Part IV
SERVICE DATA

Electrical Specifications

Power Supply Rating	Voltage	110–120 Volts AC
	Frequency (Stock No. 151)	50–60 Cycles
	(Stock No. 151A)	25–60 Cycles
	Wattage Consumption	35 Watts
	Fuse Protection	1 Amp.
Operating Limits	Deflection sensitivity at amplifier inputs.	5 peak-to-peak volts per inch (max. "gain.") or 1.75 volts (RMS)
	Deflection sensitivity at cathode-ray tube inputs	250 peak-to-peak-volts per inch
	Input Characteristics:	
	(1) With amplifier	1 megohm, approximately 30 mmfd.
	(2) Without amplifier	2 megohms, approximately 40 mmfd.
	Frequency response range of amplifiers	20–15,000 Cycles
	Maximum signal input (with amplifier)	500 Volts (RMS)
	Frequency range of timing axis	30–10,000 Cycles
	Maximum d-c voltage across input binding posts.	100 Volts with amplifiers 200 Volts direct

Radiotrons Used and Functions	1 RCA-6C6	Signal amplifier for vertical deflection
	1 RCA-6C6	Signal amplifier for horizontal deflection
	1 RCA-885	"Saw-tooth" oscillator
	1 RCA-913	Cathode-ray tube (1-inch)
	1 RCA-80	Full-wave rectifier

Physical Specifications

Overall Dimensions	Height (including carrying-handle)	9¼ inches
	Width	13¾ inches
	Depth	7¾ inches
Weight: 60 cycle		14½ pounds
25 cycle		16 pounds

Circuit Description

The schematic arrangement of the entire circuit is shown in Figure 21.

There is one usual feature to this circuit that causes surprising voltage distributions but doesn't affect the operating theory. Since the shell of the cathode-ray tube is connected to the second anode, which must be at a positive potential from the cathode, and since the shell must be grounded for safety, the positive side of the power supply has been connected to ground. This is common practice in Cathode-Ray Oscillographs, but in this case the power supply is common to the oscillograph and amplifier tubes, so the cathode, grid, suppressor and screen grids of the amplifiers are all at a high potential to ground and the plate is nearly at ground. It may be argued that no improvement has been made since the grid clips are at high voltage, but the grid clips cannot be reached when the equipment is in the case, and the resistance of the circuit is sufficiently high to limit the current to safe values at all but very low settings of the gain control.

While the voltage distribution, as shown in Figure 24 is quite unusual, the method of operating the amplifier tubes has not been affected. The grids are maintained about two volts negative from the cathode, the suppressor is connected to the cathode, the screen grid is about 35 volts positive from the cathode and the plate still more positive.

An amplifier consisting of a single RCA-6C6 constitutes the means of obtaining "gain" for the signal applied to the vertical deflecting system. The input to this stage is a high-resistance potentiometer connected to provide "gain" control. An isolation capacitor is made a part of the input circuit to exclude any d-c which may be associated

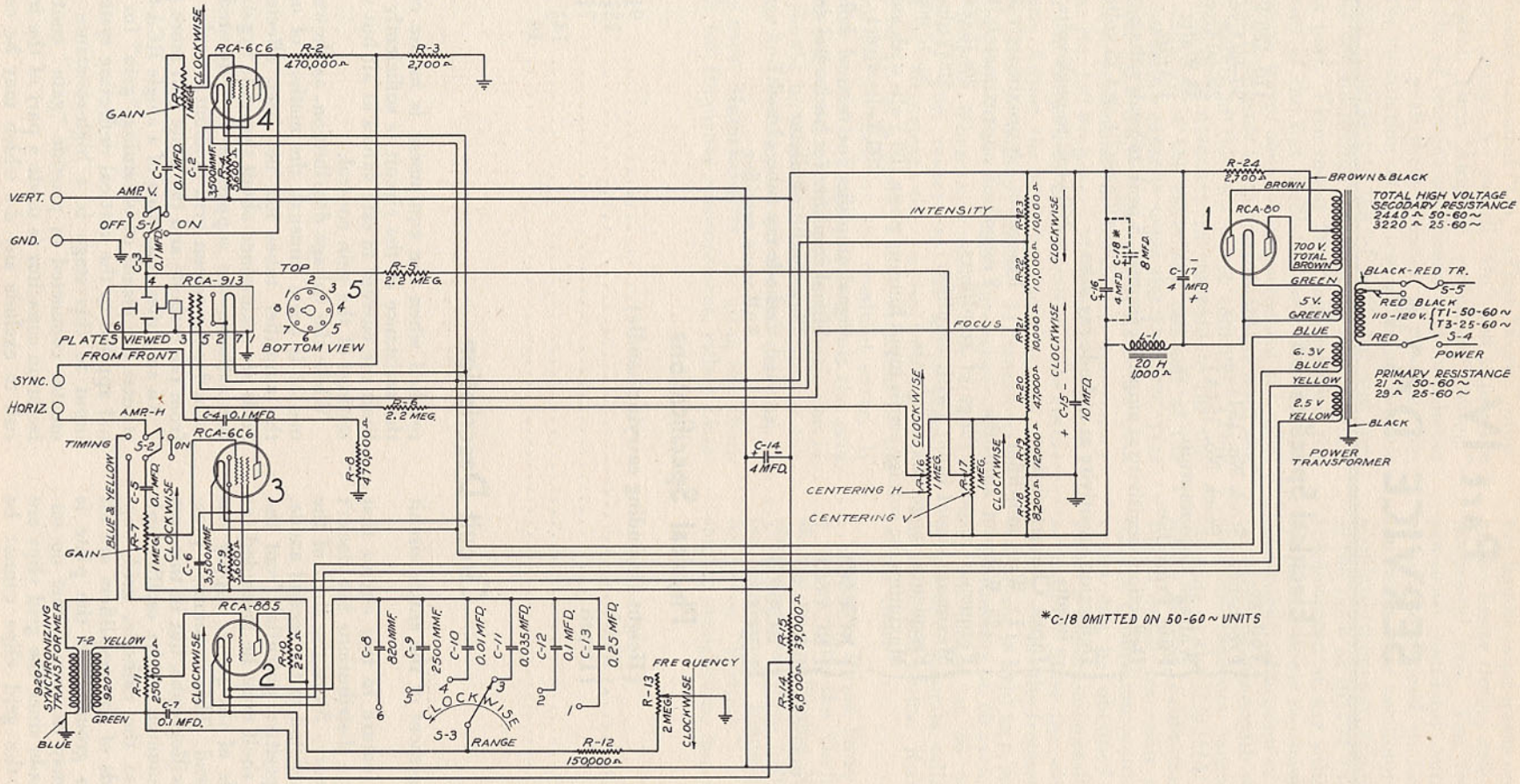

Figure 21—Schematic Diagram (Stock No. 151 and 151A) T-611032

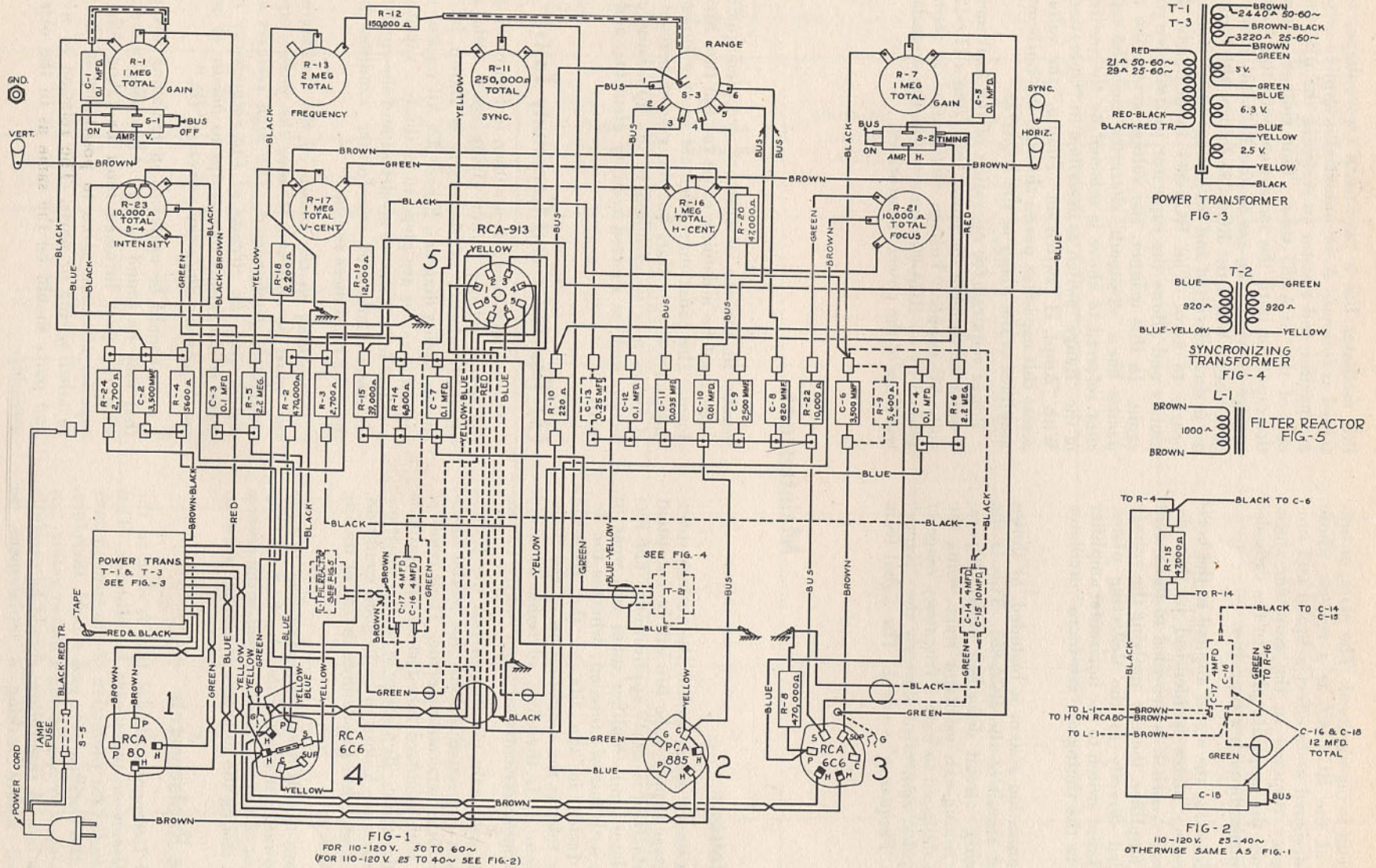

Figure 22—Connection Diagram (Stock No. 151 and 151A) T-611033

with the circuit being observed. The plate, or output circuit of the RCA-6C6 is a resistor whose value is 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 identical to that described above. A switch is provided to disconnect the vertical amplifier, thereby applying the voltage to be studied directly to the deflecting plates. There is an 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-885. This is the "Synchronizing" circuit described under "Operation." The timing axis oscillator stage, using the RCA-885, is designed to have a frequency range of 30-10,000 cycles, controlled through the "Range" switch and "Frequency" control. The signal from this oscillator has a "saw-tooth" wave-shape, obtained as follows: A d-c potential is applied across a capacitor and resistor in series in the plate circuit of the RCA-885 tube. This voltage charges the capacitor until the ionization potential (plate voltage at which the gas in the RCA-885 ionizes) is reached. When the RCA-885 ionizes the capacitor is short-circuited and the voltage across it drops nearly to zero. The RCA-885 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 "Ampl. H" switch on "Timing," the voltage across this capacitor passes through the horizontal amplifier to the plates of the RCA-913.

Power required for operation of the instrument is obtained through the power unit from a 110–120-volt, AC supply. Voltage rectification is accomplished by an RCA-80 connected in the secondary windings of the power transformer.

Maintenance

(1) Radiotrons

Under ordinary usage within the ratings specified for voltage supply, tube life will be consistent with that obtained in other applications. The rectifier, oscillator, and amplifier tubes will wear in accordance with loss of emission; whereas the determining factor in the life of the RCA-913 cathode-ray tube is the deterioration of the fluorescent screen. It is therefore advisable to avoid leaving a bright, concentrated "spot" on the screen.

It is not ordinarily possible to test the Radiotrons in their respective sockets, due to the likelihood of circuit effects causing error. Their removal and check with standard tube-testing apparatus is therefore desirable. Replacement of the questionable tube with one known to be in good condition, is another acceptable and definite means of tracing tube troubles.

To remove the RCA-913, it is necessary to slide the tube toward the back of the chassis, then snap the tube out of its clip. Replacement is the reverse operation, sliding the tube into the panel opening.

(2) 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 should, therefore, not be replaced by one having a higher rating, nor be shorted out. A fuse failure should be carefully investigated before making a replacement, as usually in the use of fuses of accepted quality, there must be a definite cause for the fuse 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.

(3) Resistance and Continuity Tests

The schematic circuit is shown in Figure 21, and the actual wiring layout giving color code and physical relation of the parts is shown in the chassis wiring diagram, Figure 22. 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 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 taken off, and especial attention given to possibility of damage to other wiring or parts. The relation of wiring and parts should be the same as in the original assembly.

RADIOTRON SOCKET VOLTAGE TABLE

120-Volt, Supply Line

RADIOTRON			Cathode Volts to Ground DC.	Screen Grid Volts To Ground DC.	Plate Volts to Ground DC.	Cathode Current MA-DC.	Anode Volts to Ground DC.		Deflecting Plates to Ground DC.		Filament or Heater Volts AC.
Socket Number	Type	Function					No. 1	No. 2	D_1	D_2	
5	RCA-913	Cathode Ray	—350	—	—	.06	—265 to —300	O	+30 to —50*	+30 to —50*	6.3
1	RCA-80	Rectifier	+35	—	—380	6	—	—	—	—	5.0
3	RCA-6C6	20—15,000 Cycle Amp.	—380	—350	—150*	.3	—	—	—	—	6.3
4	RCA-6C6	20—15,000 Cycle Amp.	—380	—350	—150*	.3	—	—	—	—	6.3
2	RCA-885	30—10,000 Cycle Osc.	—350	—	—30	.2—2ma.	—	—	—	—	2.5

* Cannot be correctly measured with ordinary voltmeter.

Figure 23

(4) Voltage Measurements

One means of learning the condition of operation and tracing the circuit faults of the Oscillograph is by checking the correctness 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 ratings, are indicated adjacent to the socket positions in Figure 24, and also given 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. Some of the voltages are not measurable with ordinary test equipment; these have been asterisked (*) in the table.

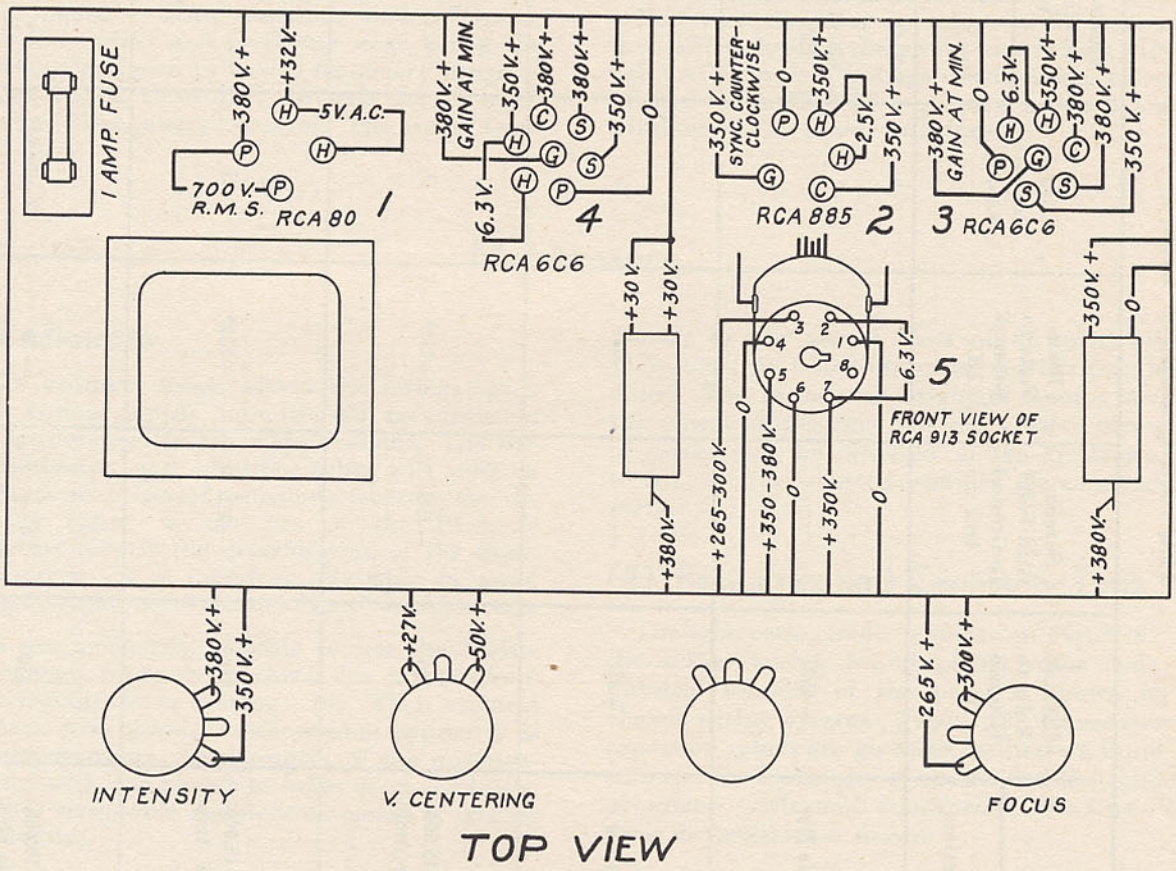

Figure 24—Radiotron Socket Voltage Diagram (Stock No. 151 and 151A)

CATHODE-RAY OSCILLOGRAPH

No. 151 and 151A

POSITION OF CONTROLS FOR VARIOUS APPLICATIONS

No.	APPLICATION OR DEMONSTRATION	SWITCH POSITIONS			CONTROLS						APPLIED VOLTAGES			REMARKS	
		Ampl. V	Ampl. H	Range	Intensity	Focus	Ampl. V Gain	Ampl. H Gain	Freq.	Sync.	"Vert." Bdg. Post	"Horiz." Bdg. Post	"Sync." Bdg. Post		
1	FIRST OBTAINING SPOT	Off	*	*	First clockwise rotation closes power switch Adjust for desired brilliancy of image Remember tube screen can be burned	Adjust for maximum concentration of electron beam (smallest line or spot) after setting for desired intensity	*	0	*	*	None	None	None	Do not burn screen; adjust the two beam centering control to center spot on screen.	Preliminary Adjustments
2	LOCATING TUBE POSITION	Off	Timing	*			*	Set for line about ¾-in. long	*	*	None	None	None	Rotate cathode-ray tube so line is exactly horizontal.	
3	APPLYING VERTICAL DEFLECTING VOLTAGE	On	*	*			Vary	0	*	*	60 cycle supply between 2 and 150 volts	None	None	Elementary Demonstration.	
4	APPLYING HORIZONTAL DEFLECTING VOLTAGE	Off	On	*			0	Vary	*	*	None	60 cycle supply between 2 and 150 volts	None	Elementary Demonstration.	
5	APPLYING DEFLECTING VOLTAGE ON BOTH AXES	On	On	*			Vary	Vary	*	*	60 cycle as above	60 cycle supply as above	None		
6	AC VOLTMETER WITHOUT AMPLIFIER	Off	*	*			*	*	*	*	Voltage to be measured	None	None	Set up is same for calibrating; use substitution method.	
7	AC VOLTMETER WITH AMPLIFIER	On	*	*			Max. or other calibrated point	*	*	*	Voltage to be measured	None	None	Set up is same for calibrating; use substitution method.	
8	OBSERVING WAVE-SHAPE OF AUDIO VOLTAGE	On	Timing	Depends on freq. of observed audio			For desired amplitude	For desired spread	Depends on freq. of observed audio	Just enough to lock image	Voltage to be observed	Jumper to Sync.	Jumper to "Horiz."	Probably greatest application.	
9	MEASURING PERCENTAGE OF MODULATION	Off	Timing	Depends on freq. of modulating audio			*	For desired spread	Depends on freq. of modulating audio	Just enough to lock image	RF Voltage to be observed	1 volt or more of audio from modulator	None	Wave-shape method.	
10	MEASURING PERCENTAGE OF MODULATION	Off	On	*			*	For desired spread at 100% mod.	*	*	RF Voltage to be observed	2 volts or more of audio from the modulator	None	Trapezoid method.	
11	"VISUAL" RF CURVE TRACING	On	Timing	Tap "1" or "2"			For desired amplitude	For desired spread	For double trace	Just enough to lock image	Audio output of chassis 2nd detector	Bdg. posts on Freq. Mod.	None	Output of oscillator impressed in grid circuit of tube preceding stage to be aligned. Center pattern with "Centering V."	
12	CHECKING PHASE SHIFT OF AMPLIFIER	On	On	*			For desired vertical deflection	For desired horizontal deflection	*	*	2 volts or more of audio output of amp.	2 volts or more of audio input to amp.	None		
13	FREQUENCY MEASUREMENT	On	Timing or On	Depends on freq. desired			For desired vertical deflection	For desired horizontal deflection	Depends on frequency desired	Just enough to lock image	2 volts or more of signal freq. to be measured	1 volt or more of standard frequency	None	Saw-tooth oscillator in step at 1, ½, ⅓, etc. times standard frequency or use standard frequency direct.	

*Denotes position immaterial.

IB-23357

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	
14118	Power Transformer—110-120 V., 50-60 cyc.	(T-1)	11726	Resistor—6800 Ohms, ¼ W.	(R-14)
14119	Synchronizing Transformer	(T-2)	11322	Resistor—¼ W., 39,000 Ohms	(R-15)
14139	Power Transformer—110-120 V., 25-60 cyc.	(T-3)	14250	Resistor—½ W., 8200 Ohms	(R-18)
6552	Filter Reactor	(L-1)	13915	Resistor—½ W., 12,000 Ohms	(R-19)
4839	Capacitor—0.1 Mfd. 400 V.	(C-1, C-5)	13596	Resistor—2 W., 47,000 Ohms	(R-20)
5005	Capacitor—0.0035 Mfd.	(C-2, C-6)	14126	Potentiometer—10,000 Ohms with Switch	(R-21, S-4)
4841	Capacitor—0.1 Mfd. 200 V.	(C-7, C-3, C-4)	3078	Resistor—½ W., 10,000 Ohms	(R-22)
12536	Capacitor—820 Mmfd.	(C-8)	14125	Potentiometer—10,000 Ohms	(R-23)
5107	Capacitor—0.0025 Mfd.	(C-9)	4750	Switch—D.P.D.T. Toggle	(S-1, S-2)
4858	Capacitor—0.01 Mfd.	(C-10)	14127	Switch—Single Gang 6 Position	(S-3)
5196	Capacitor—0.035 Mfd.	(C-11)	14133	Fuse—1 Amp.	(S-5)
11414	Capacitor—0.1 Mfd.	(C-12)	4794	Tube Socket—4 Prong	
5170	Capacitor—0.25 Mfd.	(C-13)	4814	Tube Socket—5 Prong	
14121	Bypass Condenser—4-10 Mfd.	(C14, C15)	4786	Tube Socket—6 Prong	
14120	Filter Condenser—4-4 Mfd. 475 V.	(C-18, C-16, C-17)	14128	Tube Plug—Octal Base	
14123	Potentiometer—1 Megohm	(R-1, R-7, R-16, R-17)	14129	Tube Support Bracket Ass'y	
11172	Resistor—¼ W., 470,000 Ohms	(R-2, R-8)	14130	Eye Piece	
5144	Resistor—¼ W., 2700 Ohms	(R-3, R-24)	14131	Eye Piece Base	
11647	Resistor—¼ W., 5600 Ohms	(R-4, R-9)	14137	Screen	
11626	Resistor—¼ W., 2.2 Megohms	(R-5, R-6)	4857	Binding Post (High)	
11174	Resistor—¼ W., 220 Ohms	(R-10)	4607	Binding Post (0)	
14124	Potentiometer—250,000 Ohms	(R-11)	7960	Bar Pointer Knob	
14132	Resistor—1 W., 150,000 Ohms	(R-12)	13210	Fuse Term.—Bd. Ass'y	
14122	Potentiometer—2 Megohms	(R-13)			