PRICE 50 CENTS

RCA CATHODE-RAY OSCILLOSCOPE

Type WO-57A

- Applications
- Maintenance
- Operation
- Specifications

RADIO CORPORATION of AMERICA
TEST AND MEASURING EQUIPMENT
HARRISON, N. J.

Safety Precautions

This instrument has been designed and constructed with the safety of the operator in mind. For example, an important safety feature is that the ground of the internal circuit is connected to the metal case of the instrument. To obtain the full benefit of this feature, the operator should always connect the ground terminal of the instrument securely to the ground of the equipment under test. If this rule is violated in applications where neither test point is at ground potential, the operator should be *especially careful* in such applications to insulate the case of the instrument from all grounds and to avoid bodily contact with any part of the instrument while the power is on. Bear in mind that in such applications the metal shield at the tip end of the WG-218 Direct Probe and Cable is at high voltage because the shield is grounded to the internal circuit of the instrument. Always handle the WG-218 by its insulated probe housing.

An important point to remember is that there is always danger inherent in testing electrical equipment which operates at hazardous voltages. Therefore, the operator should thoroughly familiarize himself with the equipment under test before working on it, bearing in mind that high voltages may appear at unexpected points in defective equipment. Additional precautions which experience in the industry has shown to be important are listed below.

1. It is good practice to remove power before connecting test leads to high-voltage points. If this is impractical, be *especially careful* to avoid accidental contact with equipment racks and other objects which can provide a ground. Working with one hand in your pocket and standing on a properly insulated floor lessens the danger of shock.

2. Filter capacitors may store a charge large enough to be hazardous. Therefore, discharge filter capacitors before attaching test leads.

3. Remember that leads with broken insulation provide the additional hazard of high voltages appearing at exposed points along the leads. Check test leads for frayed or broken insulation before working with them.

4. To lessen the danger of accidental shock, disconnect test leads immediately after test is completed.

5. Remember that the risk of severe shock is only one of the possible hazards. Even a minor shock can place the operator in hazard of more serious risks such as a bad fall or contact with a source of higher voltage.

6. The experienced operator continuously guards against injury and does not work on hazardous circuits unless another person is available to assist in case of accident.

Items Supplied with the WO-57A

Tubes: 4 RCA-6AU6, 1 RCA-12AX7, 1 RCA-6J6,
2 RCA-6X4, 1 RCA-3MP1
Transparent Graph Screen
Warranty Certificate
Instruction Booklet

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TEST AND MEASURING EQUIPMENT
RADIO CORPORATION OF AMERICA, HARRISON, NEW JERSEY

INSTR. WO-57A-(2)
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Cathode-Ray Oscilloscope
Type WO-57A

Contents

List of Illustrations

General Description

The RCA WO-57A Cathode-Ray Oscilloscope is an instrument of the service type providing high sensitivity, superior high- and low-frequency response, and excellent waveshape reproduction—quality features usually associated with laboratory-type oscilloscopes. Because of these features and its versatility in application, the WO-57A is particularly useful in servicing television receivers.

The direct-coupled vertical amplifier is designed to provide square-wave response with less than 2% tilt and overshoot. This amplifier, with its wide-band, flat frequency response, fully meets the requirements of sweep alignment applications and insures adequate reproduction of all television waveshapes. In addition, the direct coupling allows amplification of not only the ac component of a signal but of its dc component as well.

Both instantaneous and peak-to-peak ac/dc voltage measurements can be made directly from the screen of the WO-57A. An internal calibrating voltage, used in calibrating the vertical amplifier, is available at a panel terminal. Separate ac and dc input terminals to the vertical amplifier are also provided.

In the vertical amplifier, the two push-pull stages provide high deflection sensitivity with good stability. The use of push-pull stages produces a uniformly sharp trace over the useful portion of the oscilloscope screen, in contrast to the blurred-segment trace which results from the astigmatic distortion produced by single-ended dc amplifiers.

The sweep, or time-base, oscillator produces linear sweeps of from 15 cps to 30 kc per second. Two preset sweep frequencies of 30 cps and 7875 cps speed up signal tracing and trouble shooting in television deflection circuits and video circuits.

The WO-57A has many other features. It includes an internal sweep of power-line frequency and a phasing control which are especially useful in sweep alignment applications. The deflection switch permits reversing the direction of the sweep trace, so that response curves can be observed in the same direction relationship as shown in manufacturers' service note illustrations, thus simplifying interpretation and analysis. The sync polarity switch permits synchronizing and holding a steady pattern on the oscilloscope screen regardless of pulse polarity. The low-capacitance probe makes possible measurements in high-impedance circuits without serious capacitance-loading effects.

In addition to its conventional uses, the WO-57A may be employed in a wide variety of commercial and industrial applications requiring accurate reproduction of waveshapes.

Specifications

Electrical

Frequency Response

Vertical Amplifier:
- From 0 to 500 kc . . within 3 db down from maximum response
- From 0 to 1 Mc . . within 9 db down from maximum response

Horizontal Amplifier:
- From 20 cps to 100 kc within 3 db down from maximum response
- From 10 cps to 200 kc within 6 db down from maximum response

Input Resistance and Capacitance

Vertical Amplifier:
- Without Cable and Probes . . . 1 megohm shunted by 35 μμf
- With Direct Probe and Cable WG-218 1 megohm shunted by 90 μμf
- With Low-Capacitance Probe WG-216 1 megohm shunted by 14 μμf

Horizontal Amplifier:
- Without Cable and Probes 0.5 megohm shunted by 133 μμf

Sync Input:
- Without Cable and Probes . . 0.5 megohm shunted by 33 μμf

Deflection Sensitivity

Vertical Amplifier:	*volts per inch* rms	p-p
Without Cable and Probes	0.03	0.085
With Direct Probe and Cable WG-218	0.03	0.085
With Low-Capacitance Probe WG-216	0.3	0.85
Horizontal Amplifier:		
Without Cables and Probes	0.6	1.7

Sweep-Circuit Frequency

Variable . . . . . 15 cps to 30,000 cps

Preset:
- "TV/V" Position . . . . . 30 cps
- "TV/H" Position . . . . . 7875 cps

Tube Complement

4 RCA-6AU6, 1 RCA-12AX7, 1 RCA-6J6, 2 RCA-6X4, 1 RCA-3MP1

Input Voltages

DC/V INPUT Terminal:
- With Direct Probe & Cable WG-218 and V RANGE Switch Set for Max. Attenuation:
  - Approx. Voltage *(DC, AC P-P, or Combined Value)* for Full-Screen Deflection . . . . 150 volts
- With Low-Capacitance Probe WG-216:
  - Approx. AC Peak-to-Peak Voltage *(with up to 500 Volts DC Present)* for Full-Screen Deflection . . . . . 1500 volts
  - Max DC Voltage *(with No AC Voltage Present)* . . . . . 700 volts

AC/V INPUT Terminal:
- With Direct Probe & Cable WG-218 and V RANGE Switch Set for Max. Attenuation:
  - Max. DC Voltage Applied to Probe . . . . . 400 volts
  - Approx. AC Peak-to-Peak Voltage for Full-Screen Deflection . . . . . 150 volts
- With Low-Capacitance Probe WG-216:
  - Approx. AC Peak-to-Peak Voltage *(with up to 500 Volts DC Present)* for Full-Screen Deflection . . . . . 1500 volts
  - Max. DC Voltage *(with No AC Voltage Present)* . . . . . 700 volts

Power Supply

- Voltage Rating . . . . . 105-125 volts
- Frequency Rating . . . . . 50-60 cps
- Power Consumption . . . . . 70 watts

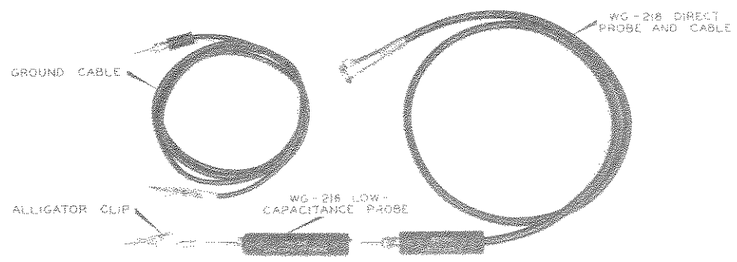
Mechanical

Dimensions

- Length . . . . . 13½ inches
- Height . . . . . 9¾ inches
- Depth . . . . . 7½ inches*
- Weight . . . . . (approx.) 18 pounds
- Finish . . . . . blue-gray hammeroid case, anodized satin aluminum panels

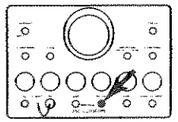
*Overall depth greater than above value due to CRT shield.

Accessory WG-214 Probe and Cable Kit

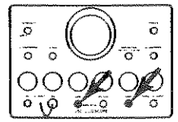


The WG-214, available on separate order, includes a WG-218 Direct Probe and Cable, a WG-216 Low-Capacitance Probe, a Ground Cable (Stock No. 48996), and a Slip-On Alligator Clip (Stock No. 59410). This kit has been especially assembled for use with the WO-57A Cathode-Ray Oscilloscope.

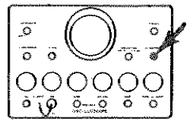
Functions of Controls and Terminals



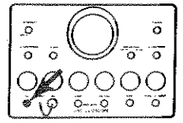
AC CAL terminal
The internal calibrating voltage is available at this terminal. When the vertical amplifier is to be calibrated, the calibrating voltage is applied directly to the AC/V INPUT terminal, the V RANGE switch is turned to position "1.0", and the V CAL control is adjusted for a total signal deflection of one inch on the screen of the cathode-ray tube.



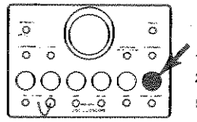
GND terminals
Are directly connected to the chassis of the oscilloscope; serve as a common ground for the chassis of the equipment under test and associated test instruments.



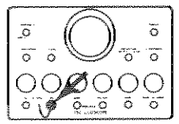
H CENTERING control
Adjusts the horizontal position of the trace.



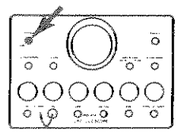
AC/V INPUT terminal
Provides a connection to the vertical amplifier through a blocking capacitor.



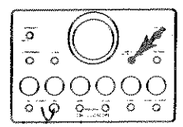
H GAIN control
Adjusts the gain of the horizontal amplifier to give the desired trace width.



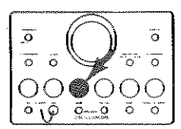
DC/V INPUT terminal
Provides a direction connection to the vertical amplifier.



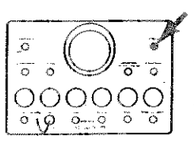
INTENSITY control
Has two functions; applies power to the instrument when turned clockwise from "OFF" position, and controls the intensity of the spot on the screen of the cathode-ray tube.



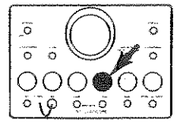
DEFLECTION switch
Reverses the direction of the horizontal sweep trace.



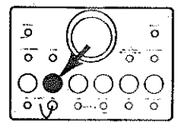
PHASE ADJ/SWEEP VER control
Serves two functions; provides continuous control of the sweep frequency over the band selected by the SWEEP RANGE control, and controls the phase of the internal sinusoidal sweep when the SYNC/H SEL switch is in "LINE" position. The PHASE ADJ/SWEEP VER control is not used when the SWEEP RANGE selector is in "TV/H" or "TV/V" position.



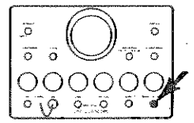
FOCUS control
Adjusts the sharpness of the pattern on the screen of the cathode-ray tube. Normally requires adjustment when the setting of the INTENSITY control has been changed.



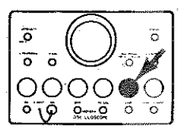
SWEEP RANGE selector
Selects the frequency band of the sweep oscillator. Positions "TV/H" and "TV/V" give preset sweep frequencies for viewing horizontal- and vertical-deflection circuit waveshapes, sync-separator waveshapes, and composite television signals.



SYNC ADJ control
Controls the amplitude of the synchronizing voltage applied to the grid of the sweep oscillator. Adjust to minimum setting necessary to lock pattern in a stationary position.



SYNC/H INPUT terminal
At this terminal, the external synchronizing or horizontal-deflection voltages are applied to the oscilloscope.



SYNC/H SEL switch
Has three functions; selects sync voltages for the sweep oscillator, applies an external horizontal-deflection voltage to the horizontal amplifier, and applies a sine wave to the horizontal amplifier.

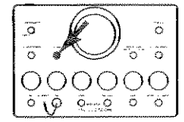
Position "INT—"—Selects the synchronizing voltage from the vertical amplifier. The trace flyback starts during the negative-going excursion of the voltage applied to the vertical amplifier.

Position "INT+"—Selects the synchronizing voltage from the vertical amplifier. The trace flyback starts during the positive-going excursion of the voltage applied to the vertical amplifier.

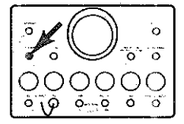
Position "EXT"—Feeds the external sync voltage applied at the SYNC/H INPUT terminal to the sweep oscillator.

Position "LINE"—Applies a sine wave of power-line frequency to the horizontal amplifier.

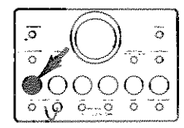
Position "INPUT"—Feeds the external-deflection voltage applied at the SYNC/H INPUT terminal to the horizontal amplifier.



V CAL control
Permits continuous adjustment of the vertical-amplifier gain. In calibrating the vertical amplifier, rotate the V CAL control until the calibrating voltage is deflected a total of one inch when the V RANGE switch is in "1.0" position.



V CENTERING control
Adjusts the vertical position of the trace.



V RANGE switch
Controls the degree of attenuation of the input voltage. After the vertical amplifier has been calibrated, multiply the setting of the V RANGE switch by the total deflection in inches to determine the signal voltage.

When the Direct Probe and Cable WG-218 is used, the attenuation is as indicated below for each switch position. When the Low-Capacitance Probe WG-216 is used, the attenuation is 10 times as great as indicated below.

Position "0.1"—Zero attenuation. Signal voltage attenuated 1 to 1.

Position "0.3"—Signal voltage attenuated 3.3 to 1.

Position "1.0"—Signal voltage attenuated 10 to 1.

Position "3.0"—Signal voltage attenuated 33 to 1.

Position "10"—Signal voltage attenuated 100 to 1.

Position "30"—Signal voltage attenuated 330 to 1.

Operation

General

Before attempting any applications, the operator is advised to familiarize himself with the instrument by following the procedure outlined below.

1. Connect the power cord at the rear of the oscilloscope to an ac outlet supplying 105-125 volts at 50-60 cycles.

2. Turn the INTENSITY control clockwise from "OFF" position, and wait a few seconds for the instrument to warm up.

3. Rotate the INTENSITY control further clockwise until a spot or a horizontal line appears on the screen. The spot, or line, should increase in brilliance as the control is turned clockwise.

CAUTION: Do not allow a small spot of high brilliancy to remain on the screen for an appreciable length of time, as discoloration or burning of the screen may result.

4. Adjust the FOCUS control for an image of maximum sharpness.

5. Turn the SYNC/H SEL switch to "INPUT" position. Unless an external signal is applied to the SYNC/H INPUT terminal, only a spot will show on the screen, illustrating that no sweep voltage is being applied to the horizontal deflection electrodes of the CRT when the SYNC/H INPUT switch is in this position. For the present, no signal will be applied to the SYNC/H INPUT terminal.

6. Position the spot in the center of the screen by adjusting the V CENTERING and the H CENTERING controls.

7. Apply the signal of power-line frequency which is available at the AC CAL terminal directly to the AC/V INPUT terminal. The screen should now display a vertical trace, illustrating that the signal has been applied to the vertical-deflection electrodes of the CRT through the V/INPUT terminal.

8. Adjust height of the vertical trace, in steps by turning the V RANGE switch, and continuously by turning the V CAL control. (If rotation of the V CAL control causes the position of the trace to move vertically, adjust the vertical-balance control, located on the rear apron of the chassis, until movement is no longer evident.)

9. Remove the signal from the AC/V INPUT terminal; the stationary spot will reappear.

10. Apply the signal available at the AC CAL terminal directly to the SYNC/H INPUT terminal, and turn the H GAIN control to its medium position. A horizontal line will appear on the screen; the signal has now been applied to the horizontal-deflection electrodes of the CRT.

NOTE: Whenever it is necessary to use an external sweep voltage, turn the SYNC/H SEL switch to "INPUT" position and apply the external sweep voltage to the SYNC/H INPUT position.

11. Remove the signal from the SYNC/H INPUT terminal. The spot will reappear.

12. Turn the SYNC/H SEL switch to "LINE" position. A horizontal trace will appear.

NOTE: When the SYNC/H SEL switch is in "LINE" position, a part of the power-line signal is internally fed to the horizontal amplifier, so that the horizontal-deflection voltage is a sine wave of power-line frequency. The "LINE" position is used whenever a sinusoidal sweep of line frequency is needed.

13. When the SYNC/H SEL switch is in "LINE" position, the PHASE ADJ/SWEEP VER control can be used to adjust the phase of the internal sinusoidal sweep.

14. Turn the SYNC/H SEL switch to "INPUT" position. The spot will reappear.

15. Turn the SYNC/H SEL switch to "INT+" or "INT—" position. A horizontal trace will appear.

NOTE: When the SYNC/H SEL switch is in "INT+", "INT—", or "EXT" position, the saw-tooth output of the sweep oscillator is internally applied to the horizontal amplifier, and a linear horizontal trace appears on the face of the CRT.

16. Adjust the SWEEP RANGE selector and the PHASE ADJ/SWEEP VER control to give a sweep of approximately line frequency. (This sweep frequency can be checked by applying a signal of line frequency to a V INPUT terminal and adjusting the controls for a single cycle.)

NOTE: When the SYNC/H SEL switch is in "INT+", "INT—", or "EXT" position, the frequency of the sweep voltage is determined by turning the SWEEP RANGE selector to the range position which includes the desired frequency and then adjusting the PHASE ADJ/SWEEP VER control to the desired frequency.

17. Apply the signal at the AC CAL terminal directly to the AC/V INPUT terminal. A single cycle of the signal waveshape now appears on the screen.

NOTE· The pattern may travel across the screen, a condition which would indicate that the sweep voltage is not of the proper frequency. Adjust the PHASE ADJ/SWEEP VER control until a single cycle appears on the screen.

18. Change the settings of the SWEEP RANGE selector and the PHASE ADJ/SWEEP VER control a few times, and note that the pattern viewed may change each time these controls are readjusted.

19. Turn the DEFLECTION switch to the position not in use, and note the direction reversal of the pattern.

20. Work the INTENSITY, FOCUS, V CAL, and H GAIN controls, and note the effects on the pattern.

21. Remove the signal from the AC/V INPUT terminal and apply an external signal of a different frequency.

22. Set the SYNC/H SEL switch to "EXT" position, and adjust the SWEEP RANGE selector and the PHASE ADJ/SWEEP VER control to produce a suitable sweep frequency.

23. If the pattern travels horizontally across the screen, apply a synchronizing voltage of the same frequency as that of the input voltage to the SYNC/H INPUT terminal, and find the SYNC ADJ control position which makes the pattern stationary.

24. Adjust the INTENSITY and FOCUS controls to give a clear, sharp trace on the screen.

25. In order to derive the most profitable use from the Cathode-Ray Oscilloscope, the operator should repeat the above procedure until he is thoroughly familiar with the controls.

Calibration of Vertical Amplifier and Voltage Measurements

When the oscilloscope is to be used to measure signal voltages, the vertical amplifier should be calibrated according to the following procedure:

1. Orientate the calibration screen with respect to the vertical and horizontal axes of the cathode-ray tube.

2. Using the Direct Probe and Cable WG-218, apply the calibrating voltage available at the AC CAL terminal directly to the AC/V INPUT terminal.

3. Turn the SYNC/H SEL switch to "INPUT" position. (A vertical trace will appear.)

4. Set the V RANGE switch to "1.0" position and adjust the V CAL control to give a total vertical deflection of one inch (one-half inch above the center of the deflection scale and one-half inch below.)

NOTE: Do not change the setting of the V CAL control while voltage measurements are being made. Otherwise, the vertical amplifier will have to be recalibrated.

5. Remove the calibrating voltage from the AC/V INPUT terminal.

6. After the vertical amplifier is calibrated, voltage measurements may be made in the following manner:

a. Using the Direct Probe and Cable and the Ground Lead of the WG-214 Probe and Cable Kit, apply the signal to be measured across the proper V INPUT terminal and a GND terminal.

b. Change the setting of the V RANGE switch to give a vertical deflection of convenient amplitude.

c. Calculate the peak-to-peak voltage by multiplying the V RANGE setting by the total vertical deflection measured in inches.

d. In order to obtain the waveshape itself on the oscilloscope screen, set the SYNC/H SEL switch to "INT—" or "INT+", and adjust the SWEEP RANGE switch and the PHASE ADJ/SWEEP VER control to produce a suitable pattern on the screen.

NOTE: The Low-Capacitance Probe WG-216 may also be used for voltage measurements. Here the procedure is the same except that the result obtained in step "c" above must be multiplied by 10, in order to compensate for the greater signal attenuation of the Low-Capacitance Probe.

When the Low-Capacitance Probe WG-216 is used in critical high-impedance circuits where dc is present, such as the grid circuit of the vertical-blocking oscillator in a television receiver, a suitable blocking capacitor should be used to prevent dc loading effects. For this purpose, a high-quality, low-leakage, paper capacitor of 0.5 μf (or larger) is suggested.

Applications

Applications in Television

Analyzing Composite Television Waveforms

The successful servicing and maintenance of modern television receivers requires techniques not usually employed in the servicing of the less intricate circuits found in broadcast and short-wave receivers. Foremost in these new techniques is the analysis of television waveforms, such as sync pulses, deflection waveforms, composite video waveforms, etc., and from that analysis, the step-by-step tracing of a waveform fault to the defective component producing it. Probably the most important waveform encountered in television service work is the composite video waveform consisting of the video signal, the blanking pedestals, and the sync pulses. Two photographs of the composite video signal are shown in Figure 1.

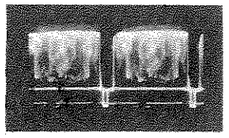


Figure 1A. Horizontal Sync Pulse

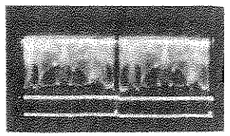


Figure 1B. Vertical Sync Pulse

The television serviceman should devote some time to the study of such waveforms by setting up a television receiver known to be in good operating condition, and noting the waveforms on the WO-57A oscilloscope at various points in the video amplifier. Traces similar to those shown in Figure 1 are obtained on the WO-57A Oscilloscope as follows:

1. Tune the television receiver to a television signal.

2. Rotate the INTENSITY control on the oscilloscope fully clockwise. Set the SYNC/H SEL switch to "INT+" or "INT—", and adjust the H GAIN control for a horizontal line of convenient length. Set the INTENSITY and FOCUS controls for the desired brightness and best focus.

3. Connect the WG-218 Direct Probe and Cable to the AC/V INPUT terminal and attach the WG-216 Low-Capacitance Probe to the probe end. Connect the Ground Cable to the television receiver chassis, and the WG-216 to the signal-grid terminal on the socket of the picture tube. (The picture tube in the receiver need not be in its socket for this test.)

4. Set the V RANGE switch and the V CAL control for a pattern of convenient height.

5. In order to obtain the horizontal sync pulse on the oscilloscope screen, proceed as follows:

   a. Set the SWEEP RANGE selector at "TV/H" position.

   b. Lock the pattern in a stationary position by advancing the SYNC ADJ control. NOTE: To avoid distortion of the pattern, always use the minimum setting of the SYNC ADJ control necessary to hold the pattern still. The pattern obtained on the oscilloscope screen should be similar to that shown in Figure 1A.

   c. In order to change the number of cycles of the horizontal sync pulse appearing on the oscilloscope screen, reset the SWEEP RANGE selector, the PHASE ADJ/SWEEP VER control, and the SYNC ADJ control to give a sweep frequency which is a submultiple of the signal frequency (in this case 15,750 cps).

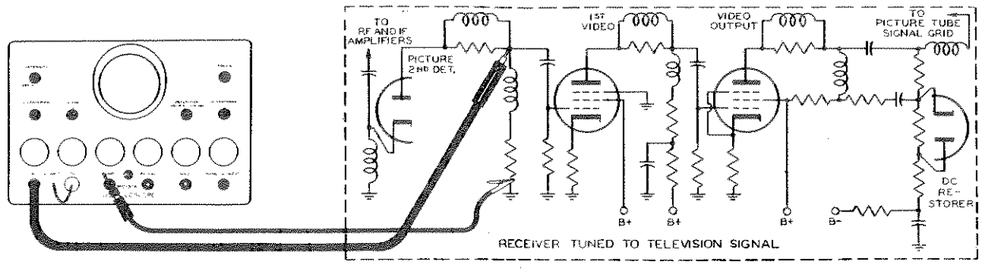


Figure 2. Video-Amplifier Test Setup

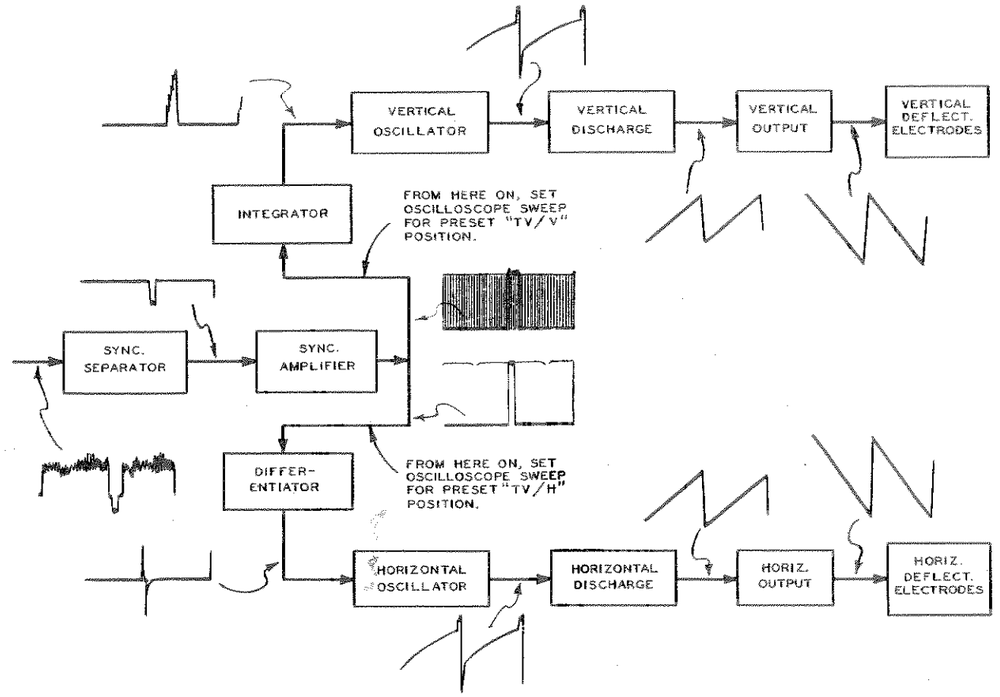


Figure 3. Signal Tracing in Sync and Deflection Circuits

6. In order to obtain the vertical sync pulse on the oscilloscope, the procedure to be followed is the same as that in paragraph 5 above, except that the preset "TV/V" position of the SWEEP RANGE selector is used instead of the "TV/H" position. The pattern should resemble that in Figure 1B.

To afford practice in tracing and observing the video signal, place the WG-216 Low-Capacitance Probe at various points in the video-amplifier circuit. The oscilloscope controls should be manipulated until the operation of the instrument is completely understood, for in the hands of an experienced operator, the WO-57A Oscilloscope is a valuable television service tool.

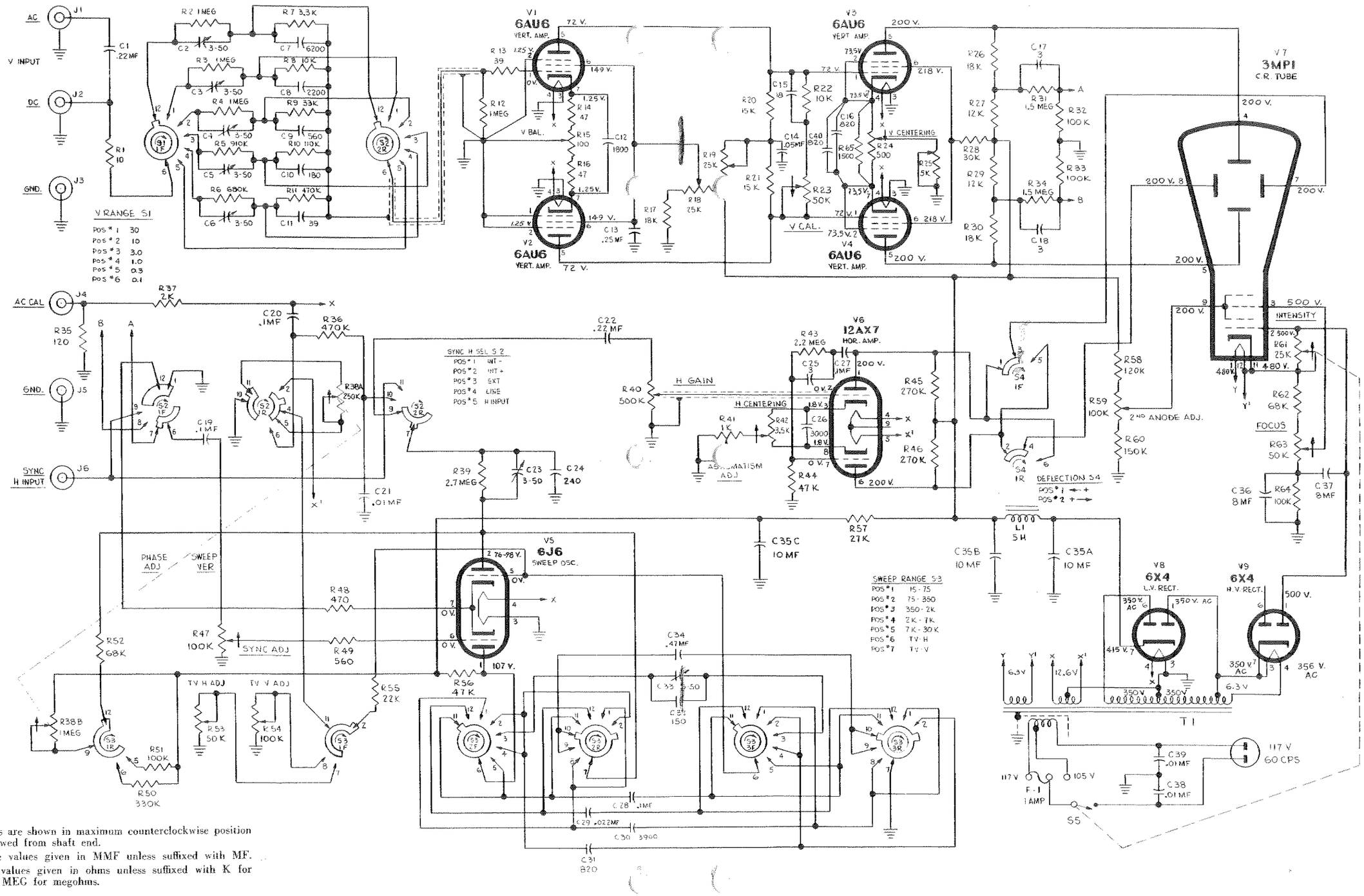
Signal Tracing in Video Amplifiers

The method of tracing a signal through the video amplifier of a television receiver is analogous to the method used in tracing an audio signal through the audio amplifier of a broadcast receiver. However, because of the wider band of frequencies handled by video amplifiers, greater care must be used to avoid changing the response characteristics when the oscilloscope probe is applied to the circuit under test.

A schematic diagram of a typical video amplifier, together with the oscilloscope probe connections used in signal tracing, is shown in Figure 2. The receiver and the oscilloscope should be set up and operated as explained in the foregoing section on composite signal waveform analysis.

The composite signal first appears across the picture-detector load; in Figure 2, the oscilloscope cables are shown connected at this point. If the waveform does not look like the waveform of Figure 1, or if the signal is absent, then the fault is ahead of the detector load. If the signal is present and normal in waveform, then the probe can be moved forward stage by stage, toward the picture tube. In going from grid to plate of each tube, the signal should appear amplified and inverted, although the waveshape remains otherwise unchanged. When the signal deviates from normal, then the fault is isolated to a stage where the deviation occurs, and a simple voltage and resistance check or tube check is usually enough to locate the defective component.

(Continued on Page 15)



All switches are shown in maximum counterclockwise position and are viewed from shaft end.

Capacitance values given in MMF unless suffixed with MF.

Resistance values given in ohms unless suffixed with K for kilohms or MEG for megohms.

Figure 4. Schematic Diagram

Replacement Parts List

Type WO-57A

Cathode-Ray Oscilloscope

When ordering Replacement Parts, please state Serial Number and Code Number of Instrument.

Symbol No.	Description	Stock No.
	Capacitors, Fixed and Variable	
C 1	Molded paper tubular, 0.22 μf, ± 20%, 400 volts	73794
C 2, 3, 4, 5, 6	Variable mica, 3-50 μμf, 500 volts	59220
C 7	Fixed mica, 6200 μμf, ± 5%, 500 volts	56989
C 8	Fixed mica, 2200 μμf, ± 5%, 500 volts	39660
C 9	Fixed mica, 560 μμf, ± 5%, 300 volts	39646
C 10	Fixed mica, 180 μμf, ± 5%, 500 volts	65141
C 11	Fixed mica, 39 μμf, ± 5%, 500 volts	39618
C 12	Fixed mica, 1800 μμf, ± 10%, 500 volts	39658
C 13	Paper tubular, 0.25 μf, ± 20%, 400 volts	70618
C 14	Paper tubular, 0.05 μf, ± 20%, 400 volts	73553
C 15	Fixed mica, 18 μμf, ± 10%, 500 volts	39610
C 16	Fixed mica, 820 μμf, ± 10%, 300 volts	39650
C 17, 18	Mica, 3 μμf, ± 10%, 500 volts	59764
C 19	Molded paper tubular, 0.1 μf, ± 20%, 400 volts	73551
C 20	Paper tubular, 0.1 μf, ± 20%, 200 volts	73784
C 21	Fixed paper tubular, 0.01 μf, ± 20%, 400 volts	73561
C 22	Same as C 1	
C 23	Same as C 2	
C 24	Fixed mica, 240 μμf, ± 10%, 500 volts	72789
C 25	Same as C 17	
C 26	Fixed mica, 3000 μμf, ± 10%, 500 volts	47024
C 27, 28	Paper tubular, 0.1 μf, ± 10%, 400 volts	73551
C 29	Molded tubular, 0.022 μf, ± 10%, 400 volts	73562
C 30	Fixed mica, 3900 μμf, ± 10%, 500 volts	39666
C 31	Same as C 16	
C 32	Fixed mica, 150 μμf, ± 10%, 500 volts	39632
C 33	Same as C 2	
C 34	Molded tubular, 0.47 μf, ± 10%, 200 volts	73787
C 35 A, B, C	Electrolytic, 10-10-10 μf, 450 volts	28113
C 36, 37	Paper tubular, electrolytic, 8 μf, 450 volts	72139
C 38, 39	Same as C 21	
C 40	Same as C 16	
C 100	Tubular trimmer, 1-8 μμf, 500 volts	93874
	Fuse	
F 1	Fuse, cartridge, glass tube, 1 amp.	14133
	Jacks and Connectors	
J 1, 2	Jack, AC and DC Vertical Input	54695
J 3	Jack, Ground, Blue	55239
J 4	Jack, AC Calibration, Red	55238
J 5	Same as J 3	
J 6	Same as J 4, Sync/Horizontal Input	
	Inductor	
L 1	Reactor, filter, 5 h., 200 ohms, 70 ma	59234
	Resistors, Fixed and Variable	
R 1	Fixed composition, 10 ohms, ± 20%, ½ watt	34761
R 2, 3, 4	Fixed composition, 1 meg., ± 5%, ½ watt	30652
R 5	Fixed composition, 910,000 ohms, ± 5%, ½ watt	71667
R 6	Fixed composition, 680,000 ohms, ± 5%, ½ watt	30562
R 7	Fixed composition, 3300 ohms, ± 5%, ½ watt	30733
R 8	Fixed composition, 10,000 ohms, ± 5%, ½ watt	3078
R 9	Fixed composition, 33,000 ohms, ± 5%, ½ watt	30685
R 10	Fixed composition, 110,000 ohms, ± 5%, ½ watt	2732
R 11	Fixed composition, 470,000 ohms, ± 5%, ½ watt	30648
R 12	Same as R 2	
R 13	Fixed composition, 39 ohms, ± 20%, ½ watt	11956
R 14	Fixed composition, 47 ohms, ± 20%, ½ watt	30732
R 15	Variable wire-wound, 100 ohms (Vertical Balance)	51081
R 16	Same as R 14	
R 17	Fixed composition, 18,000 ohms, ± 10%, 2 watts	39158
R 18, 19	Adjustable, wire-wound, 25,000 ohms, 25 watts	71664
R 20, 21	Fixed composition, 15,000 ohms, ± 10%, 2 watts	68935
R 22	Fixed composition, 10,000 ohms, ±10%, ½ watt	44294
R 23	Variable carbon, 50,000 ohms (Vertical Calibration) audio taper	36062
R 24	Variable carbon, 500 ohms (Vertical Centering) linear taper	54590
R 25	Adjustable wire-wound, 5,000 ohms, 10 watts	29260
R 26	Same as R 17	
R 27	Fixed composition, 12,000 ohms, ± 10%, 2 watts	43765
R 28	Fixed composition, 30,000 ohms, ± 10%, 2 watts	48609
R 29	Same as R 27	
R 30	Same as R 17	
R 31	Fixed composition, 1.5 meg., ± 10%, ½ watt	31449
R 32, 33	Fixed composition, 100,000 ohms, ± 20%, ½ watt	3252
R 34	Same as R 31	
R 35	Fixed composition, 120 ohms, ± 10%, ½ watt	30189
R 36	Fixed composition, 470,000 ohms, ± 20%, ½ watt	30648
R 37	Fixed composition, 2,000 ohms, ± 5%, ½ watt	33573
R 38 A, B	Variable carbon, dual, 1 meg. and 250,000 ohms (Phase Adjust and Sweep Vernier)	56135
R 39	Fixed composition, 2.7 meg., ± 20%, ½ watt	72788
R 40	Variable carbon, 500,000 ohms (Horizontal Gain) audio taper	38409
R 41	Variable carbon, 1000 ohms (Astigmatism Adjust) linear taper	46396
R 42	Variable carbon, 3500 ohms (Horizontal Centering)	59221
R 43	Fixed composition, 2.2 meg., ± 10%, ½ watt	30649
R 44	Fixed composition, 47,000 ohms, ± 10%, ½ watt	30787
R 45, 46	Fixed composition, 270,000 ohms, ± 10%, ½ watt	30651
R 47	Variable carbon, 100,000 ohms (Sync Adjust) linear taper	56141
R 48	Fixed composition, 470 ohms, ± 10%, ½ watt	30499
R 49	Fixed composition, 560 ohms, ± 20%, ½ watt	5164
R 50	Fixed composition, 330,000 ohms, ± 10%, ½ watt	14983
R 51	Same as R 32	
R 52	Fixed composition, 68,000 ohms, ± 20%, ½ watt	14138
R 53	Variable carbon, 50,000 ohms (TV Horizontal Adjust)	58726
R 54	Variable carbon, 100,000 ohms (TV Vertical Adjust and Second Anode Adjust)	56144
R 55	Fixed composition, 22,000 ohms, ± 10%, ½ watt	30492
R 56	Fixed composition, 47,000 ohms, ± 10%, 1 watt	71988
R 57	Fixed composition, 27,000 ohms, ± 10%, 1 watt	71990
R 58	Fixed composition, 120,000 ohms, ± 20%, ½ watt	30180
R 59	Same as R 54	
R 60	Fixed composition, 150,000 ohms, ± 20%, ½ watt	30493
R 61	Variable carbon, 25,000 ohms (Intensity) linear with SPST switch	58730
R 62	Same as R 52	
R 63	Variable carbon, 50,000 ohms (Focus)	71677
R 64	Fixed composition, 100,000 ohms, ± 20%, 1 watt	72635
R 65	Fixed composition, 1500 ohms, ± 10%, ½ watt	30654
R 100	Fixed composition, 0.91 meg., ± 5%, ½ watt	2732
R 101	Fixed composition, 0.11 meg., ± 5%, ½ watt	71667
	Switches	
S 1	Rotary, 2 section, 6 position (Vertical Range)	59222
S 2	Rotary, 2 section, 5 position (Sync/Horizontal Selector)	59223
S 3	Rotary, 3 section, 7 position (Sweep Range)	59224
S 4	Rotary, 1 section, 2 position (Deflection)	59225
S 5	SPST "On-Off" switch (Part of R 61)	
	Transformer	
T 1	Transformer, plate and filament (Special)	59226
	Fuse Holder	
XF 1	Holder—Fuse	59227
	Tube Sockets	
XV 1, 2, 3, 4, 5	Socket, tube, 7 pin, miniature	59228
XV 6	Socket, tube, 9-pin, miniature	59229
XV 7	Socket, tube, 12-pin, small shell, duodecal	59230
XV 8, 9	Same as XV 1	
	Miscellaneous	
	Binding Post, pin-plug type	47062
	Escutcheon, black molded rubber for front end of tube	59233
	Knob, control, large pointer type, push-on (Blue)	53683
	Knob, control, small with set screw (Blue)	53689
	Screen, graph screen	59235

(Continued from Page 11)

Whenever possible, the WG-216 Low-Capacitance Probe should be used for video-amplifier signal tracing because of the low input capacitance and consequent negligible loading of this probe. However, this probe attenuates the signal by a factor of ten, so that the direct probe may prove to be more useful in low-level stages.

Signal Tracing in Sync and Deflection Circuits

Loss of picture synchronization is quickly and easily traced to its source with the WO-57A Oscilloscope by viewing the waveforms found in the TV sync and deflection circuits. A block diagram of a typical television-receiver sync and deflection circuit is shown in Figure 3. The various waveforms appearing on the diagram illustrate the waveforms which should be seen as the probe is moved from the input of the sync separator to the points indicated in the horizontal and vertical oscillators. These waveforms will differ in receivers of different make, but the signal-tracing procedure will remain the same. Some manufacturers include, in their television service notes, photographs or diagrams of the waveforms to be expected at various points in the circuit. In this case, the signal tracing procedure is simple; merely compare the diagrams with the waveforms actually seen on the oscilloscope to determine the location of the fault.

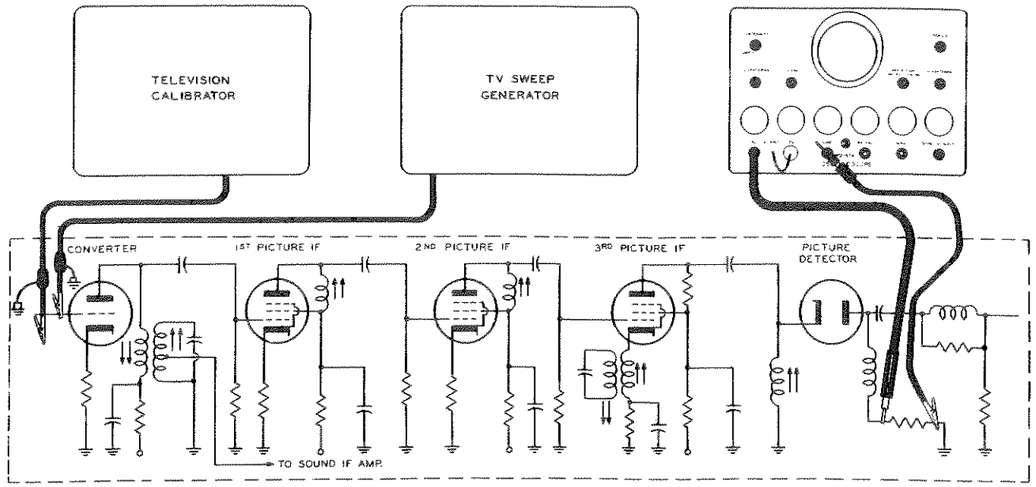


Figure 5. Setup for Alignment of Picture-IF Amplifier

Faults in deflection are traced in the same manner as are faults in synchronization. The probe is placed first at the horizontal or vertical oscillator to determine whether or not it is operating, and, if so, the signal is traced through the discharge tube to the deflection output stage and finally the deflection plates (or coils, if electromagnetic deflection is used). Here, as in the tracing of sync signals, the serviceman must understand the functions of the circuits under test in order to interpret properly the waveforms observed on the oscilloscope.

CAUTION: In modern television receivers, very high pulse voltages, often several thousand volts, exist in deflection circuits. See "Input Voltages" — under Specifications.

Measuring Peak-to-Peak Voltages

Often, in signal tracing, it is necessary to know the peak-to-peak voltage of the waveform observed on the oscilloscope. This may be necessary to determine whether or not a video stage is operating with sufficient gain, for example, or to determine whether or not sufficient sync signal exists at the deflection oscillators. The procedure for making voltage measurements is given under "Calibration of Vertical Amplifier".

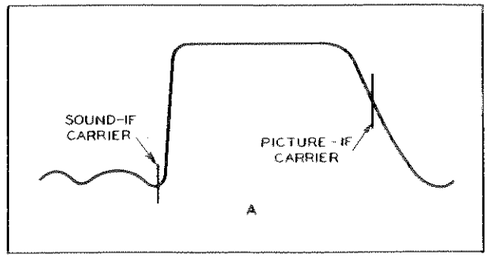


Figure 6. Picture-IF Response

Aligning Picture-IF Circuits

Because of the unusual shape of the picture-if amplifier response curve, visual alignment is required. In addition to the WO-57A Oscilloscope, a sweep generator, such as the RCA WR-59B Television Sweep Generator, and a marker oscillator, such as the RCA WR-39B Television Calibrator, are needed. The setup is as shown in Figure 5. The manufacturer's service notes should be consulted for alignment instructions, but a general alignment procedure is as follows:

1. Set up the equipment as shown in Figure 5. Tune the sweep generator to sweep the picture-if frequency.

2. If the sweep generator uses a sinusoidal sweep of line frequency, set the SYNC/H SEL switch on "LINE", and adjust the PHASE ADJ/SWEEP VER control to give a single pattern on the oscilloscope screen. If the sweep generator uses a saw-tooth sweep, feed the sweep-voltage output of the generator to the horizontal input terminals on the oscilloscope, and set the SYNC/H SEL switch to "INPUT" position and the H GAIN control to a position which will give a horizontal deflection of convenient length.

3. Adjust the tuning adjustments in the if amplifier to give a curve like that shown in Figure 6. With the WR-39B Television Calibrator, check the positions of the picture and sound carriers and the traps. The direction of the curve may be reversed by switching the DEFLECTION switch to its alternate position.

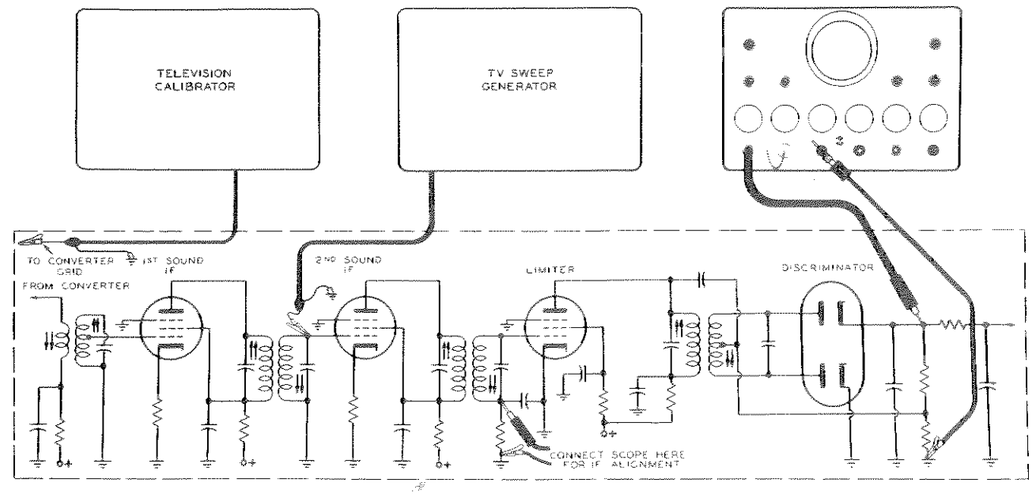


Figure 7. Setup for Alignment of Sound-IF Amplifier

CAUTION: Do not use too large a signal from the sweep generator when aligning the if amplifiers. Too large a signal may overdrive the amplifiers, thus producing a flat-top response curve even though the amplifier is incorrectly aligned. If the signal level is kept low enough so that a little noise is observed on the response curve, no difficulty of this type will be experienced.

Aligning Sound-IF Circuits

The procedure for visually aligning television sound-if circuits is the same as that used for visual alignment of the if system in a FM receiver. However, the reader is once again advised to consult the manufacturer's service notes before attempting alignment.

A suggested alignment procedure is outlined below. The setup for this procedure is illustrated in Figure 7.

1. Tune the sweep generator to the sound-if frequency.

2. Connect the Direct Probe and Cable across the limiter grid resistor and to the oscilloscope, as indicated in Figure 7. If the sweep generator uses a sinusoidal sweep of line frequency, set the SYNC/H SEL on "LINE", and adjust the PHASE ADJ/SWEEP VER control to give a single pattern on the oscilloscope screen. If the sweep generator uses a saw-tooth sweep, feed the sweep-voltage output of the generator to the horizontal-deflection terminals on the oscilloscope, and set the SYNC/H SEL switch to "INPUT" position and the H GAIN control to a position which will give a horizontal deflection of convenient length.

3. Feed the signal from the sweep generator to the grid of the stage preceding the limiter, and adjust the transformer in the limiter grid circuit for a curve like that shown in Figure 8A. The WR-39B Television Calibrator should be set at the sound intermediate frequency, and the curve should be symmetrical about the marker from the Television Calibrator.

4. Move the sweep-generator output cable back stage by stage, each time adjusting the proper transformer for the curve of Figure 8A.

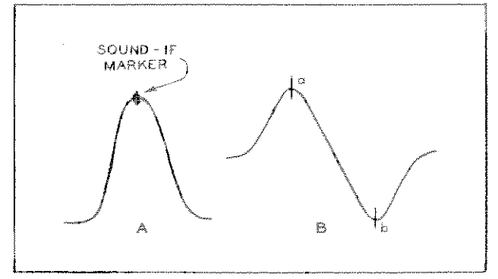


Figure 8. Sound-IF Response and Discriminator Response

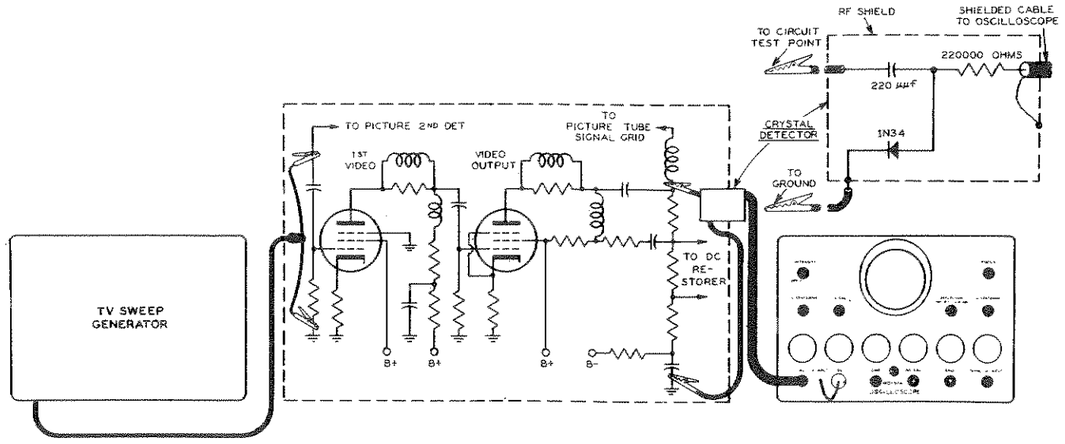


Figure 9. Setup for Checking Video-Amplifier Response

Discriminator Alignment

Connect the output cable of the sweep generator to the if-amplifier input, and the Direct Probe and Cable and the Ground Cable of the WO-57A across the discriminator output. (See Figure 7.)

The discriminator response is illustrated in Figure 8B. Adjust the secondary of the discriminator transformer for maximum symmetry of the response curve, and adjust the primary for maximum linearity between points a and b, Figure 8B.

Aligning RF Circuits

Different manufacturers recommend different methods for the alignment of the rf sections of their receivers; therefore, the oscilloscope should be used as described in the manufacturer's service notes. A method of aligning the rf section will be given here, but in all cases where service notes are available, the rf-alignment instructions therein should be given preference.

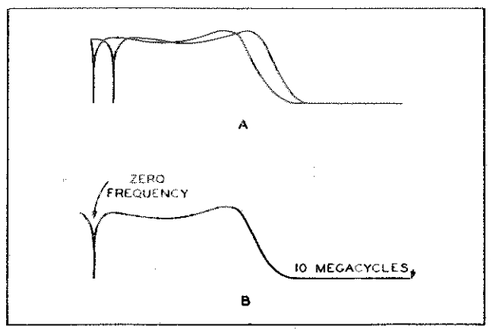


Figure 10. Video-Amplifier Response

For this method, the picture-if channel must first be properly aligned, and the oscillator in the rf section must be tuned to the correct frequency for each channel. The oscilloscope and the sweep generator should be set up as described for alignment of the picture-if amplifier, and the picture-if response curve made to approximate the curve shown in Figure 6.

The sweep-generator output cable is then transferred to the antenna terminal of the receiver, and the generator is tuned to sweep channel 13. The receiver is also tuned to channel 13. Make all necessary circuit adjustments associated with channel 13 to produce on the oscilloscope screen an if response of maximum amplitude and one which closely approximates the response curve illustrated in Figure 6.

This procedure is repeated for the remainder of the rf channels. In each case, the receiver is tuned to the channel being adjusted, and the sweep generator is tuned to sweep the proper frequency band.

Checking Video-Amplifier Frequency Response

Note in Figure 9 that a crystal detector is used in this application. The purpose of the detector is to rectify the output of the sweep generator applied to the video amplifier so that it can be properly viewed on the oscilloscope screen. In order to minimize circuit loading, use a detector of approximately the same input capacitance as the input capacitance of the kinescope grid. The schematic diagram of a suitable crystal detector is illustrated in Figure 9.

A graphical representation of the response curve of a video amplifier may be obtained on the oscilloscope as follows:

1. Set up the equipment as shown in Figure 9. Set the SYNC/H SEL to "LINE" position. A pattern similar to that shown in Figure 10A should be obtained.

2. Adjust the PHASE control until the two patterns coincide so that a single pattern similar to that of Figure 10B is obtained.

General Applications

Phase-Shift Measurements

To measure the phase shift of an audio network, apply a sine wave to the circuit under test. Then apply the signal as it appears at the input of the circuit under test across the SYNC/H INPUT and GND terminals of the WO-57A, and the output from the test circuit to the AC/V INPUT terminal. Set the SYNC/H SEL switch to "INPUT" position. If no phase shift exists, a sloping straight-line image will appear. Phase shift is indicated as an elliptical or circular trace. Refer to Figure 11 for the method of calculating phase shift.

Frequency Measurements

Two methods may be employed in using the WO-57A for frequency measurements. In one method, a sine wave of known frequency is applied to the SYNC/H INPUT terminal, and a sine wave of the frequency which is to be determined is applied to the V INPUT terminal. The pattern which appears on the oscilloscope screen, known as a Lissajou figure, indicates the ratio between the known and the unknown frequency. Several typical Lissajou figures are illustrated in Figure 12.

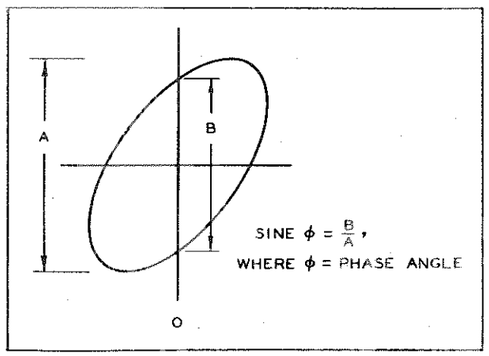


Figure 11. Measurement of Phase Shift

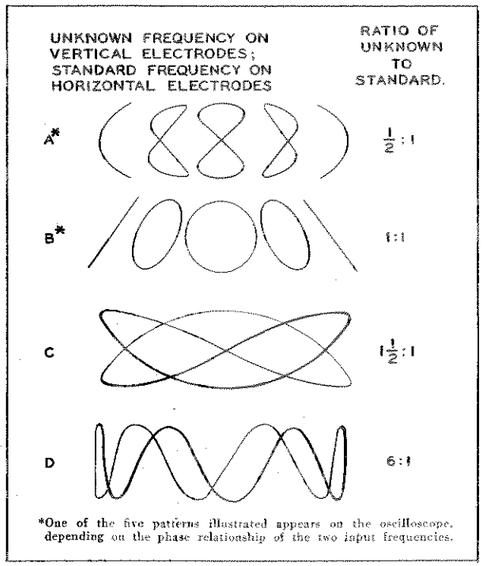


Figure 12. Lissajou's Figures for Frequency Determination

In the other method of frequency measurement, the SYNC/H SEL switch is set at "INT+" or "INT—" position. The SWEEP RANGE selector and the PHASE ADJ/SWEEP VER control are adjusted to produce a linear sweep of line frequency. The signal of unknown frequency is applied to a V INPUT terminal. If a stationary pattern is obtained on the oscilloscope screen, the frequency of the input signal must be equal to, a submultiple of, or a multiple of the line frequency.

AC-Voltage Measurements

After the instrument is calibrated as described under "Calibration of Vertical Amplifier", any ac voltage may be measured as follows:

1. Connect the AC/V INPUT terminal and a GND terminal across the voltage to be measured.

2. Set the V RANGE switch so that a readable vertical deflection is obtained. The peak-to-peak value of the measured voltage is then equal to the setting of the V RANGE switch multiplied by the number of inches of vertical deflection as shown on the graph screen. If the voltage measured is a sine wave, then the rms value of the voltage can be computed by multiplying the peak-to-peak value by .354.

NOTE: Do not touch the V CAL control after the instrument has been calibrated, or recalibration will be necessary.

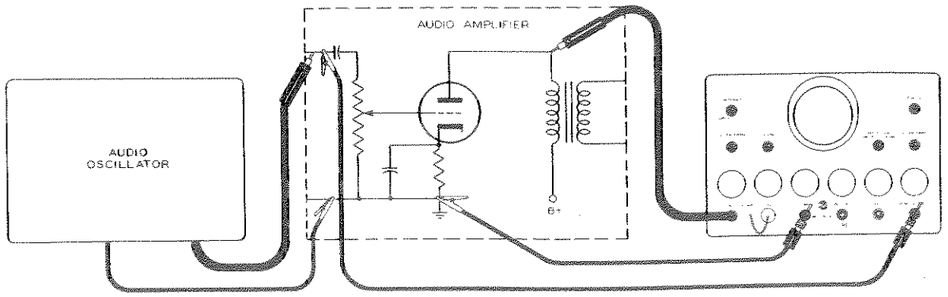


Figure 13. Audio-Amplifier Test Setup

Additional Applications of Voltmeter Feature

A few of the particular applications of the voltmeter feature of the oscilloscope are the determination of the effectiveness of a power-supply filter by measuring the ripple voltage at various places in the filter; the measurement of amplifier stage gain; the running of frequency-response curves on audio amplifiers, filters, and transformers; and the indication of resonance in audio and low supersonic frequency circuits.

Audio-Quality Measurements

The WO-57A Oscilloscope is helpful in determining the quality of audio amplifiers, and in the qualitative analysis of amplifier distortion. A suggested test setup is shown in Figure 13, and the procedure is as follows:

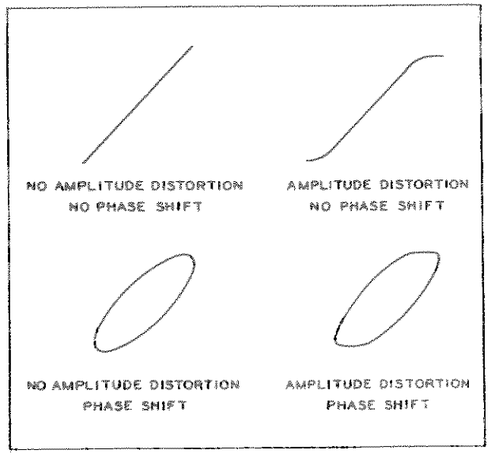


Figure 14. Distortion and Phase Shift in Audio Amplifier

1. Set the audio oscillator to the frequency at which the test is to be made.

2. Set the H GAIN control for a convenient horizontal deflection.

3. Set the V RANGE switch and V CAL control for a convenient vertical deflection.

Figure 14 shows some of the traces that may be seen, together with an explanation of the effects which produce them.

If it is necessary to study irregularities in wave shape on a linear time axis, proceed as follows:

1. Set the SYNC/H SEL switch on "INT+" or "INT−".

2. Adjust the SWEEP RANGE selector and PHASE ADJ/SWEEP VER control until four or five cycles are observed on the screen.

3. Advance the SYNC ADJ control until the pattern is stationary. NOTE: Do not advance this control any further than necessary to hold a stationary pattern.

4. Compare the waveform entering the amplifier with that leaving it to determine whether the amplifier is distorting.

The procedure for checking the overall fidelity of a receiver is similar to the foregoing method, except that the audio oscillator is used to modulate an rf signal generator. The modulated rf output of the signal generator is connected to the antenna terminals of the receiver, and the AC/V INPUT and GND terminals of the oscilloscope are connected across the loudspeaker voice coil.

Industrial Applications

Use of the cathode-ray oscilloscope with a few pieces of auxiliary apparatus has solved many perplexing problems both in the laboratory and in the shop. Obviously, it is impractical to attempt to describe in this book all the important applications of the oscilloscope. However, a few of its uses which are considered to be of current interest or which are particularly adaptable to the WO-57A are briefly described.

Engine Pressure Analysis

When the WO-57A is used with auxiliary equipment such as is shown in Figure 15, variations in pressure developed by a cylinder of an internal-combustion engine or any type of machine can be displayed on the oscilloscope screen. The oscilloscope has proven very useful in the development of internal-combustion engines when used with engine pressure-measuring devices.

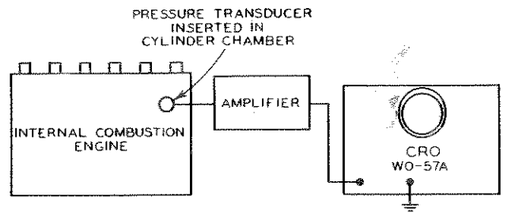


Figure 15. Engine-Pressure Analysis

The exceptional low-frequency response of the WO-57A enables it to portray graphically on its screen both static and dynamic pressures of engines, pumps, pneumatic and hydraulic systems. Transient pressures which are not recorded on conventional indicating devices can be observed on the oscilloscope screen. Abnormal pressures of extremely short duration can be viewed. The WO-57A will prove a valuable instrument for observing dangerous transient or peak pressures.

Vibration Measurements

The WO-57A can be used with a piezo-electric transducer for measuring vibration. Figure 16 illustrates a setup for obtaining vibration waveforms, indicating relative amplitudes and other characteristics of vibration, on the oscilloscope screen for observation or photographic recording. Compressing, warping, twisting strains and similar phenomena may be portrayed for study of their effects.

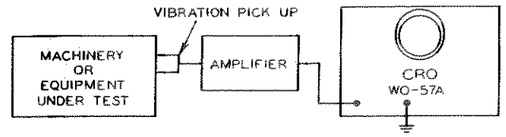


Figure 16. Vibration Analysis

Maintenance

General

The WO-57A has been properly aligned and adjusted at the factory; no further servicing is normally required. However, after long continued use the instrument may require servicing. For proper alignment of the oscilloscope, a square-wave generator and an RCA VoltOhmyst, or equivalent vacuum-tube voltmeter, are required. Voltage measurements are made with the WO-57A operating on a line voltage of 117 volts ac, at 50-60 cps. The instrument should be allowed to warm up for fifteen minutes before adjustments or measurements are made.

To gain access to the chassis for replacement of tubes or for servicing, remove the four screws at the front of the instrument and the four screws at the bottom. The chassis can then be removed from the case. Refer to Figures 18A and 18B for the physical location of the adjustable parts in the WO-57A. CAUTION: Remove power when adjusting slide resistors R18, R19, and R25 (Figure 18A).

The performance of the WO-57A, like that of any precision instrument, is dependent upon the rating and quality of its components. If it should become necessary to replace a component part, find the stock number of the part in the Replacement Parts List on page 14. Only RCA replacement parts, or parts having equivalent specifications, should be used.

Adjustment of the WG-216 Low-Capacitance Probe

Using the WG-218 Direct Probe and Cable and the Ground Cable, apply the output of a square-wave generator which has been tuned to 10 kc across a V INPUT terminal and a GND terminal, and adjust the proper controls to give a square wave of convenient amplitude on the oscilloscope screen. Attach the WG-216 Low-Capacitance Probe to the Direct Probe and Cable, and connect this probe to the output of the square-wave generator. If the square wave now obtained on the

oscilloscope screen is distorted as compared to the square wave previously viewed, adjust the Low-Capacitance Probe as indicated below. (See Figures 17A and 17B for the schematic diagram and the exploded view of the WG-216.)

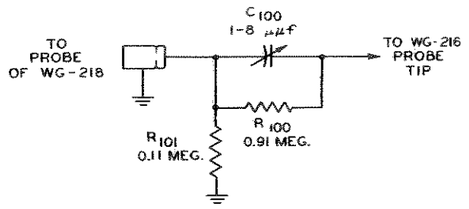


Figure 17A. Schematic Diagram of WG-216

1. Unscrew the probe tip.

2. Place a small screwdriver in the hole at point A (Figure 17B), and fit it in the slot of the capacitor tuning stud (C100).

3. Rotate the stud for the best square wave on the oscilloscope screen.

4. Replace the probe tip.

If it should become necessary to replace any of the parts in the WG-216, disassemble the probe in the following manner:

1. Unscrew and remove the probe tip.

2. Scrape the wax from the set screw on the probe housing and remove the set screw. CAUTION: When reassembling the probe, replace the wax on the set screw or otherwise insulate the exposed portion of the set screw.

3. Remove the hexagonal nut.

4. Remove the probe internal assembly from the probe housing by applying pressure at point A (Figure 17B).

5. Remove the electrical scotch tape from the probe internal assembly. The component parts of the WG-216 are now accessible.

Amplifier-Balance Adjustment

Vertical movement of the pattern on the oscilloscope screen when the vertical-gain control (V CAL control) is rotated indicates that a balance adjustment must be made in the vertical amplifier. Since this amplifier-balance adjustment is critical, the serviceman is advised to follow the procedure outlined below for best results.

1. Set the SYNC/H SEL switch at "INT—" or "INT+" and adjust the H GAIN control for a trace of convenient length. Center the trace by means of the CENTERING controls.

2. Turn the V CAL control to its extreme counterclockwise position. If the trace has moved vertically from the center of the screen, recenter with the V CENTERING control.

3. Turn the V CAL control to its extreme clockwise position. If the trace has moved from the center of the screen, recenter by adjusting the vertical balance control (R15) located on the rear apron of the instrument chassis (Figure 18B).

4. Repeat steps 2 and 3 until there is a minimum of vertical movement of the trace when the V CAL control is rotated over its entire range.

Preliminary Adjustments

The serviceman should make the following preliminary adjustments before proceeding to the final adjustments following this section.

1. Remove the chassis of the instrument from the case, connect the power cord to an ac outlet supplying 117 volts at 50-60 cps, and turn the INTENSITY control from its "OFF" position.

2. Allow 15 minutes for the instrument to warm up.

3. Adjust R18 for a screen-grid voltage of 150 volts on tubes V1 and V2. (Measurements should be made between pin 6 and ground.) CAUTION: Remove power from the instrument when adjusting slide resistor R18 (Figure 18A).

4. Adjust the vertical balance control (R15), following the procedure outlined above under "Amplifier-Balance Adjustment".

5. Connect the plates (pin 5) of V1 and V2, shorting across the load resistors R20 and R21, and adjust R19 for 72 to 80 volts between these plates and ground. CAUTION: Remove power from the instrument when adjusting slide resistor R19 (Figure 18A).

6. Connect the plates (pin 5) of V3 and V4, shorting across the load resistors of these two tubes, and adjust R25 for 200

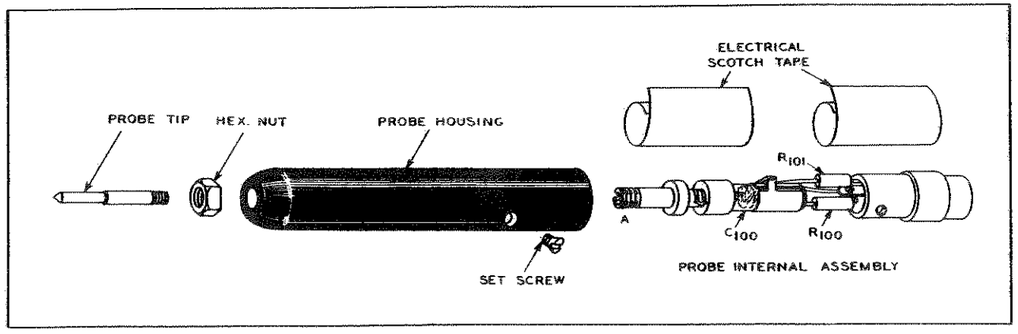


Figure 17B. Exploded View of WG-216

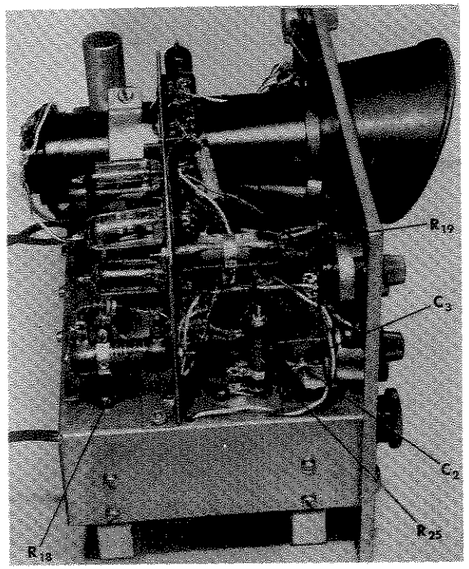


Figure 18A. Side View of WO-57A Chassis

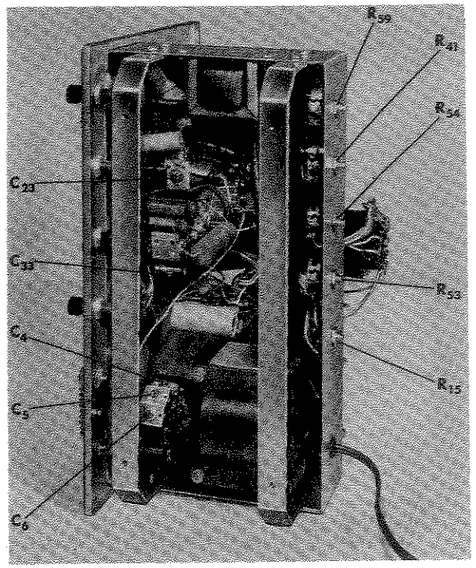


Figure 18B. Bottom View of WO-57A Chassis

volts between the plates and ground. CAUTION: Remove power from the instrument when adjusting slide resistor R25 (Figure 18A).

7. If necessary, repeat steps 3 to 6 in order to obtain voltages indicated.

8. Remove the shorts connecting the plates of V1 and V2 and the plates of V3 and V4.

9. Adjust the astigmatism-adjust control (R41) and the H CENTERING control (R42) for a voltage of 200 volts between each of the plates of the horizontal amplifier tube (V6) and ground.

10. Adjust the second-anode-adjust control (R59) for a voltage of 200 volts between pin 9 of the cathode-ray tube (V7) and ground.

Vertical-Attenuator Adjustments

1. Feed a 5000-cps square wave into either V INPUT terminal, and set the V RANGE switch on "0.1" and the V CAL control for minimum gain. Note the shape of the square wave on the oscilloscope screen.

2. Set the V RANGE switch on "0.3" and adjust C6 until the square wave closely approximates that noted in step 1.

3. Repeat step 2 for the following positions of the V RANGE switch, adjusting the corresponding capacitors for as close an approximation of the square wave observed in step 1 as possible:

Position	*Capacitor*
"1.0"	C5
"3.0"	C4
"10"	C3
"30"	C2

Sweep-Oscillator Adjustments

1. Feed a 50-kc square wave or sine wave into the vertical amplifier and adjust the oscilloscope controls until ten cycles appear on the screen of the cathode-ray tube. Adjust C23 for the best horizontal linearity on the oscilloscope screen.

2. Feed a 33-kc square wave or sine wave into the vertical amplifier, and set the SWEEP RANGE selector and the PHASE ADJ/SWEEP VER control for the highest sweep frequency. Adjust C33 for a single cycle on the oscilloscope screen.

3. Remove the input signal.

4. Feed a composite picture signal from a television receiver into the vertical amplifier of the oscilloscope. If the sync pulses are positive-going, or up, turn the SYNC/H SEL switch to "INT+" position; if the sync pulses are negative-going, or down, turn the SYNC/H SEL switch to "INT—" position.

5. Turn the SWEEP RANGE selector to "TV/H" position.

6. With the SYNC ADJ control advanced approximately 15° from its minimum position, adjust the TV/H-adjust control (R53) until two cycles of the horizontal sync pulse are stationary on the oscilloscope screen.

7. Repeat steps 4 to 6 for the preset vertical adjustment, turning the SWEEP RANGE selector to "TV/V" position and adjusting the TV/V-adjust control (R54) for two cycles of the vertical sync pulse.