SECTION M, TROUBLESHOOTING THE OSCILLOSCOPE

Troubleshooting

Illustrations: Figure 14; Figure 14A.

Steps 1 through 14. Check (✓) each step as it is completed.

1. ( ) With the power off, recheck the top side of the laminated circuit board to make sure no component is "shorted" to (touching) another component. If any component becomes heated to the point of smoking, trace its associated wiring very carefully.

2. ( ) With the power off, reinspect the copper-foil side of the laminated circuit board. Look for bits of solder connecting foils that should not be connected. Scrutinize the foil-runners for breaks. Make sure there are no unused holes or unsoldered connections.

3. ( ) With the power off, reinspect the front-panel wiring. Look for a globule of solder that may have run along a lug to the point where it is making contact with the frame of the switch or potentiometer. Make sure that there are no shorts beween adjacent lugs or components. Be especially careful in checking the V RANGE and H SWEEP/SEL switches.

4. ( ) With the power off, reexamine the rear chassis. Make sure there are no shorts between adjacent tube-socket lugs; or other parts touching each other or the chassis.

5. ( ) With the power off, check the tubes to be sure they are in their proper positions. If a tube-checker is available, test the tubes. Tubes with shorted elements or open heaters may prevent the scope from operating or operating properly.* Tubes that just read high or low will usually operate satisfactorily.

6. ( ) With the power off, and tubes out of sockets, check the resistance between tube pins and chassis ground. Use an ohmmeter such as is incorporated in a VOM (RCA WV-38A) or VoltOhmyst*. Compare against the table in Figure 14. Incorrect readings, exceeding 25%, may be caused by shorted circuits, or defective components.

*Trade Mark Reg. U. S. Pat. Office

7. ( ) Insert tubes, apply power, wait 20 seconds, and then measure voltage on pins of tube sockets indicated in the chart in Figure 14A. Be extremely careful—turn power off while connecting and disconnecting the voltmeter. Large deviations from the indicated values of voltages suggest possible sources of difficulty. In conjunction with the data and the schematic, a thorough check can be carried out to find the specific source of trouble.

8. ( ) *Circuit description.*
The 3-inch cathode ray oscilloscope is constructed from the following sub-sections:
   a. Input attenuator
   b. Vertical amplifier
   c. Sweep oscillator
   d. Horizontal amplifier
   e. CRT circuit
   f. Power supplies

9. ( ) *The Input Attenuator.*
Consists of the five variable trimmer capacitors—C-1, C-3, C-4, C-5, C-6 in combination with fixed resistors, capacitors, and the (V RANGE) rotary switch. Each step of the switch changes the voltage output of the attenuator by a ratio of 3.16 to 1. The trimmer capacitors are adjusted so that the attenuator will have a flat frequency response.

10. ( ) *Vertical Amplifier (V-1/6BR8 and V-2/6BK7):*
Consists of two tubes and their associated components. The switch in the plate circuits of the pentode and triode sections of the 6BR8 serves to change the circuitry when transferring from Narrow Band to Wide Band Operation. The change in gain results from changing the plate load resistances. The chokes, L-1, L-2, and L-3, in conjunction with their resistors, serve to enhance the frequency response of the vertical amplifier. Potentiometer R-11 is the amplifier calibration control, potentiometer R-27 (V CAL) is the gain control, and potentiometer R-35 (V POS) is the vertical positioning control for the image on the CRT. The output of the amplifier is push-pull, and is coupled to the vertical deflection plates of the CRT. In trouble-shooting, any apparent loss in vertical gain, or any wave-shape distortion may be traced to defective components in the vertical amplifier circuitry. Refer to Voltage and Resistance Tables, Figures 14 and 14A.

11. ( ) *Sweep Oscillator (V-3/12AT7):*
This is a free running relaxation oscillator with coarse frequency control obtained by changing the capacitors on H/SWEEP SEL and fine frequency variations by varying (SWEEP VERNIER) resistors in R-43A and R-43B. Grid 7 of this tube attaches through R-39 and C-23 to R-75B (SYNC/PHASE) which controls synchronization with the vertical input signal. Failure to attain a horizontal sweep can most likely be traced to this circuit.

12. ( ) *Horizontal Amplifier (V-4/12AT7):*
This is a cathode-coupled amplifier, and is coupled to the oscillator's output, or directly to an external signal. It converts the input signal to a push-pull output to drive the horizontal deflection plates of the CRT. Potentiometer R-54 (H GAIN) is the horizontal gain control, and R-60 (H POS) is the horizontal position control.

13. ( ) *CRT Circuit (V-7/3AQP1):*
The horizontal deflection plates (pins 9 and 10) are coupled to the output of the horizontal amplifier, which produces the horizontal sweep on the face of the tube. Similarly, the vertical deflection plates (pin 6 and 7) are connected to the output of the vertical amplifier, which produces the vertical trace on the face of the tube. For further details of this circuit, refer to the "Power Supply" Section.

14. ( ) *Power Supplies (V-5/6X4 and V-6/6C4):*
The oscilloscope contains two separate power supplies, *both of which contain lethal voltages*. The 6X4 is used as a full wave rectifier, and supplies the voltage to the amplifiers, oscillator, and to the vertical and horizontal plates of the CRT. Common troubles in this circuit are caused by:
   (1) Shorted 6X4 tube.
   (2) Leaky or shorted electrolytic filter capacitors (C-38, C-39).
   (3) Shorted potentiometers (R-68, R-11, R-43).

The 6C4 is used as a half wave rectifier that develops —700 VDC across capacitor C-40, and the resistor chain of R-78, R-73, R-72, R-71 and R-70. Common troubles in this circuit are caused by:
   (1) Shorted 6C4 tube.
   (2) Shorted C-40.
   (3) Shorted potentiometers R-73, R-71, and shorted CRT.

TABLE OF RESISTANCES

Set controls as follows:

INTENSITY	OFF	SYNC/PHASE	CCW
FOCUS	CCW	SWEEP VERN	CCW
V POS	CW	H GAIN	CCW
H POS	CW	V RANGE	.02
V CAL	CCW	SYNC	INT
H SWEEP SEL	15–150		

REMOVE POWER CORD FROM AC OUTLET

REMOVE TUBES V-1, V-2, V-3, V-4, V-5, V-6 from sockets.

Pin	No.	1	2	3	4	5	6	7	8	9
V-1	6BR8	1 Meg.	XX	120Ω	XX	XX	XX	XX	100Ω	1 Meg.
V-2	6BK7	XX	560K	3.2K	XX	XX	XX	XX	3.2K	0
V-3	12AT7	2.8 Meg.	1 Meg.	680Ω	XX	XX	XX	3.3K	680Ω	XX
V-4	12AT7	XX	XX	14K	XX	XX	XX	XX	14K	XX
V-5	6X4	250Ω	NC	XX	XX	NC	270Ω	XX	None	None
V-6	6C4	1.2 Meg.	NC	850Ω	850Ω	NC	850Ω	850Ω	None	None

Pin	No.	1	2	3	4	5	6
V-7	3AQP1	INF.	1.2 Meg.	1.1 Meg.	970K	NC	1.5 Meg.

Pin	No.	7	8	9	10	11	12
V-7	3AQP1	1.4 Meg.	XX	3.5M	3.8M	NC	INF.

NOTES:
INF = Infinity
XX = Do not measure
Meg. = 1,000,000 ohms
K = 1000 ohms
NC = No connection
CW = Clockwise
CCW = Counterclockwise
Ω = Ohm

Figure 14

TABLE OF VOLTAGES

Set Controls as follows:

INTENSITY	CW	H GAIN	MID
FOCUS	MID	V RANGE	CAL
V POS	MID	H/SWEEP SEL	15–150
H POS	MID	SYNC	INT
V CAL	MID		
SYNC/PHASE	MID	Insert all Vacuum Tubes.	
SWEEP VERNIER	CW	Disconnect V INPUT Cable.	

If significant deviations from the listed voltages should occur, make sure the controls are set exactly as instructed. Those controls specified to be set at "MID" should be set as close as possible to the middle of rotation.

Pin	No.	1	2	3	4	5	6	7	8	9
V-1	6BR8	0	1.8	1.75	3.15 AC	3.15 AC	XX	110	1.1	0
V-2	6BK7	250	75	80	3.15 AC	3.15 AC	250	75	80	0
V-3	12AT7	65	−9	2.25	3.15 AC	3.15 AC	145	0	2.25	0
V-4	12AT7	180	6.5	22	3.15 AC	3.15 AC	195	6.5	22	3.15 AC
V-5	6X4	325 AC	NC	3.15 AC	3.15 AC	NC	325 AC	355	None	None
V-6	6C4	−700	NC	520 AC	520 AC	NC	520 AC	520 AC	None	None

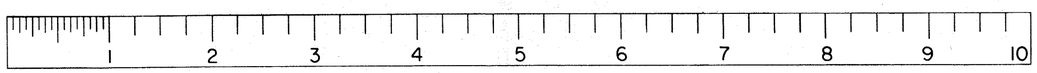
Pin	No.	1	2	3	4	5	6
V-7	3AQP1	XX	−665	655	−450	NC	200

Pin	No.	7	8	9	10	11	12
V-7	3AQP1	200	220	200	200	NC	XX

NOTES:
All voltages + DC unless otherwise marked.
All voltages measured from ground.
NC = No connection.
XX = Do not measure.
CW = Clockwise.
CCW = Counter-clockwise.
MID = Middle of rotation.

Figure 14A

WORK AREA



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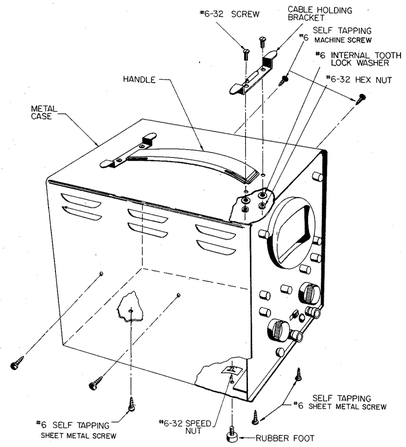
SECTION N, FINAL ASSEMBLY



MAIN MECHANICAL ASSEMBLY
FIGURE 15

Final Assembly

PARTS LIST

Symbol	Description *Marking Indicated by Quotation Marks (" ").*	Qty.
	Case, blue hammeroid	1
	Handle, black	1
	Handle brackets, cable holding	2
	Rubber feet, black	4
	#6-32 x ½" long machine screws	4
	#6 internal tooth lockwasher	4
	#6-32 hex nuts	4
	Speed nuts, flat wafer	4
	#6 x ⅜" long self-tapping machine screws (fine threads)	4
	#6 x ⅜" long self-tapping sheet metal screws (widely spaced threads)	3

Illustration: Figure 15.

Steps 1 through 7. Check (✓) each step as it is completed.

1. ( ) Assemble the handle to the case using two cable-holding brackets, four #6-32 x ½-inch long screws, four #6 internal tooth lockwashers, and four #6-32 hex nuts, making sure that cable-holding brackets are in position as shown in Figure 15, with the link on the handle under the hook on the bracket. The open portion of the link should be inside the handle when it is secured to the bracket.

2. ( ) Insert the four rubber feet in their respective holes on the bottom of the case, and fasten with the four flat-wafer speed-nuts. Screw the feet firmly into the speed nuts by hand.

3. ( ) Run power-line-cord through hole in back of metal case.

4. ( ) Insert the rubber grommet, previously placed on the cord, into hole at the rear of the case.

5. ( ) Slide the Oscilloscope chassis carefully into the metal case, aligning the chassis with the two holes on each side of the case, and the three holes on the bottom of the case. Make sure nothing catches on the screws in the bottom of the case.

6. ( ) Fasten the chassis to the case by inserting one #6 x ⅜-inch long self-tapping machine screw in each of the four holes on the sides, and one #6 x ⅜-inch long self-tapping sheet metal screw in each of the three holes on the bottom. See Figure 15. On the bottom rear of the case, insert the screw into the hole that is in line with the corresponding hole on the rear chassis bracket.

7. ( ) You have now completed your Oscilloscope. To obtain maximum utility from your instrument, read the Instruction Booklet carefully for proper operating instructions.