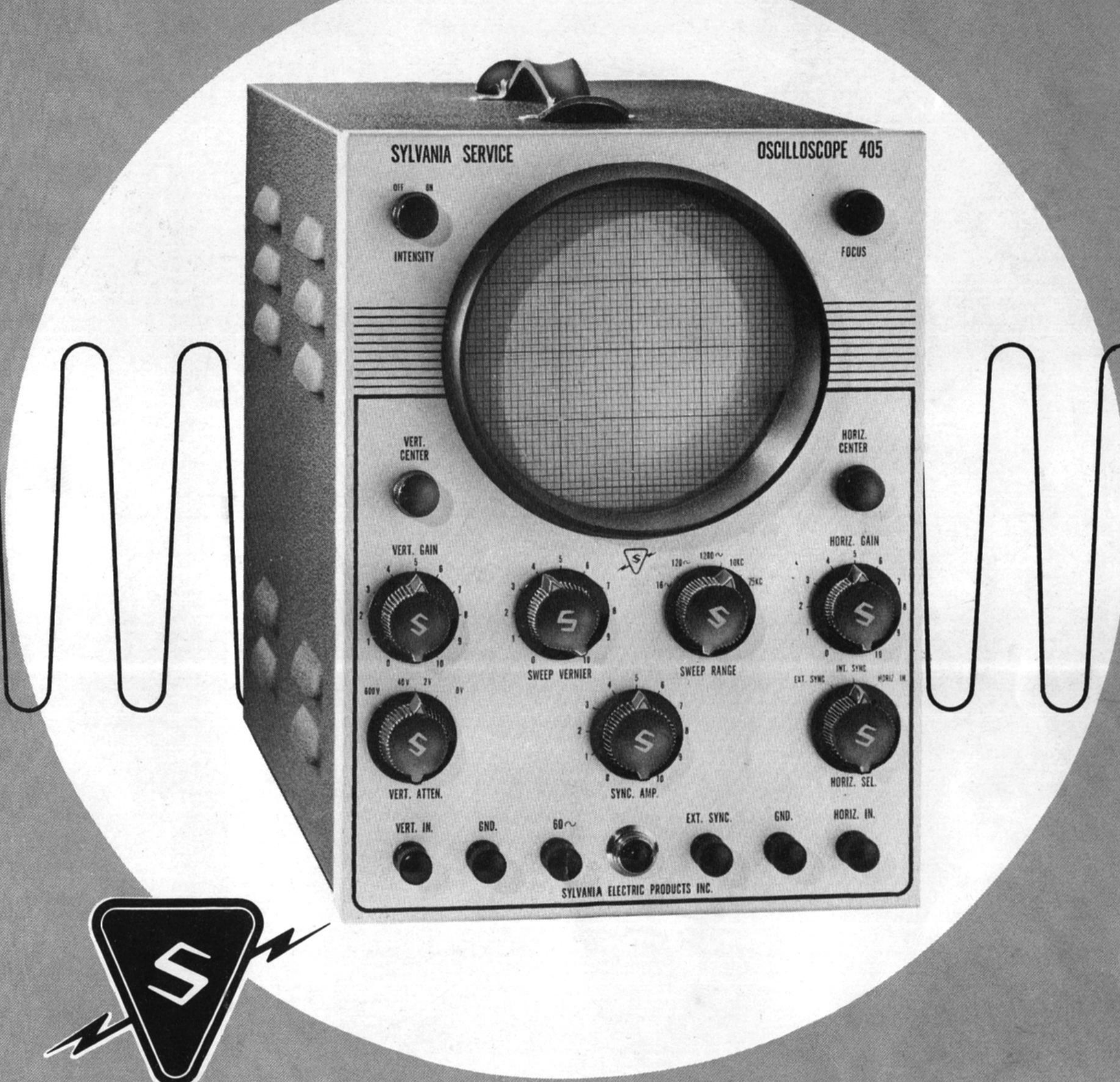

SYLVANIA
SERVICE OSCILLOSCOPE

TYPE 405

OPERATING MANUAL

SYLVANIA ELECTRIC PRODUCTS INC.

PRICE $1.00

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SYLVANIA SERVICE OSCILLOSCOPE TYPE 405

GENERAL DESCRIPTION

The Sylvania Service Oscilloscope Model 405 has been designed primarily for the radio and television servicemen's use in observation of waveforms and response curves in radio and television receivers and other general applications. It will also serve as a valuable instrument for laboratory and production work. The identical horizontal and vertical amplifiers are useful in comparing the phase angle of two signals. Its small size and light weight make it especially useful as a portable instrument. A multivibrator sweep circuit provides linear sawtooth sweeps from 16 cycles to 50 kc, usable to 75 kc, which may be synchronized internally or externally. The vertical amplifier has a sensitivity of 30 millivolts and a bandwidth to 2 cycles to 700 kc. A 60-cycle voltage is available on the front panel for voltage calibration.

SPECIFICATIONS

1. Power line requirements: 105 to 125 volts, 50 to 60 cycles. Uses 60 watts at 117 volts, 60 cycles.

2. Tube complement:
   One Sylvania Type 5UP1 - Cathode ray tube.
   One Sylvania Type 12AT7 - Cathode follower/vertical pre-amplifier.
   One Sylvania Type 12AT7 - Vertical amplifier.
   One Sylvania Type 12AT7 - Cathode follower/horizontal pre-amplifier.
   One Sylvania Type 12AT7 - Horizontal amplifier.
   One Sylvania Type 12AT7 - Sweep oscillator.
   One Sylvania Type 1V2 - High voltage rectifier.
   One Sylvania Type 6X4 - Low voltage rectifier.

3. Accelerating Potential: 1250 volts.

4. Input Impedances:

   A. Vertical amplifier: 2.2 megohms, 22 mmf.

   B. Horizontal amplifier: 2.2 megohms, 22 mmf.

5. Amplifier Frequency Response:

   A. Vertical: Sine wave 2 cycles to 700 kilocycles +0 -3 db.

   B. Horizontal: Sine wave 2 cycles to 700 kilocycles +0 -3 db.

6. Amplifier Sensitivity:

   A. Vertical: 30 millivolts (.030 volts) rms sine wave for one inch peak to peak deflection.

   B. Horizontal: 30 millivolts (.030 volts) rms sine wave for one inch peak to peak deflection.

7. Vertical Gain Controls:
   Compensated step attenuator and low impedance smooth attenuator.

8. Direction of Sweep: Left to right.

9. Deflection: Beam deflected to the **left** by a positive external signal to the HORIZ. IN. binding post. Beam deflected **up** by a positive signal to the VERT. IN. binding post.

10. Sweep Synchronization: Internal or external.

11. Maximum combined ac and dc signal voltage permissible at VERT. IN. binding post: 600 volts peak.

12. Maximum combined ac and dc signal voltage permissible at HORIZ. IN. binding post: 600 volts peak.

13. Sweep rate: 16 cycles to 75 kilocycles.

14. Output at 60~ binding post is 3.15 volts RMS.

15. Cabinet Size: 11 3/16" high, 8 3/8" wide, and 16 3/4" deep.

16. Weight: 20 pounds.

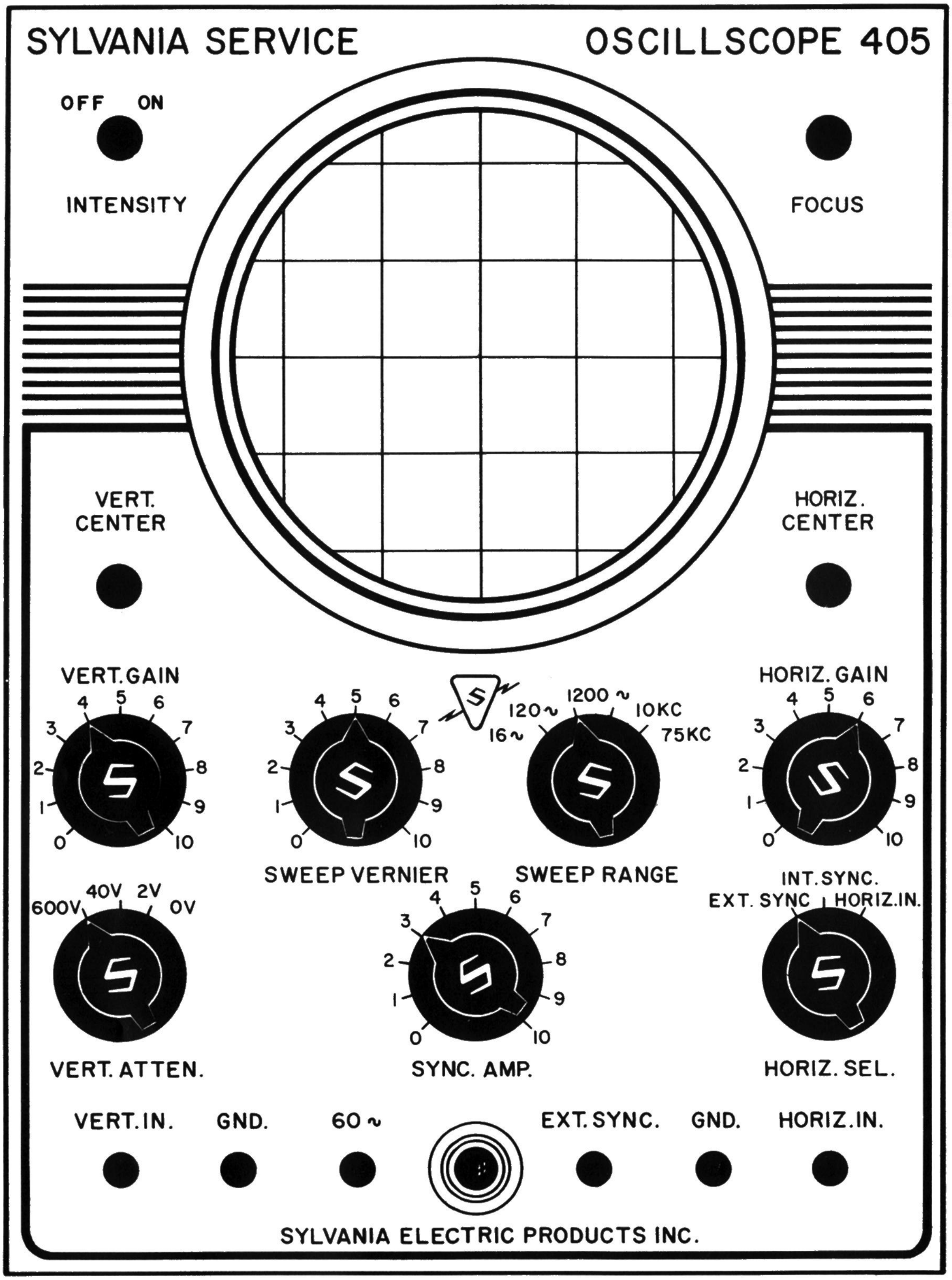


Fig. 1 — The front panel of the Type 405 Service Oscilloscope. The controls are located for most convenient operation.

OPERATING INSTRUCTIONS

NOTE: To obtain proper results with your oscilloscope, it is advisable to familiarize yourself with the panel controls by making some simple tests. These tests will assure you that your oscilloscope is in proper working condition.

1. **To Make Preliminary Tests of Control Function:**

A. Set the following controls to approximately **half scale**:

1. FOCUS
2. VERT. CENTER
3. HORIZ. CENTER
4. SWEEP VERNIER
5. SYNC. AMP.

B. Set VERT. GAIN and HORIZ. GAIN to full counterclockwise position.

C. Set VERT. ATTEN. to center position.

D. Set SWEEP RANGE to the line between 120~ and 1200~. This gives the SWEEP VERNIER control a range from 120 to 1200 cycles.

E. Set the SWEEP VERNIER to about center.

F. Set the HORIZ. SEL. to INT. SYNC.

G. Turn the instrument ON and gradually increase the INTENSITY control setting until a dot appears somewhere on the screen of the cathode ray tube. If the dot does not appear (after about half a minute warmup of the instrument) move the VERT. CENTER and HORIZ. CENTER controls slightly, as it may be off screen.

H. Adjust the VERT. CENTER and HORIZ. CENTER controls until the dot is in the exact center of the screen, and adjust the FOCUS control for sharpest image. Usually the finest focus is obtained at low intensity.

I. Now slowly increase the HORIZ. GAIN, and note that the dot will expand to a line across the face of the tube. This is the horizontal sweep, and the line will return to a dot if the HORIZ. SEL. is turned to HORIZ. IN. position. This is because in this position the internal sweep oscillator is turned off, and the horizontal amplifier is connected directly to the HORIZ. IN. binding post. Any signal applied to the HORIZ. IN. binding post will cause the line to lengthen horizontally in proportion to the peak value of the applied signal.

J. With the HORIZ. SEL. control still in the HORIZ. IN. position, apply the 60~ ac signal from the binding post on the front panel to the VERT. IN. binding post. Turn the HORIZ. GAIN control fully counterclockwise, and slowly increase the VERT. GAIN. The dot will now expand into a vertical line, which is the trace of the electron beam caused by the alternating voltage applied to the vertical deflecting plates of the cathode ray tube, through the vertical amplifier. The height of this line is proportional to the peak value of the voltage applied.

K. Turn the SWEEP RANGE control to the 16-120 cycle position and slowly increase the horizontal gain until the total trace width is about three or four inches. By careful adjustment of the SWEEP VERNIER, and the SYNC. AMP. controls a stationary sine wave pattern can be obtained, showing several cycles of the waveform of the 60 cycle signal applied to the vertical amplifier. It is the best procedure to adjust the SWEEP VERNIER with the SYNC. AMP. at full counterclockwise, until the pattern is as stationary as possible, then use only as much sync. signal as necessary.

L. Rotate the SWEEP VERNIER to obtain patterns containing up to 3 cycles of the sine wave. This indicates the manner in which a convenient number of cycles of the voltage under examination may be displayed.

2. **Summary of Control Functions:**

A. INTENSITY. Varies the brightness of the image, by changing the bias on the cathode ray tube.

B. FOCUS. Controls the width of the imageforming electron beam by varying the potential applied to the focusing electrode of the cathode ray tube.

C. VERT. CENTER. Moves the center line (zero voltage position) of the image up or down by applying fixed potential differences between the vertical deflecting plates.

D. HORIZ. CENTER. Moves the sweep center line (zero sweep position) to the left or right by applying fixed potential differences between the horizontal deflecting plates.

E. HORIZ. SEL. Allows the sweep to be synchronized by an external signal when in the EXT. SYNC. position, or by an internal signal from the vertical amplifier when in the INT. SYNC. position. When this switch is in the HORIZ. IN. position, the internal sweep multivibrator is inoperative and the beam is deflected horizontally by the signal on the HORIZ. IN. binding posts.

F. VERT. ATTENUATOR. Reduces the height of the vertical trace by attenuating the signal fed from the VERT. IN. terminal to the cathode follower. With the VERT. GAIN control set to full clockwise position, the 0-2 position applies full signal to the input cathode follower, the 2-40 applies 1/20th of the signal, etc. The VERT. GAIN control further reduces the pattern height as described in "G" below. The VERTICAL ATTENUATOR positions are marked in volts to make the proper setting simpler.

G. VERT. GAIN. Varies height of trace by changing the amount of signal fed to the vertical amplifier from the input cathode follower. Although the trace height can be made very small by rotating this control, it is still possible to overload the cathode follower, which is ahead. Therefore the VERT. ATTENUATOR should always be set at the maximum attenuation position consistent with desired trace height.

H. SYNC. AMP. Stabilizes the trace. Provides for application of a synchronizing voltage to the horizontal sweep oscillator.

I. HORIZ. GAIN. Expands the image in a horizontal direction by varying the output of the cathode follower. Note that this control does not vary the portion of the signal at the HORIZ. IN. terminal which is applied to the cathode follower. It is "wide open" all the time and can be overloaded regardless of the setting of the HORIZ. GAIN control. As a full five inches of horizontal deflection is obtained from about .15 volts input with full gain application of higher voltages is unnecessary.

J. SWEEP RANGE. Sets the frequency range on the horizontal sweep oscillator within which the SWEEP VERNIER operates. The top of the range is indicated by the number on the right side of the mark to which the SWEEP RANGE switch is set and the bottom of the range is indicated by the number to the left of the mark. For example, if it is set between the 16~ mark and the 120~ mark, the SWEEP VERNIER will vary the sweep rate between 16 cycles and 120 cycles.

K. SWEEP VERNIER. Varies smoothly the frequency of the sweep oscillator between the limits set by the position of the SWEEP RANGE control.

APPLICATIONS

Efficient application of the Type 405 Service Oscilloscope is dependent upon the user being acquainted with characteristics and limitations which are described below, Properly used, this instrument will be found to be highly effective in the study and servicing of all types of electrical and electronic equipment, including television and radio receivers, television and radio transmitters, amateur and police transmitters and receivers, and industrial and laboratory equipment.

1. **Line Voltage and Frequency.** The Sylvania Type 405 Service Oscilloscope is designed to operate on an a c power line with the nominal voltage of 117 volts and a frequency of 50 or 60 cycles. It will operate satisfactory on line voltages from 105 to 125 volts.

2. **Cathode Ray Tube Cushion and Graph Mask.** The cathode ray tube is protected by a rubber cushion which is constructed so

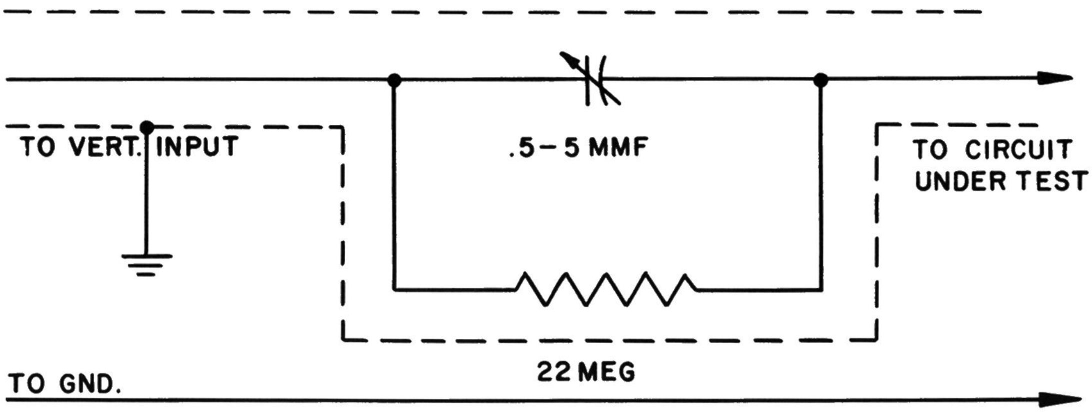


Fig. 2—Input lead termination recommended for accurate observation of pulses. The capacitance should be adjusted to be equal to about 10% of the combined capacitance of the lead and the input capacitance of the vertical amplifier.

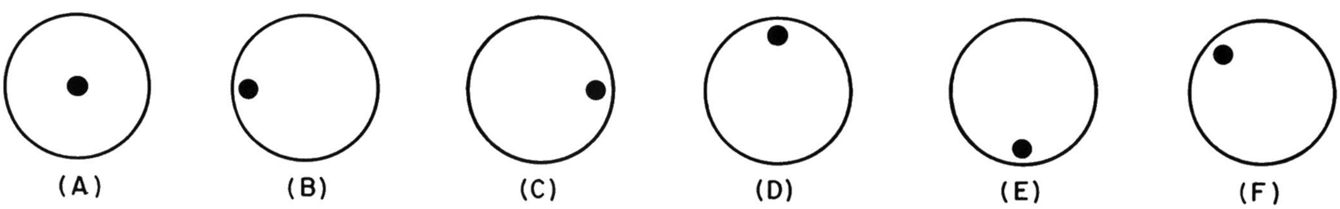


Fig. 3—Deflection of the cathode-ray beam caused by the application of d-c voltages directly to the deflection plates. The no-voltage position of the luminous spot is shown at (A). The deflections caused by voltages of opposite polarity on the horizontal plates are shown at (B) and (C), and for the vertical plates at (D) and (E). The effect of a d-c voltage on both sets of plates is shown at (F).

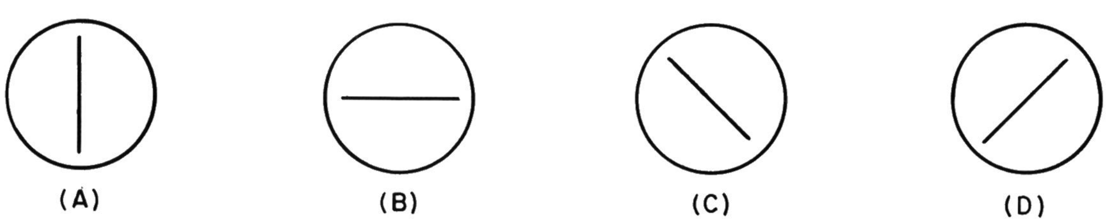


Fig. 4—A straight line pattern results as the cathode-ray beam swings back and forth under the influence of an a-c voltage. A vertical or horizontal line results when the voltage is applied to the vertical (A) or horizontal (B) deflection plates. A diagonal line results when an a-c voltage is applied to both vertical and horizontal plates, either in phase or 180° out of phase (C) or (D).

that a paper light shield may be used if desired. A plastic graph mask is placed in front of the tube to aid in measuring and comparing the voltages of waveforms displayed on the screen.

3. **Sensitivity.** The high maximum sensitivity of 30 millivolts rms per inch of deflection sometimes causes unwanted pickup from extraneous fields when a nonshielded high impedance lead is used with full gain setting. The vertical deflection amplifier has a maximum gain of approximately 550 and, therefore, the VERT. IN. or HORIZ. IN. terminals may pick up noticeable interference from stray a c fields in the vicinity of the instrument.

   In the accurate measurement of rapidly rising pulses, it is advisable to terminate the vertical input leads as shown in Fig. 2. This reduces the sensitivity of the oscilloscope by a factor of about 10 but it also reduces the capacitance in proportion.

4. **Horizontal Input Voltage.** The combined a c and d c voltage applied to the HORIZ. IN. terminals should not exceed 600 volts.

5. **Vertical Input Voltage.** The combined a c and d c voltage applied to the VERT. IN. terminals should not exceed 600 volts. With the step attenuator in the highest setting consistent with ample size of pattern high input voltages may be applied without overloading the amplifier. It is suggested that the VERT. GAIN control be set at about half scale and the VERT. ATTEN. control turned to obtain approximately the desired vertical deflection. The VERT. GAIN control can be used then to adjust the deflection to the desired amount. Care must be exercised not to cause distortion in the shape of the curve by overloading the oscilloscope amplifiers.

6. **Frequencies higher than 700 kc.** The response of the Sylvania Service Oscilloscope, Type 405 is approximately 6 db down at 1 megacycle, and 12 db at 1.5 megacycles.

7. **Voltage, Current and Frequency Measurement.**

   A. **Voltage Measurement.** The positions of the luminous dot shown in Fig. 3 indicate how the spot is deflected away from its at-rest center position to various locations on the screen by applying d c voltages directly to the deflecting plates. The patterns in Fig. 4 show the straight-line traces obtained when the spot swings rapidly back and forth under the influence of alternating voltages applied in various ways to the deflecting plates. These patterns are obtained with the horizontal linear sweep oscillator switched off. The electrostatic deflection cathode ray tube is a voltage-operated device, since deflection of its electron beam is accomplished by setting up potential differences on parallel plates, between which the beam passes. Both horizontal and vertical deflection are proportional to the instantaneous values of applied horizontal and vertical signal voltages. These voltage values may be determined by measuring the length of the traces they produce, providing the viewing screen is calibrated.

When an alternating voltage is applied to the vertical deflecting plates, the spot is shifted vertically up and down from the center of the screen by the positive and negative half-cycles, respectively. When the same value of alternating voltage is applied to the vertical plates and a linear sweep voltage is applied to the horizontal deflecting plates, the pattern on the screen takes the same shape as the voltage applied to the vertical plates when the sweep frequency is adjusted to an integral multiple of its frequency. This pattern is shown in Fig. 5. The trace shows not only positive and negative peak voltage values, but the waveform as well.

Additional information gained from a study of the pattern includes, (1) whether the positive and negative peaks are of the same amplitude, (2) whether the voltage is a true sine wave or whether it is distorted, and (3) whether the voltage under study has constant frequency.

Voltage relations of the sine wave traces are illustrated by Fig. 6. The height, measured from the center of the screen to the upper tip of the image, indicates the peak voltage of the positive half-cycle. This is the distance OA. Similarly, OB (the dis-

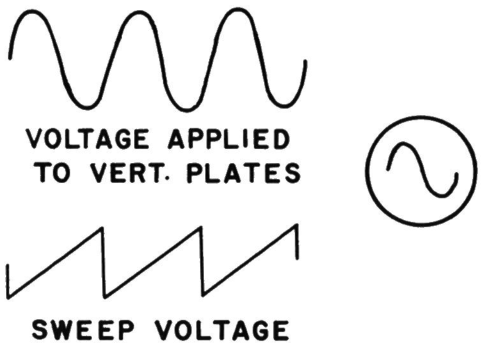


Fig. 5—The voltage waveform produced when the saw-tooth sweep voltage is applied to the horizontal plates, and an a-c voltage to the vertical plates.

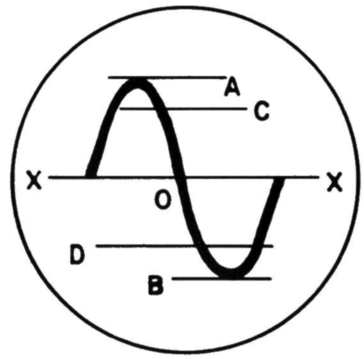


Fig. 6—Voltage relations of the sine wave. The zero base line is xx. The positive peak value is at A, the negative peak value at B, the rms value at C and the average value at D.

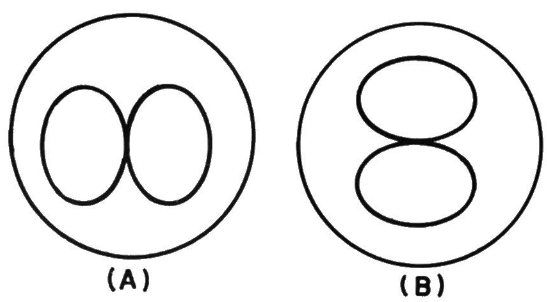


Fig. 7—Lissajous figure for a frequency ratio of 2 to 1. In (A) the higher frequency is applied to the vertical plates and in (B) to the horizontal plates.

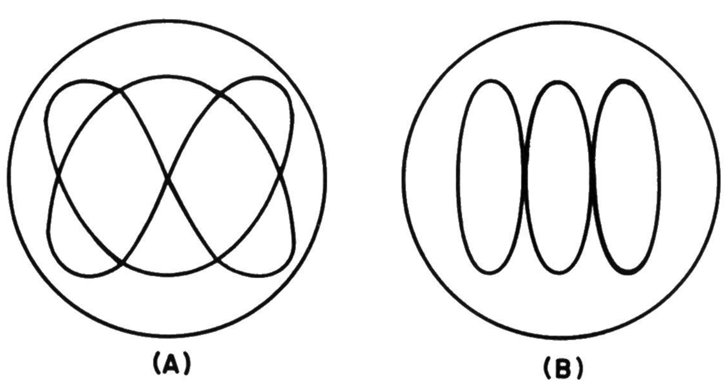


Fig. 8—Lissajous figures for the frequency ratios of 3 to 2 (A) and 3 to 1 (B).

tance measured down from center to the lower tip of the pattern) indicates the peak voltage of the negative half-cycle. For a sine wave, distance OC is 70.7% of the upper half, and, therefore, indicates the effective or rms voltage of the positive half-cycle, while distance OD is 70.7% of the lower half and indicates the rms voltage of the negative half-cycle. These points are sometimes referred to as "half-power" points. Distance AB, from one tip of the pattern to the other, indicates the peak-to-peak voltage. A point 63.6% of the highest peak above or below center would indicate the average voltage of the sine wave half-cycle.

B. **Current Measurement.** The current in any circuit may be observed by inserting a resistance of very low value in series with the circuit under test and connecting the VERT. IN. terminals across it. Because the voltage across a pure resistance and the current through it are exactly in phase with each other, the curve of voltage appearing on the screen of the oscilloscope represents a true curve of current through the resistance. The resistance must be as small as possible, so as not to interfere with the operation of the circuit, and yet give sufficient voltage drop to produce a convenient pattern size on the oscilloscope screen. If the voltage calibration of the oscilloscope and the value of the resistance both are known, the value of the current can be computed by use of Ohm's law.

C. **Frequency Measurements.** Frequency measurements are made by comparing any unknown frequency with any known frequency. If two sine waves of the same frequency are applied to the vertical and horizontal inputs of the oscilloscope, a straight line will appear on the screen if they are in phase or are 180° out of phase with each other, as shown in Figs. 4 (C) and (D).

If the two voltages are at different frequencies, a pattern known as a Lissajous Figure will be produced on the screen. For various ratios of the two frequencies definite patterns are produced. For a ratio of 2 to 1 the pattern is as shown in Fig. 7. The patterns for the ratios of 3 to 2 and 3 to 1 are shown in Figs. 8 (A) and (B). The formula for determining the frequency ratio from inspection of the pattern is based upon the number of times the curve of the pattern touches a hypothetical horizontal line at the bottom of the pattern and the number of times it touches another hypothetical vertical line at the one side of the pattern. The formula is shown below:

$$\frac{\text{Number of times the curve touches line at side of pattern}}{\text{Number of times the curve touches line at bottom of pattern}} = \frac{\text{Horizontal Frequency}}{\text{Vertical Frequency}}$$

This method is very useful for determining the frequency of an unknown signal when another signal, whose exact frequency is known, is available. Care must be exercised not to have an excessive number of points to count. It may be desirable sometimes to increase the frequency of the reference signal to reduce the number of points.

8. **Television Receiver Servicing.** The Sylvania Service Oscilloscope Type 405 is indispensable in the servicing of television receivers. It not only saves time, but it makes many service operations possible. It is very often used in conjunction with other test instruments such as sweep signal generators and marker generators.

The discussion given here of the applications of the Sylvania Service Oscilloscope Type 405 in the servicing of television receivers must necessarily be very general. Television circuits are complex in their design and operation, and there are many manufacturers in the field. While the basic design of all may be the same, the details of each receiver may be different and it is for this reason that the serviceman should refer to the manufacturer's service notes for detailed information and instructions for a particular receiver.

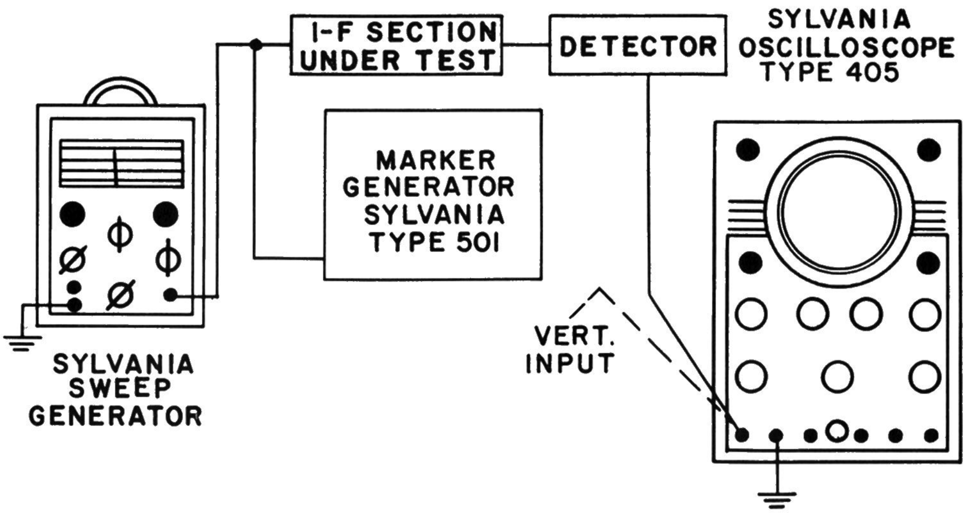


Fig. 9—Instrument connections for observing the response curve of a video i-f amplifier.

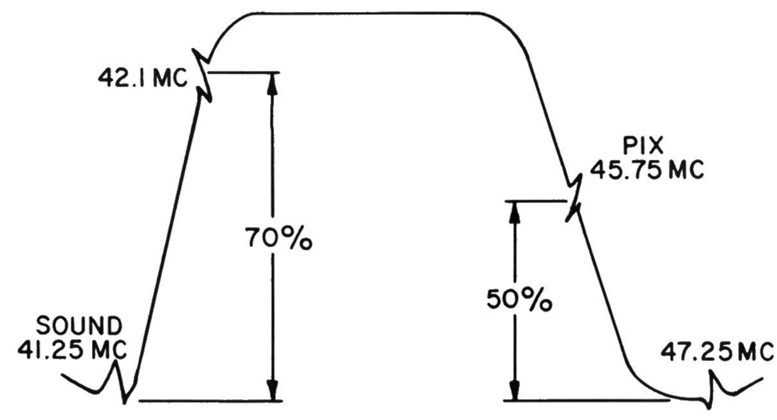


Fig. 10—Standard video i-f response curve produced by the instrument setup shown in Fig. 11.

A. **Video IF Stages.** The instruments required for the alignment of the video IF stages are an oscilloscope (Sylvania Type 405), sweep signal generator (Sylvania Type 500), and a marker generator or an accurately calibrated signal generator covering the video IF range, (Sylvania Type 501).

There are two main types of IF circuits to be discussed here. In the first, the sound portion of the signal is removed from the video portion just ahead of the IF stages, and in the second, known as the inter-carrier sound type, the sound is taken off after the video detector and video amplifier. The difference in the procedure for the different types of circuit will be pointed out.

To observe the IF response curve of a television receiver, an oscilloscope is connected to the video detector circuit as shown in Fig. 9 . The 60 cycle square wave response of the oscilloscope must be good, as in the Sylvania Type 405, to avoid distortion of the response curve.

The output of the sweep signal generator, set at about the center frequency given by the receiver manufacturer is first connected to the grid circuit of the last video IF stage. The signal sweep width should be set at approximately eight to ten megacycles to cover adequately the pass-band of the IF stage and the adjacent sound channel. The GND terminals of the Type 405 oscilloscope should be connected to the ground terminals of the sweep generator and the SWEEP RANGE control turned to the 16-120 cycle position.

The response curve of the video IF stage will now appear on the screen of the oscilloscope. It will be similar in shape to the curve shown in Fig. 10, for a pass-band IF amplifier. The oscilloscope controls should be set for a convenient pattern size and the phasing control of the oscilloscope adjusted to make the curve as close as possible to a single curve conformation. Due to the fact that both oscilloscope and signal generator sweep voltages are taken inductively from the ac line, it may sometimes be desirable to reverse the line-cord plug in **one** of the two instruments, to make the response curves come together.

In the stagger-tuned circuits the marker generator should be set to the frequency of the last stage in accordance with the manufacturer's service notes and the output lead loosely coupled to the same point in the receiver circuit where the sweep generator is connected. This will produce a "pip" in the response curve on the screen. If the pip does not appear where designated by the receiver manufacturer, the trimmer or tuning slug on the last IF stage should be adjusted until it does.

In the band-pass circuits, the marker generator should be set to the frequencies indicated by the receiver manufacturer, and the curve fitted to the correct marker pips by adjustments of the IF trimmers or tuning slugs, in accordance with the instructions in the service notes for the particular receiver under test.

The output signals from the sweep generator and the marker generator are now connected to the grid circuit of the preceding video IF stage and the procedure repeated, using the specified settings for the frequencies of both generators. The amplitude of the output signal of each generator should be adjusted to produce a good pattern on the screen. The adjustments just made on the previous stage should not be disturbed. This procedure should be repeated for each IF stage until the grid of the converter tube is reached. If the receiver had been badly out of alignment it may be advisable to repeat the entire procedure in the same order. Be sure also that the sound traps have been adjusted for minimum sound response at the video detector.

In receivers with inter-carrier sound the composite IF stages are broad enough to pass the entire television video and sound signal, although the sound carrier is considerably attenuated. The sound signal passes through the same amplifier circuits as the video signal, up to a point just before the picture tube. At this point, the sound signal appears as a frequency modulated beat between the video and the sound carriers. The sound signal is trapped off here and fed to the sound channel for further amplification. The alignment procedure is in general the same as described above. A noticeable marker pip should be obtainable for the sound carrier intermediate frequency and a strong one for the video intermediate frequency. Note that in the video IF stages the adjacent sound carrier would be **above** the video carrier in frequency, due to the inversion of the pattern in the converter stage.

B. **R F Stages.** The first step is to connect the oscilloscope to the output of the video detector, as was done for the alignment of video IF stages. The sweep signal generator is connected to the antenna terminals with its output frequency set approximately to the mid-point frequency of the channel to be aligned. Each channel is aligned individually. The output level of the sweep signal generator is set to produce a good response curve on the screen of the oscilloscope, but not high enough to overload the receiver circuits. Avoid "square-topping" caused by receiver or oscilloscope overloading.

The curve on the screen is a composite curve for the RF and IF stages, and it is important to have the IF stages correctly aligned before any judgment can be made of the RF stages. If the curve is degraded from the curve obtained for the IF stages, the RF tuning should be readjusted for the best shape. The check of RF alignment should be repeated for each of the channels.

To obtain the response curve of the RF stage alone, the oscilloscope may be connected through a demodulator probe to the grid circuit of the mixer stage, or directly across the lower half of the mixer grid resistor, if this resistance is in two sections. When the response curve is observed directly in the RF stage the video carrier frequency will be at the low frequency side of the curve and the sound carrier at the high frequency side. The service notes of the receiver manufacturer should be consulted for specific instructions for the correct procedure for obtaining the R F stage response curves.

The response curve of an amplifier stage should be of a smooth configuration through all of its bandwidths. If oscillation is present, the curve will lose the smooth outline and will become jagged because of the interference of the oscillating voltage. For the elimination of this condition the manufacturer's service notes should be consulted for specific instructions. However, the cause may be found to be in poor bypassing of the cathode, screen, or plates circuits, poor or no shielding, improper voltages, or poor grounding.

C. **Trouble Shooting by Waveform Analysis.** The Sylvania Type 405 Oscilloscope is very useful in the observation of the many voltage and current waveforms in the various portions of a television receiver circuit. At each point in the circuit there is a definite waveform required for good operation. With a knowledge of what these waveforms should be, and the proper use of the oscilloscope, much time can be saved in the servicing of television receivers.

The waveforms shown in the accompanying photographs were obtained with the VERT. IN. terminals of the oscilloscope connected to the receiver circuit as indicated for each photograph, and the horizontal sweep set to an appropriate frequency. They are typical of what can be produced on the screen of the Type 405 Oscilloscope. Proficiency in obtaining similar curves will develop rapidly with experience in the use of the oscilloscope in servicing television receivers.

For the video and horizontal deflection waveforms, the oscilloscope sweep frequency used is 7875 cycles and for the vertical deflection waveforms, the

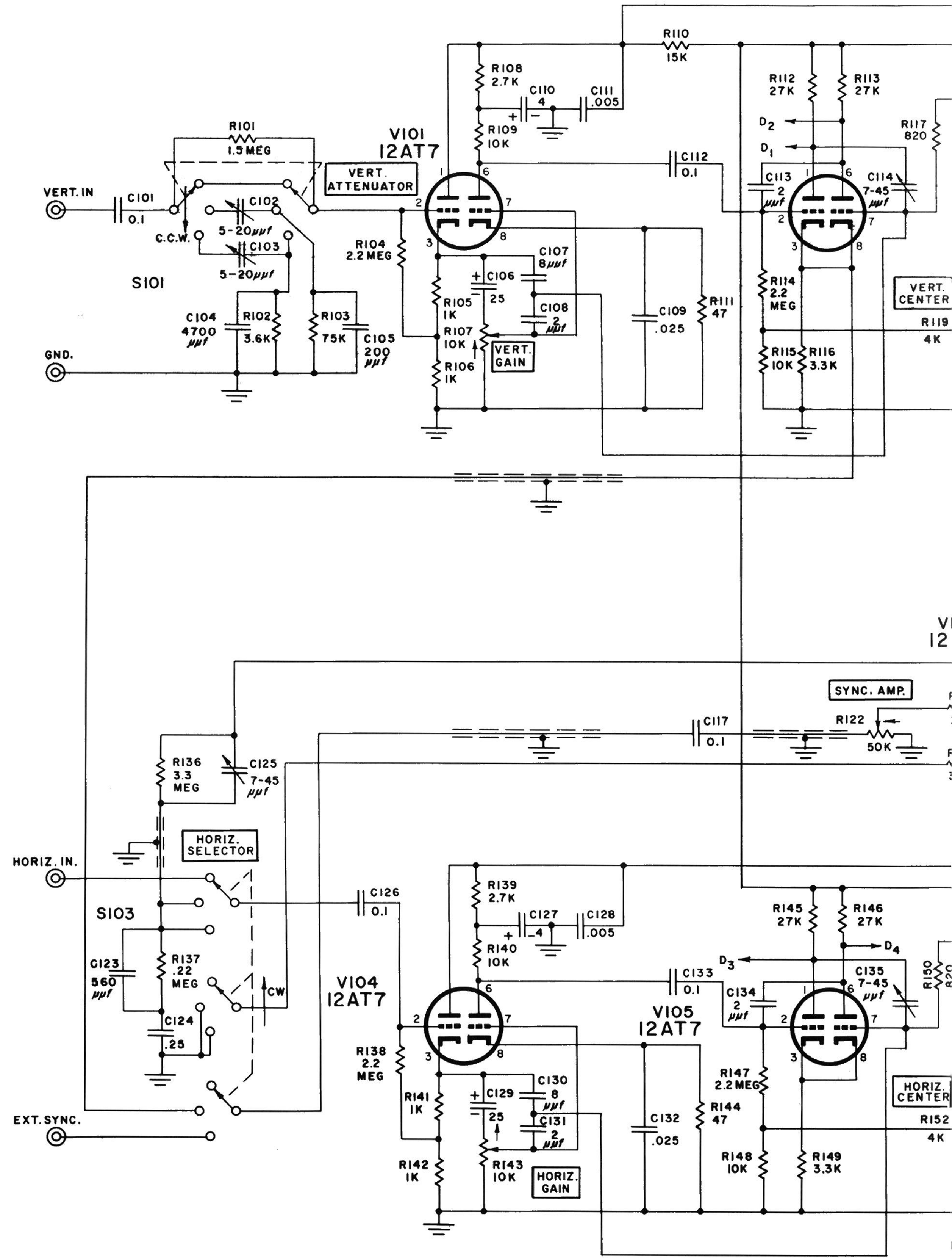
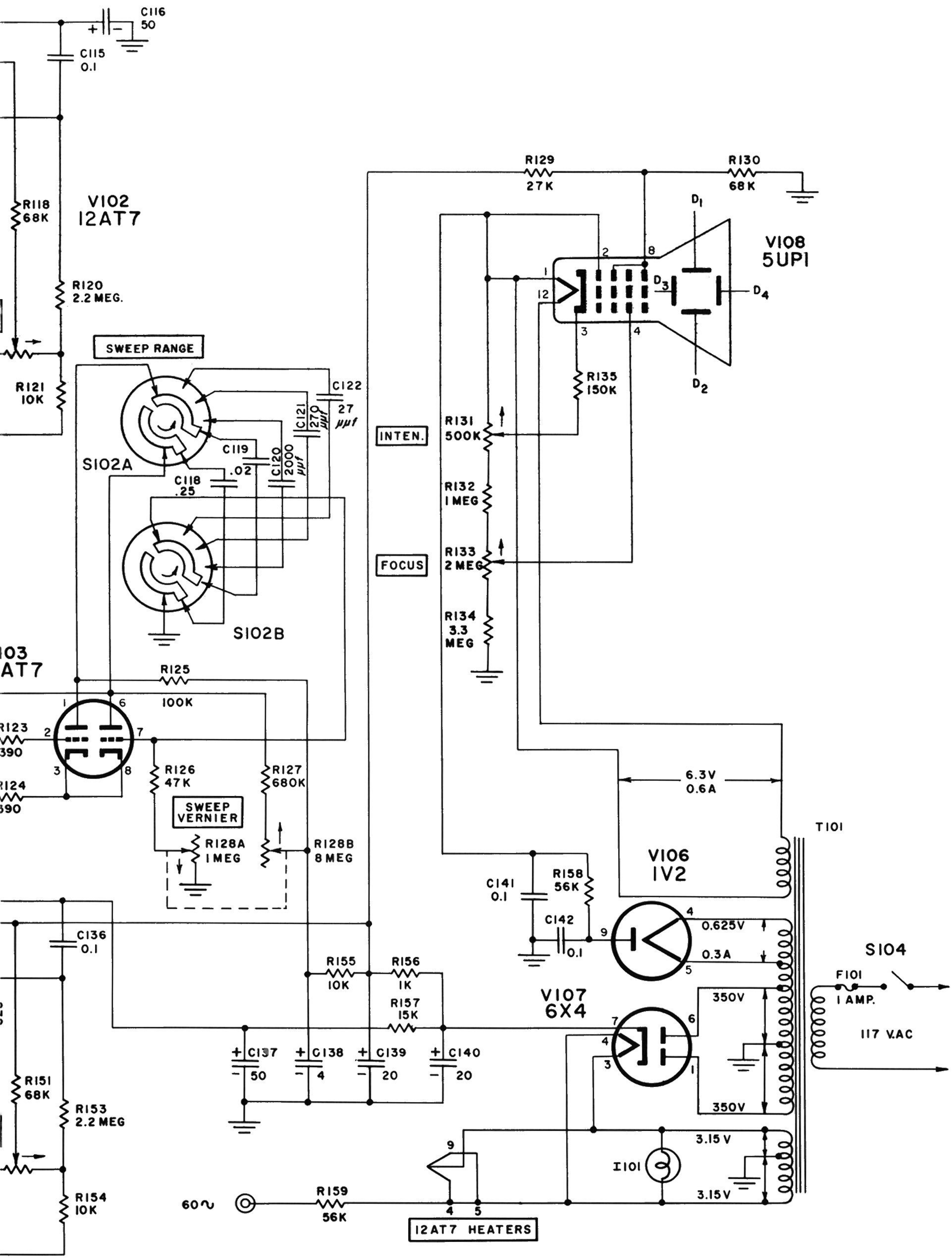


Fig. 11—Oscillos

CILLOSCOPE TYPE 405



NOTE: ALL RESISTOR VALUES IN OHMS AND ALL CAPACITOR VALUES IN MICROFARADS, UNLESS OTHERWISE SPECIFIED

scope Schematic

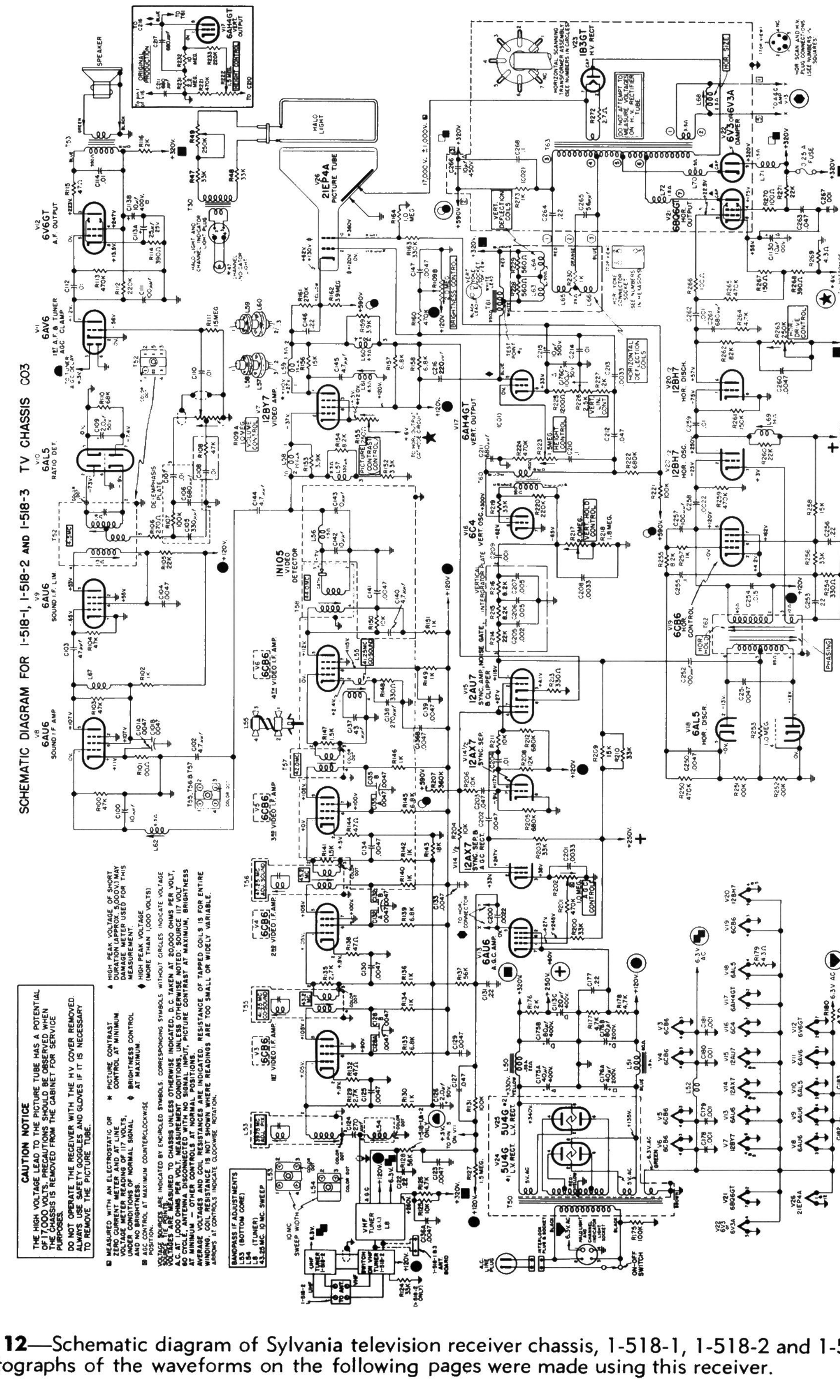
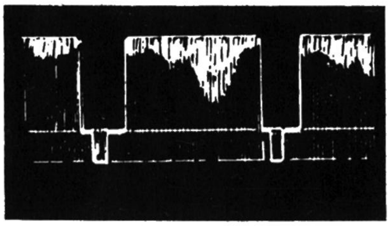
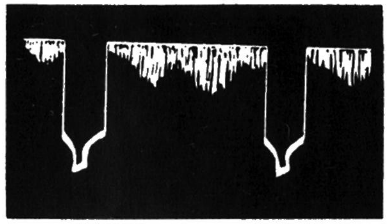


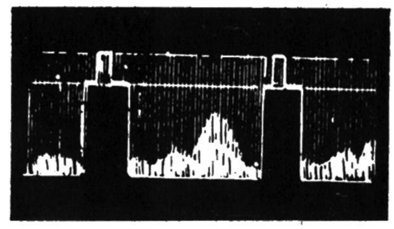
Fig. 12—Schematic diagram of Sylvania television receiver chassis, 1-518-1, 1-518-2 and 1-518-3. Photographs of the waveforms on the following pages were made using this receiver.



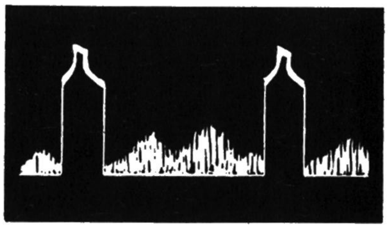
*12BY7 (V7) Video Amplifier Control Grid (Pin 2) 3.5 Volts (PP) Vertical.



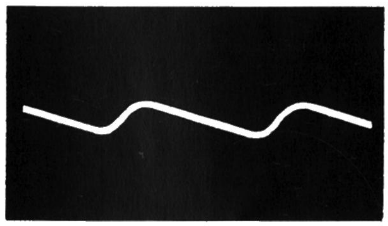
*12BY7 (V7) Video Amplifier Control Grid (Pin 2) 3.5 Volts (PP) Horizontal.



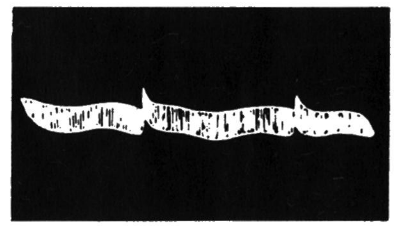
*12BY7 (V7) Video Amplifier Plate (Pin 7) 75 Volts (PP) Vertical



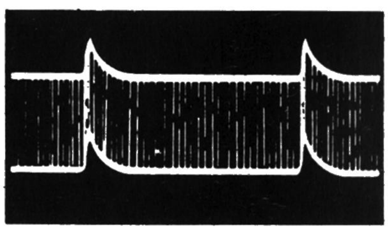
*12BY7 (V7) Video Amplifier Plate (Pin 7) 75 Volts (PP) Horizontal.



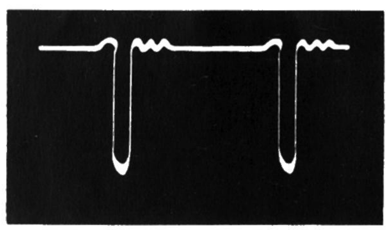
12AX7 (V14) Hor. Sync Separator and AGC Rectifier Cathode (Pin 3) 4.0 Volts (PP) Horizontal.



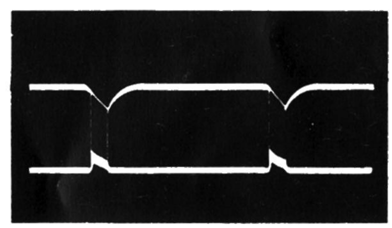
12AX7 (V14) Hor. Sync Separator and AGC Rectifier Cathode (Pin 3) 6 Volts (PP) Vertical.



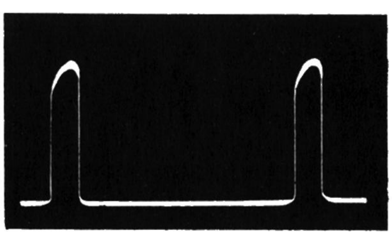
12AX7 (V14) Hor. Sync Separator and AGC Rectifier Plate (Pin 1) 45 Volts (PP) Vertical.



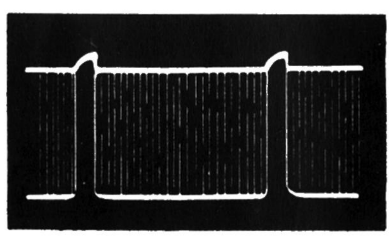
12AX7 (V14) Hor. Sync Separator and AGC Rectifier Plate (Pin 1) 45 Volts (PP) Horizontal.



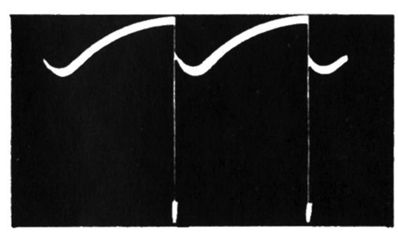
12AX7 (V14) Sync Separator Plate (Pin 6) 40 Volts (PP) Vertical.



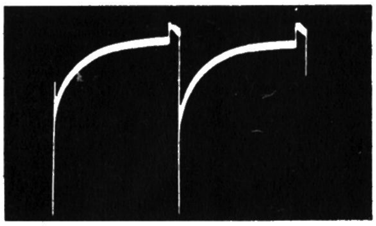
12AU7 (V15) Sync Amplifier and Clipper Plate (Pin 1) 80 Volts (PP) Horizontal.



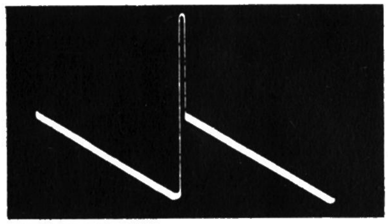
12AU7 (V15) Sync Amplifier and Clipper Plate (Pin 1) 90 Volts (PP) Vertical.



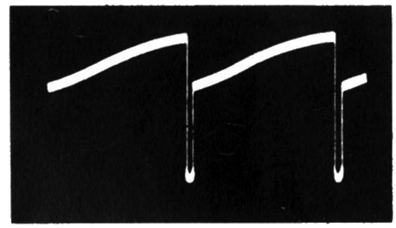
6C4 (V16) Vertical Oscillator Plate (Pin 1) 180 Volts (PP) Vertical.



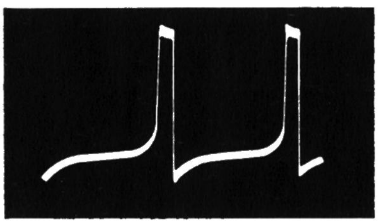
6C4 (V16) Vertical Oscillator Grid (Pin 6) 180 Volts (PP) Vertical.



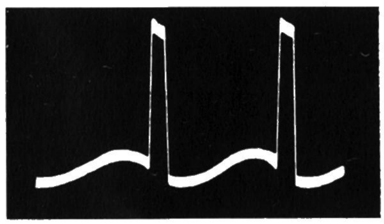
6AH4GT (V17) Vertical Output Plate (Pin 5) 700 Volts (PP) Vertical.



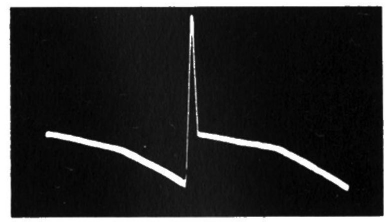
6AH4GT (V17) Vertical Output Grid (Pin 1) 85 Volts (PP) Vertical.



6AL5 (V18) Horizontal Discriminator Plate (Pin 2) 55 Volts (PP) Horizontal.

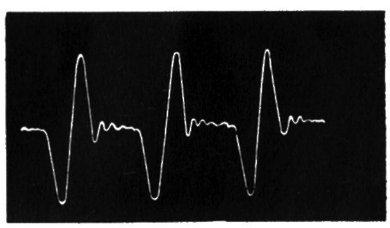


6AL5 (V18) Horizontal Discriminator Plate (Pin 7) 55 Volts (PP) Horizontal.

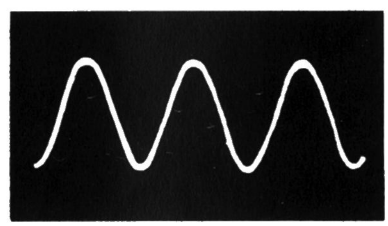


Vertical Deflection Coils (Test Point 1) 70 Volts (PP) Vertical.

12BH7 (V20) Horizontal Discharge Plate (Pin 6) 85 Volts (PP) Horizontal.



12BH7 (V20) Horizontal Oscillator Plate (Pin 1) 80 Volts (PP) Horizontal.



6CB6 (V19) Horizontal Control Plate (Pin 5) 70 Volts (PP) Horizontal.

Note 1: The terms "Horizontal", or "Vertical", refer to the oscilloscope sweep employed.

Note 2: All waveforms are taken with the oscilloscope horizontal sweep direction from left to right and with upward deflection corresponding to positive polarity.

Note 3: All waveforms are measured with respect to chassis unless otherwise indicated.

Note 4: Have Picture Contrast control at maximum.

sweep frequency is 30 cycles. By using these sweep frequencies, two cycles of the desired wave form are produced on the oscilloscope screen. The horizontal sweep direction is from left to right, and the vertical deflection corresponds to positive polarity. All waveforms are measured with respect to chassis unless otherwise specified. Any serious variation from the waveforms shown here indicates that some portion of the circuit is functioning improperly due to a defective or improperly adjusted component, or as a result of poor mechanical positioning of some component or lead wire. For exact information on a particular receiver, the manufacturer's service notes should be consulted.

9. **Radio Receiver Servicing:**

A. **AM Receivers.** Accurate alignment of AM receivers may be obtained by using the Type 405 Oscilloscope with the VERT. IN. connected to the voice coil of the loudspeaker. An amplitude modulated signal generator acts to feed a signal into the receiver and the normal procedure of aligning the IF and the RF stages is followed. The oscilloscope is used as a peak voltage indicator in this method because the horizontal deflection is not used. The pattern is a vertical straight line.

In the servicing of better quality receivers it may sometimes be desirable to examine the selectivity curves of the various stages. To do this, the VERT. IN. and GND terminals are connected across the detector load resistor and the output of a sweep signal generator is connected to the grid of the last IF tube. The frequency of the sweep generator output signal is set to the IF frequency and the sweep width set to a value wide enough to cover the audio band of the stage. For top grade receivers this would be of the order of 10 to 15 kc.

The selectivity curve will resemble one of the curves shown in Fig. 13 . The trimmers should be adjusted until the curve has the general appearance of Fig. 13 (A) which is neither too broad or too sharp.

The sweep generator lead is then moved to the grid of the previous IF tube and the process repeated with the oscilloscope still connected across the detector load resistor. The amplitude of the signal from the generator should be reduced to avoid overloading the stage. The procedure is repeated for each IF stage until the grid of the mixer tube is reached.

The next operation is to align the RF section. The frequency of the sweep signal generator and the receiver are both set to 1500 kc. and the trimmers on the RF and oscillator sections of the tuning condenser are adjusted until a selectivity curve similar to the curve of Fig. 13 (A) appears on the screen. The sweep generator and receiver are then set to 600 kc. and the padders of the tuning condenser are adjusted instead of the trimmers. The selectivity curves of the individual stages may be observed by using a detector probe connected to the VERT. IN. terminal of the oscilloscope. In this way the various stages can be aligned independently, which is sometimes very advantageous.

To insure a high-frequency pass band, it is necessary to obtain a curve (pattern) with a top as straight and horizontal as possible. The flat top must be obtained without causing too much loss of height, or producing top tilting such as is illustrated by the pattern in Fig. 13 (F).

In the alignment of a high-fidelity receiver, the oscilloscope is connected across the diode load resistor. However, when the receiver employs a power detector instead of the diode type, the VERT. IN. terminal of the oscilloscope must be connected to the plate end of the detector plate load resistor, and the GND terminal of the oscilloscope to chassis ground of the receiver, or to B-minus when the chassis is not at ground potential. The receiver manufacturer's service notes should be consulted for the

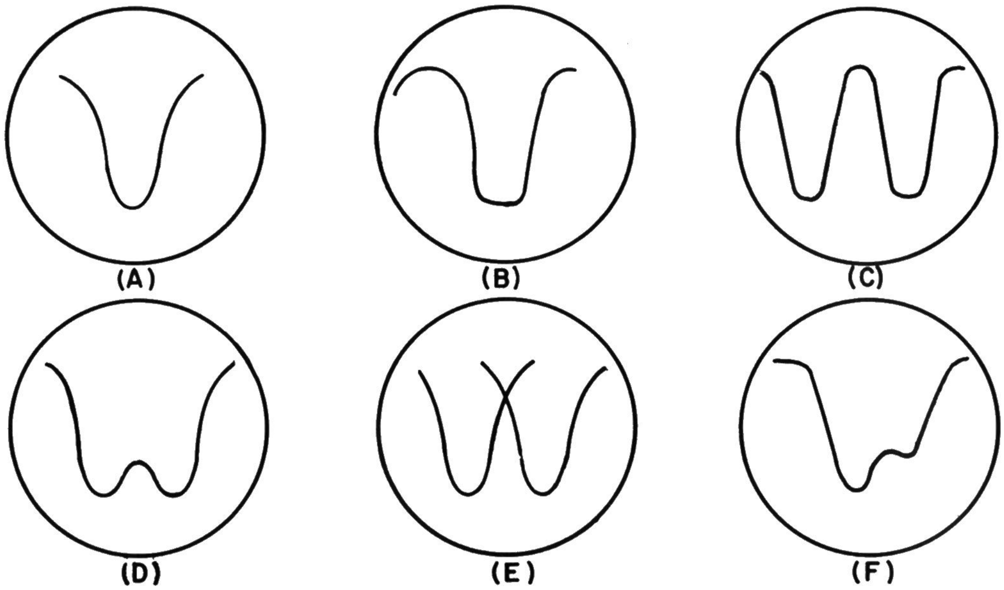


Fig. 13—Selectivity curve of i-f stages obtained using a sweep signal generator.

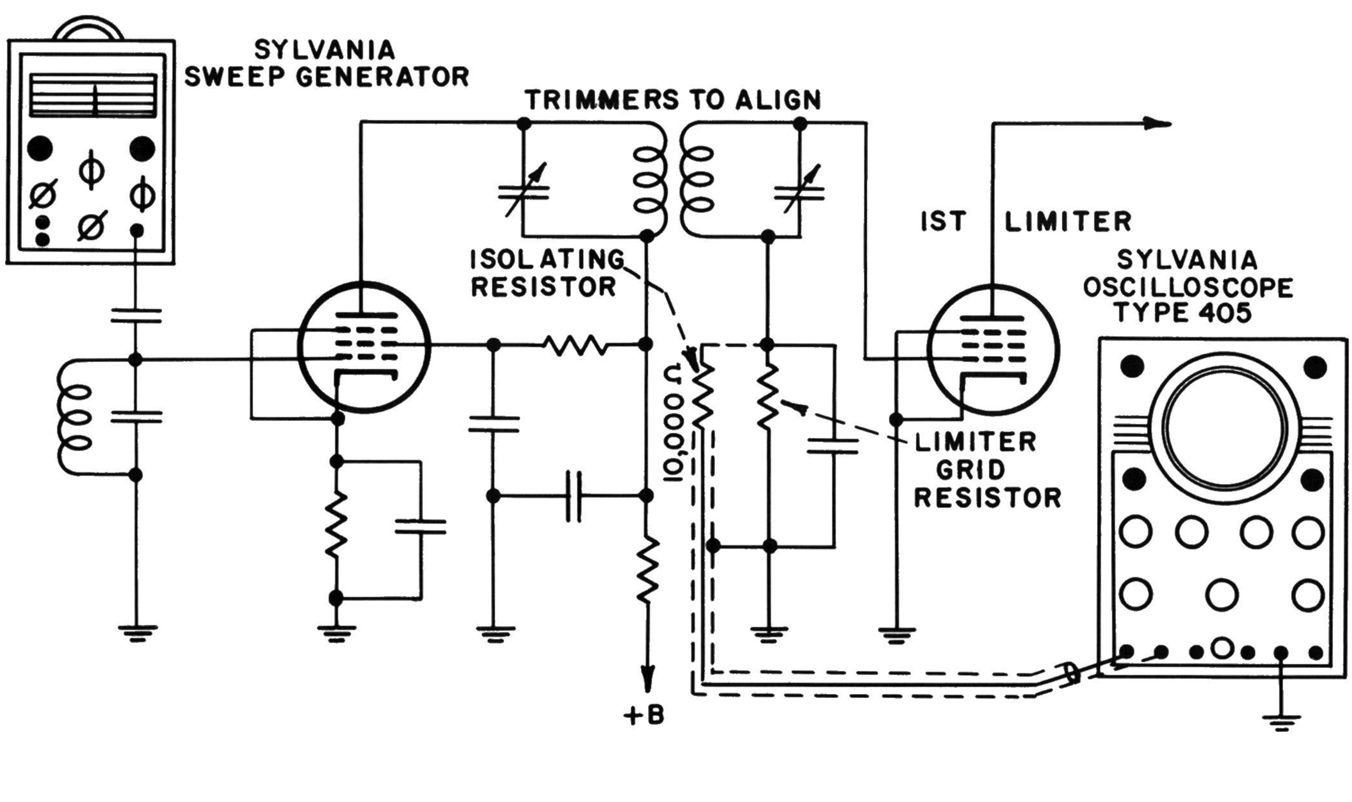


Fig. 14—Oscilloscope connections for i-f amplifier alignment in an f-m receiver.

correct value of bandwidth and for specific instructions on the alignment procedure.

B. **General Alignment Notes.** Many receivers use powdered-iron slugs for inductive tuning and trimming. Visual alignment of such receivers is done in the same way as outlined above, except that slugs instead of capacitors must be adjusted in the various stages. No special connections, not already covered, need be made.

In an all-wave receiver, alignment of the front end of set must be completed for each setting of the band switch. The generator must be set successively to frequencies near the top and bottom of each wave band, just as the frequencies of 1500 and 600 kc. were used for alignment of the broadcast range. Alignment of IF and 2nd detector stages need be performed only once.

Occasionally the connection of an oscilloscope to a radio receiver results in pickup of outside signals, noise, or hum voltage; or in internal regeneration or oscillation. Either of these conditions will cause modulation or distortion of the pattern on the screen. Usually a short, well-shielded lead to the vertical input terminals will correct the trouble. In stubborn cases, it may be necessary to include a 50,000 to 100,000 ohm series resistor in the vertical input lead as close as practicable to the point of contact in the receiver circuit.

C. **FM Receivers.** An FM receiver is very similar to, and often identical with, an AM superheterodyne receiver from the antenna and ground terminals through the IF amplifier. The audio stages are the same as in an AM receiver. The point of difference is that the AM receiver utilizes a second detector between the IF and the AF amplifiers, while the FM receiver uses a discriminator (often preceded by one or more limiter stages) in this same position. More recently-designed FM receivers employ a special type of discriminator, the ratio detector, which requires no limiter stage. Alignment of the FM receiver differs from AM alignment chiefly in the special adjustment of the discriminator or ratio detector.

D. **Discriminator-Type Receiver.** The IF circuits are aligned by connecting the VERT. IN. terminal to the high side of the first limiter grid resistor through a short shielded lead as shown in Fig. 14. An isolating resistor of approximately 100,000 ohms is sometimes used as the connection to the circuit. The output of a sweep signal generator is connected to the grid of the last IF tube. The frequency of the signal is the same as the intermediate frequency of the receiver and the frequency deviation is set to approximately plus and minus 150 kc. for a total sweep of 300 kc. The receiver manufacturer's service notes should be consulted for the exact value of intermediate frequency. The trimmers of the last IF stage should be adjusted to obtain a pattern similar to that of Fig. 13 (D). The bandwidth of the IF amplifier is somewhat broader than it would be in an AM receiver and, therefore, the sharp curve of Fig. 13 (A) will not be satisfactory.

The sweep generator output lead is next transferred to the grid of the next previous IF stage and the trimmers of this stage adjusted until the selectivity curve again matches the curve of Fig. 13 (D). The signal is fed to the grid of each IF stage until the grid of the converter stage is reached and the procedure repeated for each stage.

For discriminator alignment the VERT. IN. terminal of the oscilloscope is connected to the top of the discriminator load resistor through a shielded lead as shown in Fig. 15. The sweep generator output must remain connected to the signal grid of the converter tube. The sweep frequency of the generator is 60 cycles and the sweep frequency of the oscilloscope is set to 120 cycles. The pattern on the screen will then be similar to the

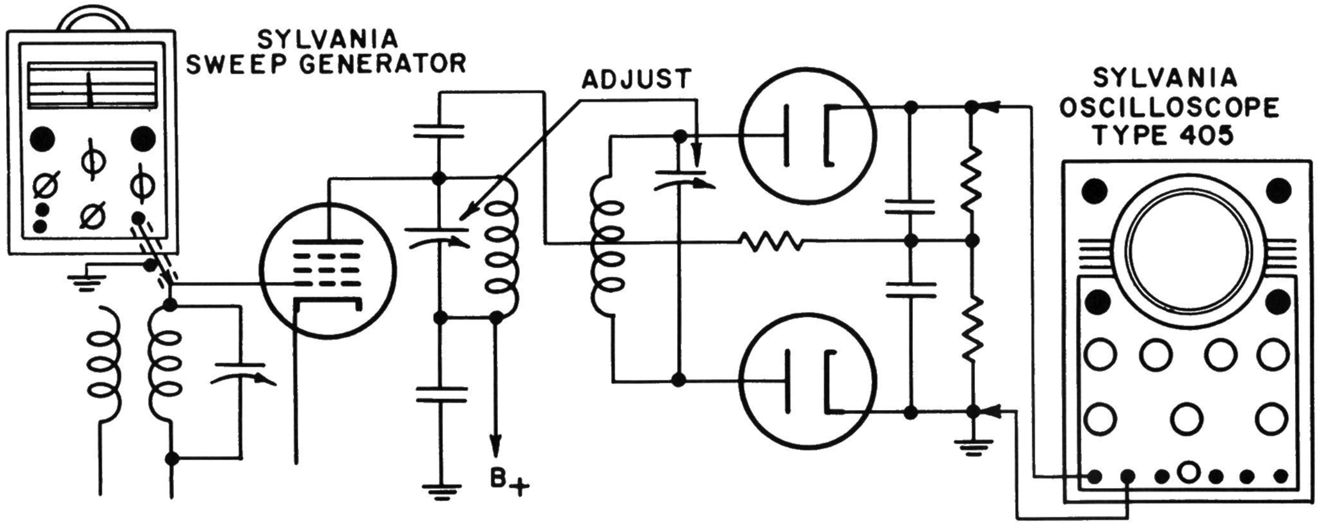


Fig. 15—Oscilloscope connections for discriminator alignment in an f-m receiver.

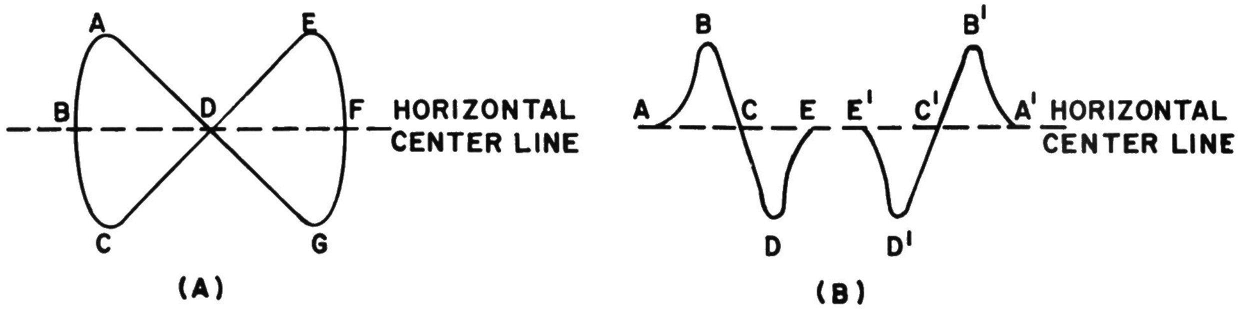


Fig. 16—Alignment pattern for discriminator or ratio detector. The frequency of the sync voltage is twice the sweep frequency of the f-m signal generator in (A) and equal to it in (B).

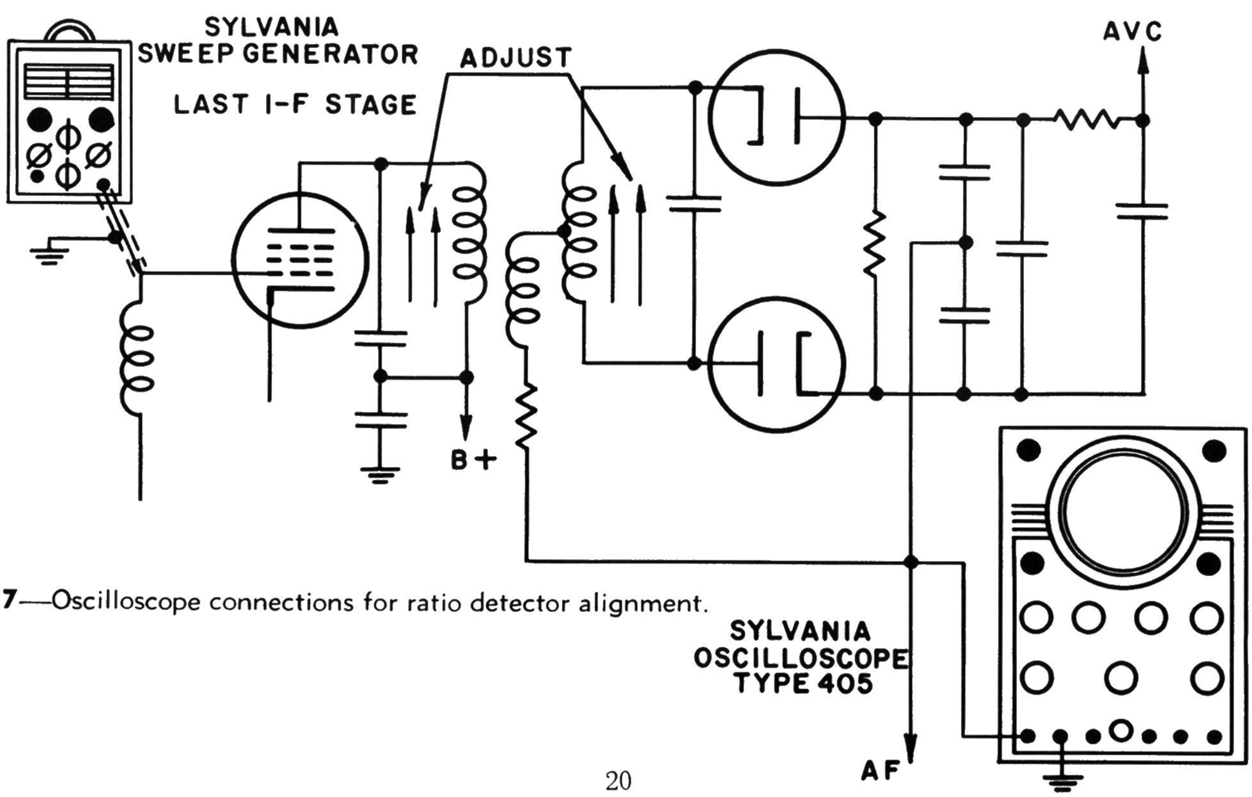


Fig. 17—Oscilloscope connections for ratio detector alignment.

curve shown in Fig. 16 (A). The trimmers of the discriminator transformer must be adjusted to bring points A and C, or E and G, equal distances from the horizontal center line (B or F). Also, the adjustments must be continued to bring B and F equal distances from D. Slant lines AG and CE will intersect, with point D resting on the horizontal line when alignment is correct. Adjustment of the primary trimmer of the discriminator transformer controls the distance of the points A, C, E, and G from the horizontal center line. Adjustment of the secondary trimmer controls the position of the cross-over point D with respect to the horizontal center line and spacing from points B and F.

If the oscilloscope is synchronized at 60 cycles and the signal generator sweep is 60 cycles, the dual pattern shown in Fig. 16 (B) will be produced on the screen during discriminator alignment. The discriminator transformer trimmers must be adjusted in this case to bring points B and D (or B' and D') equal distances from the horizontal centerline, and points A and E equal distances from C, (A' and E' equal distances from C').

E. **Ratio-Detector Type Receiver.** The IF amplifier of an FM receiver using a ratio detector is aligned in the same manner as a discriminator type receiver except that the VERT. IN. terminal of the oscilloscope is connected through a shielded lead to the high side of the detector load resistor as shown in Fig. 17. The IF amplifier up to and including the primary of the ratio detector transformer may be aligned with this connection.

The secondary of the ratio detector transformer is aligned by transferring the VERT. IN. shielded lead to a point B in Fig. 17. The same pattern as for the discriminator alignment, Fig. 16 (A), is obtained using double the sweep frequency of the signal generator. The detector trimmers are adjusted in the same manner as for discriminator alignment to obtain the proper symmetry of the pattern. For close alignment of both primary and secondary trimmers it is necessary to work back and forth with the VERT. IN. terminal connected successively to points A and B of Fig. 17.

Front End Alignment. The front end of an AM receiver (that is, the RF, converter, mixer, or first detector-oscillator section) resembles that of any other superheterodyne except that it is tuned to the band from 88 to 108 Mc. Alignment is the same as for AM front ends except for the operating frequency.

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PARTS LIST

Symbol	Description	Rating	Tol.	Part No.
		CAPACITORS		
C101	Fixed-Paper	.1mf., 600v	+20% −10%	4T-310460-5
C102	Variable-Ceramic	5-20mmf., 500v		4V-26184-2
C103	Variable-Ceramic	5-20mmf., 500v		4V-26184-2
C104	Fixed-Mica	4700mmf., 500v	±10%	4M-647210-301
C105	Fixed-Mica	200mmf., 500v	±10%	4M-620110-201
C106	Fixed-Electrolytic	25mf., 50v	+250% −10%	4D-2369-6
C107	Fixed-Ceramic	8mmf., 500v	±20%	4C-680031-216
C108	Fixed-Ceramic	2mmf., 500v	±10%	4C-520031-216
C109	Fixed-Paper	.025mf., 200v	±20%	4T-425320-5
C110	Fixed-Electrolytic	4mf., 450v	+50% −10%	4D-2369-10
C111	Fixed-Ceramic	5000mmf., 600v	±10%	4C-650231-216
C112	Fixed-Paper	.1mf., 400v	+20% −10%	4T-310470-5
C113	Fixed-Ceramic	2mmf., 500v	±10%	4C-520031-216
C114	Variable-Ceramic	7-45mmf., 500v		4V-1887-6
C115	Fixed-Paper	.1mf., 400v	+20% −10%	4T-310470-5
C116	Fixed-Electrolytic (Quad.)	50mf., 250v		4D-26388
C117	Fixed-Paper	.1mf., 400v	+20% −10%	4T-310470-5
C118	Fixed-Paper	.25mf., 400v	+20% −10%	4T-325440-5
C119	Fixed-Paper	.02mf., 400v	+20% −10%	4T-320340-5
C120	Fixed-Ceramic	2000mmf., 600v	±10%	4C-620231-616
C121	Fixed-Ceramic	270mmf., 500v	±20%	4C-627131-216
C122	Fixed-Ceramic	27mmf., 500v	±20%	4C-627031-216
C123	Fixed-Mica	560mmf., 500v	±10%	4M-656110-201
C124	Fixed-Paper	.25mf., 400v	+20% −10%	4T-325440-5
C125	Variable-Ceramic	7-45mmf., 500v		4V-1887-6
C126	Fixed-Paper	.1mf., 600v	+20% −10%	4T-310460-5
C127	Fixed-Electrolytic	4mf., 450v	+50% −10%	4D-2369-10
C128	Fixed-Ceramic	5000mmf., 600v	±10%	4C-650231-216
C129	Fixed-Electrolytic	25mf., 50v	+250%−10%	4D-2369-6
C130	Fixed-Ceramic	8mmf., 500v	±20%	4C-680031-216
C131	Fixed-Ceramic	2mmf., 500v	±10%	4C-520031-216
C132	Fixed-Paper	.025mf., 200v	±20%	4T-425320-5
C133	Fixed-Paper	.1mf., 400v	+20% −10%	4T-310470-5
C134	Fixed-Ceramic	2mmf., 500v	±10%	4C-520031-216
C135	Variable-Ceramic	7-45mmf., 500v		4V-1887-6
C136	Fixed-Paper	.1mf., 400v	+20% −10%	4T-310470-5
C137	Fixed-Electrolytic (Quad.)	50mf., 250v		4D-26388
C138	Fixed-Electrolytic	4mf., 450v	+50% −10%	4D-2369-10
C139	Fixed-Electrolytic (Quad.)	20mf., 450v		4D-26388
C140	Fixed-Electrolytic (Quad.)	20mf., 450v		4D-26388
C141	Fixed-Paper	.1mf., 2500v	+20% −10%	4T-310480-5
C142	Fixed-Paper	.1mf., 2500v	+20% −10%	4T-310480-5
		RESISTORS		
R101	Fixed-Comp.	1.5 meg., ½ W.	±5%	3C-415553-1
R102	Fixed-Comp.	3.6k., ½ W.	±5%	3C-436253-1
R103	Fixed-Comp.	75k., ½ W.	±5%	3C-475353-1
R104	Fixed-Comp.	2.2 meg., ½ W.	±10%	3C-422573-1
R105	Fixed-Comp.	1k., ½ W.	±10%	3C-410273-1
R106	Fixed-Comp.	1k., ½ W.	±10%	3C-410273-1
R107	Variable-Comp.	10k., ½ W.	±10%	3V-25675-5
R108	Fixed-Comp.	2.7k., ½ W.	±10%	3C-427273-1
R109	Fixed-Comp.	10k., ½ W.	±10%	3C-410373-1
R110	Fixed-W.W.	15k., 5 W.	±10%	3W-26401-2
R111	Fixed-Comp.	47 ohm, ½ W.	±10%	3C-447073-1
R112	Fixed-Comp.	27k., 2 W.	±10%	3C-727373-2
R113	Fixed-Comp.	27k., 2 W.	±10%	3C-727373-2
R114	Fixed-Comp.	2.2 meg., ½ W.	±10%	3C-422573-1
R115	Fixed-Comp.	10k., ½ W.	±10%	3C-410373-1
R116	Fixed-Comp.	3.3k., 1 W.	±10%	3C-633273-2
R117	Fixed-Comp.	820 ohm, ½ W.	±10%	3C-482173-1
R118	Fixed-Comp.	68k., 2 W.	±10%	3C-768373-2
R119	Variable-Comp.	4k., ½ W.	±20%	3V-18991-5
R120	Fixed-Comp.	2.2 meg., ½ W.	±10%	3C-422573-1
R121	Fixed-Comp.	10k., ½ W.	±10%	3C-410373-1
R122	Variable-Comp.	50k., ½ W.	±20%	3V-25765-4
R123	Fixed-Comp.	390 ohm, ½ W.	±10%	3C-439173-1
R124	Fixed-Comp.	390 ohm, ½ W.	±10%	3C-439173-1
R125	Fixed-Comp.	100k., ½ W.	±10%	3C-410473-1
R126	Fixed-Comp.	47k., ½ W.	±10%	3C-447373-1

PARTS LIST — Continued

Symbol	Description	Rating	Tol.	Part No.
R127	Fixed-Comp.	680k., ½ W.	±10%	3C-468473-1
R128A	Variable-Comp. (Dual)	1 meg., ½ W.	±10%	3V-26246-1
R128B	Variable-Comp. (Dual)	8 meg., ½ W.	±10%	3V-26246-1
R129	Fixed-Comp.	27k., 2 W.	±10%	3C-727373-2
R130	Fixed-Comp.	68k., 2 W.	±10%	3C-768373-2
R131	Variable-Comp.	500k., 1 W.	±20%	3V-26150
R132	Fixed-Comp.	1 meg., 1 W.	±10%	3C-610573-1
R133	Variable-Comp.	2 meg., 1 W.	±20%	3V-26151
R134	Fixed-Comp.	3.3 meg., 1 W.	±10%	3C-633573-2
R135	Fixed-Comp.	150k., ½ W.	±10%	3C-415473-1
R136	Fixed-Comp.	3.3 meg., ½ W.	±10%	3C-433573-1
R137	Fixed-Comp.	220k., ½ W.	±10%	3C-422473-1
R138	Fixed-Comp.	2.2 meg., ½ W.	±10%	3C-422573-1
R139	Fixed-Comp.	2.7k., ½ W.	±10%	3C-427273-1
R140	Fixed-Comp.	10k., ½ W.	±10%	3C-410373-1
R141	Fixed-Comp.	1k., ½ W.	±10%	3C-410273-1
R142	Fixed-Comp.	1k., ½ W.	±10%	3C-410273-1
R143	Variable-Comp.	10k., ½ W.	±10%	3V-25675-5
R144	Fixed-Comp.	47 ohm, ½ W.	±10%	3C-447073-1
R145	Fixed-Comp.	27k., 2 W.	±10%	3C-727373-2
R146	Fixed-Comp.	27k., 2 W.	±10%	3C-727373-2
R147	Fixed-Comp.	2.2 meg., ½ W.	±10%	3C-422573-1
R148	Fixed-Comp.	10k., ½ W.	±10%	3C-410373-1
R149	Fixed-Comp.	3.3k., 1 W.	±10%	3C-633273-2
R150	Fixed-Comp.	820 ohm, ½ W.	±10%	3C-482173-1
R151	Fixed-Comp.	68k., 2 W.	±10%	3C-768373-2
R152	Variable-Comp.	4k., ½ W.	±20%	3V-18991-5
R153	Fixed-Comp.	2.2 meg., ½ W.	±10%	3C-422573-1
R154	Fixed-Comp.	10k., ½ W.	±10%	3C-410373-1
R155	Fixed-Comp.	10k., ½ W.	±10%	3C-410373-1
R156	Fixed-W.W.	1k., 5 W.	±10%	3W-26401-1
R157	Fixed- W.W.	15k., 5 W.	±10%	3W-26401-2
R158	Fixed-Comp.	56k., ½ W.	±10%	3C-456373-1
R159	Fixed-Comp.	56k., ½ W.	±10%	3C-456373-1
	OTHER ITEMS			
	Cable Assembly-power			2A-25448-5
	Clamp-cable			7C-18118-3
	Clamp-handle			7C-13180
	Clip-tube contact			7C-18764
F101	Fuse	1 amp.		2F-24125-1
	Handle-leather			7H-26299
	Holder-fuse			7S-12669
	Holder-lamp			7S-25984
	Jewel-lamp			7Z-25983
	Knob-round			7K-26386
	Knob-small			7K-26274
I101	Lamp-incandescent	6-8 volt		6T-26290
	Mask-ruled			8N-26268
	Mounting-crt			8N-26140
	Post-binding			7Z-3057
	Shield-crt			7F-26272
	Socket-crt			7S-18718
	Socket-7 pin miniature			7S-26126
	Socket-9 pin miniature			7S-26127
S101	Switch-rotary (vert. atten.)			2R-26146
S102A	Switch-rotary (sweep range)			2R-26144
S102B	Switch-rotary (sweep range)			2R-26144
S103	Switch-rotary (horiz. selector)			2R-26145
S104	Switch-rotary (on-off)			3V-26150
T101	Transformer-power			5P-26148
V101	Tube-electron-12AT7			
V102	Tube-electron-12AT7			
V103	Tube-electron-12AT7			
V104	Tube-electron-12AT7			
V105	Tube-electron-12AT7			
V106	Tube-electron-1V2			
V107	Tube-electron-6X4			
V108	Tube-electron-5UP1			

APPENDIX

There are a number of books and other publications which may be found to be of value in understanding the operation of television circuits and the use of test equipment in servicing television receivers. The following is a list of books which are suggested for further study:

TV Patterns–
Sylvania Electric Products Inc., Emporium, Pa.

How to Service Radios with an Oscilloscope–
Sylvania Electric Products Inc., Emporium, Pa.

PhotoFact Television Course–
Howard W. Sams & Co., Indianapolis 5, Ind.

Practical Television Servicing–
By J. R. Johnson and J. H. Newitt.
Murray Hill Brooks, Inc., New York, N.Y.

Television–How It Works–
By John F. Rider.
John F. Rider, Publisher, New York, N.Y.

Television Simplified–
By Milton Kiver.
D. VanNostrand Co., New York, N.Y.

Television Servicing for Radiomen–
By H. P. Manly.
Frederick J. Drake Co., Wilmette, Ill.

The Video Handbook–
Boland & Boyce Inc., Publishers, Montclair, N.J.

Television for Radiomen–
By Edward M. Noll.
The Macmillan Co., New York 11, N.Y.

Basic Television–
By Bernard L. Grob.
McGraw-Hill Publishing Co., New York 18, N.Y.

Warranty

Sylvania Electric Products Inc., warrants each new Oscilloscope manufactured by it to be free from defective material and workmanship and agrees to remedy any such defect or to furnish a new part in exchange for any part of any unit of its manufacture which under normal installation, use and service discloses any defect, provided the unit is delivered by the owner to a Sylvania Authorized Service Station or to our authorized wholesaler from whom purchased, intact, for our examination, with all transportation prepaid, within 90 days from the date of the sale to original purchaser and provided examination discloses in our judgment that it is thus defective.

This warranty does not extend to any oscilloscope which has been subjected to misuse, neglect, accident, incorrect wiring not our own, improper installation or to use in violation of instructions furnished by us, nor to units which have been repaired or altered outside of our factory, nor to cases where the serial number thereof has been removed, defaced or changed, nor to accessories used therewith not of our own manufacture.

This warranty is in lieu of all other warranties expressed or implied and no representative or person is authorized to assume for us any other warranty liability.

This warranty is void unless warranty card included with instrument is filled out completely and mailed upon initial sale of the instrument by the distributor.

This warranty applies only in the United States and its possessions and the Dominion of Canada where Sylvania maintains service establishments. In other countries, write to the International Sales Division, Sylvania Electric Products Inc., 1740 Broadway, New York 19, New York, or the Local Sylvania Representative in your country.

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RADIO & TELEVISION DIVISION

1221 W. THIRD STREET

WILLIAMSPORT, PA.

Printed in U.S.A. PN-97