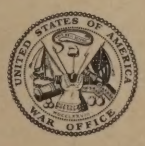
DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-5129
TO 33A1-13-56-11

OSCILLOSCOPE AN/USM-50





DEPARTMENTS OF THE ARMY AND THE AIR FORCE

MAY 1957

WARNING

HIGH VOLTAGE

is used in the operation of
this equipment.

DEATH ON CONTACT

may result if operating personnel
fail to observe
safety precautions.

Remove the power cord from the equipment and discharge the high-voltage capacitors before making repairs. This test unit contains voltages up to 3,000 volts in the high-voltage power supply. Do not replace tubes while the power is on. Poisonous fumes may be released when the low-voltage rectifiers are shorted. Be sure to provide adequate ventilation.

EXTREMELY DANGEROUS VOLTAGES EXIST IN THE FOLLOWING UNITS:

Cathode ray indicator assembly	2,500 volts dc
High-voltage power supply chassis	2,500 volts dc
Low-voltage rectifier chassis	400 volts dc

TM 11-5129
*C 4

TECHNICAL MANUAL

OSCILLOSCOPES AN/USM-50A, B, AND C

TM 11-5129
CHANGE No. 4

HEADQUARTERS,
DEPARTMENT OF THE ARMY
WASHINGTON, D.C., *4 October 1963*

TM 11-5129, 27 May 1957, is changed as follows:

Page 3, paragraph 1. Delete subparagraph *b*.

Add paragraph 1.1 after paragraph 1.

1.1. Index of Publications

Refer to the latest issue of DA Pam 310-4 to determine whether there are new editions, changes, or additional publications pertaining to the equipment. DA Pam 310-4 is an index of current technical manuals, technical bulletins, supply bulletins, lubrication orders, and modification work orders available through publications supply channels. The index lists the individual parts (-10, -20, -35P, etc.) and the latest changes to and revisions of each equipment publication.

Delete paragraph 2 and substitute:

2. Forms and Records

a. Reports of Maintenance and Unsatisfactory Equipment. Use equipment forms and records in accordance with instructions in TM 38-750.

b. Report of Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700-58 (Army), NAVSANDA Publication 378 (Navy), and AFR 71-4 (Air Force).

c. Reporting of Equipment Manual Improvements. The direct reporting by the individual user of errors, omissions, and recommendations for improving this manual is authorized and encouraged. DA Form 2028 (Recommended changes to DA technical manual parts lists or supply manual 7, 8, or 9) will be used for reporting these improvements. This form will be completed in triplicate using pencil, pen, or typewriter. The original and one copy will be forwarded direct to Commanding Officer, U.S. Army Electronics Materiel Support Agency, ATTN: SELMS-MP, Fort Monmouth, N.J. 07703. One information copy will be furnished to the individual's immediate supervisor (officer, noncommissioned officer, supervisor, etc.).

Page 9, paragraph 13*i*(3), line 2 (as changed by C 3, 11 September 1961). Delete "12" and substitute: 9.

Page 12, paragraph 2*b*. Delete subparagraph (1) and substitute:

(1) Daily preventive maintenance checks and services (par. 27.2).

(1.1) Weekly preventive maintenance checks and services (par. 27.3).

(1.2) Cleaning (par. 27.4).

Delete paragraph 27 and substitute:

27. Preventive Maintenance

Preventive maintenance is the systematic care, servicing, and inspection of equipment to prevent the occurrence of trouble, to reduce downtime, and to assure that the equipment is serviceable.

a. Systematic Care. The procedures given in paragraphs 27.2, through 27.4 cover routine systematic care and cleaning essential to proper upkeep and operation of the equipment.

b. Preventive Maintenance Checks and Services. The preventive maintenance checks and services charts (pars. 27.2 and 27.3) outline functions to be performed at specific intervals. These checks and services are to maintain army electronic equipment in a combat-serviceable condition; that is, in good general (physical) condition and in good operating condition. To assist operators in maintaining combat serviceability, the charts indicate what to check, how to check, and what the normal conditions are; the *References* column lists the paragraphs or manuals that contain detailed repair or replacement procedures. If the defect cannot be remedied by performing the corrective

* This change supersedes C 3, 11 September 1961.

actions listed, higher echelon maintenance or repair is required. Records and reports of these checks and services must be made in accordance with the requirements set forth in TM 38–750.

27.1. Preventive Maintenance Checks and Services Periods

Preventive maintenance checks and services of the equipment are required daily and weekly. Paragraphs 27.2 and 27.3 specify the items to be checked and serviced. In addition to the routine daily and weekly checks and services, the equipment should be rechecked and serviced immediately before going on a mission and as soon after completion of the mission as possible.

27.2. Daily Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Completeness	See that the equipment is complete (TM 11–6625–286–20P).	None.
2	Cleanliness	Clean the exterior surfaces, including the panel (par. 27.4).	None.
3	Connectors	Check the tightness of all connectors	None.
4	Controls	While operating (item 5), observe that the mechanical action of each knob, dial, and switch is smooth and free of external or internal binding, and that there is no excessive looseness.	None.
5	Operation	During operation, be alert for any unusual performance or condition.	Pars. 28 and 29.

27.3. Weekly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Cables	Inspect cords, cables, and wires for chafed, cracked, or frayed insulation. Replace connectors that are broken, arced, stripped, or worn excessively.	None.
2	Handles and latches	Inspect handles, latches, and hinges for looseness. Replace or tighten as necessary.	None.
3	Exterior	Inspect exposed surfaces for chips, cracks, rust, and corrosion. If required, refer to second echelon.	None.

27.4. Cleaning

Inspect the exterior of the equipment. The exterior surfaces should be clean and free of dust, dirt, grease, and fungus.

a. Remove dust and loose dirt with a clean soft cloth.

***Warning:* Cleaning compound is flammable and its fumes are toxic. Provide adequate ventilation. *Do not* use near a flame.**

b. Remove grease, fungus, and ground-in dirt from the cases; use a cloth damapened (not wet) with cleaning compound (FSN 7930–395–9542).

c. Remove dust or dirt from plugs and jacks with a brush.

d. Clean the front panel and control knobs; use a soft clean cloth. If necessary, dampen the cloth with water; mild soap may be used for more effective cleaning.

Page 13. Delete figure 4 (page 1 of C 1).

Page 14, paragraph 30*b*. Delete subparagraph (1) and substitute:

(1) Monthly preventive maintenance checks and services (par. 32.2).

(1.1) Quarterly preventive maintenance checks and services (par. 32.3).

(1.2) Touchup painting (par. 32.4).

Delete paragraph 32 and substitute:

32. Preventive Maintenance

a. Preventive maintenance is the systematic care, inspection, and servicing of equipment to maintain it in serviceable condition, prevent

breakdowns, and assure maximum operation capability. Preventive maintenance is the responsibility of all echelons concerned with the equipment and includes the inspection, testing, and repair or replacement of parts, subassemblies, or units that inspection and tests indicate would probably fail before the next scheduled periodic service. Prevention maintenance checks and services of the equipment at the second echelon level are made at monthly and quarterly intervals unless otherwise directed the the commanding officer.

b. Maintenance forms and records to be used and maintained on this equipment are specified in TM 38–750.

32.1. Monthly Maintenance

Monthly preventive maintenance checks and services on the equipment are required. Periodic daily and weekly services constitute a part of the monthly preventive maintenance checks and services and must be performed concurrently. All deficiencies or shortcomings will be regarded in accordance with the requirements of TM 38–750. Perform all the checks and services listed in the monthly preventive maintenance checks and services chart (par. 32.2) in the sequence listed. Adjustment of the maintenance interval must be made to compensate for any unusual operating conditions. Equipment maintained in a standby (ready for immediate operation) condition must have monthly preventive maintenance checks and services performed on it. Equipment in limited storage (requires service before operation) does not require monthly preventive maintenance.

32.2. Monthly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Pluckout items	Inspect seating of pluckout items	None.
2	Jacks	Inspect jacks for snug fit and good contact	None.
3	Transformers	Inspect the power transformers. All nuts must be tight. There should be no evidence of dirt or corrosion.	None.
4	Terminal blocks	Inspect terminal blocks for loose connections and cracked or broken insulation.	None.
5	Resistors and capacitors	Inspect the resistors and capacitors for cracks, blistering, or other detrimental defects.	None.
6	Gaskets and insulators	Inspect gaskets, insulators, bushings, and sleeves for cracks, chipping, and excessive wear.	None.
7	Interior	Clean interior of chassis and cabinet	None.
8	Cathode-ray tube	Inspect cathode-ray tube for burned screen spots	None.

32.3. Quarterly Preventive Maintenance Checks and Services Chart

Sequence No.	Item	Procedure	References
1	Publications	See that all publications are complete, serviceable, and current.	DA Pam 310–4.
2	Modifications	Check DA Pam 310–4 to determine if new applicable MWO's have been published. All URGENT MWO's must be applied immediately. All NORMAL MWO's must be scheduled.	TM 38–750 and DA Pam 310–4.
3	Spare parts	Check all spare parts (operator and organizational) for general condition and method of storage. There should be no evidence of overstock, and all shortages must be on valid requisitions.	TM 11–6625–286–20P.

32.4. Touchup Painting Instructions

Remove rust and corrosion from metal surfaces by lightly sanding them with fine sandpaper. Brush two thin coats of paint on the bare metal to protect it from further corrosion. Refer to the applicable cleaning and refinishing practices specified in TM 9–213.

Page 15. Delete figure 5.

Page 16, paragraph 34c (as changed by C 3, 11 September 1961). In corrective measures column,

step 9, "check V801, V802, V812" and substitute: check V802, V808, V810, and V812.

Page 55, figure 32, terminal board E401, terminal 4 (as changed by C 3, 11 September 1961). Delete "6.3VAC" and substitute: 6.3VDC.

Page 71. Add the following appendix after chapter 6:

APPENDIX

REFERENCES

DA Pam 310–4	Index of Technical Manuals, Technical Bulletins, Supply Bulletins, Lubrication Orders, and Modification Work Orders.
TM 9–213	Painting Instructions for Field Use.
TM 11–5088	Generators, Signal SG–71/FCC, SG–71A/FCC, and SG–71B/FCC.
TM 11–5551B	R. F. Signal Generator Set AN/URM–25B.
TM 11–6625–203–12	Operator and Organizational Maintenance: Multimeter AN/URM–105, Including Multimeter ME–77/U.
TM 11–6625–274–12	Operator's and Organizational Maintenance Manual: Test Sets, Electron Tube TV–7/U. TV–7A/U, TV–7B/U, and TV–7D/U.
TM 11–6625–286–20P	Organizational Maintenance Repair Parts and Special Tools List and Maintenance Allocation Chart: Oscilloscopes AN/USM–50A, –50B, and –50C.
TM 11–6625–286–35P	Field and Depot Maintenance Repair Parts and Special Tools List: Oscilloscopes AN/USM–50A, –50B, –50C.
TM 11–6625–320–12	Operator's and Organizational Maintenance Manual: Voltmeter, Meter ME–30A/U and Voltmeters, Electronic ME–30B/U and ME–30C/U.
TM 38–750	The Army Equipment Record System and Procedures.

Page 72, figure 50, foldout (as changed by C 3, 11 September 1961). Delete the caption and substitute:

Figure 50. Oscillosope OS–62A/USM–50A, complete schematic diagram.

By Order of the Secretary of the Army:

EARLE G. WHEELER,
General, United States Army,
Chief of Staff.

Official:

J. C. LAMBERT,
Major General, United States Army,
The Adjutant General.

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To be distributed in accordance with DA Form 12–32, Sec II (Unclas) requirements for Nike Ajax and Nike Hercules and Improved Nike Hercules and Target Missiles and Hawk, TM, Radio.

U. S. GOVERNMENT PRINTING OFFICE: 1963—700504

809—698

TECHNICAL MANUAL
No. 11-5129

DEPARTMENTS OF THE ARMY AND
THE AIR FORCE
WASHINGTON 25, D. C., *27 May 1957*

OSCILLOSCOPE AN/USM-50

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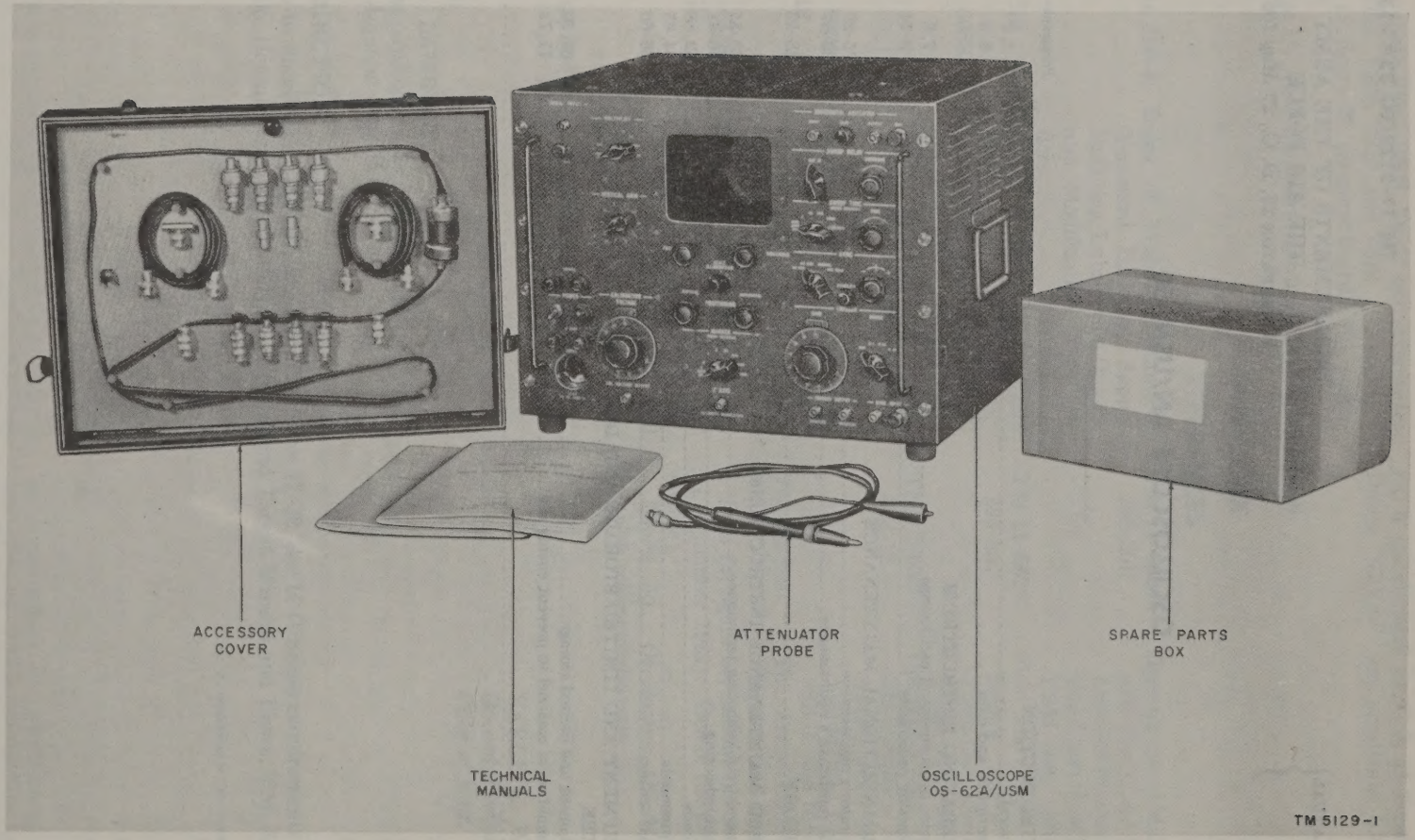


Figure 1. Oscilloscope AN/USM-50.

CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual covers the operation, maintenance, repair, and theory of Oscilloscope AN/USM–50 (fig. 1).

b. Forward all comments concerning this manual directly to Commanding Officer, U. S. Army Signal Publications Agency, Fort Monmouth, N. J.

2. Forms and Records

a. Unsatisfactory Equipment Reports.

(1) Fill out and forward DA Form 468 (Unsatisfactory Equipment Report) to Commanding Officer, U. S. Army Signal Equipment Support Agency, Fort Monmouth, N. J., as prescribed in AR 700–38.

(2) Fill out and forward AFTO Form 29 (Unsatisfactory Report) to Commander, Air Materiel Command, Wright-Patterson Air Force Base, Ohio, as prescribed in AF TO 00–35D–54.

b. Damaged or Improper Shipment. Fill out and forward DD Form 6 (Report of Damaged or Improper Shipment) as prescribed in AR 700–58 (Army); Navy Shipping Guide, Article 1850–4 (Navy); and AFR 71–4 (Air Force).

c. Preventive Maintenance Forms.

(1) Prepare DA Form 11–238 (Operator First Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)) (fig. 4) in accordance with instructions on the back of the form.

(2) Prepare DA Form 11–239 (Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar)) (fig. 5) in accordance with instructions on the back of the form.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

Oscilloscope AN/USM–50 is a wide-range, high-gain, portable test instrument. It can be used for the observation of pulses, short-period electrical disturbances, sine waves and complex wave forms.

4. Technical Characteristics

Vertical Amplifier:

Sine wave response	3 cycles to 15 mc.
Transients response	.022 microsecond rise time.
Delay	.25 microsecond.
Tilt	Less than 5 percent for a 15,000 microsecond pulse.
Sensitivity	24 to 25 millivolts per inch of vertical deflection over entire frequency range.
Linearity	Not more than 3 percent compression on a negative or positive pulse with a deflection of 1 inch.
Polarity	Upward deflection of beam for a positive pulse.
Input impedance	1 megohm shunted by 40 $\mu\mu$f for all attenuator positions.

Horizontal Amplifier:

Frequency response	10 cycles to 750 kc.
Rise time	.02-microsecond.
Sensitivity	Minimum sensitivity of 200 volts peak-to-peak per inch; maximum sensitivity of 3 volts peak-to-peak per inch of horizontal deflection.
Input impedance	1 megohm shunted by 30 $\mu\mu$f.

Sweep Generator:

Sweep range.....Continuously variable from .2 to 37,000 microseconds per inch of horizontal deflection.

Sweep modes.....Recurrent or driven.

Sweep length.....Minimum 2½ in.

Sweep delay.....Permits any 10 percent of the sweep length to be expanded 10 times on all sweeps greater than 5 microseconds.

Linearity.....Not more than 10 percent deviation between ½-inch sections of a 2½-inch sweep.

Calibration voltage generator.....A 1,000-cps square wave, adjustable from .01 to .1 millivolts peak-to-peak for internal use and a fixed output of 30 volts peak-to-peak, for external use.

Trigger generator:

Pulse repetition rate..Continuously variable in three decades from 10 to 10,000 pulses per second.

Rise time.....15 microsecond.

Width.....1.2 microsecond.

Application.....Positive pulse for internal use; positive and negative pulses available for external use.

Marker generator....Intensity modulates the cathode-ray tube trace with marker dots at intervals of .2, 1.0, 5, 20, 100, 500, and 2,000 microseconds.

Cathode-ray tube

Diameter.....3 inches overall.

Accelerating potential.....2,500 volts.

Power supply.....105 to 125 volts ac, 50 to 1,000 cps, 295 watts.

Altitude.....Up to 25,000 feet.

5. Components of Oscilloscope AN/USM-50

a. Components. The components of Oscilloscope AN/USM–50 (fig. 1) are listed below:

Quantity	Item	Height (in.)	Depth (in.)	Width (in.)	Unit weight (lb)
1	Oscilloscope OS–62A/USM	15	15¼	19½	38
1	Attenuator probe: RG–62A/U coaxial cable with type UG–260B/U connector on one end and alligator clips on other end.		60 (lg)		
1	Power cord		75 (lg)		
1	Coaxial cable: RG–62A/U coaxial cable with type UG–260B/U connectors on both ends.		40 (lg)		
2	TM 11–5129				
1 set	Running spares (*b* below)				

b. Running Spares. The spare parts box, shipped with each unit, contains the following:

Quantity	Item
1	Tube 6AH6
1	Tube 5726/6AL5W
2	Tubes 6AU6
3	Tubes 6CB6
2	Tubes 12AT7WA
1	Tube 12AU7
2	Tubes 12B4A
1	Tube 12BH7A
2	Tubes 12BY7A
1	Tube 5642
1	Tube 5651
1	Tube 6080
1	Tube 3ADP1
5	Fuses, 4-ampere, 1¼″ x ¼″
2	Lamps, incandescent type No. 44

Note. In addition, four ¼-ampere, slow-blow fuses, 1¼ inch by ¼ inch, an insulated screwdriver, and two Allen wrenches are mounted on the main frame assembly.

6. Description of Oscilloscope (fig. 1)

a. Oscilloscope OS–62A/USM (referred to as oscilloscope throughout this manual) consists of a panel-chassis assembly and a metal cabinet. All operating controls, connectors, and fuses are mounted on the panel. Two handles are provided, one on each side of the panel to protect the knobs and connectors whenever the unit is placed face downward for maintenance. When removed from the metal cabinet, the panel-chassis assembly can be rack-mounted. The metal cabinet is louvered on all sides to provide ventilation. Steel handles are welded on each side of the case.

b. The accessory cover contains a hinged panel where manuals are stored. Clips and studs are attached on the panel where all adapters and cables are held in place.

CHAPTER 2

OPERATING INSTRUCTIONS

Section I. SERVICE UPON RECEIPT OF OSCILLOSCOPE

7. Unpacking

a. Packaging Data. The oscilloscope, with accessory cover attached is packaged as shown in figure 2. The spare parts box (fig. 1) is shipped separately. The packed oscilloscope is 18 inches high, 21 inches deep, and 33 inches wide. It weighs 100 pounds and has a volume of 3.6 cubic feet.

b. Removing Contents. Perform the procedures outlined in (1) through (4) below when unpacking equipment in wooden boxes.

(1) Cut and fold back the metal straps.

(2) Remove the nails from the top and one side of the box with a nail puller. Remove the top and one side. Do not attempt to pry them off as the equipment may become damaged.

(3) Open the moistureproof barrier that covers the carton inside the box. Remove the carton.

(4) Open the carton and the moisture-vaporproof barrier within the carton. Open the inner carton and remove the contents.

8. Checking Unpacked Equipment

a. Inspect the equipment for damage incurred during shipment. If the equipment has been damaged, refer to paragraph 2.

b. See that the equipment is complete as listed on the packing slip, or check it against the table of components in paragraph 5.

c. If the equipment has been used or reconditioned, check to see whether it has been changed by a Modification Work Order (MWO). If modified, the MWO number will appear on the front panel. Check to see that the MWO number appears on the schematic diagram of the manual accompanying the equipment. If not, add a note to the overall schematic diagram.

Section II. OPERATING PROCEDURES

9. General

a. The oscilloscope is capable of presenting a variety of voltage wave forms over a wide frequency range with negligible distortion. To properly analyze, interpret, and measure these wave forms, the oscilloscope must be set up correctly.

b. The functions of the controls and methods of operation are described in paragraphs 10 through 24.

10. Controls and Connectors

(fig. 3)

The functions of the oscilloscope controls and connectors are listed below.

Control or connector	Function
SIGNAL INPUT connector	Connects test probe to input of vertical amplifier.
MULTIPLIER rotary switch	*Position* — *Function* VERT PL — Connects SIGNAL INPUT directly to one deflection plate through a capacitor, and grounds other vertical plate through a capacitor. CAL — Connects the input of the vertical amplifier to the CALIBRATION VOLTAGE potentiometer.

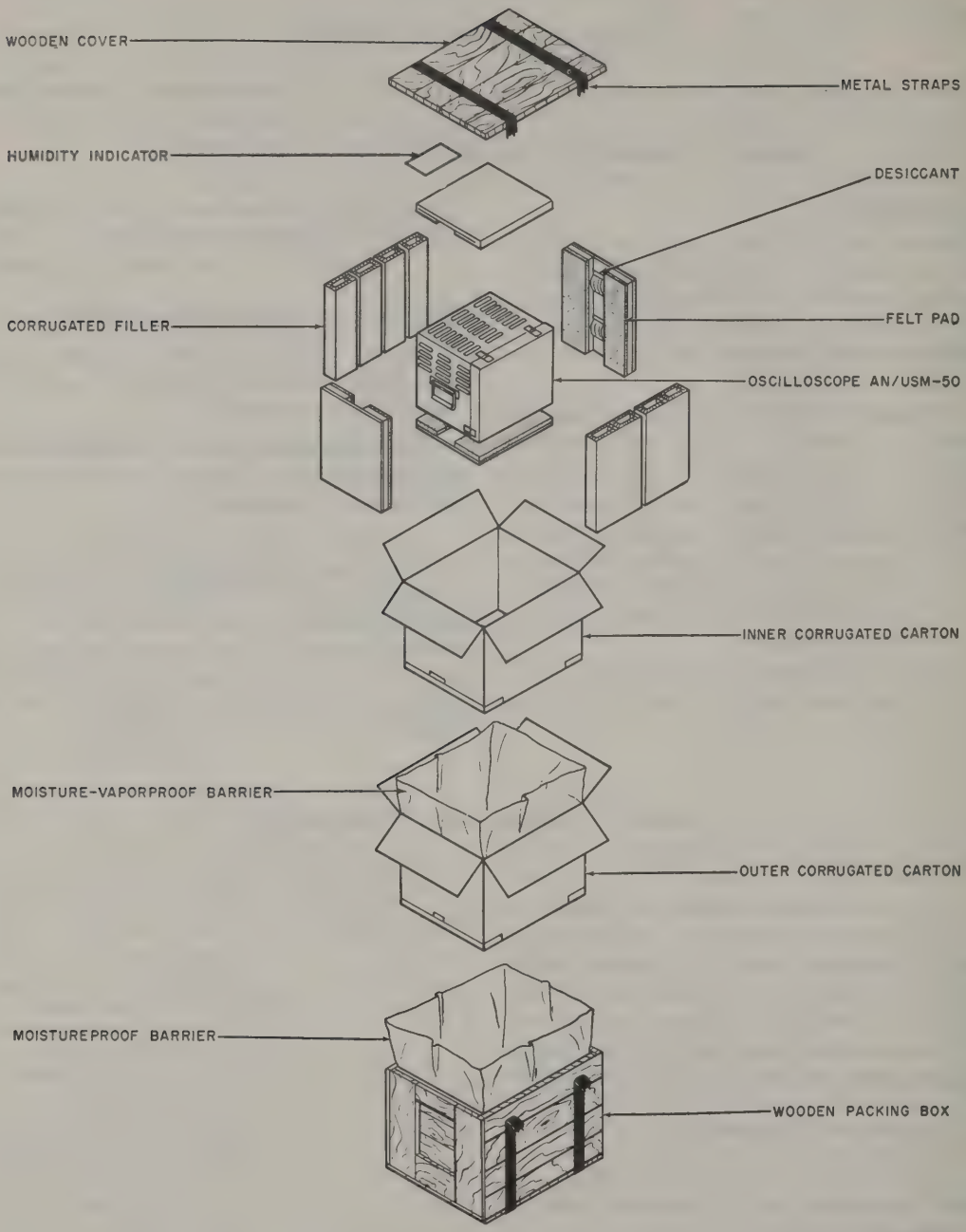


Figure 2. Packaging diagram.

Control or connector	Function
	Position — *Function*
MULTIPLIER rotary switch (cont)	1, 3, 10, 30, 100, 300 — Attenuates the signal input voltage by the amount indicated.
GND binding post	Permits direct grounding between the oscilloscope and other equipment.
VERTICAL GAIN	Provides continuous attenuation of the input voltage by a factor of zero to four times.
CALIBRATION VOLTAGE	Varies the output of the calibration generator. Provides voltages between 10 and 100 millivolts peak-to-peak at 1,000 cps as indicated on the calibrated dial, to the input of the vertical amplifier when the MULTIPLIER switch is in the CAL position.
CAL VOLTAGE OUTPUT connector	Provides a calibrated 30 volts peak-to-peak at 1,000 cps for external use.
FOCUS	Controls the focusing of the beam.
BRILLIANCE	Controls the brightness of the trace.
SCALE ILLUMINATION	Varies the illumination of the graph projected on the plexiglass plate mounted in front of the cathode-ray tube.
VERTICAL POSITIONING	Positions the beam in a vertical direction.
HORIZONTAL POSITIONING	Positions the beam in a horizontal direction.
MARKER rotary switch	In Z AXIS ON position, connects the INTENSITY MODULATION connector directly to the cathode of the crt. In all other positions, modulates the display in the form of bright dots spaced at the microsecond time intervals indicated by the switch.
Z AXIS-INTENSITY MODULATION connector.	Connects the external modulation for the beam (in the form of negative pulses) to the cathode of the crt when the MARKER switch is in the Z AXIS ON position. Supplies negative marker pulses for external use in other positions of the MARKER switch.
HORIZONTAL AMPLIFIER INPUT connector.	With the SWEEP TIME switch in the HOR AMP ON position, permits use of one horizontal amplifier tube for amplifying any external voltage within a frequency range of 10 cps to 750 kc.
HORIZONTAL AMPLIFIER OUTPUT connector.	Supplies the amplified voltage for above conditions.
HORIZONTAL GAIN	Varies the amplitude of the horizontal output voltage.

Control or connector	Function
SWEEP DELAY rotary switch.	In OUT position, the sweep is synchronized according to the setting of the SYNC switch. In the IN position, the start of the sweep is delayed and any 1 percent of the horizontal trace can be expanded by a factor of 10 times on all sweeps greater than 5 microseconds.
SWEEP DELAY INCREASE	Controls degree of delay of the expanded sweep.
SWEEP TIME rotary switch	In HOR AMP ON position permits an external voltage to be amplified and used independently of the oscilloscope functions. In all other positions, determines the sweep rate in microseconds per inch of horizontal deflection.
SWEEP TIME FINE	Permits continuous adjustment of the sweep duration between settings of the SWEEP TIME switch.
	Position — *Function*
SYNC selector rotary switch	HI EXT — Used with the SYNC INPUT connector when the sweep is being synchronized by an external pulse having an amplitude of up to 60 volts peak-to-peak.
	LO EXT — Used with external synchronizing voltage up to 2 volts peak-to-peak.
	SIGNAL — Synchronizes the sweep with the signal applied to the SIGNAL INPUT connector.
	INT TRIG — Synchronizes the sweep by positive pulses from the internal trigger generator.
STABILITY	Controls the bias and the mode of operation (recurrent or driven) of the sweep generator.
SYNC − and + polarity	Permits selection of the leading edge (+) or trailing edge (−) of the synchronizing pulse for synchronizing the sweep generator. Controls the amplitude of the synchronizing signal.
TRIGGER RANGE rotary switch	Varies the frequency of the internally generated trigger pulses used for starting the sweep, or triggering an external device simultaneously with the sweep.

Control or connector	Function
TRIGGER RATE	Varies the trigger pulse repetition rate between decade steps of the TRIGGER RANGE switch.
TRIGGER OUTPUT POSITIVE and NEGATIVE connectors.	Supply positive or negative trigger pulses to the external equipment.
SYNC INPUT connector	Permits connecting an external synchronizing signal to the sweep generator.
POWER toggle switch	Turns power on or off.
INPUT receptacle	Connector for supplying power from an ac source to the equipment through the power cord.

11. Input Voltage Limitations

a. This oscilloscope should not be used to measure voltages in excess of 450 volts, with or without the probe. This total voltage includes not only the signal but any dc component which may be present.

b. Application of a voltage exceeding 75 volts root mean square (rms) to the Z AXIS connector may damage the cathode-ray tube. When using the probe, the voltage applied to the connectors listed in *c* below will be reduced below the overload limits if the input to the probe does not exceed 450 volts.

c. The signal voltage limits for the connectors are as follows:

(1) SIGNAL INPUT, 100 volts rms.

(2) SYNC INPUT, 150 volts rms.

(3) Z AXIS-INTENSITY MODULATION, 75 volts rms.

(4) HORIZONTAL AMPLIFIER INPUT, 100 volts rms.

12. Preliminary Setting of Controls

Perform the preliminary operations listed below before starting the equipment.

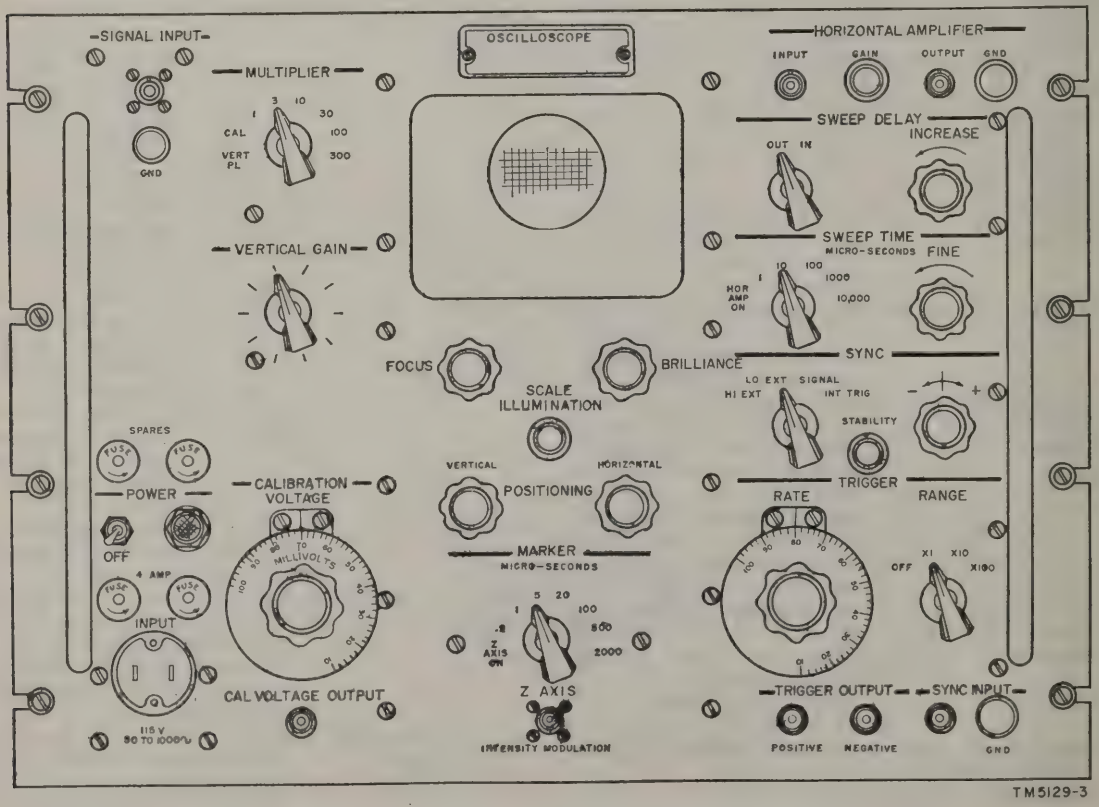


Figure 3. Oscilloscope OS-62A/USM operating controls.

Control	Position
POWER switch	OFF
MULTIPLIER switch	1
VERTICAL GAIN control	Maximum clockwise
CALIBRATION VOLTAGE dial	100 millivolts
MARKER switch	Z AXIS ON
HORIZONTAL POSITIONING control	Maximum clockwise
VERTICAL POSITIONING control	Midpoint
SCALE ILLUMINATION control	Maximum counterclockwise
FOCUS control	Maximum counterclockwise
BRILLIANCE control	Maximum counterclockwise
HORIZONTAL AMPLIFIER GAIN control	Maximum counterclockwise
SWEEP DELAY switch	OUT
SWEEP DELAY INCREASE control	Maximum clockwise
SWEEP TIME switch	1
SWEEP TIME FINE control	Maximum counterclockwise
SYNC selector switch	SIGNAL
SYNC − and + polarity control	Maximum clockwise
STABILITY control	Maximum counterclockwise
TRIGGER RATE dial	100
TRIGGER RANGE switch	OFF

13. Initial Adjustments

Note. The only equipment required to perform the initial adjustments is Multimeter ME–77/(U) which will be referred to as a multimeter throughout this manual.

With the controls set as outlined in paragraph 12:

a. Connect the power cord between the INPUT receptacle (fig. 3) and a source of 115 volts, 50 to 1,000 cycles alternating current (ac).

b. Turn the POWER switch on; the red indicating lamp will light. Allow 30 seconds for warm up.

c. Turn the BRILLIANCE control clockwise until a spot appears on the screen of the cathode-ray tube.

d. Turn the SCALE ILLUMINATION control clockwise until the scale is visible, superimposed on the screen.

e. Adjust the FOCUS control until a small round spot is visible.

f. Adjust the VERTICAL POSITIONING control to move the spot to the vertical center of the scale.

g. Adjust the HORIZONTAL POSITIONING control to move the spot to the left edge of the scale.

h. Turn the STABILITY control slowly clockwise and the spot on the screen will change into a line. As the control is rotated, the line will first expand and then contract.

Note. The STABILITY control determines the operation of the sweep in either the recurrent mode or the driven mode (par. 14), and requires careful adjustment to prevent distortion and instability of the wave form.

i. Remove the cabinet to expose terminal E801 (fig. 10). Check the following voltages in the power supply section:

(1) Connect a multimeter between terminal 15 of E801 and ground. Adjust R806 until the multimeter indicates −150.

(2) Connect the multimeter between terminal 12 of E801 and ground. Adjust R837 until the multimeter indicates +150 volts.

(3) Connect a multimeter between terminal 12 of E801 and ground. Adjust R815 until the multimeter indicates +200 volts.

(4) Connect the multimeter between terminal 11 of E801 and ground. Adjust R814 until the multimeter indicates +400 volts.

Note. If the voltages above are not obtained, refer to the troubleshooting chart (par. 57).

14. Sweep Circuit Adjustment

When the observed wave form has a constant frequency, the sweep circuit should be operated in the recurrent mode (*a* below). A transient voltage wave form is best observed when the oscilloscope is operated in the driven mode (*b* below). The STABILITY control determines the mode of operation. Before setting this control, the frequency of the wave form to be observed must be known to properly set up the SWEEP TIME switch. This switch, together with the SWEEP TIME FINE control, varies the speed of the beam across the illuminated scale. The highest speed is used for the highest frequency capable of being amplified by the vertical amplifier circuit, 15 megacycles (mc). The 1 microsecond position of the SWEEP TIME switch provides the greatest sweep speed, while the 10,000 microsecond position provides the slowest sweep speed.

a. Recurrent Mode.

(1) Start the equipment (par. 13*a–g*). The spot should appear at the left edge of the illuminated scale.

(3) Turn the STABILITY control slowly clockwise. The spot will change into a line extending off the screen to the right. Con-

tinuing the rotation, the line first expands then contracts. Although the end of the line will not be visible, the point of maximum length can be determined by adjusting the line for minimum intensity as the STABILITY control rotation is continued in the clockwise direction.

b. Driven Mode.

(1) Start the equipment (par. 13*a–g*). The spot should appear at the left edge of the illuminated scale.

(2) Turn the STABILITY control slowly clockwise. The spot will change into a line extending off the screen to the right.

(3) Turn the STABILITY control slowly counterclockwise until the line or trace disappears and only the spot remains. No further adjustment of the STABILITY control is required except on signals of very low amplitude, when it may be necessary to advance the control slightly. For fundamental frequencies over 5 megacycles, advance the STABILITY control until a stationary pattern is obtained.

15. Operation With Internally Synchronized Sweep

a. Set the controls as follows:

(1) SWEEP DELAY to OUT.

(2) TRIGGER RANGE to OFF.

(3) MARKER to Z AXIS ON.

b. Connect the attenuator probe to the SIGNAL INPUT connector.

c. Connect the alligator clips of the attenuator probe to a signal source.

d. Adjust the MULTIPLIER switch and VERTICAL GAIN to provide about 1 inch of vertical deflection. Use the lowest MULTIPLIER position with which this can be accomplished.

e. Set the SYNC selector switch to SIGNAL and the SYNC polarity control to maximum + or − depending upon whether the signal pulse is positive or negative.

f. Adjust the SWEEP TIME switch and the SWEEP TIME FINE control until the wave form is stationary.

Note. If the pattern is not stationary, adjust the SYNC polarity control. On symmetrical signals and where multiple pulses are displayed, the SYNC amplitude should be reduced. For transients, maximum SYNC amplitude is used, and the STABILITY control is set to its maximum counterclockwise position.

16. Operation With External Sync

Use the procedure described in paragraph 15, with the following exceptions:

a. Connect external synchronization to the SYNC INPUT connector.

b. Set the SYNC selector switch to LO EXT position for synchronizing voltages up to 2 volts.

c. Set the SYNC selector switch to HI EXT position for synchronizing voltages up to 60 volts.

17. Operation With Internal Trigger Sweep Synchronization

Use the procedure described in paragraph 15, with the following exceptions:

a. Set the SYNC selector switch to INT TRIG.

b. Set the TRIGGER RANGE switch and the TRIGGER RATE control for the required pulse rate.

c. Set the SYNC polarity control to the + side. This synchronizes the sweep with the leading edge of the pulse. To synchronize the sweep with the trailing edge of the pulse, set the SYNC polarity control on the − side.

Note. Use this procedure when the oscilloscope is to be synchronized with the operation of external equipment whose voltage pulses or wave forms are to be observed.

18. Sweep Delay and Expansion Controls

a. Adjust the SWEEP TIME controls so that the portion of the signal to be closely examined is near the right end of the sweep.

b. Set the SWEEP DELAY switch to the IN position.

c. Set the SWEEP DELAY INCREASE control to the maximum clockwise position.

d. Rotate the SWEEP DELAY INCREASE control counterclockwise until the desired signal display moves in from the right side to the center of the screen. The display is now about 10 times the original width

Note. If the display becomes unstable, adjust the SYNC + or − control for better synchronization.

19. Use of Markers

a. To measure the duration of the rise and fall time of any signal, turn the MARKER switch to the position that will give the most convenient time scale for the measurement to be made. The interval between the bright dots is the amount of microseconds indicated by the switch position.

b. After turning on the markers, readjust the BRILLIANCE and FOCUS controls to obtain the most satisfactory relationship of marker and pattern brightness.

c. For direct comparison of signal and markers, count the marker intervals. Another method of measurement is to use a china marking pencil and calibrate the horizontal scale with markers and then make measurements directly on the scale.

20. Signal Input Voltage Measurements

a. Adjust the calibrating voltage to match the signal amplitude as follows:

(1) Adjust the MULTIPLIER and VERTICAL GAIN control so that the pattern has a convenient amplitude, such as 10 scale divisions.
(2) Leave the VERTICAL GAIN as set in (1) above, and turn the MULTIPLIER switch to the CAL position. The calibration voltage in the form of a square wave will appear on the screen.
(3) Adjust the CALIBRATION VOLTAGE dial to produce the same amplitude of calibration voltage as selected for the signal voltage in (1) above.
(4) Multiply the setting of the MULTIPLIER switch obtained in (1) above and the setting of the CALIBRATION VOLTAGE dial obtained in (2) above (fig. 3), to determine the peak-to-peak amplitude (in millivolts) of the input signal.

b. If a series of measurements are to be made, use the following method:

(1) Set the CALIBRATION VOLTAGE dial at 50 millivolts (mv).
(2) Set the MULTIPLIER switch to CAL.
(3) Adjust the VERTICAL GAIN and POSITIONING controls until the calibration pulse has an amplitude of 10 divisions on the vertical line of the illuminated scale.
(4) Connect the voltage being measured to the SIGNAL INPUT, and, using the MULTIPLIER switch alone, adjust the amplitude of the pattern as nearly as possible to 10 scale divisions.
(5) The peak-to-peak signal amplitude in mv is equal to the product of the setting of the CALIBRATION VOLTAGE dial (in this case, 50), and the setting of the MULTIPLIER switch, and .1 times the image amplitude in scale divisions as measured in (4) above. For example—

CALIBRATION VOLTAGE dial reading	50.
MULTIPLIER switch setting	3.
Image amplitude in scale divisions	$10 \times .1 = 1.$

Peak-to-peak signal amplitude is—
$50 \times 3 \times 1 = 150$ mv.

21. Use of Probe

The probe increases the impedance and decreases the sensitivity of the oscilloscope by a factor of 10 to 1. To use, connect the probe to SIGNAL INPUT jack.

22. Applying Signal Directly to Vertical Plate

The input signal can be connected directly to one of the vertical deflecting plates by turning the MULTIPLIER switch to VERT PL. This bypasses the signal amplifier, the multiplier, and the internal synchronizing circuits. Synchronization must be provided through the external SYNC INPUT connector or from the trigger generator.

23. Use of Horizontal Amplifier

a. By turning the SWEEP TIME switch to HOR AMP ON, horizontal deflection can be obtained from external signals applied to the HORIZONTAL AMPLIFIER INPUT connector. At maximum sensitivity, 3 volts will produce 1 inch of horizontal deflection.

b. The HORIZONTAL AMPLIFIER can be also used to amplify external voltages without reference to oscilloscope functions. When a signal is applied to the HORIZONTAL AMPLIFIER INPUT jack, the output is available at the HORIZONTAL AMPLIFIER OUTPUT jack. The output voltage can be varied by the GAIN control. The maximum output voltage is about 150 volts.

24. Intensity Modulation by External Voltage

External voltage pulses may be applied to the cathode of the cathode-ray tube (crt) by connecting the probe to the Z AXIS-INTENSITY MODULATION connector and turning the MARKER switch to the Z AXIS ON position. Negative pulses will cause bright spots and positive pulses will be seen as dark markers on a bright trace.

CHAPTER 3

ORGANIZATIONAL MAINTENANCE

Section I. OPERATOR'S MAINTENANCE

25. Scope of Operator's Maintenance

a. The following is a list of maintenance duties normally performed by the operator of the oscilloscope. These procedures do not require special tools or test equipment.

b. Operator's maintenance for the oscilloscope consists of the following:

(1) Preventive maintenance (par. 27).
(2) Visual inspection (par. 28).
(3) Replacement of defective indicating lamp (par. 29*b*).
(4) Replacement of defective fuses (par. 29*a*).
(5) Checking cable connections.

26. Tools and Materials Required

The tools and materials required for operator's maintenance of the oscilloscope are listed below.

a. Tools.
Screwdriver, 6 inches.
Pliers, 6 inches.

b. Tools Supplied With Equipment.
Allen wrench, 1/16 inch.
Allen wrench, 3/32 inch.

c. Materials.
Brush, paint, flat, 1 inch wide.
Cleaning Compound (Federal stock No. 7930–395–9542).
Cheesecloth, lint-free.

27. Operator's Preventive Maintenance

a. DA Form 11–238. DA Form 11–238 (fig. 4) is a preventive maintenance checklist to be used by the operator. Items not applicable to the oscilloscope are lined out in the figure. References in the ITEM block in the figure are to paragraphs that contain additional maintenance information pertinent to the particular item. Instructions for the use of the form appear on the back of the form.

b. Items. The information below is supplementary to DA Form 11–238. The item numbers correspond to the ITEM numbers on the form.

Item	Maintenance procedures
3	Use a clean cloth to remove dust, dirt, moisture, and grease from the front panel controls and the plexiglass filter in front of the cathode-ray tube.
5	All control knobs should work smoothly, be tight on the shaft, and should not bind. Tighten all loose knobs and be sure that the knobs do not rub against the panel.
8	Remove all rust from components and touch up bare spots with paint.
9	Repair any cuts in the insulation by covering them with rubber tape. Replace or repair all broken cords and cables.

28. Operator's Visual Inspection

a. When the equipment fails to perform properly, check all the items listed below.

(1) Wrong settings of switches and controls (par. 12).
(2) Defective or poorly connected cables.
(3) Poor ground connection between oscilloscope and equipment being tested.
(4) Burned-out fuses (usually indicates some other fault).
(5) Incorrect line voltage.

b. If the above checks do not correct the equipment operation, higher echelon repair is required.

29. Operator's Repairs

a. Replacement of Line Fuses.

(1) Rotate the fuse holder in the direction indicated by the arrow (fig. 3), and pull it out.

OPERATOR FIRST ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.
OSCILLOSCOPE AN/USM-50	152

LEGEND FOR MARKING CONDITIONS: ✓ Satisfactory; X Adjustment, repair or replacement required; (X) Defect corrected.
NOTE: Strike out items not applicable.

DAILY

NO	ITEM	CONDITION S	M	T	W	T	F	S
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT (~~receiver, transmitter~~, carrying cases, ~~wire and~~ cable, ~~microphones~~, tubes, spare parts, technical manuals and accessories). PAR. 5	✓						
2	~~LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.~~							
3	CLEAN DIRT AND MOISTURE FROM ~~ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS,~~ JACKS, PLUGS, ~~TELEPHONES, CARRYING BAGS, COMPONENT PANELS.~~	✓						
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, ~~CRYSTALS,~~ FUSES, CONNECTORS, ~~VIBRATORS, PLUG-IN COILS~~ AND RESISTORS.	✓						
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, ~~WORN OR CHIPPED GEARS, MISALIGNMENT,~~ POSITIVE ACTION. PAR. 27	✓						
6	CHECK FOR NORMAL OPERATION. PAR. 11,12,13,14,	✓						

WEEKLY

NO.	ITEM	CONDITION	NO	ITEM	CONDITION
7	CLEAN AND TIGHTEN EXTERIOR OF ~~COMPONENTS AND~~ CASES~~,~~ ~~RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES,~~ AND CABLE CONNECTIONS.	✓	13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.~~	
8	INSPECT CASES, ~~MOUNTINGS, ANTENNAS, TOWERS,~~ AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE.	✓	14	~~CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.~~	
9	INSPECT CORD, CABLE, WIRE, ~~AND SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 27	✓	15	~~INSPECT METERS FOR DAMAGED GLASS AND CASES.~~	
10	~~INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS AND REFLECTORS.~~		16	~~INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHER-PROOFING.~~	
11	INSPECT ~~CANVAS ITEMS, LEATHER, AND~~ CABLING FOR MILDEW, TEARS, AND FRAYING.	✓	17	~~CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.~~	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, ~~POWER STATS, RELAYS, SELSYNS, MOTORS, BLOWERS,~~ CAPACITORS, ~~GENERATORS,~~ AND PILOT LIGHT ASSEMBLIES.	✓	18	~~CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT AND GREASE.~~	

19 IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.

DA FORM 1 MAY 51 11-238 REPLACES DA AGO FORM 419, 2 DEC 50, WHICH IS OBSOLETE.

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Figure 4. DA Form 11-238.

(2) Remove the spare fuse holder in the same manner.
(3) Replace the defective fuse with the spare.
(4) Press the fuse holder in the receptacle and turn clockwise.

b. Replacement of POWER Indicator Lamp.
(1) Turn the glass indicator jewel counterclockwise and pull out to expose the defective lamp.
(2) Press in on the lamp and turn it counterclockwise to unlock.
(3) Pull out the defective lamp and replace it with a new one. Push the lamp in and twist it clockwise to lock.

Section II. UNIT REPAIRMAN'S MAINTENANCE

30. Scope of Unit Repairman's Maintenance

a. Following is a list of maintenance duties performed by the unit repairman. The scope of these instructions has been determined by the available tools, materials, test equipment, spare parts, and the MOS of the unit repairman.

b. Unit repairman's maintenance of the oscilloscope consists of the following:
(1) Preventive maintenance (par. 32).
(2) Checking equipment performance (par. 34).
(3) Trouble shooting (par. 35).
(4) Replacement of defective tubes (par. 36).
(5) Replacement of defective scale lamps (par. 37*a*).
(6) Cathode-ray tube alinement (par. 37*b*).
(7) Hum adjustment (par. 37*c*).

31. Tools, Materials, and Test Equipment Required

The tools, materials, and test equipment required for unit repairman's maintenance are listed below.

a. Tools.
(1) Tool Equipment TE–41.
(2) Seven-pin and nine-pin tube pullers.

b. Materials.
(1) Cleaning Compound (Federal stock No. 7930–395–9542).
(2) Cleaning cloth.
(3) Fine sandpaper.

c. Test Equipment.
(1) Multimeter ME–77/(U).
(2) Electron Tube Test Set TV–7/U.

32. Unit Repairman's Preventive Maintenance

DA Form 11–239 (fig. 5) is a preventive maintenance checklist to be used by the unit repairman. Items not applicable to the equipment are lined out in the figure. References in the ITEM block in the figure are to paragraphs that contain additional maintenance information pertinent to the particular item. Instructions for the use of the form appear on the back of the form.

Warning: When power to the equipment is disconnected, some capacitors in the power supplies retain voltage of dangerous potential. Before touching exposed electrical parts, short-circuit the part to ground. When maintenance is completed, replace the equipment in its case, reconnect the power, and check for satisfactory operation.

33. Unit Repairman's Visual Inspection

Before operating the equipment, inspect it. This may save repair time and avoid further damage to the oscilloscope. Remove the case and inspect the following for defects:

a. The items listed in paragraph 28.

b. Connectors on terminal boards.

c. Anode and deflection plate connectors on crt (fig. 45).

d. The condition of the slow-blow fuses mounted in the main frame assembly (fig. 46).

34. Equipment Performance Checklist

a. General. The equipment performance checklist is a procedure to systematically check equipment performance. All corrective measures which the unit repairman can perform are given in the *corrective measures* column. When using the checklist, start at the beginning and follow each step in order. If the corrective measures shown do not repair the equipment, troubleshooting is required by a higher echelon. Note on the repair tag how the equipment performed and what corrective measures were taken.

b. Procedure. Place the oscilloscope in operation (pars. 12 and 13). Allow the equipment to warm up for 5 minutes. Operate the equipment as shown in the checklist in *c* below.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT
RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS.—See other side

EQUIPMENT NOMENCLATURE: OSCILLOSCOPE AN/USM-50 | EQUIPMENT SERIAL NO.: 152

LEGEND FOR MARKING CONDITIONS: ✓ *Satisfactory;* X *Adjustment, repair, or replacement required;* ⊗ *Defect corrected*
NOTE. *Strike out items not applicable*

NO.	ITEM	CONDITION	NO.	ITEM	CONDITION
1	COMPLETENESS AND GENERAL CONDITION OF EQUIPMENT ~~*(receiver, transmitter, carrying cases, wire and cable, microphones, tubes, spare parts, technical manuals, and accessories).*~~ PAR 5	✓	19	~~ELECTRON TUBES. INSPECT FOR LOOSE ENVELOPES, CAP CONNECTORS, CRACKED SOCKETS, INSUFFICIENT SOCKET SPRING TENSION. CLEAN DUST AND DIRT CAREFULLY. CHECK EMISSION OF RECEIVER TYPE TUBES.~~	
2	~~LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION.~~		20	~~INSPECT FILM CUTOUTS FOR LOOSE PARTS, DIRT, MISALINEMENT, AND CORROSION.~~	
3	CLEAN DIRT AND MOISTURE FROM ~~ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS,~~ JACKS, PLUGS, ~~TELEPHONES, CARRYING BAGS, COMPONENT PANELS.~~	✓	21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION.	✓
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, ~~CRYSTALS,~~ FUSES, CONNECTORS, ~~VIBRATORS, PLUG-IN COILS,~~ AND RESISTORS.	✓	22	~~INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS, BURNED, PITTED, CORRODED CONTACTS, MISALINEMENT OF CONTACTS AND SPRINGS, INSUFFICIENT SPRING TENSION, BINDING OF PLUNGERS AND HINGE PARTS.~~	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, ~~WORN OR CHIPPED GEARS, MISALINEMENT,~~ POSITIVE ACTION. PAR 27	✓	23	~~INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALINEMENT OF PLATES, AND LOOSE MOUNTINGS.~~	
6	CHECK FOR NORMAL OPERATION. PAR 11,12,13,14.	✓	24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION, AND MOISTURE.	✓
7	CLEAN AND TIGHTEN EXTERIOR OF ~~COMPONENTS AND~~ CASES, ~~RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES,~~ AND CABLE CONNECTIONS.	✓	25	~~INSPECT~~ TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT, AND LOOSE CONTACTS.	✓
8	INSPECT CASES, ~~MOUNTINGS, ANTENNAS, TOWERS,~~ AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE.	✓	26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, ~~BLOWERS, RELAY CASES,~~ AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE.	✓
9	INSPECT CORD, CABLE, WIRE, ~~AND SHOCK MOUNTS~~ FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR 27	✓	27	INSPECT TERMINAL BLOCKS FOR LOOSE CONNECTIONS. CRACKS, AND BREAKS.	✓
10	~~INSPECT ANTENNA FOR ECCENTRICITIES, CORROSION, LOOSE FIT, DAMAGED INSULATORS, AND REFLECTORS.~~		28	~~CHECK SETTINGS OF ADJUSTABLE RELAYS.~~	
11	INSPECT ~~CANVAS ITEMS, LEATHER, AND~~ CABLING FOR MILDEW, TEARS, AND FRAYING.	✓	29	~~LUBRICATE EQUIPMENT IN ACCORDANCE WITH APPLICABLE DEPARTMENT OF THE ARMY LUBRICATION ORDER.~~	
12	INSPECT FOR LOOSENESS OF ACCESSIBLE ITEMS: SWITCHES, KNOBS, JACKS, CONNECTORS, ELECTRICAL TRANSFORMERS, ~~POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS,~~ CAPACITORS, ~~GENERATORS,~~ AND PILOT LIGHT ASSEMBLIES.	✓	30	~~INSPECT GENERATORS, AMPLIDYNES, DYNAMOTORS, FOR BRUSH WEAR, SPRING TENSION, ARCING, AND FITTING OF COMMUTATOR.~~	
13	~~INSPECT STORAGE BATTERIES FOR DIRT, LOOSE TERMINALS, ELECTROLYTE LEVEL AND SPECIFIC GRAVITY, AND DAMAGED CASES.~~		31	CLEAN AND TIGHTEN CONNECTIONS AND MOUNTINGS FOR TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS.	✓
14	~~CLEAN AIR FILTERS, BRASS NAMEPLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.~~		32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING ~~AND OIL LEAKAGE.~~	✓
15	~~INSPECT METERS FOR DAMAGED GLASS AND CASES.~~		33	~~BEFORE SHIPPING OR STORING, REMOVE BATTERIES.~~	
16	~~INSPECT SHELTERS AND COVERS FOR ADEQUACY OF WEATHERPROOFING.~~		34	INSPECT CATHODE RAY TUBES FOR BURNT SCREEN SPOTS.	✓
17	~~CHECK ANTENNA GUY WIRES FOR LOOSENESS AND PROPER TENSION.~~		35	~~INSPECT BATTERIES FOR SHORTS AND DEAD CELLS.~~	
18	~~CHECK TERMINAL BOX COVERS FOR CRACKS, LEAKS, DAMAGED GASKETS, DIRT, AND GREASE.~~		36	~~INSPECT FOR LEAKING WATERPROOF GASKETS, WORN OR LOOSE PARTS.~~	
			37	~~MOISTURE AND FUNGIPROOF.~~	
38	IF DEFICIENCIES NOTED ARE NOT CORRECTED DURING INSPECTION, INDICATE ACTION TAKEN FOR CORRECTION.				

DA FORM 1 MAY 51 11-239 Replaces DA AGO Form 419, 1 Dec 50, which is obsolete. 4—10—54183-2

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Figure 5. DA Form 11–239.

c. Equipment Performance Checklist.

Step	Action	Normal indication	Corrective measures
1	Turn POWER on.	POWER indicator lights.	Check F101, F102 (par. 29*a*). Check I403 (par. 29*b*). Check power cord. Check POWER switch.
2	Rotate BRILLIANCE control.	Spot appears on screen of crt and increases in intensity with clockwise rotation.	Check V301, V302, V303 (fig. 8 and par. 36). Check F301 (fig. 41). Check anode connector (fig. 45). Check for 400 volts at terminal 9 of E201 (fig. 37). Check V804 (fig. 10).
3	Rotate SCALE ILLUMINATION control.	Scale is visible on screen of crt.	Replace scale lamps (par. 37*a*). Check for 6.3 volts ac at terminal 6 of E801 and ground (fig. 10). Higher echelon repair required.
4	Rotate FOCUS control.	Spot focuses around midpoint.	Check V802 through V813 (fig. 10). Higher echelon repair required.
5	Rotate VERTICAL POSITIONING control.	Spot moves up and down.	Check V108, V109, V110, V111 (fig. 6). Check for −150 volts from terminal 15 of E801 and ground and adjust R806 if necessary (fig. 10). Check V803, V805, V806 (fig. 10).
6	Rotate HORIZONTAL POSITIONING control.	Spot moves left and right.	Check V213 (fig 7). Check for 200 volts between terminal 9 of E801 and ground and adjust R815 if necessary (fig. 10). Check V802, V808 (fig. 10).
7	Rotate STABILITY control.	Spot changes into line extending off crt screen to right.	Check V207 (fig. 7). Check for −150 volts from terminal 8 of E201 and ground (fig. 6) and adjust R806 if necessary (fig. 10). Check V803, V805, V806 (fig. 10). Higher echelon repair required.
8	Set up controls for recurrent sweep (par. 14*a*).	Line extends off screen of crt to right.	Check V207, V208, V209, V210, V211, V212, and V213 (fig. 7). Higher echelon repair required.
9	Same as step 8: rotate MULTIPLIER switch to CAL; VERTICAL GAIN maximum clockwise; CALIBRATION VOLTAGE dial clockwise.	Square wave appears on screen and varies in amplitude as the CALIBRATION VOLTAGE dial is rotated.	Check V801, V802, V812 (fig. 10). Check V101 through V111 (fig. 6). Check for 30 volts dc at J802 (fig. 10). Higher echelon repair required.
10	Turn SWEEP TIME switch to each MICROSECOND position consecutively and adjust SWEEP TIME FINE control for square wave.	Number of square waves increases with clockwise rotation of switch and decreases with counterclockwise rotation of control.	Same as steps 8 and 9. Higher echelon repair required (par. 57*d*).
11	Same as step 8: rotate MARKER switch to .2 microsecond position.	Bright dots appear superimposed on trace of crt. Clockwise rotation decreases number of dots.	Check V501, V502, V503 and V504 (fig. 9). Higher echelon repair required.
12	Same as step 8: rotate TRIGGER RANGE switch to X1 position; connect coaxial cable between TRIGGER OUTPUT POSITIVE and SIGNAL INPUT connectors; set MULTIPLIER switch to 1.	Trigger pulses appear on screen of crt. Clockwise rotation of RANGE switch and RATE dial decreases number of pulses.	Check V201, V202, V203, V204, V205 and V206 (fig. 7). Higher echelon repair required.

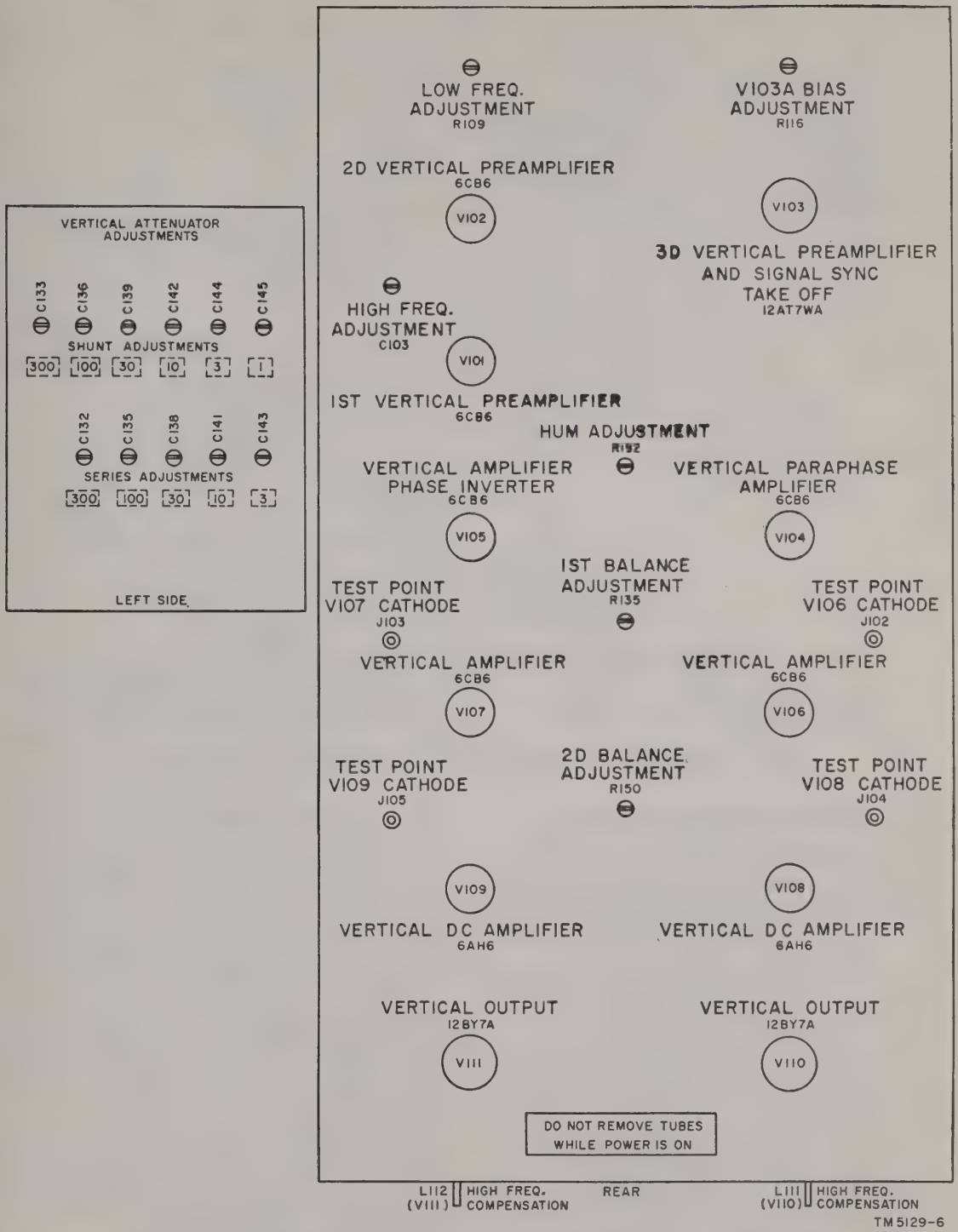


Figure 6. Tube locations, test points, and adjustments, vertical attenuator and amplifier chassis.

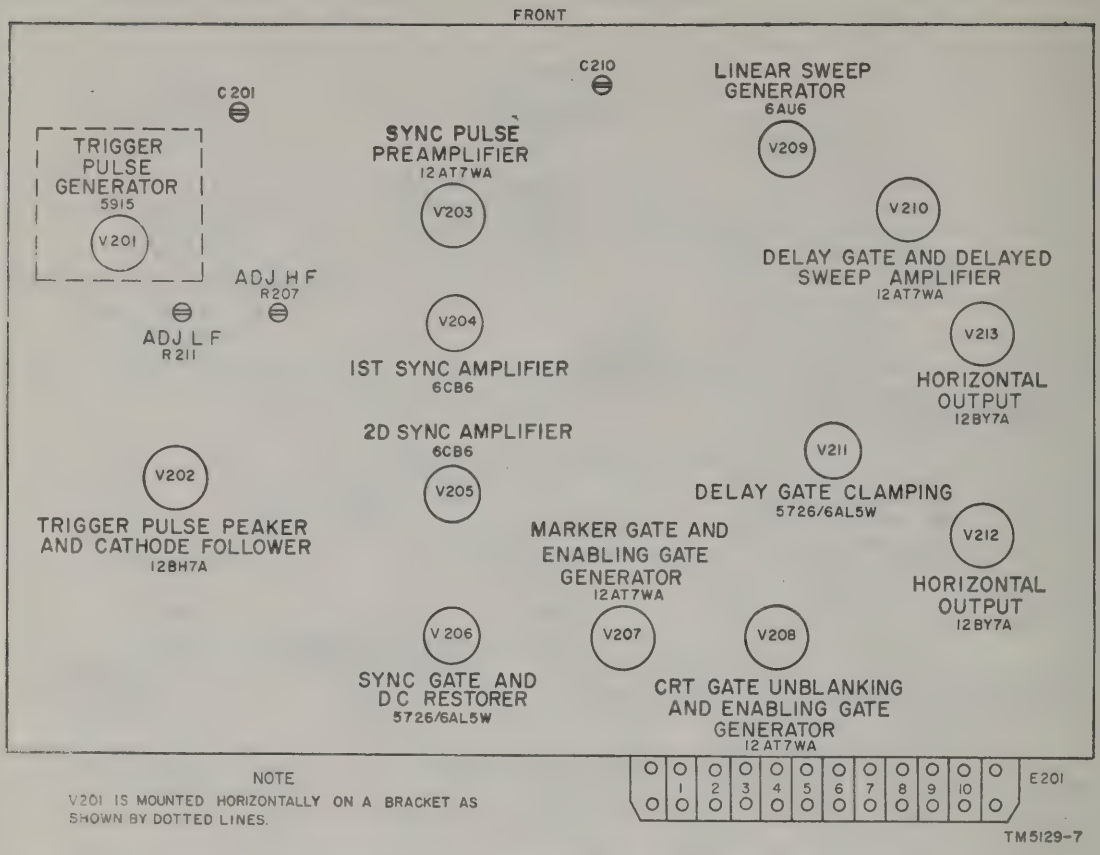


Figure 7. Tube locations and adjustments, sweep generator and trigger generator chassis.

35. Unit Repairman's Troubleshooting

a. Attenuator Check.

(1) Connect one of the coaxial cables, supplied with the equipment, between the SIGNAL INPUT and CAL VOLTAGE OUTPUT connectors.

(2) Set the MULTIPLIER switch to VERT PL.

(3) Turn the SWEEP TIME switch off.

(4) Two spots should be visible on the screen, separated by 16 divisions on the illuminated scale.

(5) Turn the MULTIPLIER switch to 300.

(6) Turn the VERTICAL GAIN control maximum counterclockwise.

(7) Turn the SWEEP TIME switch to 10,000.

(8) Turn the SWEFP TIME FINE control maximum clockwise.

(9) Turn the MARKER switch to Z AXIS ON.

(10) Adjust the STABILITY control for maximum length of pattern (par. 14*a*).

(11) Adjust the HORIZONTAL POSITIONING control so that the left end of the image coincides with the left edge of the illuminated scale.

(12) Approximately 7 cycles of a symmetrical square wave will be visible, with an amplitude of 15 divisions. (See wave form E, fig. 26).

(13) Rotate the MULTIPLIER switch counterclockwise. The image increases in amplitude at each step. Reduce the gain with the VERTICAL GAIN control.

b. Horizontal Amplifier Check.

(1) Set up the equipment for recurrent mode as described in paragraph 14*a*.

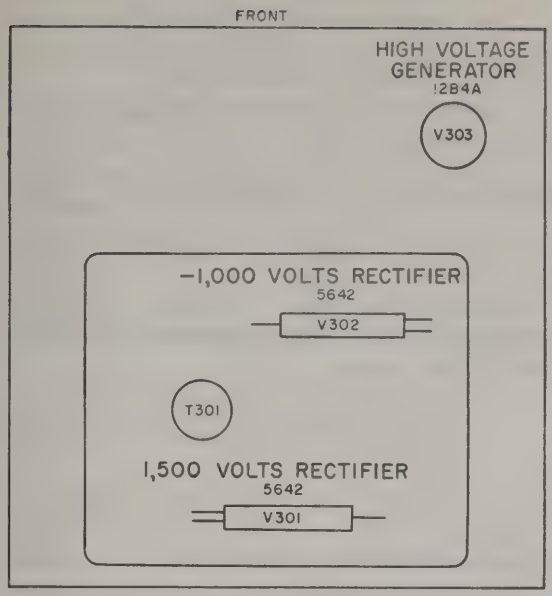


Figure 8. Tube locations, high-voltage power supply chassis.

(2) Measure the ac output at the HORIZONTAL AMPLIFIER OUTPUT connector. The open-circuit sweep voltage should be about 150 volts.

c. Sweep Time Circuit Check. Set the following controls to the positions indicated below:

(1) MULTIPLIER switch to 1.
(2) VERTICAL GAIN control maximum clockwise.
(3) SWEEP TIME switch to 10,000.
(4) SWEEP TIME FINE control maximum clockwise.
(5) SCALE ILLUMINATION control maximum counterclockwise.
(6) Adjust the STABILITY control for a horizontal trace with maximum sweep length (par. 14*a*).
(7) Adjust the HORIZONTAL POSITIONING control until the left end of the trace is visible at the left edge of the screen.
(8) Turn the MARKER switch to 2,000.
(9) Adjust the SWEEP TIME FINE control so that 5 dots appear between the left end of the trace and the right edge of the screen.

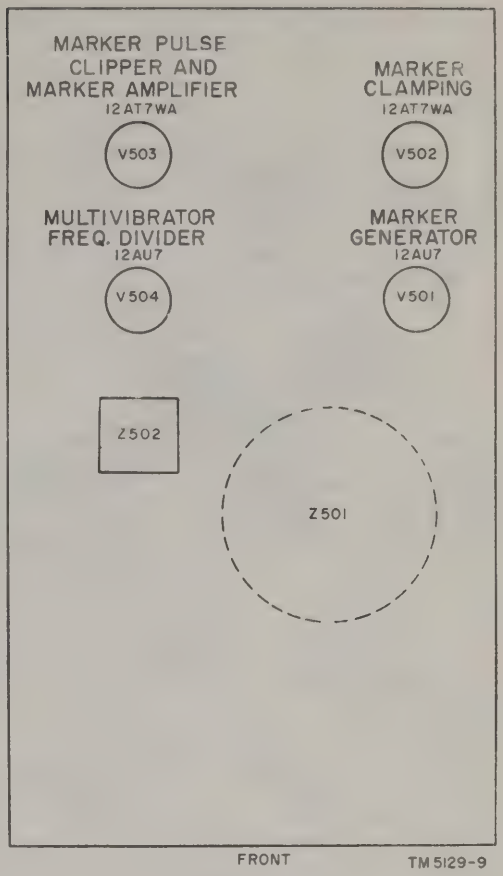


Figure 9. Tube locations, marker generator chassis.

(10) Turn the SWEEP TIME switch to 1,000.
(11) Adjust the SWEEP TIME FINE control so that 2 dots are visible, one at each edge of the screen. This indicates a 2,000-microsecond interval across the screen.

d. Sweep Delay Check. Set the following controls to the positions indicated below:

(1) TRIGGER RATE switch to 10,000 (set RATE at 100 and RANGE at X100).
(2) MARKER switch to 20 microseconds.
(3) HORIZONTAL POSITIONING control so that the sweep starts just beyond left edge of tube.
(4) SWEEP DELAY switch to OUT.
(5) SWEEP DELAY INCREASE control to midpoint.
(6) SYNC selector switch to INT TRIG.
(7) SWEEP TIME switch to 10.

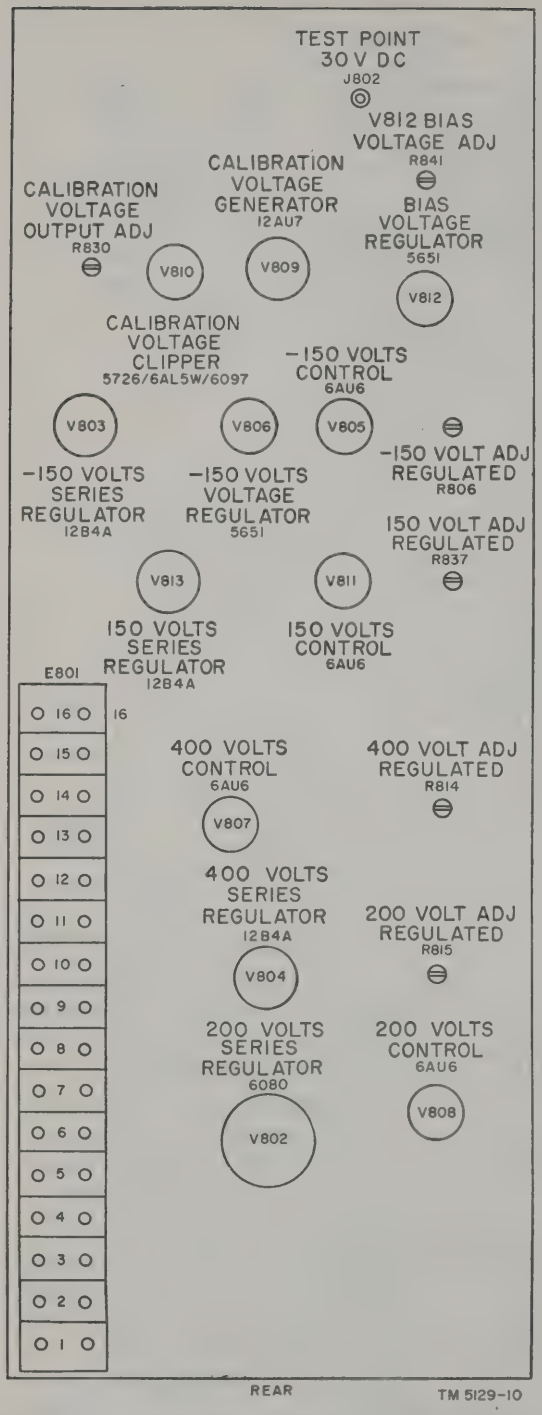


Figure 10. Tube locations, test points, and adjustments, low-voltage power supply and calibration generator chassis.

(8) Adjust the SWEEP TIME FINE control so that 3 dots (40 microseconds) equal 30 divisions on horizontal scale.

(9) Turn the SWEEP DELAY switch to IN.

(10) Turn the MARKER switch to 1.

(11) Vary the INCREASE control. The fastest portion of the expanded sweep should include less than four 1-microsecond markers in the 30 divisions.

e. SYNC Circuit Check. To perform the SYNC circuit check, set the following controls to the positions indicated below:

(1) Connect the coaxial cable between the SIGNAL INPUT and the SYNC INPUT connectors.

(2) MARKER switch to the Z AXIS ON position.

(3) MULTIPLIER switch to 1.

(4) VERTICAL GAIN control maximum clockwise.

(5) SWEEP DELAY switch to OUT.

(6) SWEEP TIME switch to 10,000.

(7) SWEEP TIME FINE control maximum clockwise.

(8) TRIGGER RATE dial to 10.

(9) TRIGGER RANGE switch to X100.

(10) Adjust the STABILITY control for maximum length of sweep (par. 14*a*).

(11) Turn the SYNC selector switch to all positions; trigger pulses will appear on the screen in all positions of the switch, with varying amplitudes (wave form K, fig. 26).

f. Trigger Circuit Check. To perform the trigger circuit check, set the following controls to the positions indicated below:

(1) Connect the coaxial cable between the SIGNAL INPUT and the TRIGGER OUTPUT POSITIVE connectors.

(2) MULTIPLIER switch to 300.

(3) VERTICAL GAIN control maximum counterclockwise.

(4) SWEEP TIME switch to 10,000.

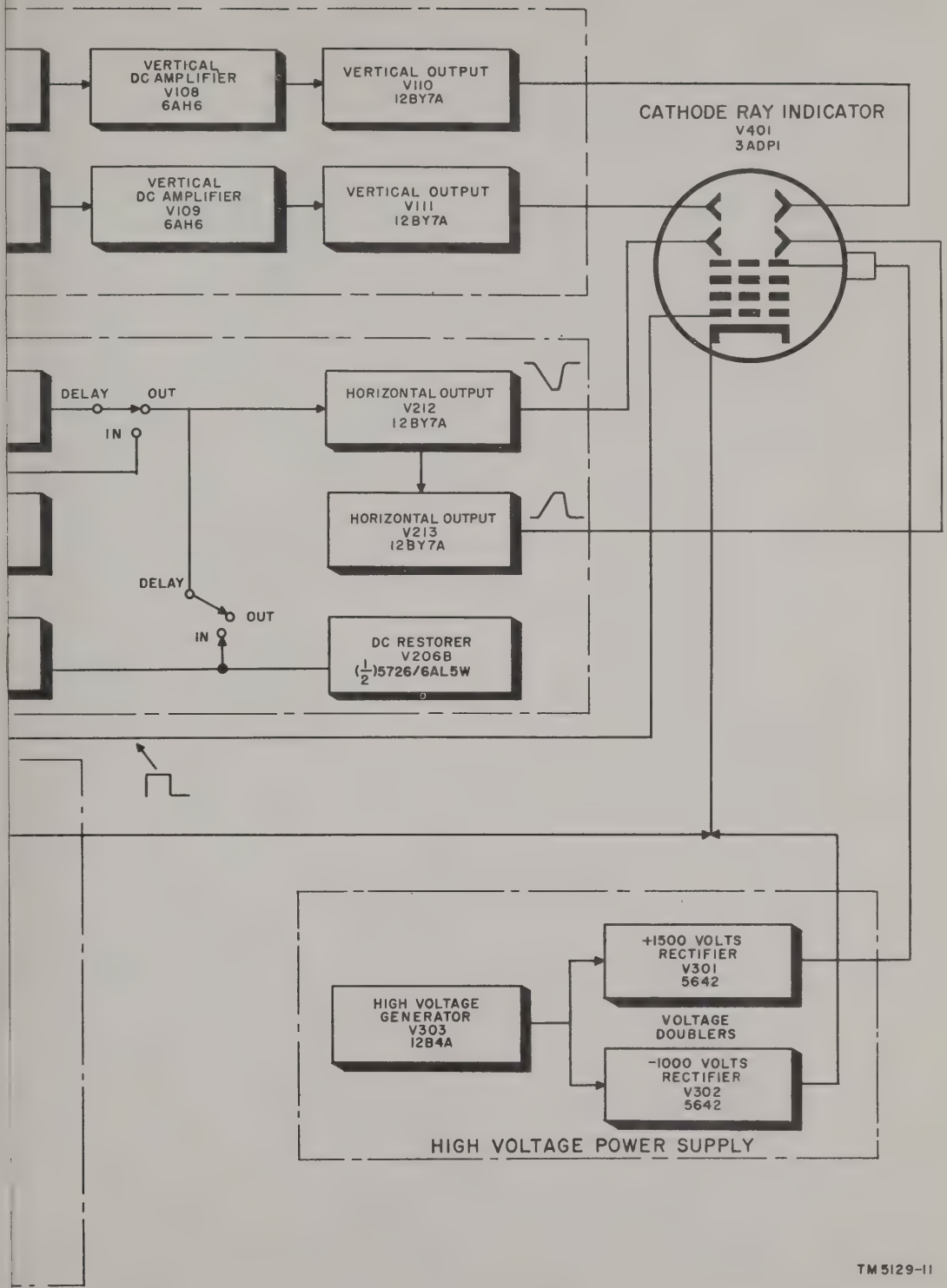
(5) SWEEP TIME FINE control maximum clockwise.

(6) MARKER switch to Z AXIS ON.

(7) TRIGGER RATE dial to 10.

(8) TRIGGER RANGE switch to X100.

(9) Adjust the STABILITY control for maxi-


VERTICAL DC AMPLIFIER V108 6AH6
VERTICAL OUTPUT V110 12BY7A
VERTICAL DC AMPLIFIER V109 6AH6
VERTICAL OUTPUT V111 12BY7A
CATHODE RAY INDICATOR V401 3ADP1
DELAY
OUT
IN
HORIZONTAL OUTPUT V212 12BY7A
HORIZONTAL OUTPUT V213 12BY7A
DELAY
OUT
IN
DC RESTORER V206B (1/2)5726/6AL5W
+1500 VOLTS RECTIFIER V301 5642
HIGH VOLTAGE GENERATOR V303 12B4A
VOLTAGE DOUBLERS
-1000 VOLTS RECTIFIER V302 5642
HIGH VOLTAGE POWER SUPPLY

TM 5129-11

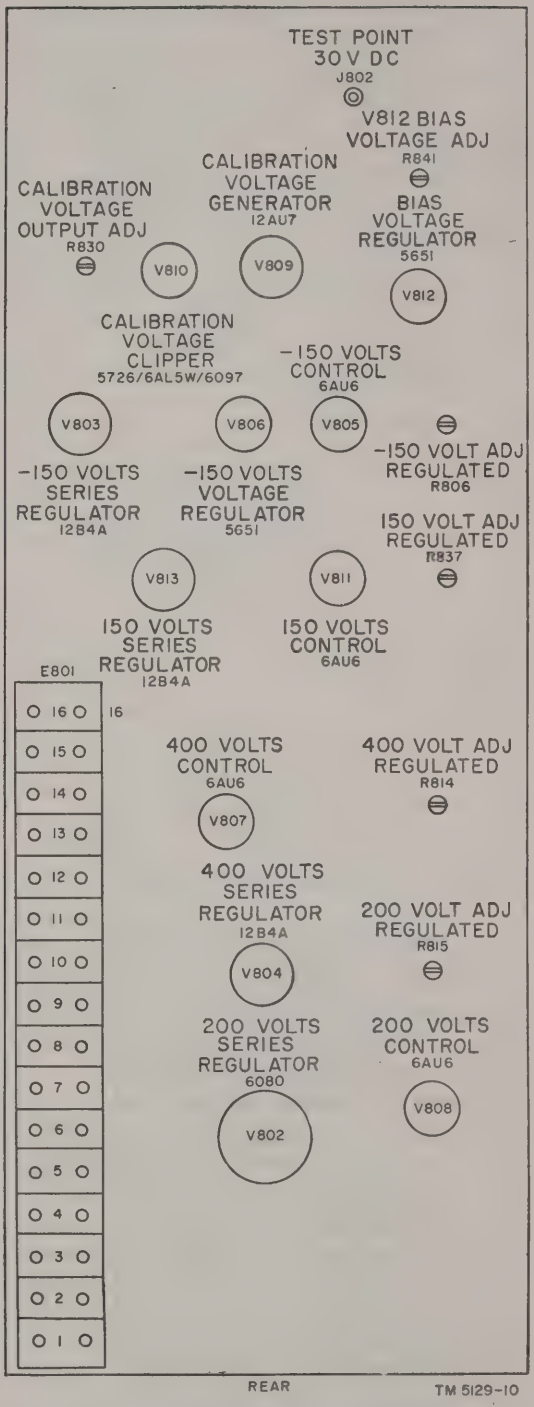


Figure 10. Tube locations, test points, and adjustments, low-voltage power supply and calibration generator chassis.

(8) Adjust the SWEEP TIME FINE control so that 3 dots (40 microseconds) equal 30 divisions on horizontal scale.

(9) Turn the SWEEP DELAY switch to IN.

(10) Turn the MARKER switch to 1.

(11) Vary the INCREASE control. The fastest portion of the expanded sweep should include less than four 1-microsecond markers in the 30 divisions.

e. SYNC Circuit Check. To perform the SYNC circuit check, set the following controls to the positions indicated below:

(1) Connect the coaxial cable between the SIGNAL INPUT and the SYNC INPUT connectors.

(2) MARKER switch to the Z AXIS ON position.

(3) MULTIPLIER switch to 1.

(4) VERTICAL GAIN control maximum clockwise.

(5) SWEEP DELAY switch to OUT.

(6) SWEEP TIME switch to 10,000.

(7) SWEEP TIME FINE control maximum clockwise.

(8) TRIGGER RATE dial to 10.

(9) TRIGGER RANGE switch to X100.

(10) Adjust the STABILITY control for maximum length of sweep (par. 14*a*).

(11) Turn the SYNC selector switch to all positions; trigger pulses will appear on the screen in all positions of the switch, with varying amplitudes (wave form K, fig. 26).

f. Trigger Circuit Check. To perform the trigger circuit check, set the following controls to the positions indicated below:

(1) Connect the coaxial cable between the SIGNAL INPUT and the TRIGGER OUTPUT POSITIVE connectors.

(2) MULTIPLIER switch to 300.

(3) VERTICAL GAIN control maximum counterclockwise.

(4) SWEEP TIME switch to 10,000.

(5) SWEEP TIME FINE control maximum clockwise.

(6) MARKER switch to Z AXIS ON.

(7) TRIGGER RATE dial to 10.

(8) TRIGGER RANGE switch to X100.

(9) Adjust the STABILITY control for maxi-

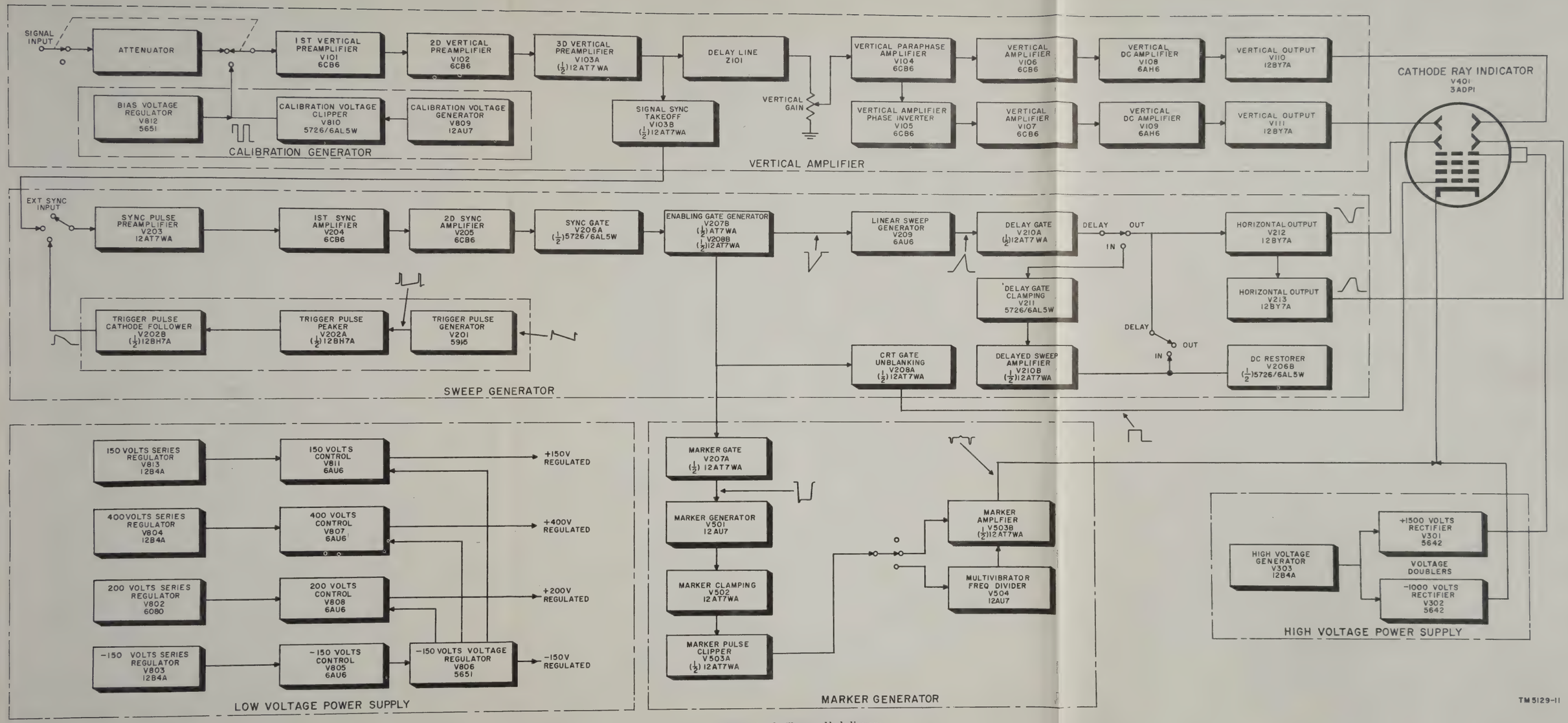


Figure 11. Oscilloscope, block diagram.

mum length of sweep. Approximately 8 cycles of wave form K, figure 26, will extend across the illuminated scale, with a maximum amplitude of 17 divisions. To clarify the narrow positive-going spikes, turn up the BRILLIANCE control.

(10) Disconnect the cable from the TRIGGER OUTPUT POSITIVE and connect the cable between the SIGNAL INPUT and TRIGGER OUTPUT NEGATIVE connectors. A wave form similar to the positive trigger pulse will appear, but inverted.

(11) Turn the TRIGGER RATE dial clockwise; the number of pulses should increase.

(12) Turn the TRIGGER RANGE switch counterclockwise; the number of pulses should decrease.

(13) Set the MARKER switch to 500. Five dots will appear across the screen.

(14) Set the SWEEP TIME switch to 100 and the MARKER switch to 100. Three dots will appear across the screen.

(15) Set the MARKER switch to 20. 12 dots will appear.

(16) Set the SWEEP TIME switch to 10, and the MARKER switch to 5. Five dots will appear on the screen.

(17) Set the MARKER switch to 1, and the SWEEP TIME switch to 1. Two dots will appear on the screen.

(18) Set the MARKER switch to .2, and 8 dots will appear.

Note. To remove the horizontal trace and permit easier counting of the marker dots, turn the BRILLIANCE control slowly counterclockwise.

g. Marker Circuit Check. To perform the marker circuit check, set the following controls to the positions indicated below:

(1) Connect the coaxial cable between the SIGNAL INPUT and the Z AXIS-INTENSITY MODULATION connectors.

(2) MULTIPLIER switch to 300.

(3) VERTICAL GAIN control maximum counterclockwise.

(4) SWEEP TIME switch to 10,000.

(5) SWEEP TIME FINE control maximum clockwise.

(6) MARKER switch to 2,000.

(7) Adjust the STABILITY control for maximum length of sweep (par. 14*a*). Approximately 4 cycles of wave form D, figure 26, will extend across the illuminated scale with an amplitude of 9 divisions.

36. Tube Testing Techniques

When tube failure is suspected try to isolate the trouble to a stage of an assembly. Use the applicable procedure below to check the tubes.

Caution: Turn off power before removing tubes. Do not rock or rotate a tube when removing it from a socket; pull it straight out with a tube puller.

a. Use of Tube Tester. Remove and test one tube at a time. Discard a tube only if its defect is obvious or if the tube tester shows it to be defective. Do not discard a tube that tests at or near its minimum test limit on the tube tester. Put back the original tube, or a new one if required, before testing the next one.

b. Tube Substitution Method. Replace a suspected tube with a new tube. If the equipment remains inoperative, remove the new tube and put back the original tube. Repeat this procedure with each suspected tube until the defective tube is located.

c. Subminiature Tubes. Inability to focus the beam, and blooming of the beam when the BRILLIANCE control is turned up, is usually due to insufficient high voltage. Remove the shield from the high-voltage power supply chassis and inspect the subminiature tubes for gas as indicated by a blue glow. Shut off the power and discharge the filter capacitors before replacing or removing the suspected tube. Remove the flexible leads from their sockets carefully and avoid bending them.

d. Preferred Type Tubes. A preferred-type electron tube, type 6AU6WGA, has been developed as a direct replacement for nonpreferred type 6AU6. When replacement of a 6AU6 type tube is necessary, replace it with a 6AU6WGA.

37. Unit Repairman's Repairs and Adjustments

a. Replacement of Defective Scale Lamps.

(1) Turn the POWER switch to OFF.

(2) Remove the four screws that hold the scale illumination assembly to the main frame (fig. 45).

(3) Turn the assembly over carefully and observe the placement of the calibrated scale.

(4) Remove the scale and wrap in lint-free cloth.

(5) Press in on the defective lamp and twist counterclockwise. Pull out the lamp.

(6) Insert the pin of the new lamp in the slot of the socket, press in and twist clockwise.

(7) Clean the calibrated scale and replace the scale lamp.

(8) Attach the assembly loosely to the main frame.

(9) Turn on the power to the equipment.

(10) Rotate the SCALE ILLUMINATION control clockwise, until the scale is visible on the screen of the crt.

(11) Turn the MULTIPLIER switch to the CAL position and adjust the controls for an image on the screen. The parallel calibration lines must be parallel to the scale, and there must be no parallax between the scale and the image.

(12) Adjust the position of the scale lamp assembly to correct conditions in (11) above. If parallax is still present, proceed with the following adjustment.

b. Cathode-Ray Tube Alinement (fig. 45).

(1) Loosen the base clamp of the cathode-ray tube.

(2) Move the cathode-ray indicator assembly axially to correct the parallax.

(3) Rotate the assembly to line up the scale lines with the image.

(4) Tighten the base clamp.

c. Hum Adjustment. If V101 or V102 is replaced, it is necessary to adjust R192 (fig. 34) to eliminate line frequency ripple from the trace. Allow equipment to warm up for 20 minutes and set the controls as indicated below:

(1) SWEEP TIME switch, 10,000.

(2) SWEEP TIME FINE control, maximum counterclockwise.

(3) SYNC selector switch, INT TRIG.

(4) SYNC polarity control, maximum +.

(5) TRIGGER RATE, 50 cycles per second (cps).

(6) MULTIPLIER, 300.

(7) VERTICAL GAIN, midpoint.

(8) Adjust R192 (fig. 34) until no ripple is visible on trace.

(9) Recheck with VERTICAL GAIN control at maximum.

d. Removal of Case. The case is attached by eight oval head screws and cup washers located at the sides of the front panel, four binding head screws at the rear of the case, and two binding head screws at the bottom of the case.

e. Removal of Vertical Attenuator and Vertical Amplifier Chassis (figs. 33, 34, and 45).

(1) Remove the knobs from the MULTIPLIER and VERTICAL GAIN control shafts.

(2) Unsolder the coaxial cable from the insulated terminal on the vertical amplifier chassis (fig. 34).

(3) Remove the leads from E402, E403, and E404 (fig. 46) on the adjacent side walls of the main frame. Tag the wires so they can be replaced correctly.

(4) Unplug the insulated leads to the vertical deflection plates of the cathode-ray tube (red and orange).

(5) Remove the four screws from the coaxial SIGNAL INPUT connector (fig. 3) and free the connector from the front panel.

(6) Remove the seven binding head screws that secure the chassis to the front panel and the six screws that secure it to the frame.

(7) Lift the chassis from the frame.

f. Removal of Sweep Generator Chassis (figs. 37, 38 and 39).

(1) Turn the TRIGGER RATE dial fully clockwise, and scratch a small mark on the dial opposite the stationary index line. This will serve to relocate the dial on the shaft when it is replaced.

(2) Remove the knobs from the SWEEP DELAY switch, the SWEEP DELAY INCREASE control, the SWEEP TIME switch, the SWEEP TIME FINE control, the SYNC selector switch, the SYNC polarity control, the STABILITY control, the TRIGGER RATE control, the TRIGGER RANGE switch, and the HORIZONTAL AMPLIFIER GAIN control shafts.

(3) Unsolder and tag the coaxial cable from the terminal on the vertical amplifier

chassis, and the two soldered connections at the rear of the sweep chassis.

(4) Disconnect and tag the nine leads from terminal strip E201 at the rear, and the four leads on the high-voltage power supply.

(5) Carefully unsnap the two connections to the crt.

(6) Remove the 16 screws that secure the chassis to the front panel and the frame.

(7) Slide the chassis to the rear and lift out the chassis.

g. Removal of Low-Voltage Rectifier Chassis.

(1) Tag and disconnect all the leads to terminal board E601 (fig. 43).

(2) Remove the four screws that secure the chassis to the main frame, and lift out the chassis.

h. Removal of Low-Voltage Power Supply and Calibration Chassis (fig. 44).

(1) Turn the CALIBRATION VOLTAGE dial fully clockwise and scratch a small mark on the dial opposite the stationary index line. This will serve to relocate the dial on the shaft when it is replaced.

(2) Remove the dial from the shaft.

(3) Unsolder the lead from the MULTIPLIER switch.

(4) Disconnect the 15 leads from terminal board E801.

(5) Remove the seven screws that hold the chassis to the frame and lift the chassis out.

CHAPTER 4

THEORY

38. Block Diagram Analysis

(fig. 11)

The oscilloscope can amplify and display voltage wave forms within a frequency range of 3 cycles to 15 mc. A self-contained calibration generator provides an accurate measurement of the peak-to-peak amplitude of the images. The pulse width and rise time of square waves and transients can be determined from the markers produced by the marker generator. A sweep delay circuit enables the sweep to be expanded 10 times for easier measurement of dissimilar wave trains. A high-voltage power supply delivers 2,500 volts to the crt. A regulated low-voltage supply maintains circuit potentials constant within a wide range of line voltage variations.

a. The voltage wave form to be analyzed is supplied to the SIGNAL INPUT connector. A constant-impedance attenuator is provided between the signal input and V101, the first vertical preamplifier. The signal is further amplified by V102 and V103A, the second and third vertical preamplifiers. A portion of the signal is supplied to the synchronization circuit through V103B for locking-in the sweep generator with the input signal. A delay line, Z101, follows V103A. The signal is delayed so that the start of the sweep can occur before the leading edge of the pulse reaches the grid of the crt. The VERTICAL GAIN control provides attenuation of the signal which then passes through a series of push-pull vertical amplifiers V104 through V111, before being applied to the vertical deflection plates of the crt.

b. The SYNC selector switch (fig. 3) selects the synchronization best suited for the type of voltage wave form being observed, external, internal trigger, or signal, and supplies it to a series of amplifiers, V203, V204, and V205. The amplified sync pulse is passed through V206A which cuts off any further sync pulses until the operation cycle of the enabling gate generator has been completed. Tubes V207B and V208B make up a multivibrator that produces the enabling gates for the cathode-ray tube grid through V208A, for the marker generator through V207A, and linear sweep generator V209. Tube V209 produces the linear sawtooth voltage which is amplified by horizontal output tubes V212 and V213, and then applied to the horizontal deflection plates of the crt. A delay circuit that consists of V201A, V211, and V210B, and V206B can be switched in to expand any 10 percent of the sweep for more detailed analysis of the voltage wave form.

c. Tube V201 operates as an oscillator to produce a sharp trigger pulse. This pulse is peaked by V202A and is coupled to the sync circuit through cathode follower V202B.

d. The high-voltage power supply furnishes 2,500 volts to the accelerator anode. Tube V303 operates as a Colpitts oscillator to generate the high-frequency, high-voltage ac. This voltage is applied to two rectifiers V301 and V302 connected as voltage doublers. Rectifier V302 supplies the −1,000 volts to the cathode of the crt, and V301 rectifies and supplies the +1,500 volts to the accelerator anode.

e. Tube V501 operates as a Hartley oscillator and generates marker pulses that are clamped by V502, clipped by V503A, and amplified by V503B before being applied to the cathode of the cathode-ray tube. The marker pulses appear as bright dots on the screen. Tube V504 is a frequency divider and produces 2,000 microsecond markers from the 500 microsecond pulses.

f. The low-voltage power supply produces all of the regulated direct-current (dc) voltages. The regulated voltages are −150, 400, 310, 200, 150, and 145 volts. The −150-volt supply consists of V803, the series regulator, V805, the control tube, and V806, the voltage regulator. Tube V806 also serves as a reference voltage for the 400-, 200-, and 150-volt supplies. The 400-volt supply consists of V804, the series regulator, and V807, the control tube. The 200-volt supply consists of V802, the series regulator,

and V808, the control tube. The 150-volt supply consists of V813, the series regulator, and V811, the control tube.

g. Tube V809 operates as a multivibrator to produce the 1,000-cycle calibration voltage. This voltage is formed into a symmetrical square wave by V810. A stable reference voltage for maintaining the constant-amplitude calibration voltage is provided by V812.

39. Vertical Attenuator and Probe

(fig. 12)

a. The input signal applied to the probe is attenuated to one tenth of its original value by a series limiting network consisting of a 9-megohm resistor shunted by a .1 −10 micromicrofarad ($\mu\mu$f) variable capacitor. The output of the probe is applied through dc blocking capacitor C146 to a step attenuator that consists of MULTIPLIER switch S101 with eight positions. The extreme counterclockwise position (VERT PL) connects the SIGNAL INPUT connector to one of the vertical deflection plates (pin 6) of the crt through contacts 7 and 11 of S101B and contacts 1 and 3 of S101D. The next clockwise position (CAL) connects the internal calibration voltage to the grid of the first vertical preamplifier stage through contacts 12 and 7 of S101A. The next six positions provide attenuation in steps of 1, 3, 10, 30, 100, and 300 times.

b. In position 1 of MULTIPLIER switch S101 the signal is not attenuated. It is applied through C146, through contacts 7 and 1 of S101B, and contacts 1 and 7 of S101A. Resistor R190 and C145 provide the correct impedance to the input signal. In position 3, the signal is applied through contacts 7 and 2 of S101B, through an attenuating network consisting of C153, C144, R189, C143, R188, and C151 and then through contacts 2 and 7 of S101A. The remaining positions of the MULTIPLIER switch provide higher attenuation through appropriate sections of S101B and S101A. The attenuating networks for these positions serve the same purpose as the one described for position 3 except that the degree of attenuation is increased.

40. Vertical Preamplifiers

(fig. 13)

a. The output from the vertical attenuator is applied to the grid of the first vertical preamplifier tube V101. Resistor R101 is the grid resistor, while R102 isolates the grid from short-duration noise pulses. The tube is biased by the cathode current that flows through R105, which is unbypassed to provide degeneration for improving frequency response. The plate load consists of R104, L101, and R103 in series. Resistor R104 is small to provide a wide band pass, L101 is a peaking coil which improves the high-frequency response, and R103, together with C104 and C107, improves the low-frequency response through low-frequency compensation. Resistor R106 is a screen grid isolating resistor and C101 is the screen grid bypass.

b. The signal voltage is coupled from the plate of V101 to the grid of V102 through C105. Resistors R108 and R109 make up the grid resistance for V102, the second vertical preamplifier, while R110 is the grid isolating resistor. Resistor R109 is variable and improves the low-frequency response. Tube V102 is biased by the cathode current that flows through R113. Resistor R107 together with C102 and C103 provides current feedback for improving the high-frequency response. The voltage developed across this network provides additional bias for V101. The capacitors across R107 cause more degeneration at low frequencies because the higher frequencies are bypassed by C102 and C103. Capacitor C103 is variable and is used to adjust the feedback for best high-frequency compensation. The plate load for V102 consists of R112 and L102 in series, and serves the same purpose as R104 and L101. Resistor R111 is the screen grid resistor and C106 is the screen grid bypass. Capacitor C109 is the plate supply bypass.

c. The signal voltage is coupled from the plate of V102 to the grid of V103A through C110. The grid resistor is R115 which is connected to the center arm of potentiometer R116. One end of R116 returns to ground, while the other end connects to the −150-volt regulated supply through isolating resistor R114. The amplification of V103A is varied by R116 which controls the grid bias. Resistor R118 is the plate isolating resistor for V103A which is operated as a cathode follower.

d. The cathode of V103A connects directly to the grid of V103B, the signal sync takeoff tube. Tube V103B is operated as a cathode follower to lessen the loading on V103A. Resistor R117 is the grid resistor for V103B and is connected to the −150-volt supply. Capacitor C108 is a bypass for the −150-volt return of R117. The signal is developed across cathode load resistor R121 and applied to the SYNC selector switch. Resistor R120 is the plate isolating resistor for V103B.

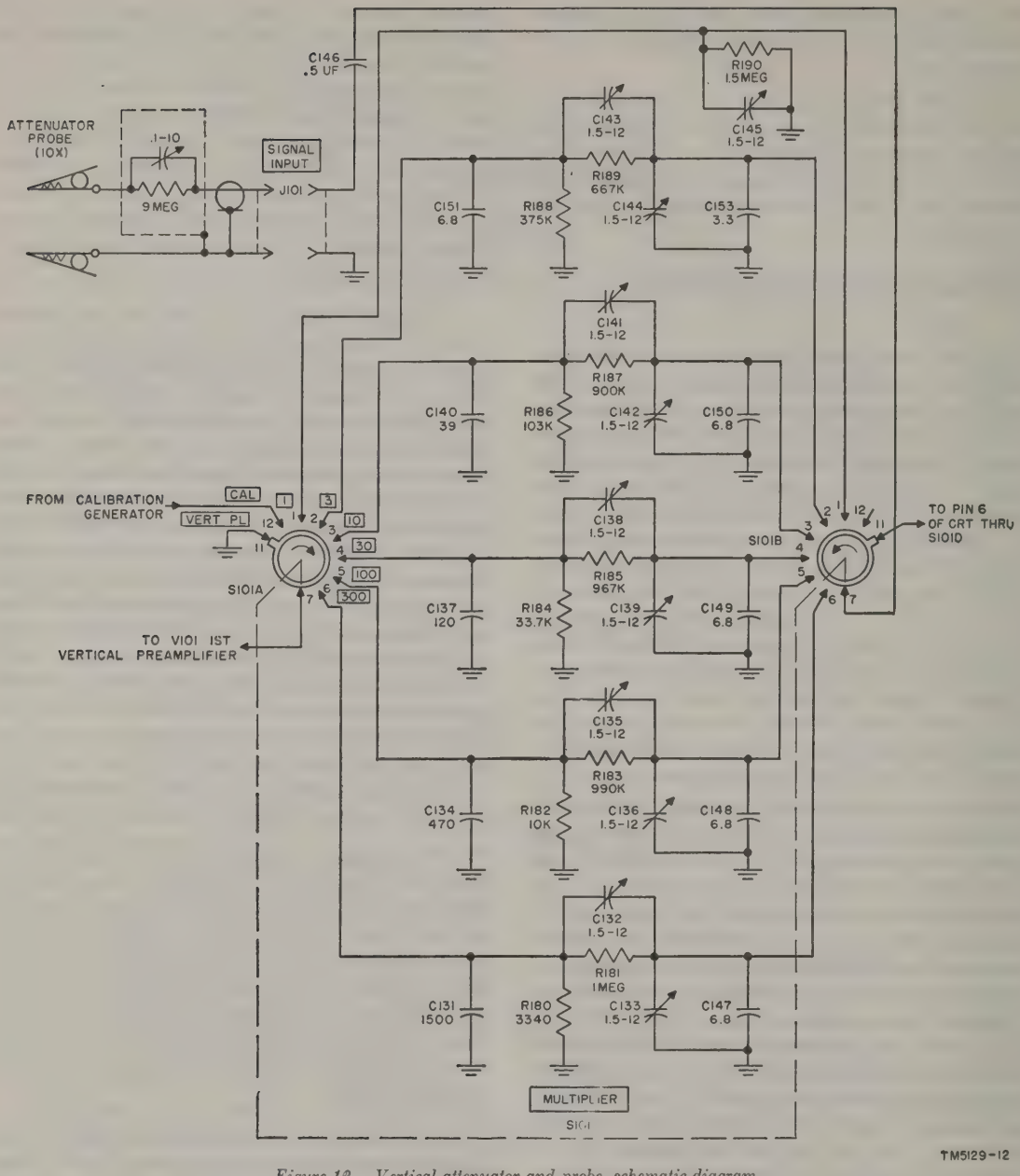


Figure 12. Vertical attenuator and probe, schematic diagram.

e. The cathode of V103A connects to the grid of V104 through isolating resistor R119. The delay line, Z101, delays the signal .25 microsecond thus permitting the sweep to start before the input signal is applied to the vertical deflection plates. Inductor L103 provides series compensation for the distributed capacitances between the delay line and V104. The signal voltage from V103A is developed across R123 and R124 in series, which acts as a voltage divider to provide an attenuation of four times. The voltage divider is shunted by R122 to lessen any loading effect on V103A.

f. Potentiometer R192 is the hum adjustment. A variable amount of out-of-phase line frequency signal

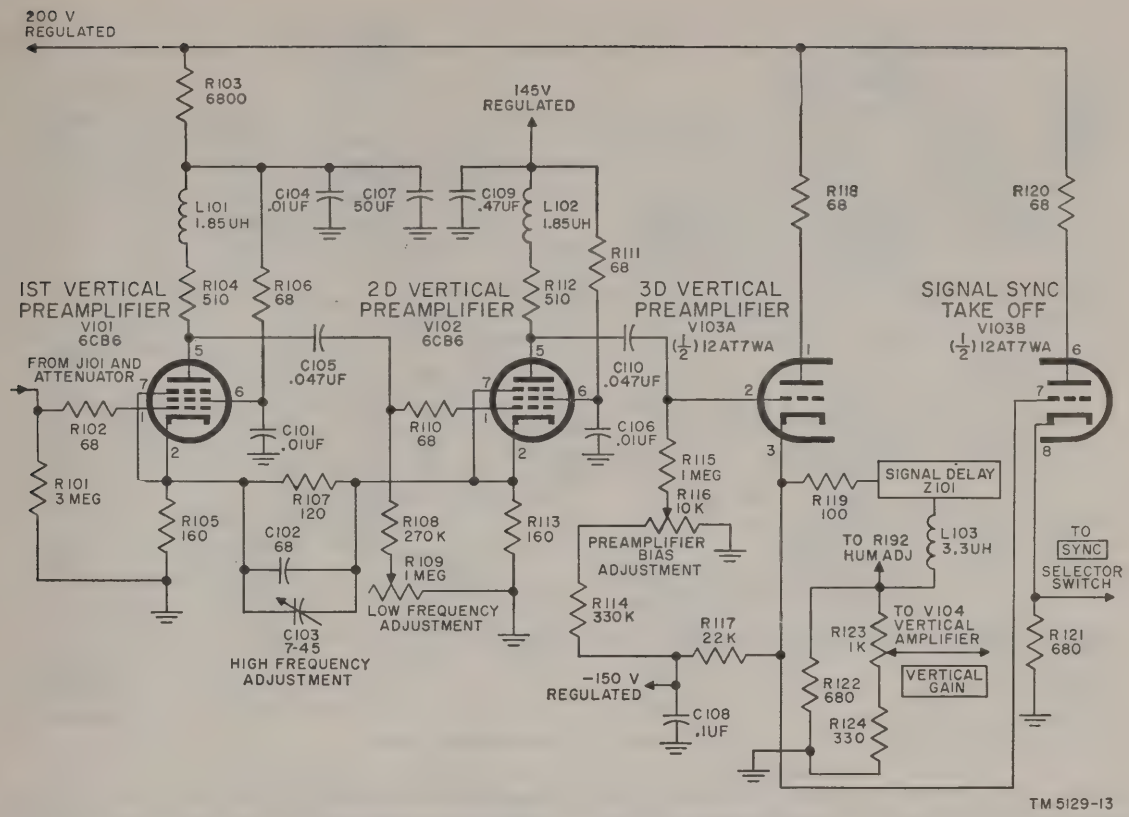


Figure 13. Vertical preamplifiers, schematic diagram.

is applied to R123 to balance out stray hum introduced in the preamplifier stages.

41. Vertical Amplifiers

(fig. 14)

a. The vertical paraphase amplifier, V104, and the vertical amplifier phase inverter, V105, provide the out-of-phase voltages for the push-pull vertical amplifier stages, V106 and V107. When a positive going signal is applied to the grid of V104 the signal polarity at the cathode, pin 2, of V104 becomes positive. The cathode, pin 2, of V105 is connected directly to pin 2 of V104, and sees a positive signal at that instant. The grid of V105 is effectively grounded through R191 and is therefore negative with respect to the cathode because of the voltage drop across R127. Thus the input signals at the grids are 180° out of phase and the plate signals of V104 and V105 are also 180° out of phase.

b. Resistor R127 is the common cathode load resistor for V104 and V105. Resistors R125 and R126 in series provide the fixed bias voltage for V104 and V105 from the −150-volt regulated line. Resistor R191 is a grid isolating resistor for the grounded grid of V105. The plate load of V104 consists of R130 and L104 in series. Inductor L104 is a shunt peaking coil and improves high-frequency response. The plate load for V105 consists of R131 and L105. Inductor L105 serves the same purpose as L104. Capacitor C113 is the plate supply bypass. Resistors R128 and R129 are screen grid resistors, and C111 and C112 are the screen grid bypasses.

c. The signal from the plate of V104 is coupled to the grid of V106 through C114 while the signal from the plate of V105 is coupled to the grid of V107 through C115. Resistors R137 and R139 are grid isolating resistors, and R134 and R136 are the grid resistors. Jacks J102 and J103 are test points. Potentiometer R135 is a balance adjustment that equalizes the signal amplitude on both grids. Resistor R138 provides the common grid return to ground and R142 biases both V106 and V107. Resistors R132 and R133 return the grids to B plus, thus placing a small positive potential on the grids and improving the

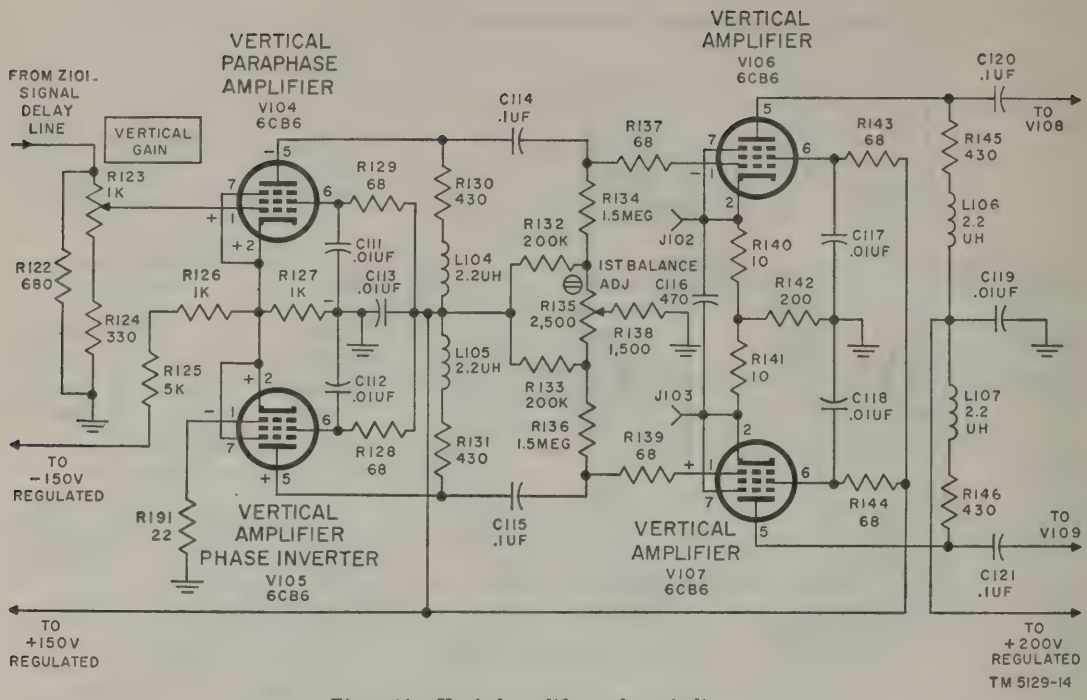


Figure 14. Vertical amplifiers, schematic diagram.

linearity on large input voltages. Capacitor C116 together with R140 and R141 provides voltage feedback and keeps the gain constant. The output from V106 is developed across R145 and peaking coil L106. Resistor R146 and L107 serve the same purpose for V107. Resistor R143, C117, R144, and C118 serve as screen grid decoupling networks. Capacitor C119 is the plate supply bypass capacitor.

42. Vertical Dc and Output Amplifiers

(fig. 15)

a. Tubes V108 and V109 are dc amplifiers which are direct coupled to the vertical output amplifiers, V110 and V111. The direct coupling improves the low-frequency response since the frequency distortion introduced by coupling capacitors is eliminated.

b. The signal is coupled from V106 to V108 through C120 (fig. 14), and from V107 to V109 through C121 (fig. 14). Resistors R152 and R154 are grid isolating resistors. Resistors R149 and R147 in series are the grid resistors for V108, and R151 and R148 are the grid resistors for V109. Potentiometer R414 is the VERTICAL POSITIONING control. Each end of R141 is connected to the junction of the series grid resistors of V108 and V109, while the center arm of the control returns to −150 volts regulated through R153. Tubes V108 and V109 are direct coupled to V110 and V111, and V110 and V111 are direct coupled to the vertical deflection plates of the crt. Changes in the dc level of the grids of V108 and V109 are deflected in the dc level of the plates of the output tubes, changing the vertical position of the crt beam.

c. Capacitor C122 together with R155 and R156 develops voltage feedback to keep gain constant. Resistor R157 is the common cathode resistor for V108 and V109. Although screen resistors R158 and R159 return to ground, the screens are positive with respect to the cathodes which are returned to negative potential. Capacitors C123 and C124 are screen grid bypasses. Jacks J105 and J106 are test points.

d. The plate load for V108 is R160 and L108 in series, and the plate load for V109 is R161 and L109 in series. Both K108 and L109 improve high-frequency response. Resistor R150 equalizes the outputs of V108 and V109. Capacitor C125 is the plate supply bypass. Resistors R163, R162, and R167 make up a voltage divider for supplying a constant cathode voltage to V110 and V111.

e. The signal is direct coupled from the plate of V108 to the grid of V110, and from the plate of V109

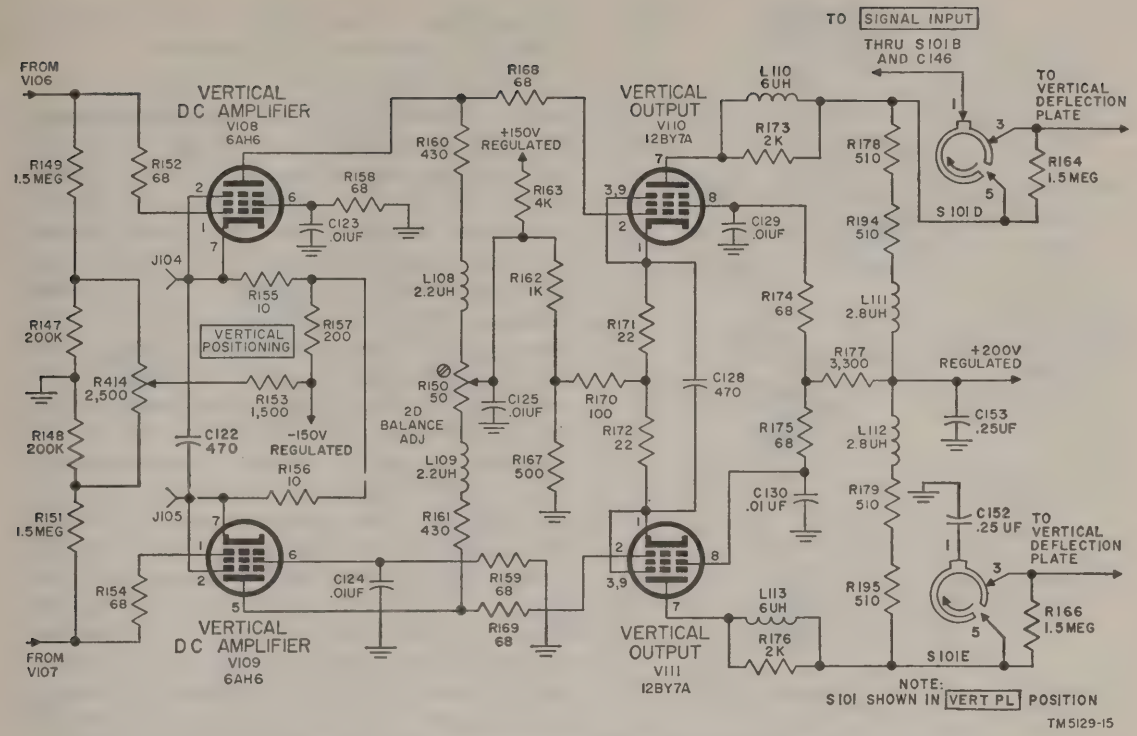


Figure 15. Vertical dc and output amplifiers, schematic diagram.

to the grid of V111. Resistors R168 and R169 are isolating resistors. Resistor R170 is the common cathode resistor for V110 and V111. Capacitor C128 together with R171 and R172 provides voltage feedback to keep the gain constant. Resistors R174 and R175 are screen isolating resistors and R177 is the common screen grid voltage-dropping resistor. Capacitors C129 and C130 are screen bypasses. The plate load for V110 consists of the series compensating combination of L110 and R173 in series with R178, R194, and shunt compensating coil L111. The plate load of V111 consists of the combination of L113 and R176 in series with R195, R179, and L112. Capacitor C153 is the plate supply bypass.

f. When the MULTIPLIER switch is in the VERT PL position, one vertical deflection plate is grounded for signal voltages through R166, S101E, and C152, while the signal input is connected to the other vertical deflection plate through C146, S101B, contacts 1 and 3 of S101D. Resistors R166 and R164 are isolating resistors between the vertical output tubes and the vertical deflection plates.

43. Cathode-Ray Indicator

(fig. 16)

a. Crt V401 has a 3-inch screen and has electrostatic deflection and focusing. The tube operates with 2,500 volts between the cathode and the accelerating anode.

b. Resistors R402 through R409 make up a voltage divider across the −1000-volt supply for applying correct dc potentials to the crt cathode and grid. Potentiometer R402 is used for calibrating the deflection sensitivity, and R403 varies the difference of potential between the control grid and cathode for controlling the intensity of the beam. Potentiometer R406 varies the difference of potential between the cathode and the first anode and controls the focal point of the beam. Capacitors C401, C402, and C403 are filter capacitors. Resistor R411 is the cathode isolating resistor, and R410 is the grid isolating resistor.

c. Capacitor C404 couples the markers and the INTENSITY MODULATION connector to the cathode of the tube. Capacitor C407 couples the unblanking pulses from V208A to the grid of the tube. Astigmatism adjustment R417 corrects for defocusing of the beam at the right edge of the screen. Resistor R148 and potentiometer R419 make up a voltage divider to supply the correct dc potential to

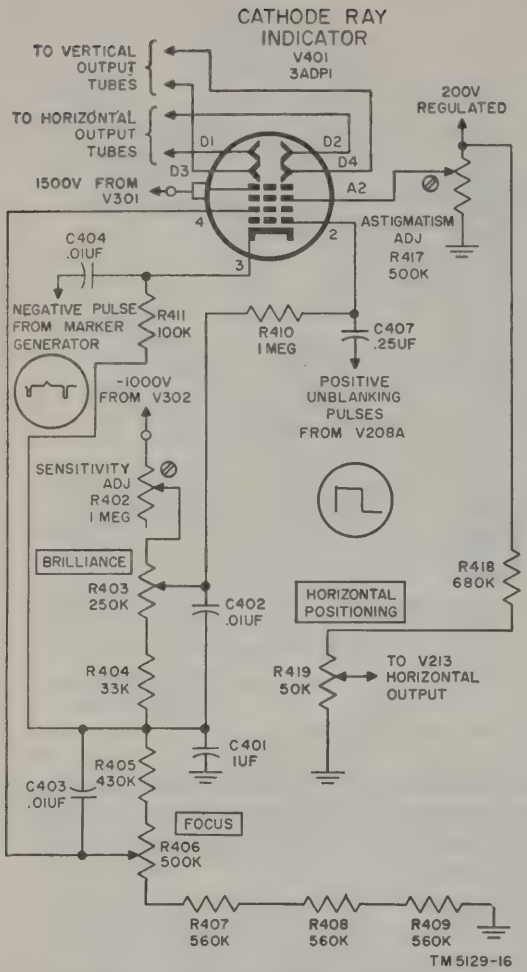


Figure 16. Cathode-ray indicator, schematic diagram.

V213 for horizontal positioning of the beam. The accelerating anode receives 1,500 volts from the high-voltage power supply.

44. Trigger Pulse Generator

(fig. 17)

a. The trigger pulse generator produces a pulse which starts the sweep when the SYNC selector switch is in the INT TRIG position. Negative and positive pulses are also available to trigger external equipment with the sweep.

b. Tube V201 operates as the trigger pulse generator and produces output voltage pulses at the screen grid. Tube V202A operates as a shock excited oscillator and converts the voltage pulses into sharp narrow spikes. Trigger pulse cathode follower V202B prevents external applications of the pulses from affecting the operation of the generator.

c. When power is applied to V201, the tube current increases and both plate and screen potential drop. The negative pulse from the plate is coupled to the control grid of V201 through C201 and sharply reduces plate and screen current. This action reduces tube current and a positive pulse is now applied to the control grid. The positive pulse on the control grid increases tube current and the cycle is repeated. The signal pulses from the screen grid are coupled through C205 to the grid of V202A. Cathode bias for V201 is developed by R205. A voltage divider consisting of R201, R202 and R203 and provides correct operating potentials for the screen and suppressor grids of the oscillator. The plate load for V201 is R204. The oscillator trigger frequency is determined by the position of the TRIGGER RANGE switch which selects C201, C202, C203, or C204 to provide the feedback between the plate and grid. A voltage divider consisting of R208, R209, R210, R211, and R212 provide the correct operating potential to the control grid of V201. The trigger rate is adjusted by R209 by changing the bias on V201. Potentiometer R211 adjusts the low-frequency rate, while R207 adjusts the high-frequency rate. Resistor R206 is the grid resistor, and R212 and C204 are the plate decoupling network. The operation of TRIGGER RATE potentiometer R209 is made more linear by R287.

d. The trigger voltage output from the screen grid of V201 is coupled to the grid of V202A through C205. The control grid is connected to B plus through R213. This places a positive potential on the grid of V202A and the tube is normally conducting. The negative voltage pulse from the screen grid of V201 sharply reduces plate current. This causes the plate voltage to rise rapidly and shocks L201 into oscillation. A sharp positive pulse is developed at the resonant frequency of L201. Following the first initial pulse, R215 damps out further oscillations and the tube returns to its normal condition until the next negative voltage pulse from V201 arrives. Resistor R214 and C208A make up the plate decoupling network.

e. The sharp positive pulses are coupled through C209 to the grid of V202B, the cathode follower. Resistor R217 is the grid resistor of V202B, but a high negative bias is supplied to the grid through R216, and keeps V202B cut off until the positive pulse is applied to the control grid. The cathode load consists of R219 and R220.

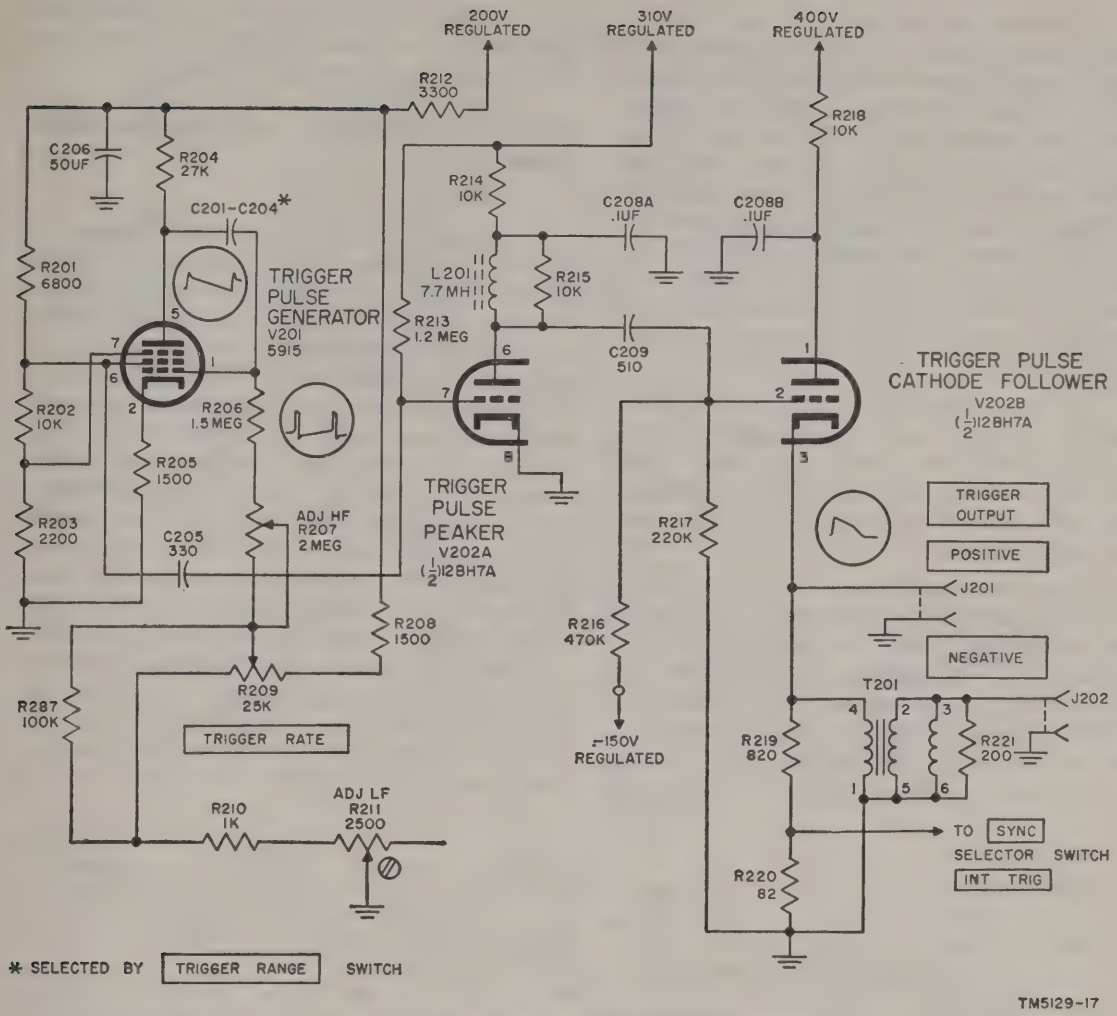


Figure 17. Trigger pulse generator, schematic diagram.

f. The current flows through cathode resistors R219 and R220 and develops pulses that are fed to the INT TRIG section of the SYNC selector switch, and to the POSITIVE output connector on the front panel. The pulses are inverted by T201 and the negative pulses are brought out to the NEGATIVE output connector on the panel. Resistor R218 and capacitor C208B make up a plate decoupling network. Transformer T201 is loaded down by R221 to prevent undesired oscillation.

45. Sync Amplifiers

(fig. 18)

a. Switch S202 selects the pulse required for synchronizing the sweep generator. The internally generated trigger pulse is applied to terminal 11 of S202; the signal synchronizing pulse is applied to terminal 10; the external synchronizing pulse is applied to terminal 9 and across a compensated voltage divider consisting of R222 and R223 in series, shunted by C210 and C211. The center tap of this combination connects to terminal 8 of S202, and is used to reduce the amplitude of the applied external synchronizing voltage.

b. The common terminal 7 of S202 connects to the grid (pin 2) of V203, the sync pulse preamplifier, through blocking capacitor C212. The selected pulse is applied to the input of V203 across grid resistor R224. Both triode sections of V203 operate as cathode followers. Resistors R226 and R227 in series

are the cathode load for the input triode section. Resistor R225 is the plate load and supplies a small signal voltage to the grid of the second triode section of V203 through coupling capacitor C213. Resistor R229 is an isolating resistor for the plate of the second triode. The grid resistor for the second triode is R232, and R230 and R231 are the cathode load. The signal voltages across each cathode load are equal in amplitude but opposite in phase. Potentiometer R228 connects across the two cathode loads and is used to select the leading or trailing edge of the pulse for synchronizing the sweep with minimum jitter or motion.

c. The pulse is directly coupled to the grid of V204, the first sync amplifier. Cathode bias is developed by R235. The amplified pulse is developed across the plate load consisting of L202 and R234 in series, and is coupled to the grid of V205, the second sync amplifier, through C216.

d. The pulse is applied to the input of V205 across grid resistor R236, while R240 supplies the cathode bias. The cathode resistors of V204 and V205 are unbypassed, providing degeneration, while C215 and R237 provide current feedback for stabilizing the gain of both amplifiers. The amplified pulse is developed across the plate load consisting of L203 and R239 in series and supplied to V206A, the sync gate. Resistor R233 and capacitor C214 make up a plate isolation network for V203, while R238 and C217 isolate the plate supply of V204.

46. Sweep Generator and Enabling Gate Generator

(fig. 19)

a. A negative going pulse from V205 is applied to the cathode of diode V206A. This causes the diode to conduct and a pulse is coupled through a capacitor (C233 to C238) selected by the SWEEP TIME switch S203B and S203C to the control grid of V208B. Tubes V208B and V207B make up a one-shot multivibrator in which V208B is normally conducting, and V207B is normally cut off. The negative pulse from V206A cuts off V208B and a positive pulse is coupled through an attenuator network consisting of R250 and C220 to the grid of V207B, causing it to conduct heavily. The voltage drop across R251 and R249 increases and the plate voltage of V207B drops, also reducing the plate voltage of diode V206A. This action cuts the diode off. This prevents any further pulses from V205 from entering until the operation cycle of V207B and V208B is completed, as determined by the timing capacitor (C233 to C238) discharge rate through R247 and R246A. The same pulse that cuts off

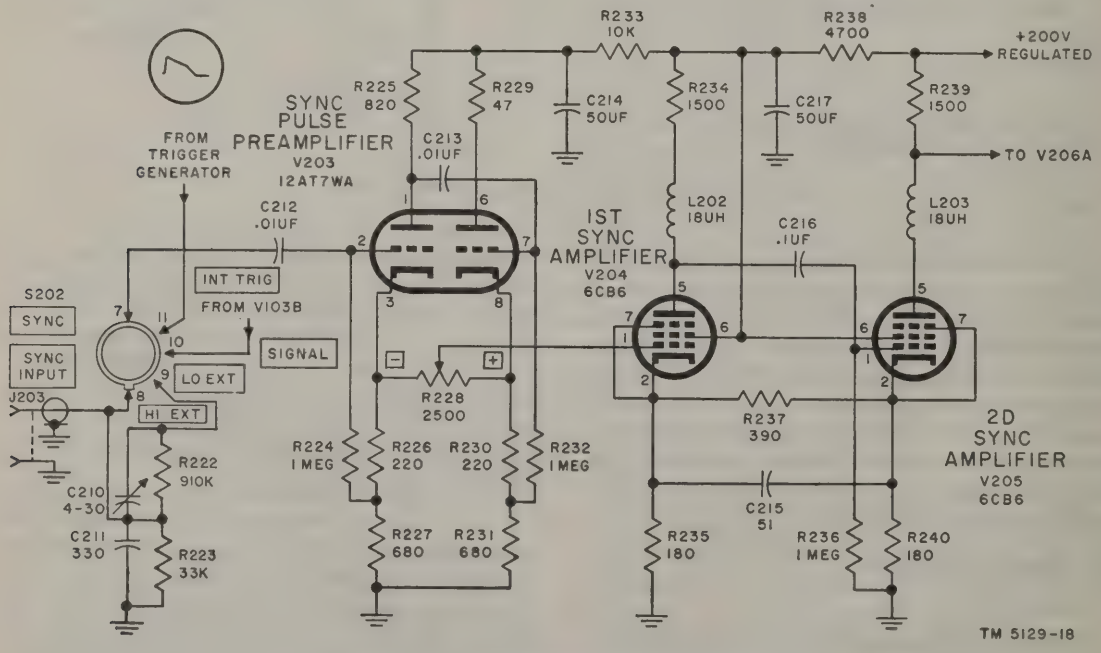


Figure 18. Sync amplifiers, schematic diagram.

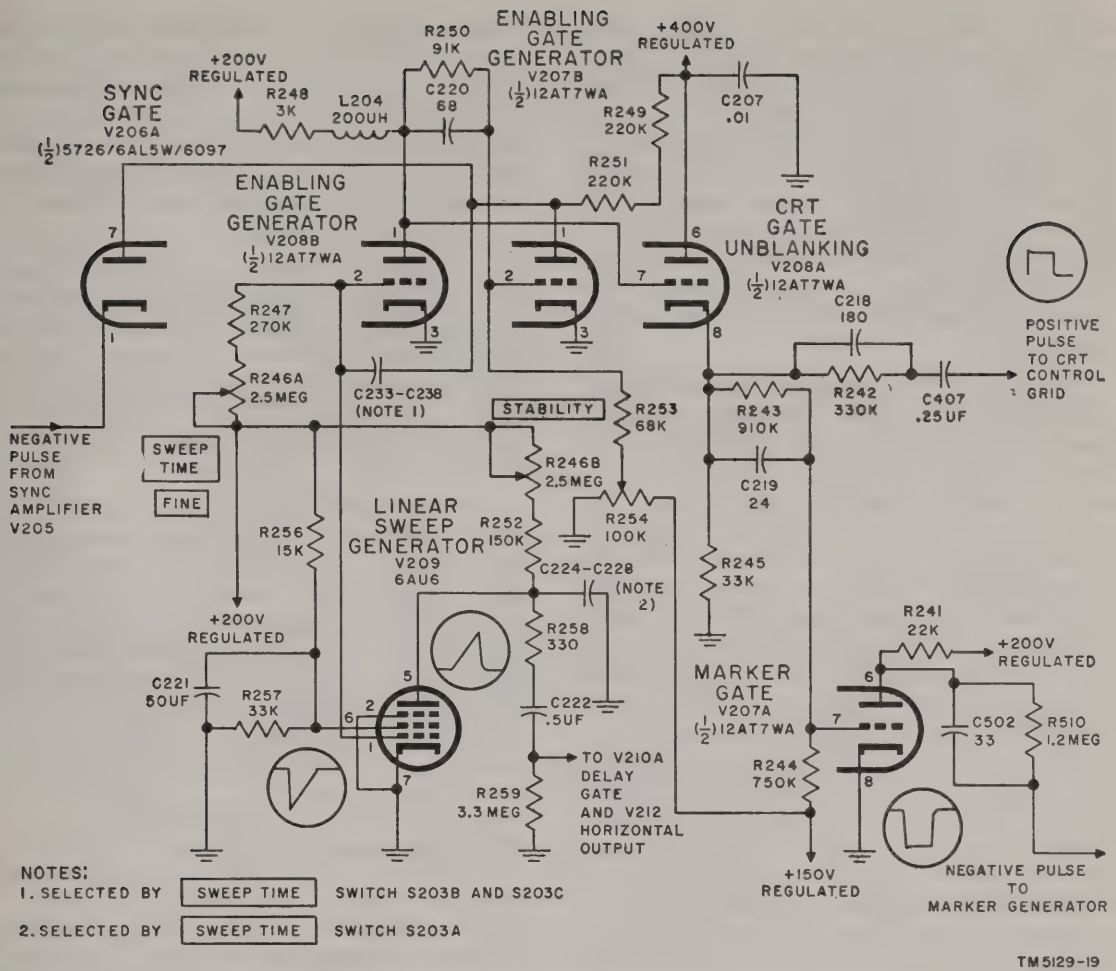


Figure 19. Sweep generator and enabling gate generator, schematic diagram.

V208B also cuts off V209, the linear sweep generator. This causes the voltage across R252 and STABILITY control R246B to drop and the plate voltage of V209 to rise charging the sawtooth forming capacitor (C224 to C228 selected by section S203A of the SWEEP TIME switch) which determines the sweep speed.

b. The sawtooth output of V209 is coupled to the delay gate and the horizontal output tubes through R258 and C222 and developed across R259. The cutting off of V208B also produces a positive pulse at the grid of V208A, causing it to conduct, and develops a positive pulse across cathode resistor R245. This positive pulse is applied to the cathode-ray tube grid through an attenuating network consisting of R242 and C218 and coupling capacitor C407 and serves as an unblanking gate signal. The positive pulse is also applied to marker keyer V207A through C219 and R243 and developed across grid resistor R244. The signal is inverted and applied to V501 through the attenuator coupling network consisting of R510 and C502. Resistor R241 drops the plate voltage.

c. Capacitor C207 is the plate bypass for cathode follower V208A and R256 is the screen grid dropping resistor for V209. The voltage at the screen grid of V209 is stabilized by R257 and C221. Resistor R253 serves as the grid resistor for V207B while R254 determines the bias for V207B.

47. Sweep Delay and Horizontal Output

(fig.20)

a. When the SWEEP DELAY switch is in the OUT position, the circuit shown in A, figure 20 is

completed. The sawtooth from the linear sweep generator is coupled to the grid of the delay gate, V210A, through R258 and C222. Clamping diode V211 fixes the level of the positive going sawtooth developed across grid resistor R259 at the input of V210A, which operates as a cathode follower. Resistor R260 is the plate isolating resistor, while R261 and R262 in series make up the cathode load. Resistor R261 is shunted by C223 and only the signal voltage developed across R262 is coupled directly to the grid of V212, the horizontal output tube.

b. Resistor R277 is the common cathode resistor for both horizontal output tubes, V212 and V213. Capacitor C230 shunts the cathode resistor but bypasses only the highest undesired frequency components. Paraphase amplifier V212 operates as follows: the signal input to the grid of V212 develops a signal voltage across the cathode load. Since R277 is common to both V212 and V213, the signal is injected into the cathode circuit of V213. The grid of V213 is grounded through C231, and the plate current variations are determined by the signal developed across cathode resistor R277. The plate voltage variations of V212 and V213 are opposite in phase but equal in amplitude. The screen voltage for V212 is supplied from the 400-volt line through R275 and R276, and for V213 through R278 and R280. The sawtooth for one deflection plate is developed across R272 and R274, the plate load for V212, and for the other deflection plate, across R281 and R283, the plate load for V213. Resistors R273 and R282 are plate isolating resistors. The dc level of the grid of V213 is determined by R419, the HORIZONTAL POSITIONING control, in series with R418 across the 200-volt line. The average plate voltage of V213 is varied by changing the grid level, thus shifting the crt beam horizontally.

c. With the DELAY switch in the IN position, the circuit shown in B, figure 20 is completed. The delay gate, V210A, couples the sawtooth to the delayed sweep amplifier, V210B through the delay clamping tube, V211. One half of V211 (pins 2 and 5) operates as a clamp and functions in the same manner described in *a* above. The other half of V211, the delay gate, operates in the following manner. The signal applied to V210A causes a signal voltage to be developed across cathode resistor R262. When the voltage across R262 exceeds a predetermined value, the delay gate diode conducts and develops a signal pulse across R271. Thus the signal is coupled into the cathode circuit of V210B. The amplified sawtooth is developed across the plate load R270, and is coupled to V212, the horizontal output, through C229. The operating point of V210B is determined by the bias developed across the voltage divider consisting of R267, R268, and R269 across the 200-volt line. SWEEP DELAY INCREASE control R268 varies the operating point and the portion of the sawtooth which is expanded.

d. Since the sawtooth is coupled to the horizontal output tube through capacitor C229, the dc level must be restored. Tube V206B is connected to the grid of V212 and functions as a dc restorer. Resistors R264, R265, and R266 are grid resistors for V212 and also load resistors for the dc restorer. The remainder of the circuit operates as described in *b* and *c* above.

e. With the SWEEP TIME switch in the HOR AMP ON position (*C*, fig. 20) V213 operates as a voltage amplifier independent of the other oscilloscope functions. The voltage to be amplified is coupled through J205 across GAIN control R285. Capacitor C231 is a blocking capacitor that couples the attenuated voltage to the input of V213 across R279, the grid resistor. Tube V213 operates as a conventional amplifier with the amplified output coupled to the OUTPUT jack, J204, through capacitor C232.

48. Marker Generator

(fig. 21)

a. Marker generator V501 has two functions. One section operates as a clamping tube to damp out oscillations and the other section operates as a Hartley oscillator. The frequency of oscillation is determined by switching in the tank circuit components contained in Z501.

b. An enabling gate (a negative pulse that triggers the oscillator) keeps the oscillator in step with the sweep. The output of V501 is coupled through V502 to marker clipper V503A and then to the cathode-ray tube cathode, in the .2 and 1.0 microsecond positions of the MARKER switch. For all other positions, the markers are further amplified by marker amplifier V503B. For the 2,000-microsecond markers, a multivibrator operating as a frequency divider divides the frequency by four.

c. In A, of figure 21 the MARKER switch is positioned to produce the .2-microsecond markers; however, the theory of operation is the same for all other positions of the switch. The damper and generator sections of V501 operate in the following

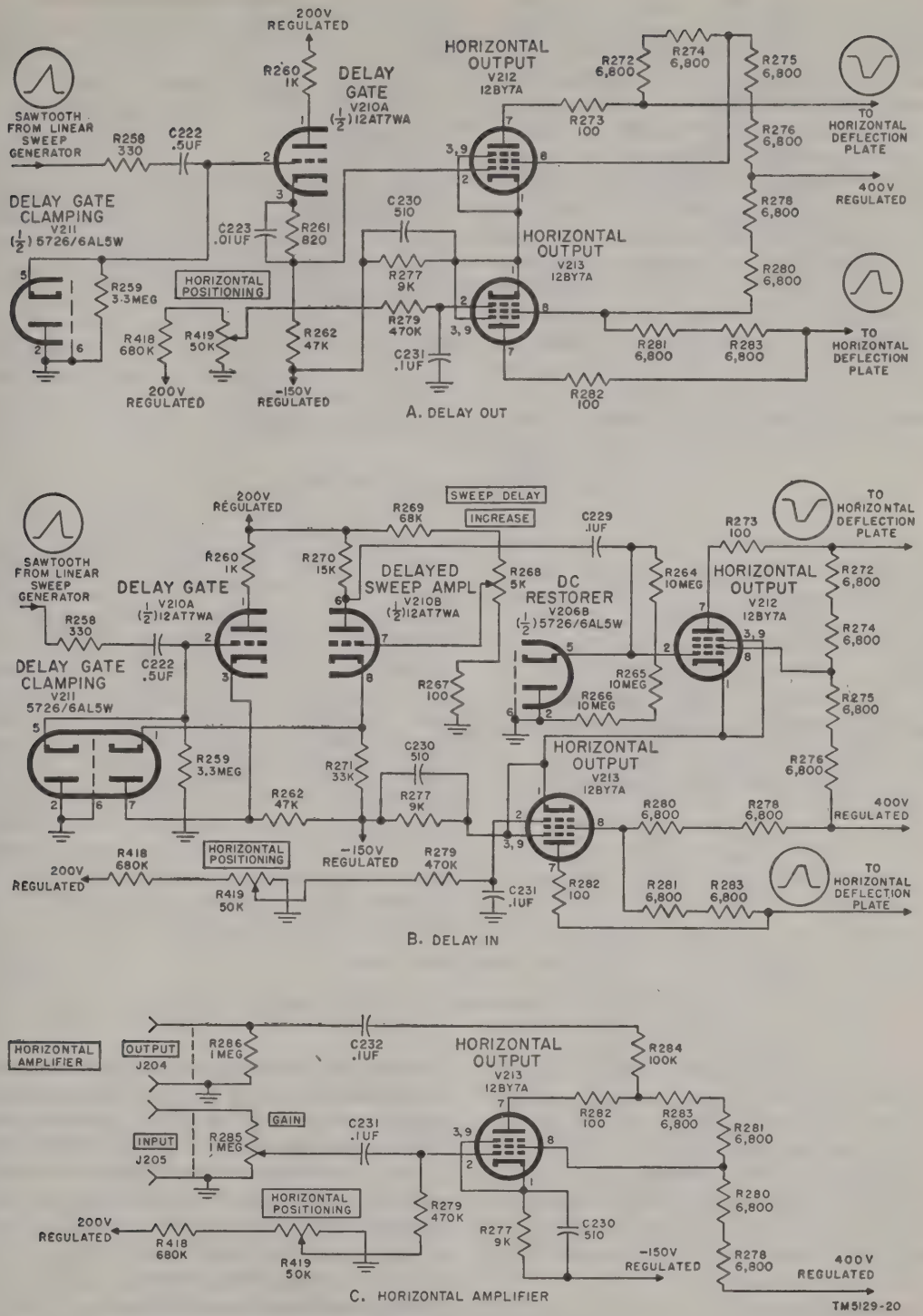


Figure 20. Sweep delay and horizontal output, schematic diagram.

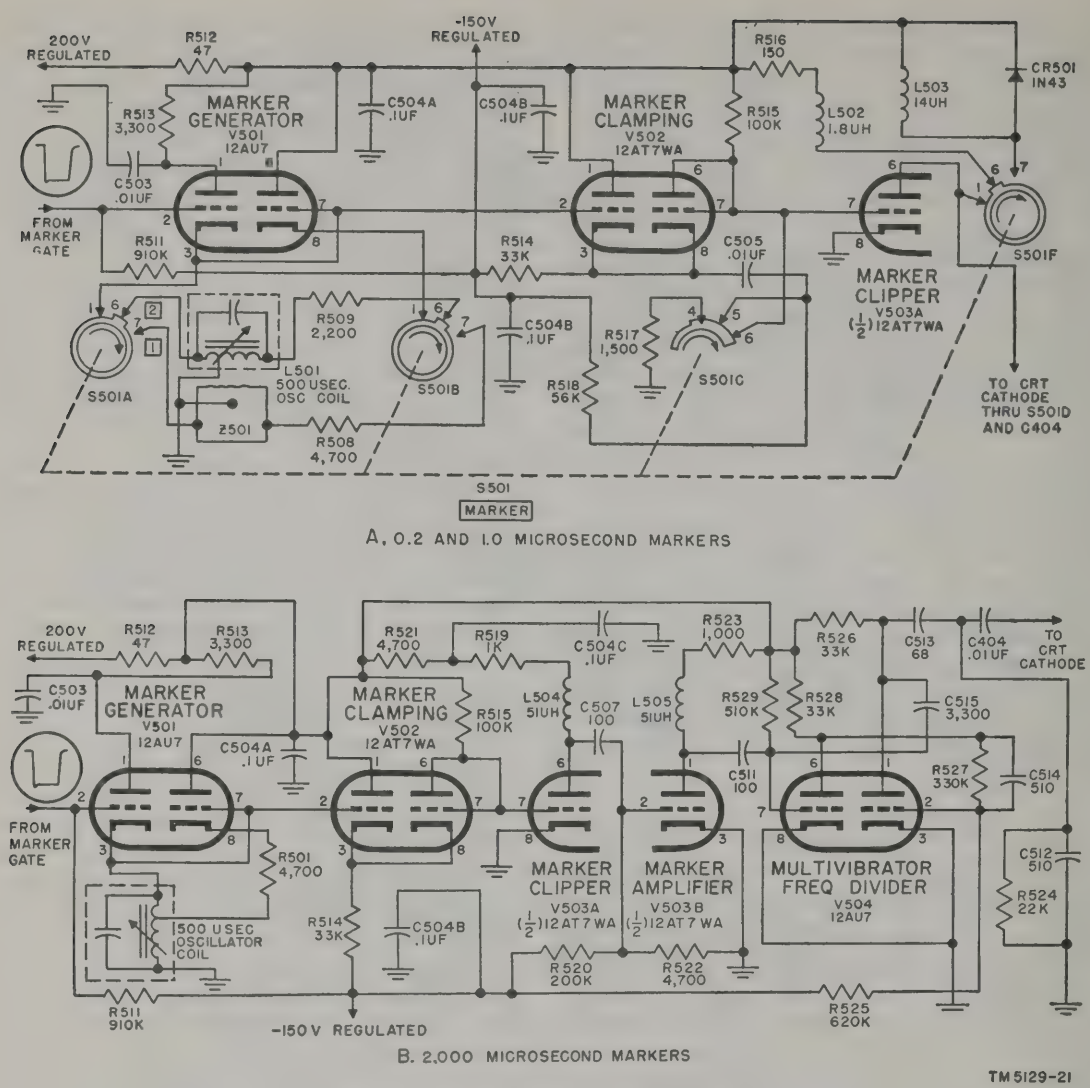


Figure 21. Marker generator, schematic diagram.

manner. The clamping triode of section of V501 (pins 1, 2, and 3) is normally conducting. The cathode returns to ground through S501A switch positions 1 and 6, and oscillator coil L501. When V501A conducts, it suppresses the oscillations. The oscillator triode section of V501 (pins 6, 7, and 8) is connected in a Hartley oscillator circuit. When a negative pulse is applied to V501A, it ceases to conduct and V501B is permitted to oscillate.

d. The negative enabling pulse from marker gate tube V207A, is applied to the input of clamping triode section V501 across grid resistor R511. This cuts off the clamping triode and the damping action is removed, permitting a new operation cycle of the oscillator triode section of V501. The marker pulse is direct coupled to one triode section of V502 (pins 1, 2, and 3) which operates as a cathode follower. The marker pulse is developed across R514, the cathode load resistor, and coupled through C505 to the plate of the diode connected section of V502 (pins 6, 7, and 8). The operating potential of the diode section of V502 is established by R515. The signal at the plate of the diode is applied directly to the grid of V503A which functions as an over driven clipper. The grid

of V503A is returned to the −150-volt line through R518 and to ground through switch positions 4, 5, and 6 of S501C and R517. The output pulse from V503A is coupled to the crt cathode through S501D and C404. Inductor L502 and R516 are the plate load for V503A when S501F is in the position shown in A, of figure 21.

e. For the 5-, 20-, 100-, and 500-microsecond markers, V503B (B, fig. 21) provides additional amplification. Resistor R521 and C504C provide decoupling for the plate supply of V503A, and the plate load consists of L504 and R519. The output from V503A is coupled to V503B through C506, C507, or C509 depending on the position of the MARKER switch. Resistors R520 and R522 are a voltage divider across the −150-volt line that provide the grid bias for V503B. The plate load for V503B is L505 and R523 in series.

f. For the 2,000-microsecond marker (B, fig. 21), frequency divider V504 is switched into the circuit by the MARKER switch. All other circuit components remain the same. Coil L505 and R523 become the plate load for V503B, and the 500-microsecond markers are coupled from the plate of V503B to pin 7 of V504 through C511. Resistor R529 returns the grid to the 200-volt plate supply to provide a low positive voltage for improving the linearity of the marker. Resistor R527 and C514 provide coupling between the triode sections of V504, while C515 couples V504B back to V504A. The circuit constants of the frequency divider are such that for every four input pulses only one output is coupled to the crt through capacitors C513 and C407. Resistor R256 is the pin 1 plate load, while C513 couples the marker to the attenuating network of R524 and C512, while C404 couples the marker to the crt cathode.

49. Calibration Voltage Generator

(fig. 22)

a. Tube V809 is operated as a free running multivibrator and produces a symmetrical output. The output is shaped into a square wave by clipper tube V810. To fix the limits of amplitude, V812 provides a stable reference voltage.

b. The symmetrical output is obtained by using similar values for the two triode sections of the multivibrator. Resistors R825 and R829 are the cathode resistors, R826 and R827 are the grid resistors, R824 and R828 are the plate load resistors, and C804 and C806 are the feedback capacitors. Capacitor C805 provides cathode coupling.

c. The multivibrator output is coupled to pins 1 and 2 of the clipper, V810, through C807. Resistors R840 and R841 are a voltage divider across the 200-volt supply and provide the 80 volts for V812, the voltage regulator. Potentiometer R841 applies part of the +30 volts reference voltage to one cathode (pin 5) of the clipper tube. Approximately +15 volts are applied to pins 1 and 2 of V810 by the action of the voltage divider R832, R830, and R831 and C811. Thus both diode sections are biased and conduct alternately when the input signal exceeds plus or minus 15 volts. This action clips off the peaks from the incoming signal and the output applied to J801 is a square wave as shown in figure 22. Resistor R832 varies the calibration voltage into the vertical amplifier for signal voltage level measurements by means of the millivolts dial on the front panel. Capacitors C809 and C811 are filter capacitors for the reference voltage.

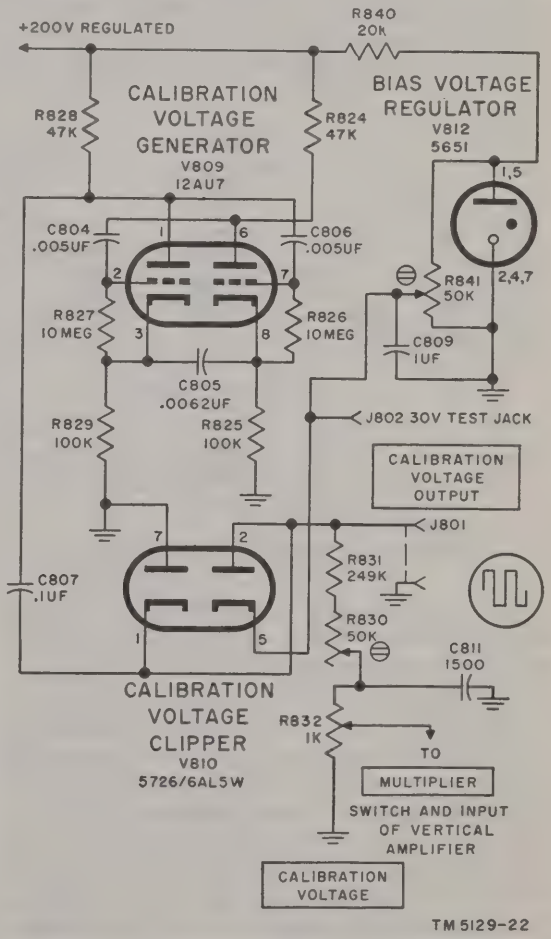


Figure 22. Calibration voltage generator, schematic diagram.

50. Regulated Supply, —150 Volts

(fig. 23)

a. A potential of 185-volts ac from terminals 7 and 8 of power transformer T401 is connected to the input of the full-wave bridge rectifier made up of CR603 and CR604. Fuse F405 is a ¼-ampere slow-blow fuse in series with the input. Tube V803 is the series regulator, and V805 is the control tube. The voltage regulator, V806 supplies 87 volts reference voltage for the 400-, 200-, and 150-volt regulated supplies.

b. When a drop in line voltage occurs, it is reflected across the voltage divider consisting of R812, R806, and R805 in series with V803. Potentiometer R806 is set to establish the —150-volt output. The reduced voltage across R806 decreases the bias of V805 which is operated as a high-gain amplifier. The current through V805 increases, decreasing the plate voltage and the bias on the grid of V803. The reduced voltage on the grid of V803 increases the current flow thus increasing the voltage output, and compensating for the drop in line voltage and load voltage.

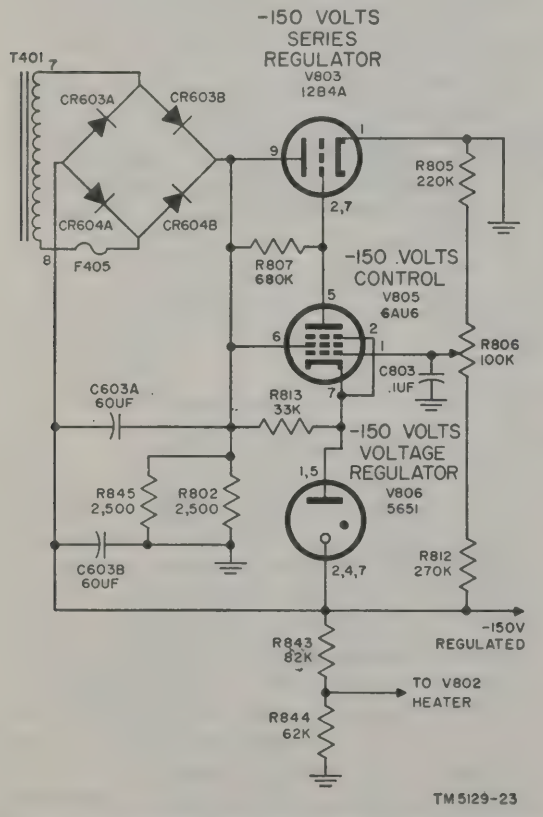


Figure 23. Regulated supply, —150 volts, schematic diagram.

c. Capacitor C603 sections A and B, is a filter capacitor and C803 couples the RF and ac variations across the load to the input of the control tube which amplifies and applies them back across the load out of phase with the original voltage for cancellation.

d. Resistors R802 and R845 in parallel are in shunt with V803 to increase the current handling capacity. Resistor R807 is the V805 plate load and R813 drops the supply voltage to provide the operating potential (87 volts) for V806. Resistors R843 and R844 are a voltage divider which supply a dc potential to the heater of V802 and reduces the difference in potential between the filament and cathode.

51. Regulated Supplies 150 Volts, 200 Volts, and 400 Volts

(fig. 24)

a. Two full-wave bridge rectifiers in series provide the operating potentials for the 150-, 200-, and 400-volt regulators. Terminals 3 and 4 of T401 provide the ac potential for one bridge rectifier consisting of CR601 and CR602. Terminals 5 and 6 of T401 provide the ac potential for bridge rectifiers CR605, CR606, CR607, and CR608. Fuses F403 and F404 are in series with the ac input to protect the equipment against shorts. Capacitors C601, C602, C604, and C605 filter the rectified dc output of the bridge circuit.

b. Tube V813 is the series regulator tube for the 150-volt regulated supply and V811 is the control tube. Resistor R839 limits the load current passing through V813. Resistor R836 is the plate load for V811, R833 is the screen dropping resistor for V811, and R834 is the screen voltage stabilizer. Resistors R835, R837, and R838 make up a voltage divider across the 150-volt load. Potentiometer R837 establishes the 150-volt level, and applies the load voltage variations to the grid of the control tube for compensation. The ac and RF voltage variations are coupled by C808 to the control tube for amplification, inversion, and cancellation. The voltage divider across the 200- and 400-volt output consists of R803 and R809. It supplies a dc potential to the heaters of V813 for reducing 60-cycle coupling from heater to load. The reference voltage is supplied by V806 (fig. 24).

c. Tube V802 is the series regulator for the 200-volt supply and V808 is the control tube. The refer-

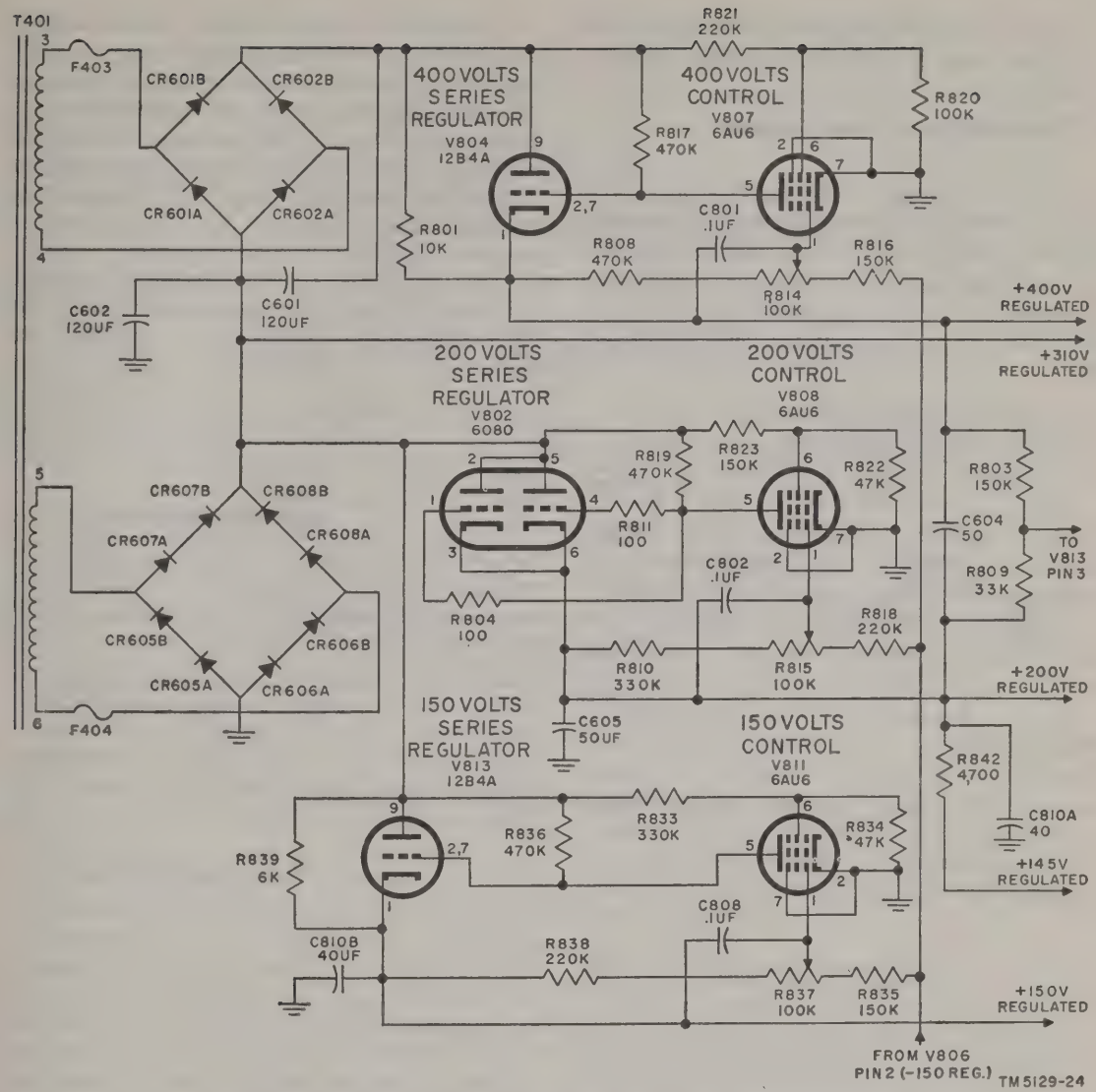


Figure 24. Regulated supplies 150 volts, 200 volts, 400 volts, schematic diagram.

ence voltage is supplied by V806. Resistors R804 and R811 are parasitic suppressor resistors. In the control circuit R819, is the V808 load resistor, R823 the screen dropping resistor, and R802 the screen voltage stabilizer. Resistors R810, R815, and R118 make up a voltage divider across the 200-volt load. The 200-volt output is established by R815 which couples the load voltage variations to the grid of the control tube for compensation, while C802 does the same for the ac and RF variations.

d. Tube V804 is the series regulator for the 400-volt supply and V807 is the control tube. The reference voltage is supplied by V806 and resistor R801 is connected across the series regulator tube for limiting the load current flow through V804. The plate load for V807 is R817. Resistor R821 is the screen grid dropping resistor for V807, and R820 is the screen voltage stabilizer. Resistors R818, R814, and R816 make up a voltage divider across the 400-volt load. The 400-volt output is established by R814 which applies the load variations to the grid of the control tube for compensation. Capacitor C801 applies the ac and RF variations in the load to the control tube for amplification, inversion and cancellation.

e. For a detailed explanation on the operation of the control tube and series regulation, refer to paragraph 50.

52. High-Voltage Power Supply

(fig. 25)

a. The high-voltage power supply supplies the 2,500-volt difference of potential between the cathode and accelerating anode of the cathode-ray tube.

b. Tube V303 operates as a Colpitts oscillator to produce the radio frequency (RF), which is stepped up by T301 and applied to voltage doubler V301 and V302.

c. Fuse F301 protects V303 if the circuit fails to oscillate. Inductors L302 and L303 are the oscillator tank circuit. Resistor R310 is a parasitic suppressor and R309 with C306 develop the oscillator grid bias. Capacitors C304 and C305 represent the feedback loop to maintain oscillations and C303 completes the RF feed-back path. The generated RF is stepped up by T301 and applied to the 1,500-volt rectifier V301 and the −1,000-volt rectifier V302. After rectification, the dc is filtered by C301 and C302. Resistors R302 and R303 are filter resistors and R301, R304, R305, R306, R307, and R308 are the rectifier load resistors.

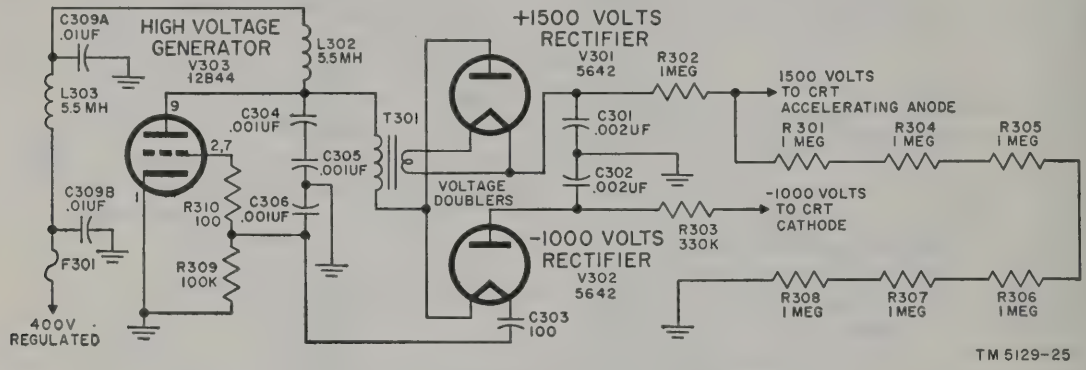


Figure 25. High-voltage power supply, schematic diagram.

CHAPTER 5

FIELD MAINTENANCE INSTRUCTIONS

Section I. GENERAL TROUBLESHOOTING TECHNIQUES

Warning: When servicing the oscilloscope, remove the power plug and discharge the capacitors when making resistance measurements.

53. Extent of Instructions

Troubleshooting at a field maintenance level includes all the techniques outlined for organizational maintenance and any other techniques that may be required to isolate a defective part. The field maintenance instructions supplement the instructions described in chapter 3. The systematic troubleshooting procedure begins with the operational and localization checks (pars. 27–34). These steps must be completed before proceeding with the troubleshooting instructions in this chapter.

54. Troubleshooting Techniques

a. General. To be effective, troubleshooting must be systematic. It is seldom possible to observe a trouble symptom and diagnose the cause immediately. Generally, it will be necessary to perform a sequence of operational checks, observations, and measurements before a fault will be revealed. If the proper sequence is used, the trouble will be traced first to a chassis, then to a stage, and finally to the defective part. The sequence of steps is referred to commonly as sectionalization, localization, and isolation of trouble.

b. Sectionalization. The first aim when troubleshooting is to sectionalize the trouble to a chassis of the oscilloscope. Determine the defective unit through visual checks or operational procedures and through additional measurements and tests described in the troubleshooting chart (par. 57).

c. Localization. After the defective unit is determined, make additional checks and measurements to localize the trouble to a stage of the chassis. First, use inspection (par. 33), operational techniques (par. 34) and short-circuit checks (par. 56). Use the specialized testing procedures (pars. 57–61) when necessary.

Caution: Do not apply power to the equipment unless the operational symptoms are known, and are of such a nature as to eliminate the possibility of further damage when power is applied. If the symptom is not known, or indicates the possible existence of short circuits, make short-circuit checks (par. 56) before applying power.

d. Isolation. After trouble has been localized to a stage of the chassis, or a group of functionally related circuits, use visual inspection, voltage measurements, and resistance measurements to determine the defective part. Data and procedure for isolating defective parts are detailed in paragraphs 56 through 61.

55. Test Equipment Required

The test equipment required for troubleshooting the oscilloscope is listed below. The technical manuals associated with the test equipment are also listed.

Test equipment	Technical manual	Common name
Electron Tube Test Set TV–7/U	TM 11–5083	Tube tester
Multimeter ME–77/U		Multimeter
Electrical Instrument Multiplier MX–1472/U		Multiplier
Oscilloscope AN/USM–50	TM 11–5129	Oscilloscope
RF Signal Generator Set AN/URM–25.	TM 11–5551B	Signal generator
Signal Generator SG–71/FGC	TM 11–5088	Audio generator
Voltmeter, Meter ME–30A/U		Vtvm

56. Checking Filament and B+ Circuits for Shorts

a. When to Check. Additional damage will be caused by applying power to equipment in which short circuits exist. When any of the following conditions apply, check first for short circuits, and clear the troubles that are found before applying power.

(1) When the nature of the symptom is not known.

(2) When symptoms reported from operational tests (pars. 33 and 34) indicate possible power supply troubles.

(3) When chassis sectionalizing procedures (pars. 57, 58, and 59) have indicated possible power supply troubles.

b. Conditions for Tests. To prepare for the short-circuit tests, perform (1) and (2) below:

(1) Remove the oscilloscope from the case (par. 37*d*).

(2) Set up the controls (par. 13).

c. Measurements. Make the resistance measurements indicated in the following chart. If abnormal results are obtained, make the additional isolating checks outlined. When the faulty part is isolated, clear the trouble before applying power to the equipment.

Short-circuit tests

Point of measurement	Normal indication	Isolating procedure
From terminal 11 of E801 to ground (fig. 10).	13,000 ohms.	If resistance is zero, check C207 for shorts. If resistance is low, check C604, C605, and C208B for shorts. If resistance is high, check F301 for open.
From terminal 8 of E801 to ground.	25,000 ohms.	If resistance is zero, check C602 for short.
From terminal 9 of E801 to ground.	6,300 ohms.	If resistance is zero, check C605, C119, and C153 for shorts. If low, check for leakage.
From terminal 13 of E801 to ground.	11,000 ohms.	If resistance is zero, check C810A and C109 for shorts. If low, check for leakage.
From terminal 12 of E801 to ground.	5,000 ohms.	If resistance is zero, check C810B and C113 for shorts. If low, check for leakage.
From terminal 15 of E801 to ground.	2,400 ohms.	If resistance is zero, check C603B, C108, and C504B. If low, check for leakage.

d. Localizing Filament Shorts.

(1) Disconnect the leads from terminals 4, 5, 6, 7, 9, 10, and 11 of E401 (fig. 32). These supply the filaments of the vertical amplifier chassis.

(2) Disconnect the leads from terminals 5 and 6 of E201 (fig. 7). These supply the filaments of the sweep generator chassis and high-voltage generator V303.

(3) Disconnect the leads from terminals 1 and 2 of E601 (fig. 32). These supply the filaments of the marker generator chassis.

(4) Disconnect the leads from terminals 1, 2, 3, 4, 5, and 6 of E801 (fig. 10). These supply the filaments of the low-voltage power supply chassis.

(5) Remove the socket from V401.

e. Isolating Filament Shorts.

(1) Replace burned-out fuse F401 or F402 (front panel fuses, fig. 3).

(2) Turn up the SCALE ILLUMINATION control.

(3) Momentarily plug in the power cord.

(4) If the scale or POWER lamps do not light, the short is in the lamp sockets, the wiring to the sockets, or in winding 9, 10, or 11 of T401. Check for burned wires, shorted socket terminals, or grounded transformer leads.

(5) Replace the V401 socket and again plug in the power cord. Terminals 16 and 17 of T401 supply the crt filament. The filament of V401 should light. If not, check for shorted or grounded leads.

(6) Replace the leads to terminals 5 and 6 of E401. These supply the filaments of the vertical amplifier chassis, V101 through V107, and V110 and V111. If these tubes do not light, inspect the sockets, wiring, and leads 9 and 11 of T401 for burns and shorts. Check tubes.

(7) Replace the leads to terminals 3 and 4 of E801 (fig. 10). These supply the filaments of V108 and V109. Inspect and test for shorts.

(8) Replace the leads to terminals 5 and 6 of E201. These supply the filaments of the sweep generator chassis, V201 through V213, and high-voltage generator V303. Inspect and test for shorts.

(9) Replace the leads to terminals 1 and 2 of E601 (fig. 32). These supply the filaments of marker generator chassis V501 through V504. Inspect and test for shorts.

(10) Replace the leads to terminals 1 and 2 of E801 (fig. 10). These supply the filaments of V804 and V813. Inspect and test for shorts.

(11) Replace the leads to terminals 3 and 4 of E801 (fig. 10). These supply the filaments of V802. Inspect and test for shorts.

(12) Replace the leads to terminals 5 and 6 of E801 (fig. 10). These supply the filaments of V801, V803, V805, V807, V808, V809, V810, V811, and V813. Inspect and test for shorts.

f. Locating Components.

(1) The vertical amplifier and attenuator chassis components are numbered in the 100 series.

(2) The sweep generator and the trigger generator components are numbered in the 200 series.

(3) The high-voltage power supply components are numbered in the 300 series.

(4) The cathode-ray indicator and the main frame assembly components are numbered in the 400 series.

(5) The marker generator components are numbered in the 500 series.

(6) The low-voltage rectifiers components are numbered in the 600 series.

(7) The low-voltage power supply and the calibration generator components are numbered in the 800 series.

57. Localizing Troubles to Chassis

a. General. Procedures are outlined in the troubleshooting chart for localizing troubles to the stages within the following chassis. Depending on the symptoms, one or more of the localizing procedures will be necessary. When use of the procedures results in localization of trouble to a particular stage, use the techniques outlined in paragraph 60 to isolate the trouble to a particular part.

(1) The vertical amplifier and attenuator chassis (figs. 27 and 33–36).

(2) The sweep generator and trigger generator chassis (figs. 28 and 37–40).

(3) The high-voltage generator chassis (figs. 29 and 41).

(4) The cathode-ray indicator and main frame assembly (figs. 45 and 46).

(5) The marker generator chassis figs. 30 and 42).

(6) The low-voltage rectifiers chassis (fig. 43).

(7) The low-voltage power supply and calibration generator chassis (figs. 31 and 44).

b. Use of Chart. The troubleshooting chart is designed to supplement the equipment performance check list (par. 34) and the sectionalization checks described in this chapter. If previous operational checks have resulted in reference to a particular step of this chart, go directly to the referenced step. If no symptoms are known, check the B+ and filament circuits for shorts (fig. 56) before starting at step 1 of the chart.

c. Conditions for Tests. All checks outlined in the chart are to be conducted with the equipment set up as indicated by the paragraph references. Test equipment should be connected to various points in the oscilloscope circuits as directed throughout the chart.

d. Troubleshooting Chart.

Note. Perform the operations in the equipment performance check list before using this chart.

(1) *Ac power.*

Item	Indication	Probable trouble	Procedure
1	POWER indicator lamp does not light.	Transformer T401 defective.	Check resistance (par. 61).
2	Scale does not appear on screen of crt when SCALE ILLUMINATION control is rotated clockwise.	Control R401 defective.	Check continuity (fig. 50).
3	After starting the equipment (par. 13), no spot appears when BRILLIANCE control is rotated clockwise.	Defective V401.	Remove high-voltage cover and check for 2,500 volts between the junction of R302 and R301 (fig. 41) with the multimeter and multiplier. If high voltage is present, replace crt V401 (par. 63).
		Defective F301 or T401.	If there is no high voltage, check fuse F301 (fig. 40) and T401 (par. 61).
		Defective high-voltage fuse.	If fuse is not open and T401 checks normal, check for 400 volts at terminal 9 of E201 (fig. 32).
		Defective low-voltage supply.	If there is no voltage at this point, the defect lies in the low-voltage power supply, V804, V806, V807, or the selenium rectifiers. Proceed to (5), item 1.

(2) *Vertical amplifier chassis.*

Item	Indication	Probable trouble	Procedure
1	Signal amplitude does not decrease when MULTIPLIER switch is turned clockwise in attenuator steps.	Shorted S101.	Check continuity (figs. 12 and 33).
2	VERTICAL GAIN control does not attenuate signal.	Open R123.	Check continuity (figs. 13 and 35).
3	No image appears in VERT PL position of MULTIPLIER switch.	Open S101.	Check continuity (figs. 12 and 33).
		Open C146.	Check continuity (figs. 12 and 33).
4	No square wave appears in CAL position of MULTIPLIER switch.	Defective S101.	Check continuity (figs. 12 and 33).
		Defective calibration voltage generator.	Troubleshoot calibration generator. (Refer to (4) below).
		Defective low-voltage supply.	Proceed to (5) below.
		Defective vertical dc and output amplifiers.	Rotate VERTICAL POSITIONING control. If trace on crt does not move up and down, make voltage and resistance checks on V108, V109, V110, and V111 (fig. 27).
		Defective vertical amplifiers V103, V104, V105, V106, and V107.	Perform adjustment procedure (par. 65*a*). If position of trace varies, this section of vertical amplifier is operating. Make voltage and resistance checks on V101, V102, and V103 (fig. 27). Check continuity of delay line Z101 (fig. 35).

(3) *Cathode-ray indicator.*

Item	Indication	Probable trouble	Procedure
1	Spot on crt screen does not appear when BRILLIANCE control is rotated clockwise.	Defective crt V401. No high voltage.	Refer to (1) above, item 3.
2	Spot does not focus.	Defective high voltage.	Check C301 and C302 (fig. 41) for shorts. Check R302 and R303 (fig. 41). Check for open resistor in voltage divider R301 and R304 through R308 (fig. 41). Check for open resistor in voltage divider R402 through R409 (fig. 46).
3	Spot does not position vertically.	Defective vertical amplifier. Defective −150-volt supply.	Check voltage and resistance on V108, V109, V110, and V111 (fig. 27). Check voltage and resistance on V803, V805, and V806 (fig. 31). Proceed to (5) below, item 1.
4	Spot does not position horizontally.	Defective V213. Defective 200-volt supply.	Check voltage and resistance on V213 (fig. 28). Open R417 and R418 (fig. 45). Check voltage and resistance on V802 and V808 (fig. 31).

(4) *Calibration voltage generator.*

Item	Indication	Probable trouble	Procedure
1	No wave form appears on crt screen in CAL position of MULTIPLIER switch.	Defective calibration generator. No bias voltage.	Check voltage and resistance of V809, V810, and V812 (fig. 31). Check 200-volt supply V802 and V809 (fig. 31). Check for open R840 and R841 (fig. 44).
2	No output at CAL VOLTAGE OUTPUT jack.	Open R830, R831, and R832. Shorted C811.	Check resistance (figs. 22 and 44). Check continuity (figs. 22 and 44).

(5) *Low-voltage power supply chassis.*

Item	Indication	Probable trouble	Procedure
1	No −150-volt dc output.	Defective components. Open F405. Defective CR603 (fig. 43). Shorted C603A or C603B (fig. 43).	Check voltage and resistance on V803, V805, and V806 (fig. 31). Replace. Replace. Replace.
2	No 150-volt dc output.	Defective components. Defective CR605 and CR608 (fig. 43).	Check voltage and resistance on V811 and V813 (fig. 31). Check C808 for short. Replace CR605 and CR608.
3	No 200-volt dc output.	Defective components.	Check voltage and resistance on V802 and V808 (fig. 31).
4	No 400-volt dc output.	Open F403 and F404. Defective components.	Replace. Check voltage and resistance on V804 and V807 (fig. 31).

(6) *Marker generator chassis.*

Item	Indication	Probable trouble	Procedure
1	No markers visible on screen in any position of MARKER switch.	Defective S501.	Check continuity (figs. 21 and 42).
		Defective components.	Check voltage and resistance on V501, V502, V503, and V504 (fig. 30).
			Check L501 through L505 (par. 61).
		Open C510 (fig. 42).	Replace.
		No dc voltages.	Check for 200 volts at terminal 6 of E601 (fig. 43).
			Check for −150 volts at terminal 4 of E601.
			Check C504 for shorts.
		No enabling gate.	Check voltage and resistance on V206, V207, and V208 (fig. 28).
			Check C502 for open (fig. 42).
2	No marker in any single switch position.	Defective oscillator coil.	Check continuity of Z501 and Z502 (figs. 42 and 50).
		Defective S501.	Check continuity (figs. 21 and 42).

(7) *Trigger generator.*

Item	Indication	Probable trouble	Procedure
1	Sweep does not synchronize in INT TRIG position of SYNC selector switch.	Defective components.	Check voltage and resistance on V201 and V202 (fig. 28).
		Defective S201, S202.	Check continuity (fig. 39).
		Open L201.	Check resistance (par. 61).
		Shorted C206.	Check continuity (fig. 39).
		Sync amplifiers defective.	Check voltage and resistance on V203, V204, V205, and V206 (fig. 28).
			Check C214 and C217 for short (fig. 39).
2	No output at panel jacks.	Defective T201.	Check continuity (par. 61).

(8) *Sweep generator chassis.*

Item	Indication	Probable trouble	Procedure
1	Horizontal amplifier inoperative.	Defective components.	Check voltage and resistance on V213 (fig. 28).
		Open R285 (fig. 37) and C231 (fig. 39).	Replace.
		Open R286 (fig. 37) and C232 (fig. 39).	Replace.
2	Sweep delay inoperative.	Defective S204.	Check continuity (fig. 38).
		Defective components.	Check voltage and resistance on V210, V211 (fig. 28).
		Open R267, R268, and R269.	Check continuity (figs. 37 and 38).
3	No horizontal sweep.	Defective components.	Check voltage and resistance on V209, V212, and V213 (fig. 28).
		Low dc voltages.	Check 200- and 400-volt supplies.
		Stability control open.	Check continuity of R254 (fig. 38).
		Defective S203.	Check continuity (fig. 39).
4	Unstable trace.	Improper setting of STABILITY control.	Refer to paragraph 14*a*.
		No synchronization.	Check S202 (fig. 39).
		Improper setting of SYNC polarity control.	Refer to paragraphs 15, 16, and 17.
		Improper setting of SWEEP TIME FINE control.	Refer to paragraph 14.

(9) *Low-voltage rectifiers chassis.*

Item	Indication	Probable trouble	Procedure
1	No dc output at E601 (fig. 32).	Defective rectifiers.	Replace (fig. 43).
		Defective capacitors.	Check C601 through C605 for shorts (fig. 43).
2	No ac inputs at E601.	Defective fuses.	Check continuity of fuses (fig. 46).
		Defective T401 (fig. 46).	Check resistance and voltage (par. 61).

(10) *High-voltage power supply chassis.*

Item	Indication	Probable trouble	Procedure
1	No high voltage.	Defective components.	Check voltage and resistance on V303 (fig. 29).
		Defective F301.	Replace (fig. 41).
		Open L302 and L303 (fig. 42).	Check continuity (par. 61).
		Shorted C309.	Replace.
2	No 1,500 volts.	Open R302 (fig. 41).	Replace.
		Shorted C301 (fig. 41).	Replace.
3	No −1,000 volts.	Open R303 (fig. 41).	Replace.
		Shorted C302 (fig. 41).	Replace.
4	Low high voltage.	Open R302 and R303 (fig. 41).	Replace.
5	Spot on crt blooms.	Resistors changed value.	Check resistances (fig. 29).
		Capacitors C303 through C306 open.	Replace (fig. 41).

58. Localizing Trouble by Wave Form Analysis

a. General. All assemblies, except the vertical amplifier chassis, generate pulses which are made available at the various output connectors. Figure 26 illustrates these wave forms and an analysis of each follows. A calibrated oscilloscope and an accurate ac voltmeter are required for measurements. For checking the vertical amplifier, a signal generator is required with a frequency range up to 15 megacycles and a calibrated output of 100,000 microvolts.

b. Vertical Amplifier. The vertical amplifier has a maximum sensitivity of 25 millivolts per inch of vertical deflection and a minimum sensitivity of 45 millivolts per inch of vertical deflection, over the frequency range of 3 cps to 15 mc. No distortion or compression of the wave form should be visible within the 2-inch limit of the illuminated scale. The VERTICAL GAIN control has an attenuation range of 4 to 1. Check the above characteristics as follows:

(1) Set the MULTIPLIER switch to 1.

(2) Set the VERTICAL GAIN control maximum clockwise.

(3) Set up the controls for maximum sweep speed (par. 14*a*).

(4) Set the signal generator to 15 mc and connect its output to the SIGNAL INPUT connector.

(5) Increase the output of the RF generator until the sine wave on the screen occupies the full 2 inches of the illuminated scale. The generator attenuator should indicate an output of less than 50 millivolts, and the signal should not be limited within the full area of the scale.

(6) A clear signal with 2 inches of vertical deflection, with a generator output setting greater than 50 millivolts, indicates weak tubes in the oscilloscope preamplifier section.

(7) A distorted signal indicates defective tubes or component in the push-pull vertical amplifier section. Check V108 through V111 (figs. 15, 27, 33, and 34).

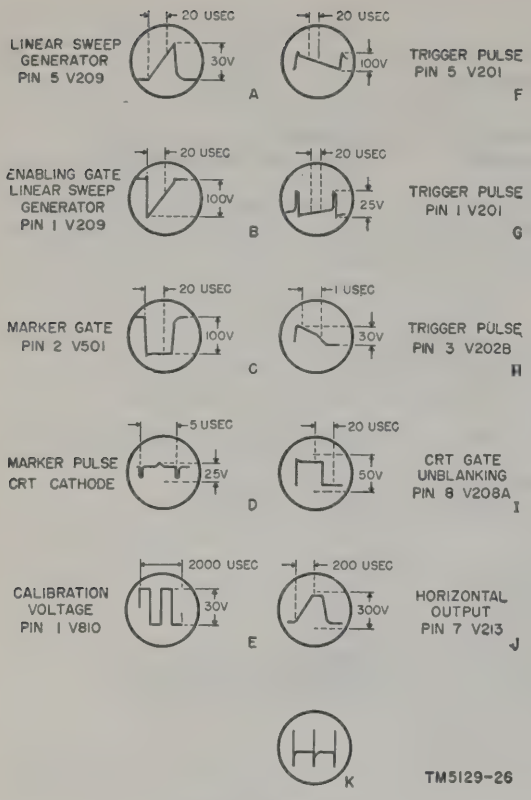


Figure 26. Wave forms.

c. Sweep Generator. The sweep generator chassis contains the trigger generator, the linear sweep generator, and the enabling gate generator. The trigger pulse is available at the TRIGGER OUTPUT connectors, the amplifier sawtooth generated by the linear sweep generator is available at the HORIZONTAL AMPLIFIER OUTPUT connector, and the efficiency of the enabling gates can be determined by the operations they control. Figure 11 shows the distribution of the wave forms. Check the above characteristics as follows:

(1) Connect the calibrated oscilloscope to the TRIGGER OUTPUT POSITIVE connector.

(2) Set up the oscilloscope to obtain 1 cycle of a 1-microsecond trigger pulse.

(3) Set up the TRIGGER RATE and RANGE controls for a 1-microsecond trigger pulse (H, fig. 26).

(4) The pulse should have a minimum amplitude of 25 volts peak-to-peak with a rise time of .15 microsecond or less, and a pulse width of approximately 1.2 microseconds.

(5) The pulse amplitude should measure approximately 8.5 volts rms minimum.

(6) If the amplitude of the wave form is low, check V201 and V202. If the signal is distorted, defective components exist in these stages (figs. 7, 17, and 28). Refer to paragraph 60.

(7) Set up the SWEEP TIME controls to generate a sweep sawtooth of 200 microseconds (par. 14).

(8) Connect a calibrated oscilloscope to the HORIZONTAL AMPLIFIER OUTPUT connector, and set up the controls to produce 1 cycle of the 200-microsecond sawtooth ((7) above).

(9) The amplitude of the sawtooth should be approximately 300 volts peak-to-peak, or a minimum of 105 volts rms as measured with the ac voltmeter (J, fig. 26).

(10) Lower amplitudes usually indicate weak tubes (V212 and V213); distortion indicates defective components in those stages (figs. 7, 20, and 28).

(11) The enabling gate applied to the grid of the crt has sufficient amplitude so that at the greatest sweep speed and the highest frequency sine wave, all sections of the voltage wave form are visible. Insufficient intensity may be due to a low amplitude enabling gate voltage.

(12) If the enabling gate voltage applied to the marker generator is of low amplitude, the intensity of the markers applied to the crt cathode will be reduced.

(13) If the enabling gate voltage applied to the linear sweep generator is of low amplitude, insufficient sweep length and visible retrace lines will result.

d. Marker Generator. The markers are used to modulate the crt beam in the form of bright dots, and are also available at the Z AXIS connector as negative going pulses for external applications. Wave form D, figure 26, illustrates the marker pulses. Check the characteristics as follows:

(1) Connect the calibrated oscilloscope to the Z AXIS connector.

(2) Set the MARKER switch to 5.

(3) Set up the controls of the calibrated

oscilloscope to produce 1 cycle of the marker pulse.

(4) The 5-microsecond pulse must have a minimum amplitude of 15 volts peak-to-peak. The minimum amplitude of the .2- and 1-microsecond pulses should be 12 volts peak-to-peak, and for the 20-, 100-, 500-, and 2,000-microsecond markers, 20 volts peak-to-peak minimum.

(5) If no markers are visible, refer to paragraph 57*d*(6).

e. Calibration Generator. The calibration generator is mounted on the low-voltage power supply chassis. The peak calibrated output of the generator is 30 volts peak-to-peak and is available at the CAL VOLTAGE OUTPUT connector. A portion of the calibration voltage is applied to the input of the vertical amplifier when the MULTIPLIER switch is in the CAL position. This voltage can be varied by the CALIBRATION VOLTAGE control which has a dial accurately calibrated from 10 to 100 millivolts. The output is a square wave with a fundamental frequency of 1,000 cps.

(1) Connect the calibrated oscilloscope to the CAL VOLTAGE OUTPUT connector.

(2) Set up the oscilloscope to display a stationary image of the 1,000-cps generator output. The square wave (E, fig. 26) must have an amplitude of 30 volts peak-to-peak and be symmetrical.

(3) If no pulse is visible, refer to the troubleshooting chart (par. 57*d*(4)). Distortion indicates defective components.

59. Power Supply Voltage Checks

a. High-Voltage Power Supply.

(1) Connect the negative lead of the multimeter to a convenient ground point on the main frame.

(2) Set the multimeter to the 5,000-volt dc range.

(3) With the power off, disconnect the anode lead from the crt and connect the positive lead (high-voltage probe) of the multimeter to the anode lead.

(4) Turn on the power. The average reading should be +1,500 volts; the minimum reading, +1,400 volts dc.

(5) Turn off the power and discharge the high-voltage filter capacitors.

(6) Set the FUNCTION knob on the multimeter to the DC REV position.

(7) Connect the high-voltage probe to the junction of R303 (fig. 41) and the negative voltage shielded lead.

(8) Turn on the power. The average reading must be −1,000 volts; the minimum over −900 volts.

b. Low-Voltage Power Supply Distribution. Terminal board E801 (fig. 32) is the termination point for the ac and dc input and output voltages. In addition to voltages in figure 32, the following measurements will check out the filament distribution:

(1) Between terminals 1 and 2, 12.6 volts ac.

(2) Between terminals 3 and 4, 6.3 volts ac.

(3) Between terminals 5 and 6, 12.6 volts ac.

60. Isolating Trouble Within Stage

When trouble has been localized to a stage or to a group of functionally related stages, either through equipment performance check list (par. 34), the troubleshooting chart (par. 57), or wave form analysis (par. 58), use the following techniques to isolate the defective part.

a. Test the tube involved (par. 36), either in the tube tester or by substituting a similar type tube which is known to be operating normally.

b. Take voltage measurements at the tube sockets (figs. 27–31), the terminal boards (fig. 32), and the test points (figs. 6, 7, and 10) related to the stages in question.

c. If voltage readings are abnormal, take resistance readings (figs. 27–32). Refer also to the winding data (par. 61).

d. Figures 33 through 46 will aid in the locating of the components. Figures 48 and 49 show the color code markings used for resistors and capacitors.

61. DC Resistances of Transformers and Coils

The dc resistances of the transformer windings and the coils in the oscilloscope are listed below.

Transformer or coil	Terminals	Ohms
T401	1–2	.5
	3–4	20
	5–6	6

REAR

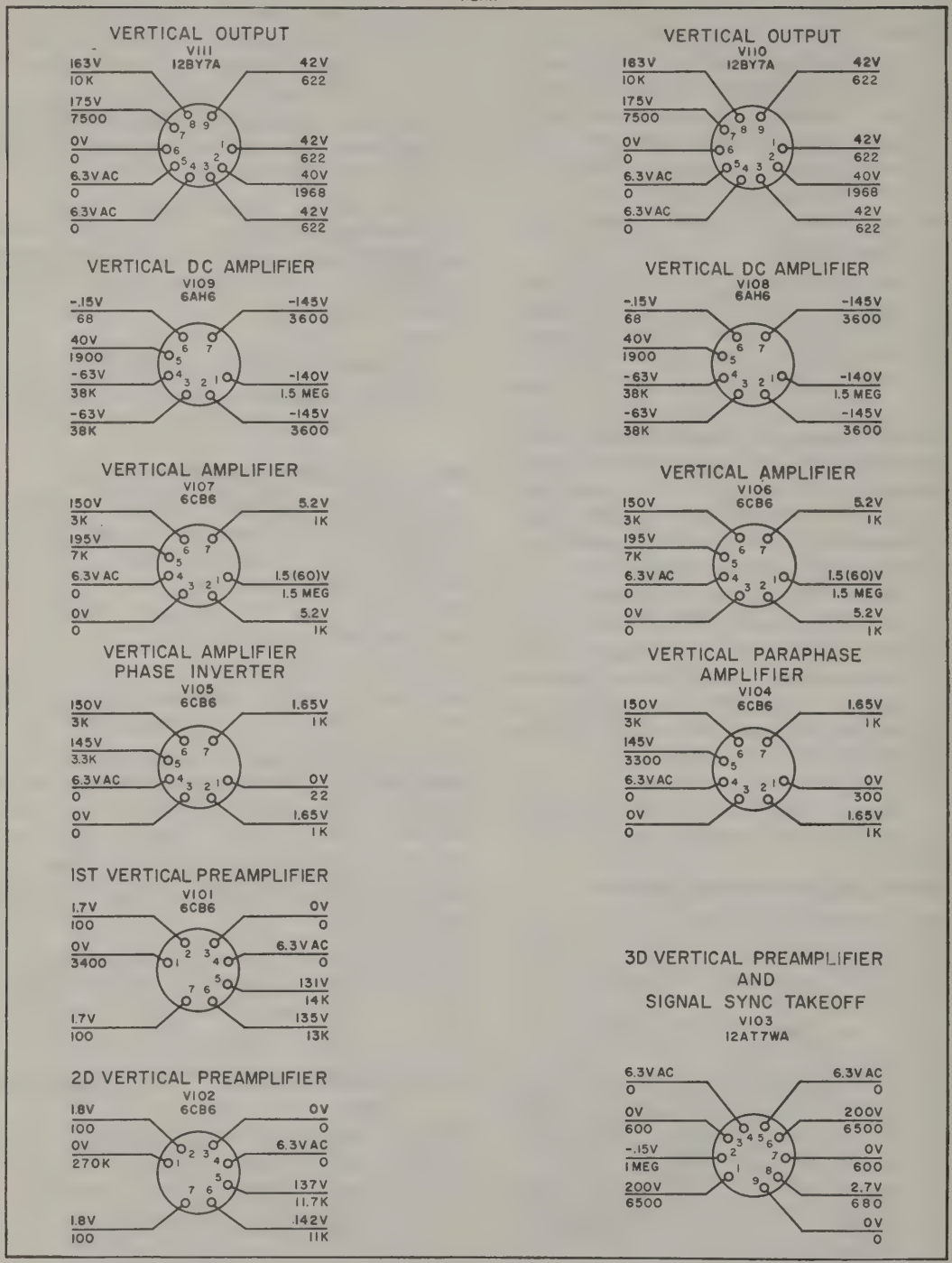
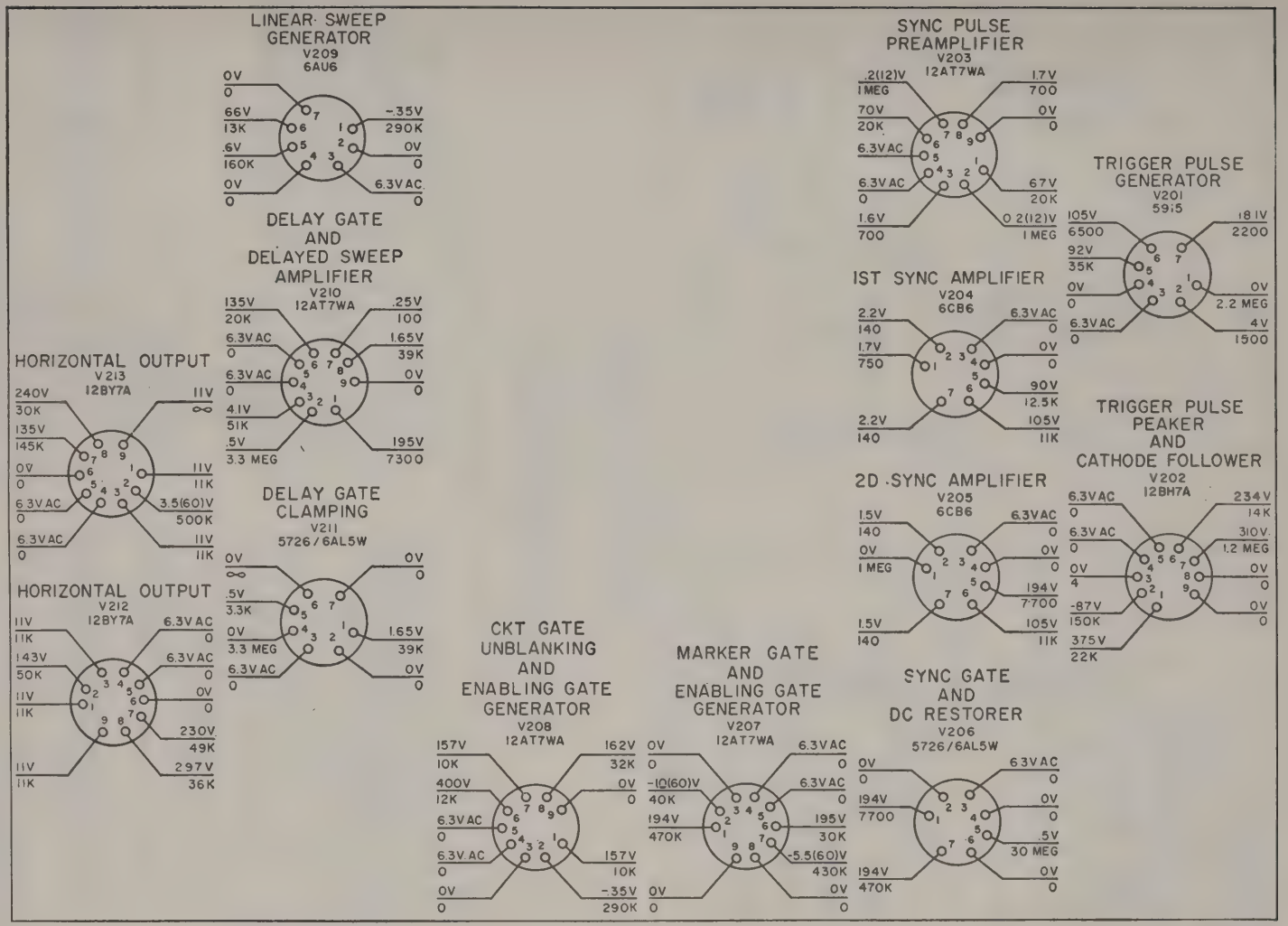


Figure 27. Resistance and voltage diagram, vertical amplifier chassis.



NOTE:
VOLTAGES IN PARENTHESIS DEPEND UPON SWITCH SETTINGS.

Figure 28. Resistance and voltage diagram, sweep generator and trigger generator chassis.

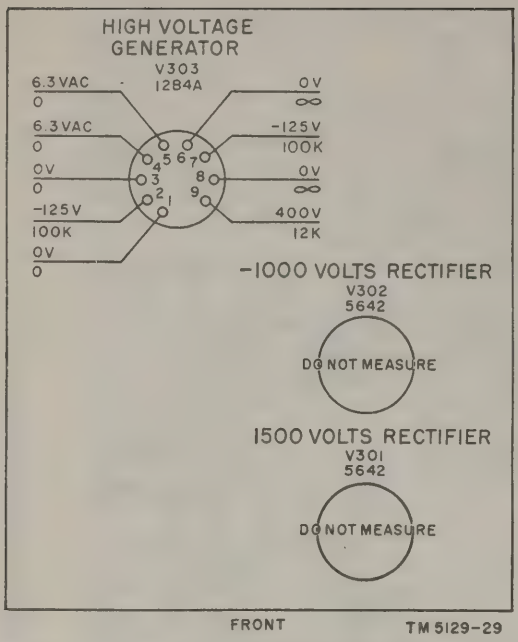


Figure 29. Resistance and voltage diagram, high-voltage power supply chassis.

Transformer or coil	Terminals	Ohms
T401 (cont)	7–8	22
	9–11	.1
	12–13	.1
	14–15	.1
	16–17	.1
T301		6.5
L302		50
L303		500
T201	1–4	4
	2–5	2.5
	3–6	2.5
L201		2
L202		2.5
L203		2.5
L204		7.5
Z101	1–2	.5
L101 through L112		.1
L501		1
L502		.2
L503		2.5
L504		7
L505		7

Section III. REPAIRS

62. General

Most of the components of the oscilloscope are accessible only when the chassis are removed from the main frame. Perform the applicable instructions listed below upon completion of repairs.

Vertical Amplifier (fig. 6).

(1) Bias voltage adjustment, R116 (par. 65*a*).

(2) Low-frequency adjustment, R109 (par. 65*b*).

(3) High-frequency adjustment, C103 (par. 65*c*).

(4) First-balance adjustment, R135 (par. 65*d*).

(5) Second-balance adjustment, R150 (par. 65*d*).

b. Attenuator (fig. 6). MULTIPLIER series and shunt adjustments (par. 65*e*).

c. Calibration Generator (fig. 10). Calibration voltage reference adjustment R841 (par. 65*f*).

d. Low-Voltage Power Supply (fig. 10).

(1) −150 volts dc output, R806 (par. 65*g*).

(2) +400 volts dc output, R814 (par. 65*g*).

(3) +200 volts dc output, R815 (par. 65*g*).

(4) +150 volts dc output, R387 (par. 65*g*).

63. Removal and Replacement of Cathode-Ray Tube

(fig. 45)

a. Removal and Replacement.

(1) Discharge the high-voltage capacitors.

(2) Remove the five plug-in leads from the deflection plates and the accelerator anode.

(3) Remove the five screws holding the socket to the bracket.

(4) Remove the socket.

(5) Push the tube gently forward while holding the front end; remove the tube.

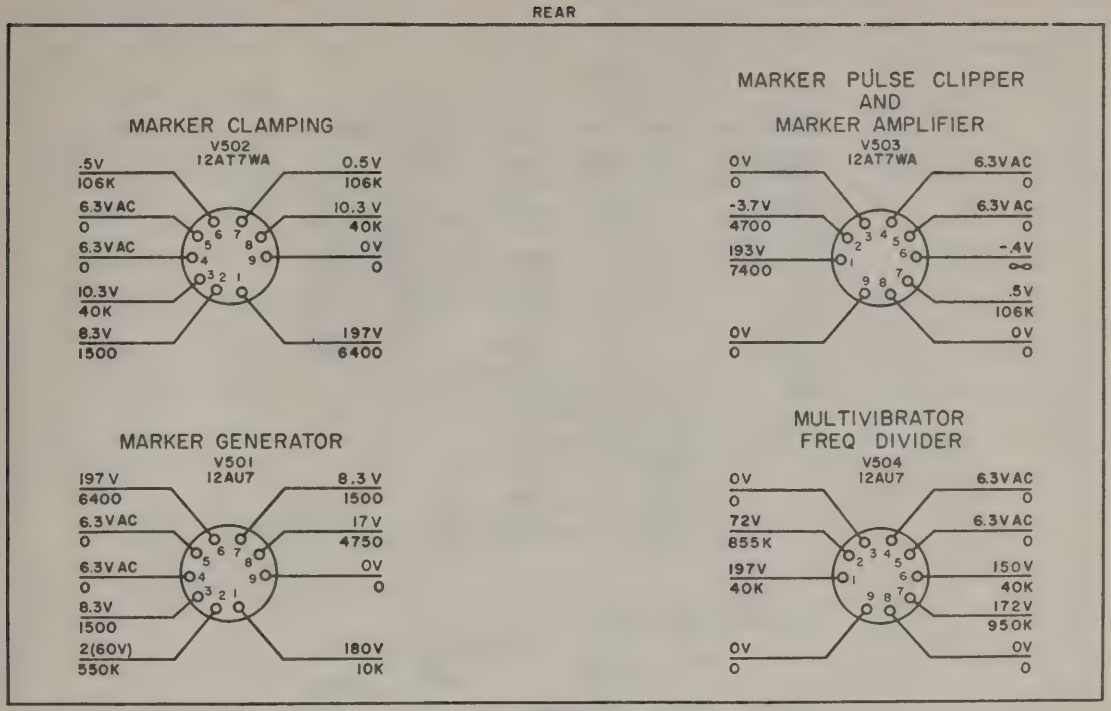


Figure 30. Resistance and voltage diagram, marker generator chassis.

b. Alinement.

(1) Loosen the four outside screws that hold the crt socket to the bracket. The cathode-ray tube can now be rotated for parallel alinement.

(2) Loosen the two hexagonal head screws that attach the tube shield to the socket assembly. Move the cathode-ray tube axially to correct parallax.

Section IV. ADJUSTMENTS

64. Test Equipment Required for Adjustments

In addition to the equipment listed in paragraph 55, Signal Generator SG–106/U is required. It will be referred to as a *square wave generator* throughout this manual.

65. Adjustment Procedures

a. V103A Bias Voltage Adjustment, R116 (fig. 6).

(1) Obtain a spot on the screen (pars. 13 and 14).

(2) With no signal input, rotate the VERTI-

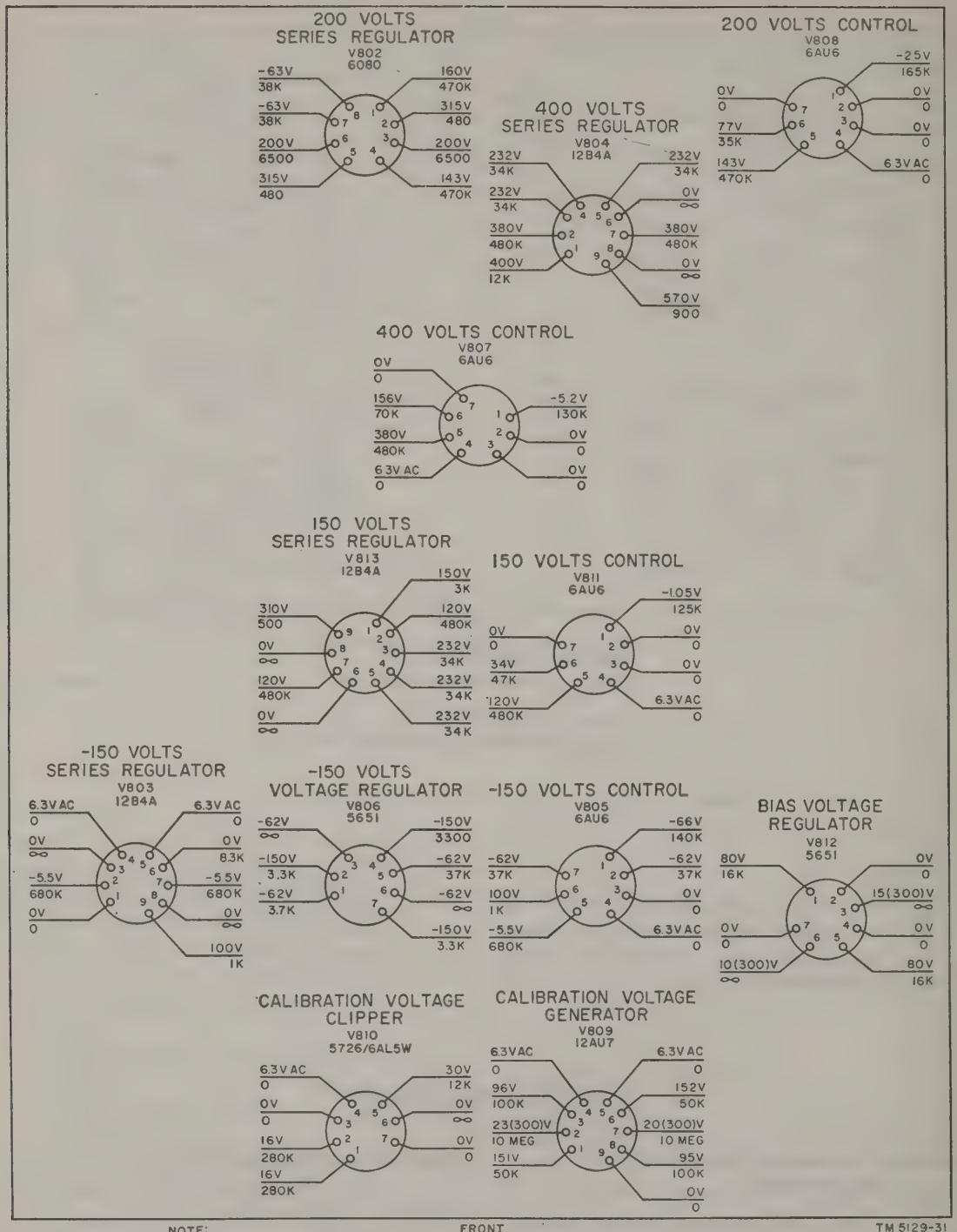


Figure 31. Resistance and voltage diagram, low-voltage power supply chassis.

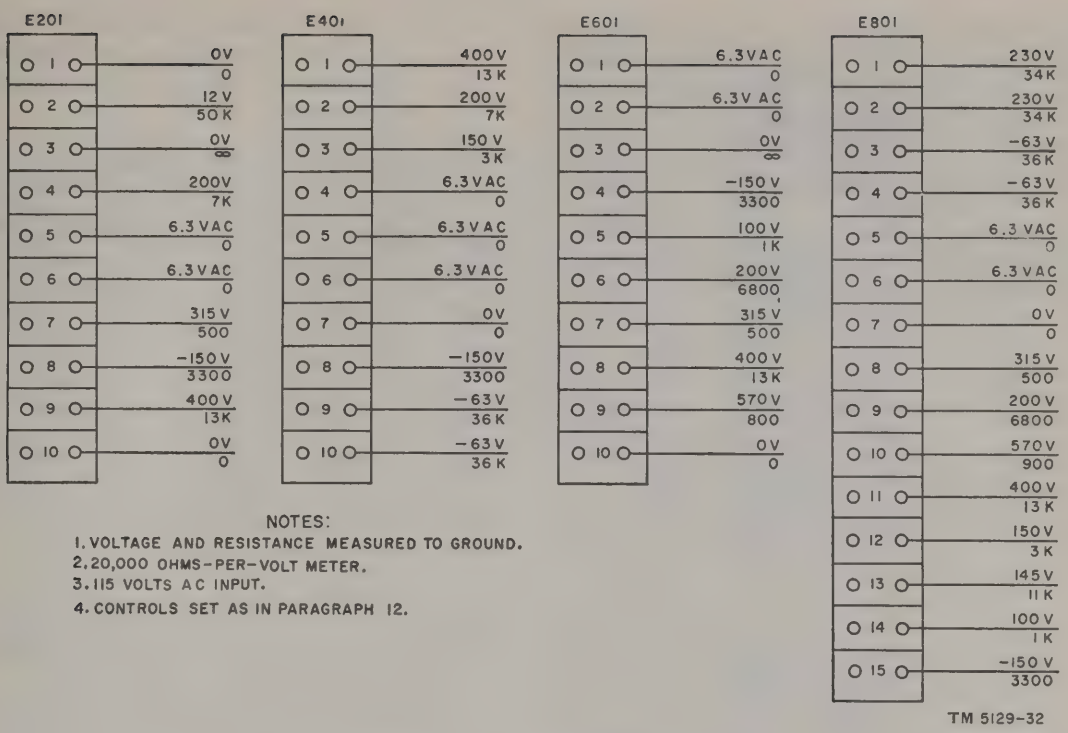


Figure 32. Resistance and voltage diagram, terminal boards.

CAL GAIN control between the maximum clockwise and counterclockwise positions.

(3) There must be no vertical movement of the spot during step 2.

(4) If the spot moves while performing step 2, adjust R116 slowly until a balance is obtained.

b. Low-Frequency Adjustment, R109 (fig. 6).

(1) Apply a 50-cps signal from the square wave generator to the SIGNAL INPUT connector.

(2) Set the MULTIPLIER switch to 1.

(3) Adjust the SWEEP TIME controls for 1 cycle of the square wave.

(4) Adjust the amplitude of the square wave to approximately 10 divisions on the calibrated scale, with the attenuator of the square wave generator.

(5) No tilt should be apparent on the top of square wave. Adjust R109 for a flattop.

c. High-Frequency Adjustment, C103 (fig. 6).

(1) Apply a 1-megacycle signal from the square wave generator to the SIGNAL INPUT connector.

(2) Set the MULTIPLIER switch to 30.

(3) Adjust the VERTICAL GAIN control for 11-division deflection.

(4) Adjust the SWEEP TIME controls for 1 cycle of the square wave for approximately 1½ inches width.

(5) Turn the SYNC polarity control maximum clockwise.

(6) The pulse must show not more than ½ division overshoot or depart from a flat top by more than ½ division.

(7) Adjust C103 if the overshoot exceeds ½ division on the scale.

d. Balance Adjustments, R135 and R150 (fig. 6).

(1) Connect the multimeter between J102 and J103. Set the multimeter to the lowest dc range.

(2) Adjust R135 until the meter indicates zero.

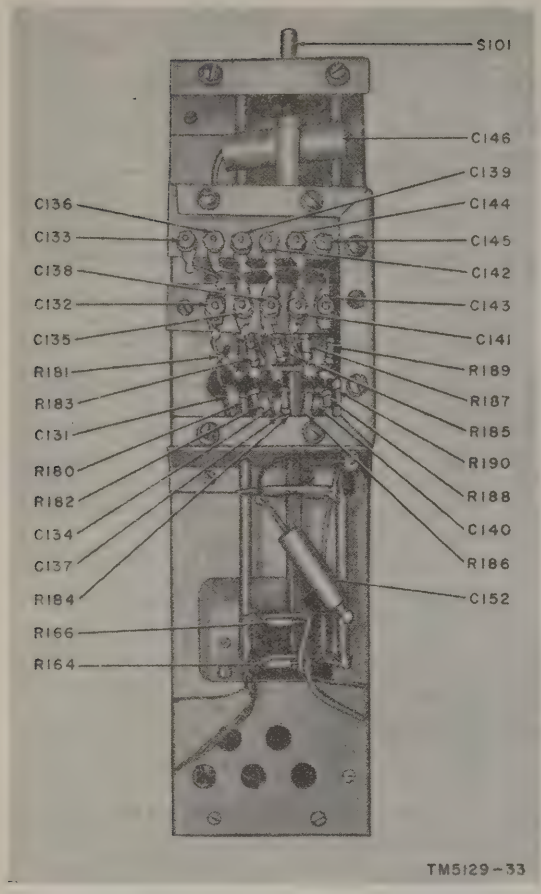


Figure 33. Vertical attenuator chassis, adjustments and components location.

(3) Connect the voltmeter between J104 and J105.

(4) Adjust R150 until the meter indicates zero.

e. Multiplier Adjustments (figs. 6 and 33). Set controls as follows:

(1) SWEEP TIME switch to 1,000.

(2) SWEEP TIME FINE control to display 3 cycles.

(3) SYNC polarity control maximum counterclockwise.

(4) SYNCH selector to SIGNAL.

(5) VERTICAL GAIN control at midpoint.

(6) Apply a 1,000-cycle square wave to the SIGNAL INPUT connector.

(7) In each position of the MULTIPLIER switch listed below, adjust the corresponding capacitor for a good quality square wave on the crt.

MULTIPLIER position	Signal input level (peak-to-peak volts)	Adjustment	
		Shunt	Series
1	.5	C145	
3	.5		C143
3	1.5	C144	
10	1.5		C141
10	5.0	C142	
30	5.0		C138
30	15.0	C139	
100	15.0		C135
100	50.0	C136	
300	50.0		C132
300	50.0	C133	

f. Calibration Voltage Level, R841 (fig. 10).

(1) Connect the multimeter between J802 and ground.

(2) Adjust R841 for a reading of 30 volts dc.

g. Regulated Voltage Output Adjustments (fig. 10).

(1) Connect the multimeter between terminal 15 of E801 and ground.

(2) Adjust R806 for a −150-volt reading on the multimeter.

(3) Connect the multimeter between terminal 11 of E801 and ground.

(4) Adjust R841 for a +400-volt reading on the multimeter.

(5) Connect the multimeter between terminal 9 of E801 and ground.

(6) Adjust R815 for a +200-volt reading on the multimeter.

(7) Connect the multimeter between terminal 12 of E801 and ground.

(8) Adjust R837 for a +150-volt reading on the multimeter.

h. Deflection Sensitivity Adjustment (fig. 45).

(1) Set the MULTIMETER switch to VERT PL.

(2) Connect the coaxial cable between the CAL VOLTAGE OUTPUT and the SIGNAL INPUT connector.

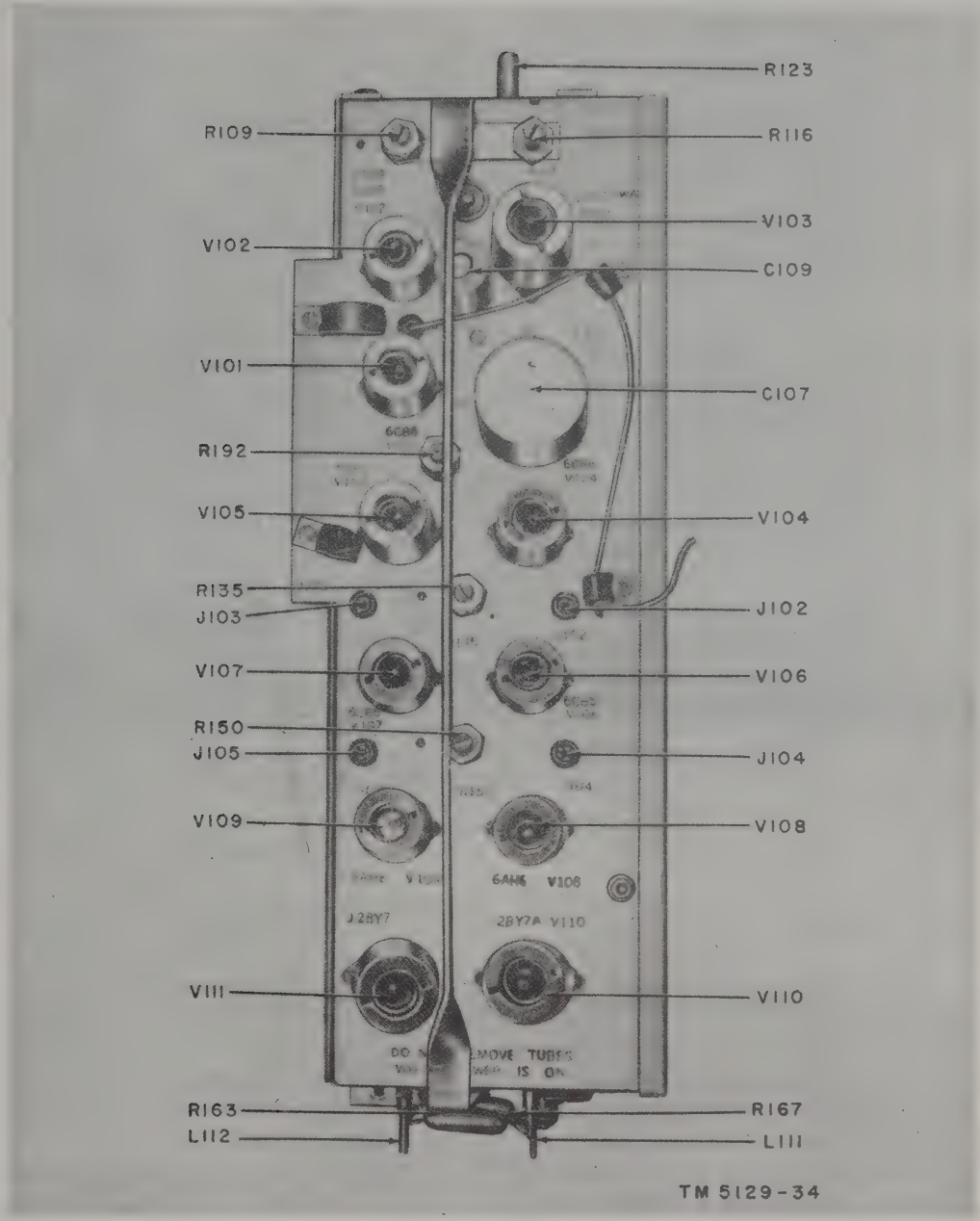


Figure 34. Vertical amplifier chassis, top view.

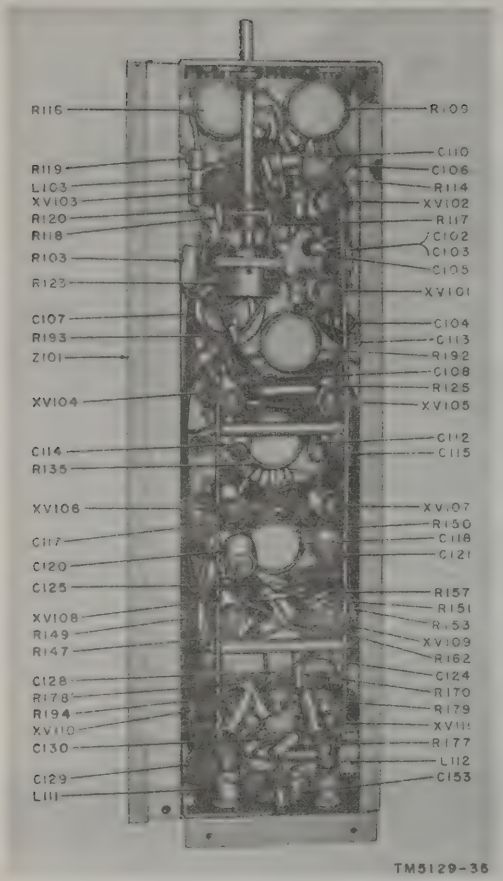


Figure 35. Vertical amplifier chassis, bottom view.

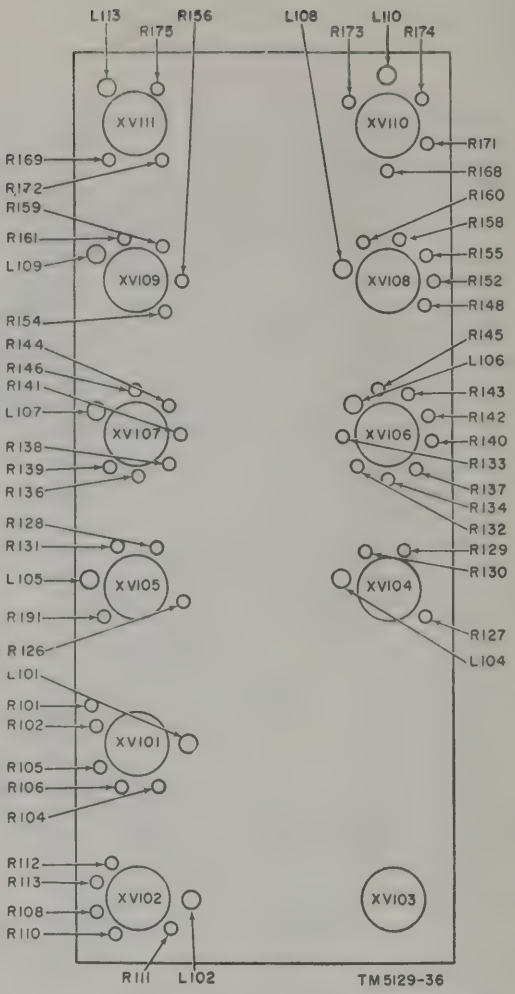


Figure 36. Vertical amplifier chassis, bottom view, socket assemblies.

(3) Adjust R402 for 15 divisions of the vertical trace.

i. Astigmatism Adjustment, R417 (fig. 45).

(1) Set the MULTIPLIER switch to CAL.

(2) Set the SWEEP TIME switch to 10,000.

(3) Set the SYNC selector switch to SIGNAL.

(4) Adjust the SWEEP TIME FINE control to stop the image.

(5) Adjust both the FOCUS control and R417 for the sharpest line at both the left and right end of image.

j. Hum Adjustment, R192 (fig. 6).

(1) Set MULTIPLIER switch to 300.

(2) Turn VERTICAL GAIN control maximum clockwise.

(3) Place the vtvm across the vertical deflection plates of the crt. Use the 100-mv scale.

(4) Adjust R192 for minimum hum; reading on the vtvm should be less than 60 mv.

k. Ripple Voltage Check (Indicates Open Filter Capacitors).

(1) Set the vtvm to the 25-mv scale.

(2) Connect one test lead to chassis ground.

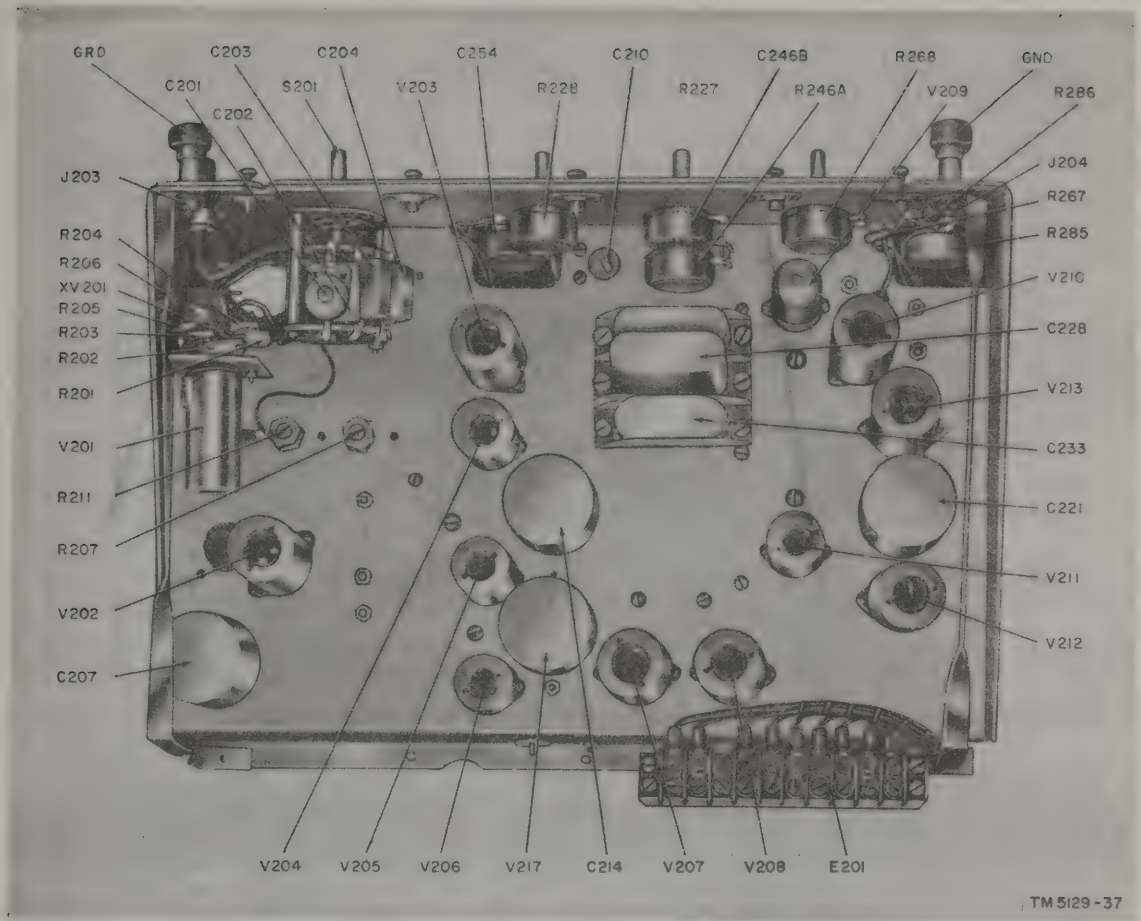


Figure 37. Sweep generator and trigger generator chassis, top view.

(3) Connect the other test lead in series with a 600-volt, .5-microfarad capacitor to the E801 terminals indicated below. Readings above those specified in the table indicate open or defective filter capacitors in the low-voltage power supply.

Terminal No.	Reading in mv
9	10
11	20
12	5
15	15

Section V. FINAL TESTING

66. Purpose

Equipment which has been repaired must meet definite minimum performance standards before it is returned to service. The tests outlined in this section are designed to measure the performance capabilities of a repaired oscilloscope. Equipment which meets the minimum standards stated in the tests will furnish satisfactory operation.

67. Test Setup

Most of the tests will be performed under the

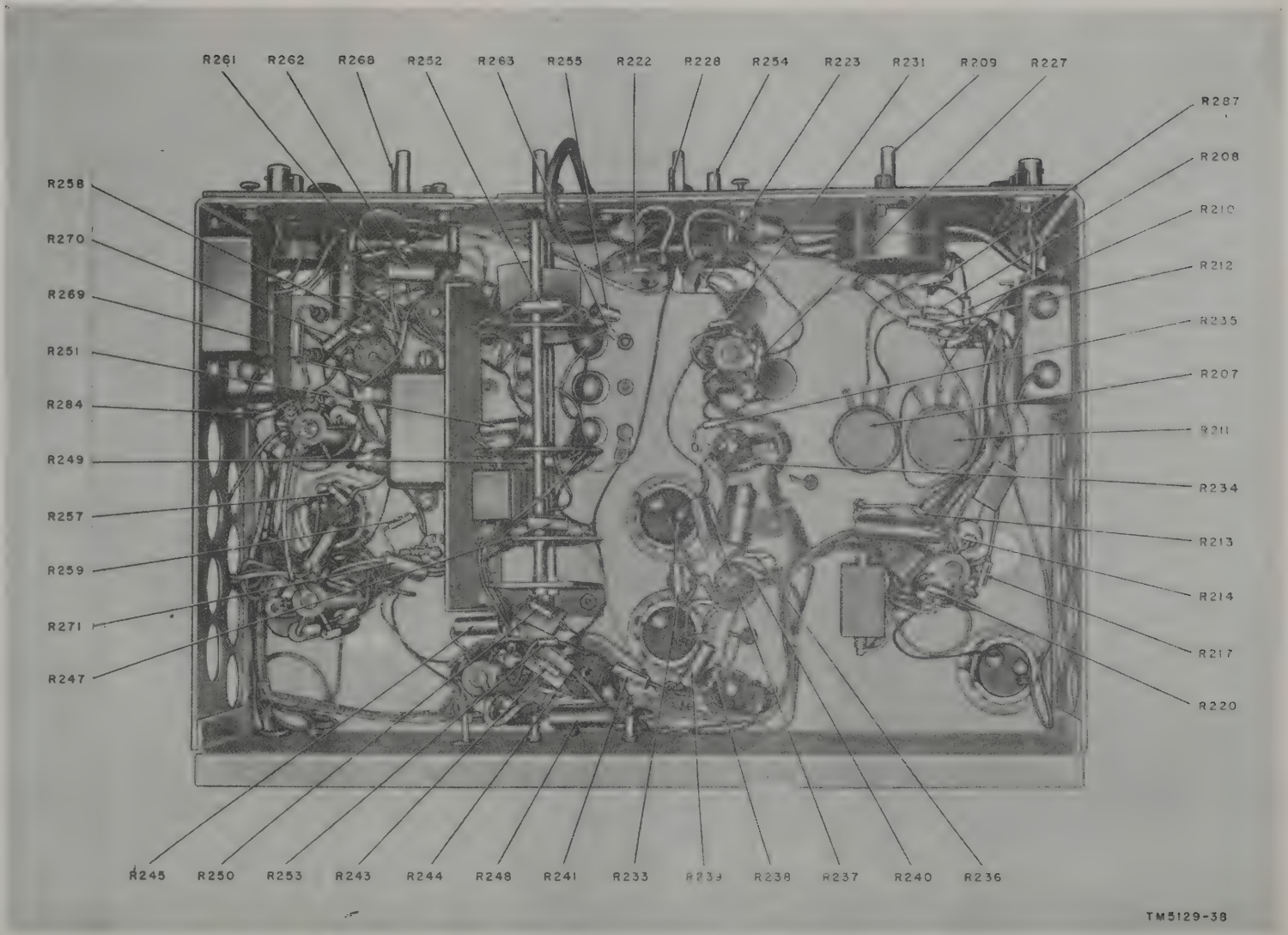


Figure 38. Sweep generator and trigger generator chassis, bottom view, showing resistors.

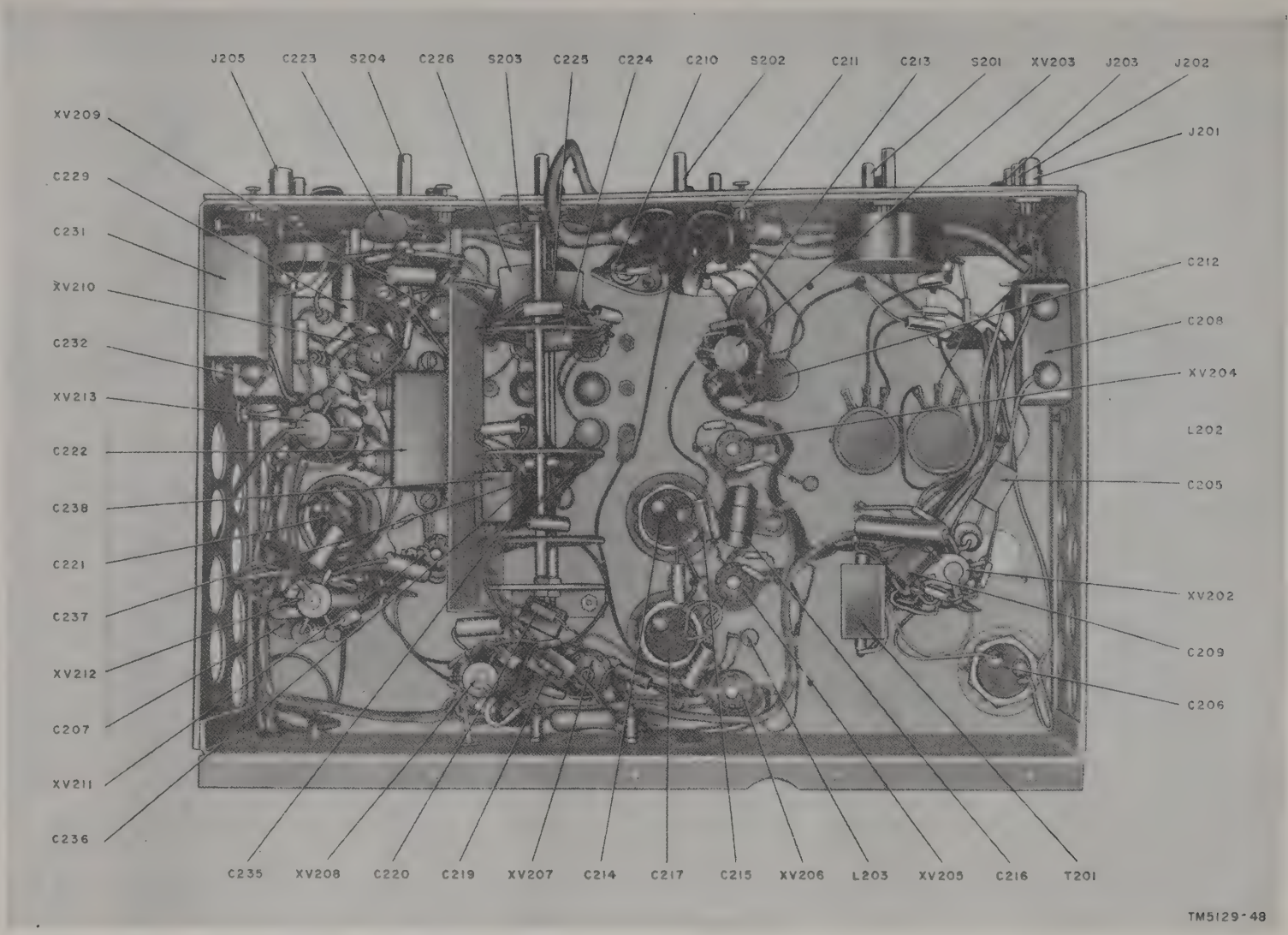


Figure 39. Sweep generator and trigger generator chassis, bottom view showing capacitors and switches.

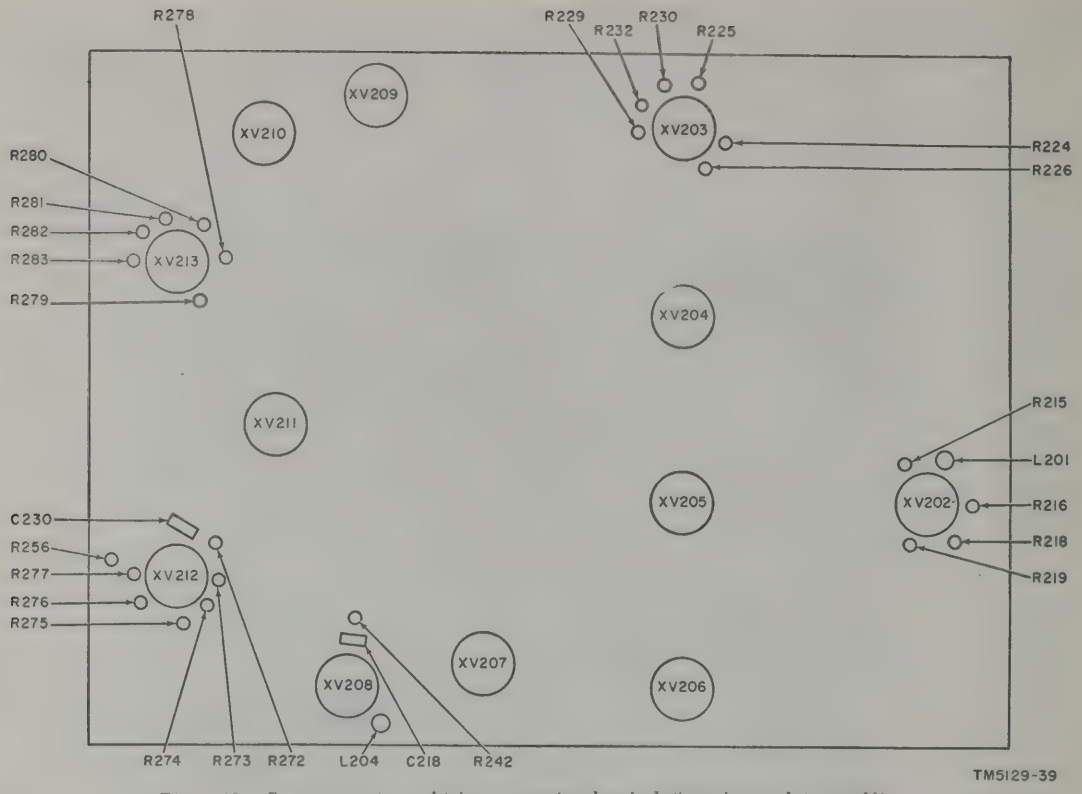


Figure 40. Sweep generator and trigger generator chassis, bottom view, socket assemblies.

conditions listed below and illustrated in figure 47. Testing will be simplified if connections and panel-control settings are made initially and modifications are made as required for the individual tests. The oscilloscope and the square wave generator (par. 64) are the only two items of test equipment required for final testing.

a. Connect the coaxial cable to the post adapter supplied with the oscilloscope and plug the adapter into the test oscilloscope.

b. Connect the other coaxial cable mounted in the accessory cover to another similar adapter and connect the square wave generator.

c. Calibrate the test oscilloscope to give maximum deflection for the wave form being analyzed. Figure 26 shows the maximum amplitudes for the wave forms.

68. Final Tests

a. Vertical Amplifier.

(1) Set the MULTIPLIER switch to 1.

(2) Turn the VERTICAL GAIN control maximum clockwise.

(3) Set the square wave generator to 1,000 cycles and connect to the SIGNAL INPUT connector.

(4) Set the SWEEP TIME controls to obtain 1 cycle of the 1,000-cps voltage.

(5) Adjust the output of the square wave generator to produce an amplitude of 10 divisions on the vertical scale (1 inch of deflection). Note the setting of the attenuator on the square generator. It should be less than 45 millivolts.

(6) Turn the MULTIPLIER switch to CAL.

(7) Adjust the CALIBRATION VOLTAGE dial to obtain an amplitude of 10 divisions on the vertical scale.

(8) The readings ((5) and (7) above) should be the same.

b. Sweep Generator.

(1) Connect the test oscilloscope to the HORI-

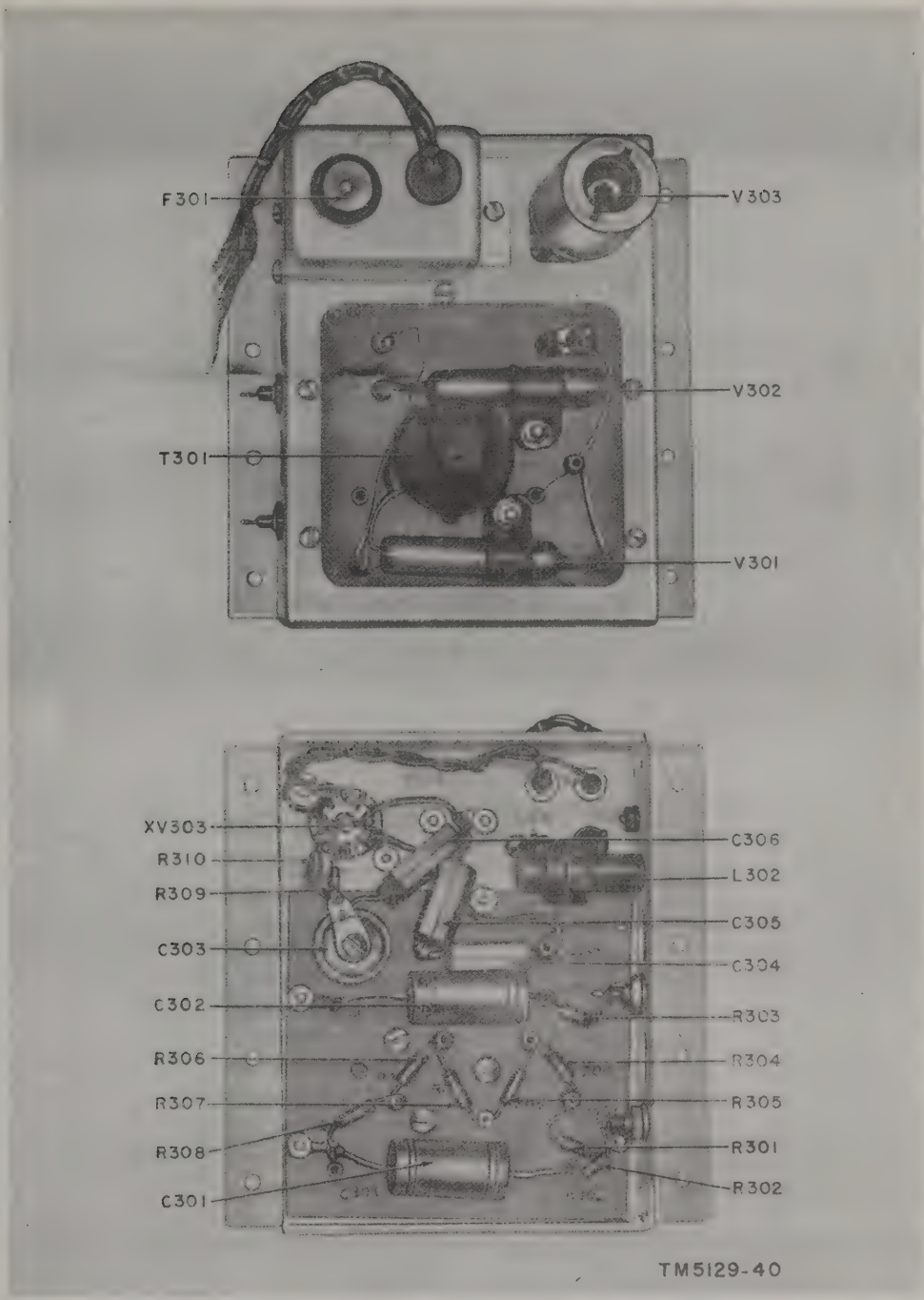


Figure 41. High-voltage power supply chassis, top and bottom views.

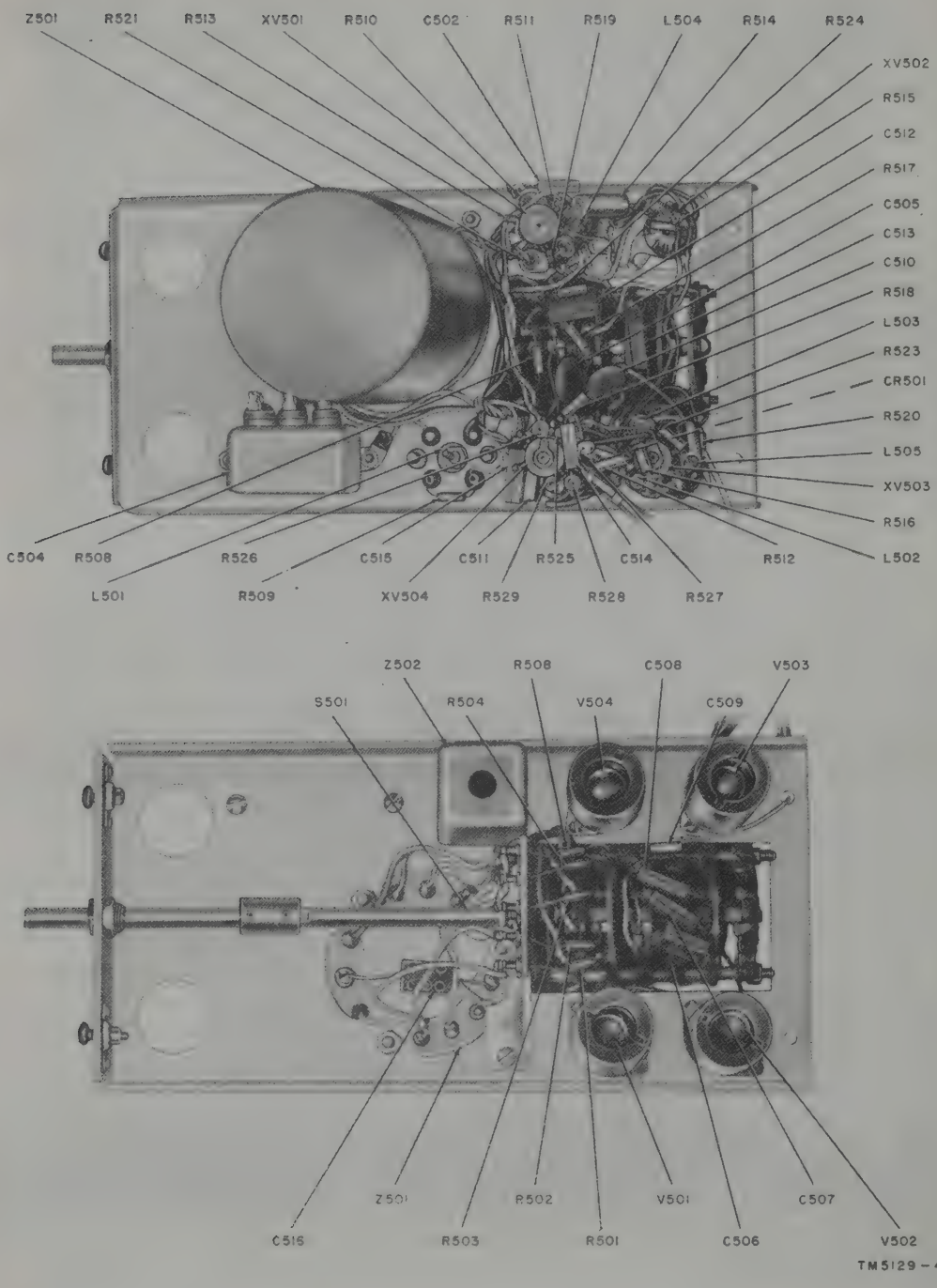


Figure 42. Marker generator chassis, top and bottom views.

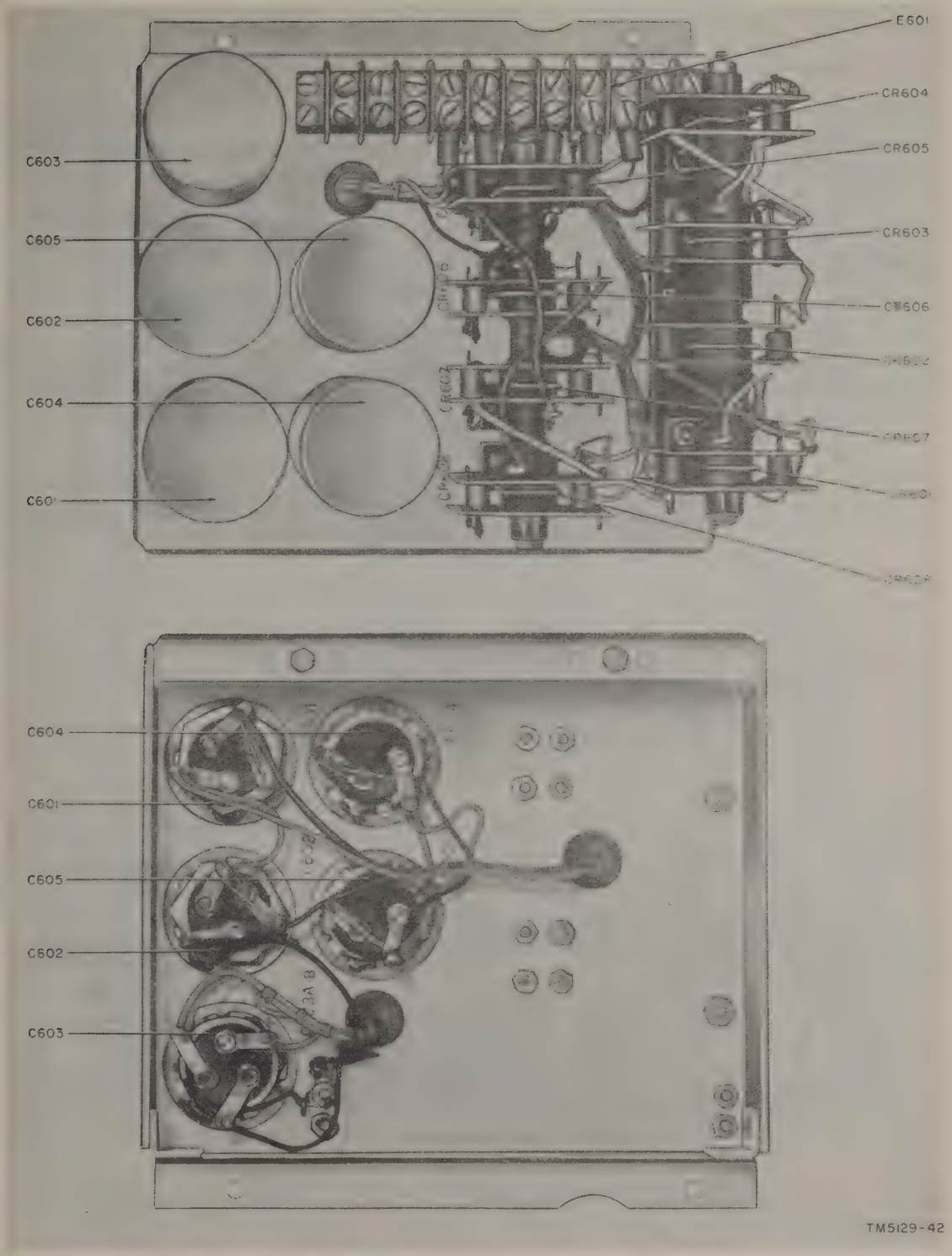


Figure 43. Low-voltage rectifiers chassis, top and bottom views.

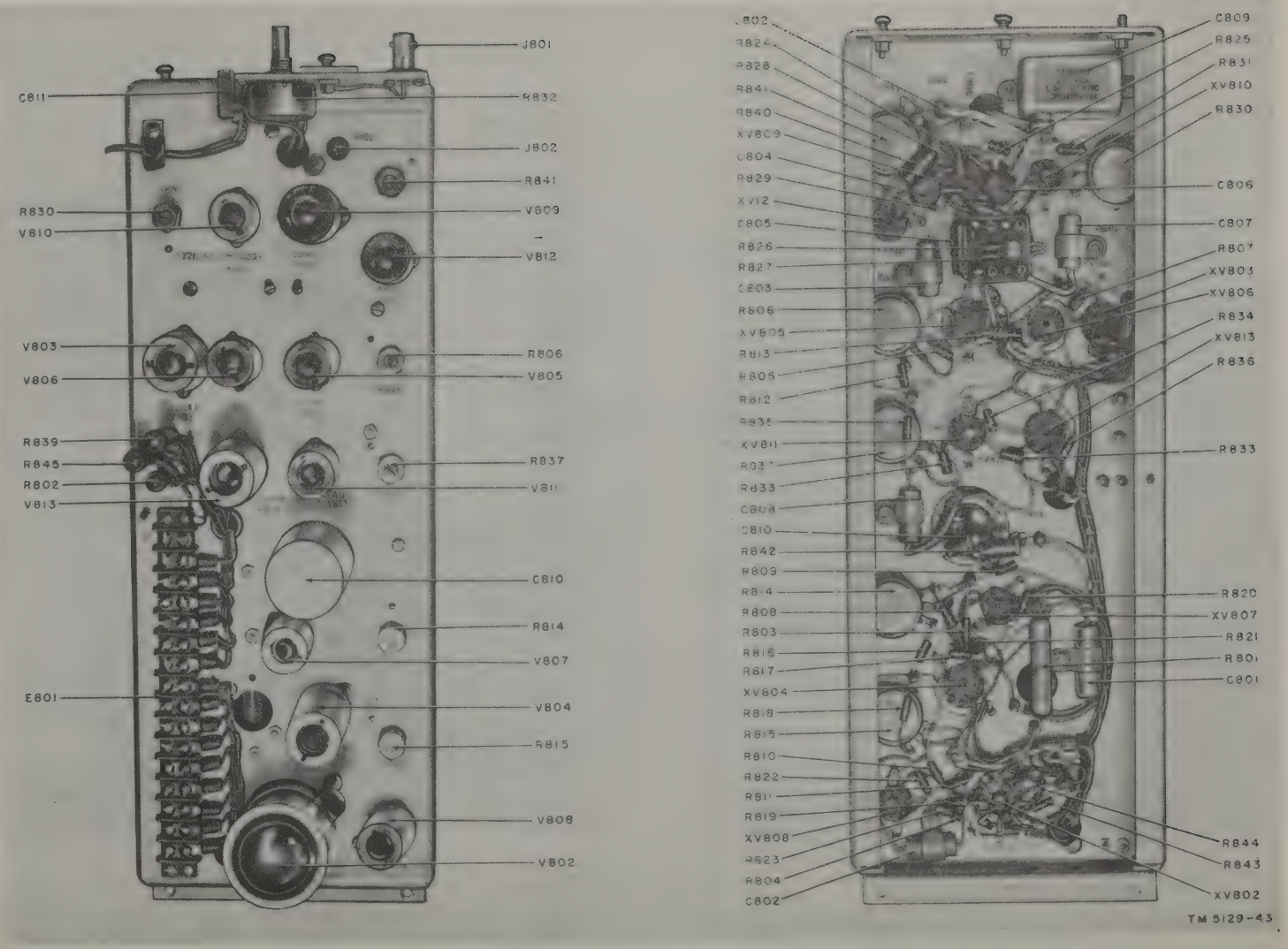


Figure 44. Low-voltage power supply and calibration generator chassis, top view.

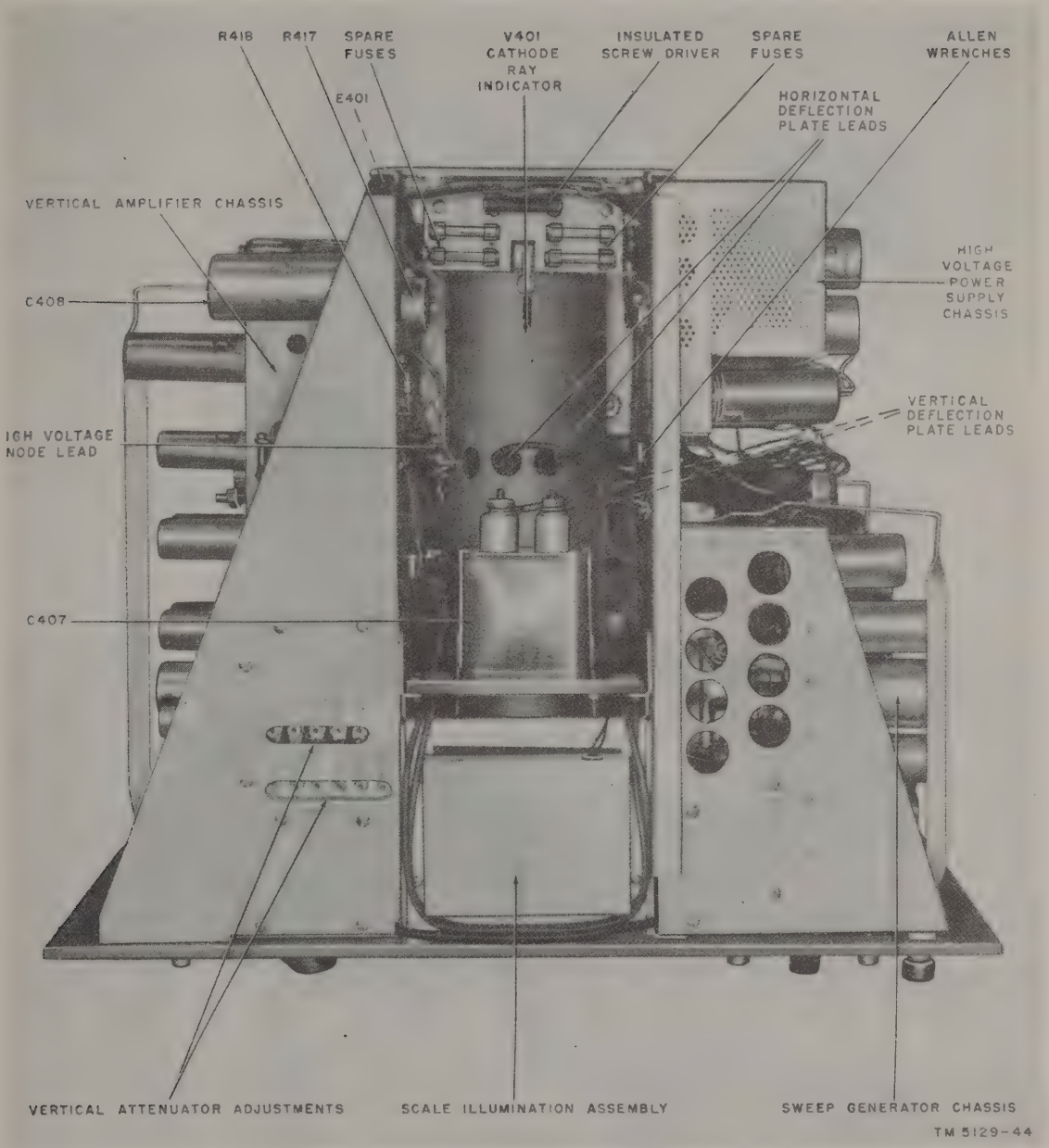


Figure 45. Main frame assembly, top view.

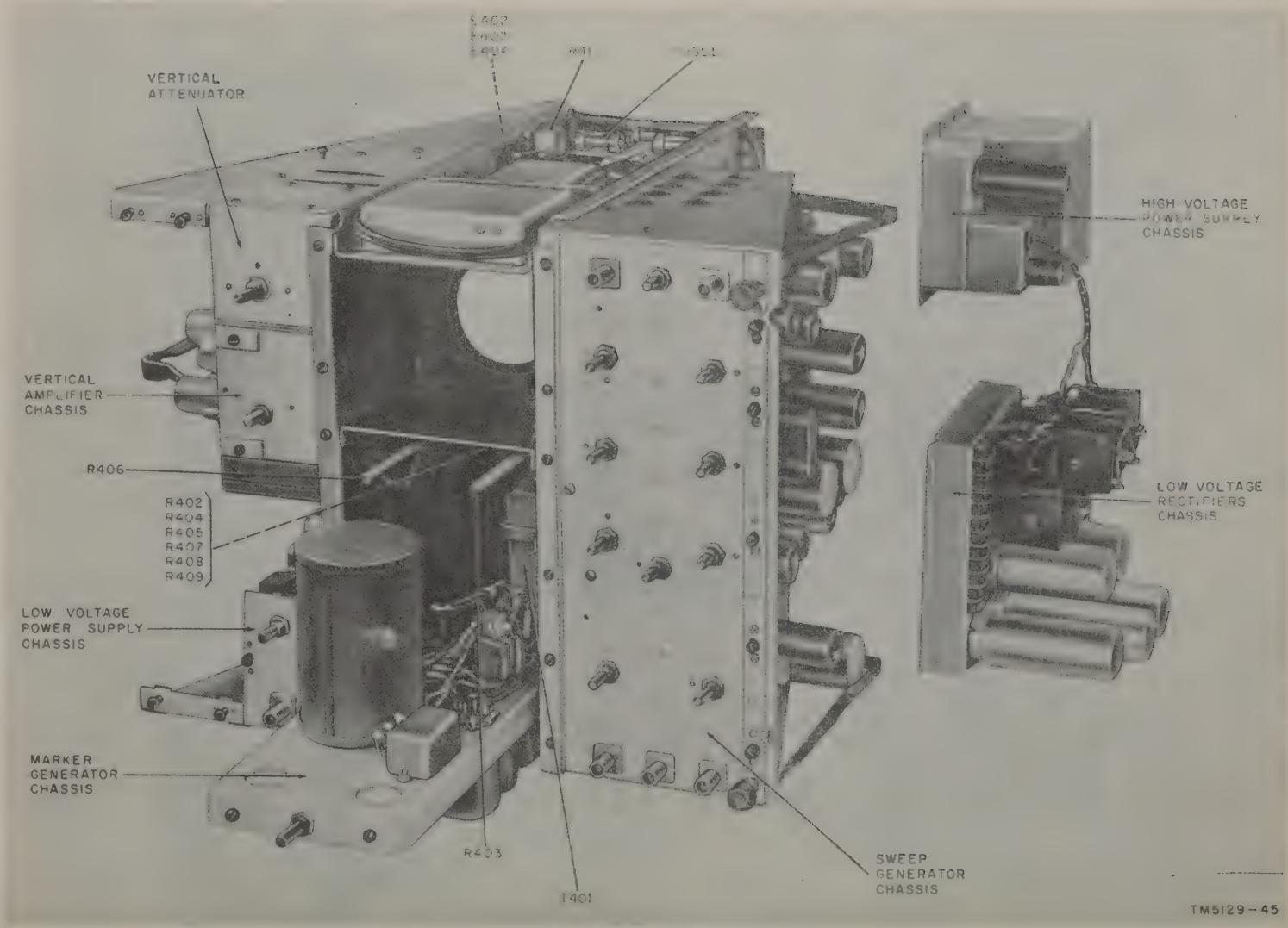


Figure 46. Main frame assembly, exploded view.

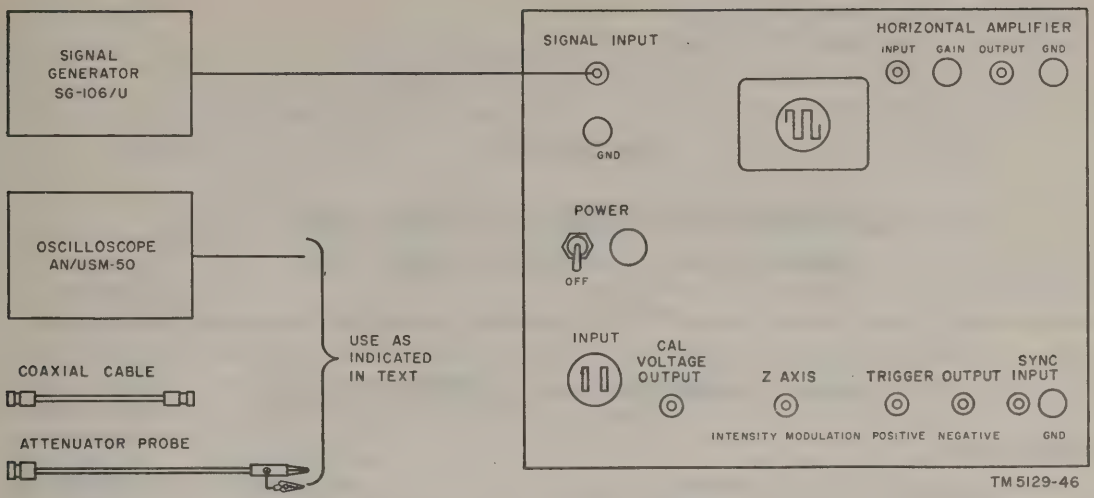


Figure 47. Connections for final test.

ZONTAL AMPLIFIER OUTPUT connector.

(2) Obtain the wave form illustrated in J, figure 26.

(3) The peak-to-peak amplitude of the wave form should be 300 volts, plus or minus 10 percent.

c. Marker Generator.

(1) Connect the test oscilloscope to the Z AXIS connector.

(2) Obtain the wave form illustrated in D, figure 26.

(3) The amplitude and pulse width should be as indicated in D, figure 26.

d. Trigger Generator.

(1) Connect the test oscilloscope to the TRIGGER OUTPUT POSITIVE connector.

(2) Obtain the wave form illustrated in H, figure 26.

(3) The amplitude and pulse width should be as indicated in H, figure 26.

e. Calibration Generator.

(1) Connect the test oscilloscope to the CAL VOLTAGE OUTPUT connector.

(2) Obtain the wave form illustrated in E, figure 26.

(3) The amplitude and pulse width should be as indicated in E, figure 26.

f. Fast Circuit Operation Test. Connect one end of the coaxial cable to the SIGNAL INPUT connector. Connect the other end to the positions listed below:

(1) CAL VOLTAGE OUTPUT connector. If the calibration generator is functioning, wave form E, figure 26 will appear.

(2) Z AXIS connector. Wave form D, figure 26 will appear.

(3) TRIGGER OUTPUT POSITIVE connection. Wave form K, figure 26 will appear.

(4) TRIGGER OUTPUT NEGATIVE connector. Wave form K, figure 26 will appear inverted.

(5) SYNC INPUT connector. Rotate the SYNC switch to all positions. Trigger pulses will appear in all positions with varying amplitudes.

CHAPTER 6

SHIPMENT AND LIMITED STORAGE AND DEMOLITION TO PREVENT ENEMY USE

Section I. SHIPMENT AND LIMITED STORAGE

69. Disassembly

The following instructions are recommended as a guide for preparing Oscilloscope AN/USM–50 for transportation and storage.

a. Disconnect the power cord from the source of ac voltage and place it within the accessory cover (fig. 1).

b. Disconnect the attenuator probe and all other cables and adapters. Place all accessory parts within the accessory cover (fig. 1).

c. Be sure that the two spare fuses are securely in place on the front panel.

d. Tighten all screws that secure the front panel to the oscilloscope case.

e. Attach the accessory over to the case with the four latch fasteners.

70. Repacking for Shipment or Limited Storage

The exact procedure for repacking depends on the material available and the conditions under which the equipment is to be shipped or stored. Use the procedures outlined below whenever possible. The information concerning the original packaging (par. 7 and fig. 2) will also be helpful.

a. Material Requirements.

(1) The following materials are required for packaging Oscilloscope AN/USM–50:

Material	Quantity
Paper, corrugated, single-faced, flexible	320 sq ft
Barrier, material, waterproof	220 sq ft
Wadding, cellulose, 2 inches thick	2.5 sq ft
Tape, water-resistant, gummed, kraft	60 ft
Tape, pressure-sensitive	60 ft
Strapping, flat steel	12 ft
Desiccant	10 lb
Wooden shipping box	1
Humidity indicator	1

(2) The dimensions for the wooden box are 1¾ feet by 1½ feet by 1¾ feet.

b. Packaging.

(1) Place the cellulose wadding inside the accessory cover.

(2) Fasten the accessory cover to the case.

(3) Cushion the oscilloscope with cells of corrugated paper on all sides.

(4) Place cushioned oscilloscope within a close-fitting corrugated fiberboard box.

(5) Place the required amount of desiccant within the box.

(6) Seal the box with gummed tape.

(7) Place the sealed fiberboard box within a water-vaporproof barrier material.

(8) Place a humidity indicator card on top of the sealed interior carton and secure with tape.

(9) Heat-seal the water-vaporproof bag leaving a small opening to exhaust the air.

(10) Evacuate the excess air from the bag and complete the heat-seal.

(11) Place the moisture-vaporproofed oscilloscope within a close-fitting fiberboard box.

(12) Seal with the water-resistant tape.

c. Packing.

(1) Pack package in a wooden box. Fabricate the box to fit the contents snugly and line it with a waterproof case liner. Place the technical literature under the lid of the box. Fill voids in the box with pads of flexible corrugated paper. Use metal strapping around the boxes.

(2) Mark the shipping containers in accordance with MIL–STD–129A.

Section II. DEMOLITION OF MATERIEL TO PREVENT ENEMY USE

71. General

The demolition procedure outlined in paragraph 72 will be used to prevent the enemy from using or salvaging this equipment. Demolition of the equipment will be accomplished only upon order of the commander.

72. Methods of Destruction

a. Smash. Smash the controls, tubes, coils, switches, capacitors, transformers, and plexiglas window; use sledges, axes, handaxes, hammers, crowbars, or other heavy tools.

b. Cut the coaxial cables and the power cord, and slash the rectifiers; use axes, handaxes, or machets.

c. Burn. Burn cords and technical manuals; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

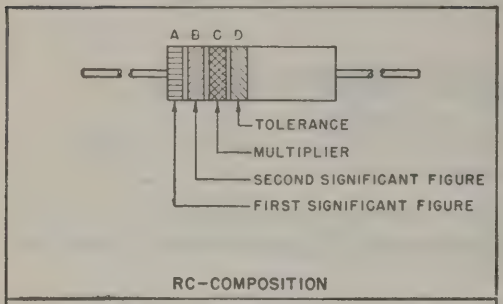
d. Bend. Bend panel and case.

e. Explode. If explosives are necessary, use firearms, grenades, or TNT.

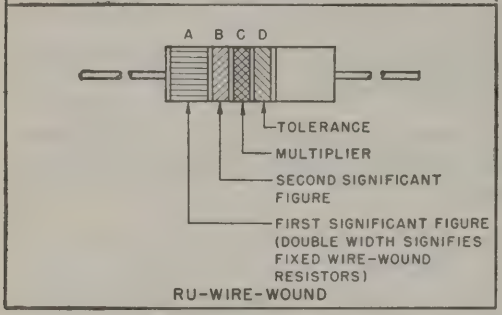
f. Dispose. Bury or scatter the destroyed parts in slit trenches, foxholes, or throw them into streams.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)

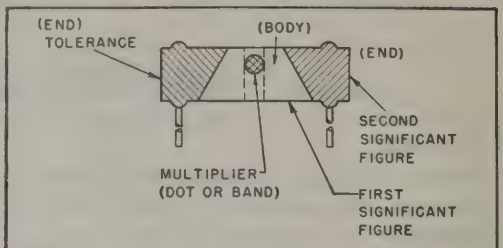


RC-COMPOSITION

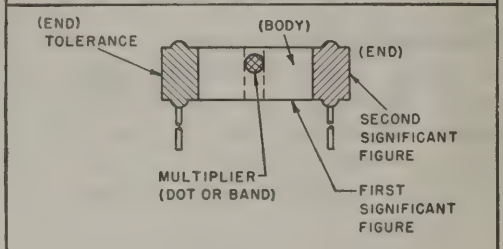


RU-WIRE-WOUND

RADIAL-LEAD RESISTORS (UNINSULATED)



RZ-COMPOSITION



RZ-COMPOSITION

RESISTOR COLOR CODE

BAND A OR BODY*		BAND B OR END*		BAND C OR DOT OR BAND*		BAND D OR END*	
COLOR	FIRST SIGNIFICANT FIGURE	COLOR	SECOND SIGNIFICANT FIGURE	COLOR	MULTIPLIER	COLOR	RESISTANCE TOLERANCE (PERCENT)
BLACK	0	BLACK	0	BLACK	1	BODY	± 20
BROWN	1	BROWN	1	BROWN	10	SILVER	± 10
RED	2	RED	2	RED	100	GOLD	± 5
ORANGE	3	ORANGE	3	ORANGE	1,000		
YELLOW	4	YELLOW	4	YELLOW	10,000		
GREEN	5	GREEN	5	GREEN	100,000		
BLUE	6	BLUE	6	BLUE	1,000,000		
PURPLE (VIOLET)	7	PURPLE (VIOLET)	7				
GRAY	8	GRAY	8	GOLD	0.1		
WHITE	9	WHITE	9	SILVER	0.01		

*FOR WIRE-WOUND-TYPE RESISTORS, BAND A SHALL BE DOUBLE-WIDTH. WHEN BODY COLOR IS THE SAME AS THE DOT (OR BAND) OR END COLOR. THE COLORS ARE DIFFERENTIATED BY SHADE, GLOSS, OR OTHER MEANS.

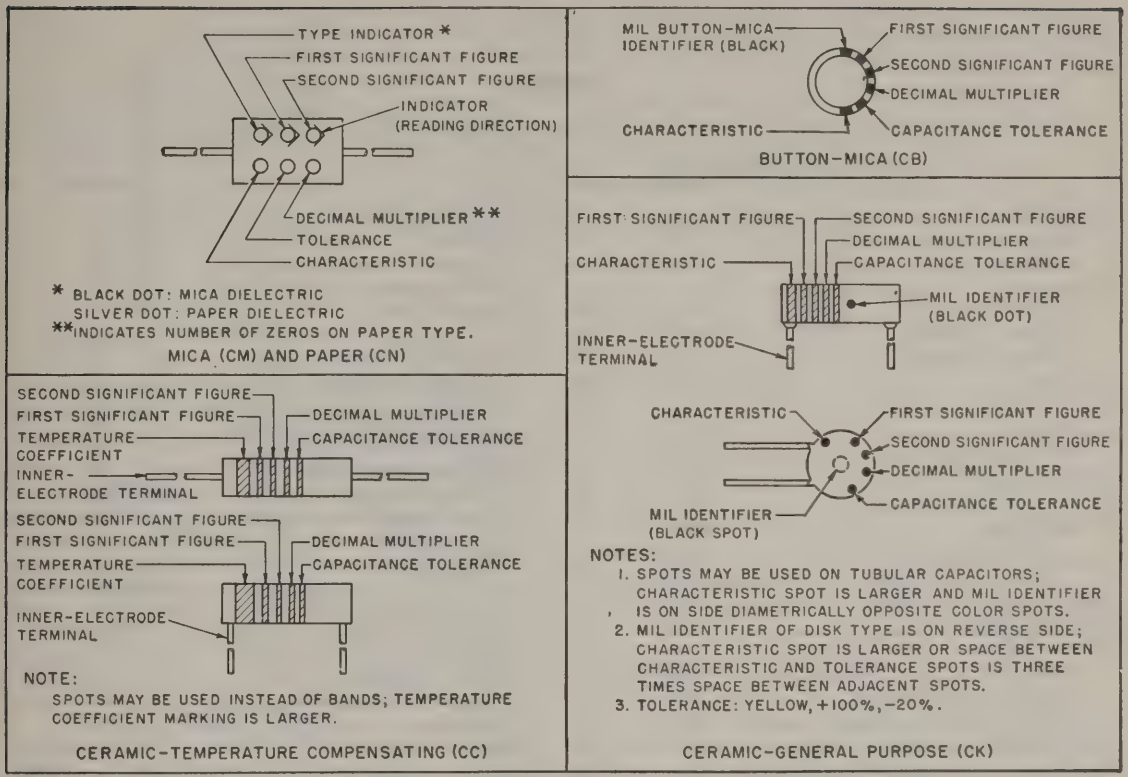
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

EXAMPLES (BODY MARKING):
10 OHMS ±20 PERCENT: BROWN BODY; BLACK END; BLACK DOT OR BAND; BODY COLOR ON TOLERANCE END.
3,000 OHMS ±10 PERCENT: ORANGE BODY; BLACK END; RED DOT OR BAND; SILVER END.

STD-R1

Figure 48. MIL-STD resistor color code markings.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER		CHARACTERISTIC[1]				TOLERANCE[2]					TEMPERATURE COEFFICIENT (UUF/UF/°C)
		DECIMAL	NUMBER OF ZEROS	CM	CN	CB	CK	CM	CN	CB	CC		
											OVER 10UUF	10UUF OR LESS	CC
BLACK	0	1	NONE		A			20	20	20	20	2	ZERO
BROWN	1	10	1	B	E	B	W				1		-30
RED	2	100	2	C	H		X	2		2	2		-80
ORANGE	3	1,000	3	D	J	D			30				-150
YELLOW	4	10,000	4	E	P								-220
GREEN	5		5	F	R						5	0.5	-330
BLUE	6		6		S								-470
PURPLE (VIOLET)	7		7		T	W							-750
GRAY	8		8			X						0.25	+30
WHITE	9		9								10	1	-330(±500)[3]
GOLD		0.1						5		5			+100
SILVER		0.01						10	10	10			

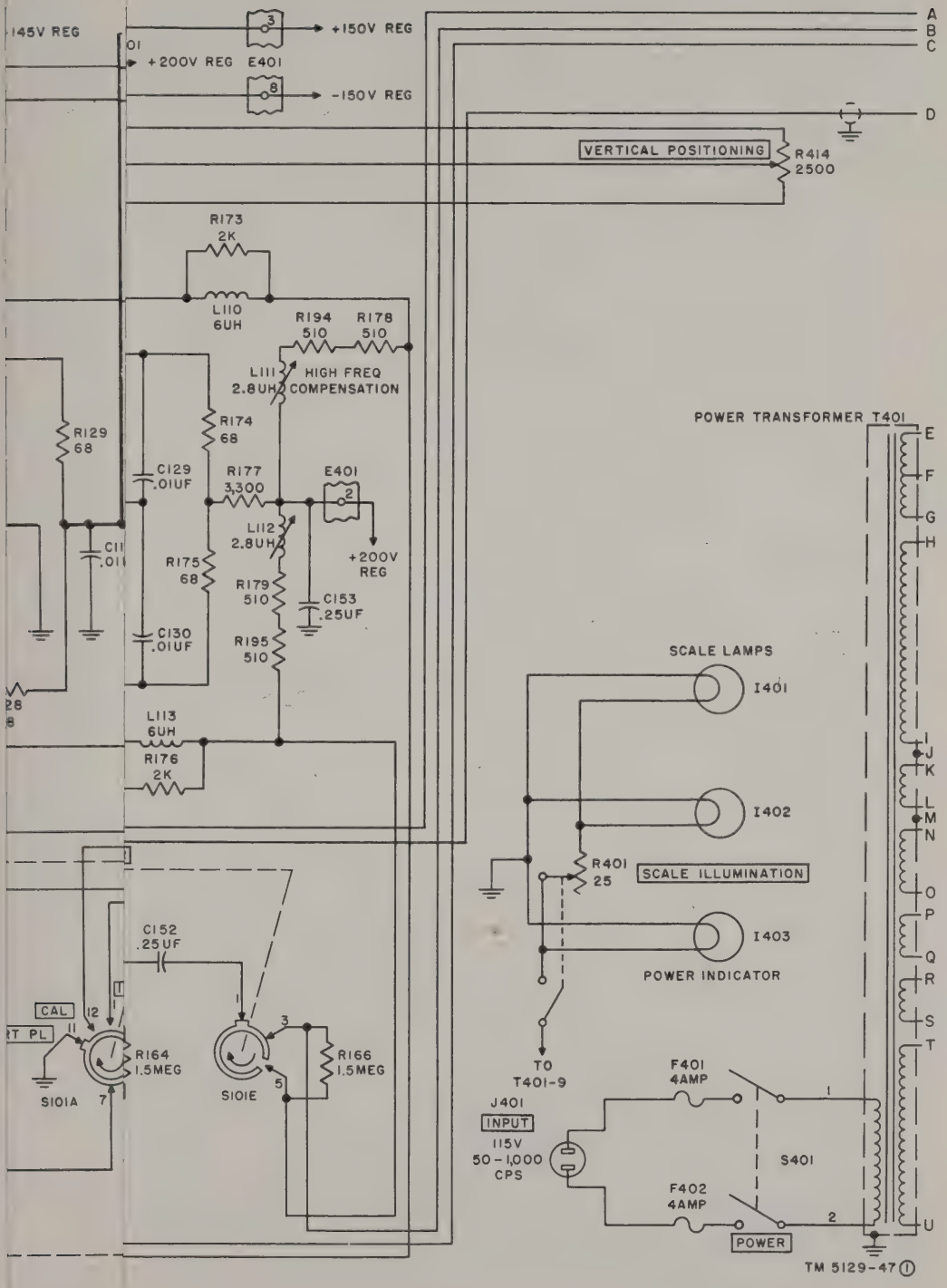
1. LETTERS ARE IN TYPE DESIGNATIONS GIVEN IN MIL-C SPECIFICATIONS.
2. IN PERCENT, EXCEPT IN UUF FOR CC-TYPE CAPACITORS OF 10 UUF OR LESS.
3. INTENDED FOR USE IN CIRCUITS NOT REQUIRING COMPENSATION.

STD-CI

Figure 49. MIL-STD capacitor color code markings.

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Adjustments	14	9
Delay	47	33
Generator	46	32
Sweep delay check	35*d*	19


-145V REG
+150V REG
+200V REG
E401
-150V REG
A
B
C
D
VERTICAL POSITIONING
R414
2500
R173
2K
L110
6UH
R194
510
R178
510
L111
2.8UH
HIGH FREQ
COMPENSATION
R174
68
R129
68
C129
.01UF
R177
3,300
E401
L112
2.8UH
+200V
REG
R175
68
R179
510
C153
.25UF
C130
.01UF
R195
510
L113
6UH
R176
2K
POWER TRANSFORMER T401
E
F
G
H
I
J
K
L
M
N
O
P
Q
R
S
T
U
SCALE LAMPS
I401
I402
R401
25
SCALE ILLUMINATION
I403
POWER INDICATOR
C152
.25UF
CAL
R164
1.5MEG
S101A
S101E
R166
1.5MEG
TO
T401-9
F401
4AMP
J401
INPUT
115V
50-1,000
CPS
S401
F402
4AMP
POWER
TM 5129-47 (1)

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Repacking:		
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Sweep delay check	35*d*	19

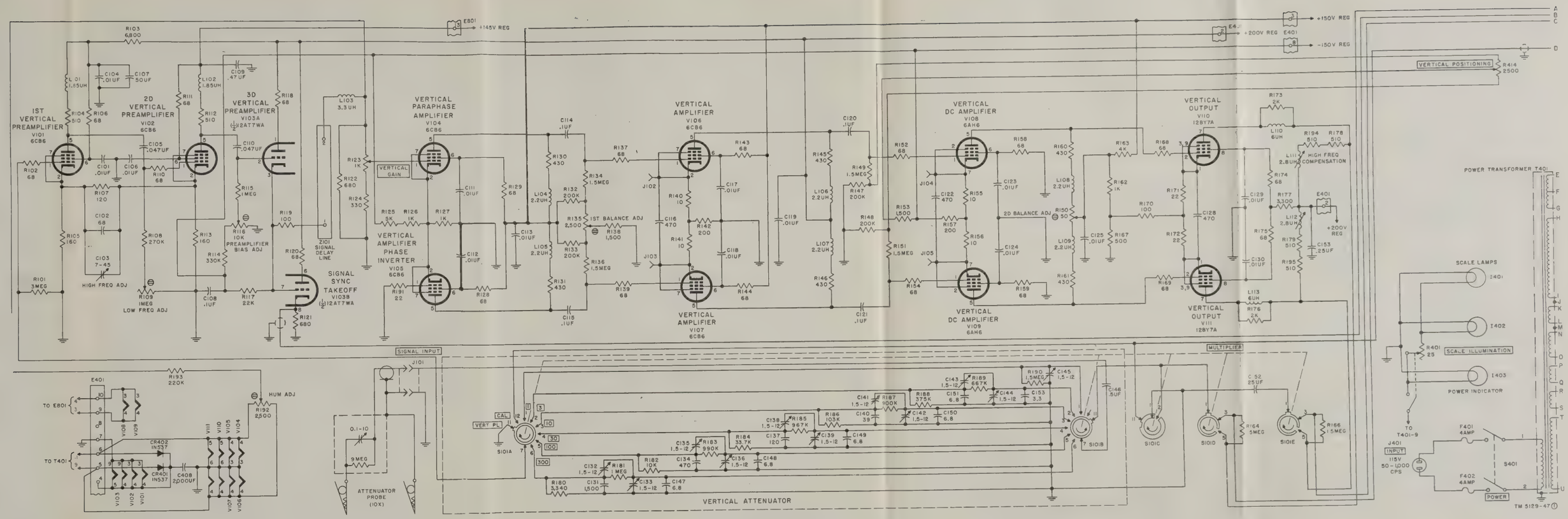
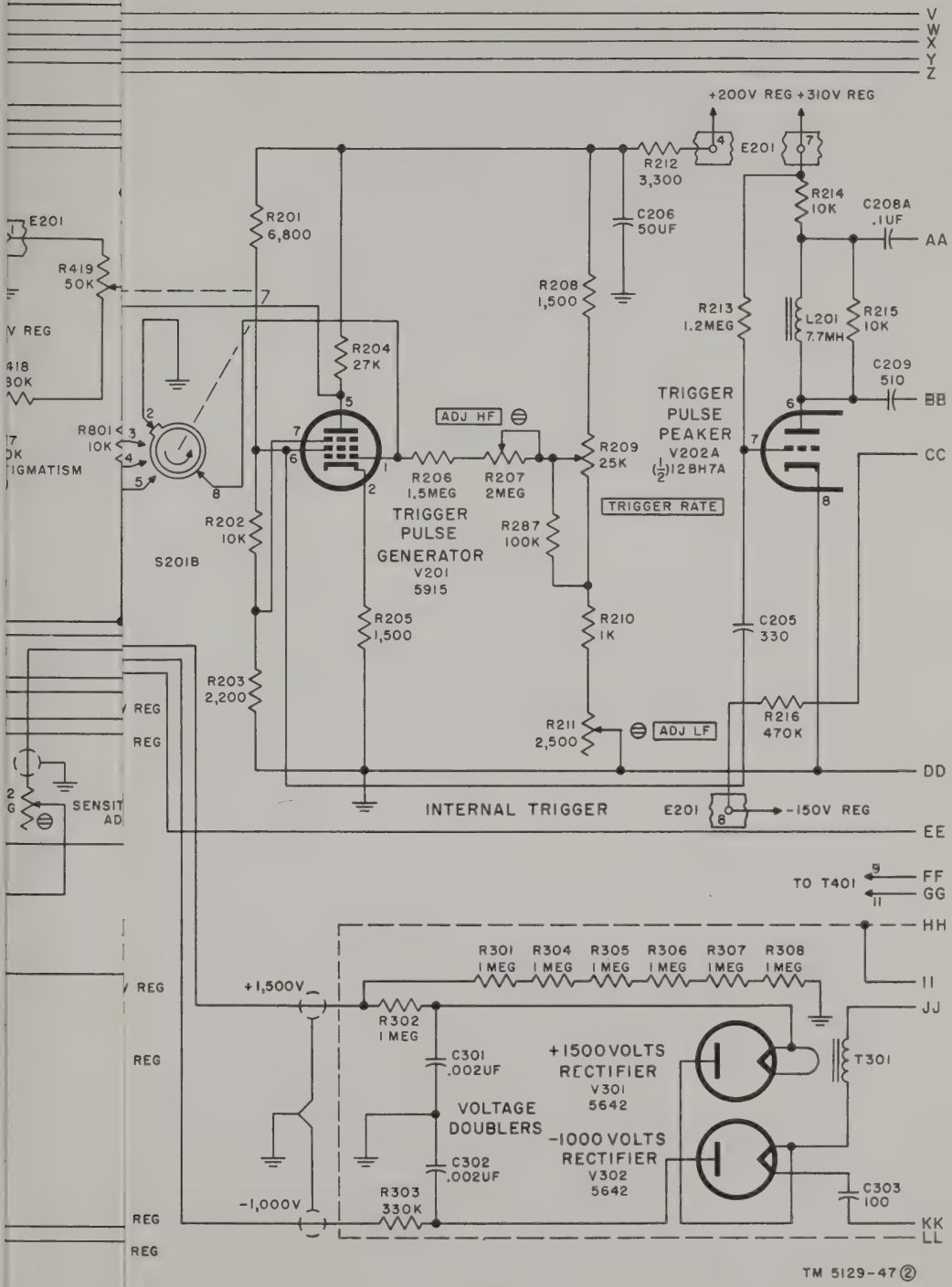


Figure 50. Oscilloscope AN/USM-62, complete schematic diagram.


V
W
X
Y
Z
+200V REG
+310V REG
E201
R212
3,300
R214
10K
C208A
.1UF
AA
C206
50UF
R201
6,800
R208
1,500
R213
1.2MEG
L201
7.7MH
R215
10K
C209
510
BB
R204
27K
TRIGGER
PULSE
PEAKER
V202A
(½)12BH7A
CC
ADJ HF
R209
25K
R206
1.5MEG
R207
2MEG
TRIGGER RATE
R801
10K
S201B
TRIGGER
PULSE
GENERATOR
V201
5915
R202
10K
R287
100K
R205
1,500
R210
1K
C205
330
R203
2,200
R216
470K
R211
2,500
ADJ LF
DD
INTERNAL TRIGGER
E201
-150V REG
EE
TO T401
FF
GG
HH
R301
1 MEG
R304
1 MEG
R305
1 MEG
R306
1 MEG
R307
1 MEG
R308
1 MEG
II
+1,500V
JJ
R302
1 MEG
C301
.002UF
+1500 VOLTS
RECTIFIER
V301
5642
T301
VOLTAGE
DOUBLERS
-1000 VOLTS
RECTIFIER
V302
5642
C302
.002UF
C303
100
R303
330K
-1,000V
KK
LL
TM 5129-47②

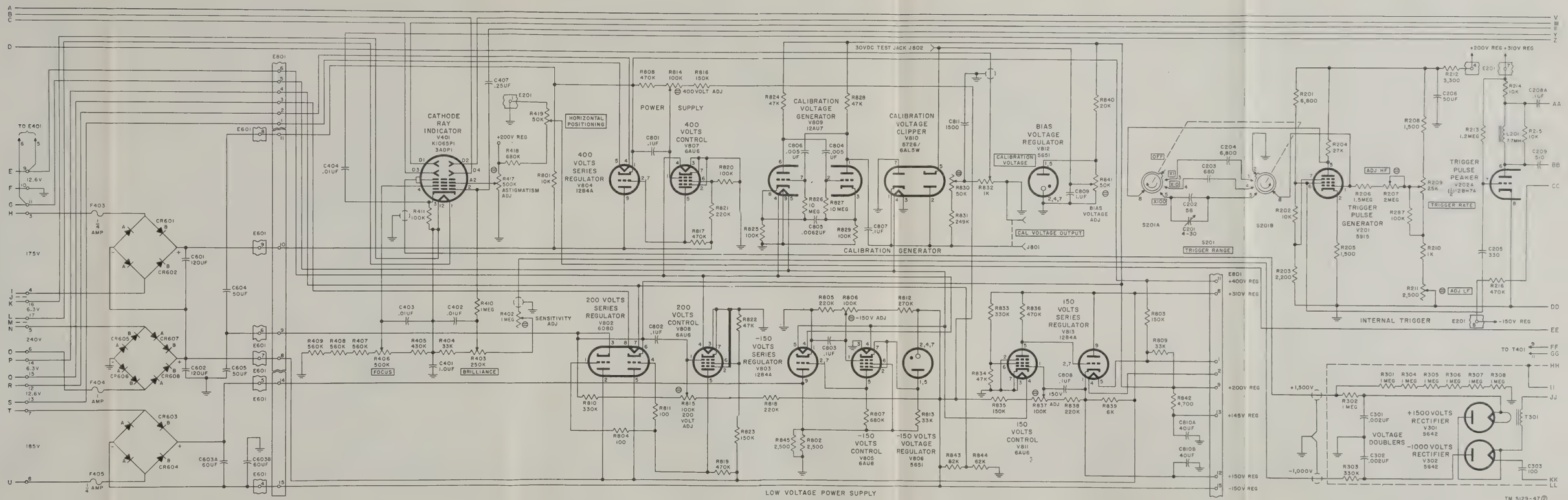
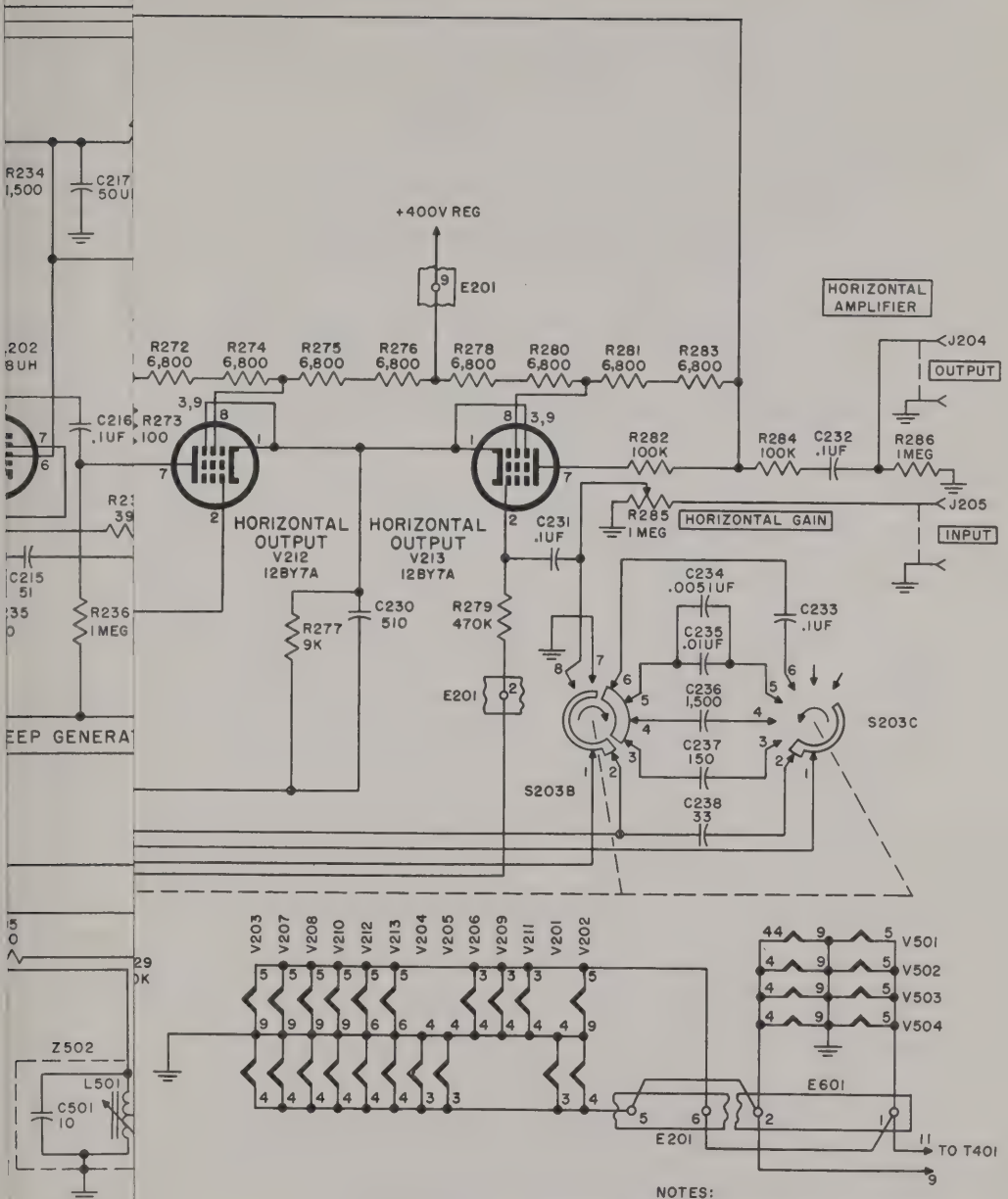


Figure 60.—Continued.



NOTES:

1. UNLESS OTHERWISE INDICATED RESISTORS ARE IN OHMS CAPACITORS IN UUF.
2. MARKER GENERATOR SWITCHES SHOWN IN "OFF" POSITION.
3. ELECTROLYTIC CAPACITORS C601, C603A AND C604 HAVE CASES INSULATED FROM GROUND.
4. ROTARY SWITCHES ARE VIEWED FROM KNOB SIDE.

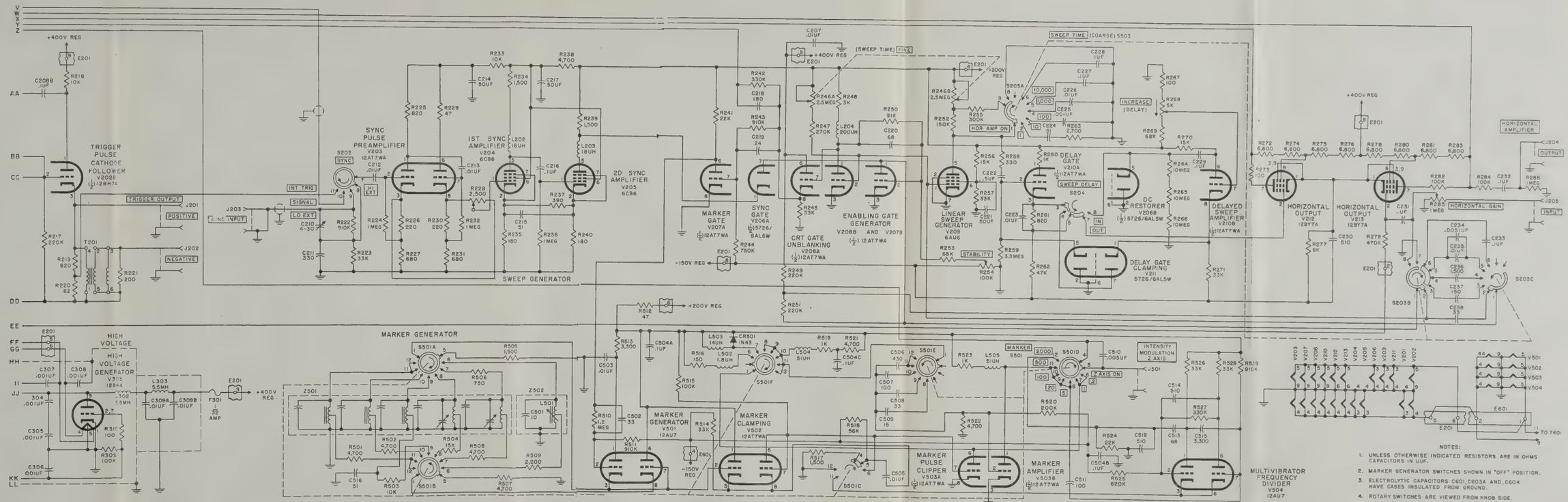


Figure 60.—Continued.

NOTES:

1. UNLESS OTHERWISE INDICATED RESISTORS ARE IN OHMS CAPACITORS IN UUF.
2. MARKER GENERATOR SWITCHES SHOWN IN "OFF" POSITION.
3. ELECTROLYTIC CAPACITORS C601, C603A AND C604 HAVE CASES INSULATED FROM GROUND.
4. ROTARY SWITCHES ARE VIEWED FROM KNOB SIDE.

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[AG 413.44 (20 May 57)]

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WRAMC
AFIP
AMS
ARWC
CGSC
Br Svc Sch
Gen Depots
Sig Sec, Gen Depots
Sig Depots
POE (OS)
Trans Terminal Comd
Army Terminals
OS Sup Agencies
Army Sig Pub Agency
Army Sig Comm Engr Agency
Army Comm Agency
White Sands Sig Agency
Yuma Test Sta
Army Elct PG
Sig Fld Maint Shops
Sig Lab
Mil Dist
JBUSMC
Units org under fol TOE:
11–7
11–16
11–57
11–127
11–128
11–500
11–557
11–587
11–592
11–597

NG: State AG; units—same as Active Army.

USAR: None.

For explanation of abbreviations used, see SR 320–50–1.

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