts as a grid return and bias resistor. The condenser-resistor combination also operates to attenuate the lower frequencies, those below approximately 300 cycles. This cut-off frequency was chosen for several reasons.

Should a large 60 cycle or 120 cycle hum be superimposed on the signal, the low hum frequency would not mask the higher signal frequency. 400 cycles is also the usual modulating frequency of signal generators and it was, therefore, thought advisable to have the vacuum tube voltmeter pass this frequency. The graph (Fig. 3) shows the exact voltage required for full-scale deflection of the v.t.v.m. for the audio spectrum. It should be noted that the meter is not calibrated for voltage, but rather in relative signal value. V.t.v.m. sensi-

(*Continued on page* 132)

Fig. 1. Schematic diagram of the single-tube signal tracer. The unit is constructed in two separate parts, a detector probe and the battery and meter box.



R_1—20 megohm, ½ w. res.
R_2—300 ohm rheostat
R_3—600 ohm, ½ w. res.
C_1—300 μμfd mica cond.
C_2—.002 μfd cond.
S_1—D.p.s.t. sw.
S_2—D.p.d.t. sw.
M—1 ma., 150 ohm meter

New Type Signal Tracer

(*Continued from page* 31)

tivity is 1.8 volts full scale from 250 c.p.s. to well past the aural range of 10,000 c.p.s. Below 250 cycles, the sensitivity of the voltmeter is reduced because of the high-pass filter, the sensitivity at 120 cycles being 2.2 volts full scale and dropping to 5.4 volts at 60 cycles. The sensitivity at 40 cycles is even less and although it doesn't appear on the graph, the voltage required for full-scale deflection at this frequency is in the vicinity of 15 volts.

Sensitivity of the probe at the radio frequencies is shown in Fig. 2. It should be noted that the frequency response is flat to 10 mc. Above this point, resonance takes place in the tube and associated parts tending to increase the sensitivity at 15 mc. The sensitivity then takes a decided drop past 20 mc. At 40 mc., the probe requires 1.3 volts to obtain one scale deflection on the meter. Although the probe is essentially flat to 10 mc., the loading on the circuit increases as the frequency is increased. The useful range is to approximately 10 mc. Above 10 mc., loading is excessive due to the material used in the probe.

The remainder of the instrument consists of the battery box, meter, and balancing control. A 45 volt battery is used to supply plate voltage for the 1T4, with a 1½ volt cell taking care of the filament voltage. One of the characteristics of this type of v.t.v.m. is the large idling current. This is caused by the lack of grid bias. When a signal is applied to the

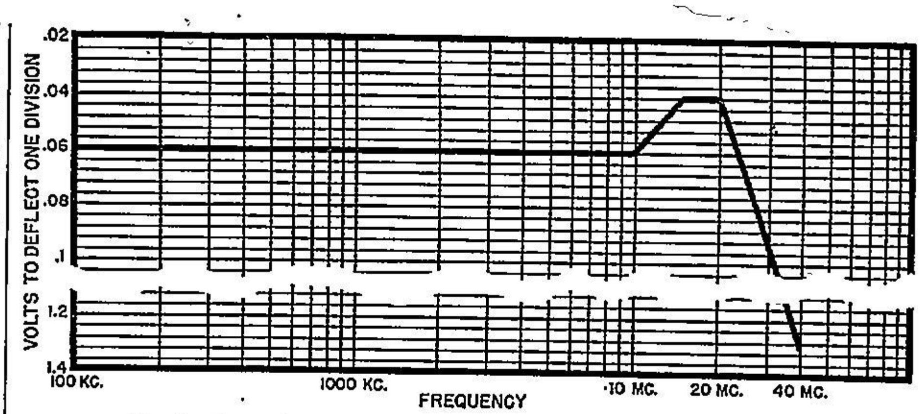


Fig. 2. Curve shows the sensitivity of the probe at radio frequency.

grid, rectification takes place and the grid current flowing through the grid resistor biases the tube, causing the plate current to drop. Ordinarily, this would cause the meter to read backwards. In this unit, however, the meter is connected backwards—the plus terminal being connected to the plate and the minus terminal connected to "B+". A bucking voltage is applied across the meter so that the meter reads zero with no signal applied. When a signal is applied, the meter reads up scale in the conventional manner.

As an example of how this signal tracer could be used to locate trouble in a receiver, the following illustration is given. A typical a.c.-d.c. receiver with a loop antenna and the following tubes, 12SA7, 12SK7, 12SQ7, 50L6, 35Z5, has intermittent operation and a very distorted signal.

With the receiver set to receive a station, take readings at the control grid and plate of each tube, starting with the 12SA7 control grid and working toward the 50L6 plate. As the probe is moved from grid to plate of each stage, the reading of the v.t.v.m. should increase. Failure of the meter to increase indicates a defective stage. The above, of course, can only be done while the receiver is in the inoperative condition. If when we touch the control grid pin of the 12SK7, we get a reading of 20 on the meter and the plate shows no signal, the trouble is obviously due to a defective 12SK7 stage.

This can be caused by a defective tube, open i.f. transformer, or open cathode resistor. The exact cause can be found with a tube-tester, or any standard volt-ohm-milliammeter.

The distortion can then be detected the same way. When using the v.t.v.m. to detect audio, the needle will fluctuate with the modulation. A steady deflection indicates hum. If it is desired to listen to the distortion, phones are plugged into the jacks provided, and the meter disconnected by means of a switch on the panel. The probe can then be touched to the grid and plate of each tube until the received signal is distortionless. If when connected to the grid of the 50L6, no distortion is noticed and, when connected to the plate, it shows considerable distortion, the trouble is then in the 50L6 and its associated circuits. The cathode can be shorted to one side of the filament, or a high resistance leak can occur between the grid and the cathode or filament. Distortion or hum throughout the receiver can be caused by a defective 35Z5, the filter condenser, or a.c. that is in the power supply.

Although only two instances are shown above, the signal tracer can be used for various other purposes. The oscillator for example can be checked for oscillation by simply holding the probe near the coil or tuning condenser. If oscillation ceases when the condenser is rotated, the plates of the variable condenser may be shorted or the tube may be defective.

Thus, it becomes readily apparent that "bugs" may be found quickly and under innumerable conditions with the simple expediency of a model CA-11 signal tracer.

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Fig. 3. The voltage required for full-scale deflection of the v.t.v.m.