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SERVICING WITH A MODERN OSCILLOSCOPE
PART 1
By FRED DALASTA, Sylvania Sales Engineer

Many servicemen would like to become more familiar with the use of the cathode ray oscilloscope in modern servicing. A few years ago there was a flurry of interest in oscilloscopes, but this interest died out partially due to the high cost of the instrument at that time. However, in the quest for more expert servicing, and with the advent of FM and television an oscilloscope is becoming a "must" to the progressive service engineer. This is the first of a series of articles which it is hoped will aid our readers to fully appreciate the real possibilities of the oscilloscope which is becoming more widely used in AM, FM, television, audio circuits, etc.

In this issue we will consider the action of the electron beam in the cathode ray tube, the operation of the new Sylvania Oscilloscope, and its application in the analysis of a typical superheterodyne receiver.

The Cathode Ray Tube

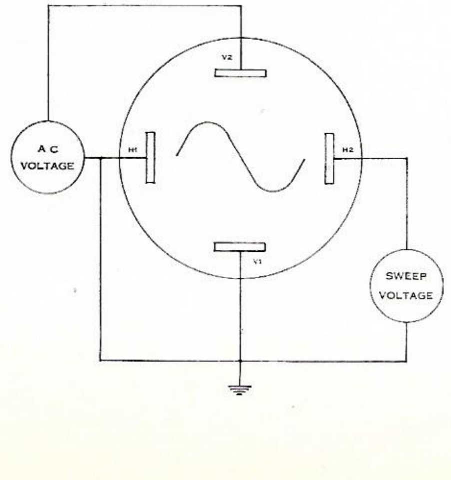
The cathode ray tube is quite similar to the common receiving tube in many respects, but instead of the electron beam accelerating in space toward the plate, as in the receiving tube, the cathode ray tube provides that the electron beam be accelerated and guided (focussed) so that the beam passes beyond the accelerating anodes and strikes the specially prepared screen located within the tube. Wherever the beam strikes the screen a luminous spot appears which is caused by the fluorescent property of the screen. The brightness of this spot (magnitude of beam current) is varied with a change in potential of the control grid much as the plate current is varied by the control grid voltage in a receiving tube. The spot will move on the screen when the electron beam is subjected to an electrostatic or magnetic field. Electrostatic deflection, as used in the Sylvania Oscilloscope, is accomplished by passing the electron beam between a pair of electrodes called deflecting plates. When a voltage difference is applied between the plates, the electron beam is bent or deflected toward the more positive plate. With two pair of deflecting plates placed at right angles, the beam can be deflected in two mutually perpendicular directions simultaneously and the luminous spot observed over a wide useful area on the screen of the tube.

The outstanding feature of the oscilloscope is its ability to show a picture of a wave form or a combination of two or more wave forms whose amplitude is directly proportional to the actual voltage of the signal. The oscilloscope circuit supplies a sawtooth sweep voltage to the horizontal plates to cause the spot on the screen to move from the left side to the right side of the screen leaving a succession of luminous traces. When the spot reaches the right side of the screen, it returns with such speed that no objectionable trace is seen because it does not remain in any one spot long enough to cause sufficient fluorescence.

Now, when an alternating voltage is applied to the vertical plate in addition to this sweeping action applied to the horizontal plate, this line will be drawn up and down by the variations in applied AC voltage. We see indicated on the screen a continuous picture of these variations. Actually, we see only the variations which take place in the time taken by the spot to be moved across the screen by the horizontal sweep. (Figure 1). Thus, if the spot moves across the screen in $1/60$ of a second and a 60 cycle sine wave is applied to the vertical plates, we will see but one complete cycle. If the spot takes a little more or less than $1/60$ of a second to get across, each sweep will show a different portion of the wave and a confused pattern will result.

FIGURE 1

VOLTAGES APPLIED TO PLATES



Using the Oscilloscope

Let us now place an oscilloscope, such as the Sylvania Type 131, in operation. First, check the AC power source for correct line voltage and frequency before plugging in the instrument. Set the VERTICAL and HORIZONTAL CENTERING and FOCUS pointers at the midpoint of their rotation. Set the INTENSITY (also Power Switch) control to ½ clockwise rotation. Set the HORIZONTAL GAIN between 2 and 4 and the COARSE FREQUENCY to 15-90 position.

After the tubes have warmed up, a horizontal trace will appear on the screen. Adjust the VERTICAL and HORIZONTAL CENTERING to position the trace on the screen. Readjust the FOCUS and INTENSITY to obtain the desired trace with respect to brightness and width. Adjust the HORIZONTAL GAIN for about a 2½″ trace. With a little practice one can readily remember the function of each control. The only precaution necessary is to avoid the maximum clockwise position of the INTENSITY control. A small bright

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SERVICING WITH A MODERN OSCILLOSCOPE *(Continued)*

spot on the screen will tend to burn the screen particularly if it is left on a long time. The other controls may be rotated without harm to the instrument.

To observe a 60 cycle sine wave, set the Sync Selector at Line Frequency. Connect the 6.3V AC terminal to the Vertical Input terminal and adjust Vertical Gain for the desired pattern height on the screen. Turn the Fine Frequency control to obtain 2 or 3 sine waves on the screen then adjust the Sync Amplitude to give a steady pattern. Do not advance the Sync Amplitude further than is necessary because the wave form may become distorted.

For frequencies other than 60 cycles, set the Sync Selector at the Intensity position and connect the signal to be observed between Vertical Input and Ground. Set the Coarse Frequency so that the desired number of complete cycles can be obtained. For example, if a 400 cycle signal is connected between Vertical Input and Ground, set the Coarse Frequency at 90-500 position. Then by varying the Fine Frequency, one to four complete sine waves may be obtained on the screen.

Analysis of a Typical Superheterodyne Receiver

In the analysis of a typical receiver the first step is to check the tubes and tube voltages. If these are found to be satisfactory, it is recommended to begin from the speaker and work toward the antenna to test for defects.

A modulated variable frequency generator and an audio signal generator are both required for use in conjunction with the oscilloscopes but both functions may be combined in one instrument.

Note: Whenever possible follow the receiver manufacturer's instructions. The following are general instructions:

1. Assuming the receiver is not working, the first step is to connect the Vertical Input and Ground terminals of the Oscilloscope across the voice coil of the speaker. (If the receiver is in operating condition, use the part of the instructions which apply in the particular case.) Set the Sync Selector to Intensity and use the 90-500 Coarse Frequency range. Set the AF signal generator for 400 cycle out through a .02 to .5 uf condenser to the input grid of the last stage and the ground lead to the chassis. (Use a series condenser of .01 uf 400v if the set is an AC-DC unit.) Set the output of the AF signal generator no higher than is necessary to obtain an audible tone from the speaker. Adjust the Vertical Gain to give the desired pattern height. Set the Fine Frequency and the Sync Amplitude control to obtain two cycles and a steady pattern, respectively.

2. A symmetrical sine wave should be obtained on the screen of the Oscilloscope. If the wave form is distorted as in Figure 2, the stage may be overloaded (improper bias on), the tube may not have the proper bias caused by a defective cathode resistor or a leaky cathode by-pass condenser. Figure 3 shows the effect of too high a bias. A combination of Figures 2 and 3 would indicate the overloading of the tube.

Hum and noise may be detected in a trace as shown in Figure 4, which is sometimes caused by a defective filter condenser or tube. A ripple voltage (60 cycle or 120 cycle) is indicated by this undulating wave form caused by insufficient filtering. Distortion in the wave form also may indicate trouble in the screen or plate by-pass condenser, coupling condensers, or output transformer. An irregular wave form may be obtained showing second harmonic content (Figure 5), or a picture may be obscured by a strong high frequency signal (parasitic oscillation). Practice will enable the operator to recognize these and other symptoms rapidly and apply the standard cures.

Proceed to the next stage and connect the 400 cycle signal to the input of the first audio stage and observe the wave form as indicated above.

3. The next step is to align the IF stage, which requires that the signal be at the IF frequency with audio modulation. Connect the modulated signal through a .05 ufd condenser to the input grid of the IF amplifier tube. Turn the receiver tuning condenser fully closed and set the receiver volume control at maximum. Adjust the output of the signal generator to obtain a low audible signal from the speaker and set the Vertical Gain to obtain the desired trace height on the screen. Adjust the Fine Frequency control to present 2 or 3 cycles on the screen and keep the Sync Amplitude control as far counterclockwise as possible consistent with keeping the pattern stationary on the screen. Then adjust the trimmers of the last IF transformer for maximum deflection on the screen of the Oscilloscope.

4. If there is more than one IF stage, connect the signal generator successively to the grid of each IF amplifier tube and finally to the grid of the converter tube, adjusting for maximum output in each case. With the signal at the converter grid, all IF trimmers should be

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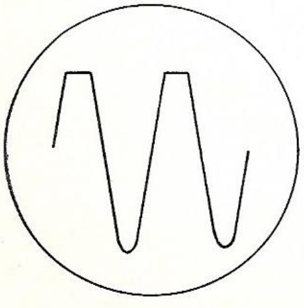

FIGURE 2

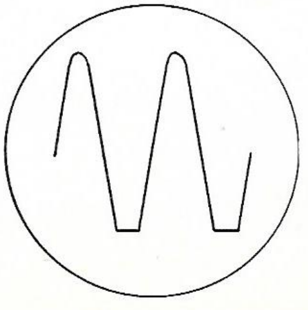

FIGURE 3

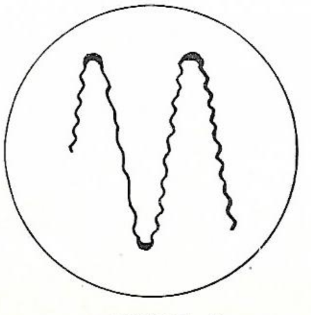

FIGURE 4

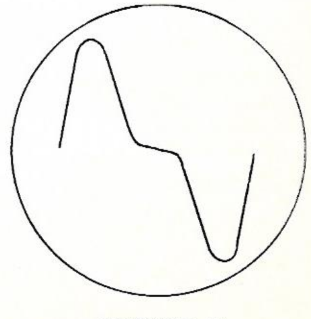

FIGURE 5

MEASURING CAPACITANCE WITH THE SYLVANIA POLYMETER

Contributed by FRANCIS W. SWANTZ

EDITOR'S NOTE: Mr. Swantz is now with one of our distributors in St. Louis. He says, "Since many servicemen must watch their budgets carefully, it is imperative that they wisely invest their spare change in the most essential and necessary test equipment. My twenty-five years of radio service experience, including ten years of instrumentation, lead me to believe that the Polymeter is the most necessary and versatile of all instruments. With it the radio man can test tubes, align radios, trace a signal through the set, make impedance measurements, as well as measure any values of current, voltage or ohms. The Polymeter is limited only by the user's fundamental knowledge and initiative."

We hope he will send us some more suggestions.

It is very simple to hook up a circuit using the Polymeter and a potentiometer, a spare transformer and a few standard condensers so as to read capacitance values with considerable accuracy. The simplest circuit is shown in Figure 1. The transformer is any radio transformer having enough low voltage secondary windings to add in series to a little over 10 volts. R1 is a potentiometer having any convenient value between 50 and 500 ohms. Adjust the slider until the output voltage is 10 volts, as measured by the Polymeter on the 10 volt AC scale. Then place the unknown condenser in series and read the voltage again on the same scale. Curve "A" of Figure 1 is used to find the capacitance. Divide the capacitance scale values by ten when using curve "A".

This method is very satisfactory for values between .0001 and .001 but should not be relied on for higher values since this circuit uses the input impedance of the meter itself as the reference standard and some variation should be expected between meters. If you have 3 known values, between .0001 and .001 mfd you can check your meter against the one used for the curve and draw a similar curve through your experimental points. On these low values it is best to use short

FIGURE 1

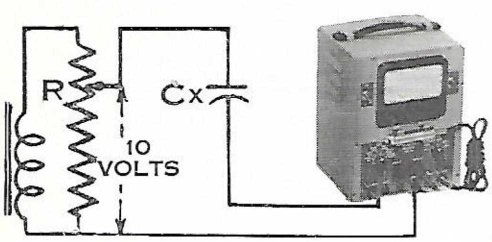

FIGURE 3

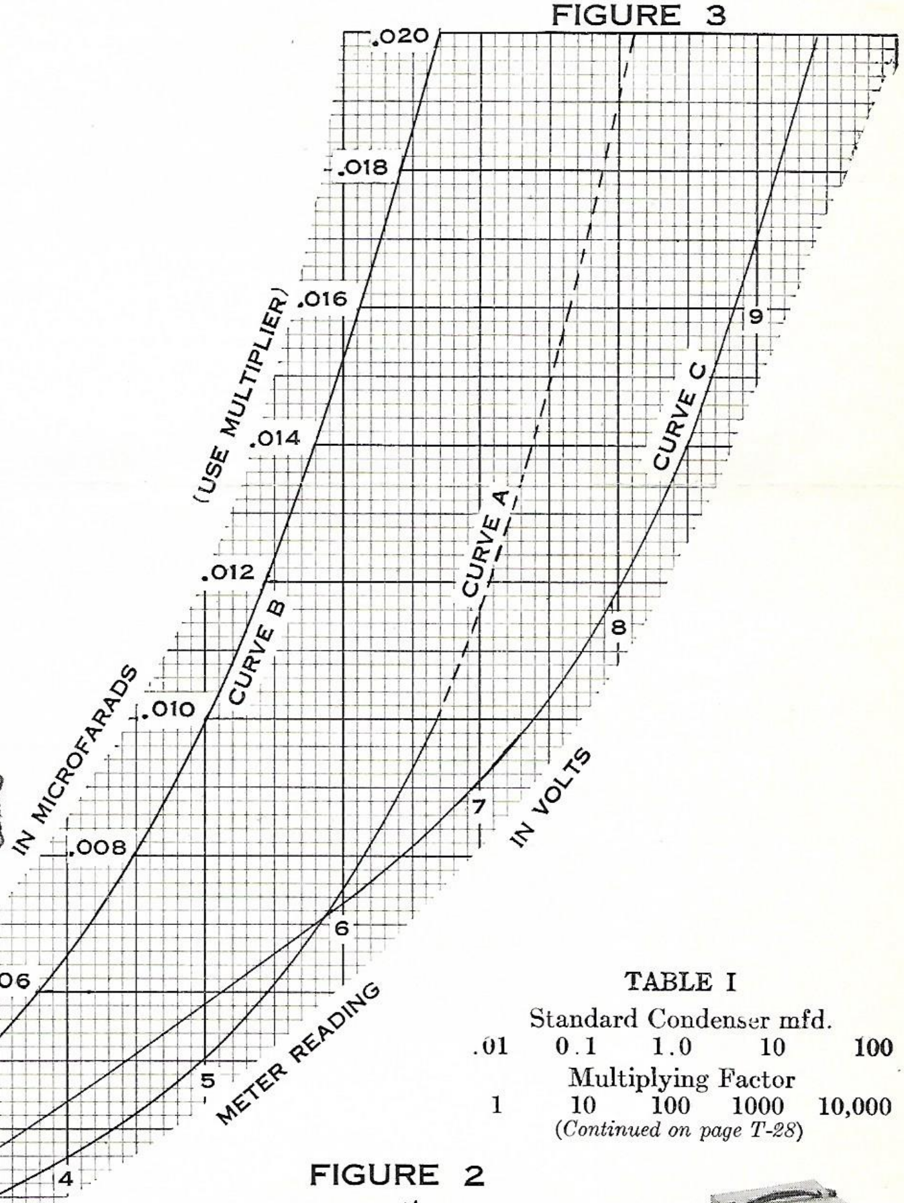

TABLE I

Standard Condenser mfd.	.01	0.1	1.0	10	100
Multiplying Factor	1	10	100	1000	10,000

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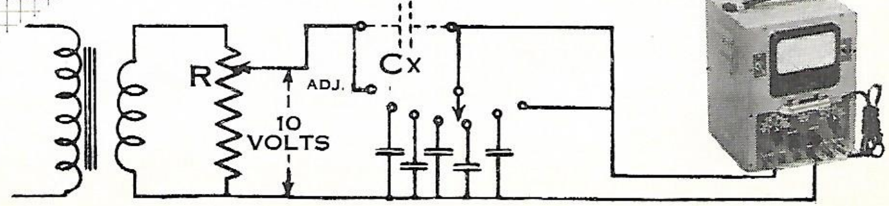
FIGURE 2



Servicing With A Modern Oscilloscope *(Cont'd)*

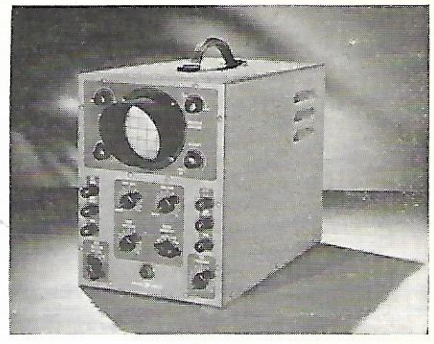
re-checked for final alignment. Decrease the output of the signal generator when necessary to maintain pattern height on the screen.

5. Set the signal generator to 1400 KC and connect the output through a 200 uuf condenser to the antenna terminal of the receiver. Tune the receiver dial to 1400 KC and adjust the shunt oscillator trimmer for maximum output on the screen.

6. (If the receiver has one or more RF stages, perform the following next. If not perform step 7.) With the receiver adjusted as in step 5, do not move the receiver dial but adjust the antenna trimmer (and any RF grid shunt trimmers in case of more than one RF stages) for maximum output as shown by maximum vertical deflection. At this point, the signal generator output may be so low as to give considerable noise indication on the screen. If so, reduce the setting of the volume control on the receiver, and increase the output of the signal generator.

7. Set the signal generator to 600 KC, leaving it connected to the antenna and ground terminals of the receiver. Tune the receiver to the signal generator frequency and adjust the series padder of the receiver oscillator for maximum output while rocking the receiver dial. Repeat the 600 KC and 1400 KC oscillator adjustments (steps 5 and 7) so that little or no change in either adjustment is needed when the other adjustment is made.

This completes the analysis of receiver alignment using an AM signal generator and the Oscilloscope. For the alignment of the IF and RF stages, a vacuum tube voltmeter such as the Sylvania Polymeter Type 134 would suffice as an output indicator.



Sylvania Type 131
A Typical Modern Oscilloscope

In the next article of this series, the procedure for aligning a FM receiver will be outlined. Since new FM broadcast stations are being put into operation weekly, and the number of receivers manufactured is rapidly increasing, we feel the FM alignment with an oscilloscope should be of considerable interest.

Measuring Capacitance With the Sylvania Polymeter *(Cont'd)*

direct wiring so as not to add too much wiring capacity. No twisted pair for this job.

To check higher values of capacitance the circuit of Figure 2 is used. In this the Polymeter is shunted by a known condenser and voltage readings obtained are transferred to capacitance values by use of curve "B". In this case the shunting condensers are so large in comparison with the possible variation in Polymeter capacitance that the accuracy obtainable is dependent only on the accuracy of the standard and the accuracy of reading the meter.

By using 5 standards which are simple multiples of 10 the range of measurement can readily cover the range of values used in service work. If these standards are built into a box with a selector switch an extra point on the switch can be used for reading the calibrating voltage and another to include the circuit of Figure 1. Table 1 shows the multiplying factors for the suggested values of standards.

EDITOR'S NOTE: This will be fine if paper or oil condensers are used, but we cannot recommend the use of electrolytic condensers for standards as we believe that they may soon require reforming if used on AC. We recommend instead the use of a 270 ohm resistor for the 10 mfd and 27 ohms for the 100 mfd range. This gives a different shape of curve which we have marked curve "C". However, electrolytic condensers can be measured quite satisfactorily.

SERVICE HINTS

RCA Model 110K—Oscillation and Tube Failures: This set has given me considerable trouble. A year ago I put in all new filters and four new 6K6G output tubes. The set oscillated and made an awful racket maybe once a day or it might be good for a week. Today it came in again with the 6K6G cathode resistor burned out, shorted 6K6G tubes and one side of the output transformer open. I installed new ones but the tone was not right and the current drawn by the output tubes was too high. I got suspicious of the two .007 mfd. condensers connected to the 6K6G plates and found them to be open. This proved to be the cause of all the trouble as these are to prevent the stage from oscillating. If the line voltage is low the set might perform OK but every once in a while it would act up and eventually something had to burn out.—P. J. Carrelle, Cliffside Park, New Jersey.

* * *

Zenith Models 6D413, 6D414, D426, 6D427, 6D446, 6D455, (Chassis 5660): The original tube complement included a type 12Q7-G. When replacing this tube with a metal 12Q7 or a metal-based 12Q7GT place some spaghetti insulation over the shielded control-grid lead. This will eliminate the probability of a short from the shield to the tube.

The reason for this precaution is that the shield over the grid lead connects to chassis and the tube is grounded through pin #1 to the AC line. The chassis is isolated from the AC line by Condenser C2 (0.1 mfd.) and Resistor R-12 (220 K) and a short between the shield and tube places the chassis at line potential as R-12 and C2 are shorted out.—Joseph S. Napora, Dayton 3, Ohio.

* * *

New Zenith Changer (Cobra Tone Arm): In this model the pick-up hops from groove to groove after playing about half-way through a record. This is caused by a small burr left on the corrugated piece of metal the arm plays across in rejection process. I smooth this off with a small flat file.—W. H. Colvin, Lancaster, Ohio.