INSTRUCTION BOOK No. 1-56031R

CATHODE RAY OSCILLOSCOPE

TYPE 1A56031

ISSUE 2

Manufactured Entirely in Australia

by

AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED

47 YORK STREET, SYDNEY

INSTRUCTION BOOK No. 1-56031R

CATHODE RAY OSCILLOSCOPE

TYPE 1A56031

ISSUE 2

Manufactured Entirely in Australia

by

AMALGAMATED WIRELESS (AUSTRALASIA) LIMITED

47 YORK STREET, SYDNEY

091059

INDEX

1. BRIEF SPECIFICATION

1.1 Application

The A.W.A. Cathode Ray Oscilloscope 1A56031 is intended for use in practical applications in television servicing. Although designed primarily for television servicing, it can be used in industrial applications as well as in the usual oscilloscope applications, such as wave-shape analysis, adjustments of radio receivers and transmitters, determination of peak-to-peak and instantaneous voltages, and tracing of valve characterisics. It features a wide frequency range, a square wave response and a sensitivity which provides wave-shape reproduction of unusual accuracy and clarity on its five-inch screen.

1.2 Power Supply

The instrument is self-contained for operation from 240V. A.C. mains. A fuse is fitted in the active leg of the mains input.

1.3 Performance Specification

(a) **Frequency Response**
Vertical and Horizontal Amplifiers:
Between 0-500 kc/s: within 2.5db. from max response.
Between 0-1 Mc/s: within 7.2 db. from max. response.

(b) **Input Resistance and Capacitance**

Vertical Amplifier:	
Without cable and probes:	1M ohm shunted by 85uuF.
With direct probe and cable 5R56020:	1M ohm shunted by 75uuF.
With low capacitance probe 4R56020:	10M ohms shunted by 10uuF.
Horizontal Amplifier:	
Without cable and probes:	1M ohm shunted by 85uuF.
Sync. Input:	
Without cable and probes:	1M ohm shunted by 85uuF.

(c) **Deflection Sensitivity:**

	millivolts/inch rms	millivolts/inch p-p
Vertical Amplifier:		
With direct probe and cable 5R56020	10.6	30
With low capacitance probe 4R56020	106	300
Horizontal Amplifier:		
Without cable and probe	21.2	60

(d) **Sweep-Circuit Frequency:**

Variable	3 to 30,000 cycles
Pre-set: TV/V position	25 cycles
Pre-set: TV/H position	7812.5 cycles

(e) **Maximum Input Voltage:** 500V. peak, including any D.C. which may be present.

(f) **Power Supply:**

Voltage input	240V. A.C.
Frequency	50 cycles
Power	70 watts

1.4 Valve Complement

Type	Quantity
2X2	1
5UP1	1
6AU6	4
6X4	1
12AU7	5

1.5 Mechanical

The instrument is enclosed in a steel case, the outside dimensions of which are as follows:

Height:	14 inches
Width:	10 inches
Depth:	19 inches
Weight:	36lbs.
Finish:	Dimenso

INSTALLATION NOTE

Before placing the instrument into general operation, the function of the V. BAL. and H. BAL. controls, which are screwdriver adjustments accessible from the front panel, should be understood.

The setting of these adjustments is important if maximum operating stability is to be maintained.

The simple procedure outlined below should be followed at the time of installation and should be repeated if necessary during operation of the instrument.

The V. BAL. adjustment is provided to correct for any change in position of the pattern on the cathode-ray tube screen when the VERT. GAIN vernier control is rotated. Similarly for the H. BAL. adjustment. If these adjustments are set immediately upon applying power to the instrument, they may have to be readjusted after the unit has warmed up. For maximum stability over an extended operating period, these adjustments should be set after the instrument has warmed up for at least 15 minutes.

To check the adjustments, proceed as follows:

1. Connect the power cable to a 240 volt 50 cycle supply.
2. Turn the INTENSITY control clockwise to obtain a spot of suitable brilliance.
3. Set the front panel controls as follows:
   VERT. GAIN and HORIZ. GAIN at "30" on "AC."
   VERT. and HORIZ. GAIN vernier controls fully counter-clockwise.
   SYNC. selector at "+."
4. Centre the spot by adjusting the V. SHIFT and H. SHIFT controls.
5. Connect the Direct Probe cable connector to the VERT. INPUT connector and connect the probe tip to the "E" terminal.
6. Connect the HORIZ. INPUT terminal to the "E" terminal.
7. Rotate the VERT. GAIN vernier control clockwise. If the spot changes position vertically, adjust the V. BAL. control with a screwdriver until the spot does not change position when the vernier control is rotated.
8. Repeat the above procedure with the HORIZ. GAIN vernier and H. BAL. control.

2. INSTALLATION

2.1 Removal of Case

(a) Remove four screws from the front corners and one from the bottom of the case.

(b) Remove chassis from the case by pushing on the rear chassis apron through the hole provided for the power cord at the rear of the case.

2.2 Valves

If these arrive packed separately they should be inserted in their respective sockets according to the stencilling on the chassis. The cathode ray tube is installed from the top of the chassis after removing the latter from the case.

(1) Hold C.R. tube in one hand with base plug uppermost and drop rubber ring over neck of tube.
(2) Lower metal shield down over tube, making sure that base plug passes cleanly through triangular clip at the end.
(3) Lower the tube and shield assembly into the instrument, plug into the tube socket and engage the hooks of the retaining spring in the holes at the narrow end of the shield. Position the tube in the rim attached to the front panel.
(4) Spring the ruled celluloid graticule into place in the four holes provided near the mouth of the shield.
(5) Align the C.R. tube screen as in sub-section 2.5.

2.3 Handling of Miniature Valves

Particular care should be taken when handling, removing or inserting the miniature glass-based valves. The pins are sealed directly into the glass base, there is no locating plug, and the valve is aligned with its socket by means of the large spacing between first and seventh pins. Do not attempt to force a valve into its socket as this may result in bent pins or breakage of the glass envelope.

Similarly, when removing a valve, pull it out in a straight line and do not rock it from side to side. A combined tool is available for straightening bent pins and easing tight socket contacts.

2.4 Connecting Mains Voltage

Connect the power cord to the A.C. outlet supplying 240V. at 50 cycles.

2.5 Initial Alignment of C.R. Tube

When the C.R. tube is first installed, or when a new tube is inserted, the following procedure should be carried out to align the horizontal trace.

(i) INTENSITY control in full anti-clockwise position.
(ii) VERT. GAIN selector at position "30" on the A.C. range.
(iii) VERT. GAIN vernier set for minimum gain.
(iv) HORIZ. GAIN selector at MAINS position.
(v) HORIZ. GAIN vernier for minimum gain.
(vi) After switching on allow at least 15 minutes for the instrument to warm up.
(vii) Turn the INTENSITY control until a sufficiently bright image appears on the screen.
(viii) Adjust the HORIZ. GAIN control until a horizontal line is obtained. Focus the line as sharply as possible, and try to memorise its position relative to the nearest horizontal line on the graticule.

WARNING: SWITCH OFF THE MAINS VOLTAGE BEFORE CARRYING OUT THE NEXT STEP.

(ix) Release the hooks of the retaining spring from the metal shield of the C.R. tube and twist the tube by grasping near the base end until the trace is horizontal.
NOTE: Two or more trial adjustments may be necessary.
(x) Replace the spring clip in the metal shield.
(xi) Return the chassis to its case and replace and tighten the retaining screws.

3. OPERATING INSTRUCTIONS

3.1 General

Before using the instrument the operator should refer to sub-section 3.3 on Functions of Controls and Terminals in order to derive the most profit from it.

3.2 Calibration of Vertical Amplifier

When the instrument is to be used as a voltmeter, the vertical amplifier should be calibrated according to the following procedure.

(a) Connect the direct probe and cable type 5R56020 to the VERT. INPUT terminal, then connect the probe to the 3V. P-P terminal.

(b) Set the VERT. GAIN selector on either "3" A.C. or "3" D.C. and adjust the VERT. GAIN vernier until three divisions of vertical deflection are obtained on the oscilloscope screen.

(c) Disconnect the cable from the 3V. P-P terminal.
NOTE: DO NOT TOUCH the VERT. GAIN vernier while voltage measurements are being made, otherwise the vertical amplifier will have to be re-calibrated.

(d) Connect the direct probe and cable across the voltage to be measured and set the V. GAIN selector for a convenient vertical deflection.
The peak-to-peak voltage at the probe tip is the VERT. GAIN selector setting multiplied by one-third the number of divisions of vertical deflection.
When a sine wave voltage is being measured, the above value can be multiplied by 0.354 to give the r.m.s. voltage. The 4R56020 low capacitance probe may also be used for voltage measurements. The setting up procedure is the same except that the results obtained above are multiplied by 10 in order to compensate for the greater signal attenuation of the probe.

3.3 Function of Controls and Terminals

(a) **INTENSITY Control:**
Adjusts the intensity of the spot on the cathode-ray tube screen.

(b) **FOCUS Control:**
Adjusts the sharpness of pattern on the cathode-ray tube screen. Normally the control requires adjustment when setting of INTENSITY control has been changed.

(c) **V. SHIFT Control:**
Adjusts the vertical position of the trace.

(d) **VERT. GAIN Selector Switch (S1):**
This switch controls the degree of attenuation of input voltage to the vertical amplifier. It is calibrated for both A.C. and D.C. voltages. To determine the amplitude of signal voltage when the vertical amplifier has been calibrated, multiply VERT. GAIN selector setting by one-third the number of divisions of deflection.
When the direct probe and cable 5R56020 is used the attenuation is as indicated below for each selector position.
NOTE: When the low capacitance probe 4R56020 is used the attenuation is ten times as great as indicated below.
Position ".03"—Zero attenuation (signal voltage attenuated 1 to 1).
Position "0.3"—Signal voltage attenuated 10 to 1.
Position "3.0"—Signal voltage attenuated 100 to 1.
Position "30"—Signal voltage attenuated 1,000 to 1.

(e) **VERT. GAIN Vernier Control:**
This vernier movement permits continuous adjustment of vertical-amplifier gain. It is used with VERT. GAIN selector to adjust trace height to the desired value.

(f) **V. BAL.:**
This control should be adjusted for minimum vertical movement of the **spot** trace as the VERT. GAIN vernier control is rotated through its range.

(g) **H. SHIFT:**
Adjusts the horizontal position of the trace.

(h) **HORIZ. GAIN Switch:**
This has three functions, which are indicated below:

(i) Controls the degree of attenuation of input voltage to the horizontal amplifier. This control is marked for both A.C. and D.C. voltages. Attenuation is as indicated below for each selector position.
Position ".03"—Zero attenuation. (Signal voltage attenuated 1 to 1).
Position "0.3"—Signal voltage attenuated 10 to 1.
Position "3.0"—Signal voltage attenuated 100 to 1.
Position "30"—Signal voltage attenuated 1,000 to 1.
(ii) When an internal linear sweep is desired, set this control to "SWEEP" position; this position applies anode voltage to sweep oscillator valve and couples the output from this valve to the input of the horizontal amplifier.
(iii) When a sinusoidal sweep of 50 cycles is desired at the input to the horizontal amplifier, this selector is switched to "MAINS" position.

(i) **HORIZ. GAIN Vernier Control:**
This permits continuous adjustment of horizontal amplifier gain. It is used with H. GAIN selector switch to adjust horizontal trace to the desired width.

(j) **H. BAL.:**
This control should be adjusted for minimum horizontal movement of the spot trace as the HORIZ. GAIN vernier is rotated through its range.

(k) **SWEEP Selector Switch (S4):**
This switch selects the frequency band of the sweep oscillator.
Positions "TV/V" and "TV/H" give pre-set sweep frequencies of 25 cycles and 7,812.5 cycles respectively for viewing vertical and horizontal deflection circuit wave shapes, sync-separator wave-shapes and composite television signals.

(l) **SWEEP Vernier Control:**
This provides continuous control of sweep frequency over bands covered by the SWEEP selector switch.

(m) **PHASE Control:**
This provides control of the phase of the sinusoidal sweep voltage fed to the horizontal amplifier, when the HORIZ. GAIN selector is set at MAINS position, and controls the phase of the line frequency voltage used to synchronise the sweep oscillator when the SYNC. selector is at MAINS position and the HORIZ. GAIN selector is at the SWEEP position.

(n) **SYNC. Selector Switch (S3):**

This selects the synchronising voltage for the sweep oscillator as follows:
(i) **"–" Position**
Selects the synchronising voltage from the vertical amplifier. Sweep-trace flyback starts during negative going excursion of the voltage applied to vertical amplifier.
(ii) **"+" Position**
Selects the synchronising voltage from the vertical amplifier. Sweep-trace flyback starts during positive going excursion of the voltage applied to the vertical amplifier.
(iii) **"MAINS" Position**
Selects the synchronising voltage from the power supply so the sweep oscillator is synchronised with 50 cycle mains frequency. When the SYNC. selector is in "MAINS" position and the HORIZ. GAIN selector in "SWEEP" position, the PHASE control can be used to adjust the phase of the sweep voltage with respect to the input voltage.
(iv) **"EXT." Position**
This position feeds the sweep oscillator with an external synchronising voltage applied at SYNC. terminal.

(o) **SYNC. Vernier Control:**
This controls the amplitude of synchronising voltage applied to the grid of the sweep oscillator and is adjusted to the setting which will just lock the pattern in a stationary position on the cathode ray tube.

(p) **SYNC. Terminal:**
An external synchronising voltage can be applied at this terminal.

(q) **VERT. INPUT Terminal:**
The voltage to be applied to the vertical amplifier is introduced at this terminal through the direct probe and cable 5R56020. When the VERT. GAIN selector is on its A.C. positions, the signal is applied to the vertical amplifier through a blocking capacitor; when the VERT. GAIN selector is on its D.C. position, the signal is applied directly to the vertical amplifier.

(r) **HORIZ. INPUT Terminal:**
The voltage to be applied to the horizontal amplifier is introduced at this terminal.

(s) **3V. P-P Terminal:**
An internal calibrating voltage is available at this terminal. See sub-section 3.2 (c) for the calibration procedure.

(t) **EARTH Terminal:**
This is directly connected to the chassis.

4. TECHNICAL DESCRIPTION

4.1 General

This instrument has a sensitivity of 10.6 r.m.s. millivolts per inch. The frequency response of both the vertical and horizontal amplifiers from 0 to 500 kc/s is within 2.5 db. down from maximum response; the frequency response from 0 to 1.0 Mc/s is within 7.2 db. down from maximum response.

4.2 Amplifiers

The vertical and horizontal amplifiers are electrically identical. Each amplifier consists of three push-pull stages of amplification, a feature which provides high deflection sensitivity with good stability. The trace can be centered on any portion for examination of wave-shape details. The use of push-pull stages also reduces astigmatic distortion thus producing a uniformly sharp trace over the entire useful area of the screen.

Both the vertical and horizontal amplifiers are designed to provide low frequency response flat down to D.C.

Low frequency square wave response, essential to correct sweep alignment, is assured.

High frequency square wave response up to at least 100 kc/s ensures faithful reproduction of blanking and pulse wave-shapes. A square wave response with negligible tilt and overshoot provides a reliable display of sync-pulse, vertical and horizontal deflection, video amplifier and composite television wave-shapes. Frequency-compensated step and vernier attenuators maintain response independent of changes in gain.

Both peak-to-peak and D.C. voltage measurements can be made directly from the screen of the oscilloscope. A voltage for calibrating either the vertical or horizontal amplifier is available at the panel terminal.

4.3 Sweep Circuit

The sweep, or time-base oscillator produces a linear sawtooth voltage with an extremely fast retrace, further ensuring faithful wave-shape reproduction. This oscillator is of the multivibrator type, with a range of 3 to 30,000 cycles per second. Two pre-set sweep frequencies of 25 c.p.s. and 7812.5 c.p.s. speed up signal tracing and trouble shooting in television, r.f., deflection, and video circuits.

The sweep oscillator can be synchronised by an internally supplied voltage of mains frequency, by an externally supplied voltage, or by a signal which is either positive or negative in polarity and which is internally selected from the vertical amplifier. This feature ensures a steady pattern on the oscilloscope screen. When the sweep oscillator is synchronised with the line voltage, the phase control can be used to centre any portion of the wave-shape on the oscilloscope screen.

A phase-controlled sinusodial sweep of mains frequency, essential in sweep alignment applications, is available internally; its phase can be adjusted by the phase control. This arrangement eliminates the need for an external phase-controlled mains source.

4.4 Output

The five-inch cathode ray tube gives a large, clear display for accuracy in alignment applications. The metal shield which surrounds this tube greatly minimises hum pick-up, thereby eliminating the necessity for carefully arranging sets and equipment on the service bench to avoid hum deflection.

5. APPLICATION

5.1 Phase Shift Measurements

To measure the phase shift of an electrical 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 HORIZ. INPUT and EARTH terminals, and the output from the test circuit to the VERT. INPUT terminals. If no phase shift exists, a sloping straight line image will appear. Phase shift is indicated as an elliptical or circular trace. See Fig. 1 for the method of calculating phase shift. The instrument is particularly useful in the measurement of phase shift at low frequencies because of its low frequency response. In such applications, the D.C. input should be used.

5.2 Frequency Measurements

Two methods which are as follows, may be employed for frequency measurements.

(i) A sine-wave of known frequency is applied to the HORIZ. INPUT terminal and a sine wave of the frequency which is to be determined is applied to the VERT. INPUT terminal. The pattern which appears on the oscilloscope screen, known as a Lissajou figure, indicates the ratio between the known and unknown frequency. Several typical Lissajou figures are illustrated in Fig. 2.

(ii) The HORIZ. GAIN selector is set at "SWEEP" position and the SYNC. selector is set at "MAINS," thus producing a linear sweep of mains frequency. The signal of unknown frequency is applied to the VERT. 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 mains frequency.

5.3 A.C. Voltage Measurements

After calibration has been completed as outlined in Section 3, any A.C. voltage may be measured as follows:

(i) Connect the voltage to be measured across the VERT. INPUT and the EARTH terminals.

(ii) Set the VERT. GAIN selector so that a readable vertical deflection is obtained. The peak-to-peak value of the measured voltage is then equal to the VERT. GAIN selector setting multiplied by one-third the number of divisions of vertical deflection as shown on the oscilloscope screen. If the voltage measured is a sine wave, then the r.m.s. value of the voltage can be computed by multiplying the peak-to-peak value by 0.354.

NOTE: Do not touch the VERT. GAIN vernier after the instrument has been calibrated, or re-calibration will be necessary.

5.4 Additional Applications on Voltage Measurements

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 frequency circuits.

5.5 Measurement of Impedance and Power Factor of Loudspeakers

A set-up for the measurement of the impedance and power factor of loudspeakers or other devices is shown in Fig. 3. The sum of the resistors R1 and R2 is made equal to the anode resistance of the output valve used with the speaker. The voltage E is made equal to the uEg. of the output valve. This method of measurement utilises the relationship between the vertical and horizontal deflection factors of the cathode-ray tube; K is the ratio of the vertical deflection factor (in direction A to B) to the horizontal deflection factor (in direction C to D). The calculation of impedance magnitude "Z" and the power factor "cos ϕ" are independent of the accelerating voltages applied to the anodes of the cathode-ray valve. The phase angle ϕ and the power-factor cos ϕ, are obtained from $\sin \phi = (FG/AB)$. The magnitude of the impedance vector is given by: $Z = K(AB/CD)\ R1$.

If the frequency and magnitude of E are varied, resulting variations of impedance and power factor can be determined.

5.6 Audio Quality Measurements

The instrument is helpful in determining the quality of audio amplifiers, and in the qualitative analysis of amplifier distortion.

The procedure is as follows:

(i) Set the audio oscillator to the frequency at which the test is to be made.
(ii) Set the HORIZ. GAIN selector and HORIZ. GAIN vernier for a convenient horizontal deflection.
(iii) Set the VERT. GAIN selector and VERT. GAIN vernier for a convenient vertical deflection.

Fig. 4 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:

(i) Set the SWEEP selector on "+" or "–" positions.
(ii) Adjust the SWEEP selector and SWEEP vernier controls until four or five cycles are observed on the screen.
(iii) Advance the SYNC. vernier control until the pattern is stationary.
NOTE: Do not advance this control any further than necessary.
(iv) 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 R.F. signal generator. The modulated R.F. output of the signal generator is connected to the earth terminals of the receiver, and the VERT. INPUT and EARTH terminals of the oscilloscope are connected across the loudspeaker voice coil.

5.7 Resistance Welding Applications

Because of its low frequency response and the identical phase shift characteristics of its vertical and horizontal amplifiers, the instrument is suitable to the operational analysis and servicing of resistance-welding devices. The oscilloscope can be used to check the waveforms and phase relationship of the control and supply voltages. The time-consuming process of re-adjusting the welding instrument for correct operation can be eliminated with the oscilloscope. It is merely necessary to record the waveforms at the time of initial adjustment (for any particular operation), and later quickly resetting the instrument by adjusting it for the same pattern on the oscilloscope screen. The oscilloscope can be used to insure that the correct settings are maintained throughout the welding operation.

5.8 Engine Pressure Analysis

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 proved very useful in the development of internal-combustion engines when used with engine pressure-measuring devices.

The exceptional low frequency response of the type 1A56031 enables it to portray 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 pressure of extremely short duration can be viewed; therefore it will prove a valuable instrument for observing dangerous transient or peak pressure.

5.9 Vibration Measurements

The instrument may be used for obtaining vibration wave-forms, indicating relative amplitudes and other characteristics of vibration, on the oscilloscope screen for observing or photographic recording. Compressing, warping, twisting strains and similar phenomena may be portrayed for study of their effects.

5.10 Circuit Analysis with Square Waves

Because of its ability to accurately reproduce waveforms which comprise a wide band of frequencies the oscilloscope is useful in both low and high frequency square wave analysis of amplifiers, filters and other frequency responsive devices.

The waveforms shown in Fig. 8 are typical of those produced by circuit analysis with square waves; this illustrates the various types of square wave distortion in a video amplifier and indicates the circuit defect associated with the distortion.

A comprehensive discussion of square wave analysis will be found in various text books and periodicals, and is beyond the scope of this handbook.

5.11 Analysing 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 waveform consisting of the video signal, the blanking pedestals, and the sync. pulses. The television technician 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 oscilloscope screen at various points in the video amplifier. The method of obtaining a composite video signal in the screen is as follows:

(i) Tune the television receiver to a television signal.
(ii) Plug the instrument in. Set the HORIZ. GAIN selector to "SWEEP" position and adjust the HORIZ. GAIN vernier for a horizontal line of convenient length. Set the INTENSITY and FOCUS controls for the desired brightness and best focus.
(iii) Connect the direct probe and cable to the VERT. INPUT terminal and attach the low capacitance probe to the probe end. Connect the ground cable to the television receiver chassis, and the low capacitance probe 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.)
(iv) Set the VERT. GAIN selector on an A.C. position and adjust the VERT. GAIN vernier control for a pattern of convenient height. Set the SYNC. selector on "+" or "–" position.
(v) In order to obtain the horizontal sync. pulse on the oscilloscope screen, proceed as follows:
  (a) Set the SWEEP selector switch at TV/H position.
  (b) Carefully rotate the SYNC. vernier control until a clear square wave pattern is obtained on the oscilloscope screen.
  NOTE: To avoid distortion of the pattern, always use the minimum setting of the SYNC. vernier necessary to hold the pattern still.
(vi) In order to obtain the vertical sync. pulse on the oscillosope, the procedure to be followed is the same as that set out in (v) above, except that the pre-set TV/V position of the SWEEP selector is used instead of the TV/H position.

To afford practice in tracing and observing the video signal, place the 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 technician, the instrument is a valuable television service tool.

A chart showing the effects of different circuit faults on the horizontal sync. pulse is shown in Fig. 6. The chart also shows the effects of these faults on the overall frequency response of the receiver, and upon the picture observed on the picture tube. As experience with the oscilloscope is acquired, the technician will be able rapidly to analyse circuit faults from the characteristics of the composite signal noted on the oscilloscope.

5.12 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.

The receiver and the oscilloscope should be set up and operated as explained in the foregoing section on composite signal waveform analysis.

The VERT. GAIN selector switch should be set on an A.C. position.

The composite signal first appears across the picture detector load; the oscilloscope cables should be connected at this point. If the waveform does not look like a square wave pattern, 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 valve. In going from grid to anode of each valve, the signal should appear amplified and inverted, although the wave-shape 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 valve check is usually enough to locate the defective component. Peaking coil faults are usually evidenced by a change in the shape of a horizontal sync. pulse; limiting in a stage is evidenced by a compression of the sync. pulse, or the "whites" of the signal or both (see Fig. 5).

Whenever possible, the 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. The capacitance of the direct probe loads the circuit to which it is attached, thus decreasing slightly the high frequency input to the oscilloscope. The effect on the waveform observed on the oscilloscope is a slight rounding of the horizontal sync-pulse leading edge. After a little experience, the operator will be able to differentiate between distortion of the horizontal sync. pulse due to a faulty circuit and the slight rounding of the pulse caused by the direct probe. If the probe is placed at the cathode of one of the video amplifier valves and the cathode resistor is unbypassed, the circuit response will be unaffected, and the sync. pulse may be observed as it appears in the circuit.

5.13 Signal Tracing in Sync. and Deflection Circuits

Loss of picture synchronisation is quickly and easily traced to its source with the 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 Fig. 7. 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.

Faults in deflection are traced in the same manner as are faults in synchronisation. 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 valve 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 operator 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 "Maximum Input Voltages" under Performance Specification.

5.14 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."

6. MAINTENANCE

6.1 General

The instrument has been correctly aligned and adjusted at the factory; therefore no further servicing is normally required. However, after long continuous use the instrument may require servicing.

For the proper adjustment and alignment of the instrument an audio oscillator, a signal generator and a square wave generator are required.

To gain access to the chassis for replacement of valves or servicing, the procedure outlined in sub-section 2.1 should be followed. The complete adjustments after servicing are listed below.

6.2 Amplifier-Balance Adjustment

Any vertical movement of the spot on the face of the cathode-ray tube when the VERT. GAIN vernier is rotated indicates that the vertical balance (V. BAL.) control is out of adjustment.

Horizontal movement of the spot when the HORIZ. GAIN vernier is rotated indicates that the horizontal balance (H. BAL.) control is out of adjustment.

The procedure for adjusting these two controls is to insert a screwdriver into each in turn and adjust them for minimum vertical and horizontal movement of the spot when the associated gain verniers are rotated through their range.

6.3 Adjustment of Low-Capacitance Probe (4R56020)

Using the direct probe and cable, apply the output of a square wave generator which has been tuned to 10 kc/s to the VERT. INPUT terminal, and adjust the control to give a square wave of convenient amplitude on the cathode-ray tube screen.

Attach the low-capacitance probe to the direct probe and cable and connect this probe to the output of a square wave generator.

If the square wave now obtained is distorted as compared to the square wave previously viewed, adjust the low capacitance probe as follows:

(i) Unscrew the probe tip.
(ii) Fit a small screwdriver in the slot of the capacitor tuning stud.
(iii) Rotate the stud for the best square wave on the screen of the cathode ray tube.
(iv) Replace the probe tip.

6.4 Sweep-Oscillator Adjustments

The procedure for adjusting the sweep oscillator is outlined below.

(i) Remove the chassis from the case and plug in the power cord to an A.C. outlet.
(ii) Rotate the INTENSITY control to obtain a spot of normal brilliance and set the VERT. GAIN selector to position "30" on the A.C. range.
(iii) Tune an audio oscillator to approximately 10 kc/s and apply the oscillator output to the VERT. INPUT terminals, using the direct probe and cable.
(iv) Set the VERT. GAIN vernier for a convenient vertical deflection, the HORIZ. GAIN selector to SWEEP position and the HORIZ. GAIN vernier for a convenient horizontal deflection.
(v) Set the SWEEP selector and the SWEEP vernier to a suitable position to obtain approximately 8 cycles on the screen pattern. Set the SYNC. selector to "+" or "–" positions and the SYNC. vernier for a stationary pattern.
(vi) Adjust screwdriver-controlled capacitor C30 for an undistorted sine wave on the face of the cathode-ray tube. This adjustment controls the linearity of the sawtooth output of the sweep oscillator.

6.5 Vertical Amplifier Adjustments

The general procedure for adjusting the vertical amplifier is outlined below.

Note: If any adjustable parts are replaced, it is necessary only to take the adjustments associated with the replaced part; it is not necessary to follow the entire procedure for readjusting the vertical amplifier.

(i) Remove the chassis from the case as in sub-para 2.1 and then connect the power cord to an A.C. supply.
(ii) Set the VERT. GAIN selector and HORIZ. GAIN selector to position "30" on the A.C. range, and

rotate the VERT. GAIN and HORIZ. GAIN verniers to their extreme counterclockwise position. A spot should appear on the oscilloscope screen.

CAUTION:

DO NOT ALLOW A SMALL SPOT OF HIGH BRILLANCE to remain on the screen for an appreciable length of time because discolouration and burning of the screen may result. The spot may be reduced in intensity by means of the INTENSITY control.

(iii) Centre the spot with the H. SHIFT and V. SHIFT controls.

(iv) Rotate the adjustable screwdriver controls of capacitors C10-C13 completely counterclockwise.
NOTE: **HIGH** VOLTAGES are present at the adjustable screws of these capacitors when the power is applied to the instrument.

(v) Set the VERT. GAIN selector to "0.3" on the A.C. range and apply the voltage available at the 3V. P-P terminal to the VERT. INPUT terminal.

(vi) Adjust pre-set control R9 for maximum vertical gain. Remove the voltage applied to the VERT. INPUT terminal.

(vii) Re-adjust V. BAL. and H. BAL. controls, if necessary.

(viii) Set the HORIZ. GAIN selector to "SWEEP" position, and adjust the HORIZ. GAIN vernier for a horizontal sweep width of approximately four inches.

(ix) Tune the square wave generator for a 100 kc/s output of approximately 1.0V. peak-to-peak. Apply this output to the oscilloscope with the direct probe and cable.

(x) Set the SWEEP selector and the SWEEP vernier for a square wave pattern of a convenient number of cycles on the oscilloscope screen, and adjust the VERT. GAIN vernier to its extreme counterclockwise postion. Set the VERT. GAIN selector to postion "0.3" on either the A.C. or D.C. range.

(xi) Adjust pre-set capacitors C12 and C13 by equal amounts until the square wave on the oscilloscope screen just begins an overshoot condition.

(xii) Rotate the VERT. GAIN vernier clockwise and lower the output from the square wave generator to give a vertical deflection of approximately four inches on the screen.

(xiii) Adjust pre-set capacitors C10 and C11 by equal amounts until the corner of the square wave just begins to round off.

(xiv) Tune the square wave generator for a 10 kc/s output; set the VERT. GAIN selector to "0.3" position on the A.C. range; and then adjust the output of the square wave generator to provide approximately three inches of vertical deflection on the face of the cathode ray tube.

(xv) Adjust pre-set capacitor C3 for the best square wave.

(xvi) Repeat steps (xiv) and (xv), setting the VERT. GAIN selector first to position "3" and then to position "30," and adjust pre-set capacitors C5 and C7 respectively.

6.6 Horizontal Amplifier Adjustments

The general procedure for adjusting the horizontal amplifier is outlined below.

If any of the adjustable parts are replaced it is necessary only to make the adjustments associated with the replaced part; it is not necessary to follow the entire procedure for readjusting the horizontal amplifier.

(i) Follow the procedure outlined in steps (iii) to (v) of sub-section 6.5 above.

(ii) Rotate the adjustable screwdriver controls of capacitors C24-C27 completely counterclockwise.
NOTE: HIGH VOLTAGES are present at the adustable screws of these capacitors when the power is applied to the instrument.

(iii) Set the HORIZ. GAIN selector to MAINS position and the HORIZ. GAIN vernier completely counterclockwise.
Adjust pre-set control R47 for maximum horizontal gain.

(iv) Set the HORIZ. GAIN selector to "0.3" position on the D.C. range and the HORIZ. GAIN vernier fully counter-clockwise.

(v) Apply 100 kc/s square wave from a square wave generator to the HORIZ. INPUT terminal, using the 5R56020 direct probe and cable, and apply a 100 kc/s, 10V., r.m.s. signal from a signal generator to the VERT. INPUT terminal. These two inputs may be synchronised by applying a sync. voltage to the sync. terminal of the square wave generator from the output terminal of the signal generator.

(vi) Adjust screwdriver-controlled capacitors C26 and C27 by equal amounts until the square wave pattern just begins an overshoot condition.

(vii) Set the HORIZ. GAIN vernier to its maximum clockwise position, and reduce the output voltage of the square wave generator to produce a convenient horizontal deflection.

(viii) Adjust screwdriver-controlled capacitors C24 and C25 by equal amounts until the corner of the square wave just begins to round off.

(ix) Replace the signal generator with the audio oscillator and tune the square wave generator and the audio oscillator to 10 kc/s, synchronising the two outputs for a stationary square wave on the oscilloscope screen.

(x) Set the HORIZ. GAIN selector to "0.3" on the A.C. range.

(xi) Adjust screwdriver-controlled capacitor C18 for the best square wave response.
NOTE: It may be necessary to increase the output voltage of either the square wave generator or the audio oscillator for this adjustment.

(xii) Repeat steps (x) and (xi), setting the HORIZ. GAIN selector first to position "3" and then to position "30" on the A.C. range, and adjusting screwdriver-controlled capacitors C20 and C22 respectively for the best square wave response.

6.7 Voltage Measurements

It is difficult to specify exact voltages in a direct-coupled amplifier of this type, and a better check is obtained by resistance measurements (see sub-section 6.8). However, the following voltages can be checked:

Socket Pin No.	V5 (VALVE)	V10	V11	V12
1		40V.	880V. A.C.	360V. A.C.
2	-1030V.			
3	-1010V.	4V.		
4	-750V.			
5				
6	270V.	100V.		360V. A.C.
7	270V.			440V.
8	270V.	4V.		
9 and 10	270V.			

NOTES: 1. Voltages on V5 measured with a high-impedance voltmeter (Voltohmyst) with respect to earth. Voltages at pins 6, 7, 9 and 10 depend on the setting of SHIFT controls (R19 and R60).

2. Voltages on V10, V11 and V12 measured with a moving coil instrument with a resistance of 1000 ohms/volt, with respect to the -48V. line.

3. The voltages at pin 1 of V11 and V12 depend on the setting of the FINE SWEEP control (R97).

6.8 Resistance Measurements

The resistance measurements provide a more accurate picture of circuit parameters, and, together with a check of valve conditions, should give adequate indication of possible causes of faulty operation.

Valve	From Pin No.	To	Resistance	Varies With
V1, V2, V6, V7	2 and 7	-48V.	6 kohms to 3 kohms	R9 and R47
	5	+375V.	48 kohms to 44 kohms	R14 and R53
	6	+375V.	34 kohms to 24 kohms	R11 and R51
	5 (V1) (V6)	pin 5 V2 / pin 5 V7	14 kohms to 1 kohms	R14 and R53
V3	3	pin 8 V3	730 ohms	
	3 and 8	-48V.	15 kohms to 16 kohms	R19
	1 and 6	+375V.	40 kohms	
V4	3 and 8	-48V.	16 kohms	
	1 and 6	+375V.	22 kohms	
	1 and 6	pin 8 V5	250 kohms	
V8	3 and 8	-48V.	15 kohms to 17 kohms	R60
	1 and 6	+375V.	40 kohms	
	3	pin 8 V8	2 kohms	
V9	3 and 8	-48V.	16 kohms	
	1 and 6	+375V.	22 kohms	

7. COMPONENT SCHEDULE

When ordering replacements parts please quote ALL details given below for a particular component.

Circ. Ref. No.	Description	A.W.A. Type Number (unless otherwise stated)
(a) **Capacitors**		
C1	0.25 uF., ±20%, 400V.W., paper tubular	Ducon TPB85
C2	150uuF., ±5%, 500V.W., silver mica	Simplex MS
C3	2-18 uuF., variable, air dielectric, miniature, Polar C30-01	2U52838
C4	1500 uuF., ±5%, 500V.W., silver mica	Simplex SS
C5	2-18 uuF., variable, air dielectric miniature, Polar C30-01	2U52838
C6	0.015uF., ±20%, 400V.W., paper, tubular	Ducon TPB85
C7	2-18 uuF., variable, air dielectric miniature, Polar C30-01	2U52838
C8	16 uF., –20+50%, 450V.P.W., electrolytic tubular metal case	Ducon ET
C9	16 uF., –20+50%, 450V.P.W., electrolytic tubular metal case	Ducon ET
C10	2-7 uuF., variable, air dielectric	T.C.C. type TSK0207
C11	2-7 uuF., variable, air dielectric	T.C.C. type TSK0207
C12	2-7 uuF., variable, air dielectric	T.C.C. type TSK0207
C13	2-7 uuF., variable, air dielectric	T.C.C. type TSK0207
C14	0.1 uF., ±20%, 400V.W., paper, tubular	Ducon TPB85
C15	50 uF., –20+100%, 125V.P.W., electrolytic tubular metal case	U.C.C. type ESK
C16	0.25 uF., ±20%, 400V.W., paper, tubular	Ducon TPB85
C17	150uuF., ±5%, 500V.W., silver mica	Simplex MS
C18	2-18uuF., variable, air dielectric miniature, Polar C30-01	2U52838
C19	1500 uuF., ±5%, 500V.W., silver mica	Simplex SS
C20	2-18 uuF., variable, air dielectric, miniature, Polar C30-01	2U52838
C21	0.015 uF., ±20%, 400V.W., paper tubular	Ducon TPB85
C22	2-18 uuF., variable, air dielectric, miniature, Polar C30-01	2U52838
C23	16 uF., –20+50%, 450V.W., electrolytic, tubular metal case	Ducon ET
C24	2-7 uuF., variable, air dielectric	T.C.C. type TSK0207
C25	2-7 uuF., variable, air dielectric	T.C.C. type TSK0207
C26	2-7 uuF., variable, air dielectric	T.C.C. type TSK0207
C27	2-7 uuF., variable, air dielectric	T.C.C. type TSK0207
C28	0.1uF., ±20%, 200V.W., paper, tubular	Ducon TPB85
C29	330 uuF., ±5%, 500V.W., silver mica	Simplex MS
C30	2-18 uuF., variable, air dielectric, miniature, Polar C30-01	2U52838
C31	0.1 uF., ±20%, 400V.W., paper, tubular	Ducon TPB85
C32	0.1 uF., ±20%, 400V.W., paper, tubular	Ducon TPB85
C33	0.1 uF., ±20%, 400V.W., paper, tubular	Ducon TPB85
C34	1 uF., ±20%, 350V.W., paper, tubular, metal case	U.C.C. Type PMP
C35	0.1 uF., ±20%, 400V.W., paper, tubular	Ducon TPB85
C36	0.01 uF., ±20%, 400V.W., paper, tubular	Ducon TPB85
C37	1000 uuF., ±5%, 500V.W., silver mica	Simplex SS
C38	22 uuF., ±5%, 500V.W., ceramic, tubular	Ducon CTR. NPO-A
C39	470 uuF., ±5%, 500V.W., silver mica	Simplex SS
C40	0.1 uF., ±20%, 1.5 kV.W., paper, rectangular metal case	Ducon 6S01
C41	0.1 uF., ±20%, 1.5 kV.W., paper, rectangular metal case	Ducon 6S01
C42	16 uF., 500V.W., 600V. surge, electrolytic	Ducon type EO
C43	16 uF., 500V.W., 600V. surge, electrolytic	Ducon type EO
C44	0.1 uF., ±20%, 400V.W., paper, tubular	Ducon TPB85
C45	Not used	
C46	470 uuF., ±5%, 500V.W., silver mica	Simplex SS
C47	16 uF., –20+50%, 450V.P.W., electrolytic, tubular metal case	Ducon ET
C48	150 uuF., ±5%, 500V.W., ceramic, tubular	Ducon CTR. NPO-D
C49	Not used	
C50	6.8 uuF., ±0.5uuF., 500V.W., ceramic tubular	Ducon CTR. NPO-A
C51	6.8 uuF., ±0.5uuF., 500V.W., ceramic tubular	Ducon CTR. NPO-A
C52	68 uuF., ±5%, 500V.W., ceramic, tubular	Ducon CTR. NPO-C
C53	Not used	
C54	Not used	
C55	Not used	
C56	Not used	
C57	Not used	
C58	0.5 uF., ±20%, 400V.W., paper tubular	Ducon TPB85
(b) **Resistors**		
R1	1M ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R2	0.1M ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R3	0.91M ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R4	10k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R5	1M ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R6	1k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA

Circ. Ref. No.	Description	A.W.A. Type Number (unless otherwise stated)
R7	1M ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R8	2700 ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R9	3k ohms, variable, wire-wound	I.R.C. type W
R10	82 ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R11	10k ohms, variable, wire-wound	I.R.C. type W or Colvern 3001
R12	82 ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R13	560 ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R14	0.1M ohms, variable, carbon, curve C	56031T26
R15	560 ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R16	8200 ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R17	8200 ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R18	40k ohms, ±5%, 15W., wire-wound, vitreous enamel ctg.	Ducon RWV5-K
R19	1k ohms, variable, carbon, curve A, I.R.C. type 2	56031T29
R20	6800 ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R21	8200 ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R22	2700 ohms, ±10%, 1/4W., carbon	I.R.C. type BTS
R23	12k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R24	12k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R25	12k ohms, ±5%, 2W., carbon	Welwyn type C25
R26	10k ohms, ±5%, 2W., carbon	Welwyn type C25
R27	22k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R28	22k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R29	3.3M ohms, ±5%, 1/4W., carbon	I.R.C. type BTS
R30	56k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R31	3.3M ohms, ±10%, 1/4W., carbon	I.R.C. type BTS
R32	560k ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R33	0.1M ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R34	0.15M ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R35	0.5M ohms, variable, carbon, curve C	56031T40
R36	220k ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R37	0.33M ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R38	0.5M ohms, variable, carbon	I.R.C. type A
R39	0.47M ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R40	1M ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R41	0.1M ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R42	0.91M ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R43	10k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R44	1M ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R45	1M ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R46	1M ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R47	3k ohms, variable, wire-wound	I.R.C. type W
R48	2700 ohms, ±5%., 1/2W., carbon	I.R.C. type BTA
R49	82 ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R50	82 ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R51	10k ohms, variable, wire-wound	I.R.C. type W or Colvern 3001
R52	560 ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R53	0.1M ohms, variable, carbon, curve C	56031T26
R54	560 ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R55	8200 ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R56	8200 ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R57	40k ohms, ±5%, 15W., wire-wound, vitreous enamel ctg.	Ducon RWV5-K
R58	8200 ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R59	6800 ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R60	2k ohms, variable, carbon	56031T29-1
R61	12k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R62	12k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R63	12k ohms, ±5%, 2W., carbon	Welwyn type C25
R64	10k ohms, ±5%, 2W., carbon	Welwyn type C25
R65	22k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R66	22k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA
R67	0.56M ohms, ±10%, 1/4W., carbon	I.R.C. type BTS
R68	1M ohms, ±10%, 1/4W., carbon	I.R.C. type BTS
R69	220k ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R70	10M ohms, ±10%, 1/4W., carbon	I.R.C. type BTS
R71	470 ohms, ±5%, 1/4W., carbon	I.R.C. type BTS
R72	100 ohms, ±5%, 1/4W., carbon	I.R.C. type BTS
R73	27k ohms, ±10%, 1/4W., carbon	I.R.C. type BTS
R74	0.1M ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R75	1M ohms, variable, carbon, curve C	56031T26-1
R76	47k ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R77	100k ohms, ±5%, 1/2W., carbon	I.R.C. type BTA

Circ. Ref. No.	Description	A.W.A. Type Number (unless otherwise stated)
R78	680k ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R79	1.5k ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R80	47k ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
*R81	1.5M ohms, variable, carbon, ganged to R97, curve A	56031T26-2
R82	250k ohms, variable, carbon, curve A	56031T24-1
R83	1M ohms, variable, carbon, curve A	56031T24-2
R84	12k ohms, ±5%, 2W., carbon	Welwyn type C25
R85	12k ohms, ±5%, 2W., carbon	Welwyn type C25
R86	5.6k ohms, ±5%, 2W., carbon	Welwyn type C25
R87	82 ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R88	0.1M ohms, ±10%, 1/4W., carbon	I.R.C. type BTS
R89	27k ohms, ±10%, 1/4W., carbon	I.R.C. type BTS
R90	5.6k ohms, ±5%, 2W., carbon	Welwyn type C25
R91	0.1M ohms., variable, carbon, curve C	56031T15
R92	22k ohms, ±5%, 1/4W., carbon	I.R.C. type BTS
R93	Not used	
R94	Not used	
R95	3300 ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R96	5600 ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
*R97	8M ohms, variable, carbon, ganged to R81	56031T26-2
R98	1M ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R99	82k ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R100	82k ohms, ±10%, 1/2W., carbon	I.R.C. type BTA
R101	470k ohms, ±10%, 1/4W., carbon	I.R.C. type BTS
R102	470k ohms, ±10%, 1/4W., carbon	I.R.C. type BTS
R103	0.47M ohms, ±10%, 1/2W., carbon	I.R.C. type BTA

*Ganged potentiometers mounted on one spindle. The dual unit is I.R.C. type PE4X.

(c) Sockets

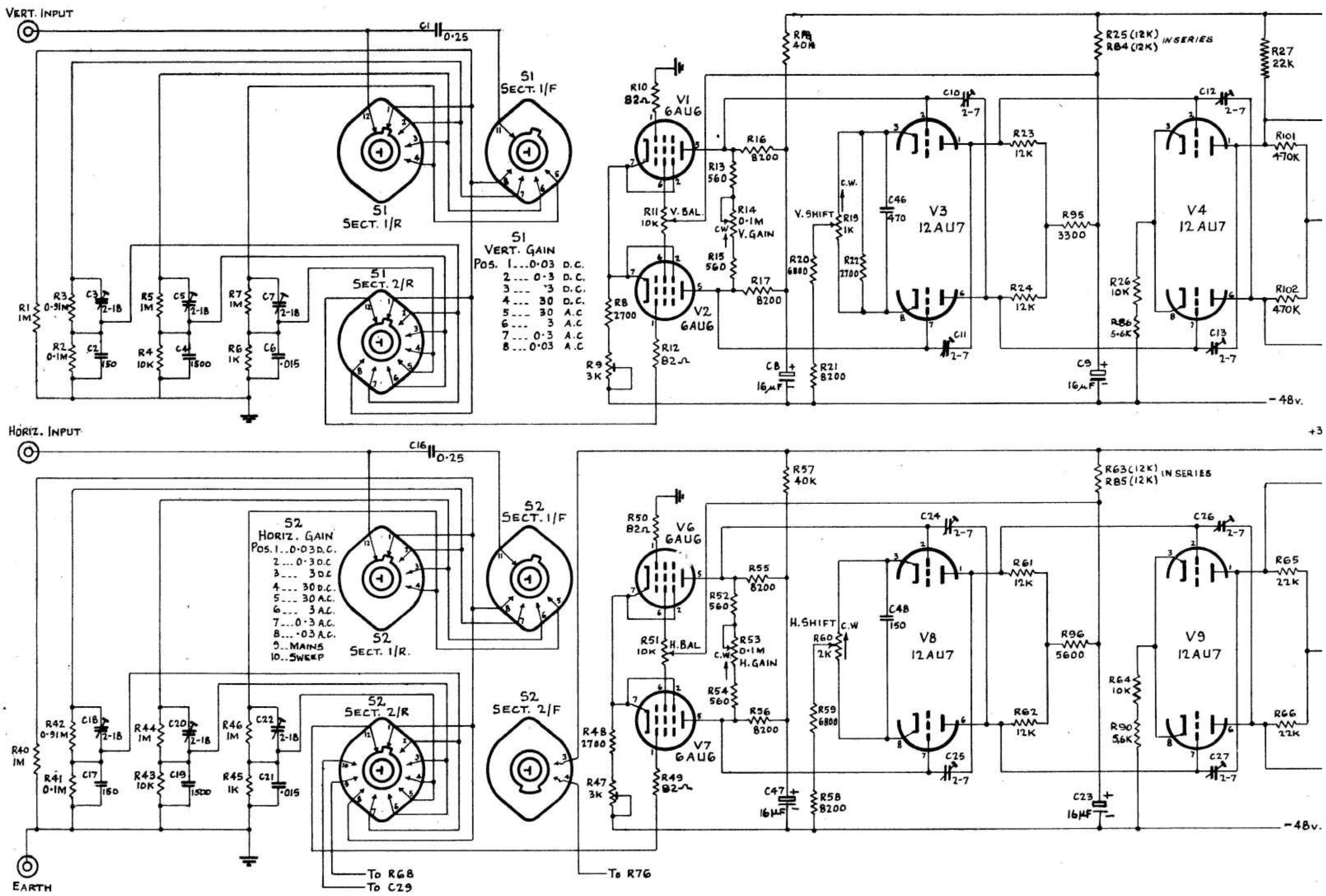
Circ. Ref. No.	Description	A.W.A. Type Number
V1	7-pin, miniature, button-type	Pt. 19965
V2	7-pin, miniature, button-type	Pt. 19965
V3	9-pin, miniature, button-type	Clix VH499/902CPS
V4	9-pin, miniature, button-type	Clix VH499/902CPS
V5	12-pin, small shell, Duodecal, bakelite	Code 794592
V6	7-pin, miniature, button-type	Pt. 19965
V7	7-pin, miniature, button-type	Pt. 19965
V8	9-pin, miniature, button-type	Clix VH499/902CPS
V9	9-pin, miniature, button-type	Clix VH499/902CPS
V10	9-pin, miniature, button-type	Clix VH499/902CPS
V11	4-pin, steatite, Amphenol	1S3331
V12	7-pin, miniature, button-type	Pt. 19965

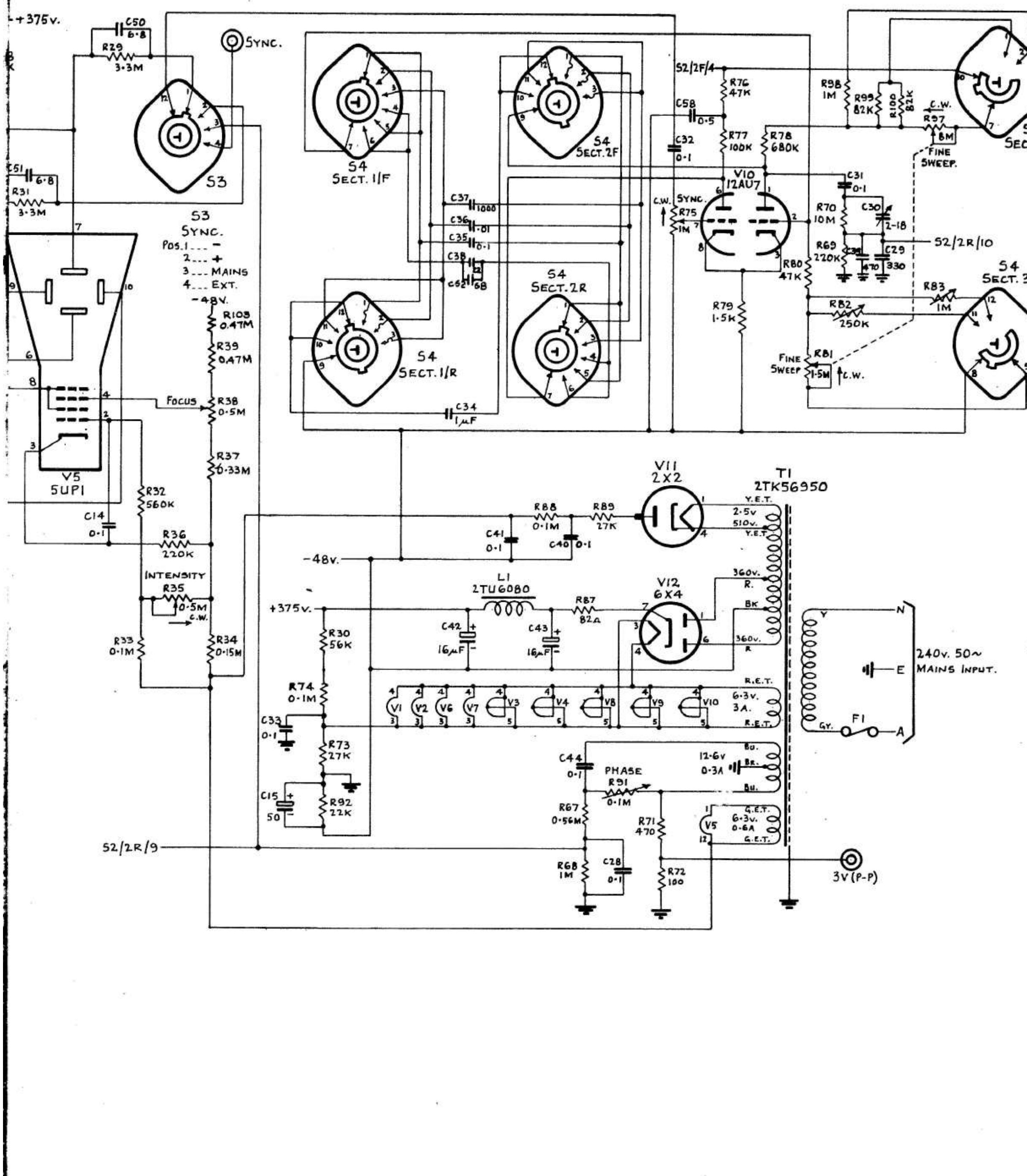
(d) Switches

Circ. Ref. No.	Description	A.W.A. Type Number
S1	Oak "H" type	56031V111
S2	Oak "H" type	56031V114
S3	Oak "H" type	56031V112
S4	Oak "H" type	56031V113

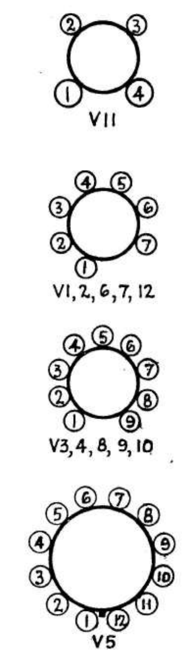
(e) Miscellaneous

Circ. Ref. No.	Description	A.W.A. Type Number
FS1	Glass cartridge fuse, loaded 1.5A	S8940
L1	Filter inductor	2TU6080
T1	Power Transformer	2TK56950


VERT. INPUT
C1 0·25
S1 SECT. 1/F
S1 SECT. 1/R
S1 SECT. 2/R
S1
VERT. GAIN
POS. 1...0·03 D.C.
2... 0·3 D.C.
3... 3 D.C.
4... 30 D.C.
5... 30 A.C
6... 3 A.C
7... 0·3 A.C
8... 0·03 A.C
R1 1M
R3 0·91M
R2 0·1M
C3 2-18
C2 150
R5 1M
C5 2-18
R4 10K
C4 1500
R7 1M
C7 2-18
R6 1K
C6 ·015
R10 82Ω
V1 6AU6
R11 V. BAL. 10K
R8 2700
R9 3K
V2 6AU6
R12 82Ω
R13 560
R14 0·1M
V. GAIN
R15 560
R16 8200
R17 8200
R18 40K
C8 16μF
R20 6800
R21 8200
V. SHIFT
R19 1K
C.W.
R22 2700
C46 470
V3 12AU7
C10 2-7
C11 2-7
R23 12K
R24 12K
R95 3300
R25 (12K)
R84 (12K) IN SERIES
C9 16μF
R26 10K
R86 5·6K
V4 12AU7
C12 2-7
C13 2-7
R27 22K
R101 470K
R102 470K
-48V.
HORIZ. INPUT
C16 0·25
S2
HORIZ. GAIN
POS. 1...0·03 D.C.
2... 0·3 D.C
3... 3 D.C
4... 30 D.C.
5... 30 A.C.
6... 3 A.C.
7... 0·3 A.C.
8... ·03 A.C.
9... MAINS
10... SWEEP
S2 SECT. 1/F
S2 SECT. 1/R.
S2 SECT. 2/R
S2 SECT. 2/F
R40 1M
R42 0·91M
R41 0·1M
C18 2-18
C17 150
R44 1M
C20 2-18
R43 10K
C19 1500
R46 1M
C22 2-18
R45 1K
C21 ·015
EARTH
To R68
To C29
To R76
R50 82Ω
V6 6AU6
R51 H. BAL 10K
R48 2700
R47 3K
V7 6AU6
R49 82Ω
R52 560
R53 0·1M
H. GAIN
R54 560
R55 8200
R56 8200
R57 40K
C47 16μF
R59 6800
R58 8200
H. SHIFT
R60 2K
C.W
C48 150
V8 12AU7
C24 2-7
C25 2-7
R61 12K
R62 12K
R96 5600
R63 (12K)
R85 (12K) IN SERIES
C23 16μF
R64 10K
R90 5·6K
V9 12AU7
C26 2-7
C27 2-7
R65 22K
R66 22K
-48V.



BOTTOM VIEW OF SOCKETS.



NOTES.
1. COMPONENT VALUES.
RESISTORS IN OHMS.
K = 1,000 Ω M = 1,000,000 Ω
CAPACITORS IN µF (e.g. ·01) OR µµF. (e.g. 150)
2. OAK SWITCHES VIEWED FROM KNOB END IN EXTREME ANTI-CLOCKWISE POSITION.
3. ↑ INDICATES CLOCKWISE ROTATION VIEWED FROM KNOB END.

AWA

OSCILLOSCOPE.
TYPE 1A56031.
DRG. 56031G3.

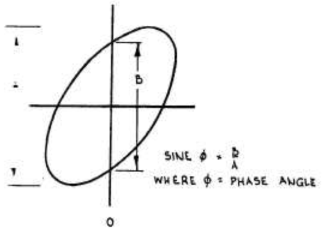


FIG. 1

MEASUREMENT

OF

PHASE SHIFT

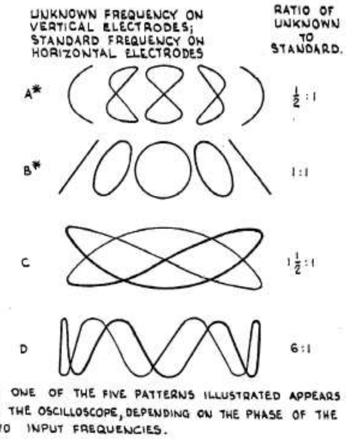


FIG. 2

LISSAJOU'S FIGURES

FOR

FREQUENCY DETERMINATION

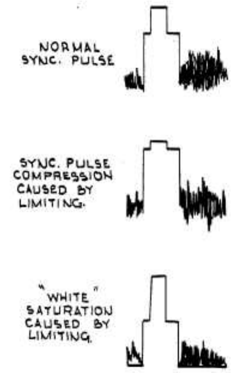


FIG. 5

SYNC. PULSE

COMPRESSION

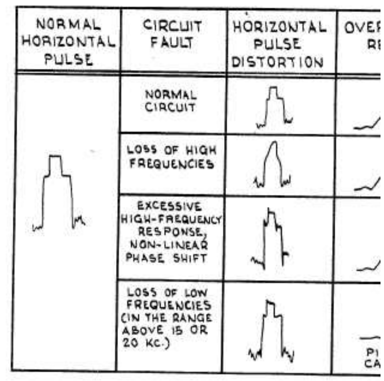


FIG. 6

SYNC. — PHASE DISTORTI

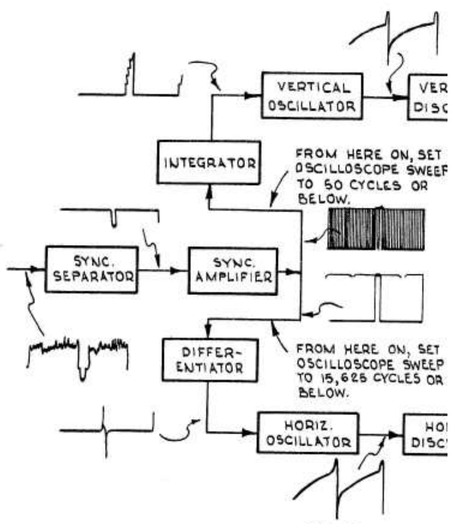


FIG. 7

SIGNAL TRACING IN SYNC. AND DEFLECTIO

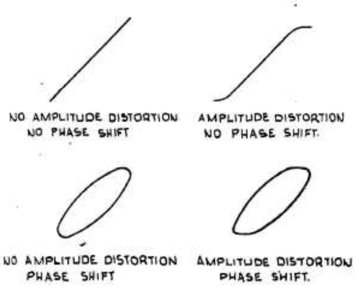


FIG. 4

DISTORTION AND PHASE SHIFT

IN

AUDIO AMPLIFIER

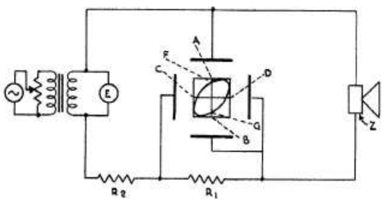
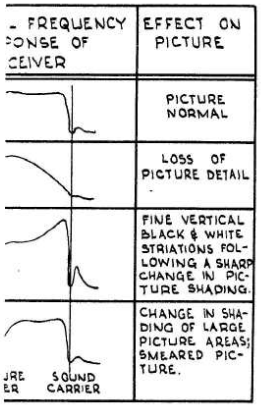


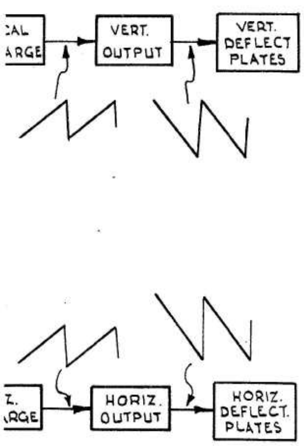
FIG. 3

MEASUREMENT

OF

IMPEDANCE AND POWER FACTOR.





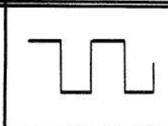
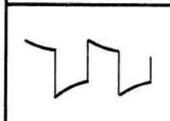
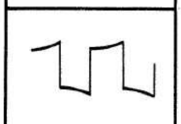
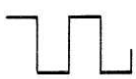
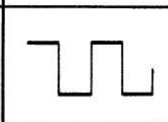
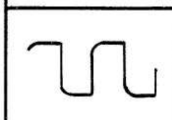
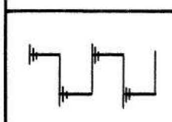
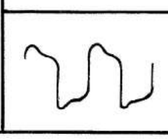
INPUT TO VIDEO AMPLIFIER	SHAPE OF OUTPUT WAVE SEEN ON C-R SCREEN	EFFECT ON TELEVISION PICTURE	DEFECT	CHECK THESE CIRCUIT COMPONENTS
SQUARE WAVE (ABOUT 50 CYCLES) 		PICTURE NORMAL	NO DEFECTS. GOOD LOW-FREQUENCY RESPONSE AND NEGLIGIBLE PHASE SHIFT.	
		GRADUAL CHANGE IN PICTURE SHADING FROM TOP TO BOTTOM OF PICTURE. (THIS EFFECT CAN BE MINIMIZED BY DC-RESTORER ACTION.	LEADING LOW-FREQUENCY PHASE SHIFT. (USUALLY ACCOMPANIED BY A LOSS OF LOW-FREQUENCY GAIN.)	COUPLING CAPACITORS, SCREEN AND CATHODE BY PASS CAPACITORS, LOW-FREQUENCY COMPENSATION CIRCUITS, SCREEN AND GRID RESISTORS.
			LAGGING. LOW-FREQUENCY PHASE SHIFT. (USALLY CAUSED BY OVER-COMPENSATION)	
SQUARE WAVE (ABOUT 25 KC) 		PICTURE NORMAL	NO DEFECTS. GOOD HIGH-FREQUENCY AND TRANSIENT RESPONSE.	
		PICTURE DETAIL IS POOR; SHARP CHANGES IN PICTURE SHADING ARE FUZZY"	POOR HIGH-FREQUENCY RESPONSE.	PEAKING COILS, LOAD RESISTORS, LEAD DRESS OF PEAKING COILS AND COUPLING NETWORKS
		FINE VERTICAL BLACK AND WHITE STRIATIONS FOLLOWING. A SHARP CHANGE IN PICTURE SHADING.	EXCESSIVE HIGH-FREQUENCY RESPONSE AND NON-LINEAR TIME DELAY; ALSO HIGH-FREQUENCY CUT OFF MAY BE TOO SHARP.	PEAKING COILS, LOAD RESISTORS, DAMPING RESISTORS SHUNTING PEAKING COILS, LEAD DRESS.
		WHITE BORDER FOLLOWING A BLACK-TO-WHITE TRANSITION; BLACK BORDER FOLLOWING A WHITE-TO-BLACK TRANSITION.	EXCESSIVE OR NOT ENOUGH MID-FREQUENCY RESPONSE AND NON-LINEAR TIME DELAY.	PEAKING COILS, LOAD RESISTORS, DAMPING RESISTORS SHUNTING PEAKING COILS LEAD DRESS.

FIG. 8

SQUARE WAVE ANALYSIS CHART.

CIRCUITS

EXPLANATORY DIAGRAMS

DRG. 56031 G2