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.

SYLVANIA ELECTRIC PRODUCTS INC.

RADIO & TELEVISION DIVISION

1221 W. THIRD STREET

WILLIAMSPORT, PA.

Printed in U.S.A. PN 90

SYLVANIA TELEVISION SERVICE OSCILLOSCOPE

TYPE 403

OPERATING MANUAL

SYLVANIA ELECTRIC PRODUCTS INC.

PRICE $1.00

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GENERAL DESCRIPTION

The identical horizontal and vertical amplifiers provide extreme sensitivity (0.01 volts rms for 1 inch peak to peak deflection vertically and 0.02 volts rms for 1 inch peak to peak deflection horizontally). The use of push-pull DC coupled amplifiers results in excellent phase-time response characteristics and enables the true value of DC to be measured.

The hard-tube multivibrator sweep circuit provides linear sweeps from 5 cycles to 50kc in 4 ranges, with 2 preset television sweeps. Symmetrical and non-astigmatic sweep is assured by using DC coupled, balanced, push-pull deflection amplifiers.

Other features afforded by the 403 oscilloscope include: a frequency compensated attenuator to assure undistorted waveforms at any gain setting, high accelerating voltage in addition to a masked gun aperture type cathode ray tube, for a bright and well formed trace. Retrace blanking is effective at all sweep frequencies to provide an undistorted display. A 6 volt rms calibrating and a sawtooth sweep voltage are available on the front panel for service convenience. The large 7 inch cathode ray tube is protected by a heavy plastic, low-parallax cross-lined screen and an exclusive impact-resistant rubber mounting.

SPECIFICATIONS

1. Power line requirements: 105 to 125 volts, 50 to 60 cycles. Uses 100 watts at 117 volts, 60 cycles.

2. Tube Complement:

   One Sylvania Type 7VP1—Cathode ray tube.

   Four Sylvania Type 6BH6—Vertical amplifiers in push-pull, horizontal amplifiers in push-pull.

   Two Sylvania Type 12AU7—Second push-pull stage vertical, second push-pull stage horizontal.

   Two Sylvania Type 12BH7—Vertical deflection output, horizontal deflection output.

   One Sylvania Type 12AV7—Sweep oscillator.

   One Sylvania Type 6C4—Sync. amplifier.

   One Sylvania Type 1V2—High voltage rectifier.

   Two Sylvania Type 6X4—Low Voltage rectifier.

   Two Sylvania Type IN34A—Sync. limiters.

3. Accelerating Potential: 1280 volts.

4. Input Impedances:

   A. Vertical amplifier: 1 megohm, 26 mmf.

   B. Horizontal amplifier: 1 megohm, 53 mmf.

5. Amplifier Frequency Response:

   A. Vertical: Sine wave 0 to 500kc, within +0-2db. Square waves of any frequency between 10 cycles and 30 kilocycles will be reproduced accurately with negligible phase shift or overshoot.

   B. Horizontal: Sine wave 0 cycles to 500kc, within +0-2db. Square waves of any frequency between 10 cycles and 30 kilocycles will be reproduced accurately with negligible phase shift or overshoot.

6. Amplifier Sensitivity:

   A. Vertical: Ten millivolts (.010 volts) rms sine wave for one inch peak-to-peak deflection.

   B. Horizontal: Twenty millivolts (.020 volts) rms sine wave for one inch peak-to-peak deflection.

7. Vertical Gain Controls:
   Compensated decimal step attenuator and low impedance 10:1 smooth attenuator; maximum attenuation, 10,000:1.

8. Direction of Sweep: Left to right.

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

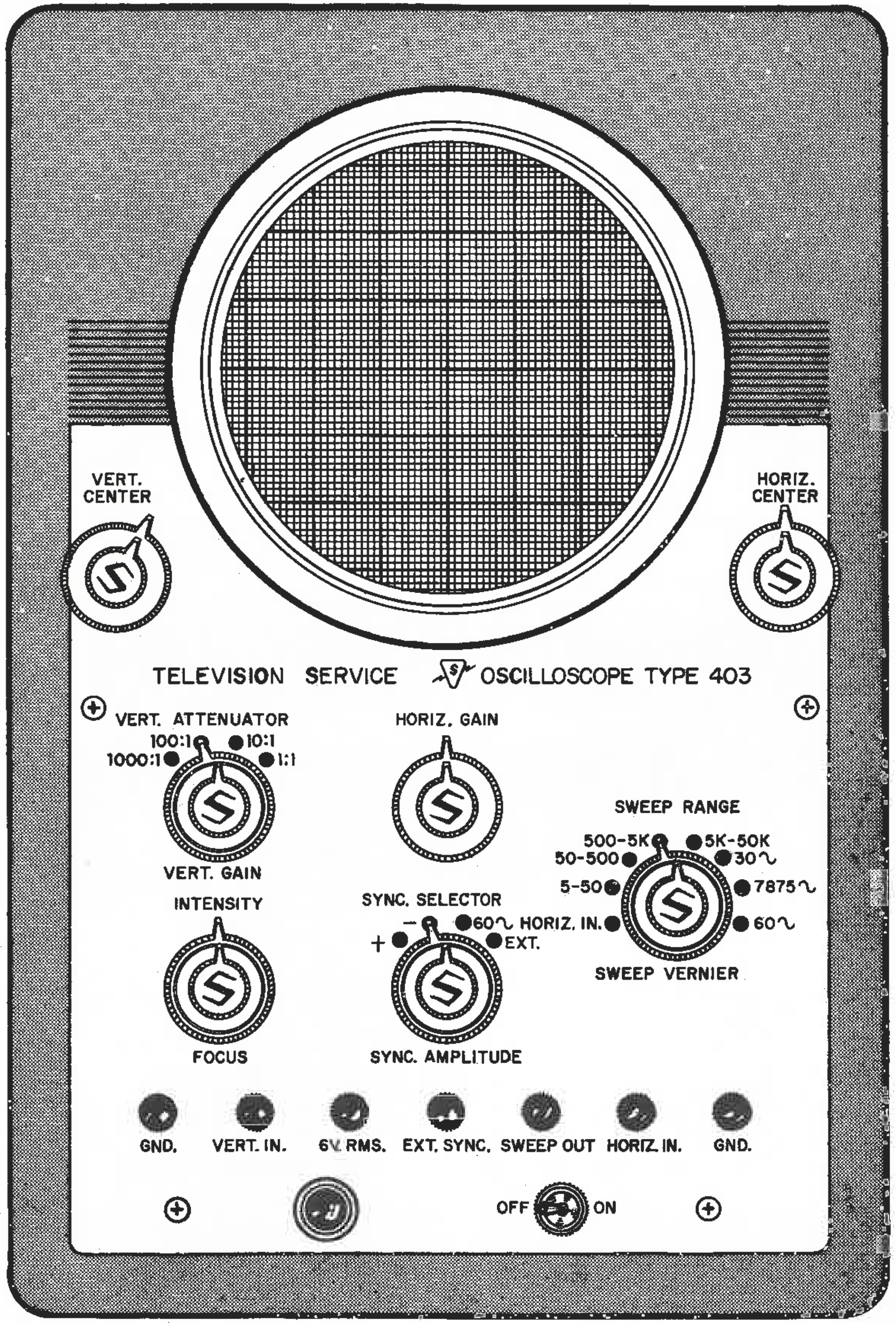


Fig. 1—The front panel of the Type 403 Television Service Oscilloscope. The controls are located for convenient operation.

10. Sweep Synchronization: Phase inverter type. Variable in amplitude and polarity.
11. Maximum combined ac and dc signal voltage permissible at VERT. IN. terminal: 600 volts peak.
12. Maximum combined ac and dc signal voltage permissible at HORIZ. IN. terminal: 600 volts peak.
13. Sweep rate: 5 cycles to 50 kilocycles.
14. Cabinet Size: 17$\frac{1}{16}$" high, 11$\frac{3}{8}$" wide, and 19$\frac{1}{2}$" deep.
15. Weight: 43 pounds.

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. AMPLITUDE

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

C. Set VERT. ATTENUATOR to 100:1.

D. Set SWEEP RANGE to 50-500 position. This gives the SWEEP VERNIER control a range from 50-500 cycles.

E. Set the SWEEP VERNIER to about center.

F. Set the SYNC. SELECTOR to +.

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 warm-up 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 SWEEP RANGE 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-to-peak value of the applied signal.

J. With the SWEEP RANGE, control still in the HORIZ. IN. position, apply a 6 volt ac signal to the VERT. IN. terminals (it can be taken from the 6v rms binding post.) Turn the HORIZ. GAIN control fully counter-clockwise, 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 to peak value of the voltage applied.

K. Return the SWEEP RANGE control to the 50-500 position, and slowly increase the horizontal gain, until the total trace width is about four or five inches. By careful adjustment of the SWEEP VERNIER, and the SYNC. AMPLITUDE control, a stationary sine wave pattern can be obtained, showing the wave form of the 6 volt signal applied to the vertical amplifier. It is the best procedure to adjust the SWEEP VERNIER with the SYNC. AMPLITUDE at full counter clockwise, until the pattern is as stationary as possible, then use only as much sync. signal as necessary. The SYNC. AMPLITUDE control operates in a phase-inverter circuit, so that signals of either positive or negative polarity may be used to synchronize the internal sweep oscillator.

L. Rotate the SWEEP VERNIER to obtain patterns containing up to 5 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 image-forming 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. SYNC. SELECTOR. Provides for synchronization of the sweep oscillator with either an external signal (EXT. position); with a sixty cycle sine wave signal provided internally or with the signal applied to the VERT. IN. connector (+ or — position).

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

G. VERT. GAIN. Varies height of trace by changing the plate load on the first push-pull stage. Although the trace height can be made very small by rotating this control, it is still possible to overload this stage. Therefore the VERT. ATTENUATOR should always be set at the maximum attenuation position consistent with desired trace height.

H. SYNC. AMPLITUDE. 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 plate load of the first push-pull stage. Note that this control does not vary the portion of the signal at the HORIZ. IN. terminal which is applied to the first stage. As full horizontal deflection (twice screen diameter) is obtained from about ¼ volts input, application of higher voltages is unnecessary.

J. VERT. ATTENUATOR. Reduces the height of the vertical trace by attenuating the signal fed from the VERT. IN. terminal to the first push-pull stage. With the VERT. GAIN control set to full clockwise position, the 1:1 position applies full signal to the first push-pull stage the 10:1 applies 1/10th of the signal, etc. The VERT. GAIN control further reduces the pattern height as described in "G".

K. SWEEP RANGE. Sets the frequency range of the horizontal sweep oscillator to operate within the limits marked on each range setting. For example, if the SWEEP RANGE switch is set at the 50-500 position, the SWEEP VERNIER will vary the sweep repetition rate between 50 cycles and 500 cycles.

1. There are four special positions on this switch. The HORIZ. IN. position turns off the sweep oscillator and connects the horizontal amplifier direct to the HORIZ. IN. binding post. The 60 cycle position turns off the sweep oscillator, and applies a 60 cycle sine wave voltage to the horizontal amplifier. The 7875 position provides two cycles of a waveform that is at the horizontal sweep frequency of a television receiver. The 30 position provides two cycles of a waveform that is at the vertical sweep frequency of a television receiver.

APPLICATIONS

Efficient application of the Type 403 Television 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 403 Television 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 satisfactorily on line voltages from 105 to 125 volts.

2. **Safety Shield and Graph Mask.** The face of the 7-inch cathode ray tube is protected by a plastic shield one-eighth of an inch thick. A graph mask is placed on the inside surface to mini-

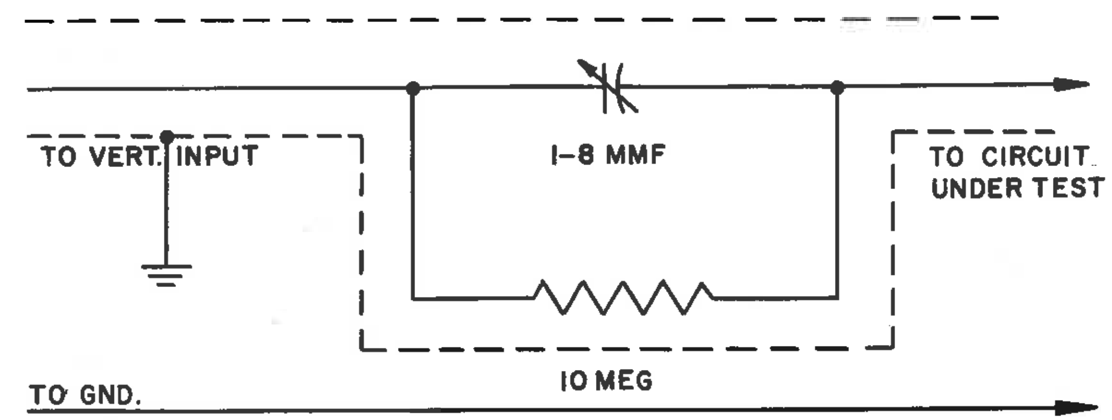


Fig. 2—Input lead termination recommended for accurate observation of pulses. The capacitance should be adjusted to be equal to about 10% of the combined capacitance of the lead and the input capacitance of the vertical amplifier.

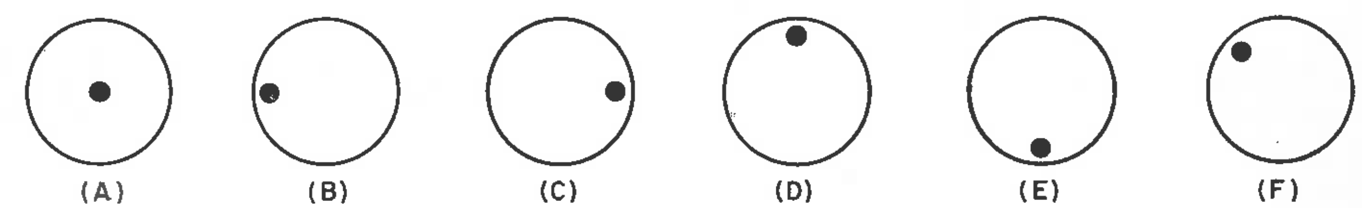


Fig. 3—Deflection of the cathode-ray beam caused by the application of dc voltages to the input terminals. The no-voltage position of the luminous spot is shown at (A). The deflections caused by voltages of oposite polarity on the horizontal input are shown at (B) and (C), and for the vertical input at (D) and (E). The effect of a dc voltage on both inputs is shown at (F).

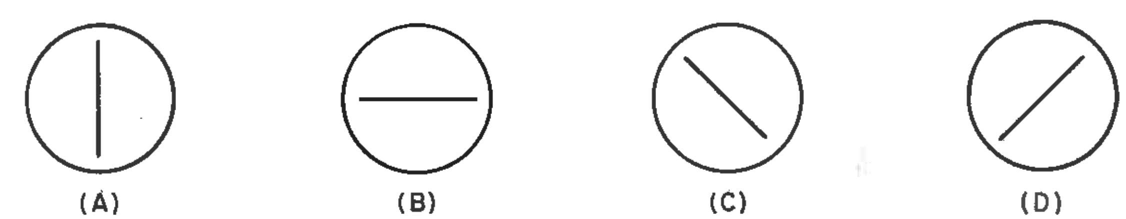


Fig. 4—A straight line pattern results as the cathode-ray beam swings back and forth under the influence of an a-c voltage. A vertical or horizontal line results when the voltage is applied to the vertical (A) or horizontal (B) input terminals. A diagonal line results when an a-c voltage is applied to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

mize the adverse effect of parallax. The plastic mask is held by a spun-aluminum bezel which can be removed from the oscilloscope if the operator wishes to observe the pattern directly on the screen. The inside surface of the aluminum bezel has been made parallel, rather than tapered, so that a paper light shield can be used if desired.

3. **Sensitivity.** The high maximum sensitivity of 10 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 2500 and, therefore, the VERT. IN. terminal itself 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 ac and dc voltage applied to the HORIZ. IN. terminals should not exceed 600 volts.

5. **Vertical Input Voltage.** The combined ac and dc voltage applied to the VERT. IN. terminals should not exceed 600 volts. A step attenuator in the highest setting (1000:1 is high and 1:1 is low) consistent with ample size of pattern higher 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. ATTENUATOR 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 500kc.** The response of the Sylvania Television Service Oscilloscope, Type 403, is approximately 6db down at 1 megacycle.

7. **Voltage, Current, Frequency and Phase 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 to the input terminals. 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.

   DC voltages may be measured by direct application of the unknown voltage to the VERT. IN. terminals. As the amplifiers are d-c coupled there is no blocking action by capacitors. The oscilloscope may be calibrated by using the Sylvania Voltage Calibrator or the conveniently located 6 volt (rms) output. The type 403 may be used for accurate measurement of applied d-c, as well as peak, or peak-to-peak values of superimposed alternating voltages.

   When an alternating voltage is applied to the vertical input terminals, 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 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 input 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.

   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 distance measured down from center to the lower tip of the pattern) indicates the peak

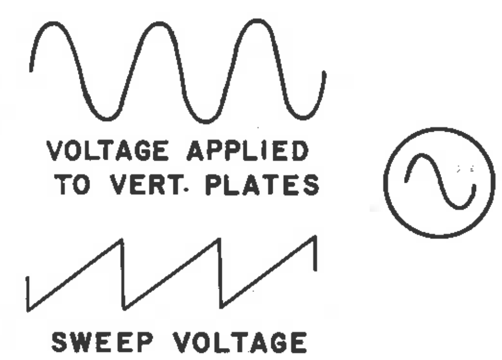


Fig. 5—The voltage waveform produced when the saw-tooth sweep voltage is applied to the horizontal plates, and an a-c voltage to the vertical plates.

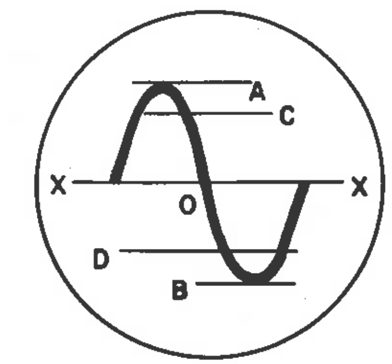


Fig. 6—Voltage relations of the sine wave. The zero base line is xx. The positive peak value is at A, the negative peak value at B, the rms value at C and the average value at D.

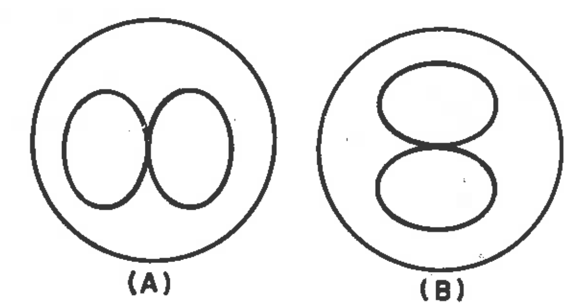


Fig. 7—Lissajous figure for a frequency ratio of 2 to 1. In (A) the higher frequency is applied to the vertical plates and in (B) to the horizontal plates.

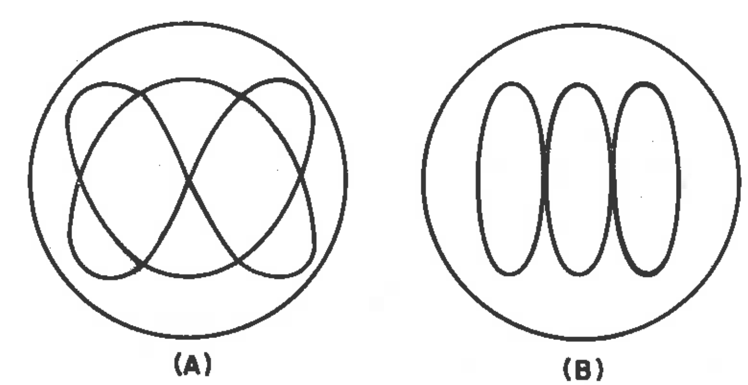


Fig. 8—Lissajous figures for the frequency ratios of 3 to 2 (A) and 3 to 1 (B).

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 2 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.

D. **Phase Measurement.** The Type 403 Oscilloscope may be used to compare the phase of two signals of the same frequency by feeding one into the horizontal input and the other into the vertical input and observing the lissajous pattern on the screen. Of course, these signals must lie within the frequency response of the oscilloscope. The amplitude of the two signals should be made as nearly identical as possible by adjusting the gain controls on the horizontal and vertical amplifiers. If great accuracy is desired on this measurement, the source impedance of the signals fed into the oscilloscope should be 600 ohms or less. If it is necessary to use source impedances higher than 600 ohms, phase errors can be avoided by putting 27 mmf. of capacitance across the oscilloscope vertical input terminals, thereby making the total vertical input capacitance equal to the horizontal input capacitance.

8. **Television Receiver Servicing.** The Sylvania Television Service Oscilloscope Type 403 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 Television Service Oscilloscope Type 403 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

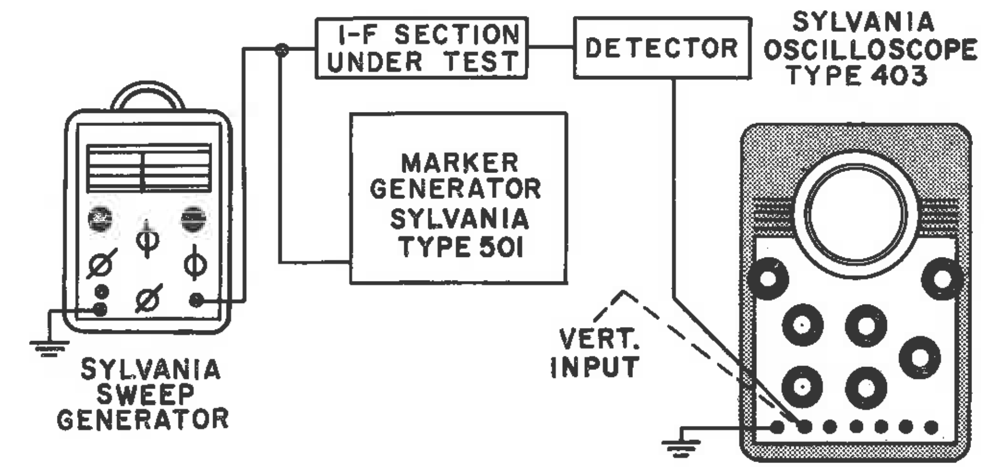


Fig. 9—Instrument connections for observing the response curve of a video i-f amplifier.

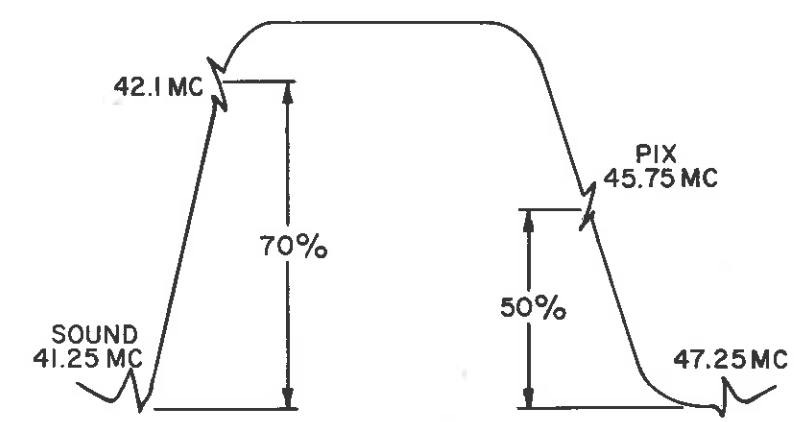


Fig. 10—Standard video i-f response curve produced by the instrument setup shown in Fig. 9.

notes for detailed information and instructions for a particular receiver.

A. **Video I-F Stages.** The instruments required for the alignment of the video i-f stages are an oscilloscope (Sylvania Type 403), sweep signal generator (Sylvania Type 500), and a marker generator or an accurately calibrated signal generator covering the video i-f range, (Sylvania Type 501).

There are two main types of i-f circuits to to be discussed here. In the first, the sound portion of the signal is removed from the video portion just ahead of the i-f 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 i-f 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 403, 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 i-f stage. The signal sweep width should be set at approximately eight to ten megacycles to cover adequately the pass-band of the i-f stage and the adjacent sound channel. The GND terminals of the Type 403 oscilloscope should be connected to the ground terminals of the sweep generator and the sweep range control turned to the 60 Cycle position.

The response curve of the video i-f 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 i-f 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 a-c 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 i-f 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 i-f 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 i-f 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 i-f 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 i-f 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 i-f stages the adjacent sound carrier would be **above** the video carrier in frqeuency, 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 the video i-f stages. The sweep signal generator is connected to the antenna terminals with its output frequency set approximately to the mid-point frequency of the

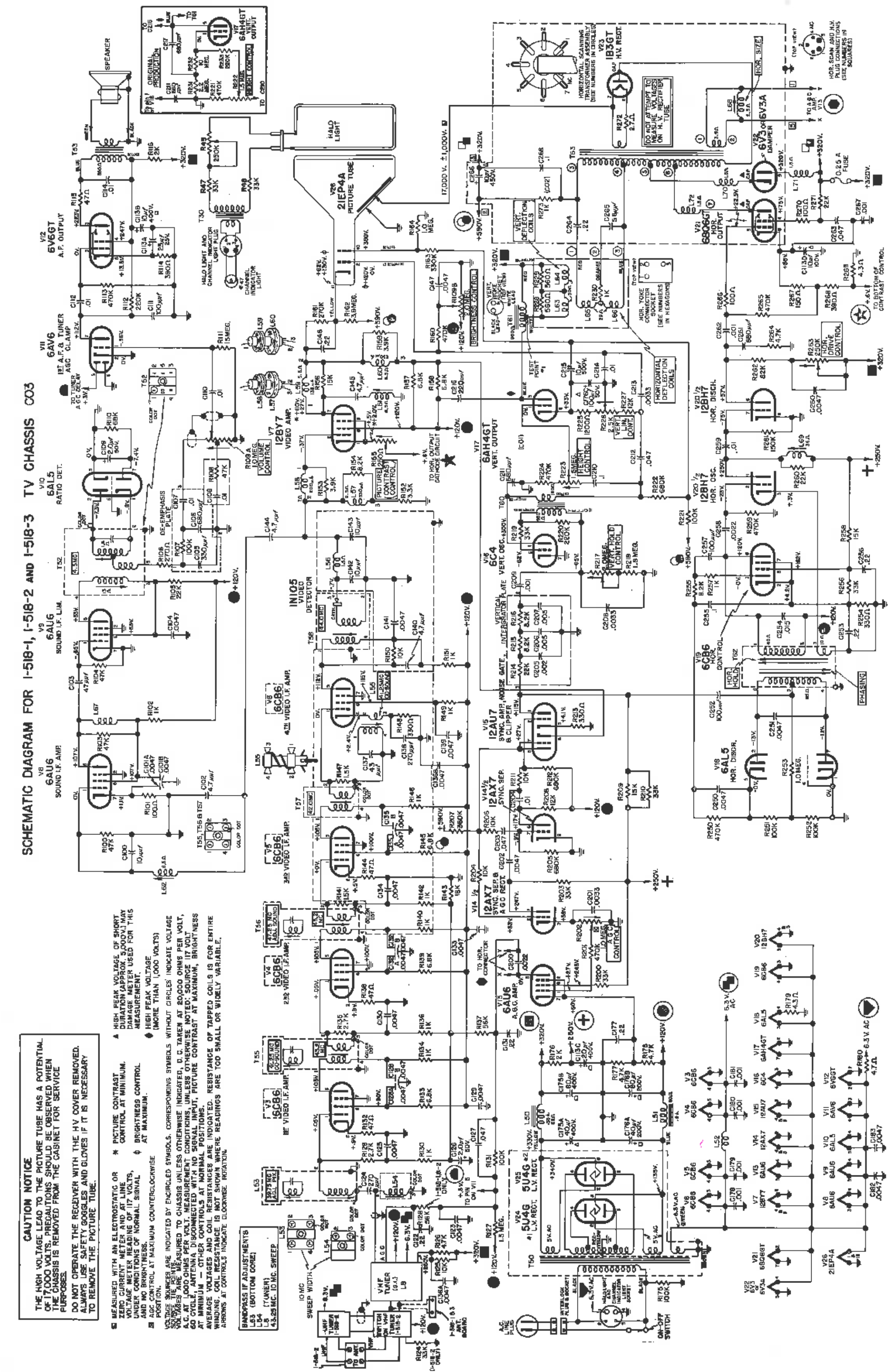


Fig. 11—Schematic diagram of Sylvania television receiver chassis, 1-518-1, 1-518-2 and 1-518-3. Photographs of the waveforms on the following pages were made using this receiver.

SYLVANIA TELEVISION SERVICE OSCILLOSCOPE TYPE 403

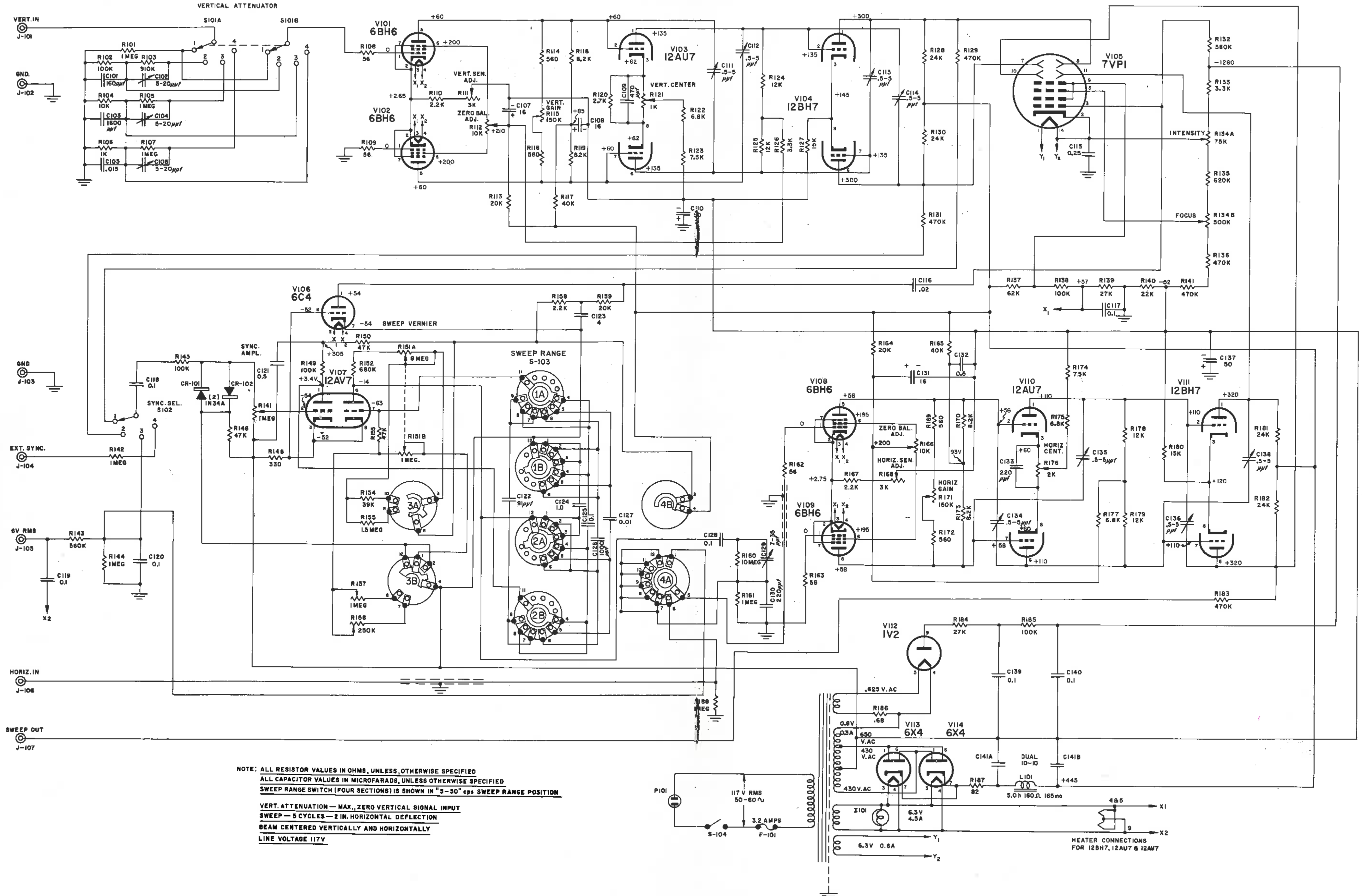


Fig. 12 —Oscilloscope Schematic

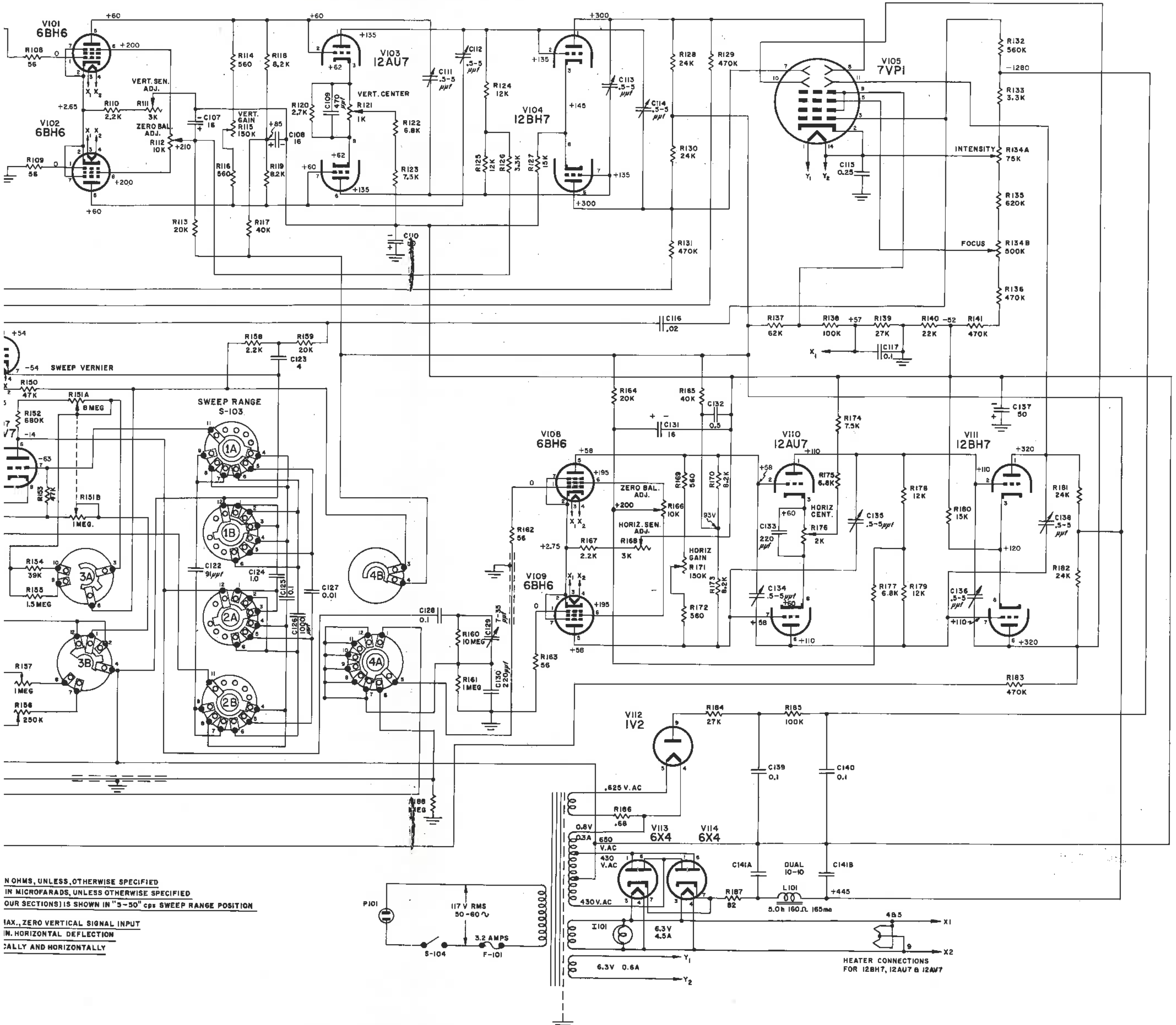


Fig. 12 —Oscilloscope Schematic

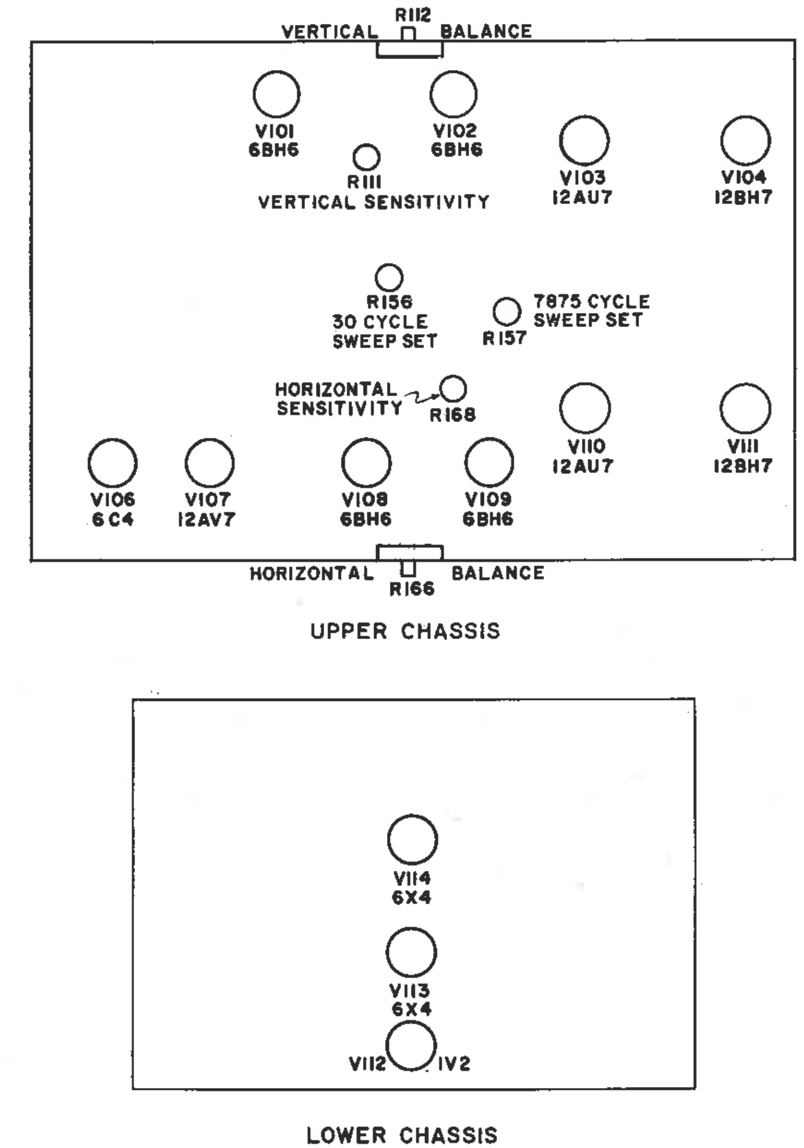


Fig. 13—Secondary Controls and Tube Layout.

Note: *The balance controls should be adjusted, thereby obtaining no change in centering with changes in gain. The horizontal balance control, R-166, is available through a hole in the cabinet on the right side. The vertical balance control, R-112, is available through a hole in the cabinet on the left side.*

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 r-f and i-f stages, and it is important to have the i-f stages correctly aligned before any judgment can be made of the r-f stages. If the curve is degraded from the curve obtained for the i-f stages, the r-f tuning should be readjusted for the best shape. The check of r-f alignment should be repeated for each of the channels.

To obtain the response curve of the r-f 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 r-f 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 plate circuits, poor or no shielding, improper voltages, or poor grounding.

C. **Trouble Shooting by Waveform Analysis.** The Sylvania Type 403 Oscilloscope is very useful in the observation of the many voltage and current wave forms 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 403 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 sweep frequency is 30 cycles. By using these sweep frequencies, two cycles of the desired waveform 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. **A-M Receivers.** Accurate alignment of a-m receivers may be obtained by using the Type 403 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 i-f and the r-f 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 i-f tube. The frequency of the sweep generator output signal is set to the i-f 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. When the sweeping frequency of the signal generator is 60 cycles, the SWEEP RANGE control on the oscilloscope may be turned to 60 Cycle, and no sync connection will be necessary.

The selectivity curve will resemble one of the curves shown in Fig. 14. The trimmers should be adjusted until the curve has the general appearance of Fig. 14 (A) which is neither too broad or too sharp.

The sweep generator lead is then moved to the grid of the previous i-f 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 i-f stage until the grid of the mixer tube is reached.

The next operation is to align the r-f section. The frequency of the sweep signal generator and the receiver are both set to 1500 kc. and the trimmers on the r-f and oscillator sections of the tuning condenser are adjusted until a selectivity curve similar to the curve of Fig. 14 (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. 14 (F).

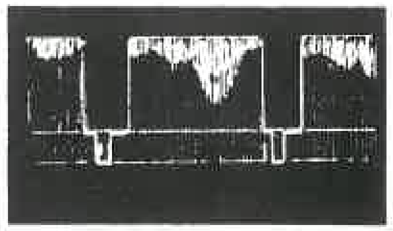
In the alignment of a high-fidelity receiver, the oscilloscope is connected across the diode load resistor. However, when the receiver employs a power detector instead of the diode type, the VERT. IN. terminal of the oscilloscope must be connected to the plate end of the detector plate load resistor, 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 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.

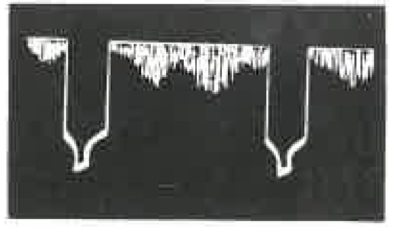
In an all-wave receiver, alignment of the front end of set must be completed for each setting of the band switch. The generator must be set successively to frequencies near the top and bottom of each wave band, just as the frequencies of 1500 and 600 kc. were used for alignment of the broadcast range. Alignment of i-f 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.

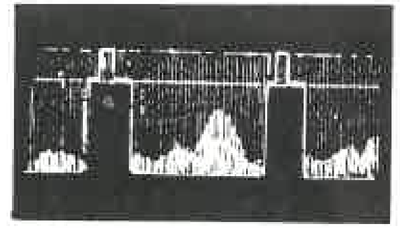
C. **F-M Receivers.** An f-m receiver is very similar to, and often identical with, an a-m superheterodyne receiver from the antenna and ground terminals through the i-f amplifier. The audio stages are the same as in an a-m receiver. The point of difference is that the a-m receiver utilizes a second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



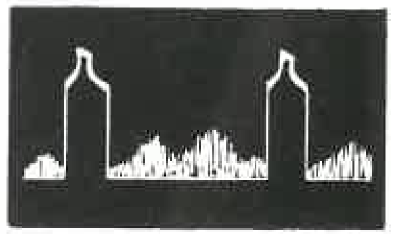
*12BY7 (V7) Video Amplifier Control Grid (Pin 2) 3.5 Volts (PP) Vertical.



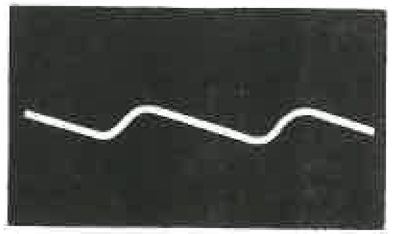
*12BY7 (V7) Video Amplifier Control Grid (Pin 2) 3.5 Volts (PP) Horizontal.



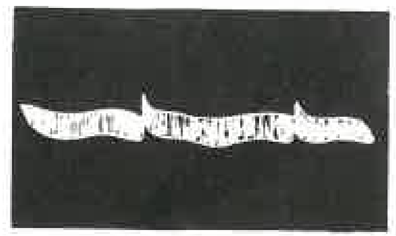
*12BY7 (V7) Video Amplifier Plate (Pin 7) 75 Volts (PP) Vertical



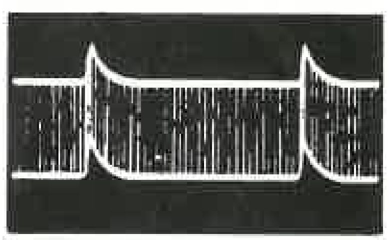
*12BY7 (V7) Video Amplifier Plate (Pin 7) 75 Volts (PP) Horizontal.



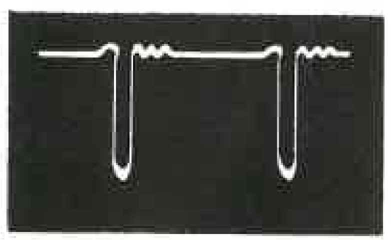
12AX7 (V14) Hor. Sync Separator and AGC Rectifier Cathode (Pin 3) 4.0 Volts (PP) Horizontal.



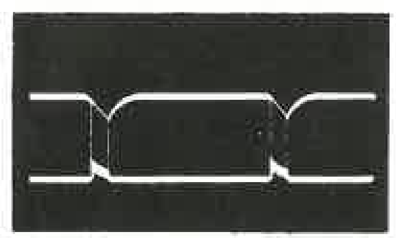
12AX7 (V14) Hor. Sync Separator and AGC Rectifier Cathode (Pin 3) 6 Volts (PP) Vertical.



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

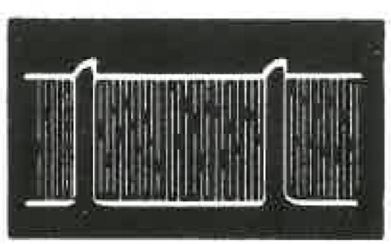


12AX7 (V14) Hor. Sync Separator and AGC Rectifier Plate (Pin 1) 45 Volts (PP) Horizontal.

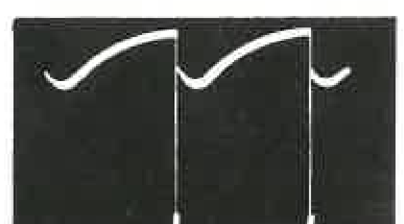


12AX7 (V14) Sync Separator Plate (Pin 6) 40 Volts (PP) Vertical.

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.

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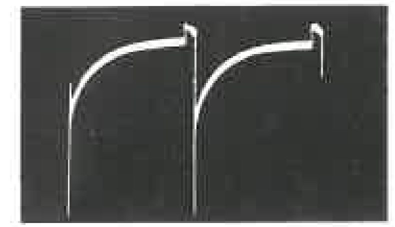
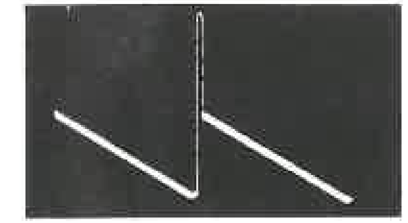
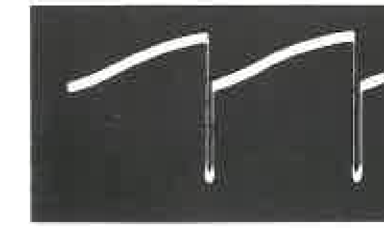


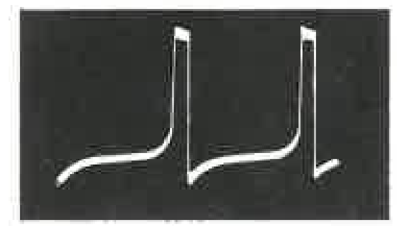
6C4 (V16) Vertical Oscillator Grid (Pin 6) 180 Volts (PP) Vertical.



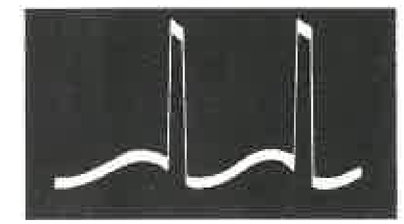
6AH4GT (V17) Vertical Output Plate (Pin 5) 700 Volts (PP) Vertical.



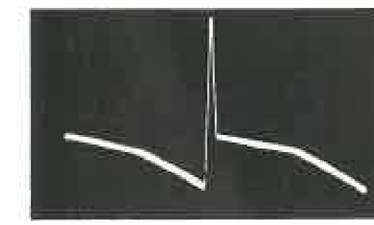
6AH4GT (V17) Vertical Output Grid (Pin 1) 85 Volts (PP) Vertical.



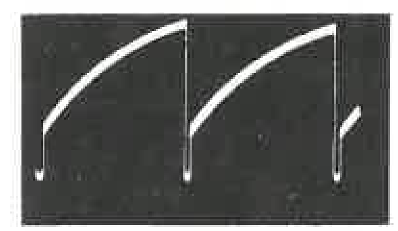
6AL5 (V18) Horizontal Discriminator Plate (Pin 2) 55 Volts (PP) Horizontal.



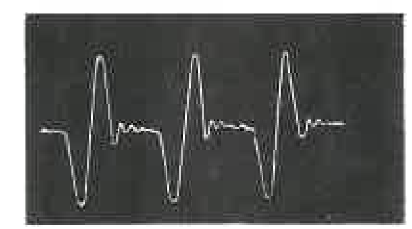
6AL5 (V18) Horizontal Discriminator Plate (Pin 7) 55 Volts (PP) Horizontal.



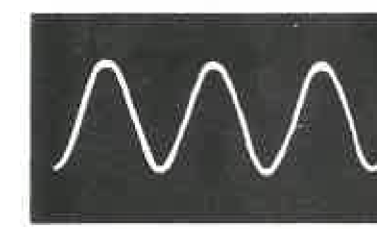
Vertical Deflection Coils (Test Point 1) 70 Volts (PP) Vertical.



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.

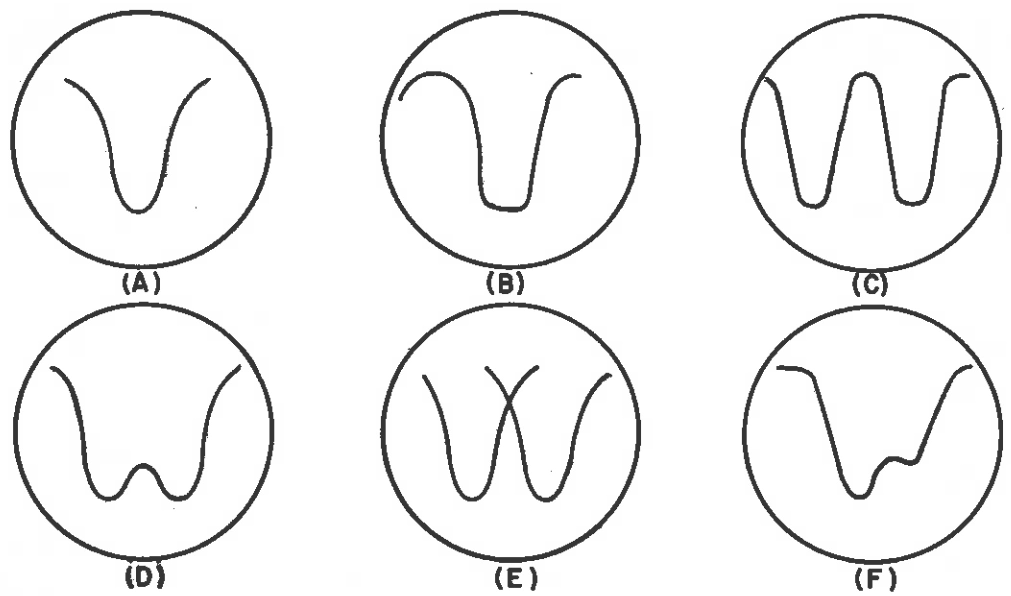


Fig. 14—Selectivity curve of i-f stages obtained using a sweep signal generator.

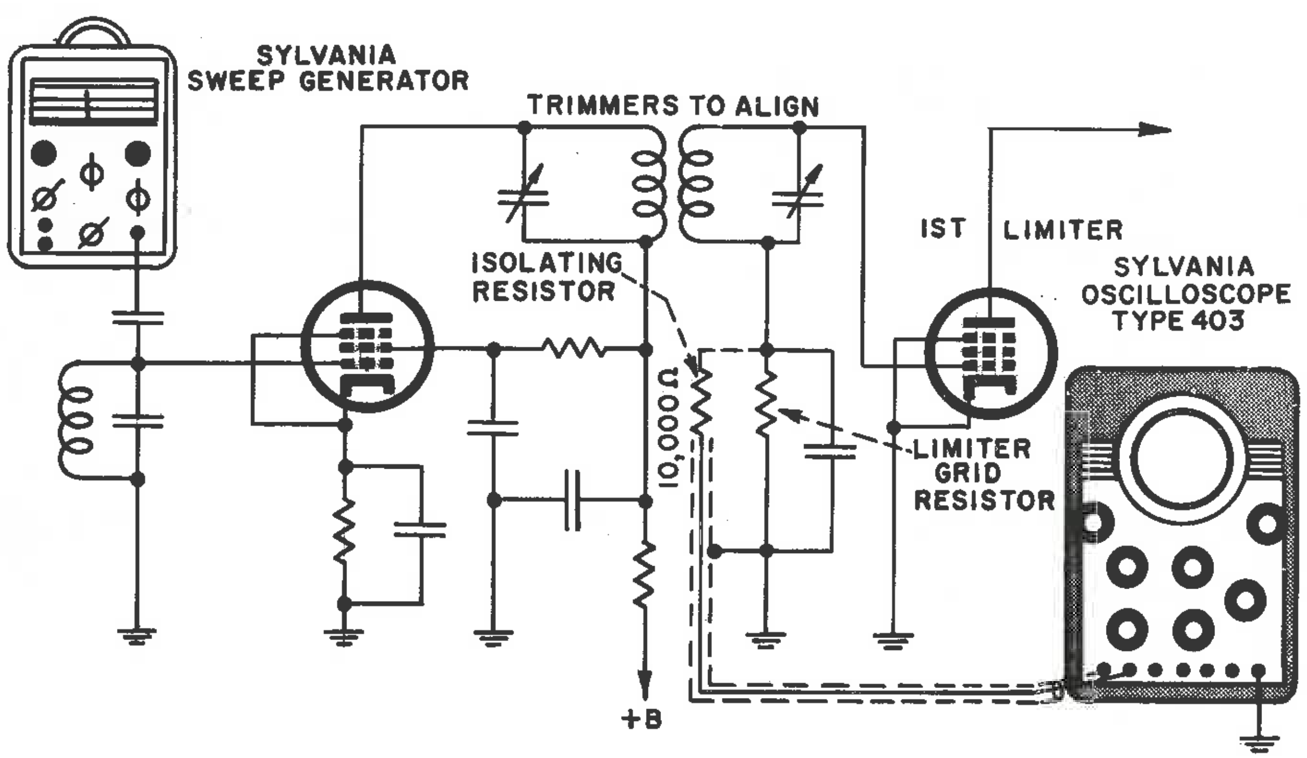


Fig. 15—Oscilloscope connections for i-f amplifier alignment in an f-m receiver.

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Alignment of the f-m receiver differs from a-m alignment chiefly in the special adjustment of the discriminator or ratio detector.

D. **Discriminator-Type Receiver.** The i-f 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. 15. 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 i-f-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 i-f stage should be adjusted to obtain a pattern similar to that of Fig. 14 (D). The bandwidth of the i-f amplifier is somewhat broader than it would be in an a-m receiver and, therefore, the sharp curve of Fig. 14 (A) will not be satisfactory.

The sweep generator output lead is next transferred to the grid of the next previous i-f stage and the trimmers of this stage adjusted until the selectivity curve again matches the curve of Fig. 14 (D). The signal is fed to the grid of each i-f 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. 16. 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 curve shown in Fig. 17 (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. 17 (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 i-f amplifier of an f-m 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. 18. The i-f 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 point B in Fig. 18. The same pattern as for the discriminator alignment, Fig. 17 (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. 18.

Front End Alignment. The front end of an a-m receiver (that is, the r-f, 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 a-m front ends except for the operating frequency.

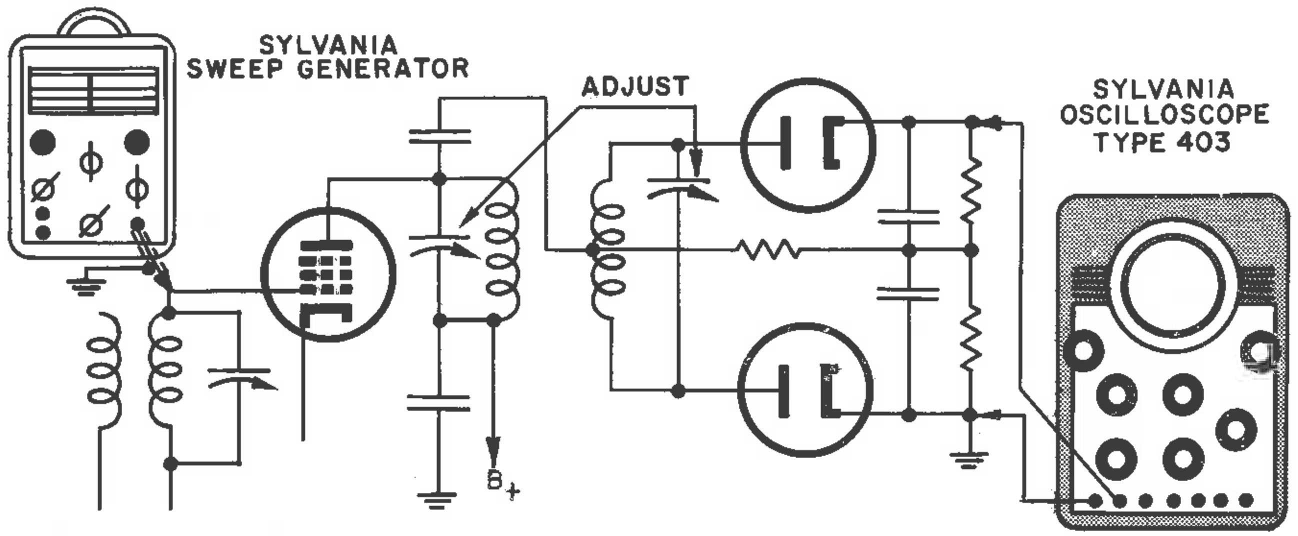

Fig. 16—Oscilloscope connections for discriminator alignment in an f-m receiver.

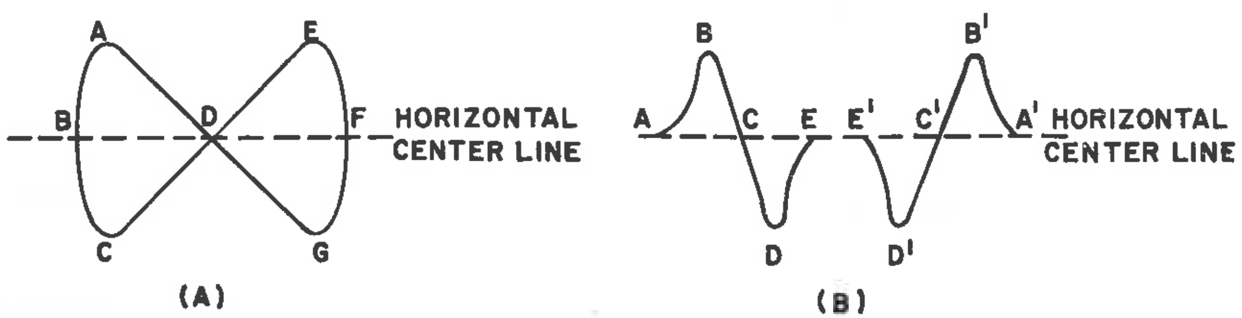

Fig. 17—Alignment pattern for discriminator or ratio detector. The frequency of the sync voltage is twice the sweep frequency of the f-m signal generator in (A) and equal to it in (B).

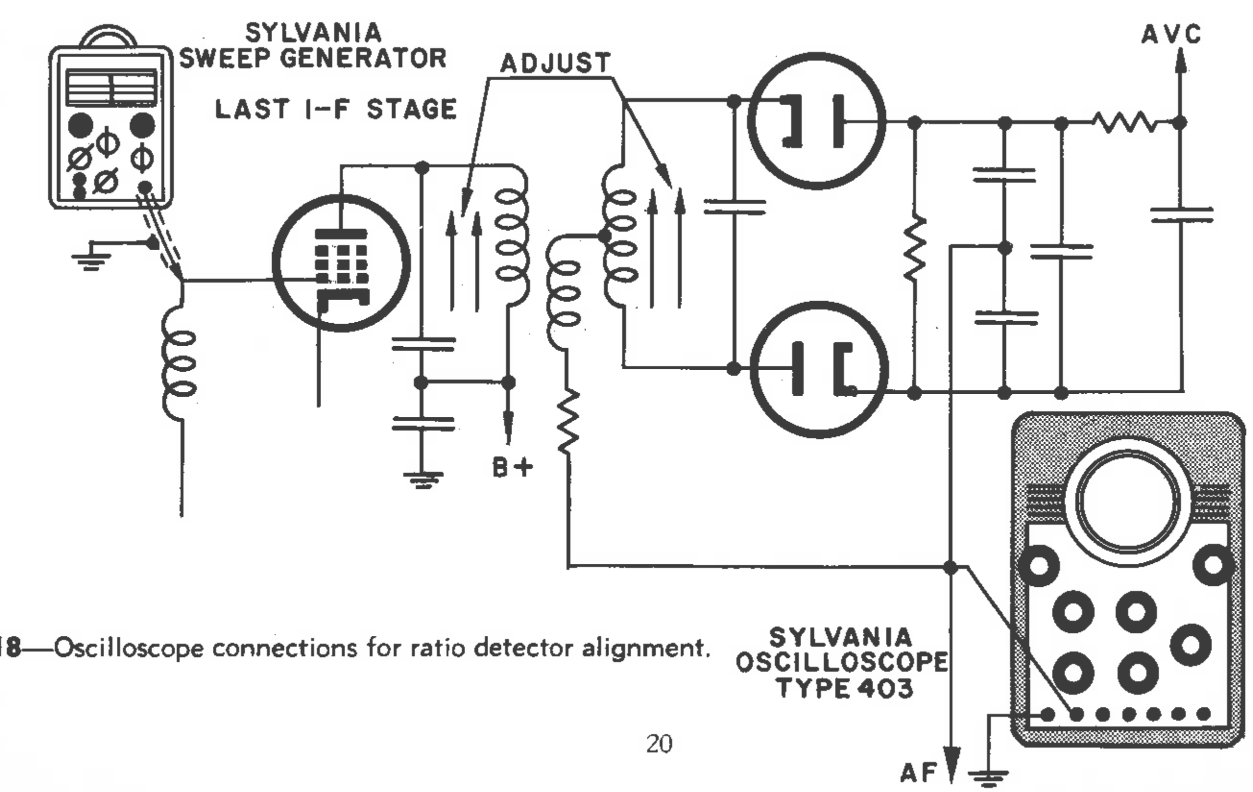

Fig. 18—Oscilloscope connections for ratio detector alignment.

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Bayly Engineering, Lt.

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Attn: Mr. Richard Lomastro

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PARTS LIST

Symbol	Description	Rating	Tol.	Part No.
		Capacitors		
C-101	Fixed-Mica	160 mmf., 500 v.	±2%	4M-216110-206
C-102	Variable-Ceramic	5-20 mmf., 500 v.		4V-26184-2
C-103	Fixed-Mica	1600 mmf., 500 v.	±5%	4M-516210-306
C-104	Variable-Ceramic	5-20 mmf., 500 v.		4V-26184-2
C-105	Fixed-Paper	.015 mf., 400 v.	±10%	4T-215340-5
C-106	Variable-Ceramic	5-20 mmf., 500 v.		4V-26184-2
C-107	Electrolytic	16 mf., 450 v.	±10%	4D-25264-2
C-108	Electrolytic	16 mf., 150 v.	±10%	4D-25264-1
C-109	Fixed-Mica	470 mmf., 500 v.	±10%	4M-647110-203
C-110	Electrolytic	50 mf., 50 v.	—10 + 250%	4D-2369
C-111	Variable-Tubular	.5-5 mmf., 500 v.		4V-18387
C-112	Variable-Tubular	.5-5 mmf., 500 v.		4V-18387
C-113	Variable-Tubular	.5-5 mmf., 500 v.		4V-18387
C-114	Variable-Tubular	.5-5 mmf., 500 v.		4V-18387
C-115	Fixed-Metal Cased	.25 mf., 1500 v.	±10%	4U-25716
C-116	Fixed-Paper	.02 mf., 1600 v.	±10%	4T-25714
C-117	Fixed-Glass Sealed	.1 mf., 200 v.	±20%	4T-25525-1
C-118	Fixed-Paper	.1 mf., 400 v.	±10%	4T-410440-5
C-119	Fixed-Glass Sealed	.1 mf., 200 v.	±20%	4T-25525-1
C-120	Fixed-Glass Sealed	.1 mf., 200 v.	±20%	4T-25525-1
C-121	Fixed-Oil Filled	.5 mf., 400 v.	—15 + 25%	4T-25480-1
C-122	Fixed-Mica	91 mmf., 500 v.	±5%	4M-591010-206
C-123	Electrolytic	4 mf., 450 v.	—10 + 20%	4D-25264-4
C-124	Fixed-Glass Sealed	1 mf., 200 v.	—15 + 25%	4T-25674-1
C-125	Fixed-Paper	.1 mf., 400 v.	±10%	4T-410440-5
C-126	Fixed-Mica	1000 mmf., 500 v.	±10%	4M-610210-303
C-127	Fixed-Mica	.01 mf., 500 v.	±10%	4M-610310-303
C-128	Fixed-Paper	.1 mf., 400 v.	±10%	4T-410440-5
C-129	Variable-Ceramic	7-35 mmf., 500 v.		4V-26184-1
C-130	Fixed-Mica	220 mmf., 500 v.	±10%	4M-622110-203
C-131	Electrolytic	16 mf., 450 v.	±10%	4D-25264-2
C-132	Fixed-Oil Filled	.5 mf., 400 v.	—20 + 30%	4T-25676-1
C-133	Fixed-Mica	220 mmf., 500 v.	±10%	4M-622110-203
C-134	Variable-Tubular	.5-5 mmf., 500 v.		4V-18387
C-135	Variable-Tubular	.5-5 mmf., 500 v.		4V-18387
C-136	Variable-Tubular	.5-5 mmf., 500 v.		4V-18387
C-137	Electrolytic	50 mf., 50 v.	—10 + 250%	4D-2369
C-138	Variable-Tubular	.5-5 mmf., 500 v.		4V-18387
C-139	Fixed-Paper	.1 mf., 2500 v.	—10 + 20%	4T-25775
C-140	Fixed-Paper	.1 mf., 2500 v.	—10 + 20%	4T-25775
C-141A	Electrolytic (Dual)	10 mf., 500 v.	±10%	4D-25637
C-141B	Electrolytic (Dual)	10 mf., 500 v.	±10%	4D-25637
		Resistors		
R-101	Fixed-Comp.	1 meg., ½ w.	±5%	3C-410553-1
R-102	Fixed-Comp.	100 k., ½ w.	±5%	3C-410453-1
R-103	Fixed-Comp.	910 k., ½ w.	±5%	3C-491453-1
R-104	Fixed-Comp.	10 k., ½ w.	±5%	3C-410353-1
R-105	Fixed-Comp.	1 meg., ½ w.	±5%	3C-410553-1
R-106	Fixed-Comp.	1 k., ½ w.	±5%	3C-410253-1
R-107	Fixed-Comp.	1 meg., ½ w.	±5%	3C-410553-1
R-108	Fixed-Comp.	56 ohms, ½ w.	±5%	3C-456053-1
R-109	Fixed-Comp.	56 ohms, ½ w.	±5%	3C-456053-1
R-110	Fixed-Deposited Metal	2.2 k., 1 w.	±1%	3M-24999-7
R-111	Variable-Comp.	3 k., 2 w.	±10%	3V-25640-1
R-112	Variable-Comp.	10 k., 2 w.	±10%	3V-25640-2

PARTS LIST — Continued

Symbol	Description	Rating	Tol.	Part No.
		Resistors		
R-113	Fixed-W.W.	20 k., 5 w.	±5%	3W-13666-2
R-114	Fixed-Comp.	560 ohms, ½ w.	±10%	3C-456173-1
R-115	Variable-Comp.	150 k., ½ w.	±20%	2R-25693
R-116	Fixed-Comp.	560 ohms, ½ w.	±10%	3C-456173-1
R-117	Fixed-W.W.	40 k., 5 w.	±5%	3W-13666-3
R-118	Fixed-Deposited Metal	8.2 k., 1 w.	±1%	3M-24999-9
R-119	Fixed-Deposited Metal	8.2 k., 1 w.	±1%	3M-24999-9
R-120	Fixed-Comp.	2.7 k., ½ w.	±10%	3C-427273-1
R-121	Variable-Comp.	1 k., 2 w.	±10%	3V-25642-1
R-122	Fixed-Comp.	6.8 k., 1 w.	±5%	3C-668253-1
R-123	Fixed-Comp.	7.5 k., 1 w.	±5%	3C-675253-1
R-124	Fixed-Deposited Metal	12 k., 1 w.	±1%	3M-24999-10
R-125	Fixed-Deposited Metal	12 k., 1 w.	±1%	3M-24999-10
R-126	Fixed-Comp.	3.3 k., ½ w.	±10%	3C-433273-1
R-127	Fixed-W.W.	15 k., 5 w.	±5%	3W-13666-1
R-128	Fixed-Deposited Metal	24 k., 2 w.	±1%	3M-25263-1
R-129	Fixed-Comp.	470 k., ½ w.	±5%	3C-447453-1
R-130	Fixed-Deposited Metal	24 k., 2 w.	±1%	3M-25263-1
R-131	Fixed-Comp.	470 k., ½ w.	±5%	3C-447453-1
R-132	Fixed-Comp.	560 k., ½ w.	±10%	3C-456473-1
R-133	Fixed-Comp.	3.3 k., ½ w.	±5%	3C-433253-1
R-134A	Variable-Comp. (Dual)	75 k., 1 w.	±10%	3V-25644
R-134B	Variable-Comp. (Dual)	500 k., 1 w.	±10%	3V-25644
R-135	Fixed-Comp.	620 k., 1 w.	±5%	3C-662453-1
R-136	Fixed-Comp.	470 k., 1 w.	±5%	3C-647453-1
R-137	Fixed-Comp.	62 k., 1 w.	±5%	3C-662353-1
R-138	Fixed-Comp.	100 k., 1 w.	±5%	3C-610453-1
R-139	Fixed-Comp.	27 k., ½w.	±10%	3C-427373-1
R-140	Fixed-Comp.	22 k., ½ w.	±10%	3C-422373-1
R-141	Fixed-Comp.	470 k., 1 w.	±5%	3C-647453-1
R-142	Fixed-Comp.	1 meg., ½ w.	±10%	3C-410573-1
R-143	Fixed-Comp.	560 k., ½ w.	±10%	3C-456473-1
R-144	Fixed-Comp.	1 meg., ½ w.	±10%	3C-410573-1
R-145	Fixed-Comp.	100 k., ½ w.	±10%	3C-410473-1
R-146	Fixed-Comp.	47 k., ½ w.	±5%	3C-447353-1
R-147	Variable-Comp.	1 meg., ½ w.	±20%	2R-25692
R-148	Fixed-Comp.	330 ohms, ½ w.	±5%	3C-433153-1
R-149	Fixed-Comp.	100 k., ½ w.	±5%	3C-410453-1
R-150	Fixed-Comp.	47 k., ½ w.	±5%	3C-447353-1
R-151A	Variable-Comp. (Dual)	8 meg., ½ w.	±20%	2R-25698
R-151B	Variable-Comp. (Dual)	1 meg., ½ w.	±20%	2R-25698
R-152	Fixed-Comp.	680 k., ½ w.	±5%	3C-468453-1
R-153	Fixed-Comp.	47 k., ½ w.	±5%	3C-447353-1
R-154	Fixed-Comp.	39 k., ½ w.	±10%	3C-439373-1
R-155	Fixed-Comp.	1.5 meg., ½ w.	±10%	3C-415573-1
R-156	Variable-Comp.	250 k., 2 w.	±10%	3V-25640-3
R-157	Variable-Comp.	1 meg., 2 w.	±10%	3V-25677-1
R-158	Fixed-Comp.	2.2 k., 1 w.	±5%	3C-622253-1
R-159	Fixed-W.W.	20 k., 5 w.	±5%	3W-13666-2
R-160	Fixed-Comp.	10 meg., ½ w.	±10%	3C-410673-1
R-161	Fixed-Comp.	1 meg., ½ w.	±10%	3C-410573-1
R-162	Fixed-Comp.	56 ohms, ½ w.	±5%	3C-456053-1
R-163	Fixed-Comp.	56 ohms, ½ w.	±5%	3C-456053-1
R-164	Fixed-W.W.	20 k., 5 w.	±5%	3W-13666-2
R-165	Fixed-W.W.	40 k., 5 w.	±5%	3W-13666-3
R-166	Variable-Comp.	10 k., 2 w.	±10%	3V-25640-2

PARTS LIST — Continued

Symbol	Description	Rating	Tol.	Part No.
		Resistors		
R-167	Fixed-Deposited Metal	2.2 k., 1 w.	±1%	3M-24999-7
R-168	Variable-Comp.	3 k., 2 w.	±10%	3V-25640-1
R-169	Fixed-Comp.	560 ohms., ½ w.	±10%	3C-456173-1
R-170	Fixed-Deposited Metal	8.2 k., 1 w.	±1%	3M-24999-9
R-171	Variable-Comp.	150 k., 2 w.	±20%	3V-25675-1
R-172	Fixed-Comp.	560 ohms, ½ w.	±10%	3C-456173-1
R-173	Fixed-Deposited Metal	8.2 k., 1 w.	±1%	3M-24999-9
R-174	Fixed-Comp.	7.5 k., 1 w.	±5%	3C-675253-1
R-175	Fixed-Comp.	6.8 k., 1 w.	±5%	3C-668253-1
R-176	Variable-Comp.	2 k., 2 w.	±10%	3V-25642-2
R-177	Fixed-Comp.	6.8 k., ½ w.	±10%	3C-468273-1
R-178	Fixed-Deposited Metal	12 k., 1 w.	±1%	3M-24999-10
R-179	Fixed-Deposited Metal	12 k., 1 w.	±1%	3M-24999-10
R-180	Fixed-W.W.	15 k., 5 w.	±5%	3W-13666-1
R-181	Fixed-Deposited Metal	24 k., 2 w.	±1%	3M-25263-1
R-182	Fixed-Deposited Metal	24 k., 2 w.	±1%	3M-25263-1
R-183	Fixed-Comp.	470 k., 1 w.	±5%	3C-647453-1
R-184	Fixed-Comp.	27 k., ½ w.	±10%	3C-427373-1
R-185	Fixed-Comp.	100 k., 2 w.	±10%	3C-710473-1
R-186	Fixed-Comp.	.68 ohms, ½ w.	±10%	3C-468973-1
R-187	Fixed-Comp.	82 ohms, 2 w.	±10%	3C-782073-1
R-188	Fixed-Comp.	1 meg., ½ w.	±10%	3C-410573-1
		Other Items		
	Bezel			8M-25171
	Cable Assemble-power			2A-25448-1
L-101	Choke-filter			5F-18486
CR-101	Crystal-1N34A			5X-25019
CR-102	Crystal-1N34A			5X-25019
	Jewel-red			7Z-18595
	Knob-large			7K-25396
	Knob-small			7K-25397
	Knob-single control			7K-25432
	Lamp-incandescent			6T-2828
	Mask-painted			8N-25327
	Mounting-cathode ray tube			8N-18562
	Panel-etched			8M-25293
	Post-binding			7Z-2844
	Strap-carrying			7H-24901
S-101	Switch-rotary (vert. atten.)			2R-25693
S-102	Switch-rotary (sync. selector)			2R-25692
S-103	Switch-rotary (sweep range)			2R-25698
S-104	Switch-toggle (on-off)			2T-18755-1
T-101	Transformer-power			5P-25199
V-101	Tube-Electron-6BH6			6R-23852
V-102	Tube-Electron-6BH6			6R-23852
V-103	Tube-Electron-12AU7			6R-20689
V-104	Tube-Electron-12BH7			6R-23651
V-105	Tube-Electron-7VP1			6C-26044
V-106	Tube-Electron-6C4			6R-20710
V-107	Tube-Electron-12AV7			6R-23968
V-108	Tube-Electron-6BH6			6R-23852
V-109	Tube-Electron-6BH6			6R-23852
V-110	Tube-Electron-12AU7			6R-20689
V-111	Tube-Electron-12BH7			6R-23651
V-112	Tube-Electron-1V2			6R-25715
V-113	Tube-Electron 6X4			6R-20802
V-114	Tube-Electron 6X4			6R-20802

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.