

Cathode-Ray Oscillograph

Stock No. 158 TECHNICAL SUMMARY

POWER SUPPLY:

Rating	les
(Specifications based on 117 volts, 60 cycl	es)
Power Consumption 55 wa	atts
Fuse Protection 1 amp	ere

TUBE COMPLEMENT:

RCA-6C6 Horizontal Amplifier
RCA-6SJ7 1st Stage Vertical Amplifier
RCA-1852 2nd Stage Vertical Amplifier
RCA-884 Timing Circuit Oscillator
RCA-5BP1/1802-P1

Cathode-Kay Tube	(aincn)
RCA-80 Low-voltage	Rectifier
RCA-879 High-voltage	Rectifier

OVERALL DIMENSIONS:

Height (including carrying

handl	e)		 	 	 14 ³ / ₈ inches
Width			 	 	 8 inches
					191/2 inches
Weight	(ne	et)	 	 	 30 [°] pounds

With cable 0.4 volts (r.m.s.) per inch* Without Cable .0.04 volts (r.m.s.) per inch*
Frequency Response of Vertical Amplifier:
Flat within 1 db to 200 kc.*
Flat within3 db. to 500 kc.* Useful range 5 cycles to 1 mc.
Frequency Response of Horizontal Amplifier:
Flat within 1 db. to 45 kc.*
Flat within –3 db. to 100 kc.*
Input Characteristics:
Vertical amplificr with cable 1.15 mcgohms, 16 mmfd.
Vertical amplifier without cable

Deflection Sensitivity at Vertical Amplifier

0.15 mcgohms, 38 mmfd.

Timing Frequency Range . . 4 cycles to 18 kc.*

" Guaranteed values. Factory standards exceed these values.

enable the operator to readily adapt the equipment

OPERATING DATA (Gain Max.):

Input:

to his particular use.

DESCRIPTION

The Stock No. 158 Cathode-Ray Oscillograph is a reliable instrument for the observation of electrical circuit phenomena. Although specifically designed for use in servicing television receivers, it is practically unlimited in application, some of its more common uses include the study of wave shapes and transients, measurement of modulation, adjustment of radio receivers and transmitters, determination of peak voltages, and tracing of vacuum-tube characteristics. Its major but not only advantage over older types of visual devices is its freedom from inertia, allowing the observation of very rapid changes of current or voltage without appreciable distortion. The instrument is entirely portable, as shown by the cover illustration, and operates from an a-c source of 105 to 125 volts, 50 to 60 cycles An integral power-supply unit furnishes all voltages required for operation.

Figure 1 shows the essential units of the instrument in block diagram form.

The primary purpose of these instructions is to give the fundamentals of operation. As the use of cathode-ray apparatus becomes more widespread, many new applications will be found and a thorough understanding of these fundamentals will VERTICAL AMPL VERTICAL AMPL CATHODE RAY TUBE CATHODE RAY TUBE OVER SUPPLY UNIT UNIT INV. AC

For a comprehensive discussion of the fundamentals of cathode-ray tubes and an analysis of the figures which appear on the screen, see "A General Discussion of the Cathode-Ray Tube," RCA-IB-26453.

WARNING A POTENTIAL OF 1500 VOLTS IS PRESENT AT THE CATHODE-RAY TUBE SOCKET AND AT OTHER POINTS ON THE CHASSIS. ALWAYS DISCONNECT THE POWER CORD BEFORE REMOVING THE CHASSIS FROM THE CABINET. Remove the screws at the rear of the case. Withdraw the chassis from the case, feeding the power cable through the hole in the back. Make certain that all tubes are firmly in their sockets and that all grid-cap connections are in place. Unpack the cathode ray tube and install it in its proper mounting and connect the socket, rotating the tube if necessary so that the socket key is located at the top. Replace the chassis in the case and replace the screws at the rear. With the "Intensity" control in the extreme counterclockwise ("Off") position, plus the power-supply cable into an electrical outlet supplying 105-125 volts at 50-60 cycles. The instrument is then ready for operation.

NOTE: AN INTERLOCK SWITCH, LO-CATED AT THE REAR OF THE CHASSIS, 'OPENS THE POWER CIRCUIT WHEN THE CHASSIS IS REMOVED FROM THE CASE. DO NOT ATTEMPT TO OPERATE THE EQUIPMENT WHILE WITHDRAWN FROM THE CASE AS THE HIGH POTENTIALS USED ARE DANGEROUS.

OPERATION

Controls

Refer to the schematic and wiring diagrams for the location of circuit units designated by symbols.

1. "Intensity" control (R-41) consists of a potentiometer located in the high side of the highvoltage bleeder and controls the bias on the grid of the cathode-ray tube, which in turn determines the quantity of electrons emanating from the "gun," thus controlling the spot size. The power switch (S2) is attached to this potentiometer. Initial clockwise rotation of this control closes the switch and additional rotation increases the spot size.

2. "Focus" control (R-43) is a potentiometer located in the high-voltage bleeder. Its position controls the No. 1 anode voltage, which, with constant voltage on anode No. 2, determines the distance at which the electron beam focuses. In general, for a given "Intensity" setting, the "Focus" control should be set for maximum distinctness of spot or image.

3. "Vertical Amplifier" switch (S-6) is an input attenuator in the grid circuit of the first amplifier stage. The attenuation steps are approximately 1:5. Connection to the input is made through a special cable which may be omitted if higher input capacity is permissible. An increase in sensitivity of approximately 10 to 1 is obtained without the cable. Input connection, in this case, is made to terminal #2 of the input jack.

4. "Horizontal Amplifier" switch (S-3) has five positions: The amplifier "On" and "Off" and three "Timing" positions. On all "Timing" positions the "saw-tooth" or timing-axis oscillator feeds through an amplifier to the horizontal deflecting plates of the cathode-ray tube. At "On," the "Horizontal" phone tip jacks are connected through an amplifier to these deflecting plates while at "Off," the phone tip jacks are connected straight through to the deflecting plates. In booth of the latter two cases, there is a series condenser in the input circuit.

5. "Vertical Gain" control (R-33) consists of a potentiometer located in the grid circuit of the 2nd stage of the vertical amplifier. With the "Vertical Amplifier" switch set for any given position this potentiometer controls the vertical deflection. By advancing the "Vertical Amplifier" switch from a lower to the next largest number the sensitivity is cut approximately 5 to 1.

6. "Horizontal Gain" control (R-2) consists of a potentiometer located in the input circuit of the horizontal amplifier. With the "Horizontal Amplifier" switch set at "Timing" or "On," this potentiometer controls the horizontal deflection. Due to the capacity load on this input potentiometer, when operating on "Timing" at the higher audio frequencies, linear sweep will not be obtained at all setting of this control. For best results, the control should be set for maximum linearity.

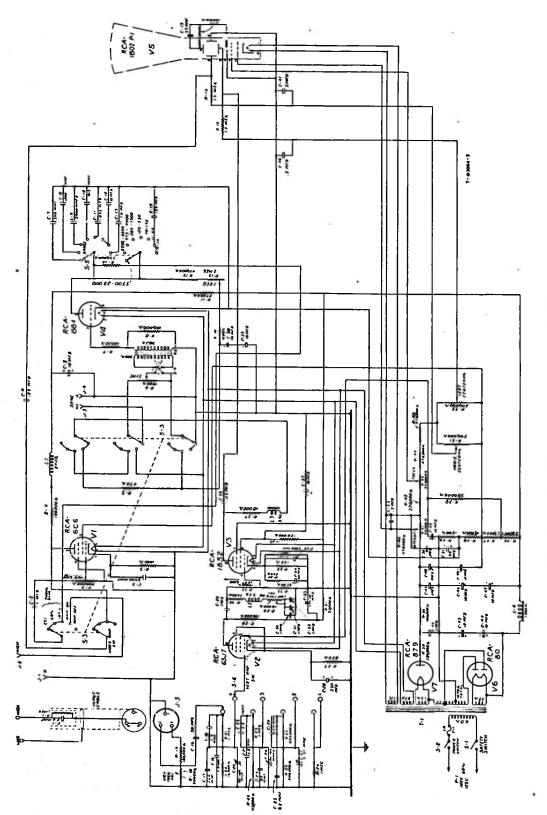
7. "Range" switch (S-5) selects one of eight timing capacitor values. It thus changes the timing-axis oscillator frequency in steps, giving eight ranges approximately as shown on the front panel.

8. "Freq." control (R-12) is a rheostat connected in series with the timing condenser. It changes the timing-axis oscillator frequency gradually as it is rotated, and in conjunction with the "Range" switch gives a continuous range between the extremes of frequency.

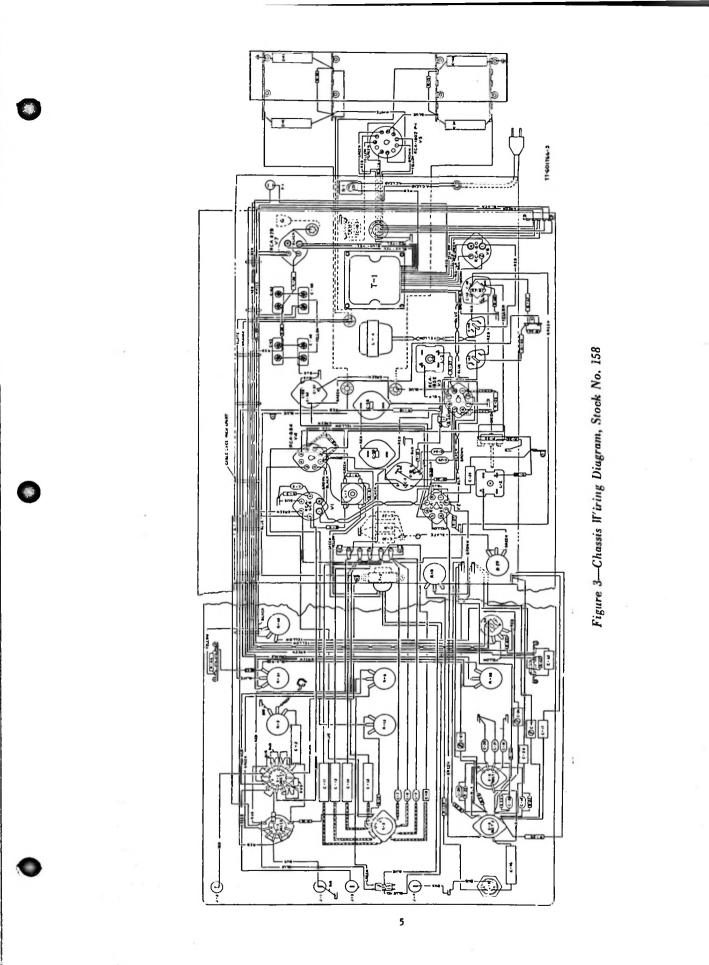
9. "Sync." control (R-6) is a potentiometer used to control the amount of synchronizing voltage fed to the grid of the RCA-884 tube. In general, it should be set as far counter-clockwise as is consistent with a locked image, since over-synchronization results in a poor wave-form produced by the timing-axis oscillator.

10. The "Sync." switch provides for a 180degree phase shift of the image on the screen.

11. "Horizontal Amplifier" switch (S-3) has three timing positions, "Int.," "60," and "Ext." for synchronization. At "Int.," the voltage drop across resistor R-5 in the plate circuit of the vertical amplifier is fed through the "Sync." control and input transformer to the grid of the RCA-884 tube. Thus, the timing-axis oscillator can be synchronized with the signal on the vertical axis at the fundamental frequency or at any sub-multiple, such as $\frac{1}{2}$, $\frac{1}{3}$... Synchronization is not effective if it is attempted to operate the timing-axis oscillator at







a higher frequency than that of the synchronizing voltage. When set to "60" a portion of the 60 cycle filament voltage is used for synchronization. On "Ext.," the "Sync." phone tip jack is connected to the "Sync." control. This allows the use of an external source for synchronizing.

12. The two "centering" controls regulate the amount of d-c potential between the two deflecting plates of each pair, and thereby allows adjustment of the position of the spot or image. There is sufficient voltage across these controls to move the spot approximately two inches on the screen. Start with both of these controls adjusted at about midposition.

13. There are four phone tip jacks provided on the panel. A voltage applied to the "Horizontal" jacks, with the horizontal amplifier switch S-3 in the "On" position, will result in a horizontal deflection of the spot. The "Sync." phone tip jack is used for external synchronization of the saw tooth oscillator. Caution: Do not apply more than 15 (r.m.s.) volts to "Ext. Sync." jack or damage to input components may result. The "Gnd." jacks are connected to the chassis. A switch labeled "Sync." controls the synchronization of the saw tooth oscillator with the source on either positive or negative impulses.

Applications

The following procedures are included in order to familiarize the operator with the operations and connections involved in particular applications. All applications of the equipment are not described, but analysis of any other problem will show wherein it is similar to or differs from those given, enabling the operator to work out his own sequence of operation.

As has been pointed out previously, most applications of this instrument are performed with the output of the unit under test connected to the vertical plates of the cathode-ray tube, and the wave shape studied by application of known constants on the horizontal plates of the tube. Before any measurements are attempted, the operator is urged to go through the following procedure in order to familiarize himself with the controls and their location and to get the "feel" of their operation:

1. Connect the power plug to an a-c source of 110/120 volts, 50/60 cycles. Turn the "Intensity" control clockwise, causing a spot to appear on the screen, increasing in size as the "Intensity" control is advanced further clockwise. The "Focus" control should then be adjusted until maximum distinctness of the spot or image occurs. The centering controls should be set about mid-position.

CAUTION. DO NOT ALLOW A SMALL SPOT OF HIGH BRILLIANCY TO REMAIN STATION-ARY ON THE SCREEN FOR ANY LENGTH OF TIME, AS DISCOLORATION OR BURNING OF THE SCREEN WILL RESULT. With the spot on the screen and with the "Intensity" control retarded so that the spot is not too brilliant, adjust the position of the spot to the center of the screen by rotation of the two centering controls. After initial adjustment, these controls will rarely require re-adjustment, unless the cathode-ray tube is replaced.

To turn the equipment off, turn the "Intensity" control to its extreme counterclockwise position, until a distinct "snap" is heard.

2. Apply a source of 60-cycle current to the input cable. To adjust the length of the resultant line appearing on the screen, turn the "Attenuator" switch to one of its four positions and adjust the "Gain" control until the length is as desired. Application of the same 60-cycle source to the "Horizontal" pin jacks with the "Horizontal Amplifier" switch 'On." or "Off" will similarly show a horizontal line on the screen, the length of which may be varied (with the "Horizontal Amplifier" switch "On") by manipulation of "Horizontal Cain" control.

3. To expand (2) further, have 60 cycles available at both "Horizontal" and "Vertical" terminals.

CAUTION. Since all ground or "Gnd" pin jacks on the oscillograph are common, it is advisable to use an isolating transformer for one supply, so that there is no common connection between the two.

Apply the horizontal 60-cycle supply to the deflecting plates, preferably through the amplifier and its gain control, then apply the 60-cycle vertical supply through the other amplifier and its gain control. The result will be a diagonal line. Horizontal amp. switch must be turned to "on" to do this (see "A General Discussion of the Cathode-Ray Tube," RCA-IB-26453, Figure 5 and explanation.)

AC VOLTMETER WITH AMPLIFIER—For this application, the characteristics of the unit are as follows: Input resistance—1.1 megohm, input capacity—approximately 8 mmfs; voltage range—approximately 175 volts (higher with external attenuator); calibration—approximately 0.64 peak volts per inch or 0.4 r-m-s volts per inch.

Procedure—Make connections and adjust controls. With the "Vertical Gain" control in the extreme clockwise position, a line one inch long is obtained on the screen for about 0.64 peak volts input. Intermediate positions of the gain control give different calibrations, of course, and if considerable use is made of this feature, it may be advisable to plot a curve of the inputs required to give a one-inch deflection at various intermediate positions of the gain control. If working at a frequency above 10,000 cycles, it must be remembered that retarding the gain control from maximum impairs the linearity of the amplifier.

A particular application of operation as an a-c voltmeter is in making hum measurements in a power supply unit. In this case, the "Gnd." pin jack or cable ground lead ("Vertical") is connected to the common lead of the filter circuit of the unit under test and the input cable is used to check the a-c ripple present at the various circuit component terminals.

AUDIO · QUALITY MEASUREMENTS—Use of the "saw-tooth oscillator" feature of the oscillograph provides a check which cannot be made with an ordinary voltmeter. This is extremely helpful in determining the audio quality of a receiver or similar instrument and also in locating causes of audio distortion.

Procedure-Apply the output from a constant frequency record or audio oscillator to the input cable. Turn the "Range" switch to that tap giving a range including the frequency of the input signal and adjust the "Freq." control until the saw-tooth oscillator frequency is near that of the input signal. If the two frequencies are identical, one cycle of the input signal will be observed on the screen; if the saw-tooth oscillator frequency is one-half that of the input signal, two cycles of the latter will appear; if one-third, three cycles, etc. Next, connect this constant frequency record or audio oscillator output to the audio input of the unit under test and connect the output of the unit under test to the input cable of the oseillograph. If the resultant wave does not correspond to that obtained when the input was direct to the oscillograph, audio distortion is present.

If it is desired to measure the overall audio fidelity of a receiver, for instance, the procedure is similar to that above except that the voltage modulating an r-f oscillator is fed into the oscillograph. adjusted as above. Then the modulated oscillator is connected to the r-f input terminals of the receiver and the loudspeaker voice coil connected to the oscillograph. Comparison of the two resultant waves will indicate how much distortion occurs in the receiver under test. Observing the quality of the input to the receiver from the test oscillator will also show how much distortion is being fed into the receiver from the test oscillator. This is desirable since it may show that all the distortion present in the receiver output may not be due to the receiver characteristics, but to those of the test oscillator (assuming no distortion from modulation).

MODULATION INDICATOR—(1) One method of measuring the modulation of a transmitter is to place the modulated r-f output of the transmitter into the vertical plates of the cathode-ray tube and the audio input signal to the transmitter on the "Sync." pin jack.

Procedure—Connect a constant-frequency input to the transmitter and connect a small pickup coil, located near the transmitter tank coil, to the input cable. The pickup on this coil should be from 1.2-10 volts. Connect the "Sync." pin jacks of the oscillograph to the transmitter audio amplifier at a point providing a 2- to 4-volt signal.

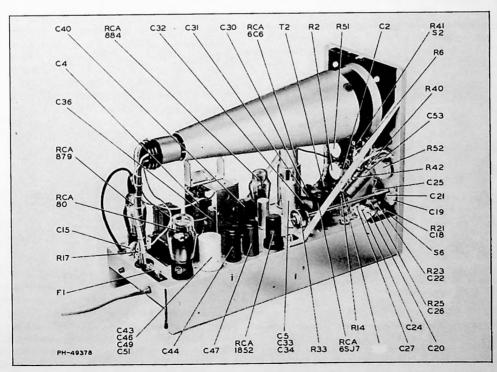


Figure 4—Top View of Chassis

Set "Horizontal Amplifier" switch to "Ext." position. Turn the "Range" switch to the tap which includes the frequency of the input signal and adjust "Freq." control until the saw-tooth oscillator interlocks with the signal on the vertical plates. Adjustment of the "Sync." control provides control of the voltage from the audio amplifier to the grid of the RCA-884 tube. Adjustment of "Horizontal Gain" control varies the horizontal deflection.

(2) Another and somewhat similar method of modulation measurement is to connect the pickup coil to the input cable as before, but connect the audio signal (from the transmitter audio amplifier) to the "Horizontal" pin jacks. Adjust "Horizontal Gain" control until desired horizontal deflection is obtained. The percentage modulation can then be readily determined. See Figure 31, "A General Discussion of the Cathode-Ray Tube," RCA-IB-26453.

ALIGNMENT OF INTERMEDIATE-FREQUENCY STAGES — For alignment of the intermediate-frequency stages of a receiver, it is essential that an auxiliary apparatus, a frequency modulator, be available to sweep the intermedite frequency for which the receiver is designed. One type of frequency modulator consists of sweep condenser and a synchronizing generator rotated in synchronism by a driving motor. The condenser is arranged to "sweep" the frequency of the r-f input to the receiver (or i-f stages) and the synchronizing generator connects to the "sync." jack of the oscillograph so as to synchronize the saw-tooth oscillator with the frequency variation of the test oscillator input to the receiver. An electronic sweep test oscillator may be used to provide both a frequency-modulated signal and a synchronizing signal, so that no other frequency modulator is required.

The test oscillator output should be coupled to the grid of the tube preceding the i-f stage under alignment. It is essential that this connection be made without altering any of the operating characteristics of this stage. If the grid of the tube to which connection is to he made is at zero d-c potential with respect to ground, connect the oscillator to the grid of the tube and disconnect the lead normally on the grid, the low side of the test oscillator output returning to chassis ground. If the grid is not at zero d-c potential with respect to ground, connect the high side of the oscillator to the grid (disconnecting the lead on the grid) and the other side to the "--C" lead for this grid.

The "Vertical" input cable of the oscillograph should be connected to the audio output of the second detector. For a diode detector, this connection may be across the volume control alone or across both the volume control and automatic volume control resistor, if this connection is convenient. When the second detector is a triode, tetrode or pentode, resistance-coupled to the first audio stage, the connection to the input cable may be to the plate of the tube, the "Gnd" lead being connected to ground. In the case of a triode, tetrode or pentode, transformer- or impedancecoupled to the first audio stage, connect a resistor

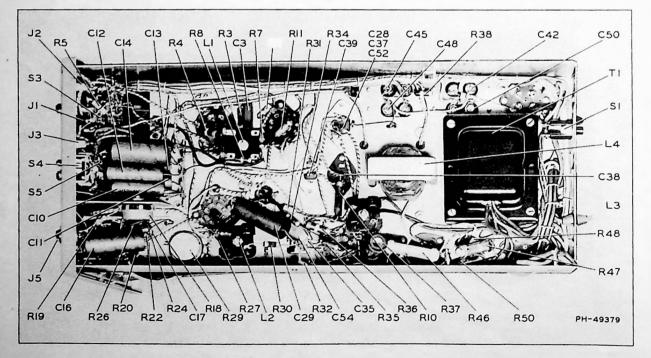


Figure 5—Bottom View of Chassis

of approximately 20,000 ohms in series with the plate of the tube and by-pass the inductance in the plate circuit by a 1.0 mfd or larger capacitor. This changes the impedance of the plate circuit to resistance rather than inductive reactance; the input cable should be connected to the plate of the tube and the "Gnd." lead to ground in order to take the audio voltage off his resistor.

ALIGNMENT OF RADIO-FREQUENCY STACES—The equipment used for r-f alignment is identical to that for i-f alignment, except that the test oscillator output is connected to the antenna lead of the receiver, and different frequencies are employed.

FREQUENCY MEASUREMENTS—In using the oscillograph for frequency measurement, either Lissajou figures (sine waves on both axes) may be used, or the linear timing axis may be employed on the horizontal axis. The most flexible method for frequencies up to 100,000 cycles is the linear timing axis method. The frequency stability of the saw-tooth oscillator running free is not good enough to depend upon for accurate measurements, but when this oscillator is synchronized with a standard-frequency voltage, its frequency stability is the same as that of the standard, and it can be synchronized at any sub-multiple of the

The schematic arrangement of the entire circuit is shown in Figure 2.

An amplifier consisting of two stages constitutes the means of obtaining gain for the signal applied to the vertical deflecting system. The input to this stage is a high-resistance step attenuator connected to provide stepped gain control. An isolation capacitor is made a part of the input circuit to exclude from the grid any direct current which may be associated with the circuit being observed. The plate circuit of the output tube (RCA-1852) is composed of two elements in series, a resistor and an inductance whose values are so designed as to effect a broad and uniform frequency response in the amplifier stage. Coupling from the amplifier plate to the cathode-ray tube is made through a capacitor.

The amplifier for the signal applied to the horizontal deflecting plates is a single stage. A switch is provided to disconnect the Horizontal Amplifier, thereby applying the voltage to be studied directly to the deflecting plate. Extra contacts are used on the input switch to the horizontal amplifier for feeding in the timing or "saw-tooth" oscillator signal.

A synchronization system is included, as shown in the input circuit of the RCA-884. This is included in the Horizontal Amplifier switch and is described under "Operation." The timing axis oscillator stage, using the RCA-884, is designed to have a frequency range of approximately 4-18,000 cycles, controlled through the "Range" switch and "Frequency" control. The signal from this oscillator has a "saw-tooth" wave shape, obtained as standard frequency down to about one-tenth. This allows convenient calibration of a device at many points between one-hundredth of-and ten times a single standard-frequency source, and every point is as accurate as the standard. If a 1000-cycle standard source is used, calibration points between 10 and 10,000 cycles are easily obtained. Using Lissajou figures, calibration points between 100 and 10,000 cycles can be obtained. A frequency standard which is almost universally available is the 60-cycle a-c supply. Since the advent and rapid spread of electric clocks, the frequency of nearly all commercial power is held to a very close tolerance. This allows accurate calibration at frequencies up to about 600 cycles. "Sync." switch S-4 reverses the input to the saw-tooth oscillator and in so doing provides synchronization with impulses of opposite polarity.

CHECKING PHASE SHIFT—To check phase shift of electrical equipment with the oscillograph, observe the screen pattern with the input to the equipment connected to the "Horizontal" jacks and the output from the equipment connected to the input cable. If no phase shift exists, a sloping straight-line image will appear. The internal amplifiers in the oscillograph introduce some phase displacement which must be considered.

CIRCUITS

follows: A d-c potential is applied across a capacitor and resistor in series in the plate circuit of the RCA-884 tube. This voltage charges the capacitor until the ionization potential (plate voltage at which the gas in the tube ionizes) is reached. When the RCA-884 ionizes, the capacitor is short-circuited and the voltage across it drops nearly to zero. The tube immediately deionizes and allows the capacitor to start charging again. In this manner, the voltage across the capacitor has a "saw-tooth" characteristic. The capacitor referred to above is selected by the position of the "Range" switch as described in "Operation." With the "Horizontal Amplifier" switch on "Timing," the voltage across this capacitor passes through the horizontal amplifier to the plates of the cathode-ray tube. The operation of the "Sync." control, in the grid circuit of the RCA-884 is described under "Operation."

The cathode-ray tube is described under "General Discussion of Cathode-Ray Tube," RCA-IB-26453. Controls used to alter the intensity, focus and zero adjustments are described under "Operation."

Power required for operation of the instrument is obtained through the power unit from a 110- to 120-volt, 50- to 60-cycle supply. Voltage rectification is accomplished by one RCA-80 and one RCA-879 rectifier tube, one being used full-wave and the other half-wave. One of these tubes supplies plate voltages for the amplifier stages and sweep oscillator, filtered through a reactor-capacitor combination. The other supplies the high voltage to the cathode-ray tube for polarization purposes.

MAINTENANCE

Under ordinary circumstances no adjustments need be made on the instrument but if these are disturbed they can be readjusted only with the use of square wave inputs obtained from a reliable square generator. Normally this means returning the instrument to the factory.

Radiotrons

Under ordinary usage within the ratings specified for voltage supply, tube life will be consistent with that obtained in other applications. The amplifier, oscillator and rectifier tubes will wear in accordance with loss of emission; where as the determining factor in the life of the cathode-ray tube is the deterioration of the fluorescent screen. It is therefore advisable to avoid leaving a bright, concentrated "spot" on the screen. Also, the image of the phenomena under observation should be removed from the screen when not actually being studied or measured; this item of care will enable a long and useful life to be obtained from the tube.

It is ordinarily not possible to test the Radiotrons in their respective sockets, due to the likelihood of circuit effects causing error. However, through the use of the RCA Chanalyst, amplifier tubes may be checked while in their circuits and under operating conditions by the signal-tracing method.

The tubes may also be removed and checked with standard tube testing apparatus or the questionable tube may be replaced with one known to be in good condition.

On the cathode-ray tube, excessive wear and approach to its limit of life is indicated by inability to obtain a satisfactory focus, and also by the screen becoming streaked and spotted. When it becomes necessary to install a new cathode-ray tube, some rotational adjustment may be required to bring the axes of deflection into their proper horizontal and vertical planes. This is accomplished by loosening the wing nut on the cathode-ray tube shield clamp, rotating the socket as desired, and then tightening the wing nut.

Fuse Replacements

A small 1-ampere cartridge fuse is used in the primary circuit of the power transformer. This fuse is intended for protection of the entire power system of the oscillograph, and, therefore, should not be replaced by one having a higher rating, nor be shorted out. A fuse failure should be carefully investigated before making a replacement, since with fuses of accepted quality, there usually will be a definite cause for the breakdown. The cause may originate from a surge in the power-supply line, but the greater percentage of causes may be centered in the apparatus protected, such as shorted rectifier elements, and so forth. Occasionally, a fuse may open from heat generated at one of its clip contacts. These points should therefore be kept clean and in secure contact with the fuse.

Resistance and Continuity Tests

The chassis wiring layout giving color code and physical relation of the parts is shown in Figure 3. All resistor and capacitor values are given to facilitate a rapid and sure test for continuity of circuit and the condition of same. Coils and transformer windings have their d-c resistances shown.

In working on the chassis of the oscillograph, care must be observed to have the power supply completely disconnected. The high voltages associated with the circuits of the cathode-ray tube make it especially dangerous to attempt to handle or work on the chassis while the power is "On."

Care should be exercised in replacing any part that may be found faulty. All wiring associated with the part involved must be removed, and especial attention given to the possibility of damage to other wiring or parts. The relation of wiring and parts should be the same as in the original assembly. The insulation and spacing of the highvoltage leads is very necessary and an important item to be adhered to in servicing of the instrument.

Voltage Measurements

One means of learning the condition of operation and tracing the circuit faults of the oscillograph is by checking the values of the voltages and currents at the Radiotron sockets. The normal values, which can be expected to be found when the instrument is working properly under the specified power rating, are indicated by the Radiotron Socket Voltage Table. In general, the values shown are measured from the socket contacts to ground; however, the heater or filament voltages are a-c and appear between the F-F or H-H clips. All readings given are actual operating values, and do not allow for any errors likely to be caused by current drain of the measuring instrument.

TUBE SOCKET VOLTAGES

Approximate tube socket voltages read with respect to ground: (Measured with RCA VoltOhmyst). 115 volts applied to primary.

Tube	Function	Er	Ek	Eg	E _{sg}	\mathbf{E}_{sup}	Ep
RCA-6C6	Horizontal Am- plifier		+1.8 to +27		+102 to +105	0	+232 to +330
RCA-6SJ7	Vertical Ampli- ficr (1st Stage)		+2.4		+73	+2.65	+195
RCA-1852	Vertical Ampli- fier (2ndStage)		+1.9		+157	0	+260
RCA-884	Sweep Oscillator		+7 to +9				+53
RCA-879	High - Voltage Rectifier	AC1190					1165
RCA-80	Low-Voltage Rec- tifier	+520					AC435
Tube	Function	Er	$\mathbf{E}_{\mathbf{g}}$	Deflection Plate			
	Cathode - Ray			No. 3	No. 9	lst Anode	2nd Anode
P-1	Tube	to —960	—845 to —925	+88 to -72	+88 to -72	-620 to -820	0

REPLACEMENT PARTS

Insist on genuine factory-tested parts, which are readily identified and may be purchased from authorized dealers.

3873 Cable—Input cable complete 32059 Holder—Tubular type with screw cap with screw cap fandle_Carrying handle 12814 Capacitor—5.6 mmid. (C1, C18, C21, C23) 47061 Jack—Red binding jack 12948 Capacitor—3.2 mmid. (C23) 47061 Jack—Red binding jack 12813 Capacitor—3.0 mmid. (C13) 32116 Knob—Control knob 12813 Capacitor—3.00 mmid. (C23) 47062 Post-Binding post (use and 47022) 12837 Capacitor—1.200 mmid. (C3, C35) 12414 Resistor—100 ohms, ¼ w 03656 Capacitor—0.05 mid. (C10) 14076 Resistor—1.200 ohms, ¼ w 03657 Capacitor—0.15 mid. (C12, C14, C42, C42, C48, C50) 13714 Resistor—1.200 ohms, ¼ w 03649 Capacitor—0.25 mid. (C4, C14, C36), C31, C329, C44, C47) 13714 Resistor—10,000 ohms, ½ 03865 Capacitor—0.5 mid. (C16, C40, C41, C43, C38, C39, C44, C47) 14076 Resistor—10,000 ohms, ½ 03867 Capacitor—0.5 mid. (C16, C40, C41, C38, C39, C44, C47) 13714 Resistor—10,000 ohms, ½ 13867 Capacitor—0.10 mid., 300 volts, 10 mid., 13 volts, 10 mid., 14 volts, 10 mid., 14 volts, 10 mid	DN
12814 Capacitor - 5.6 mmfd. (C1, C18, C22, C26) with acrew cap 14079 Capacitor - 6.8 mmfd. (C19, C21) 47061 Jack - Red binding jack 12813 Capacitor - 3.2 mmfd. (C12) 47061 Jack - Red binding jack 12813 Capacitor - 3.2 mmfd. (C13) 47062 Jack - Red binding jack 12813 Capacitor - 3.00 mmfd. (C17) 13428 Resistor - 1.00 ohms, ¼ w 13094 Capacitor - 0.05 mfd. (C10) 14076 Resistor - 1.00 ohms, ¼ w 03656 Capacitor - 0.05 mfd. (C10, C40, C41, C42, C48, C50) 12141 Resistor - 1.200 ohms, ¼ w 03046 Capacitor - 0.5 mfd. (C16, C40, C41, C36) 13141 Resistor - 1.000 ohms, ¼ 03047 Capacitor - 0.5 mfd. (C2, C13, C29, C30, C31, C32) 3216 Resistor - 18,000 ohms, ¼ 18000 Capacitor - 0.5 mfd. (C2, C13, C29, C30, C31, C32) 32462 Resistor - 18,000 ohms, ¼ 18004 Capacitor - 0.5 mfd. (C4, C44, C43, C45, C49, C51) 14157 Resistor - 18,000 ohms, ¼ 1807 Capacitor - 0.5 mfd. (C2, C42, C42, C43, C46, C49, C41, C43, C45, C49, C41, C43, C45, C49, C43, C45, C49, C41, C43, C45, C49, C43, C46, C49, C41, C43, C46, C49,	
14070 13001Capacitor -6.2 mmid. (C19, C21) Capacitor -33 mmid. (C15)47061 Capacitor -33 mmid. (C15)Jack-Red binding jack 4728112846 12813Capacitor -30 mmid. (C17) Capacitor -300 mmid. (C17)32116 Capacitor -300 mmid. (C17)32116 Resistor -470 ohms, 14 weight of the second	
13001Capacitor-8.2 mmfd. (C25)47228Jack-Red binding jack12946Capacitor-300 mmfd. (C1)32116Knob-Control knob13894Capacitor-300 mmfd. (C1)13428Resistor-150 ohms, ½13894Capacitor-300 mmfd. (C3)30446Resistor-150 ohms, ½13057Capacitor-015 mfd. (C1)14720Resistor-200 ohms, ½30846Capacitor-0.05 mfd. (C4, C14, C36)14720Resistor-1,200 ohms, ½30847Capacitor-0.05 mfd. (C4, C14, C36)13716Resistor-2,200 ohms, ½30848Capacitor-0.5 mfd. (C4, C40, C41,13716Resistor-2,000 ohms, ½30849Capacitor-0.5 mfd. (C4, C40, C41,13716Resistor-30,000 ohms, ½C31, C32)C31, C32)13716Resistor-18,000 ohms, ½33860Capacitor-0.5 mfd. (C4, C40, C41,14557Resistor-18,000 ohms, ½C31, C32)C39, C44, C47)13716Resistor-200 ohms, ½33860Capacitor-20 mfd., 300 volts, 10 mfd.,14561Resistor-200 ohms, ½33861Capacitor-230 mfd., 15 volts, 10 mfd.,12454Resistor-30,000 ohms, ½33862Capacitor-230 mfd., 15 volts, 10 mfd.,14561Resistor-30,000 ohms, ½33861Choke-Filter reactor (L4)14567Resistor-20,000 ohms, ½33861Condenser-3 to 30 mmfd., variable condenser-3 to 30 mmfd., variable condenser-3 to 30 mmfd., variable condenser-120,000 ohmsive frequency control-1,000 ohmswynchronizing control (R6)306413064133862Control-10,000 ohmswynchronizing control (R63)33662 <td></td>	
12946Capacitor-33 mmid. (C15)22116Knob-Control knob12813Capacitor-300 mmid. (C1)47062Post-Binding post (use and 47228)12834Capacitor-300 mmid. (C3)3046Resistor-470 ohms. ¼ w 488112835Capacitor-300 mmid. (C3)11414Resistor-470 ohms. ¼ w 488112836Capacitor-300 mmid. (C1)12267Resistor-470 ohms. ¼ w 4885612837Capacitor-0.30 mmid. (C1)12267Resistor-200 ohms. ¼ w 4885612836Capacitor-0.31 mid. (C1)12267Resistor-1.200 ohms. ¼ w 4885612846Capacitor-0.25 mid. (C4, C14, C36)13716Resistor-1.200 ohms. ¼ w 453.000 ohms. ¼12846Capacitor-0.25 mid. (C4, C14, C36)13714Resistor-1.600 ohms. ¼ w C33.12847Capacitor-10 mid., 300 volts (C38, C39, C44, C47)30400Resistor-18,000 ohms. ½ w B386212847Capacitor-10 mid., 450 volts, 10 mid., 350 volts, 10 mid., 150 volts, 20 mid., 350 volts, 10 mid., 150 volts, C5, C37, C52)3154Resistor-20,000 ohms. ½ R386712847Choke-HPilter reactor (L4)14550Resistor-20,000 ohms. ½ R38672000 ohms. 400 ohms. ½ R45012847Condenser-3 to 30 mmid., variable condenser (C27)3054Resistor-20,000 ohms. ½ R45013867Choke-HPilter reactor (L4)14553Resistor-20,000 ohms. ½ R45013867Condenser-60 to 120 mmid., variable condenser-60 to 120 mmid., variable condenser-60 to 120 mmid., variable condenser-60 to 120 mmid., variable condenser-60 to 120 mmid., variable control-1,0	
12813 12814Capacitor-300 mmfd. (C2) Capacitor-300 mmfd. (C1)47062 resistor-420 ohms, 4/s Resistor-420 ohms, 4/s Resistor-4200 ohms, 4/s Resistor-420,000	
13894Capacitor-390 mmfd. (C17)13428Resistor-470 ohms, $\frac{1}{2}$ with the second seco	
12337 Capacitor500 mmid. (C1) 13428 Resistor150 ohms, ½ w 13054 Capacitor300 mmid. (C3) 30546 Resistor470 ohms, ½ w 30856 Capacitor035 mid. (C1) 14076 Resistor100 ohms, ½ w 30847 Capacitor0.1 mid. (C1) 12267 Resistor1,200 ohms, ½ w 30848 Capacitor0.1 mid. (C2) 12267 Resistor220 ohms, ½ w 30849 Capacitor0.1 mid. (C4, C14, C36) 13714 Resistor2,200 ohms, ½ 30849 Capacitor0.5 mid. (C4, C14, C36) 13714 Resistor2,200 ohms, ½ C30 C31, C22)	
4881 Capacitor 3300 mmid. (C3, C35) 12414 Resistor560 ohms, 1/4 w 30856 Capacitor015 mid. (C10) 14720 Resistor1200 ohms, 1/4 w 30848 Capacitor015 mid. (C12) 12267 Resistor1200 ohms, 1/4 w 8000 Capacitor0.1 mid. (C12) 12267 Resistor1200 ohms, 1/4 w 30849 Capacitor0.1 mid. (C4, C14, C35). 13714 Resistor2200 ohms, 1/4 w 30840 Capacitor0.5 mid. (C4, C14, C36). 13714 Resistor1200 ohms, 1/4 w 30850 Capacitor0.5 mid. (C4, C14, C36). 13714 Resistor18,000 ohms, 2/4 w 33879 Capacitor10 mid., 300 volts (C38, 30409 Resistor30,000 ohms, 2/4 w 33880 Capacitor10 mid., 150 volts (C38, 14167 Resistor30,000 ohms, 2/4 w 33880 Capacitor10 mid., 250 volts (C42, 6134 Resistor30,000 ohms, 2/4 w 33880 Capacitor10 mid., 250 volts (C43, 76 c43, C46, C49, C51) 6143 33880 Capacitor250 mid., 15 volts, 10 mid., 12447 Resistor30,000 ohms, 2/4 w 33815 Capacitor250 mid., 15 volts, 10 mid., 3252 </td <td></td>	
30856 Capacitor015 mfd. (C10) 14076 Resistor-820 ohms, ½ 30857 Capacitor015 mfd. (C11) 14770 Resistor-1.000 ohms, ½ 30848 Capacitor0.1 mfd. (C12) 12267 Resistor-1.200 ohms, ½ 30849 Capacitor0.5 mfd. (C4, C14, C35) 13714 Resistor-2.200 ohms, ½ 30849 Capacitor0.5 mfd. (C4, C14, C35) 13714 Resistor-2.200 ohms, ½ 30840 Capacitor0.5 mfd. (C2, C13, C29, C30, C31, C32) 33862 Resistor-27,000 ohms, ½ 33870 Capacitor10 mfd., 300 volts, 10 mfd., 12487 Resistor-27,000 ohms, ½ Resistor-33,000 ohms, ½ 33861 Capacitor10 mfd., 450 volts, 10 mfd., 15 volts, 10 mfd., 12487 Resistor-33,000 ohms, ½ Resistor-33,000 ohms, ½ 33862 Capacitor10 mfd., 150 volts, 20 mfd., 14560 Resistor-20,000 ohms, ½ Resistor-20,000 ohms, ½ 33861 Capacitor10 mfd., 150 volts, 10 mfd., 150 volts, 10 mfd., 30154 Resistor-20,000 ohms, ½ 33861 Capacitor10 mfd., 150 volts, 10 mfd., 30154 Resistor-20,000 ohms, ½ 33861 Condenser -620 to 120 mmfd., variable condenser (C27) 14583 Resistor200,000 ohms, ½ 33861	
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18000 Capacitor -0.1 mfd. , 1,250 volts (C42, C45, C48, C50) 6134 Resistor -2.200 ohms, 1 (2apacitor -0.5 mfd. (C4, C14, C36) 30849 Capacitor -0.5 mfd. (C4, C14, C36) 13716 Resistor -2.500 ohms, 1/4 (Resistor -2.500 ohms, 1/4 30850 Capacitor -0.5 mfd. (C16, C40, C41, C31, C32) 13716 Resistor $-10,000 \text{ ohms, 1/4}$ 33879 Capacitor $-10 \text{ mfd., 300 volts}$ (C38, C39, C44, C47) 3219 Resistor $-27,000 \text{ ohms, 1/4}$ 33880 Capacitor $-10 \text{ mfd., 300 volts, 10 mfd.,300 volts, 10 mfd., 300 volts, 20 mfd.,25 volts (C43, C46, C49, C51) 14167 Resistor -27,000 \text{ ohms, 2/4} 33865 Capacitor -10 \text{ mfd., 450 volts, 10 mfd.,300 volts, 10 mfd., 150 volts (C28,C37, C52) 6133 Resistor -33,000 \text{ ohms, 2/4} 33159 Capacitor -250 \text{ mfd., 150 volts (C28,C37, C52) 6143 Resistor -200,000 \text{ ohms, 2/4} 33861 Choke -\text{Writcal amplifier plate}condenser (C27) 13483 Resistor -200,000 \text{ ohms, 1/4} 33870 Control -10,000 \text{ ohms} - ychchonizing}control (R6) 30041 Resistor -200,000 \text{ ohms, 1/4} 33861 Control -1000 \text{ ohms} - ychchonizing}control (R6) 30784 Resistor -100,000 \text{ ohms, 1/4} 33861 Control -10,000 \text{ ohms} - ychcial gaincontrol (R6)$	
30849 Capacitor -0.25 mfd. (C4, C14, C36) Capacitor -0.5 mfd. (C16, C40, C41, C53) 13714 Resistor -5,600 ohms, ½ Resistor -10,000 ohms, ½ 30860 Capacitor -0.5 mfd. (C16, C40, C41, C33) 14559 Resistor -18,000 ohms, ½ 33879 Capacitor -10 mfd., 300 volts, 10 mfd., 300 volts, 10 mfd., 150 volts, 20 mfd., 25 volts (C43, C46, C49, C51) 3219 Resistor -27,000 ohms, ½ 33880 Capacitor -10 mfd., 450 volts, 10 mfd., 300 volts, 10 mfd., 150 volts, 20 mfd., 300 volts, 10 mfd., 150 volts (C28, C33, C34) 12454 Resistor -33,000 ohms, ½ 33851 Capacitor -250 mfd., 15 volts (10 mfd., 350 volts, 10 mfd., 150 volts (C28, C37, C52) 14560 Resistor -100,000 ohms, ½ 33867 Choke -Filter reactor (L4) 14583 Resistor -200,000 ohms, ½ 33867 Choke -Vertical amplifier plate condenser (C27) 11676 Resistor -200,000 ohms, ½ 33870 Condenser -60 to 120 mmfd., variable condenser (C20, C24) 36243 Resistor -470,000 ohms, ½ 33871 Control -10,000 ohmssynchronizing control (R6) 30653 Resistor -10 mg, ½ watt 33861 Control -0,000 ohmscompensating control (R18) 31769 Socket -4-contact tube so code-ray tube (V5) 33864 Control -0,000 ohmscompensating control (R	vatt (R10)
30860 Capacitor—0.5 mfd. (C16, C40, C41, C33) 14559 Resistor—10,000 ohms, ½ R17, R20) 18416 Capacitor—1 mfd. (C2, C13, C29, C30, C31, C32) 3219 Resistor—18,000 ohms, ½ Resistor—18,000 ohms, ½ 33879 Capacitor—10 mfd., 300 volts (C38, C39, C44, C47) 30409 Resistor—27,000 ohms, ½ 33880 Capacitor—10 mfd., 150 volts, 20 mfd., 300 volts, 10 mfd., 150 volts, 20 mfd., 25 volts (C43, C46, C49, C51) 12487 Resistor—33,000 ohms, 2 33855 Capacitor—250 mfd., 15 volts, 10 mfd., 350 volts, 10 mfd., 150 volts (C28, C33, C34) 14550 Resistor—100,000 ohms, 2 33881 Choke—Filter reactor (L4) 14583 Resistor—200,000 ohms, ½ 33866 Condenser—60 to 120 mmfd., variable condenser (C27) 3052 Resistor—470,000 ohms, ½ 33870 Condenser—60 to 120 mmfd., variable condenser (C27) 30632 Resistor—102,000 ohms, ½ 33871 Control—10,000 ohms—owrtical gain control (R6) 30764 Resistor—102,000 ohms, ½ 33861 Control—10,000 ohms—owrtical gain control (R6) 33871 Sccket—4-contact tube so Socket—4-contact tube so Socket—4-contact tube so Socket—4-contact tube so Socket—1-contact magn. ¼ 33864 Control—50,000 ohms—intensity con- trol and power switch (R41, S2)	
18416Capacitor —1 mid. (C2, C13, C29, C30, C31, C32)R17, R20)33879Capacitor —10 mid., 300 volts (C38, C39, C44, C47)33862Resistor —18,000 ohms, 2033880Capacitor —10 mid., 300 volts, 10 mid., 300 volts, 10 mid., 150 volts, 20 mid., 25 volts (C43, C46, C49, C51)14467Resistor —27,000 ohms, 2033865Capacitor —10 mid., 450 volts, 10 mid., 450 volts, 10 mid., 150 volts (C28, C37, C52)6143Resistor —100,000 ohms, 1433867Capacitor —250 mid., 150 volts, 10 mid., 350 volts, 10 mid., 150 volts (C28, C37, C52)3252Resistor —100,000 ohms, 1412477Choke —Filter reactor (L4)Resistor —220,000 ohms, 15Resistor —220,000 ohms, 1433861Condenser —60 to 120 mmid., variable control =1,000 ohms—synchronizing at control (R3)30631Resistor —470,000 ohms, 1233874Control —1,000 ohms—torrelat control (R33)31662Resistor —100,000 ohms, 1233862Control —1,000 ohms—torrelat (R41, S2)33871Socket —4-contact tube so ode-ray tube33864Control —1,000 ohms—torrelat (R41, S2)33871Socket —4-contact tube so ode-ray tube33865Control —50,000 ohms—intensity con- trol and power switch (R41, S2)33871Socket —4-contact tube so socket —4-cont	
18416 Capacitor—1 mfd. (C2, C13, C29, C30, C31, C32) 3362 Resistor—18,000 ohms, ½ 33879 Capacitor—10 mfd., 300 volts (C38, C39, C44, C47) 30409 Resistor—27,000 ohms, ½ 33860 Capacitor—10 mfd., 300 volts, 10 mfd., 300 volts, 10 mfd., 150 volts, 20 mfd., 22 volts (C43, C46, C49, C51) 12454 Resistor—33,000 ohms, 2 33865 Capacitor—10 mfd., 450 volts, 10 mfd., 450 volts, 40 mfd., 25 volts (C5, C33, C34) 12454 Resistor—30,000 ohms, 2 33159 Capacitor—250 mfd., 15 volts, 10 mfd., 350 volts, 10 mfd., 150 volts (C28, C37, C52) 30154 Resistor—100,000 ohms, 1 12477 Choke—Filter reactor (L4) 13450 Resistor—200,000 ohms, 1 33867 Choke—Horizontal amplifier plate condenser (C27) 11676 Resistor—200,000 ohms, 1 33874 Control—1,000 ohms—vertical gain control (R6) 30652 Resistor—470,000 ohms, 1 33861 Control—1,000 ohms—vertical gain control (R33) 30784 Resistor—470,000 ohms, 1 33874 Control—0,000 ohms—compensating control (R33) 30262 Resistor—1 meg., 1/4 watt 33863 Control—50,000 ohms—compensating control (R18) 31769 Sccket—4-contact tube so socket—6-contact tube so socket—6-contact tube so socket—6-contact tube so socket—6-contact tube so socket—6-contact tube so socket—6-contact	4 watt (K/,
C31, C32 C31, C32 Capacitor—10 mfd., 300 volts (C38, C39, C44, C47) C38, C44, C47) 33880 Capacitor—10 mfd., 300 volts (C38, C44, C47) 14167 Resistor—27,000 ohms, 2/ Resistor—27,000 ohms, 2/ 214167 33860 Capacitor—10 mfd., 300 volts, 10 mfd., 150 volts, 20 mfd., 12447 Resistor—33,000 ohms, 2/ 4167 Resistor—33,000 ohms, 2/ 8247 33865 Capacitor—10 mfd., 450 volts, 10 mfd., 25 volts (C43, C46, C49, C51) 14167 Resistor—130,000 ohms, 2/ 8247 33159 Capacitor—250 mfd., 15 volts, 10 mfd., 350 volts (C28, C37, C52) 30154 Resistor—100,000 ohms, 1/ 83881 12477 Choke—Horizontal amplifier plate choke (L1) 13483 Resistor—200,000 ohms, 1/ 83867 Resistor—200,000 ohms, 1/ 83867 33866 Condenser—60 to 120 mmfd., variable condenser (C27) 1453 Resistor—470,000 ohms, 1/ 8453 33870 Connector—Input cable connector (R6) 30652 Resistor—1 meg., 1// wati 30652 33861 Control—1,0000 ohms—eynchronizing control (R3) 33871 Socket—4-contact tube so 30652 33861 Control—1,000 ohms—compensating control (R41, S2) 33871 Socket—4-contact tube so 30652 33863 Control—50,000 ohms—intensity control and power switch (R41, S2) 3300	watt (R48)
33879 Capacitor—10 mfd., 300 volts (C38, C39, C44, C47) 30409 Resistor—27,000 ohms, ½ 33880 Capacitor—10 mfd., 150 volts, 20 mfd., 300 volts, 10 mfd., 150 volts, 20 mfd., 25 volts (C43, C46, C49, C51) 12454 Resistor—33,000 ohms, ½ 33865 Capacitor—10 mfd., 450 volts, 10 mfd., 450 volts, 40 mfd., 25 volts (C5, C33, C34) 14560 Resistor—100,000 ohms, ½ 33159 Capacitor—250 mfd., 15 volts, 10 mfd., 350 volts, 10 mfd., 150 volts (C28, C33, C34) 3014 Resistor—100,000 ohms, ½ 33867 Choke—Filter reactor (L4) 30784 Resistor—220,000 ohms, ½ 33867 Choke—Vertical amplifier plate choke (L1) 11676 Resistor—220,000 ohms, ½ 33874 Condenser (C20, C24) 30963 Resistor—470,000 ohms, ½ 33874 Control—1,000 ohms—low frequency compensating control (R29) 33871 Socket—4-contact tube so socket—4-contact tube so socket=1-contact magn cathode-ray tube (V5)	
$ \begin{array}{c} C39, C44, C47) \\ Capacitor-10 mfd., 300 volts, 10 mfd., \\ 300 volts, 10 mfd., 150 volts, 20 mfd., \\ 25 volts (C43, C46, C49, C51) \\ A50 volts, 10 mfd., 150 volts, 20 mfd., \\ 25 volts (C43, C46, C49, C51) \\ A50 volts, 40 mfd., 25 volts (C5, \\ C33, C34) \\ C33, C34) \\ C33, C34) \\ Capacitor-250 mfd., 15 volts, 10 mfd., \\ 350 volts, 10 mfd., 150 volts (C28, \\ C37, C52) \\ Choke-Horizontal amplifier plate choke \\ (L2, L3) \\ 11859 \\ Condenser (C27) \\ Condenser (C27) \\ Condenser (C20, C24) \\ Control-10,000 ohms-synchronizing \\ control (R6) \\ 33861 \\ Control-10,000 ohms-wretical gain \\ control (R6) \\ Control-10,000 ohms-compensating \\ control (R13) \\ Control-250,000 ohms-compensating \\ control (R13) \\ 33862 \\ Control-50,000 ohms-witch (R41, S2) \\ Control-250,000 ohms-horizontal \\ 33864 \\ Control-250,000 ohms-horizontal \\ 33864 \\ Control-50,000 ohms-compensating \\ control (R18) \\ 33864 \\ Control-250,000 ohms-compensating \\ control (R18) \\ 33864 \\ Control-250,000 ohms-horizontal \\ 33864 \\ Control-250,000 ohms-compensating \\ control (R18) \\ 33864 \\ Control-250,000 ohms-horizontal \\ 33864 \\ Control-250,000 ohms-horizontal \\ 33864 \\ Control-250,000 ohms-horizontal \\ 33865 \\ Control-250,000 ohms-horizontal \\ 33866 \\ Control-250,000 ohms-horizontal \\ 33866 \\ Control-250,000 ohms-horizontal \\ 33867 \\ Control-250,000 ohms-horizontal \\ 33868 \\ Control-250,000 ohms-horizontal \\ 33868 \\ Control-250,000 ohms-horizontal \\ 33868 \\ Control-250,000 ohms-horizontal \\ 33886 \\ Control-500,000 ohms-horizontal \\ 33886 \\ Control-500,000 ohms-horizontal \\ 33886 \\ Control-500,000 ohms-horizontal \\ 33887 \\ Control-500,000 ohms-horizontal \\ 33886 \\ Control-500,000 ohms-horizontal \\ 33886 \\ Control-500,000 ohms-horizontal \\ Sa887 \\ Control-500,000 ohms-horizontal \\ Sa887 \\ Control-500,000 ohms-horizontal \\ Sa887 \\ Control-500,000 ohms$	watt (R11)
300 volts, 10 mfd., 150 volts, 20 mfd., 25 volts (C43, C46, C49, C51) 12487 Resistor-33,000 ohms, 2 (1450 33865 Capacitor-10 mfd., 450 volts, 10 mfd., 450 volts, 40 mfd., 25 volts (C5, C33, C34) 14560 Resistor-100,000 ohms, 7 (150,000 ohms, 10) 33159 Capacitor-250 mfd., 15 volts, 10 mfd., 350 volts, 10 mfd., 150 volts (C28, C37, C52) 30154 Resistor-100,000 ohms, 7 (12477 Choke-Horizontal amplifier plate choke (L1) 11676 Resistor-200,000 ohms, 7 (12, L3) R50 33866 Condenser (C27) 14583 Resistor-30,000 ohms, 7 (12, L3) R50 33870 Condenser (C20, C24) 12285 Resistor-470,000 ohms, 7 (15) R450 33874 Condenser (C20, C24) 12201 Resistor-1.0 meg., 1/4 watt 30652 Resistor-1.0 meg., 1/4 watt 30653 33861 Control-10,000 ohms-synchronizing control (R6) 33871 Socket-4-contact tube so Socket-4-contact tube so Socket-4-contact tube so Socket-4-contact tube so Socket-4-contact tube so 33864 Control-50,000 ohms-intensity con- trol and power switch (R41, S2) 33001 Socket-11-contact magn (S3) 33864 Control-250,000 ohms-horizontal gain control or centering control 33886 Switch-Range switch (V5) 33886 Contro	
25 volts (C43, C46, C49, C51) 6143 Resistor-43,000 ohms, ¼ 33865 Capacitor-10 mfd., 450 volts, 10 mfd., 450 volts, 40 mfd., 25 volts (C5, C33, C34) 3252 Resistor-100,000 ohms, ¼ 33159 Capacitor-250 mfd., 15 volts, 10 mfd., 350 volts, 10 mfd., 150 volts (C28, C37, C52) 30154 Resistor-100,000 ohms, ¼ 33867 Choke-Filter reactor (L4) 33861 Resistor-200,000 ohms, ¼ 33867 Choke-Vertical amplifier plate choke (L1) 11676 Resistor-200,000 ohms, ½ 33867 Condenser-3 to 30 mmfd., variable condenser (C27) 12285 Resistor-470,000 ohms, ½ 33870 Connector-Input cable connector 30963 Resistor-470,000 ohms, ½ 33871 Control-10,000 ohms-synchronizing control (R6) 30652 Resistor-11 meg., ¼ watt 33861 Control-10,000 ohms-vertical gain control (R6) 31769 Socket-4-contact tube so Socket-4-contact tube so 33863 Control-50,000 ohms-intensity con- trol and power switch (R41, S2) 33001 Socket-1-contact magn cathode-ray tube (V5) 33864 Control-250,000 ohms-horizontal gain control or centering control 33887 Switch-Horizontal amp	
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choke (L1)14583Resistor-220,000 ohms, y33867Choke-Vertical amplifier plate choke (L2, L3)30784Resistor-220,000 ohms, y11859Condenser-S to 30 mmfd., variable condenser (C27)30784Resistor-470,000 ohms, y33866Condenser-G0 to 120 mmfd., variable condenser (C20, C24)36243Resistor-470,000 ohms, y33870Connector-Input cable connector (J5)30963Resistor-820,000 ohms, y33874Control-1,000 ohms-synchronizing control (R6)30652Resistor-1 meg., y'17694Control-10,000 ohms-low frequency control (R33)31769Socket-4-contact tube so33861Control-10,000 ohms-compensating control (R18)31769Socket-4-contact tube so33864Control-50,000 ohms-intensity con- trol and power switch (R41, S2)33861Socket-11-contact magn. cathode-ray tube33859Control-500,000 ohms-focus control (R43)33887Switch-Range switch (K3)33859Control-500,000 ohms-horizontal gain control or centering control33887Switch-Range switch (K4)	watt (R24)
(L2, L3)R5011859Condenser—3 to 30 mmfd., variable condenser (C27)1228533866Condenser—6 to 120 mmfd., variable condenser (C20, C24)3624333870Connector—Input cable connector (J5)3096333874Control—1,000 ohms—synchronizing control (R6)3096317694Control—10,000 ohms—low frequency compensating control (R29)3387133864Control—50,000 ohms—compensating control (R18)3175933864Control—50,000 ohms—intensity con- trol and power switch (R41, S2)3386133864Control—50,000 ohms—focus control (R43)3388733859Control—50,000 ohms—horizontal gain control or centering control33887Switch—Range switch (R43)Socket—Horizontal gain control or centering control33887Switch—Range switch (R43)Switch—Range switch (S3)	
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33870Connector—Input cable connector (J5)30963Resistor—820,000 ohms, y Resistor—1 meg., y/a watt Resistor—1 meg., y/a watt Resistor—1 meg., y/a watt Resistor—1 meg., y/a watt Resistor—1 meg., y/a watt Resistor—1.5 meg., y/a watt Resistor—Calibration screen-Calibration screen-Calibration-Screen-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibration-Calibratio	watt (R44,
(J5)13730Resistor—1 meg., ¼ watt33874Control—1,000 ohms—synchronizing control (R6)30652Resistor—1 meg., ¼ watt17694Control—10,000 ohms—low frequency compensating control (R29)12201Resistor—1.5 meg., ¼33861Control—10,000 ohms—vertical gain control (R33)33871Screen—Calibration screet ode-ray tube33862Control—50,000 ohms—compensating control (R18)33864Socket—4-contact tube so socket—6-contact tube so socket—8-contact octal (V2, V3, V4)33864Control—50,000 ohms—focus control (R43)33887Switch—Horizontal ampoint of or centering control33859Control—50,000 ohms—horizontal gain control or centering control33887Switch—Range switch (R33)	watt (R25)
33874Control-1,000 ohms-synchronizing control (R6)30652Resistor-1 meg. ¼ wat Resistor-1.5 meg., ¼17694Control-10,000 ohms-low frequency compensating control (R29)33871Screen-Calibration scree ode-ray tube33861Control-10,000 ohms-vertical gain control (R33)31769Socket-4-contact tube so socket-4-contact tube so33863Control-50,000 ohms-intensity con- trol and power switch (R41, S2)33864Socket-3-contact magn. (V2, V3, V4)33864Control-250,000 ohms-focus control (R43)33887Switch-Horizontal switch-Horizontal gain control or centering control33887	(R23, R26)
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compensating control (R29)33871Screen—Calibration screen33861Control—10,000 ohms—vertical gain control (R33)31769Socket—4-contact tube so13984Control—50,000 ohms—compensating control (R18)18351Socket—6-contact tube so33863Control—50,000 ohms—intensity con- trol and power switch (R41, S2)33084Socket—11-contact magn. cathode-ray tube33864Control—250,000 ohms—focus control (R43)33886Switch—Horizontal amp (S3)Switch—Range switch33859Control—500,000 ohms—horizontal gain control or centering control33887Switch—Range switch	watt (KIS,
control (R33)31769Socket—4-contact tube so13984Control—50,000 ohms—compensating control (R18)18351Socket—6-contact tube so33863Control—50,000 ohms—intensity con- trol and power switch (R41, S2)33001Socket—1-contact tube so33864Control—250,000 ohms—intensity con- trol and power switch (R41, S2)33001Socket—1-contact magn. cathode-ray tube (V5)33859Control—50,000 ohms—horizontal (R43)Switch—Horizontal gain control or centering control33887Switch—Range switch	en for cath-
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control (R18)33084Socket—8-contact octal (V2, V3, V4)33863Control—50,000 ohms—intensity con- trol and power switch (R41, S2)33001Socket—11-contact magn cathode-ray tube (V5)33864Control—250,000 ohms—focus control (R43)33886Switch—Horizontal amp (S3)33859Control—500,000 ohms—horizontal gain control or centering control33887 Switch—Range switch (S3)	ocket (V1)
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33859 Control—500,000 ohms—horizontal 33886 Switch—Horizontal amp (S3) 33859 Control—500,000 ohms—horizontal 33887 Switch—Range switch (S3)	al socket for
33859 Control—500,000 ohms—horizontal gain control or centering control 33887 Switch—Range switch (33885 Switch—Safety interlock	lifier switch
gain control or centering control 33885 Switch-Safety interlock	\$5)
(R2, R31, R32)	
33860 Control 2 megfrequency control 33869 Switch-Vertical amplifie	r switch (S6)
(Fine) (R12)	60 cycle
33872 Escutcheon—Front panel escutcheon power transformer (T 30926 Foot—Elastic foot for case 14119 Transformer — Synchron	
14133 Fuse-1 ampere line fuse (F1)	

Replacement Parts supplied are within Engineering Specification Tolerances.

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REPLACEMENT PARTS

Insist on genuine factory-tested parts, which are readily identified and may be purchased from authorized dealers.

STOCK No.	DESCRIPTION	STOCK No.	DESCRIPTION	
33873 12814	Cable—Input cable complete Capacitor—5.6 mmfd. (C1, C18, C22,	32059	Holder—Tubular type fuse holder with screw cap	
12014	C26)	30925	Handle-Carrying handle for case	
14079	Capacitor-6.8 mmfd. (C19, C21)	47061	Jack-Black binding jack (J1, J4)	
13001	Capacitor-8.2 mmfd. (C25)	47228	Jack-Red binding jack (J2, J3)	ļ
12948	Capacitor-33 mmfd. (C15)	32116	Knob—Control knob	
12813	Capacitor-82 mmfd. (C23)	47062	Post-Binding post (use with 47061	
13894	Capacitor-390 mmfd. (C7)		and 47228)	
12537	Capacitor-560 mmfd. (C17)	13428	Resistor-150 ohms, 1/4 watt (R35).	
13054	Capacitor-1,200 mmfd. (C8)	30546	Resistor-470 ohms, 1/4 watt (R5)	
4881	Capacitor—3,300 mmfd. (C3, C35)	12414	Resistor—560 ohms, 1/4 watt (R34)	
30856	Capacitor015 mfd. (C10)	14076	Resistor—820 ohms, $\frac{1}{4}$ watt (R27) .	
30857	Capacitor035 mfd. (C11)	14720	Resistor—1,000 ohms, ¼ watt (R3).	
30848	Capacitor-0.1 mfd. (C12)	12267	Resistor—1,200 ohms, ¼ watt (R49).	
18000	Capacitor—0.1 mfd., 1,250 volts (C42,	6134 13716	Resistor—1,200 ohms, 1 watt (R10)	
20040		13714	Resistor—2,200 ohms, ¼ watt (R32). Resistor—5,600 ohms, ¼ watt (R30).	
30849	Capacitor-0.25 mfd. (C4, C14, C36)	14559	Resistor—10,000 ohms, $\frac{1}{4}$ watt (R30)	
30860	Capacitor-0.5 mid. (C16, C40, C41,	14553	R17, R20)	
18416	C53)	3219	Resistor-18,000 ohms, 1/2 watt (R48)	
10410	Capacitor—1 mfd. (C2, C13, C29, C30, C31, C32)	33862	Resistor—18,000 ohms, 20 watt (R37)	
33879	Capacitor-10 mfd., 300 volts (C38,	30409	Resistor-27,000 ohms, 1/2 watt (R11)	1
55075	C39, C44, C47)	14167	Resistor-27,000 ohms, 2 watt (R47)	
33880	Capacitor-10 mfd., 300 volts, 10 mfd.,	12454	Resistor-33,000 ohms, 1/4 watt (R31)	
	300 volts, 10 mfd., 150 volts, 20 mfd.,	12487	Resistor-33,000 ohms, 2 watt (R46)	
	25 volts (C43, C46, C49, C51)	6143	Resistor-43,000 ohms, 1/4 watt (R22)	
33865	Capacitor-10 mfd., 450 volts, 10 mfd.,	14560	Resistor-100,000 ohms, 1/4 watt (R8,	
	450 volts, 40 mfd., 25 volts (C5,		R19)	
	C33, C34)	3252	Resistor-100,000 ohms, 1/2 watt (R28,	
33159	Capacitor-250 mfd., 15 volts, 10 mfd.,		R39)	
	350 volts, 10 mfd., 150 volts (C28,	30154	Resistor-100,000 ohms, 1 watt (R4)	
	C37, C52)	13483	Resistor-120,000 ohms, 1 watt (R36,	
12477	Choke-Filter reactor (L4)		R38)	
33881	Choke-Horizontal amplifier plate	11676	Resistor-200,000 ohms, ¹ / ₄ watt (R24)	
00060	choke (L1)	14583	Resistor-220,000 ohms, 1/2 watt (R42)	
33867	Choke—Vertical amplifier plate choke	30784	Resistor—330,000 ohms, $\frac{1}{2}$ watt (R14,	
11000	(L2, L3)	12285	R50) Resistor 470,000 chara 1/ mott (D12	
11859	Condenser—3 to 30 mmfd., variable	12203	Resistor-470,000 ohms, 1/4 watt (R13,	
33866	condenser (C27)	36243	R40) Resistor-470,000 ohms, 1 watt (R44,	
33000	Condenser—60 to 120 mmfd., variable	50245	R45)	
33870	condenser (C20, C24) Connector—Input cable connector	30963	Resistor-820,000 ohms, 1/4 watt (R25)	
33070	(J5)	13730	Resistor—1 meg., ¼ watt (R23, R26)	
33874	Control—1,000 ohms—synchronizing	30652	Resistor—1 meg., 1/2 watt (R1, R21)	,
	control (R6)	12201	Resistor-1.5 meg., 1/4 watt (R15,	1
17694	Control-10,000 ohms-low frequency		R16)	
	compensating control (R29)	33871	Screen-Calibration screen for cath-	
33861	Control-10,000 ohms-vertical gain		ode-ray tube	
	control (R33)	31769	Socket-4-contact tube socket (V6, V7)	
13984	Control-50,000 ohms-compensating	18351	Socket-6-contact tube socket (V1)	
	control (R18)	33084	Socket-8-contact octal tube socket	
33863	Control-50,000 ohms-intensity con-		(V2, V3, V4)	
	trol and power switch (R41, S2)	33001	Socket-11-contact magnal socket for	
33864	Control-250,000 ohms-focus control		cathode-ray tube (V5)	-
	(R43)	33886	Switch-Horizontal amplifier switch	
33859	Control-500,000 ohms - horizontal		(S3)	
	gain control or centering control	33887	Switch-Range switch (55)	
	(R2, R51, R52)	33885	Switch-Safety interlock switch (S1)	
33860	Control-2 megfrequency control	33868	Switch—Sync switch (S4)	
	(Fine) (R12)	33869	Switch—Vertical amplifier switch (S6)	
33872	Escutcheon-Front panel escutcheon	33884	Transformer-105-125 V, 60 cycle	
30926	Foot-Elastic foot for case	14110	power transformer (T1)	
14133	Fuse—1 ampere line fuse (F1)	14119	Transformer - Synchronizing trans-	
		1	former (T2)	

Replacement Parts supplied are within Engineering Specification Tolerances.

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