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DEPARTMENT OF THE ARMY TECHNICAL MANUAL

DEPARTMENT OF THE AIR FORCE TECHNICAL ORDER

TM 11-2535B

TO 33A1-3-4-11

METER TEST SET TS-682A/GSM-1

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

JULY 1955

WARNING

DANGEROUS VOLTAGES EXIST IN THIS EQUIPMENT

Be careful when working on the 270-volt plate and power supply circuits, or on the 115-volt ac and dc line connections

DON'T TAKE CHANCES!

EXTREMELY DANGEROUS VOLTAGES EXIST IN THE FOLLOWING UNIT:

Meter Test Set TS-682A/GSM-1 2,000-volt circuit

TECHNICAL MANUAL
No. 11-2535B
TECHNICAL ORDER
No. 33A1-3-4-11

DEPARTMENTS OF THE ARMY AND THE AIR FORCE

WASHINGTON 25, D. C., *6 July 1955*

METER TEST SET TS-682A/GSM-1

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CHAPTER 1

INTRODUCTION

Section I. GENERAL

1. Scope

a. This manual contains information on the operation, theory, and maintenance of Meter Test Set TS–682A/GSM–1. This information applies only to Meter Test Set TS–682A/GSM–1.

b. Forward comments on this publication direct to Commanding Officer, The Signal Corps Publications Agency, Fort Monmouth, New Jersey, ATTN: Standards Division.

2. Forms and Records

The following forms will be used for reporting unsatisfactory conditions of equipment and when performing preventive maintenance.

a. DD Form 6, Report of Damaged or Improper Shipment, will be filled out and forwarded as prescribed in SR 745–45–5 (Army), Navy Shipping Guide, Article 1850–4 (Navy), and AFR 71–4 (Air Force).

b. DA Form 468, Unsatisfactory Equipment Report, will be filled out and forwarded to the Office of the Chief Signal Officer as prescribed in SR 700–45–5.

c. DD Form 535, Unsatisfactory Report, will be filled out and forwarded to Commanding General, Air Materiel Command, Wright-Patterson Aid Force Base, Dayton, Ohio, as prescribed in SR 700–45–5 and AF TO 00–35D–54.

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

e. DA Form 11–239, Second and Third Echelon Maintenance Check List for Signal Corps Equipment (Radio Communication, Direction Finding, Carrier, Radar) will be prepared in accordance with instructions on the back of the form (fig. 12).

f. Use other forms and records as authorized.

Section II. DESCRIPTION AND DATA

3. Purpose and Use

a. Meter Test Set 682A/GSM–1 (fig. 1) provides repair personnel in maintenance companies and repair depots with a means of checking the operation and accuracy of voltmeters and ammeters. It also functions as an accurately metered power supply, furnishing all direct-current (dc) and alternating-current (ac) power to meters under test.

b. Meter Test Set TS–682A/GSM–1 (fig. 1) is used as a standard meter. A meter under test is read and this reading is checked against the reading of the test set standard meter. The readings are compared to determine the accuracy of the meter under test. In this manual, the major component of the TS–682A/GSM–1 is referred to as the *test set*.

4. Technical Characteristics

a. Power Requirements.

Power input, ac	115 volts, 60 cps, single phase.
Power input, dc	Storage battery, 12 volts, capable of supplying 100 amperes for 1 minute.

b. Equipment Meter Ranges.

Dc voltage scales	0 to 100 mv, 0 to 1 volt, 0 to 2 volts, 0 to 5 volts, 0 to 10 volts, 0 to 20 volts, 0 to 50 volts, 0 to 100 volts, 0 to 200 volts, 0 to 500 volts, 0 to 1,000 volts, and 0 to 2,000 volts.

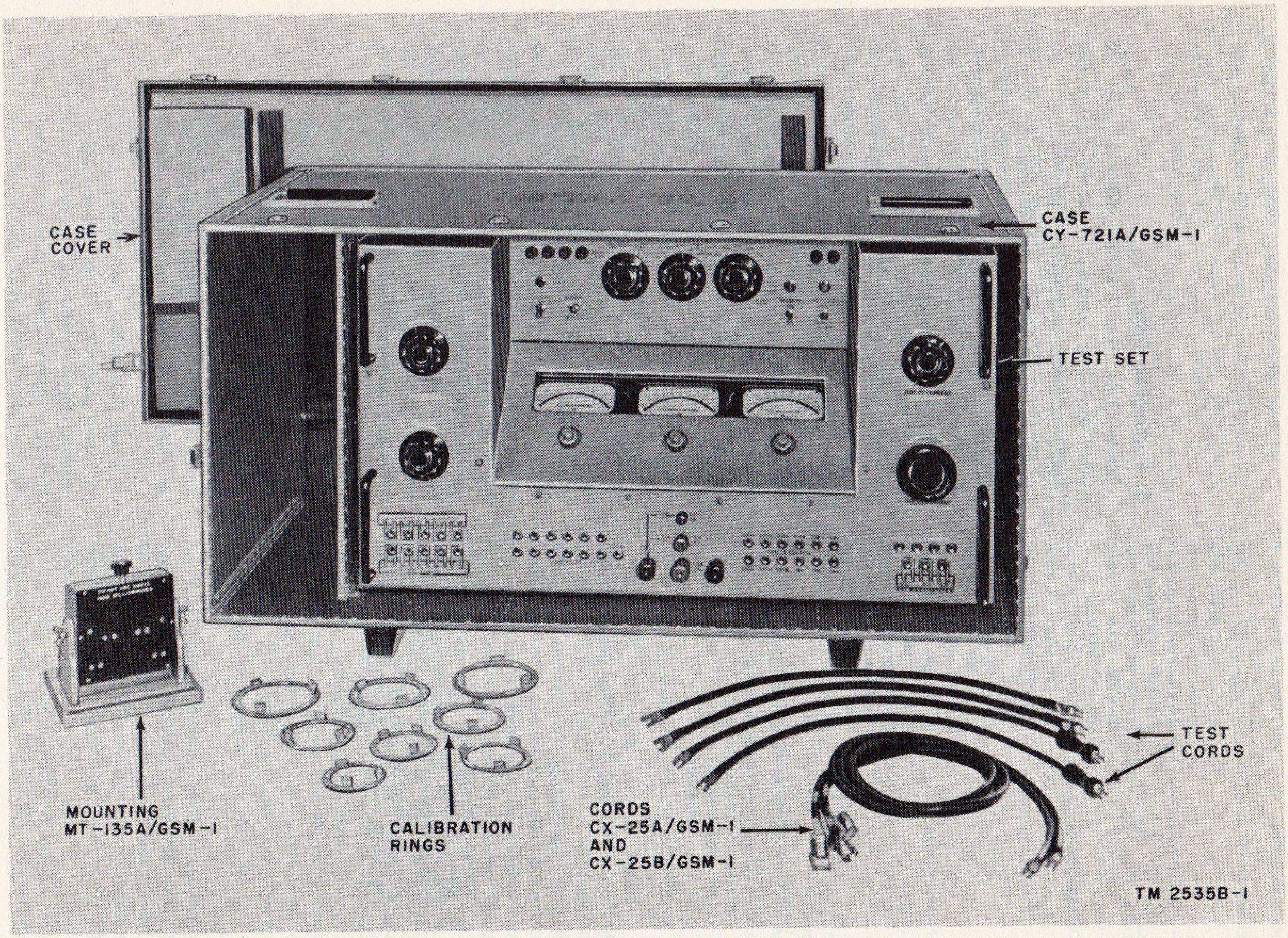

Figure 1. Meter Test Set TS-682A/GSM-1.

Dc current scales	0 to 100 ua, 0 to 200 ua, 0 to 500 ua, 0 to 1 ma, 0 to 2 ma, 0 to 5 ma, 0 to 10 ma, 0 to 20 ma, 0 to 50 ma, 0 to 100 ma, 0 to 200 ma, 0 to 500 ma, 0 to 1 amp, 0 to 2 amp, 0 to 5 amp, 0 to 10 amp, 0 to 20 amp, 0 to 50 amp, and 0 to 100 amp.
Ac voltage scales	0 to 1 olt, 0 to 2 volts, 0 to 5 volts, 0 to 10 volts, 0 to 20 volts, 0 to 50 volts, 0 to 100 volts, 0 to 200 volts, 0 to 500 volts, 0 to 1,000 volts, and 0 to 2,000 volts.
Ac current scales	0 to 100 ma, 0 to 200 ma, 0 to 500 ma, 0 to 1 amp. 0 to 2 amp, 0 to 5 amp, 0 to 10 amp, 0 to 20 amp, 0 to 50 amp, 0 to 100 amp.

c. Output.

(1) Current output, dc voltage ranges (*b*(1) above):

0- to 100-mv range	30 ma.
0- to 1-volt through 0- to 1,000-volt ranges	15 ma.
0- to 2,000-volt ranges	5 ma.

(2) Current output, ac voltage ranges (*b*(3) above):

0- to 1-volt through 0- to 100-volt ranges	.5 ma.
0- to 200-volt through 0- to 2,000-volt ranges	150 ma.

(3) Voltage output, dc range (*b*(2) above):

Voltage available for all dc ranges.	750 mv for 0 to 100 ua through 0 to 100 amperes.

(4) Ac power output (unity power factor):

2.5 watts	0 to 100 ma through 0 to 500 ma.
10 watts	0 to 1 amp through 0 to 100 amperes.

5. Packaging Data

Meter Test Set TS–682A/GSM–1 may be packed for either domestic or overseas shipment. Packaging details are shown in figure 5.

a. Overseas Shipment. When the test set is packed for oversea shipment, the test set is placed in the carying case with the face of the equipment up. Mounting MT–135A/GSM–1, the test cords, the battery connecting cords, and the calibration rings are placed in the small compartment of Case CY–721A/GSM–1 (fig. 1). The equipment, in Case CY–721A/GSM–1, is placed in the inner corrugated carton (fig. 5). The inner corrugated carton is sealed with gummed tape. The boxed equipment then is placed in a moisture-vaporproof barrier, which is heat-sealed, and this package is placed in the waterproof outer corrugated carton. The manuals are placed under the lid and the outer corrugated carton is sealed with waterproof tape. The packaged test set is placed in a wooden packing case with a waterproof case liner. The wooden container is reinforced with flat metal straps. The packed Meter Test Set TS–682A/GSM–1 is 56 inches long, 34 inches wide, and 32 inches high. It weights 520 pounds and displaces approximately 35 cubic feet.

b. Domestic Shipment. For domestic shipment, the test set is packed in the same manner as for oversea shipment (*a* above), except that the inner moisture-vaporproof barrier and the outer corrugated carton are omitted.

6. Table of Components

The table below lists the weights and dimensions of the components of Meter Test Set TS–682A/GSM–1. The test set and its components are shown in figure 1.

Quantity	Name of component	Dimensions (in.)			Weight (lb)	Volume (cu ft)
		Width	Depth	Height		
1	Test set	37⅜	18⅜	20 3/16	280	8.
1	Case CY–721A/GSM–1	47½	23½	22¼	85	14. 6.
1	Mounting MT–135A/GSM–1	6	8	7½	4	0. 20.
1	Cord CX–25A/GSM–1	72			3	
1	Cord CX–25B/GSM–1	72			3	
2	Test cord (terminated with spade lugs).	24			2 (ea)	
1	Test cord (terminated with plug having .25-inch diameter shank).	24			1	
1	Test cord (terminated with plug having .2065-inch diameter shank).	24			1	
8	Calibration rings		0.095 (ea)	2½ to 4 29/32 od	1 (ea)	0. 01 (ea).
1 set	Running spares (par. 8).					

Note. This list is for general information only. See appropriate supply publications for information pertaining to requisition of spare parts.

7. Description

a. General. Meter Test Set TS–682A/GSM–1 (fig. 1) is a multirange precision test set used to measure the performance characteristics of ac and dc voltmeters and ammeters. The TS–682A/GSM–1 consists of a test set, Mounting MT–135A/GSM–1 on which the meter under test is mounted, test cords, dc power supply Cords CX–25A/GSM–1 and CX–25B/GSM–1, eight calibration rings, and Case CY–721A/GSM–1.

b. Test Set.

(1) The test set (fig. 2) is inclosed in a heavy aluminum cabinet on which all parts and the inclosing panels are mounted. Three standard meters are mounted in a shock-mounted case. The meters are mounted at a 45° angle on the front of the test set. The meter panel, the **U**-shaped panel on which the output controls, jacks, and binding posts are mounted, and the offset switch panel are faced with insulating phenolic sheets.

(2) The ac power cord is located at the rear of the test set (fig. 6). Binding posts for connection of an external 12-volt storage battery can be reached through a door in the rear panel. A pocket mounted on this panel holds a set of calibration data charts.

c. Mounting MT–135A/GSM–1. Mounting MT–135A/GSM–1 (figs. 3 and 4) is used to mount panel-type meters and to connect these meters electrically to the test set for calibration or repair. The mounting consists of a wooden box mounted on a metal shaft between two wooden pedestals. The pedestals are mounted on a wooden base. Thumbscrews at each end of the mounting shaft allow the box to be tilted so that the meter under test can be set in its normal operating position. The meter under test is mounted through two meter mounting holes on the front of the box (fig. 3). Jaws inside the box are adjusted by a knob on top of the unit to hold the meter firmly on the mounting. Two binding posts on the rear of the box are used to connect the mounting to the test set (fig. 4).

d. Calibration Rings. Eight cadmium-plated steel calibration rings are supplied with the test set (fig. 1). The inside diameters of the rings range from 1.5 to 3.9 inches to accommodate meters of different sizes. Each ring has three spring-steel retainers.

e. Cords CX–25A/GSM–1 and CX–25B/GSM–1. Cords CX–25A/GSM–1 (positive) and

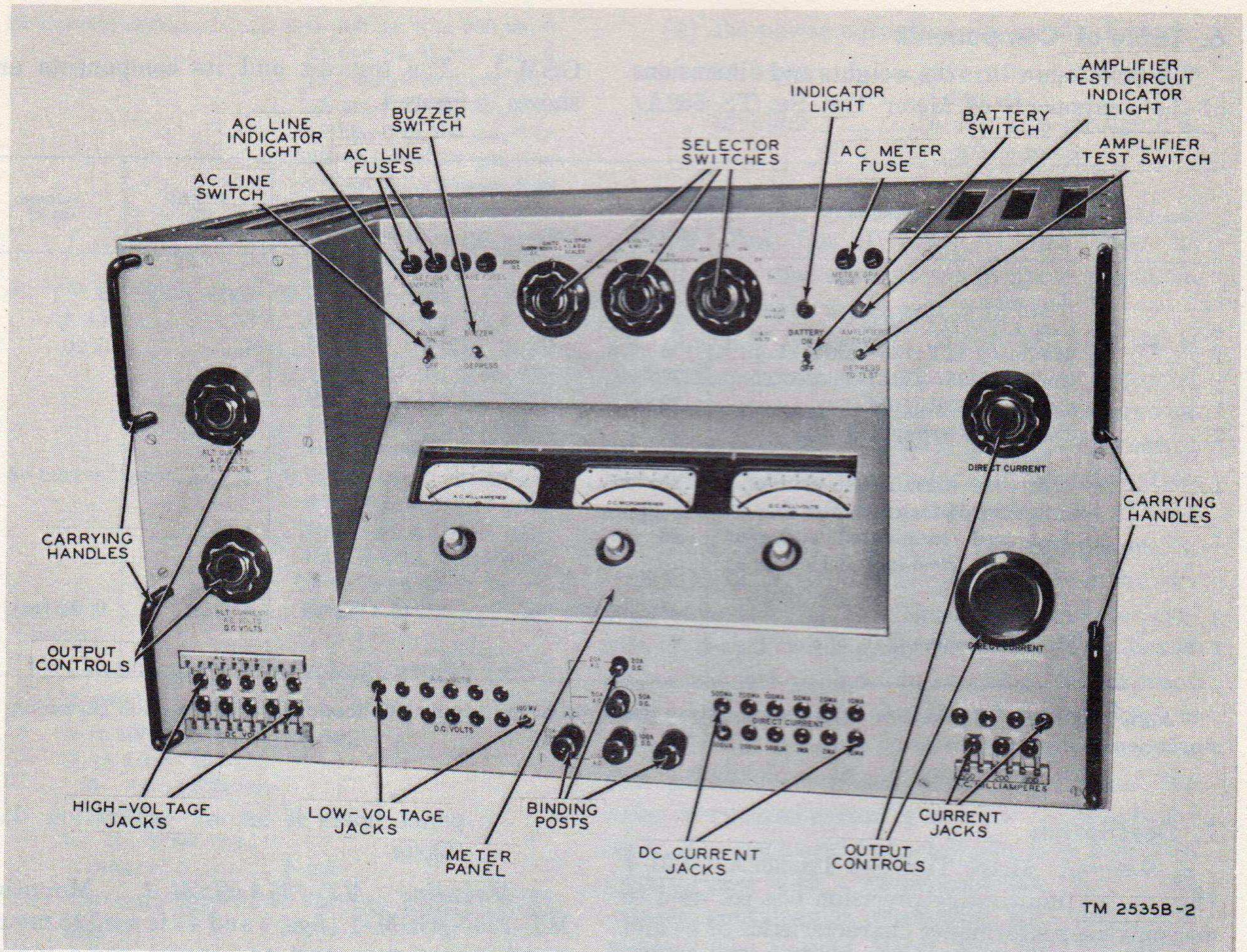

Figure 2. Test set, front view.

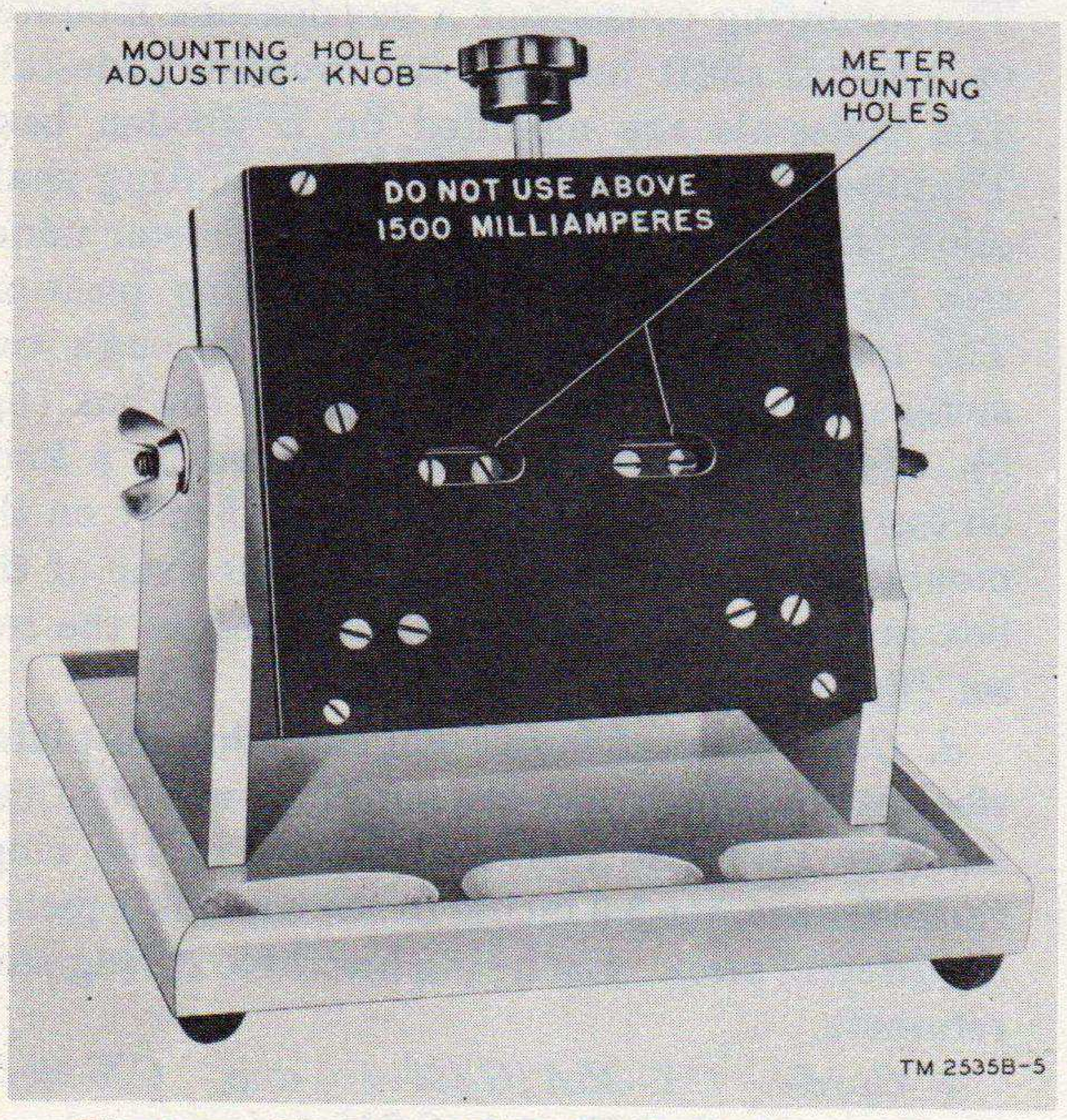

Figure 3. Mounting MT–135A/GSM–1, front view.

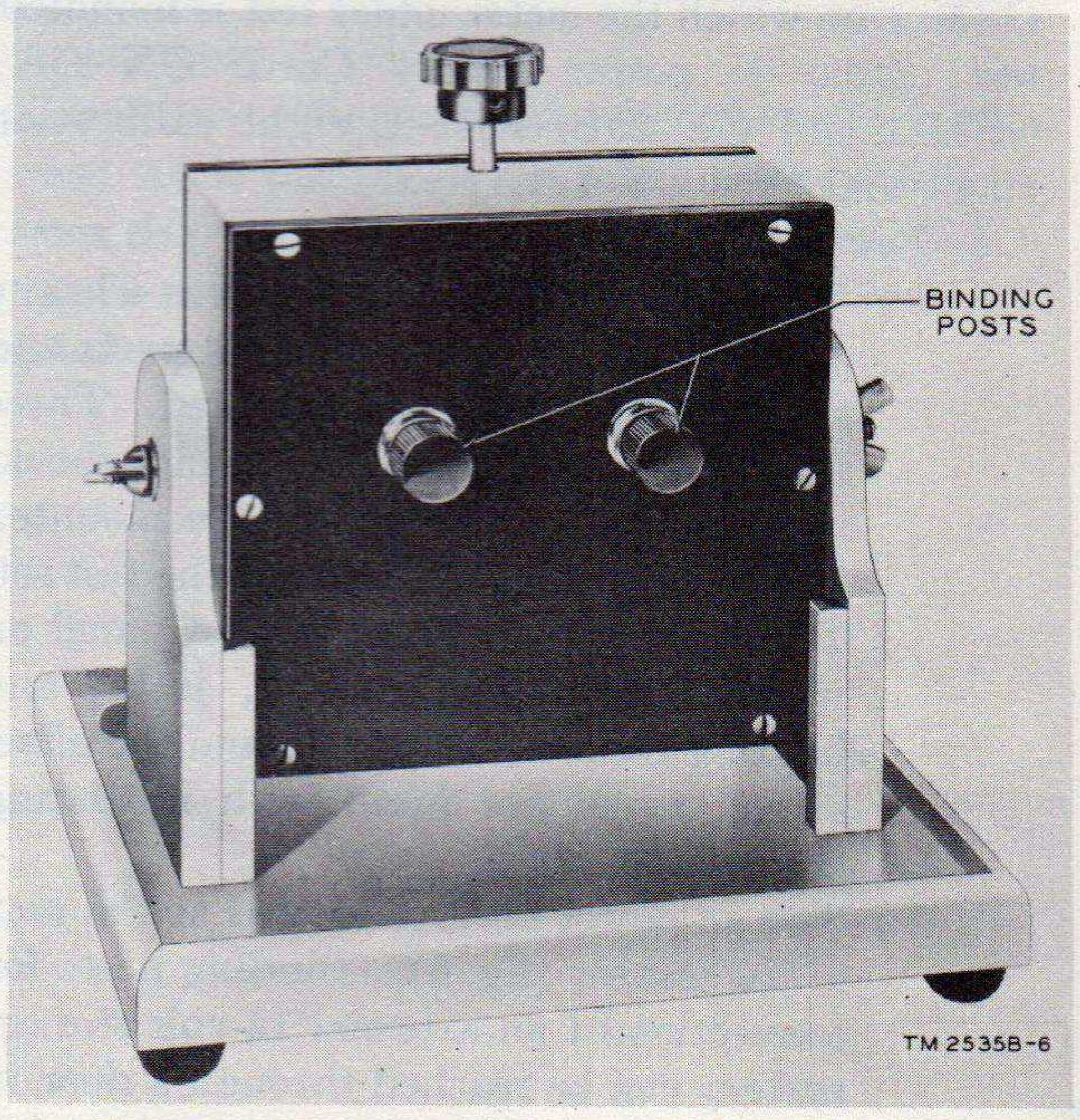

Figure 4. Mounting MT–135A/GSM–1, rear view.

CX-25B/GSM-1 (negative) (fig. 1) are used to connect a 12-volt storage battery to the test set. The cords are 6 feet long and are rubber insulated. Each cord has a battery clip at one end, marked for polarity, and a spade-type terminal at the other end.

f. Test Cords. Four 24-inch rubber-jacketed test cords (fig. 1) are used to connect the meter mounting to the test set. Two of the cords terminate in spade-type terminals at both ends; these are used to connect the mounting to the test set binding posts. Two of the cords terminate in spade-type terminals at one end and plugs at the other end. The cord with a plug having a .25-inch diameter shank is used to connect the mounting to the voltage jacks of the test set; the cord with a plug having a .2065-inch diameter shank is used to connect the mounting to the current jacks.

g. Case CY-721A/GSM-1. Case CY-721A/GSM-1 (fig. 1) is used to transport the test set and is constructed of aluminum-clad plywood. A separate compartment holds Mounting MT-135A/GSM-1, the calibration rings, and the cords. The cover is fastened by 12 spring-loaded latches. The case is mounted on four steel channeled legs. Two carrying handles are mounted on the top, two on the cover, and two on each end of the case.

8. Running Spares

The following chart lists the running spare parts for the test set.

Quantity	Item	Description
1	Vacuum tube	2X2A.
1	Vacuum tube	5R4GY.
1	Vacuum tube	5751.
1	Vacuum tube	6AS7G.
1	Vacuum tube	5814.
2	Fuse	Cartridge-type, 5 amperes, 250 volts.
1	Fuse	Cartridge-type, .15 ampere, 250 volts.
1	Lamp	Glow, miniature bayonet base, 1/25 watt.
3	Lamp	Incandescent, miniature bayonet base, 6–8 volts, .25 ampere.

CHAPTER 2

INSTALLATION

Section I. SERVICE UPON RECEIPT OF EQUIPMENT

9. Shelter Requirements

Meter Test Set TS–682A/GSM–1 is used in depot repair shops. The equipment usually is used in permanent or semipermanent installations. To insure the best conditions for operation of the test set, the following requirements should be met:

a. The bench and the floor should be able to hold the weight of the equipment without vibration.

b. Sufficient space should be allowed for repair of the test set.

c. A 115-volt, 60-cycle per second (cps) ac source must be available.

d. Lighting for both day and night operation should be adequate.

e. The temperature of the building or shelter should be between 55° F. and 95° F. at all times.

10. Uncrating, Unpacking, and Checking Equipment

a. General. Meter Test Set TS–682A/GSM–1 may be packaged for either oversea or domestic shipment (par. 5). When new equipment is received, unpack it where it will not be exposed to dust, dirt, or excessive moisture and where it will be near its permanent or semipermanent location. Be careful when uncrating and unpacking the test set. Do not thrust tools into the wooden box or fiberboard cartons. When packing, do not damage the packaging materials any more than is necessary. These materials may be used when repacking the test set for storage or for shipment. Be careful when handling the equipment. It can be damaged easily when it is not protected by the shipping container.

b. Unpacking and Uncrating Equipment.

(1) Place the wooden packing case near the operating location.

(2) Cut the metal straps with a suitable cutting tool or twist them with pliers until the metal straps break. Remove the metal straps.

(3) Remove the nails from the top and one side of the wooden packing case. Do not attempt to pry off the sides and top; the equipment may be damaged. Remove the wooden cover.

(4) Break the sealed moistureproof barrier and lift the outer corrugated carton out of the wooden packing case.

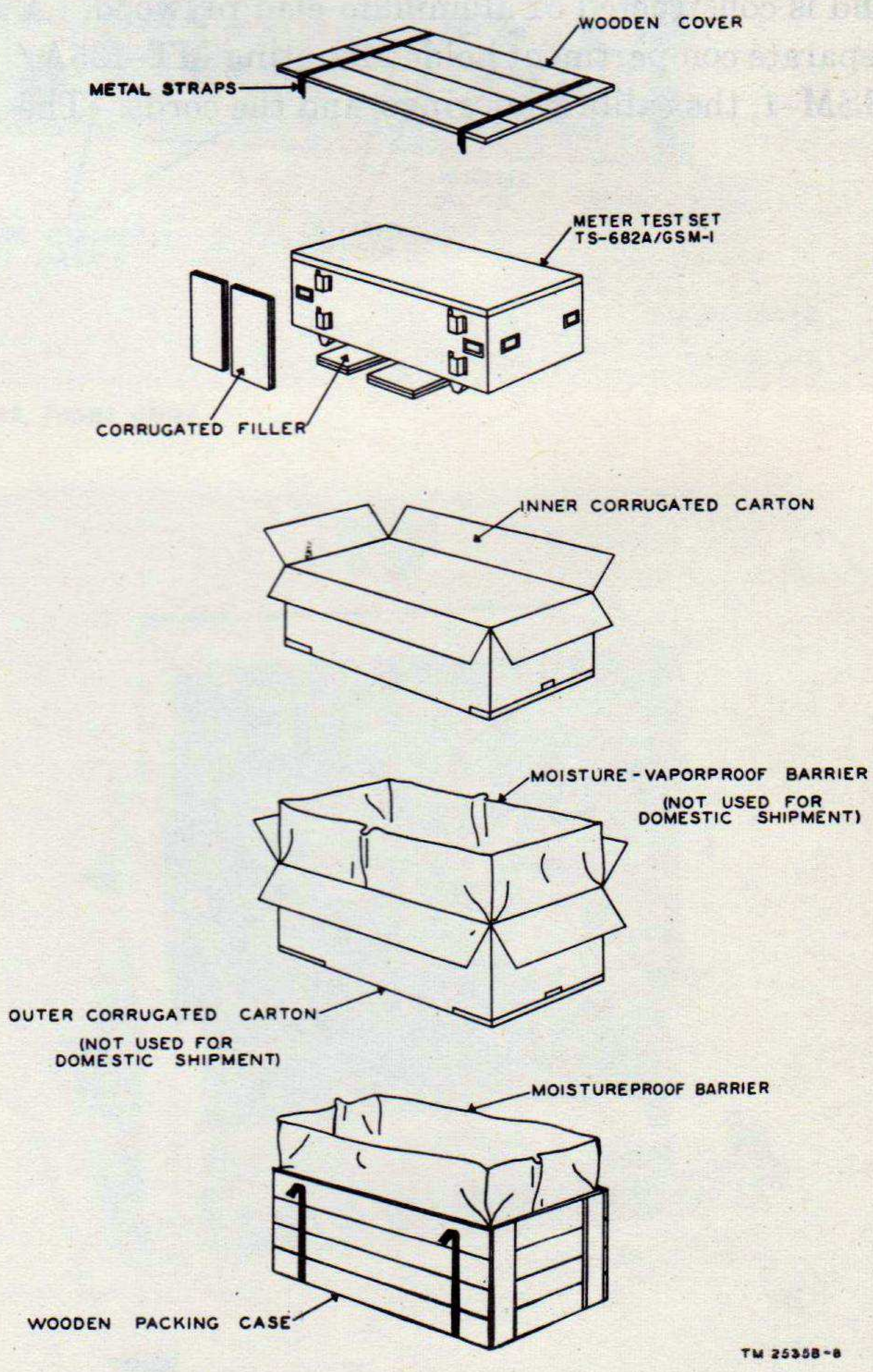

Figure 5. Packaging details for Meter Test Set TS–682A/GSM–1.

(5) Open the outer corrugated carton and break the sealed moisture-vaporproof barrier within the outer corrugated carton.

(6) Remove the inner corrugated carton.

(7) Open the inner corrugated carton and remove the equipment from this inner corrugated carton. Remove the corrugated filler or other packing material and place it near its final location.

(8) Open the case and inspect the equipment for damage.

(9) Check the contents of the case against the master packing slip.

(10) Pull the test set from the case by the handles on the front of the equipment (fig. 2). Place the test set on a workbench.

(11) Remove the backplate from the test set (fig. 35) and check to see that the tubes are seated firmly in their sockets.

(12) Place all the packaging materials in the wooden packing case for use in repacking the test set.

Section II. INITIAL ADJUSTMENT OF EQUIPMENT

11. Power Supply Requirements

a. Ac Power Supply. A source of 115-volt, 60-cycle ac power is required for the operation of the test set.

b. Dc Power Supply. An external 12-volt storage battery is required for operation of the dc ammeter test circuits. The battery must be able to supply 100 amperes for a period of 1 minute.

12. Preliminary Adjustments

a. Move the AC LINE switch (fig. 7) to the OFF position.

b. Move the BATTERY switch to the OFF position.

c. Turn the four output control knobs to their extreme counterclockwise positions.

13. Connecting Power Supplies

a. Plug the ac power cord into a 115-volt, 60-cycle ac outlet.

b. Connect the 12-volt storage battery to the binding posts just inside the door on the rear panel of the test set (fig. 6).

(1) Connect the spade-type terminal of Cord CX-25A/GSM-1 (positive) to the positive (+) binding posts; connect the battery clip to the positive battery terminal.

(2) Connect the spade-type terminal of Cord CX-25B/GSM-1 (negative) to the negative (−) binding post; connect the battery clip to the negative battery terminal.

Caution: Be sure to observe polarity when connecting the cords to the battery and to the test set.

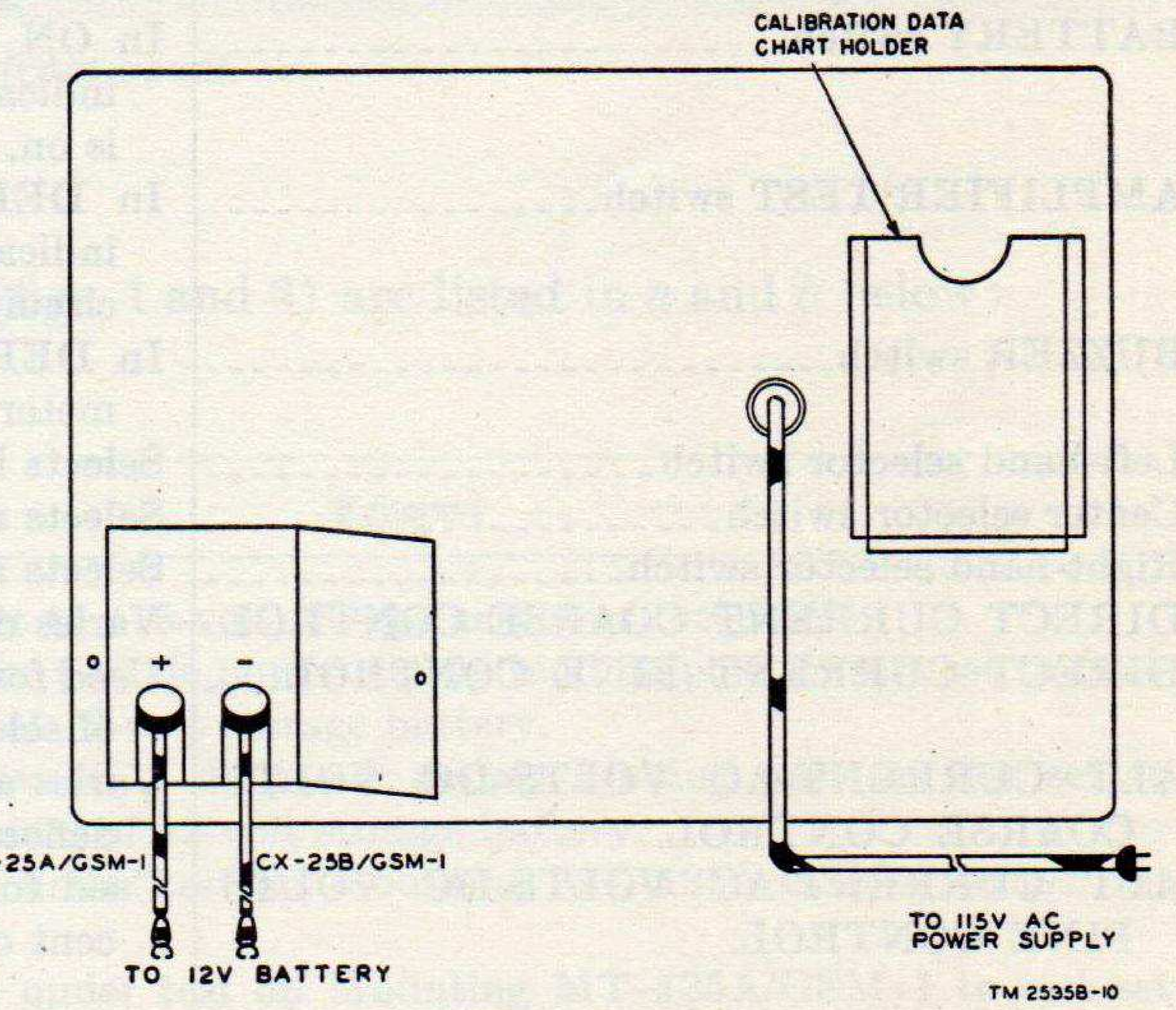

Figure 6. Rear of test set showing battery and ac power supply connectors.

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CHAPTER 3
OPERATION

Section I. CONTROLS, INSTRUMENTS, AND CONNECTING FACILITIES

Note. This section locates, illustrates, and describes the use of the various controls and instruments that are provided for the proper operation of the equipment.

14. Switches and Controls and Their Uses

a. Haphazard operation or improper setting of switches and controls (fig. 7) of the test set can damage the equipment. For this reason, it is important to know the function of every switch and control on the test set.

b. The following chart lists the controls of the test set and indicates their functions. All panel designations pertaining to ac ranges are marked in blue; all designations pertaining to dc ranges are marked in black; all designations common to both ac and dc ranges are marked in white.

Switch or control	Function
AC LINE switch	In ON position, connects equipment to ac power source.
BATTERY switch	In ON position, applies 12 volts dc for direct current tests. Amber indicator light above switch lights to indicate that dc power supply is on.
AMPLIFIER TEST switch	In DEPRESS TO TEST position, checks amplifier circuit. White indicator light above switch lights to indicate proper operation of circuit.
BUZZER switch	In DEPRESS position, energizes buzzer used to overcome friction in meter movements.
Left-hand selector switch	Selects high dc voltage ranges and groups of other ranges.
Center selector switch	Selects range units.
Right-hand selector switch	Selects ac and dc current ranges.
DIRECT CURRENT COARSE CONTROL	Varies dc current output from zero to full scale in selected range.
DIRECT CURRENT FINE CONTROL	Used for fine adjustment of output power over approximately 10 percent of selected range.
ALT CURRENT-AC VOLTS-DC VOLTS COARSE CONTROL.	Varies ac and dc voltage and alternating current from zero to full-scale deflection.
ALT CURRENT-AC VOLTS-DC VOLTS FINE CONTROL.	Used for fine adjustment of output power over approximately 10 percent of selected range.

15. Meters

Three precision meters mounted on the test set (fig. 7) are used to cover all ac and dc voltage and current ranges. The meters and their associated ranges are listed below.

Meter	Range
AC MILLIAMPERES (left-hand) meter.	Ac voltage ranges: 1 volt to 2,000 volts. Ac current ranges: 100 ma to 500 ma. 1 ampere to 100 amperes.
DC MICROAMPERES (center) meter.	Dc voltage ranges: 1 volt to 2,000 volts. Dc current ranges: 100 ua to 500 ua. 1 ma to 500 ma.
DC MILLIVOLTS (right-hand) meter.	Dc voltage ranges: 100 mv. Dc current ranges: 1 ampere to 100 amperes.

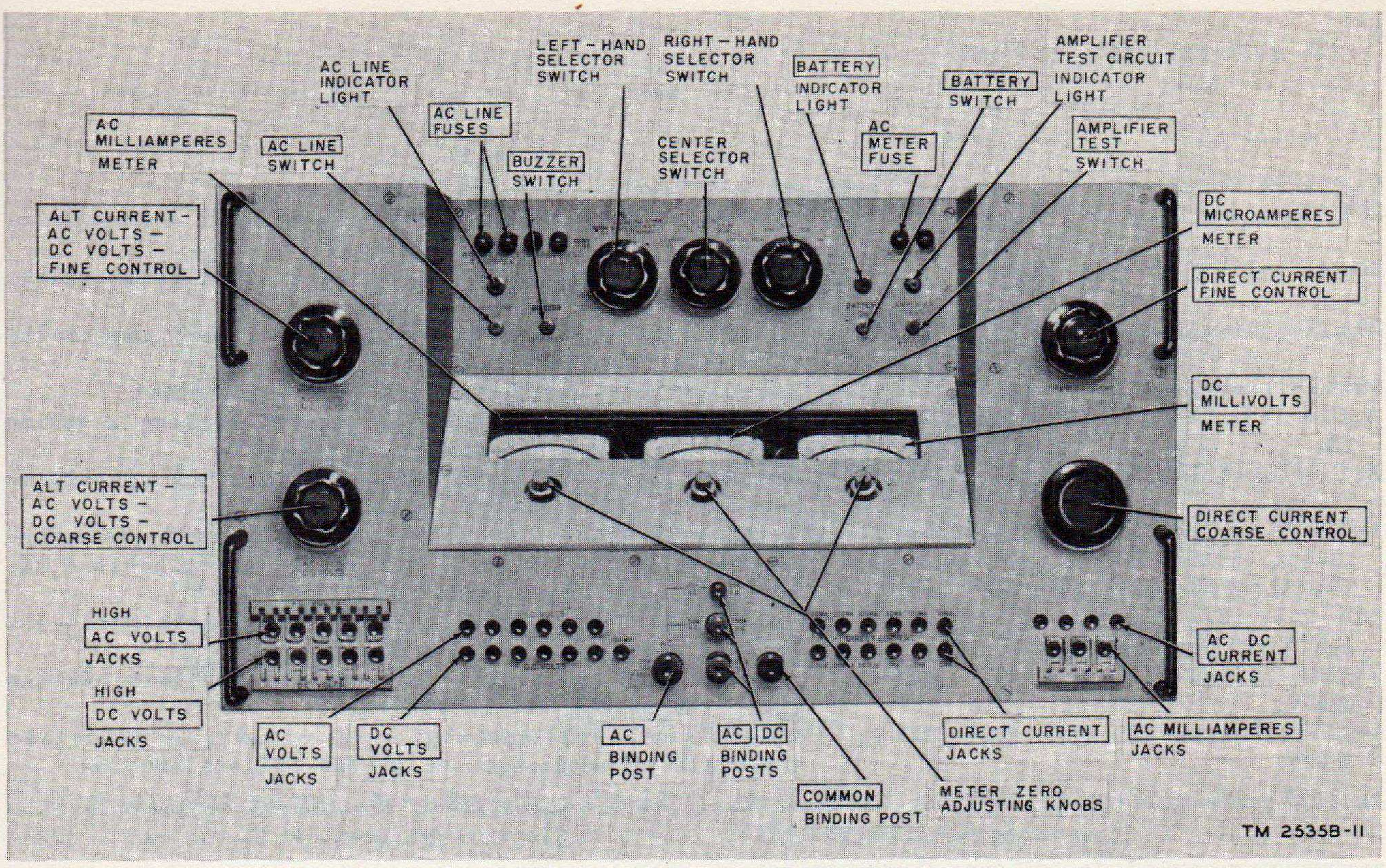

Figure 7. Test set, front panel.

16. Connecting Facilities

The cords for the power supply and test connections (figs. 1 and 6) are listed in *a* and *b* below:

a. Cables and Cords.

Facility	Function
Ac power cord	Connects test set to 115-volt, 60-cps ac power receptacle.
Cord CX-25A/GSM-1 (positive)	Connects positive (+) dc power supply binding post on test set to positive terminal of 12-volt storage battery.
Cord CX-25B/GSM-1 (negative)	Connects negative (−) dc power supply binding post on test set to negative terminal of 12-volt storage battery.
Test cords (terminated with spade lugs)	Connects meter under test on Mounting MT-135A/GSM-1 to test set binding posts.
Test cord (terminated with plug having .25 inch diameter shank).	Connects meter under test on Mounting MT-135A/GSM-1 to test set voltage jacks.
Test cord (terminated with plug having .2065 inch diameter shank).	Connects meter under test on Mounting MT-135A/GSM-1 to test set current jacks.

b. Jacks and Binding Posts.

Facility	Function
COMMON binding post	Connection for all ac voltage measurement circuits.
20A AC and 20A DC binding post	Connection for 20-ampere ac and 20-ampere dc supply to the meter to be tested.
50A AC and 50A DC binding post	Connection for 50-ampere ac and 50-ampere dc supply to the meter to be tested.
20A, 50A, 100A AC binding post	Connection for 20-ampere, 50-ampere, and 100-ampere ac supply to the meter to be tested.
100A DC binding post	Connection for 100-ampere dc supply to the meter to be tested.
A. C. & D. C. CURRENT jacks 10A, 5A, 2A, 1A.	Connections for 10-ampere, 5-ampere, 2-ampere, 1-ampere ac and dc supply to the meter to be tested.
A. C. MILLIAMPERES jacks 500, 200, 100	Connections for 500-milliamperes, 200-milliamperes, and 100-milliamperes ac supply to the meter to be tested.
DIRECT CURRENT 500MA, 200MA, 100MA, 50MA, 20MA, 10MA, 100UA, 200UA, 500UA, 1MA, 2MA, 5MA jacks.	Connections for dc current supply to the meter to be tested in the following ranges: 500, 200, 100, 50, 20, 10, 5, 2, 1 milliampere jacks and 100, 200, and 500 microampere jacks.
50V., 20V., 10V., 5V., 2V., 1V., A.C. VOLTS, D.C. VOLTS jacks.	Connections for ac and dc volts supply to the meter to be tested in the following ranges: 50, 20, 10, 5, 2, and 1 volt.
AC VOLTS jacks 100V., 200V., 500V., 1000V., 2000V.	Connections for ac volts supply to the meter to be tested in the following ranges: 100, 200, 500, 1000 and 2000 volts.
DC VOLTS jacks 100V., 200V., 500V., 1000V., 2000V.	Connections for dc volts jacks which supply voltage to the meters to be tested in the following ranges: 100, 200, 500, 1000, and 2000 volts.

Section II. OPERATION UNDER USUAL CONDITIONS

17. Mounting Meter Under Test on Mounting MT–135A/GSM–1

a. Selecting Calibration Ring. Many meters are mounted on a steel panel. To test and calibrate this type of meter, use a steel calibration ring over the meter case to simulate normal operating conditions. Select a ring of the approximate diameter of the meter to be tested, and slip the ring over the case before mounting the meter on Mounting MT–135A/GSM–1 (fig. 8). The spring-steel retainers on the calibration ring secure the ring to the meter.

b. Mounting Meter.

(1) Press down on the knob on top of the mounting box to open the jaws inside the box.

(2) Place the meter terminals in the mounting holes and release the knob.

(3) Loosen the thumbscrews at each end of the mounting shaft and tilt the box until the meter under test assumes the angle it normally occupies in the equipment from which it was taken. Tighten the thumbscrews securely. Figure 8 shows a meter mounted on Mounting MT–135A/GSM–1; B, figure 8, shows the mounting box in a tilted position.

18. Preliminary Starting Procedures

Before connecting the meter under test to the test set and before operating the equipment, make the following preliminary adjustments on the test set (fig. 7).

a. Move the AC LINE switch to the OFF position.

b. Move the BATTERY switch to the OFF position.

c. Turn the four output control knobs to their extreme counterclockwise positions (fig. 2).

Caution: Do not move any of the four output control knobs from their extreme counterclockwise position until the meter to be tested has been connected to the jacks or binding posts.

d. Adjust the three standard meters to zero by turning the zero adjusting control associated with each meter and located below the meter.

e. Move the AC LINE switch to the ON position. Allow 1 minute for the test set to warm up.

f. Check the operation of the amplifier circuit by depressing the AMPLIFIER TEST switch.

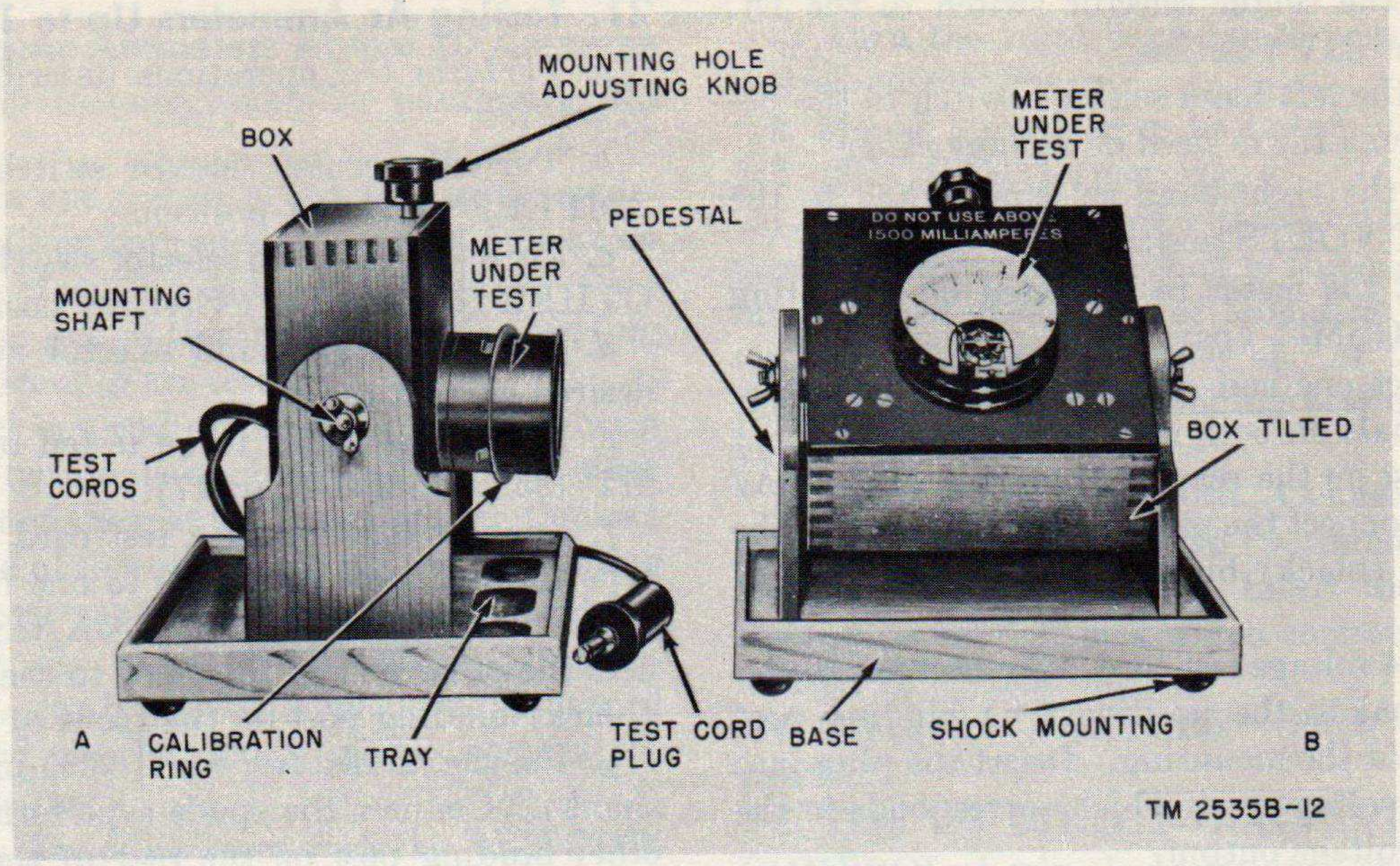

Figure 8. Meter under test mounted on Mounting MT–135A/GSM–1, side view and view with box in tilted position.

The white indicating light above the switch should light if this circuit is operating normally.

19. Testing Ac Voltmeters

a. Perform the operations described in paragraph 18.

b. Turn the center selector switch to the AC VOLTS position.

c. Turn the left-hand selector switch to the ALL OTHER AC and DC SCALES position.

d. Turn the right-hand selector switch to the AC and DC VOLTS position.

e. Mount the meter to be tested on Mounting MT–135A/GSM–1 (par. 17).

f. Connect one end of a test cord with spade-type terminals on both ends to one of the binding posts on the rear of Mounting MT–135A/GSM–1. Connect the other end of this cord to the COMMON (black) binding post on the front of the test set.

g. Use the voltage test cord (.25-inch diameter shank). Connect the spade-type terminal to the other binding post on the rear of the mounting. Insert the plug into the test set voltage jack which corresponds to the desired ac voltage output.

h. Rotate the AC VOLTS COARSE CONTROL slowly clockwise until the pointer reaches the mark on the ac voltage scale of the left-hand meter.

i. Make a fine adjustment with the AC VOLTS FINE CONTROL; at the same time, depress the BUZZER switch to overcome possible friction in the test set meter movement.

j. Compare the reading of the meter under test with the reading of the standard ac meter. To obtain a more precise reading of the standard meter, accurate to .25 percent, use the calibration data chart (par. 25) covering the ac voltage ranges of the meter under test.

k. Repeat the procedures in *f* through *i* above for as many different readings as necessary to test the action and accuracy of the meter under test.

l. When tests have been completed, proceed as follows to prepare the test set for testing another meter:

(1) Turn the output controls to their maximum counterclockwise positions.

(2) Remove one test cord plug from the jack on the front of the test set. Remove the other test cord terminal from the COMMON binding post.

(3) Remove both test cords from the binding posts on the rear of Mounting MT–135A/GSM–1.

(4) Remove the tested meter from the mounting.

20. Testing Dc Voltmeters

a. Perform the operations described in paragraph 18.

b. Turn the center selector switch to the DC VOLTS and MV position.

c. Turn the left-hand selector switch to the position covering the desired dc voltage range.

d. Turn the right-hand selector switch to the AC and DC VOLTS position.

e. Mount the meter to be tested on Mounting MT–135A/GSM–1 (par. 17).

f. Connect one end of a test cord with spade-type terminals on both ends to the negative (–) binding post on the rear of Mounting MT–135A/GSM–1. Connect the other end of this cord to the COMMON (black) binding post on the front of the test set.

g. Use the voltage test cord. Connect the spade-type terminal to the positive (+) binding post on the rear of the mounting. Insert the plug into the test set voltage jack which corresponds to the desired dc voltage output.

h. Rotate the DC VOLTS COARSE CONTROL slowly clockwise until the pointer of the standard dc voltage (right-hand) meter reaches the approximate mark.

i. Make a fine adjustment with the DC VOLTS FINE CONTROL; at the same time, depress the BUZZER switch to overcome possible friction in the test set meter movement.

j. Compare the reading of the meter under test with the reading of the standard dc meter. For a more precise reading of the standard meter, accurate to .25 percent, use the calibration data chart (par. 25) covering the dc voltage ranges of the meter under test.

k. Repeat the procedures in *g* through *j* above for as many readings as necessary to test the action and accuracy of the meter under test.

l. When tests have been completed, proceed as follows to prepare the test set for testing another meter:

(1) Turn the output controls to their maximum counterclockwise positions.

(2) Remove one test cord plug from the jack on the front of the test set. Remove the other test cord terminal from the COMMON binding post.

(3) Remove both test cords from the binding posts on the rear of Mounting MT–135A/GSM–1.

(4) Remove the tested meter from the mounting.

21. Testing Ac Ammeters Up to 10 Amperes

a. Perform the operations described in paragraph 18.

b. Turn the center selector switch to the AC AMPERES and MA position.

c. Turn the left-hand selector switch to the ALL OTHER AC and DC SCALES position.

d. Turn the right-hand selector switch to the desired current range.

e. Mount the meter to be tested on Mounting MT–135A/GSM–1 (par. 17).

f. Connect one end of a test cord with spade-type terminals on both ends to one binding post on the rear of Mounting MT–135A/GSM–1. Connect the other end of this cord to the COMMON (black) binding post on the front of the test set.

g. Use the current test cord (.2065-inch diameter shank). Connect the spade-type terminal to the other binding post on the rear of the mounting. Insert the plug into the test set current jack which corresponds to the desired ac output.

h. Rotate the ALT CURRENT COARSE CONTROL slowly clockwise until the pointer of the standard ac (left-hand) meter reaches the approximate mark.

i. Make a fine adjustment with the ALT CURRENT FINE CONTROL; at the same time, depress the BUZZER switch to overcome possible friction in the test set meter movement.

j. Compare the reading of the meter under test with the reading of the standard ac meter. To obtain a more precise reading of the standard meter, accurate to .25 percent, use the calibration data chart (par. 25) covering the ac ranges of the meter under test.

k. Repeat the procedures in *g* through *j* above for as many readings as necessary to test the action and accuracy of the meter under test.

l. When tests have been completed, proceed as follows to prepare the test set for testing another meter:

(1) Turn the output controls to their maximum counterclockwise positions.

(2) Remove one test cord plug from the jack on the front of the test set. Remove the other test cord terminal from the COMMON binding post.

(3) Remove both test cords from the binding posts on the rear of Mounting MT–135A/GSM–1.

(4) Remove the tested meter from the mounting.

22. Testing Ac Ammeters Above 10 Amperes

a. Perform the operations in paragraph 21*a* through *e*.

b. Connect one end of a test cord with spade-type terminals on both ends to one binding post on the rear of Mounting MT–135A/GSM–1. Connect the other end of this cord to the blue binding post on the front of the test set.

c. Connect one end of the other test cord with spade-type terminals on both ends to the other binding post on the rear of the mounting. Connect the other end of this cord to the red test set binding post which corresponds to the desired ac output.

d. Rotate the ALT CURRENT COARSE CONTROL slowly clockwise until the pointer of the standard ac (left-hand) meter reaches the approximate mark.

e. Make a fine adjustment with the ALT CURRENT FINE CONTROL; at the same time, depress the BUZZER switch to overcome possible friction in the test set meter movement.

f. Compare the reading of the meter under test with the reading of the standard ac meter. To obtain a more precise reading of the standard meter, accurate to .25 percent, use the calibration data chart (par. 25) covering the ac ranges of the meter under test.

g. Repeat the procedures in *b* through *f* above for as many readings as necessary to test the action and accuracy of the meter under test.

h. When tests have been completed, proceed as follows to prepare the test set for testing another meter:

(1) Turn the output controls to their maximum counterclockwise positions.

(2) Remove the test cord terminals from the binding posts of the test set.

(3) Remove both test cords from the binding posts on the rear of Mounting MT–135A/GSM–1.

(4) Remove the tested meter from the mounting.

23. Testing Dc Ammeters Up to 10 Amperes

a. Perform the operations described in paragraph 18.

b. Turn the center selector switch to the DC AMPERES or DC MA and UA position, whichever is appropriate.

c. Turn the left-hand selector switch to the ALL OTHER AC and DC SCALES position.

d. Turn the right-hand selector switch to the desired current range.

e. Mount the meter to be tested on Mounting MT–135A/GSM–1 (par. 17).

f. Connect one end of a test cord with spade-type terminals on both ends to the negative (−) binding post on the rear of Mounting MT–135A/GSM–1. Connect the other end of this cord to the COMMON (black) binding post on the front of the test set.

g. Use the current test cord. Connect the spade-type terminal to the positive (+) binding post on the rear of the mounting. Insert the plug into the test set current jack which corresponds to the desired dc current output.

h. Move the BATTERY switch to the ON position.

i. Turn the DIRECT CURRENT COARSE CONTROL slowly clockwise until the pointer of the standard dc (center) meter reaches the approximate mark.

j. Make a fine adjustment with the DIRECT CURRENT FINE CONTROL; at the same time depress the BUZZER switch to overcome possible friction in the test set meter movement.

k. Compare the reading of the meter under test with the reading of the standard dc meter. To obtain a more precise reading of the standard meter, accurate to .25 percent, use the calibration data chart (par. 25) covering the dc ranges of the meter under test.

l. Repeat the procedures in *g* and *i* through *k* above for as many readings as necessary to test the action and accuracy of the meter under test.

m. When tests have been completed, proceed as follows to prepare the test set for testing another meter:

(1) Turn the output controls to their maximum counterclockwise positions.

(2) Remove one test cord plug from the jack on the front of the test set. Remove the other test cord terminal from the COMMON binding post.

(3) Move the BATTERY switch to the OFF position.

(4) Remove both test cords from the binding posts on the rear of Mounting MT–135A/GSM–1.

(5) Remove the tested meter from the mounting.

24. Testing Dc Ammeters Above 10 Amperes

a. Perform the operations described in paragraph 18.

b. Turn the center selector switch to the DC AMPERES position.

c. Turn the left-hand selector switch to the ALL OTHER AC and DC SCALES position.

d. Turn the right-hand selector switch to the desired current range.

e. Mount the meter to be tested on Mounting MT–135A/GSM–1 (par. 17).

f. Connect one end of a test cord with spade-type terminals on both ends to one binding post on the rear of Mounting MT–135A/GSM–1. Connect the other end to this cord to the COMMON (black) binding post on the front of the test set.

g. Connect one end of the other test cord with spade-type terminals on both ends to the other binding post on the rear of the mounting. Connect the other end of this cord to the red test set binding post which corresponds to the desired dc output.

h. Move the BATTERY switch to the ON position.

i. Turn the DIRECT CURRENT COARSE CONTROL slowly clockwise until the pointer of the standard dc (center) meter reaches the approximate mark.

j. Make a fine adjustment with the DIRECT CURRENT FINE CONTROL; at the same time, depress the BUZZER switch to overcome possible friction in the test set meter movement.

k. Compare the reading of the meter under test with the reading of the standard dc meter. To obtain a more precise reading of the standard meter, accurate to .25 percent, use the calibration data chart (par. 25) covering the dc ranges of the meter under test.

l. Repeat the operations in *g* and *i* through *k* above for as many readings as necessary to test the action and accuracy of the meter under test.

25. Use of Calibration Charts

a. To obtain the most precise results in checking or calibrating meters, use the calibration charts located in a special pocket on the back of the test set (fig. 6). Values of dc voltage and current read on all of the test set meters and corrected according to the calibration charts are accurate to .25 percent. A sample calibration data chart is shown in figure 9.

b. Obtain the correct value of voltage or current that is being supplied to the meter under test by reading the value on the standard meter and referring to the calibration data for the ac or dc voltage or current range selected. For each 20 meter scale marking, given in the column designated SCALE MARK, a corrected value of voltage or current is given in the right-hand column. Select the corrected value of voltage or current from the column opposite the scale marking.

26. Stopping Procedure

a. Turn the four output controls to their maximum counterclockwise positions.

b. Remove the test cord plugs and terminals from the jacks and binding posts on the front of the test set.

c. Remove the test cord terminals from the binding posts on the rear of Mounting MT–135A/GSM–1.

d. Remove the tested meter from the mounting.

e. Move the AC LINE switch to the OFF position.

f. Move the BATTERY switch to the OFF position.

CALIBRATION DATA CHART FOR METER TEST SET TS-682A/GSM-1

Date 12 JUL 54 Serial No. XX

D.C. CURRENT RANGES

0-100UA RANGE		0-200UA RANGE		0-400UA RANGE		0-1MA RANGE		0-2MA RANGE		0-4MA RANGE	
SCALE MARK.	UA	SCALE MARK.	UA	SCALE MARK.	UA	SCALE MARK.	MA	SCALE MARK.	MA	SCALE MARK.	MA
5	5.05	10	10.00	20	20.00	5	.0495	10	.0995	20	.2000
10	10.10	20	20.10	40	40.05	10	.1010	20	.2005	40	.4005
15	15.10	30	30.05	60	60.05	15	.1505	30	.3000	60	.5995
20	20.00	40	40.00	80	80.00	20	.2005	40	.4000	80	.8000
25	25.10	50	50.00	100	100.00	25	.2505	50	.5010	100	1.0005
30	30.10	60	60.05	120	120.05	30	[illegible]	60	.6000	120	1.2010
35	35.05	70	70.05	140	140.00	35	[illegible]	70	.7000	140	1.4005
40	40.05	80	79.90	160	160.00	[illegible]	[illegible]	80	.8010	160	1.6010
45	44.95	90	89.95	180	[illegible]	[illegible]	[illegible]	90	.9000	180	1.8000
50	49.90	100	99.90	200	[illegible]	[illegible]	.5000	100	1.0000	200	2.0000
55	55.05	110	110.05	220	[illegible]	55	.5520	110	1.1020	220	2.2020
60	60.50	120	120.30	240	240.20	60	.6085	120	1.2060	240	2.4085
65	65.20	130	130.60	260	260.30	65	.6570	130	1.3050	260	2.6080
70	70.00	140	139.90	280	279.95	70	.7000	140	1.4005	280	2.8000
75	74.90	150	149.85	300	299.95	75	.7505	150	1.5000	300	3.0000
80	79.80	160	159.80	320	319.90	80	.8005	160	1.6000	320	3.2005
85	84.80	170	169.90	340	339.85	85	.8510	170	1.7005	340	3.4000
90	89.90	180	179.90	360	359.90	90	.9025	180	1.8005	360	3.6005
95	95.05	190	190.00	380	380.05	95	.9560	190	1.9050	380	3.8030
100	100.00	200	200.05	400	400.05	100	1.0030	200	2.0020	400	4.0030

SAMPLE

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Figure 9. Sample calibration data chart.

Section III. OPERATION UNDER UNUSUAL CONDITIONS

27. General

Operation of the test set may be difficult in regions where extreme climatic conditions prevail. Although the test set is designed to maintain its technical characteristics over a wide temperature and humidity range, adverse conditions may cause errors in measurements unless additional precautions are taken. Paragraphs 28 through 30 recommend procedures that will minimize the effects of unusual climatic conditions on the operation and accuracy of the test set.

28. Operation in Arctic Climates

Subzero temperatures and climatic conditions associated with cold weather affect the efficient operation of test equipment. Follow the instructions and precautions in *a* through *e* below when operating the test set under such adverse conditions.

a. Handle the equipment carefully.

b. Locate the test set in a heated inclosure. Keep the test set out of cold drafts as much as possible, especially when any panels have been removed for replacement of parts.

c. Keep the equipment as dry as possible. Keep the ac power cord connected; the heater will continue to operate, even through the test set is not in use as long as the ac power cord is connected to the ac power source.

d. If the heater has been disconnected and if the test set has been exposed to the cold, allow the equipment to reach room temperature and allow it to dry thoroughly before attempting to make any tests.

e. Keep the storage battery fully charged to minimize the effect of extreme cold on the battery. A storage battery with a low charge may freeze and burst open in subzero temperatures.

29. Operation in Tropical Climates

When operated in tropical climates, install the test set in tents or huts or, when necessary, in underground dugouts. When the equipment is used in areas of high humidity, keep the ac power cord connected so that the heater will function at all times when the equipment is not in use. In addition, place the equipment on an open, raised framework to provide the best ventilation possible.

30. Operation in Desert Climates

a. When the test set is used in desert areas, the main operational problem is to prevent sand, dust, and dirt from entering the equipment. The ideal preventive precaution is to house the equipment in a dustproof shelter. Since, however, such a building is seldom available and would require air conditioning, the next best precaution is to make the building in which the equipment is located as dustproof as possible with available materials.

b. Never tie power cords or other wiring to either the inside or the outside of tents. Desert areas are subject to sudden wind squalls which may jerk the connections loose or break the lines.

c. Make frequent preventive maintenance checks (par. 36).

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CHAPTER 4

ORGANIZATIONAL MAINTENANCE

Section I. ORGANIZATIONAL TOOLS AND EQUIPMENT

31. General

The actual allowable organizational maintenance that can be performed on Meter Test Set TS–682A/GSM–1 depends on the existing military regulations (standard operating procedures) and the tools and test equipment available. Only qualified personnel supplied with the correct tools and test equipment are authorized to perform preventive maintenance on the test set. Before starting preventive maintenance procedures, all the tools, materials, and test equipment needed to perform the operations circled on the preventive maintenance forms (figs. 11 and 12) should be available.

32. Tools, Materials, and Test Equipment

The tools, materials, and test equipment used to maintain the test set are listed in *a* through *c* below. Paragraph 33 contains instructions for the fabrication of a shorting stick used to discharge capacitors before preventive maintenance procedures are performed.

a. Tools.

Name of item
Shorting stick (par. 33).
ool Equipment TE–41 (Department of the Army Supply Manual SIG 6–TE–41).

b. Materials.

Name of item and description	Use
Abrasive, sheet: sandpaper, No. 000.	Remove rust and corrosion from metal parts.
Paint brush: soft hair; flat; 1″ wide.	Remove dust, dirt, and lint from meter glass, from binding posts, and from switch and control knobs.
Carbon tetrachloride	Remove gummy deposits from test cord clips and terminals and binding post contact surfaces.
Cleaning compound	Remove grease, oil, and corrosion from equipment.
Textile cloth: cheesecloth; lint-free.	Clean various parts of equipment.
Stick, orange	Remove fungus growth from equipment.

c. Test Equipment.

Name of item
Electron Tube Test Set TV–7/U (TM 11–5083).
Multimeter TS–297/U (TM 11–5500).

33. Shorting Stick

a. General. A shorting stick (fig. 10) is used to discharge capacitors before attempting to perform maintenance or troubleshooting operations. Normally when the AC LINE switch is moved to the OFF position, capacitors will discharge to ground through bleeder resistors or voltage dividers. If failure should occur in a discharging network, however, and the capacitors remain charged, a severe burn may result if a charged capacitor is touched.

b. Fabrication of Shorting Stick.

(1) Use a hardwood dowel approximately ½ inch in diameter and 15 inches long. Drill a hole ⅛ inch in diameter and 2 inches deep in one end of the dowel.

(2) Press-fit a piece of copper or brass bus wire into the hole. Leave approximately 1 inch of wire extending beyond the dowel.

(3) Solder one end of a 36-inch length of flexible, stranded, No. 10 wire to the bus wire as close to the dowel as possible. Attach a battery clamp to the other end of the flexible wire.

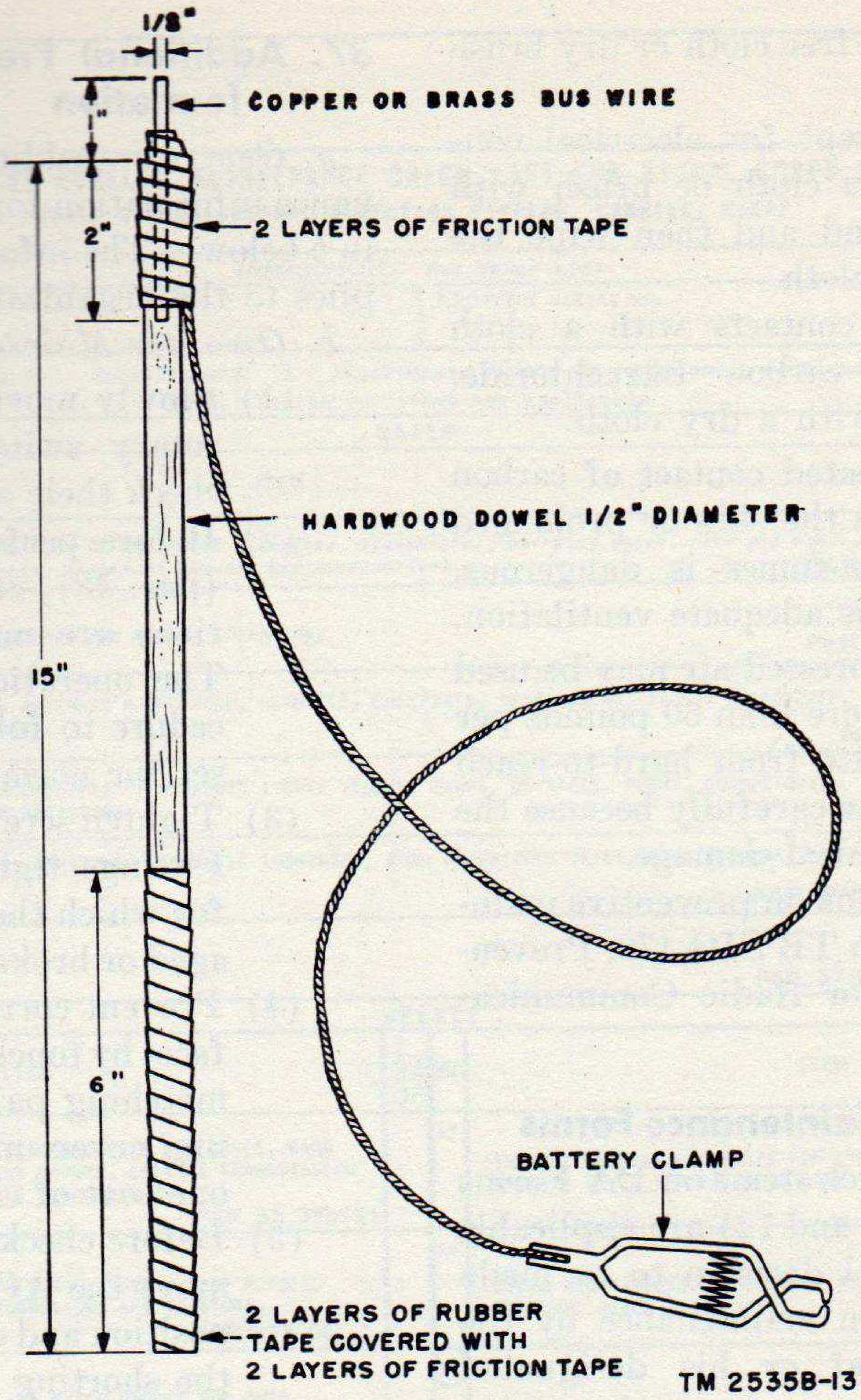

Figure 10. Shorting stick.

(4) Wrap several layers of friction tape over the soldered connection. Allow approximately ½ inch of untaped bus wire to extend beyond the tape. Continue to tape from the soldered connection down over the dowel to within 2 inches of the soldered joint.

(5) Wrap two layers of rubber tape and two layers of friction tape around the other end of the dowel for about 6 inches. This forms an insulated handle for the shorting stick.

c. Use of Shorting Stick.

(1) Connect the battery clamp to a chassis ground located near the capacitor to be discharged.

(2) Hold the shorting stick by the insulated handle and touch the exposed bus wire to the capacitor terminals. The capacitor will discharge immediately.

Section II. PREVENTIVE MAINTENANCE SERVICES

34. Definition of Preventive Maintenance

Preventive maintenance is work performed on equipment (usually when the equipment is not in use) to keep it in good working order so that breakdowns and needless interruptions in service will be kept to a minimum. Preventive maintenance differs from troubleshooting and repair since its object is to prevent certain troubles before they occur.

35. General Preventive Maintenance Techniques

a. Use No. 000 sandpaper to remove corrosion.

b. Use a clean, dry, lint-free cloth or dry brush for cleaning.

(1) If necessary, except for electrical contacts, moisten the cloth or brush with cleaning compound and then wipe the parts dry with a cloth.

(2) Clean electrical contacts with a cloth moistened with carbon tetrachloride. Wipe them dry with a dry cloth.

Caution: Repeated contact of carbon tetrachloride with the skin or prolonged breathing of the fumes is dangerous. Make sure there is adequate ventilation.

c. If available, dry compressed air may be used at a line pressure of not more than 60 pounds per square inch to remove dust from hard-to-reach places. Use compressed air carefully because the air blast can cause mechanical damage.

d. For further information on preventive maintenance techniques, refer to TB SIG 178, Preventive Maintenance Guide for Radio Communication Equipment.

36. Use of Preventive Maintenance Forms

a. The decision as to which items on DA Forms 11–238 and 11–239 (figs. 11 and 12) are applicable to the test set is a tactical decision to be made in the case of first echelon maintenance by the communication officer/chief or his designated representative and, in the case of second or third echelon maintenance, by the individual making the inspection. Instructions for the use of each form appear on the reverse side of the form.

b. Circled item numbers in figures 11 and 12 are partially or totally applicable to the test set. References in ITEM columns of each form are to paragraphs in the text which contain additional maintenance information.

37. Additional Preventive Maintenance Information

a. General. Additional preventive maintenance information for use by the operator is given in *b* below. The information in *b* and *c* below applies to the organizational repairman.

b. Operator Maintenance.

(1) Slowly move the knobs of controls and rotary switches in both directions to check their action.

(2) Before performing the operational test (par. 48), check to see that all connections are made securely and properly. The operational test describes the procedure to follow when checking the test set for normal operation.

(3) Tighten screws, bolts, and nuts carefully. Fittings tightened beyond the pressure for which they are designed will be damaged or broken.

(4) Prevent corrosion of exposed metal surfaces by touching up damaged places with matching paint (par. 39). After cleaning, cover unpainted metal fittings with one coat of clear lacquer.

(5) Before checking capacitors for looseness, move the AC LINE switch to the OFF position and discharge all capacitors with the shorting stick (par. 33*c*).

c. Organizational Repairman Maintenance.

(1) Except for removing dust and lint (par. 46*b*), relay contacts should be cleaned and burnished by an experienced repairman.

(2) The power transformer normally operates at a relatively high temperature. Therefore, overheating of this transformer cannot be detected by touch.

Section III. WEATHERPROOFING

38. Weatherproofing

a. General. Most materials are harmed by fungus growth, insects, dust, corrosion, salt spray, excessive moisture, and extreme temperature. Therefore, Signal Corps equipment requires special treatment and maintenance when it is operated under severe climatic conditions such as prevail in tropical, arctic, and desert regions. References to publications which describe the special treatment and maintenance to be applied to the test set to prevent equipment failure are given in *b* through *d* below.

b. Tropical Maintenance. A special moistureproofing and fungiproofing treatment has been devised which, if properly applied, provides a reasonable degree of protection. This treatment is explained in TB SIG 13, Moistureproofing and Fungiproofing Signal Corps Equipment, and TB SIG 72, Tropical Maintenance of Ground Signal Equipment.

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.

LEGEND FOR MARKING CONDITIONS: Satisfactory; X Adjustment, repair or replacement required; Ⓧ Defect corrected.

NOTE: Strike out items not applicable.

DAILY

NO.	ITEM	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. 6,8							
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 9							
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR. 35							
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 46							
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 37b (1)							
6	CHECK FOR NORMAL OPERATION. PAR. 37b(2),48							

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. PAR. 35,37b(3)		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. PAR.37b (4)		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. 44		15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 39	
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, POWERSTATS, RELAYS, SELSYNS, MOTORS, BLOWERS, CAPACITORS, GENERATORS, AND PILOT LIGHT ASSEMBLIES. PAR. 37b(5)		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, 1 DEC 50, WHICH IS OBSOLETE.

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Figure 11. DA Form 11-238.

SECOND AND THIRD ECHELON MAINTENANCE CHECK LIST FOR SIGNAL CORPS EQUIPMENT

RADIO COMMUNICATION, DIRECTION FINDING, CARRIER, RADAR

INSTRUCTIONS: See other side

EQUIPMENT NOMENCLATURE	EQUIPMENT SERIAL NO.

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. 6,8		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. PAR. 46,66 a	
2	LOCATION AND INSTALLATION SUITABLE FOR NORMAL OPERATION. PAR. 9		20	INSPECT FILM CUT-OUTS FOR LOOSE PARTS, DIRT, MISALIGNMENT AND CORROSION.	
3	CLEAN DIRT AND MOISTURE FROM ANTENNA, MICROPHONE, HEADSETS, CHESTSETS, KEYS, JACKS, PLUGS, TELEPHONES, CARRYING BAGS, COMPONENT PANELS. PAR 35		21	INSPECT FIXED CAPACITORS FOR LEAKS, BULGES, AND DISCOLORATION. PAR. 44	
4	INSPECT SEATING OF READILY ACCESSIBLE "PLUCK-OUT" ITEMS: TUBES, LAMPS, CRYSTALS, FUSES, CONNECTORS, VIBRATORS, PLUG-IN COILS AND RESISTORS. PAR. 46		22	INSPECT RELAY AND CIRCUIT BREAKER ASSEMBLIES FOR LOOSE MOUNTINGS; BURNED, PITTED, CORRODED CONTACTS; MISALIGNMENT OF CONTACTS AND SPRINGS; INSUFFICIENT SPRING TENSION; BINDING OF PLUNGERS AND HINGE PARTS. PAR. 44	
5	INSPECT CONTROLS FOR BINDING, SCRAPING, EXCESSIVE LOOSENESS, WORN OR CHIPPED GEARS, MISALIGNMENT, POSITIVE ACTION. PAR. 37b(1)		23	INSPECT VARIABLE CAPACITORS FOR DIRT, MOISTURE, MISALIGNMENT OF PLATES, AND LOOSE MOUNTINGS.	
6	CHECK FOR NORMAL OPERATION. PAR. 37b(2), 48		24	INSPECT RESISTORS, BUSHINGS, AND INSULATORS, FOR CRACKS, CHIPPING, BLISTERING, DISCOLORATION AND MOISTURE. PAR. 38b, 44	
7	CLEAN AND TIGHTEN EXTERIOR OF COMPONENTS AND CASES, RACK MOUNTS, SHOCK MOUNTS, ANTENNA MOUNTS, COAXIAL TRANSMISSION LINES, WAVE GUIDES, AND CABLE CONNECTIONS. PAR. 35,37b(3)		25	INSPECT TERMINALS OF LARGE FIXED CAPACITORS AND RESISTORS FOR CORROSION, DIRT AND LOOSE CONTACTS. PAR. 37b(5)	
8	INSPECT CASES, MOUNTINGS, ANTENNAS, TOWERS, AND EXPOSED METAL SURFACES, FOR RUST, CORROSION, AND MOISTURE. PAR. 37b(4)		26	CLEAN AND TIGHTEN SWITCHES, TERMINAL BLOCKS, BLOWERS, RELAY CASES, AND INTERIORS OF CHASSIS AND CABINETS NOT READILY ACCESSIBLE. PAR. 35,37b(3)	
9	INSPECT CORD, CABLE, WIRE, AND SHOCK MOUNTS FOR CUTS, BREAKS, FRAYING, DETERIORATION, KINKS, AND STRAIN. PAR. 44		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. PAR. 75	
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. PAR 37b(5)		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. PAR. 35,37b(3)	
14	CLEAN AIR FILTERS, BRASS NAME PLATES, DIAL AND METER WINDOWS, JEWEL ASSEMBLIES.		32	INSPECT TRANSFORMERS, CHOKES, POTENTIOMETERS, AND RHEOSTATS FOR OVERHEATING AND OIL-LEAKAGE. PAR 37c(3)	
15	INSPECT METERS FOR DAMAGED GLASS AND CASES. PAR. 39		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. PAR. 38b	
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. o6—16—64362-1

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Figure 12. DA Form 11-239.

c. Arctic Maintenance. Special precautions necessary to prevent poor performance or total operational failure of the equipment in extremely low temperatures are explained in TB SIG 66, Winter Maintenance of Signal Equipment, and TB SIG 219, Operation of Signal Equipment at Low Temperatures.

d. Desert Maintenance. Special precautions necessary to prevent equipment failure in areas subject to extremely high temperatures, low humidity, and excessive sand and dust are explained in TB SIG 75, Desert Maintenance of Ground Signal Equipment.

e. Lubrication. There are no lubrication orders for this equipment. The moving parts of this test set will be kept free of lubricants.

39. Preventing Corrosion and Touchup Painting

a. Scarred Surfaces. When the finish on the case or test set panels has been scarred or damaged, prevent corrosion by touching up bared surfaces. Before touching up the damaged surfaces, use No. 000 sandpaper to clean the damaged portions down to the bare metal; obtain a bright, smooth finish and apply paint with a small brush.

Caution: Do not use steel wool. Minute particles may enter the case and cause harmful internal shorting or grounding of circuits.

b. Corroded Surfaces. When damaged portions of the case or test set panels are corroded, remove rust by cleaning the corroded metal with cleaning compound. In severe cases, it may be necessary to complete the preparations for painting with sandpaper. Clean the surfaces down to the bare metal and apply paint with a small brush. Paint used will be authorized and consistent with existing regulations.

Section IV. TROUBLESHOOTING AT ORGANIZATIONAL MAINTENANCE LEVEL

40. General

a. The troubleshooting and repair work that can be performed at the organizational level is limited in scope by the tools, test equipment, and replaceable parts available.

b. Use of the material in paragraphs 42 through 46 may help to determine which circuits are at fault and to localize the fault to a defective subassembly or defective pluck-out part. The test equipment required for organization maintenance procedures is listed in paragraph 32*c*.

c. Use the procedure outlined in the equipment performance check list (par. 48) to check the test set for normal performance.

41. Test Equipment Required for Organizational Maintenance

Electron Tube Test Set TV-7/U and Multimeter TS-297/U are required for testing the test set. If these equipments are not available, other types of equipment having equal accuracy and corresponding characteristics may be used.

42. General Troubleshooting Information

a. General. Refer to the schematic diagram (fig. 45) and to the simplified circuit diagrams (figs. 15–30) for information regarding the detailed operation of circuits. To locate a particular part, refer to the illustrations showing the location of parts in the test set (figs. 31–40). These illustrations will help to locate parts that are to be replaced with new parts. The resistor and capacitor color code charts (figs. 43 and 44) also will help to locate circuit parts.

b. Continuity Tests. Many circuits and parts in the test set can be checked for continuity; that is, to see that a part or circuit is continuous from point to point. Tube socket voltage and resistance values are given in figures 41 and 42. Use Multimeter TS-297/U to make continuity tests and to take voltage and resistance measurements.

43. Organizational Troubleshooting Procedures

a. General. The first step in troubleshooting is to sectionalize the fault to the circuit responsible for the abnormal operation of the test set. The second step is to localize the fault by tracing it to the part responsible for the abnormal condition.

b. Sectionalization of Trouble. The troubleshooting procedure at the organizational maintenance level will determine in which circuit the trouble exists. For troubleshooting procedures, refer to paragraphs 44 through 48.

c. Localization of Trouble. After the trouble has been isolated to a single circuit (*a* above), trace the fault to the defective part. This may be possible at the organizational maintenance level if the trouble exists in a pluck-out part or if the trouble sectionalization procedures have located the defective part. If it is not possible to localize the trouble to the defective part and to make a repair, field maintenance is necessary.

44. Visual Inspection

a. When operational failure is encountered and the cause is not immediately apparent, check the items listed in *b* below before starting a detailed examination of the test set.

b. In addition to defective tubes (par 46*c*) and open or short-circuited resistors or capacitors, failure of the test set to operate properly may be caused by one or more of the following faults:

(1) Worn, broken, or disconnected cords or connectors.
(2) Improperly connected battery or test cords.
(3) Burned-out fuses.
(4) Pitted or burned relay contacts.
(5) Wires or parts broken or disconnected.

45. Removal of Pluck-Out Parts

a. Tubes. All tubes can be reached by removing the top panel of the test set. They are mounted on top of the amplifier chassis and rectifier chassis just inside the framework (fig. 34) at the top rear of the test set. To remove a tube, proceed as follows:

(1) Remove the tube shield by pressing down on the shield and rotating counterclockwise until it is released.
(2) Use a tube puller to remove the tube. If a tube puller is not available, allow the tube to cool, grasp it, and pull the tube straight up.
(3) If a tube marking has become illegible, label the tube as soon as it is removed.

b. Removal of Lamps. The indicator lamps are located on the rear of the switch panel. All the lamps have bayonet-type bases. The AC LINE and BATTERY indicator lamps are incandescent lamps; the AMPLIFIER TEST indicator lamp is a neon lamp. To remove a lamp, unscrew the lamp cap, press the lamp inward and rotate it counterclockwise, and then withdraw it from its socket.

c. Removal of Fuses. The two AC LINE FUSES and the METER FUSE are cartridge-type fuses. They are located on the switch panel of the test set. To remove a fuse, press the fuse-holder cap and turn it counterclockwise. Withdraw the cap and remove the fuse from its holder.

Caution: The two AC LINE FUSES are rated at 5 amperes each; the METER FUSE is rated at .15 ampere. When replacing fuses, be extremely careful to use fuses of the correct rating.

46. Inspecting, Cleaning, and Testing Pluck-Out Parts and Relays

a. Inspecting and Cleaning Pluck-Out Parts. After pluck-out parts have been removed from the test set, check the exposed contacts for corrosion. If necessary, clean the contacts with No. 000 sandpaper.

b. Inspecting and Cleaning Relays. The relay box is mounted vertically on the framework at the rear of the test set. To service the relays, remove the rear cover. Inspect contacts of the relays thoroughly. If they are dirty, burned, or pitted, clean and burnish them according to instructions in paragraph 75. Remove loose dust and lint from the contacts and from the exterior of the relays with a soft bristle brush. Do not use enough force to change the adjustment of the relays.

c. Testing Tubes. Test the tubes with Electron Tube Test Set TV-7/U.

47. Troubleshooting by Using Equipment Performance Checklist

a. General. The equipment performance checklist (par. 48) will help to locate trouble in the test set. The checklist is divided into four parts: preparatory, starting, equipment performance, and stopping. To use the checklist, *follow the items in numerical sequence.*

b. Action or Condition Column. For some items, the information given in the action or condition column consists of the switch or control setting under which the item is to be checked. For other items, it represents an action that must be taken to check the normal performance of the test set which is given in the normal indication column.

c. Normal Indications. The normal indications include the visible and audible signs that the operator should perceive when checking the items. If the indications are not normal, the operator should apply the corrective measures recommended in the corrective measures column.

d. Corrective Measures. The corrective measures listed are those the operator can make.

48. Equipment Performance Checklist

	Item No.	Item	Action or condition	Normal indication	Corrective measures
PREPARATORY	1	Cord CX-25A/GSM-1 (positive).	Connect to positive (+) battery binding post of test set and to positive terminal of 12-volt storage battery.		
	2	Cord CX-25B/GSM-1 (negative).	Connect to negative (−) battery binding post of test set and to negative terminal of 12-volt storage battery.		
	3	Ac power cord	Connect to 110-volt, 60-cps ac outlet.		
	4	Output controls	Rotate to extreme counterclockwise positions.		
START	5	AC LINE switch	Operate to ON position	AC LINE indicator lamp lights.	Check AC LINE switch. Check AC LINE indicator lamp (par. 45*b*). Check 5-ampere AC LINE FUSES (par. 45*c*).
	6	BATTERY switch	Operate to ON position	BATTERY indicator lamp lights.	Check Cords CX-25A/GSM-1 and CX-25B/GSM-1 for proper polarity (par. 13*b*). Check battery. Check BATTERY indicator lamp (par. 45*b*).
EQUIPMENT PERFORMANCE	7	Selector switches and ALT CURRENT—AC VOLTS—DC VOLTS COARSE CONTROL.	Select several ac voltage, and dc voltage ranges. Rotate COARSE CONTROL clockwise.	All meters read full scale on selected ranges.	Field maintenance is required.
	8	ALT CURRENT—AC VOLTS—DC VOLTS FINE CONTROL.	Rotate clockwise and counterclockwise for fine adjustment of selected ranges.	All meters vary within 10 percent of full-scale deflection on selected ranges. Selected voltage or current output present at jack or binding post corresponding with selected range. Measure with TS-297/U.	Field maintenance is required.
	9	Selector switches and DIRECT CURRENT COARSE CONTROL.	Select several dc ranges. Rotate COARSE CONTROL clockwise.	The center and right meters read full scale on selected ranges.	Field maintenance is required.
	10	DIRECT CURRENT FINE CONTROL.	Rotate clockwise and counterclockwise for fine adjustment of selected ranges.	The center and right meters vary within 10 percent of full-scale deflection on selected ranges. Selected current output present at jack or binding post corresponding with selected range. Measure with TS-297/U.	Field maintenance is required.

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	Item No.	Item	Action or condition	Normal indication	Corrective mearures
STOP	11	Output controls	Rotate to extreme counterclockwise position.		
	12	AC LINE switch	Operate to OFF position.	AC LINE indicator lamp goes out.	
	13	BATTERY switch	Operate to OFF position.	BATTERY indicator lamp goes out.	

CHAPTER 5
THEORY

49. General

a. The test set has facilities for measuring current in both ac and dc ranges. It is also able to measure ac and dc voltages. Through its own power supply it is able to furnish voltages and currents in a wide range to meters that are to be checked for accuracy. The test set has an ac meter amplifier circuit with a warning amplifier operating in conjunction with it.

b. The test set furnishes a regulated current or voltage, either ac or dc, to a meter to be tested. This meter is connected to an amplifier which in turn is connected to a standard meter that is part of the test set. The meter in the test set is used as a standard meter. A comparison is made between the readings of the two meters.

50. Block Diagram Analysis of Test Circuits

The block diagram (fig. 13) shows the six fundamental circuits described in detail in paragraphs 54 through 59. It serves as a reference in the use and servicing of the test set. The voltage control unit (par. 59) controls the output in all measurements except direct current.

a. Dc Ammeter Test Circuit. Current controls R61, R79, and R94, shunts R138 through R144, current jacks J36 through J39 and binding posts E5 through E9, and dc millivoltmeter M2 comprise the dc ammeter test circuit.

b. Dc Milliammeter and Microammeter Test Circuit. Dc milliampere and microampere jacks J24 through J35, series shunts R99 through R120, current controls R61, R79, and R94, and meter M1 are used for dc microampere and dc milliampere measurements.

c. Dc Voltmeter Test Circuit. Voltage controls T3, T4, R91, fixed voltage transformer T2, rectifiers V1 and V2, dc voltage jacks J12 through J23, precision multipliers R1 through R11, and dc microammeter M1 make up the dc voltage circuits. The millivolt range uses dc millivoltmeter M2 and dc voltage jacks J12 through J23 directly without connection to the precision multipliers.

d. Ac Voltmeter Test Circuit. This circuit consists of voltage control unit T3, T4, and R91, voltage transformer T1, ac voltage jacks J1 through J11, precision multipliers R1 through R11, the ac meter amplifier, and ac milliammeter M3. Precision multipliers R1 through R11 are used to obtain both dc and ac voltage ranges.

e. Ac Ammeter Test Circuit. Voltage control unit T3, T4, and R91, current transformer T7, shunts R138 through R144, ac and dc jacks J36 through J39, and binding posts E5 through E9, the ac meter amplifier, and ac milliammeter M3 comprise the ac ampere circuit. Shunts R138 through R144 are used to obtain both ac and dc ampere ranges (pars. 54 and 57).

51. Block Diagram Analysis of Ac Meter Amplifier

The ac meter amplifier (fig. 14) consists of two circuits. There is an ac meter amplifier with its output measured by meter M3 (*a* below), and there is a warning amplifier with its output connected to a neon warning lamp (*b* below).

a. Any test signal that enters the ac meter amplifier circuit is amplified by first voltage amplifier V3A, second voltage amplifier V3B, and third voltage amplifier V4A. The signal is inverted by phase inverter V4B and coupled to the output stage which is coupled to meter M3 which measures the output signal. This reading is compared to the reading of the meter under test.

b. If the amplitude of the signal that enters the ac meter amplifier circuit is so low that it would affect the accuracy of the meter reading, the warning amplifier takes over. The signal is amplified in first warning amplifier V6A, second warning amplifier V6B, and in third warning amplifier V7A which is connected to neon lamp V8. This neon lamp when lighted warns the operator that reading of the meter is not accurate.

52. Detailed Analysis of Ac Meter Amplifier

a. The ac meter amplifier (fig. 15) provides the means for making ac voltage and current measure-

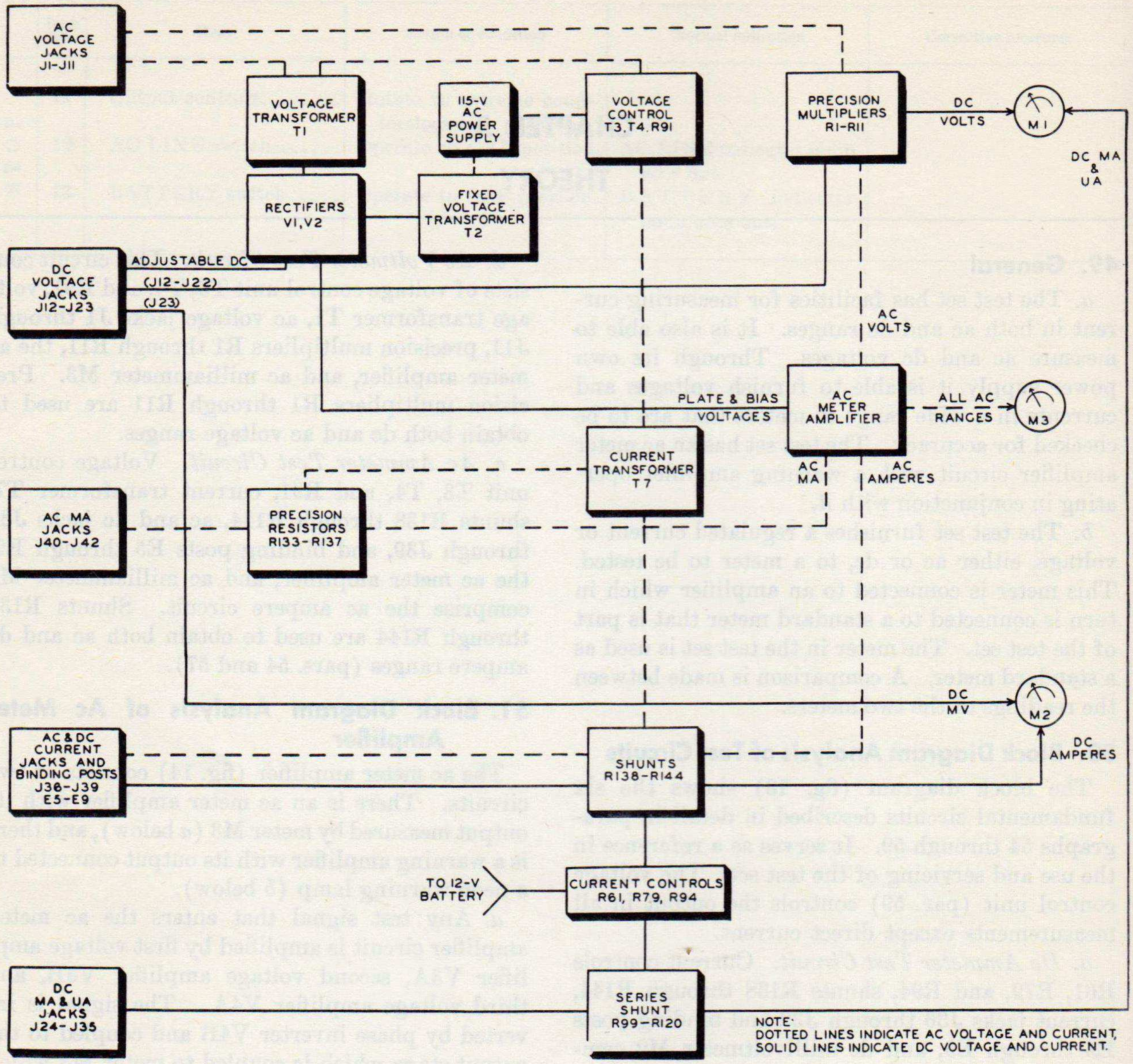

Figure 13. Meter Test Set TS-628A/GSM-1, block diagram.

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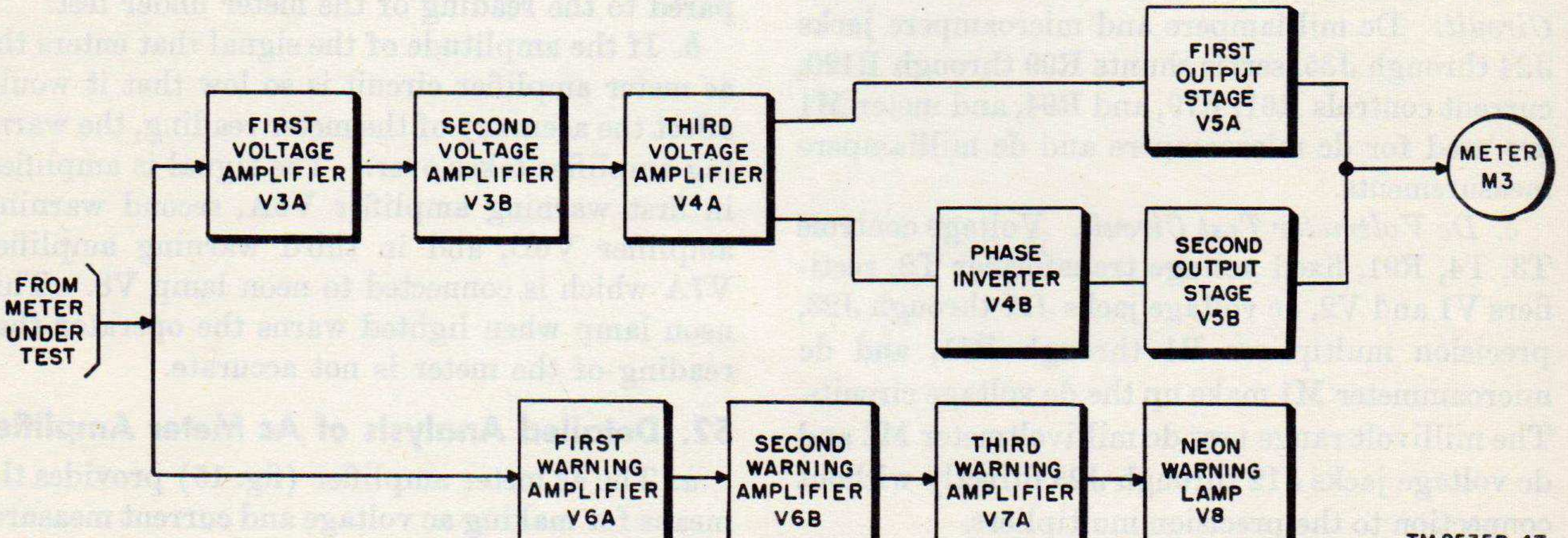

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Figure 14. Ac meter amplifier circuit, block diagram.

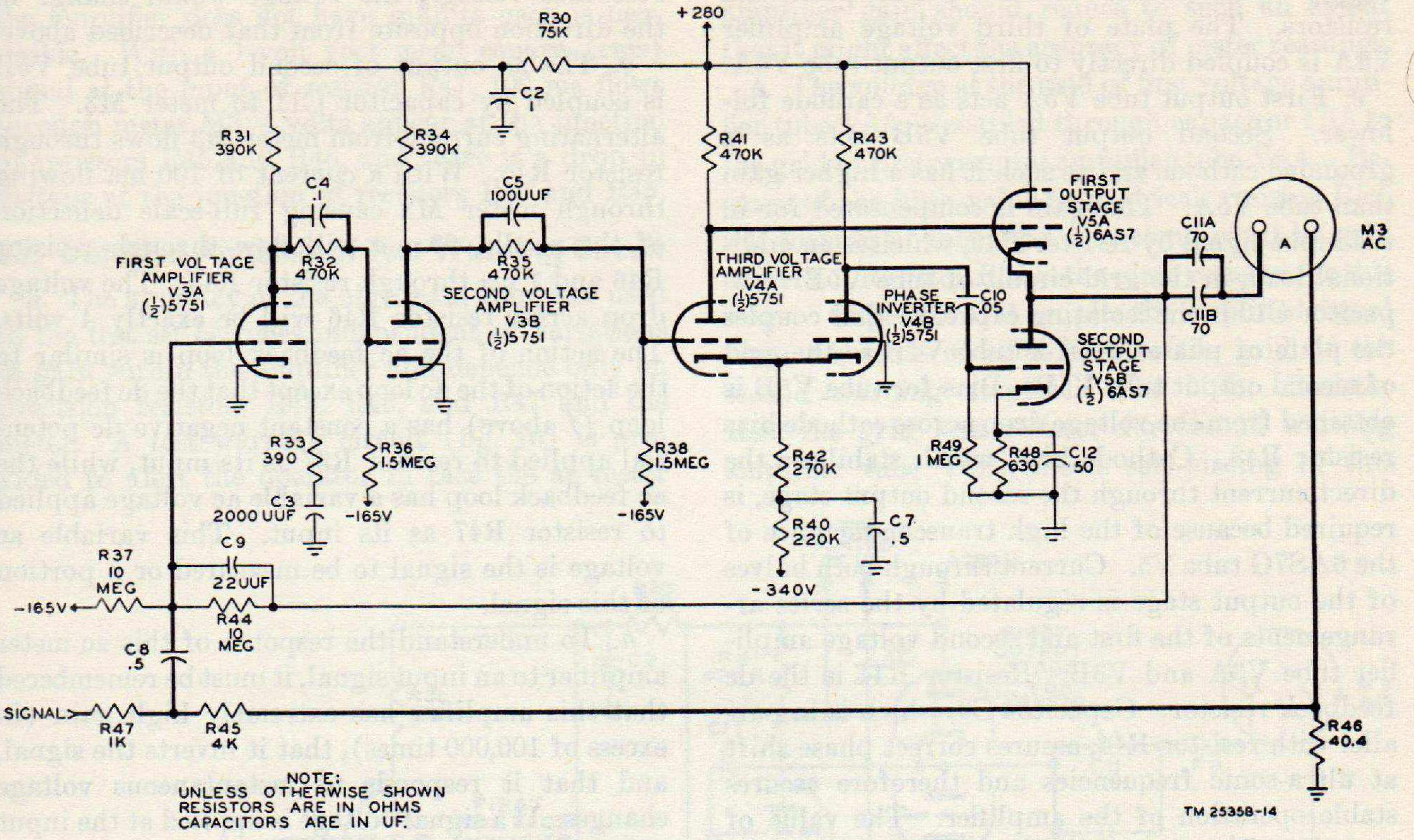


Figure 15. Ac meter amplifier circuit, simplified schematic diagram.

ments. The amplifier drives 0- to 100-milliampere (ma) ac meter M3. The amplifier-meter combination may be regarded as a vacuum-tube meter having an input resistance of 1,000 ohms and a sensitivity of 1,000 ohms per volt (full-scale values of 1 ma, 1 volt).

b. The ac meter amplifier is a dc amplifier with two feedback loops. A dc feedback loop automatically adjusts the bias of each stage throughout the ac meter amplifier so that the output stage has approximately equal dc voltage drops across both halves of tube V5. The first stage, which consists of one-half of voltage amplifier tube V3, is operated with its cathode connected directly to ground. No cathode bias is required because of the dc feedback loop. This direct grounding gives a low impedance ac path to ground so that line voltage signals or harmonics of line voltage signals are not likely to disturb the operation of the circuit. Resistor R31 is the plate load resistor. Resistors R32 and R36 form a voltage divider. The upper end of resistor R32 is connected to the plate of first voltage amplifier V3A; the bottom of resistor R36 is connected to a negative voltage. This division makes the junction of resistors R32 and R36 slightly negative and automatically adjusts to the correct bias required by second voltage amplifier V3B. Resistor R33 and capacitor C3 from the plate of tube V3A to ground control the frequency response of the ac meter amplifier at high frequencies so that stable operation is achieved. The stabilizing action of the network has a large amount of negative feedback.

c. The second stage is the second half of tube V3, which is referred to as V3B. The second stage is a voltage amplifier; it also has a directly grounded cathode. Resistor R34 is the plate resistor. Resistors R35 and R38 form a voltage divider network that lowers the dc level to the grid of the third voltage amplifier tube V4A and also provides the bias for tube V4A. Capacitors C4 and C5 broaden the response of the second and third voltage amplifiers and allow for a good high-frequency response. Capacitor C4 is also effective at 60 cps so that the overall gain at 60 cps is higher than the dc gain. Resistor R30 and capacitor C2 are for filtering and also to prevent unwanted interstage coupling.

d. The third stage is a twin triode which is a voltage amplifier and a phase inverter. Resistor R42 is the common cathode resistor. Resistor R40 and capacitor C7 filter ripple from the negative supply. Resistors R41 and R43 are the plate load resistors. The plate of third voltage amplifier V4A is coupled directly to first output tube V5A.

e. First output tube V5A acts as a cathode follower. Second output tube V5B acts as a grounded cathode and as such it has a higher gain than tube V5A. This gain is compensated for in the input signal by resistor R49, which is an additional load, in the grid circuit of tube V5B. Capacitor C10 is the isolating capacitor that couples the plate of phase inverter tube V4B to the grid of second output tube V5B. Bias for tube V5B is obtained from the voltage drop across cathode bias resistor R48. Cathode bias, which stabilizes the direct current through the second output stage, is required because of the high transconductance of the 6AS7G tube V5. Current through both halves of the output stage is regulated by the series arrangements of the first and second voltage amplifier tube V3A and V3B. Resistor R44 is the dc feedback resistor. Capacitor C9, which is in parallel with resistor R44, assures correct phase shift at ultra-sonic frequencies and therefore assures stable operation of the amplifier. The value of capacitor C9 has a negligible effect on the amplifier at 60 cps.

f. Resistors R44 and R37 form a voltage divider network between the output of the amplifier and the negative reference voltage. The voltage at the junction of these resistors will adjust automatically to the correct bias voltage for first voltage amplifier tube V3A. Capacitor C8 is a dc blocking capacitor that allows bias voltage to be formed at this point without loading by the low impedance ac feedback loop. The feedback action is such that if the dc voltage at the junction of the first and second output stage is lower in magnitude than the negative reference voltage, the grid of first voltage amplifier tube V3A will become more negative than normal. This causes the first voltage amplifier plate and the grid of second voltage amplifier V3B to become more positive than normal. This positive voltage on the grid of tube V3B causes the voltage at its plate to become lower than normal and the voltage at the grid of tube V4A to become positive. Since the plate of tube V4A is directly coupled to tube V5A, the grid of V5A and the cathode output becomes more positive until the correct voltage is reached. If the dc voltage at the junction of tube V5A and V5B were higher in magnitude than the negative reference voltage, the voltage would change in the direction opposite from that described above.

g. The ac output of second output tube V5B is coupled by capacitor C11 to meter M3. The alternating current from meter M3 flows through resistor R45. With a current of 100 ma flowing through meter M3 causing full-scale deflection of the needle, 99 ma will flow through resistor R46 and 1 ma through resistor R45. The voltage drop across resistor R46 will be exactly 4 volts. The action of the ac feedback loop is similar to the action of the dc loop except that the dc feedback loop (*f* above) has a constant negative dc potential applied to resistor R37 as its input, while the ac feedback loop has a variable ac voltage applied to resistor R47 as its input. This variable ac voltage is the signal to be measured or a portion of this signal.

h. To understand the response of this ac meter amplifier to an input signal, it must be remembered that this amplifier has extremely high gain (in excess of 100,000 times), that it inverts the signal, and that it responds to instantaneous voltage changes. If a signal voltage is applied at the input of resistor R47 and if this signal is instantaneously positive, the output of resistor R47 will become positive. This positive signal at the output of resistor R47 is coupled through capacitor C8 to the grid of first voltage amplifier tube V3A. The signal is then amplified by second and third voltage amplifier tubes V3B and V4A, inverted by phase inverter tube V4B, and coupled through capacitor C11 to ac milliammeter M3. The current flowing through meter M3 is split in a ratio of 99 to 1 through resistors R46 and R45 respectively (*g* above). This current is in a direction to make the output of resistor R46 become negative which is opposite to the input polarity. Since the output of resistor R46 is negative, it tends to make the junction of resistor R45 and R44 negative and cancel the positive input to the grid of first voltage amplifier tube V3A. The amount of cancellation depends on the gain of the amplifier tubes; the voltage remaining at this junction will be large enough only to produce the proper output across resistor R46.

i. If the gain were to be increased indefinitely, then the residual ac voltage error at the grid of first voltage amplifier tube V3A would diminish toward zero. The voltage error of the meter amplifier is less than 1 millivolt (mv) for a full-scale signal; therefore the error produced because the amplifier does not have infinite gain is negligible. With a 1-volt root mean square (rms) signal at the input of resistor R47, 100 ma flows through meter M3, 4 volts appear at the junction of resistors R45 and R46, and there is a drop in voltage at the junction of resistors R47 and R45.

53. Detailed Analysis of Test Warning Circuit

a. The accuracy of the high-gain amplifier used in the test set becomes independent of variations in gain within the amplifier and depends only on precision resistors R45, R46, and R47 and the meter. A test warning circuit (fig. 16) is provided to alert the operator in case the ac meter amplifier gain should reduce to such an extent that it might affect the accuracy of meter readings.

b. The voltage at the grid of first voltage amplifier tube V3A is coupled through capacitor C13 to the grid of first warning amplifier tube V6A. Because of the high value of grid leak resistor R52, self-biasing of tube V6A is accomplished by grid current. Resistor R53 is the plate resistor for this stage. Capacitor C14 couples the amplified signal from the plate of tube V6A to the grid of the second warning amplifier tube V6B. Resistor R55, the grid leak resistor for second warning amplifier tube V6B, allows self-biasing of this

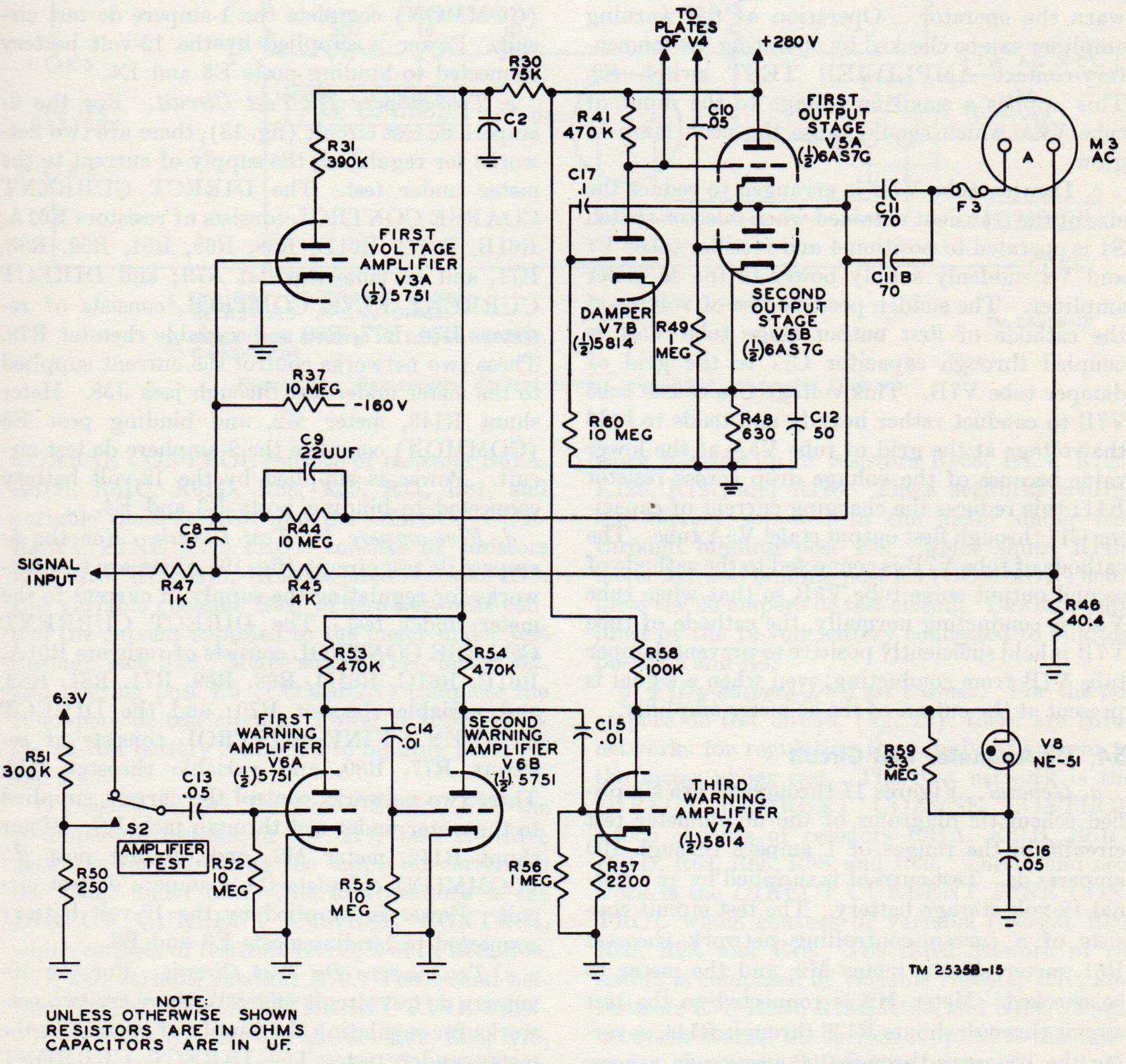


Figure 16. Ac meter amplifier and test warning circuit, simplified schematic diagram.

stage. Resistor R54 is the plate resistor for tube V6B. Capacitor C15 couples the amplified signal from the plate of tube V6B to the grid of third warning amplifier tube V7A. Resistor R56 is the grid leak resistor for tube V7A. Bias for the third warning amplifier is obtained through cathode bias resistor R57. Resistor R58 is the plate resistor for this stage. Resistor R59 provides a charging path to blocking capacitor C16 so that no dc voltage will appear across neon lamp V8. The three-stage warning amplifier, with tubes V6A, V6B, and V7A, provides ample gain so that if a signal of an amplitude low enough to affect meter accuracy should appear at the grid of first voltage amplifier tube V3A, the neon lamp will light to warn the operator. Operation of the warning amplifier can be checked by operating the momentary-contact AMPLIFIER TEST switch S2. This applies a small ac voltage to the input of tube V6A which should cause the neon lamp to glow.

c. Damper tube V7B is arranged to reduce the size of the transient obtained when selector switch S1 is operated to position 4 and rectifier tubes V1 and V2 suddenly supply power to the ac meter amplifier. The sudden positive rise of voltage at the cathode of first output stage tube V5A is coupled through capacitor C17 to the grid of damper tube V7B. This voltage rise causes tube V7B to conduct rather heavily and tends to hold the voltage at the grid of tube V5A at the lower value because of the voltage drop across resistor R41; this reduces the charging current of capacitor C11 through first output stage V5A tube. The cathode of tube V7B is connected to the cathode of second output stage tube V5B so that when tube V5B is conducting normally, the cathode of tube V7B is held sufficiently positive to prevent damper tube V7B from conducting, even when a signal is present at the output of the ac meter amplifier.

54. Dc Ammeter Test Circuit

a. General. Figures 17 through 23 are simplified schematic diagrams of the dc ammeter test circuits in the ranges of 1 ampere through 100 amperes dc. Test current is supplied by an external 12-volt storage battery. The test circuit consists of a current-controlling network rheostat R61, meter shunts, meter M2, and the meter to be checked. Meter M2 is connected to the test circuit through shunts R138 through R144, covering the 1-ampere through 100-ampere dc ranges. The current-controlling network consists of rheostat R61, rheostat R94, fixed resistors R92, R93, R96, and R62 through R71, and relay K5.

b. One-ampere Dc Test Circuit. For the 1-ampere dc test circuit (fig. 17), there are two networks for regulating the supply of current to the meter under test. The DIRECT CURRENT COARSE CONTROL consists of resistors R61B, R61C, R61D, R65, R69, R70, R81, R82, R83, R84, and variable rheostat R70; and the DIRECT CURRENT FINE CONTROL consists of resistors R75, R76, R77, R80, and variable rheostat R78. These networks control the current supplied to the meter under test through jack J39. Meter shunt R144, meter M2, and binding post E5 (COMMON) complete the 1-ampere dc test circuit. Power is supplied by the 12-volt battery connected to binding posts E3 and E4.

c. Two-ampere Dc Test Circuit. For the 2-ampere dc test circuit (fig. 18), there are two networks for regulating the supply of current to the meter under test. The DIRECT CURRENT COARSE CONTROL consists of resistors R61A, R61B, R61C, R61D, R68, R69, R81, R82, R83, R71, and variable rheostat R79; and DIRECT CURRENT FINE CONTROL consists of resistors R76, R77, R80 and variable rheostat R79. These two networks control the current supplied to the meter under test through jack J38. Meter shunt R143, meter M2, and binding post E5 (COMMON) complete the 2-amphere dc test circuit. Power is supplied by the 12-volt battery connected to binding posts E3 and E4.

d. Five-ampere Dc Test Circuit. For the 5-ampere dc test circuit (fig. 19), there are two networks for regulating the supply of current to the meter under test. The DIRECT CURRENT COARSE CONTROL consists of resistors R61A, R61B, R61C, R61D, R68, R69, R71, R81, R82, and variable rheostat R70; and the DIRECT CURRENT FINE CONTROL consists of resistors R77, R80, and variable rheostat R79. These two networks control the current supplied to the meter under test through jack J37. Meter shunt R142, meter M2, and binding post E5 (COMMON) complete the 5-ampere dc test circuit. Power is supplied by the 12-volt battery connected to binding posts E3 and E4.

e. Ten-ampere Dc Test Circuit. For the 10-ampere dc test circuit (fig. 20), there are two networks for regulating the supply of current to the meter under test. The DIRECT CURRENT

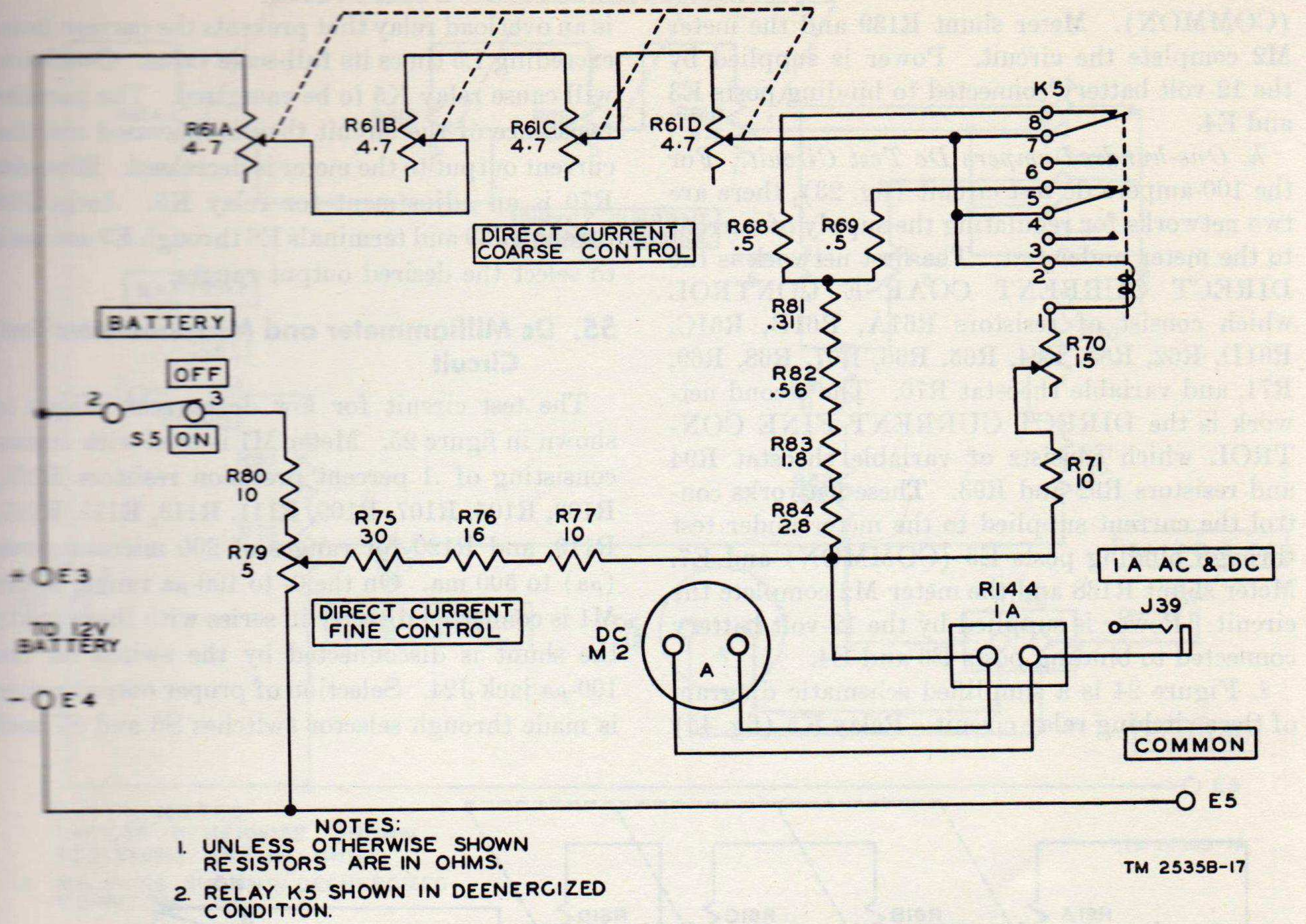


Figure 17. One-ampere dc test circuit, simplified schematic diagram.

COARSE CONTROL consists of resistors R61A, R61B, R61C, R61D, R68, R69, R71, R81, and variable rheostat R70; and the DIRECT CURRENT FINE CONTROL consists of resistors R92, R93, R72, R73, R74, variable rheostat R79, and variable rheostat R94. These networks control the current supplied to the meter under test through jack J36. Meter shunt R141, meter M2, and binding post E5 (COMMON) complete the 10-ampere dc test circuit. Power is supplied by the 12-volt battery connected to binding posts E3 and E4.

f. Twenty-ampere Dc Test Circuit. For the 20-ampere dc test circuit (fig. 21), there are three networks for regulating the supply of current to the meter under test. The first network is the DIRECT CURRENT COARSE CONTROL which consists of resistors R61C, R 61D, R68, R69, R71, and variable rheostat R70. The second network is the DIRECT CURRENT FINE CONTROL which consists of resistors R92, R93, R72, R73, and variable rheostat R79. The third network is made up of resistors R123, R124, R125, R126, R127, and R128. These networks control the current supplied to the meter under test through binding post E9. Meter shunt R140, meter M2, and binding post E5 (COMMON) complete the 20-ampere dc test circuit. Power is supplied by the 12-volt battery connected to binding posts E3 and E4.

g. Fifty-ampere Dc Test Circuit. For the 50-ampere dc test circuit (fig. 22), there are three networks for regulating the supply of current to the meter under test. The first network is the DIRECT CURRENT COARSE CONTROL which consists of resistors R61A, R61B, R61C, R61D, R62, R63, R68, and R69. The second network is the DIRECT CURRENT FINE CONTROL which consists of variable rheostat R94, R92, R93, and R72. The third network of resistors is composed of variable rheostat R70, and resistors R71, R123, R124, R125, and R126. These networks control the current supplied to the meter under test through binding posts E9 and E5

(COMMON). Meter shunt R139 and the meter M2 complete the circuit. Power is supplied by the 12-volt battery connected to binding posts E3 and E4.

h. One-hundred-ampere Dc Test Circuit. For the 100-ampere dc test circuit (fig. 23), there are two networks for regulating the supply of current to the meter under test. The first network is the DIRECT CURRENT COARSE CONTROL which consist of resistors R61A, R61B, R61C, R61D, R62, R63, R64, R65, R66, R67, R68, R69, R71, and variable rheostat R70. The second network is the DIRECT CURRENT FINE CONTROL which consists of variable rheostat R94 and resistors R92 and R93. These networks control the current supplied to the meter under test through binding posts E5 (COMMON) and E7. Meter shunt R138 and the meter M2 complete the circuit. Power is supplied by the 12-volt battery connected to binding posts E3 and E4.

i. Figure 24 is a simplified schematic diagram of the switching relay circuit. Relay K5 (fig. 45) is an overload relay that prevents the current from exceeding 1.5 times its full-scale value. Overloads will cause relay K5 to be energized. The parallel resistance of the circuit then is increased and the current output to the meter is decreased. Rheostat R70 is an adjustment for relay K5. Jacks J36 through J39 and terminals E6 through E9 are used to select the desired output ranges.

55. Dc Milliammeter and Microammeter Test Circuit

The test circuit for low dc current ranges is shown in figure 25. Meter M1 is used with shunts consisting of .1 percent precision resistors R101, R103, R105, R107, R109, R111, R113, R115, R117, R119, and R120 for ranges of 200 microamperes (μa) to 500 ma. On the 0- to 100-μa range, meter M1 is connected directly in series with the output; the shunt is disconnected by the switch on the 100-μa jack J24. Selection of proper output range is made through selector switches S6 and S7 and

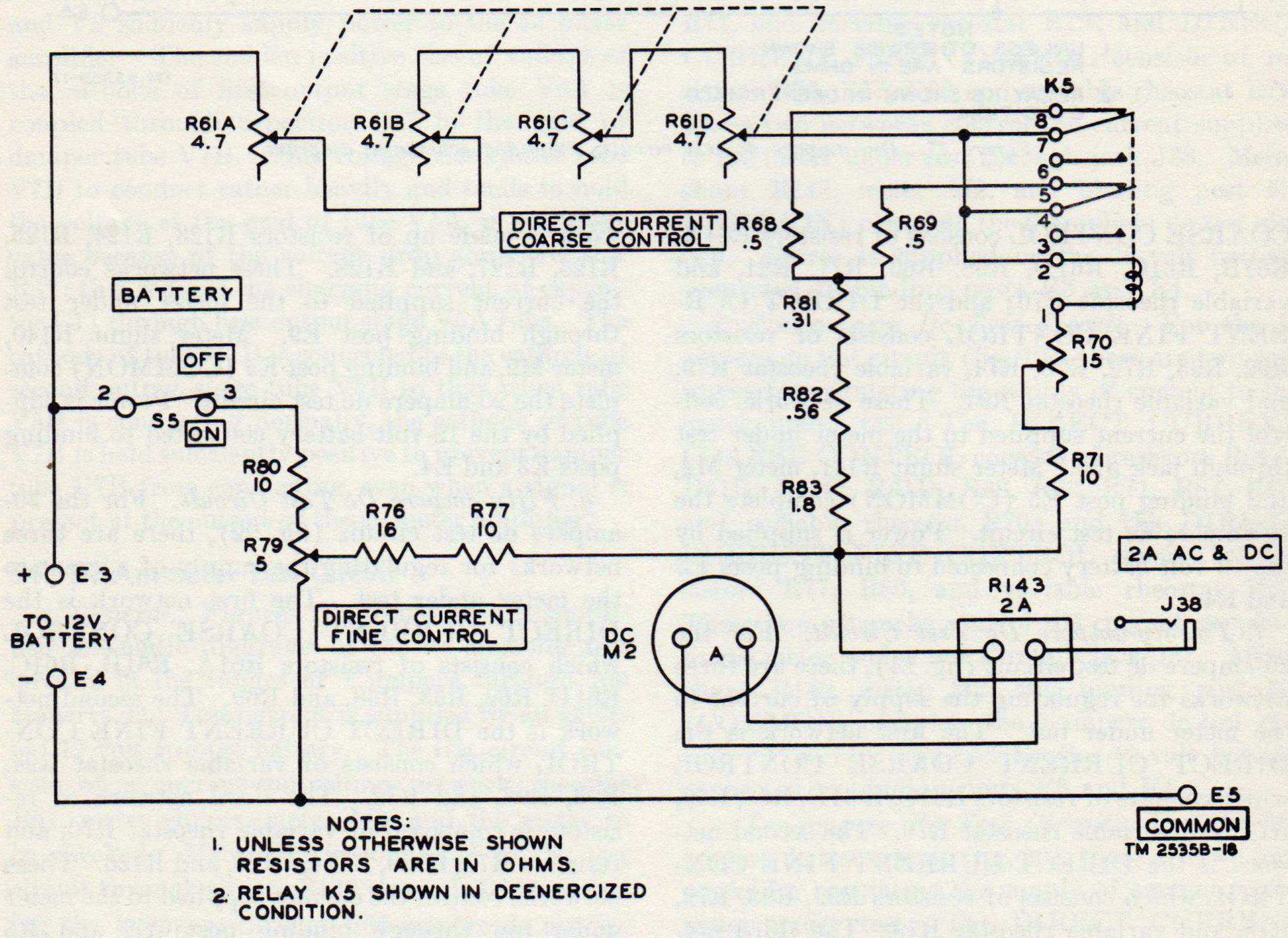


Figure 18. Two-ampere dc test circuit, simplified schematic diagram.

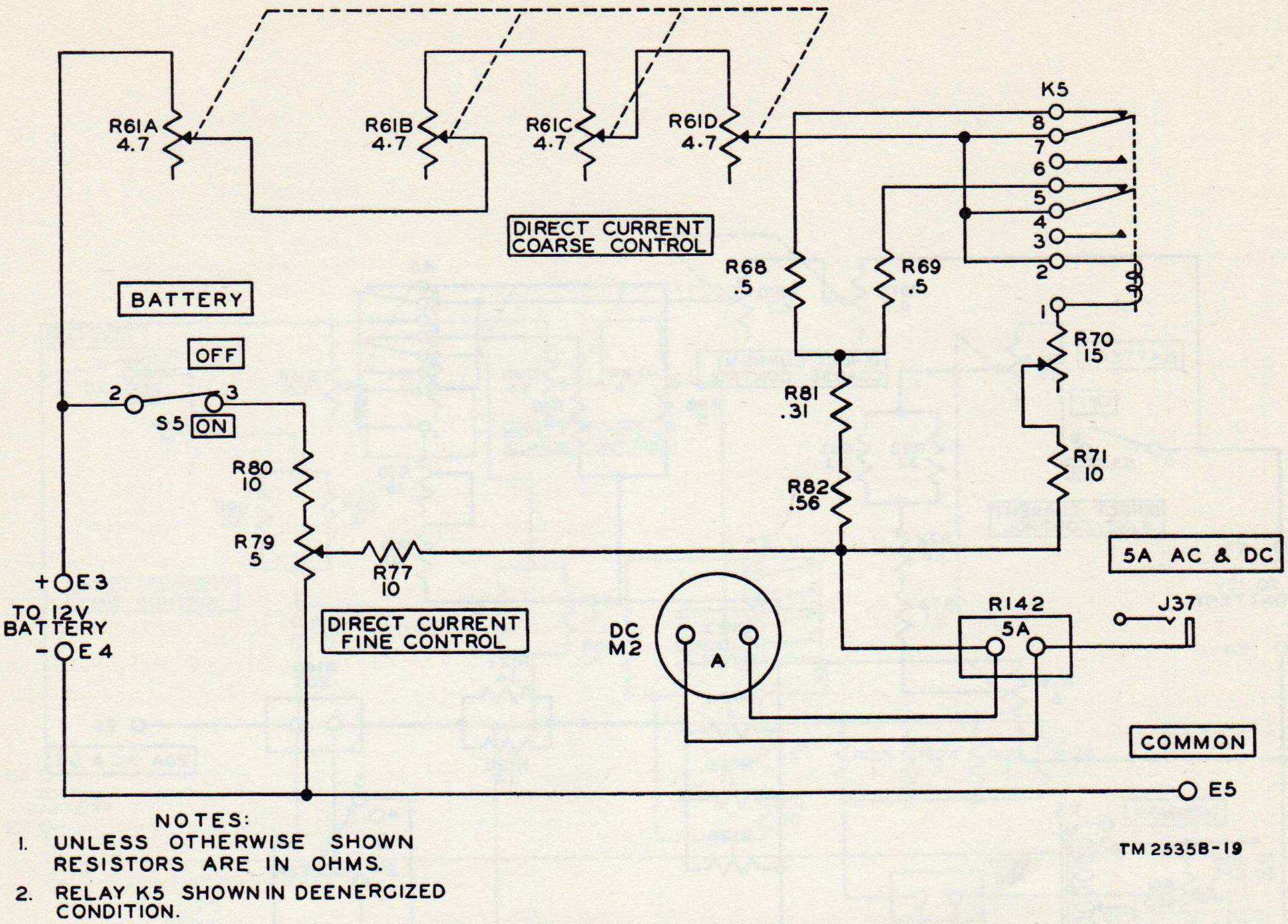


Figure 19. Five-ampere dc test circuit, simplified schematic diagram.

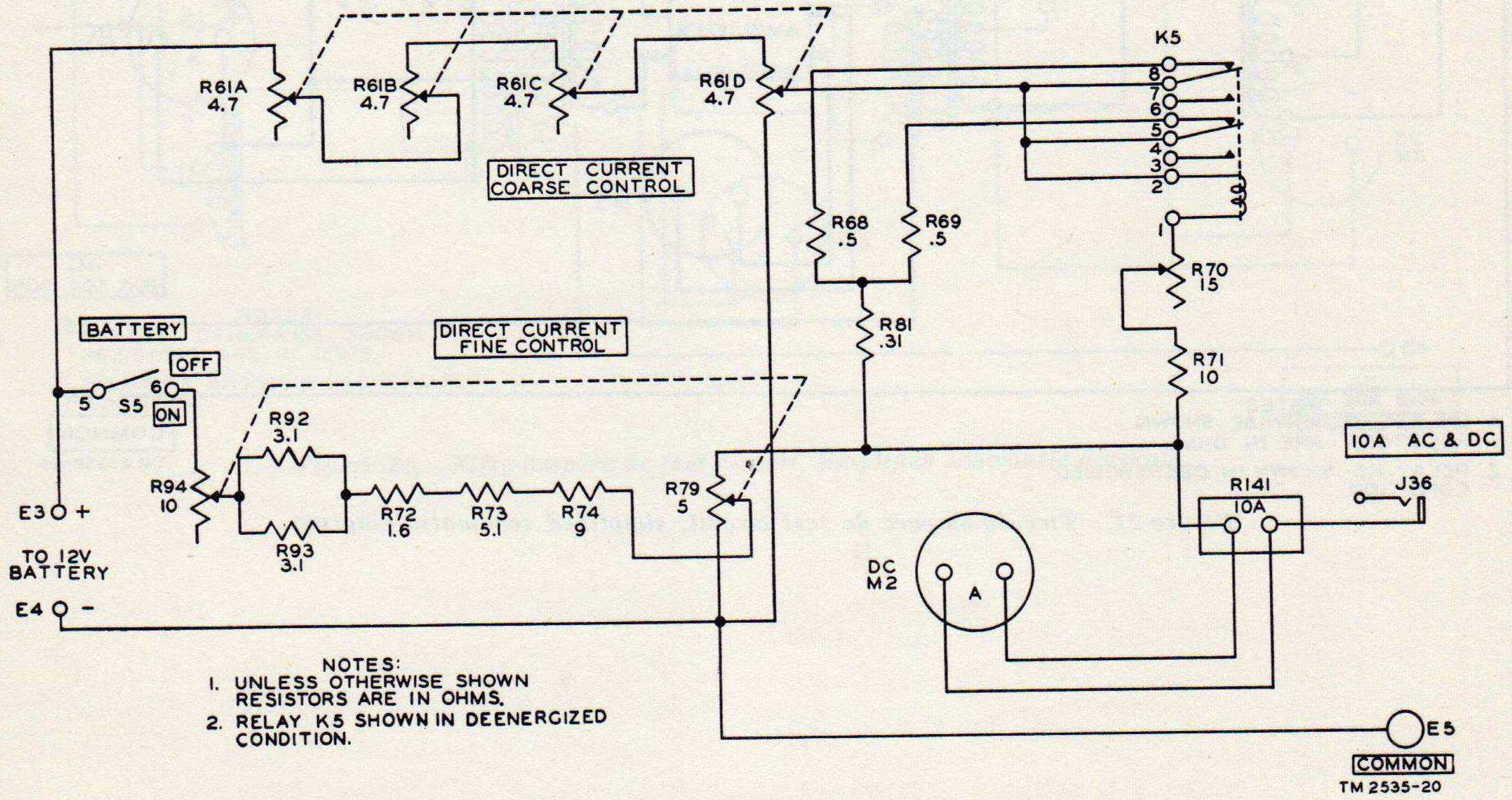


Figure 20. Ten-ampere dc test circuit, simplified schematic diagram.

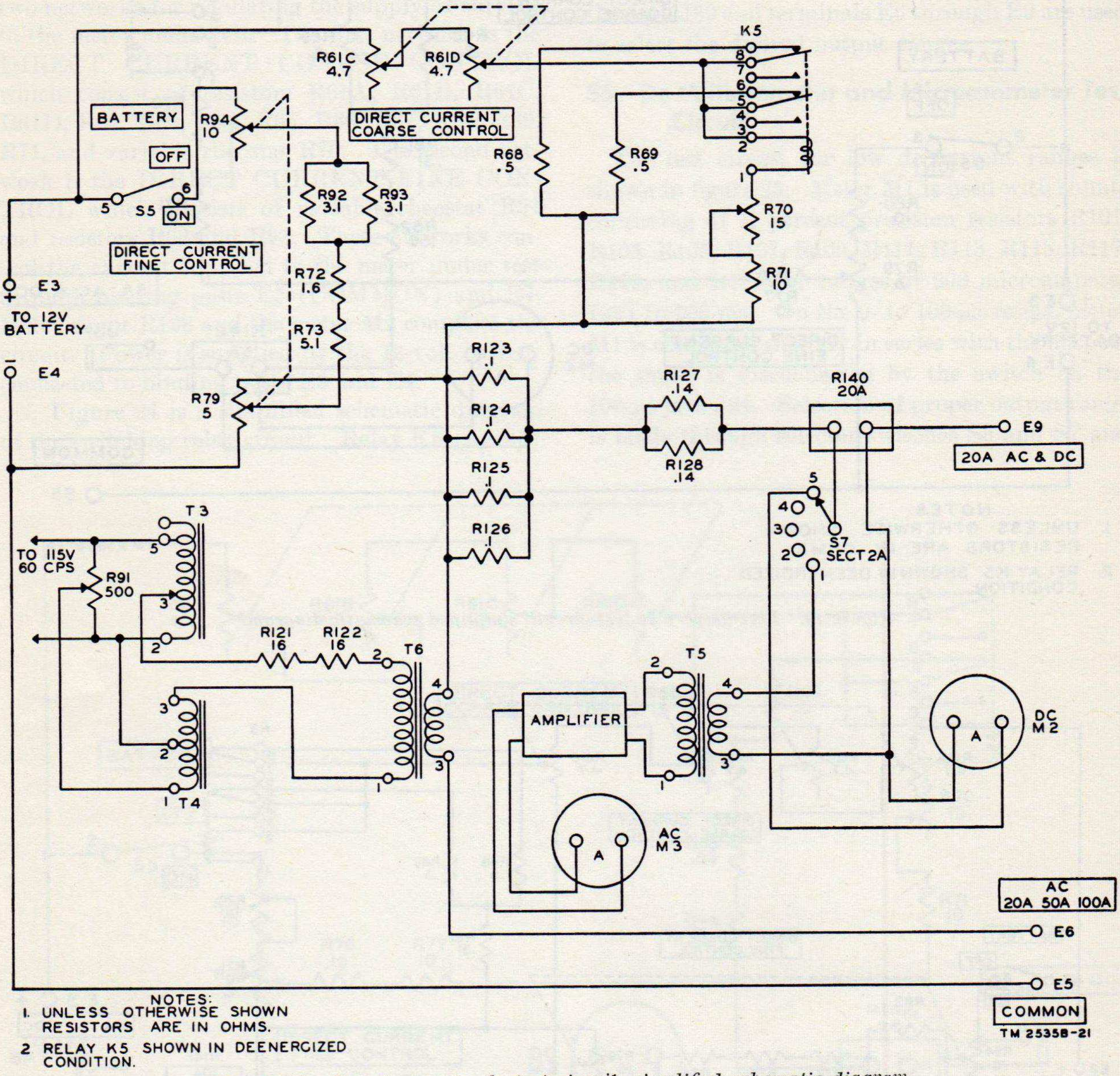


Figure 21. Twenty-ampere dc test circuit, simplified schematic diagram.

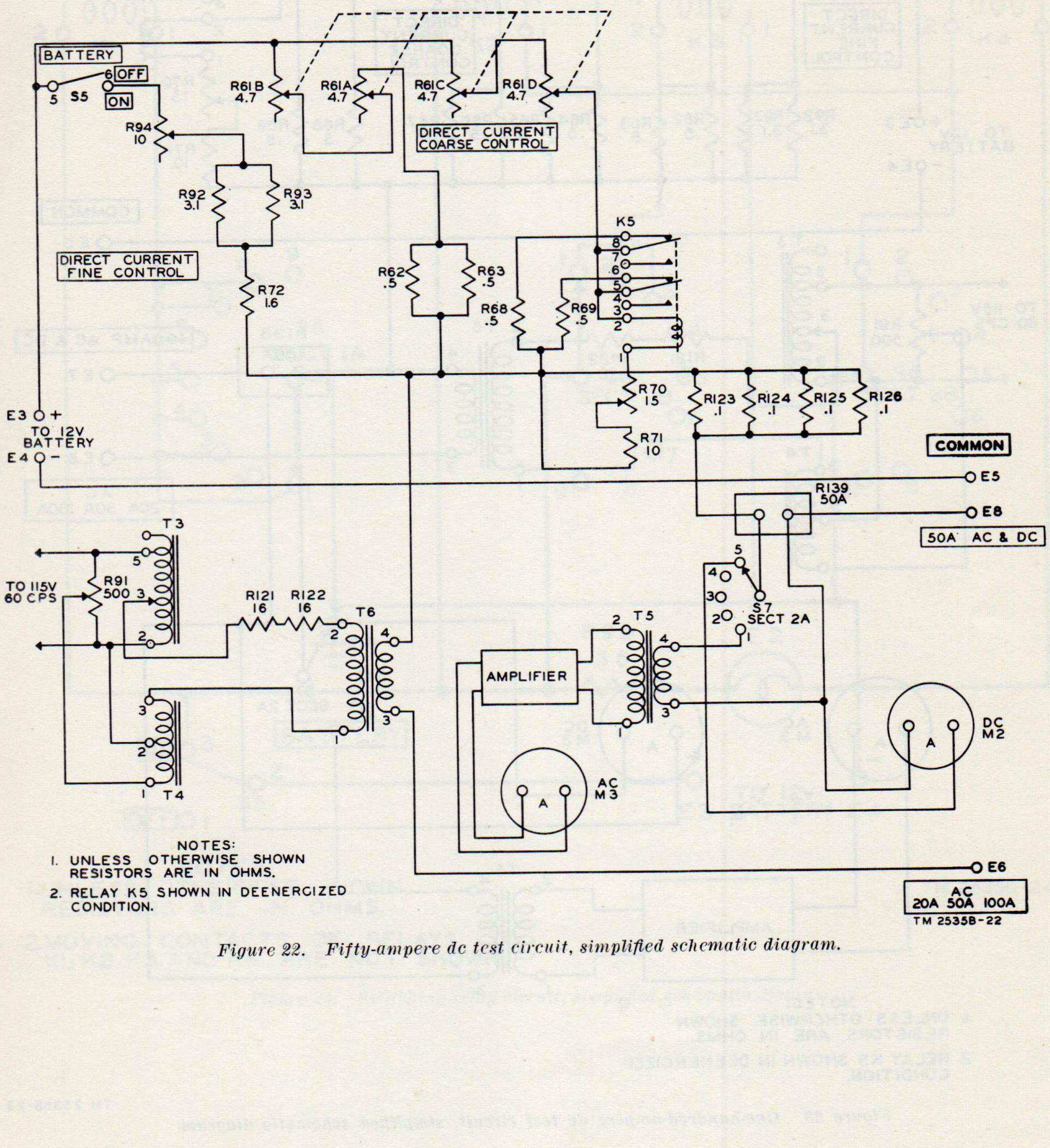


Figure 22. Fifty-ampere dc test circuit, simplified schematic diagram.

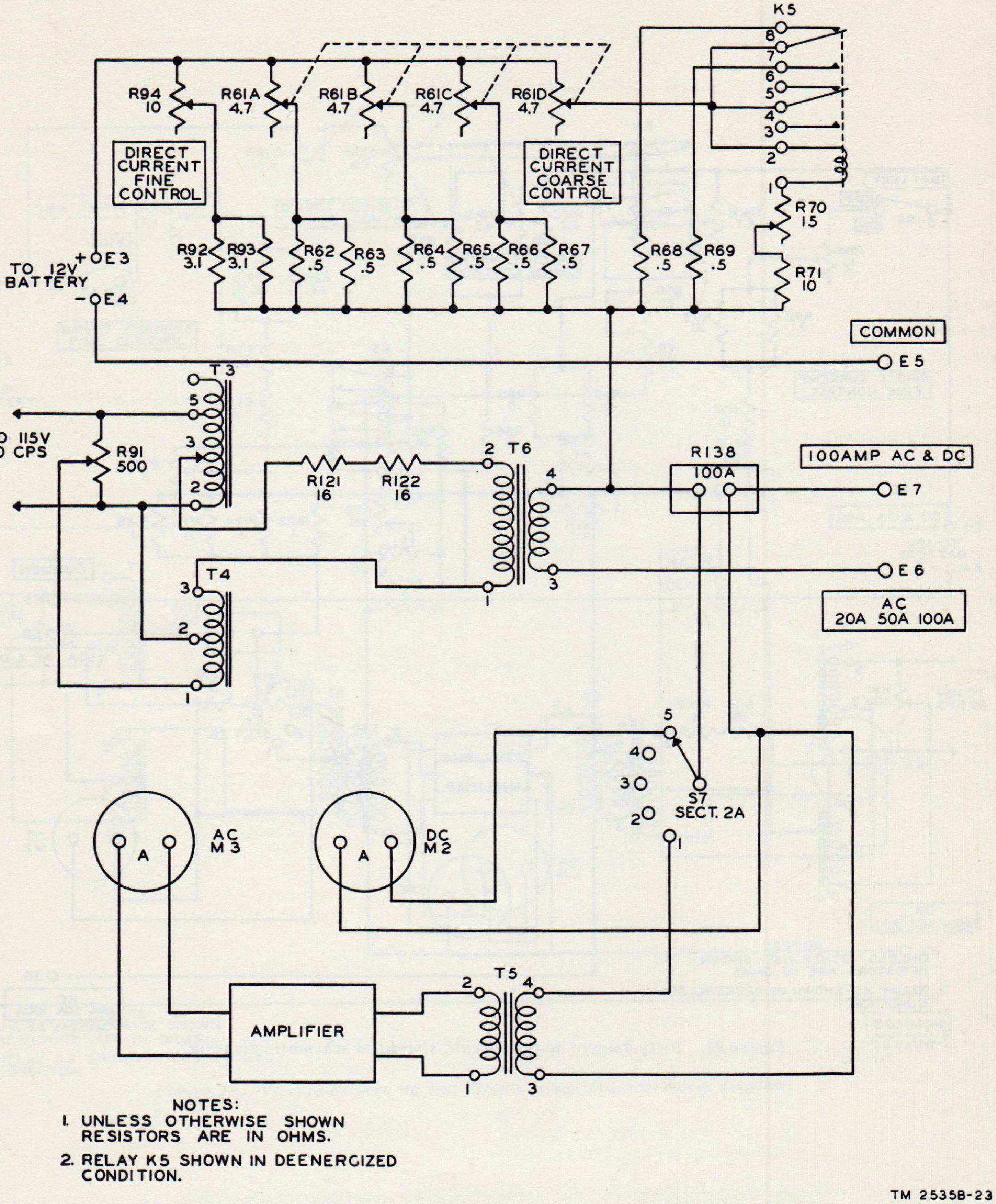
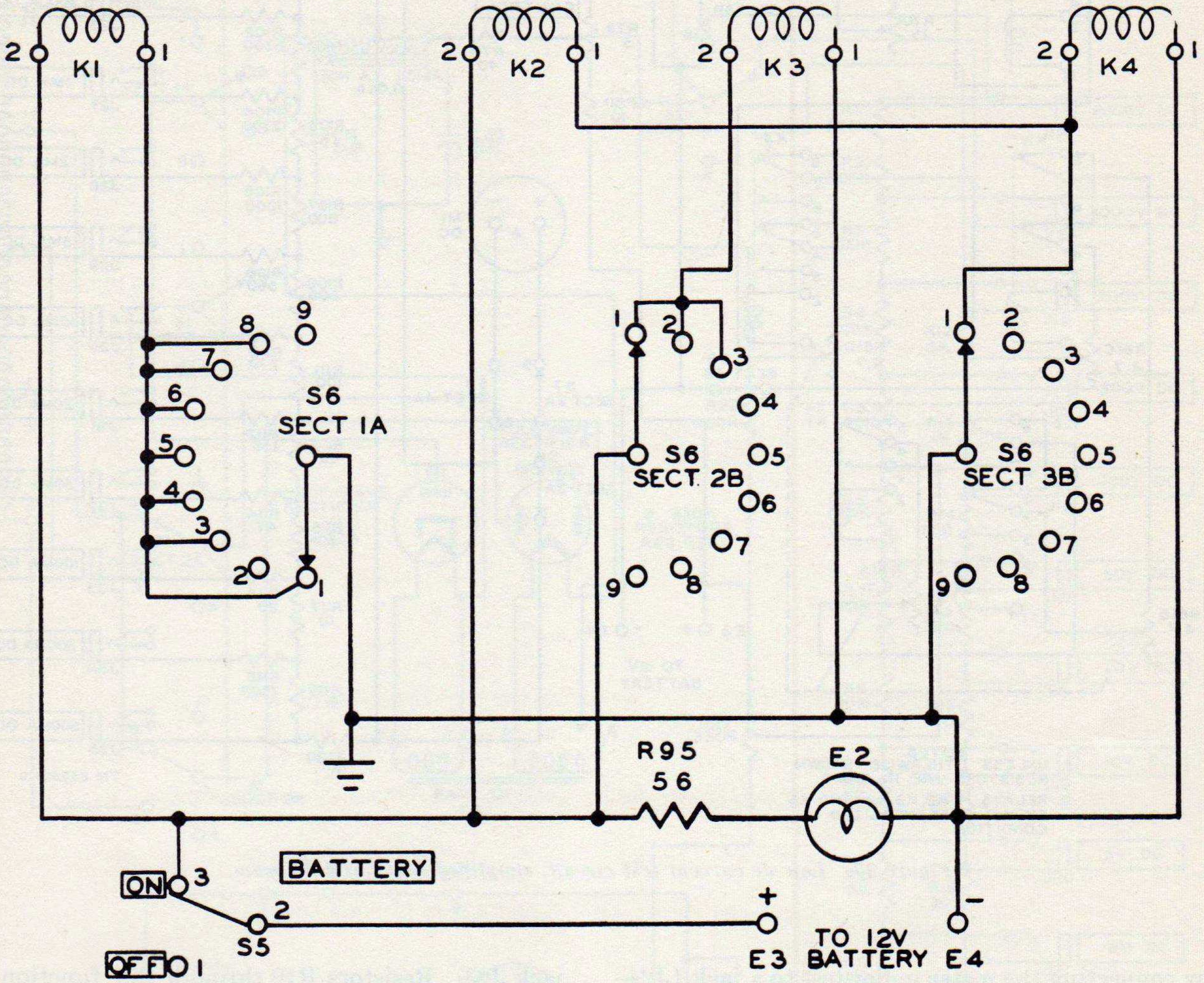


Figure 23. One-hundred-ampere dc test circuit, simplified schematic diagram.



NOTES:
1. UNLESS OTHERWISE SHOWN RESISTORS ARE IN OHMS.
2. MOVING CONTACTS OF RELAYS K1, K2, K3, AND K4 ARE NOT SHOWN.

TM 2535B-24

Figure 24. Switching relay circuit, simplified schematic diagram.

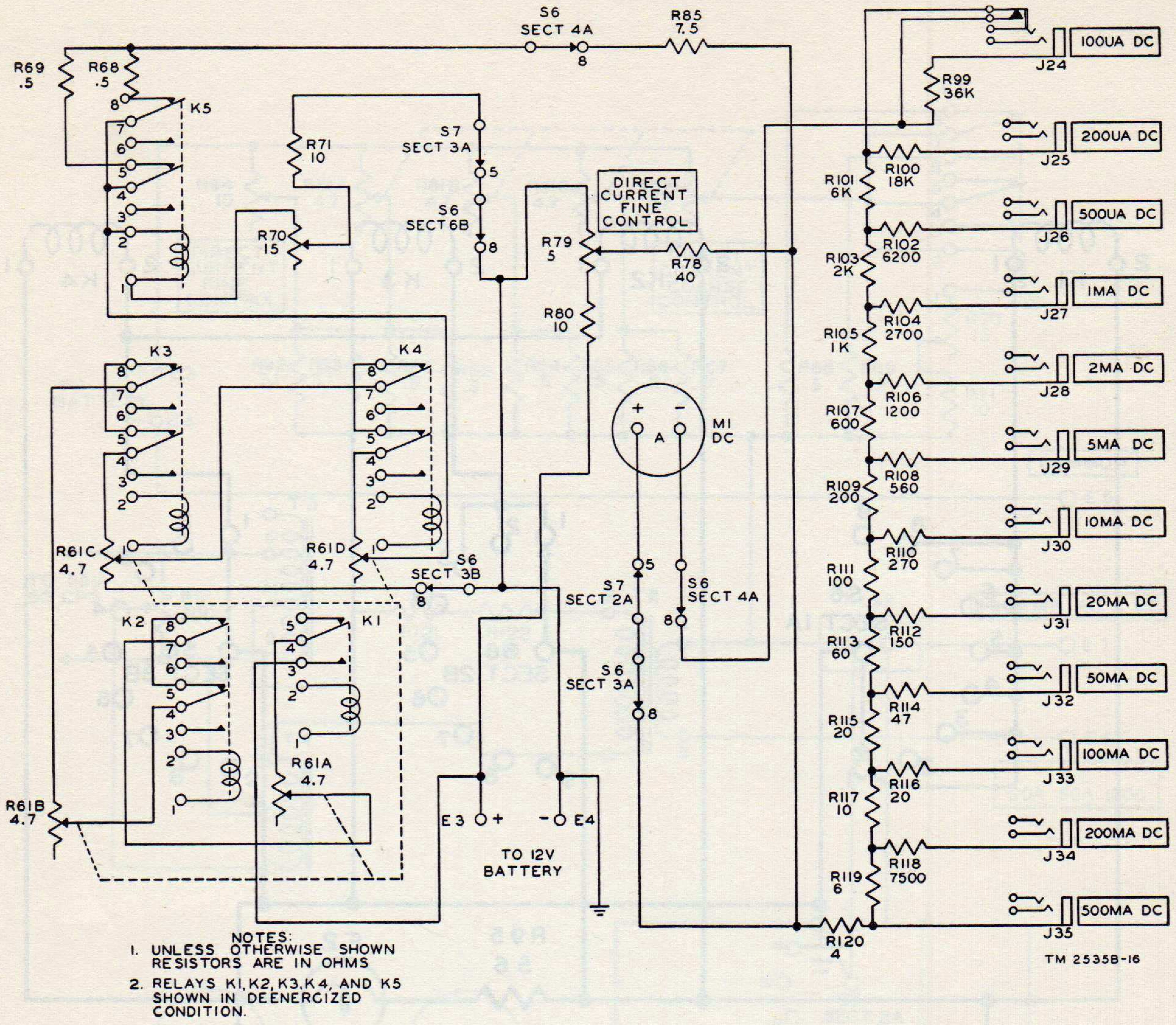


Figure 25. Low dc current test circuit, simplified schematic diagram.

by connecting the meter under test to a jack (J24–J35) with the desired current designation.

56. Dc Voltmeter Test Circuit

a. 100 Millivolts to 500 Volts. Figure 26 is a simplified schematic diagram of the dc voltage test circuit. The 5R4WGY rectifier tube V2 obtains its ac potential from transformer T1 and supplies full-wave rectified voltage for the range of 100 mv to 500 volts. The standard meter for the 100-mv range is meter M2, a dc millivoltmeter. All other dc voltage ranges up to and including 2,000 volts are read on meter M1. Meter M2 is selected automatically for the 100-mv range when the test cord plug is inserted into the 100-mv jack J23. Resistors R12 through R21 function as voltage dividers for the various ranges.

b. 1,000-volt Range. The 1,000-volt supply consists of 5R4WGY rectifier tube V2 connected for half-wave rectification. Filtering is accomplished by a pi-section filter consisting of capacitors C19 and C20 and filter choke L1.

c. 2,000-volt Range. The 2,000 volts dc necessary for this range is supplied by 2X2A rectifier tube V1. The output also is filtered by the pi-section filter which consists of capacitors C19 and C20 and filter choke L1.

d. Voltage Control. Voltage control for all the dc voltage ranges (*a–c* above) is effected by powerstat T3, autotransformer T4, and rheostat

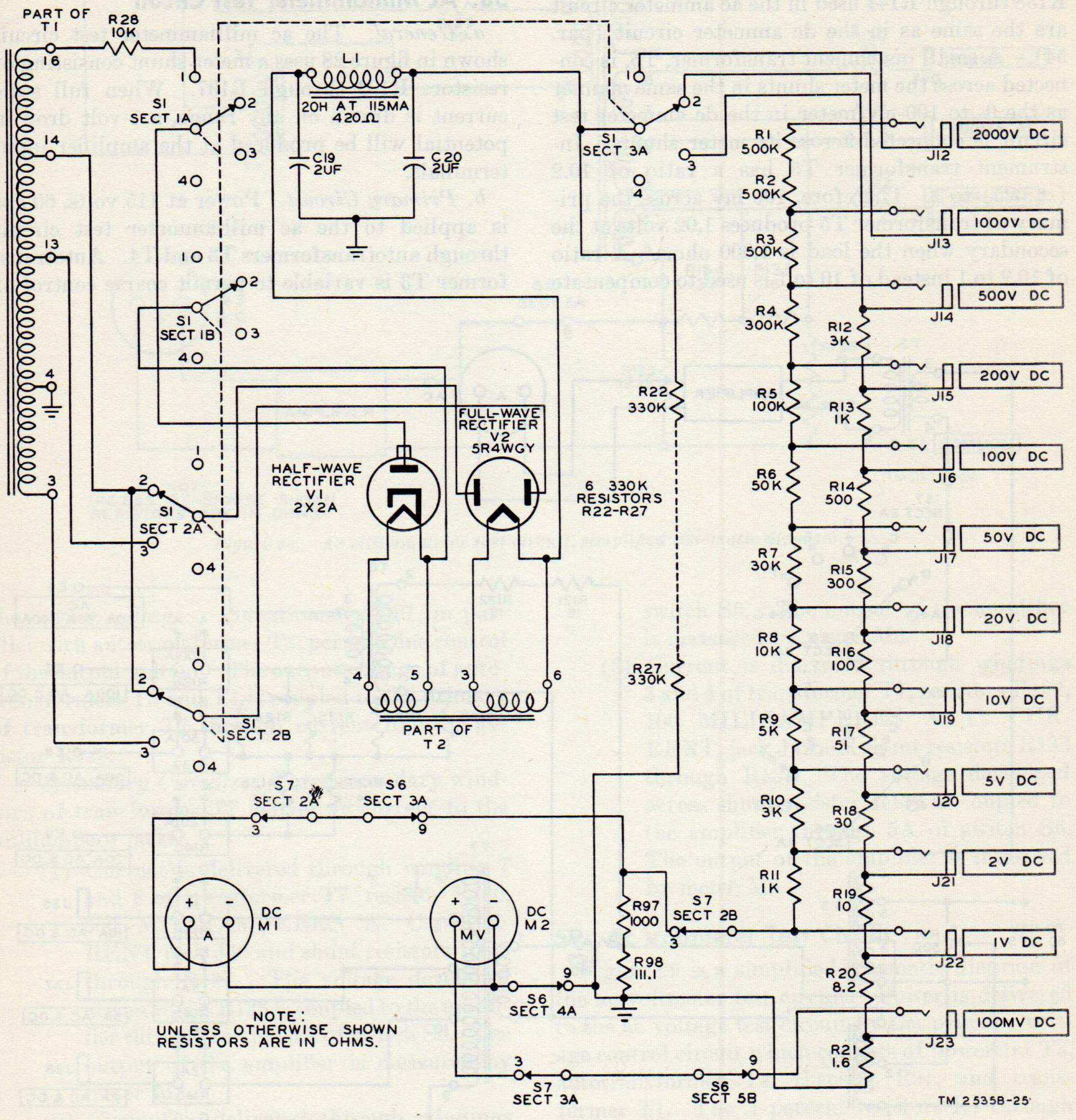


Figure 26. Dc voltage test circuit, simplified schematic diagram.

R91 which are connected across the primary of transformer T1.

57. Ac Ammeter Test Circuit

Figure 27 is a simplified schematic diagram of the ac ammeter test circuit. The meter shunts R138 through R144 used in the ac ammeter circuit are the same as in the dc ammeter circuit (par. 54). A small instrument transformer, T5, is connected across the meter shunts in the same manner as the 0- to 100-mv meter in the dc ammeter test circuit is connected across its meter shunts. Instrument transformer T5 has a ratio of 10.2 (±.025) to 1. Therefore, 100 mv across the primary of transformer T5 produces 1.02 volts at the secondary when the load is 1,000 ohms. A ratio of 10.2 to 1 instead of 10 to 1 is used to compensate for voltage drops in the loads and switches. A resistance network compensates for the fact that transformer T5 does not load the shunts as does the 0- to 100-mv dc meter for which the shunts were calibrated.

58. Ac Milliammeter Test Circuit

a. General. The ac milliammeter test circuit shown in figure 28 uses a meter shunt consisting of resistors R133 through R137. When full scale current is drawn on any range, a 1-volt drop in potential will be produced at the amplifier input terminals.

b. Primary Circuit. Power at 115 volts, 60 cps is applied to the ac milliammeter test circuit through autotransformers T3 and T4. Autotransformer T3 is variable to permit coarse control of

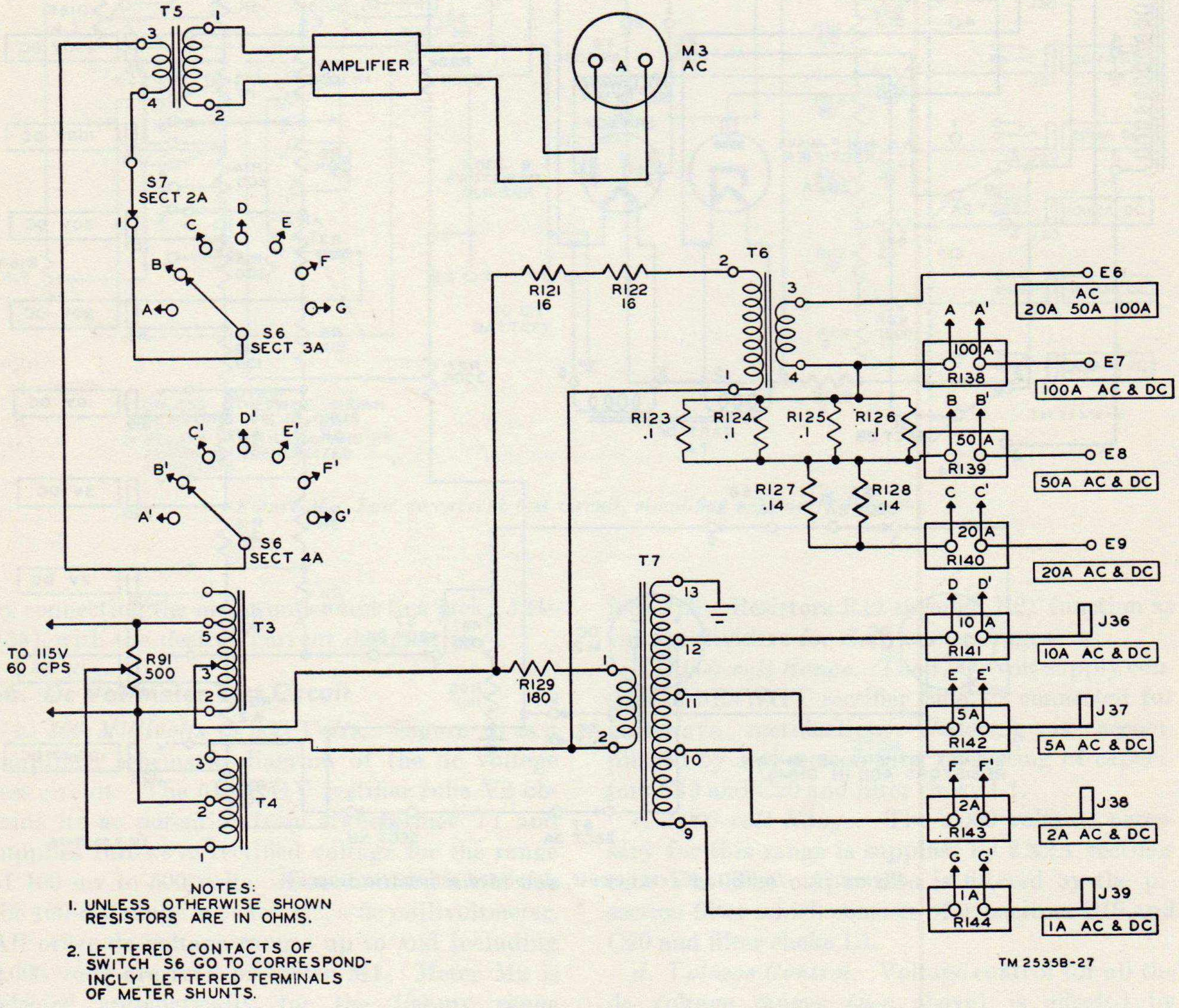


Figure 27. Ac ammeter test circuit, simplified schematic diagram.

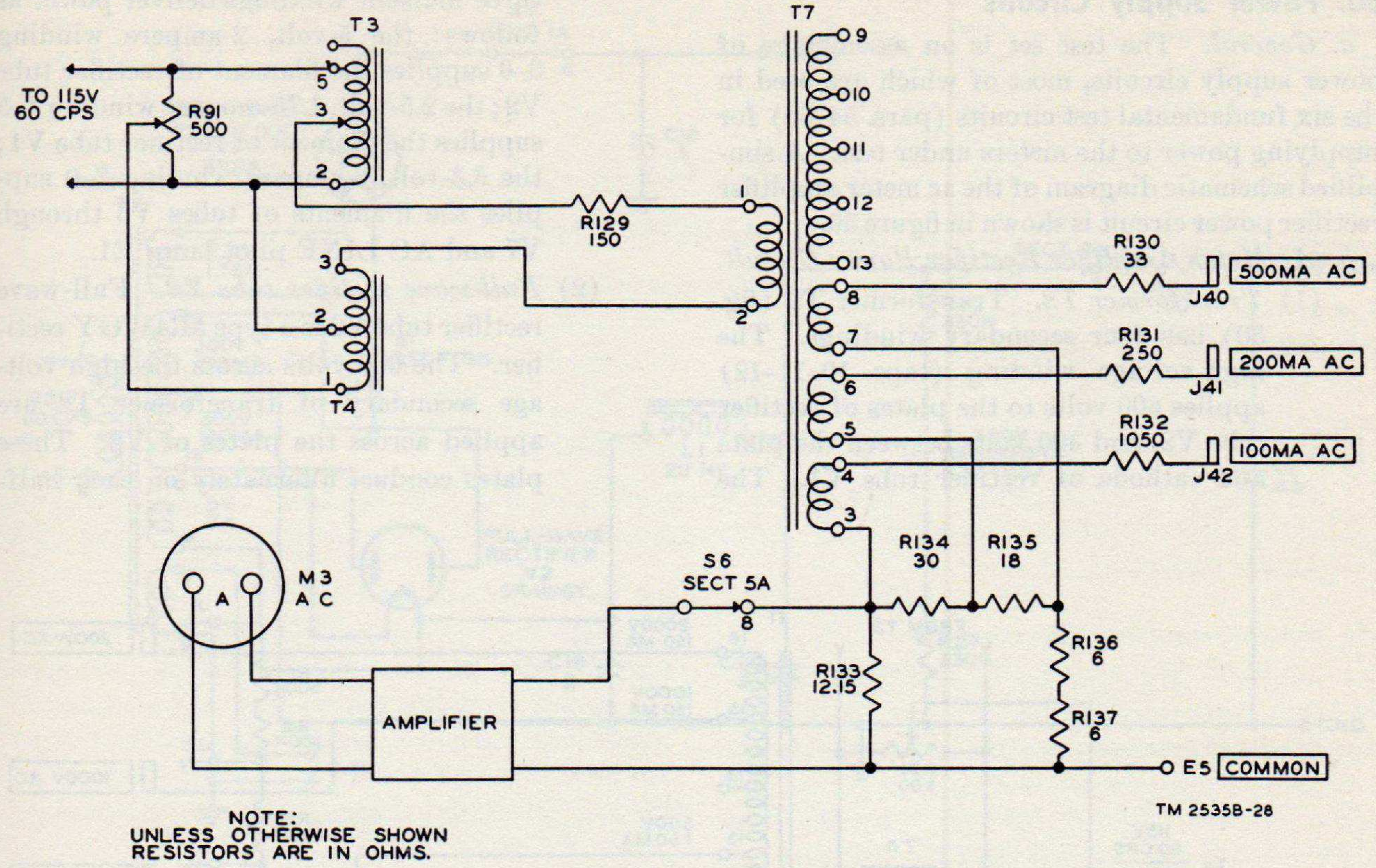


Figure 28. Ac milliammeter test circuit, simplified schematic diagram.

the output voltage. Potentiometer R91, in parallel with autotransformer T3, permits fine control of the output voltage. The output voltage of autotransformers T3 and T4 is coupled to the primary of transformer T7 through current limiting resistor R129.

c. Secondary Circuits. Three secondary windings of transformer T7 deliver ac current to the milliampere jacks.

(1) Current is delivered through winding 7 and 8 of transformer T7, resistor R130, 500 MILLIAMPERES A. C. CURRENT jack J40 and shunt resistors R133 through R137. The voltage developed across shunt R133 is coupled to the amplifier through section 5A of switch S6. The output of the amplifier is measured by meter M3.

(2) Current is delivered through windings 5 and 6 of transformer T7, resistor R131, 200 MILLIAMPERES A. C. CURRENT, jack J41 and shunt resistors R133 through R137. The voltage developed across shunt resistor R133 is coupled to the amplifier through section 5A of switch S6. The output of the amplifier is measured by meter M3.

(3) Current is delivered through windings 3 and 4 of transformer T7, resistors R132, 100 MILLIAMPERES A. C. CURRENT, jack J42 and shunt resistors R133 through R137. The voltage developed across shunt resistor R133 is coupled to the amplifier through 5A of switch S6. The output of the amplifier is measured by meter M3.

59. Ac Voltmeter Test Circuit

Figure 29 is a simplified schematic diagram of the ac voltmeter test circuit. Power is delivered to the ac voltage test circuit by the primary voltage control circuit which consists of powerstat T3, autotransformer T4, rheostat R91, and transformer T1. The .1 percent resistors R4 through R11 used in the dc voltage test circuit (fig. 26) are used as meter multipliers in the ac voltage ranges. The amplifier and meter combination has a sensitivity of 1,000 ohms per volt and is used in the same manner as an ordinary 1,000-ohm-per-volt meter movement (par. 52*a*).

60. Power Supply Circuits

a. General. The test set is an assemblage of power supply circuits, most of which are used in the six fundamental test circuits (pars. 54–59) for supplying power to the meters under test. A simplified schematic diagram of the ac meter amplifier rectifier power circuit is shown in figure 30.

b. Ac Meter Amplifier Rectifier Power Circuit.

(1) *Transformer T2.* Transformer T2 (fig. 30) has four secondary windings. The high-voltage winding (taps 10–11–12) applies 600 volts to the plates of rectifier tube V2, and 300 volts between the plate and cathode of rectifier tube V1. The three filament windings deliver power as follows: the 5-volt, 2-ampere winding 3–6 supplies the filament of rectifier tube V2; the 2.5-volt, 1.75-ampere winding 4–5 supplies the filament of rectifier tube V1; the 6.3-volt, 6-ampere winding 7–9 supplies the filaments of tubes V3 through V7 and AC LINE pilot lamp E1.

(2) *Full-wave rectifier tube V2.* Full-wave rectifier tube V2 is a type 5R4WGY rectifier. The 600 volts across the high-voltage secondary of transformer T2 are applied across the plates of V2. These plates conduct alternately on each half-

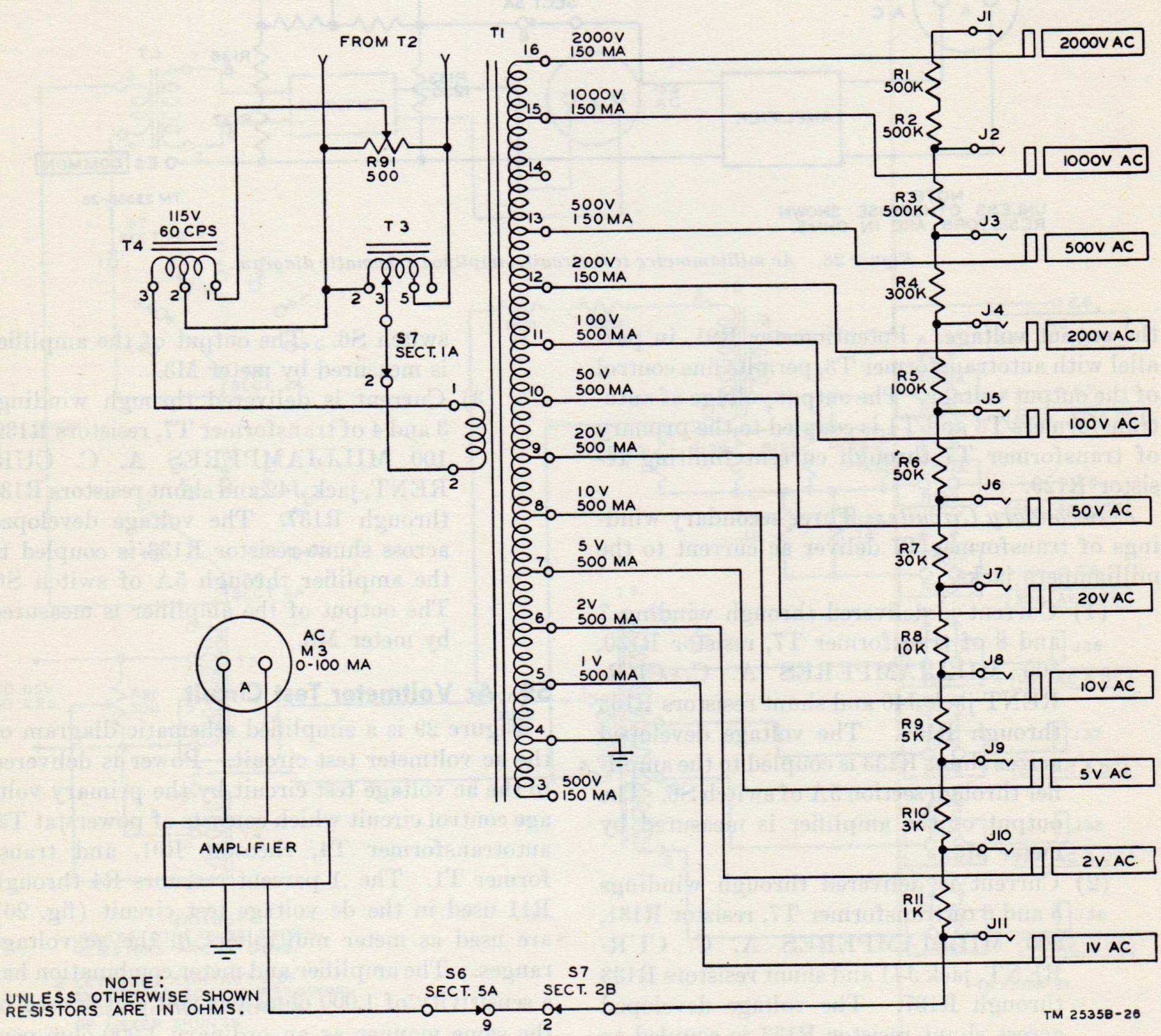


Figure 29. Ac voltmeter test circuit, simplified schematic diagram.

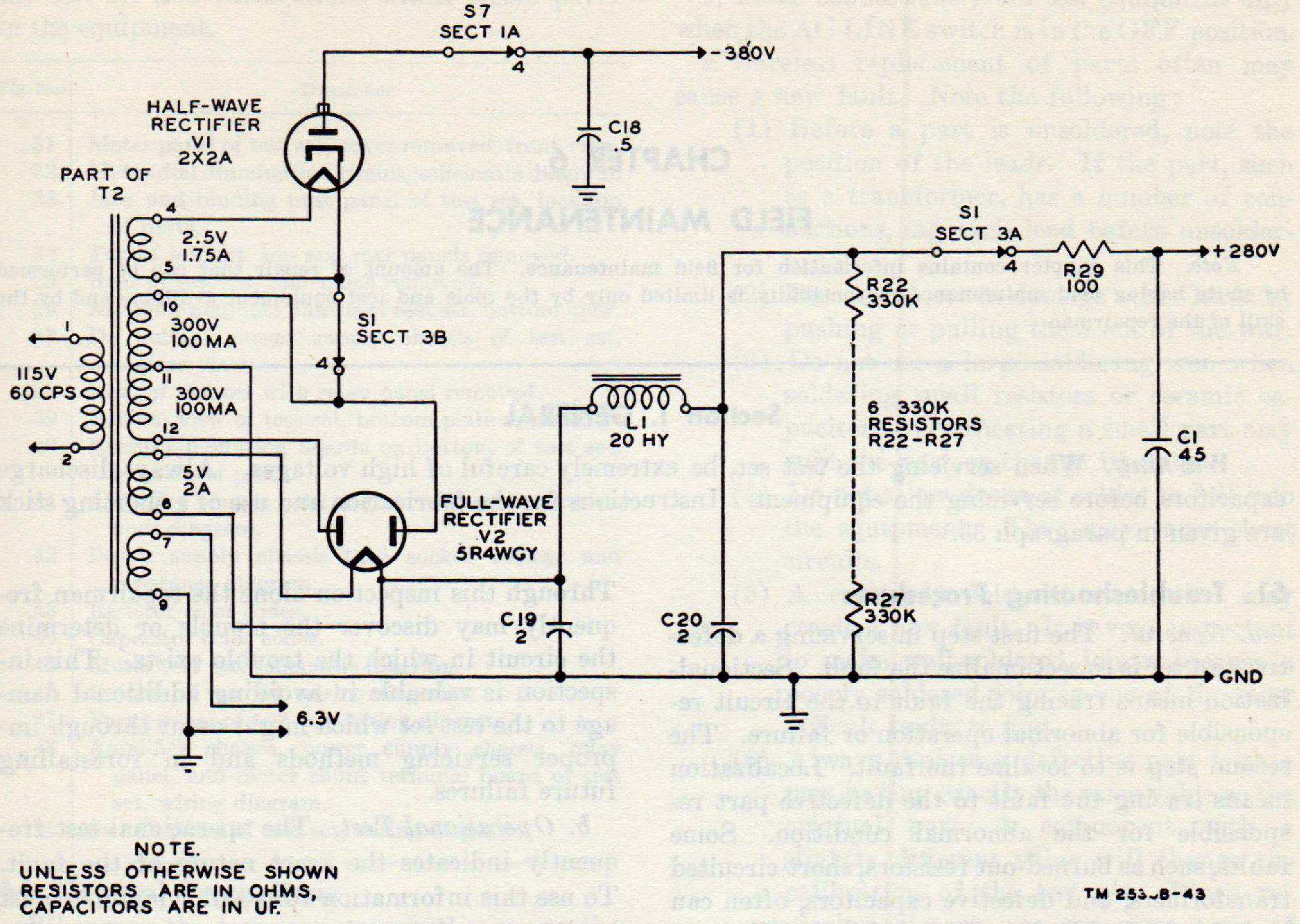


Figure 30. Ac meter amplifier rectifier power circuit, simplified schematic diagram.

cycle of the applied voltage, and a pulsating dc voltage appears at the common filament. This rectified voltage is subsequently filtered ((3) below).

(3) *Filter network.* The filter network that consists of capacitor C19, filter choke L1, and capacitor C20 reduces the ripple content in the output of full-wave rectifier tube V2. Resistors R22 through R27 form a safety bleeder for the charge on high-voltage filter capacitor C19. Resistor R29 is a current-limiting resistor. Capacitor C1, on the amplifier chassis, provides additional filtering. The filtered 280-volt supply provides the necessary voltages for the plates of tubes V3 through high-voltage tube V7.

(4) *Half-wave rectifier tube V1.* Half-wave rectifier tube V1 is a 2X2A rectifier which, with selector switch S1 in position 4, has 300 volts from the center tapped high-voltage winding applied between its plate and cathode. The half-wave output is filtered by capacitor C18. The resultant 380-volt supply is used variously as bias voltage and negative reference voltage in the ac meter amplifier.

CHAPTER 6

FIELD MAINTENANCE

Note. This chapter contains information for field maintenance. The amount of repair that can be performed by units having field maintenance responsibility is limited only by the tools and test equipment available and by the skill of the repairman.

Section I. GENERAL

Warning: When servicing the test set, be extremely careful of high voltages. Always discharge capacitors before servicing the equipment. Instructions for the fabrication and use of a shorting stick are given in paragraph 33.

61. Troubleshooting Procedures

a. General. The first step in servicing a defective test set is to sectionalize the fault. Sectionalization means tracing the fault to the circuit responsible for abnormal operation or failure. The second step is to localize the fault. Localization means tracing the fault to the defective part responsible for the abnormal condition. Some faults, such as burned-out resistors, short-circuited transformers, and defective capacitors, often can be located by sight, smell, or hearing. The majority of faults, however, must be localized by checking voltages and resistances. The procedures for removing, inspecting, cleaning, and testing pluck-out parts are outlined in paragraphs 44 through 46.

b. Sectionalization and Localization of Trouble. The testing methods listed in paragraph 62 aid in isolating the source of trouble. The tests are arranged in an order designed to simplify the process of tracing a trouble to a specific component; follow the procedures in the sequence given. The servicing operation should cause no further damage to the equipment. Localize the trouble to a single stage or circuit, then isolate the trouble to a part within that stage or circuit by taking appropriate voltage, resistance, and continuity measurements.

62. Testing Methods

a. Visual Inspection. The purpose of visual inspection is to locate any visible trouble. Through this inspection alone the repairman frequently may discover the trouble or determine the circuit in which the trouble exists. This inspection is valuable in avoiding additional damage to the test set which might occur through improper servicing methods and in forestalling future failures.

b. Operational Test. The operational test frequently indicates the exact nature of the fault. To use this information fully, all symptoms must be interpreted in relation to one another. To perform the operational test, use the equipment performance checklist (par. 48).

c. Troubleshooting Chart. The trouble symptoms listed in the troubleshooting chart (par. 68) will aid greatly in localizing trouble. They can be used to determine the circuit or part which is causing abnormal operation or equipment failure.

d. Intermittent Trouble. If an intermittent trouble is present, often it may be made to appear by tapping or jarring the suspected part. It is possible that the trouble is not in the test set, but that an external connection may be improper or defective. Check for loose or improper connections, and move internal wires and components with an insulated tool. This test may indicate the exact location of a faulty connection or part.

63. Troubleshooting Data

The troubleshooting data below lists the circuit and wiring diagrams required for troubleshooting the test set and illustrations which locate parts in the equipment.

Fig. No.	Description
31	Meter panel of test set, cover removed, front view.
32	Meter dial illumination circuit, schematic diagram.
33	Jack and binding post panel of test set, location of parts.
34	Top of test set, top and rear panels removed.
35	Rear of test set, rear panel removed.
36	Ac meter amplifier chassis of test set, bottom view.
37	Dc voltage power supply chassis of test set, bottom view.
38	Rear of test set with relay panel removed.
39	Bottom view of test set, bottom plate removed.
40	Resistor mounting boards on bottom of test set, location of parts.
41	Amplifier chassis tube socket voltage and resistance diagram.
42	Power supply chassis tube socket voltage and resistance diagram.
43	Resistor color codes.
44	Capacitor color codes.
45	Meter test set, schematic diagram.
46	Bottom of test set, wiring diagram.
47	Front panel of test set, wiring diagram.
48	Amplifier chassis, power supply chassis, relay panel, and meter shunt terminal board of test set, wiring diagram.
49	Switch panel of test set, wiring diagram.

64. General Precautions

Whenever the test set is serviced, observe the following precautions carefully:

a. Be careful of high voltages when working on the equipment with the power on and the panels removed. To remove power from the test set completely, remove the ac line cord from the ac outlet and disconnect the storage battery.

b. Make connections from test equipment only when the AC LINE switch is in the OFF position.

c. Careless replacement of parts often may cause a new fault. Note the following:

(1) Before a part is unsoldered, note the position of the leads. If the part, such as a transformer, has a number of connections, tag each lead before unsoldering it.

(2) Be careful not to damage other leads by pushing or pulling them out of the way.

(3) Do not use a large soldering iron when soldering small resistors or ceramic capacitors. Overheating a small part may ruin the part or change its value.

(4) Do not allow drops of solder to fall into the equipment. They may cause short circuits.

(5) A carelessly soldered connection may create a new fault. It is very important to make well-soldered joints, because a poorly soldered joint is one of the most difficult faults to find.

(6) Always replace a defective part with a part having exactly the same value as the original part. A component with a slightly different value will change the calibration of the test set. When replacing a part, use the same type of ground that was used in the original wiring. *This is very important.*

d. Do not overtighten screws when assembling mechanical couplings.

e. When assembling a part that is held by screws, always replace the lockwashers.

Section II. TROUBLESHOOTING AT FIELD MAINTENANCE LEVEL

65. Test Equipment Required for Troubleshooting

Test equipment required for troubleshooting the test set and the applicable publications are listed below.

Name of item	Technical manual
Multimeter TS–352/U or Multimeter TS–352B/U.	TM 11–5527 or TM 11–5527A
Test Sest I–49, I–49–A, or I–49–B or Resistance Bridge ZM–A/U or ZM–4B/U.	TM 11–2019
Electron Tube Test Set TV–2/U--------	TM 11–2661

66. Checking Circuit Parts

a. Tubes. Test tubes with Electron Tube Test Set TV–2/U. The check should include tests for short circuits, transconductance, excessive gas, and filament to cathode leakage.

b. Voltage and Resistance. Refer to the tube socket voltage and resistance diagrams (figs. 41 and 42) for voltages and resistances normally present. Use Multimeter TS–352/U or TS–352B/U.

c. Resistors. Check resistors with Resistance Bridge ZM–4A/U or ZM–4B/U. Refer to the schematic diagram (fig. 45) or to the resistor color code chart (fig. 43) for the resistance and tolerance of each resistor in the test set.

d. Capacitors. Normally, capacitors are not calibrated in troubleshooting. Check for point-to-point circuit continuity and, if a capacitor is open or short-circuited, replace it.

e. Switches. Check switches for continuity between contacts. Refer to the schematic diagram to determine between which points continuity should exist in each position of a switch.

f. Filter Choke. Check the dc resistance of the filter choke with Multimeter TS–352/U or TS–352B/U. The resistance should be 420 ohms.

g. Relays. Check the dc resistance of the winding of each relay with Multimeter TS–352/U or TS–352B/U. The resistances should be as follows:

Relay	Dc resistance (ohms)
K1	75
K2, K3, K4, K5	63

h. Rheostats. Connect Multimeter TS–352/U or TS–352B/U to the rheostat terminals and turn the control to the extreme clockwise position. Refer to the schematic diagram (fig. 45) for normal resistances. Turn the control slowly to the extreme counterclockwise position; the meter needle should move steadily toward zero. A sudden dip of the needle indicates that the rheostat is defective.

i. Transformers. Check the dc resistance of transformer windings with Multimeter TS–352/U or Multimeter TS–352B/U. The resistances should be as follows:

Transformer	Winding	Dc resistance (ohms)
T1	1–2	0. 6
	3–4	70
	3–5	70
	3–6	70
	3–7	70
	3–8	70
	3–9	70
	3–10	71. 5
	3–11	74
	11–12	18
	12–13	48
	13–14	43
	14–15	42
	15–16	150
T2	1–2	3
	3–6	0
	4–5	0
	7–9	0
	10–11	120
	11–12	120
T4	1–2	26
	2–3	1
T5	1–2	18
	3–4	0
T6	1–2	1
	3–4	0
T7	1–2	6
	3–4	40
	5–6	10
	7–8	1. 8
	9–10	1. 4
	9–11	1. 8
	9–12	2
	9–13	2
L1	1–2	400

j. Meter Shunts. Check meter shunts for mechanical looseness between terminal lugs and main body of shunt. Two types of trouble can occur. If the DC MILLIVOLTMETER fails to operate, one of the shunts may be open. If the meter functions, but is inaccurate on one range, it is likely that one shunt has changed value. In this case, replace the questionable shunt.

k. Meters. Meters must be checked for accuracy by checking their basic movements against a .1 percent standard meter. Basic meter movements are given below:

(1) DC MICROAMMETER, 100 microampheres dc.

(2) DC MILLIVOLTMETER, 100 millivolts dc.

(3) AC MILLIAMMETER, 100 milliamperes ac.

l. Jacks. Check jacks visually for proper pressure of contact against plug. Check for continuity between contact point and lead connecting jack to internal circuitry. Check for insulation breakdown on voltage jacks.

m. Binding Posts. Check continuity from external connection to internal connection. Check for short or leakage to chassis. Replace broken or faulty binding posts or insulating bushings.

67. Locating Ac Meter Amplifier Circuit Faults

a. Testing Tubes. Most troubles in the ac meter amplifier are caused by defective tubes. If trouble is indicated in the amplifier circuit and the cause is not apparent immediately, check all tubes with Electron Tube Test Set TV–2/U. The tube check should include tests for short circuits, excessive gas, and filament-to-cathode leakage. When a tube fault is indicated and no facilities are available to test the tubes, replace one tube at a time with a tube known to be good to determine which tube, if any, is causing the trouble.

b. Measuring Power Supply Output. If trouble in the ac power supply is indicated, measure the positive output at terminal 1, section 3B, of selector switch S1, and measure the negative output at terminal 4, section 1A, of selector switch S1. Use Multimeter TS–352/U or TS–352B/U.

c. Measuring Voltage and Resistance. Most amplifier troubles can be located and corrected without removing the amplifier chassis from the test set. If it is necessary to remove the amplifier from the test set, however, take voltage and resistance measurements on the underside of the chassis with Multimeter TS–352/U or TS–352B/U and Test Set I–49 or Resistance Bridge ZM–4A/U or ZM–4B/U. All dc voltages in the meter amplifier may be incorrect if a trouble occurs that affects the dc feedback loop (par. 49). Isolate such a trouble by locating the stage where the direction of the voltage offset at the input is not reversed at the output.

68. Troubleshooting Chart

The following chart is supplied as an aid in locating trouble that exists in the test set. It lists the symptoms that the repairman can observe while testing the equipment, and the troubles that are most likely to cause the symptoms. References are made to the paragraphs that contain a discussion of the theory of operation of the circuit that is likely to be defective. In addition, the chart indicates the corrective measures that the repairman should perform, references to the schematic diagram of the circuit to be checked, references to the illustrations that show where parts are located, and references to the paragraph in which the recommended troubleshooting procedure is outlined. Point-to-point voltage tests can be used to supplement these procedures.

a. Dc Ammeter Test Circuits (pars. 54 and 55).

Symptom	Probable trouble	Corrective measures
Battery lamp E2 does not light	Lamp E2 defective (fig. 24). 12-volt storage battery dead or improperly connected to binding posts E3 and E4 (fig. 24).	Check lamp E2 (fig. 34, par. 44). Replace if defective (par. 45*b*).
		Check battery and recharge if low. Check battery connections (figs. 6 and 32, par. 13*b*) and reverse polarity if necessary.
	BATTERY switch S5 defective (fig. 24).	Check switch S5 (fig. 34, par. 66*e*). Replace if defective (par. 72*a*).
	Resistor R95 defective (fig. 24)	Check resistor R95 (fig. 37, par. 66*c*). Replace if defective (par. 69).
No dc output at jacks J24 through J39 and binding posts E7, E8 and E9.	Selector switch S6 defective (figs. 24 and 26).	Check switch S6 (fig. 34, par. 66*e*). Replace if defective (par. 72*a*).
	Selector switch S7 defective (figs. 21–23).	Check switch S7 (fig. 34, par. 66*e*). Replace if defective (par. 72*a*).
	BATTERY switch S5 defective (figs. 17–22).	Check switch S5 (fig. 34, par. 66*e*). Replace if defective (par. 72*a*).
No dc output at one or all of jacks J24 through J35.	Resistor or resistors in shunt network consisting of resistors R99 through R120 defective (fig. 25).	Check resistors R99 through R120 (fig. 40, par. 66*c*). Replace those found to be defective (par. 69).

Symptom	Probable trouble	Corrective measures
No dc output at jacks J36 through J39 or binding posts E7 through E9.	Shunt in shunts R138 through R144 defective (figs. 17–23).	Check shunts R138 through R144 (figs. 38, par. 66*k*). Replace defective shunt (par. 69).
Excessive dc output at one or all of jacks J24 through J39 and binding posts E7 through E9.	Resistor or resistors R62 through R69 (figs. 18–23).	Check resistors R62 through R69 (fig. 35, par. 66*c*). Replace those found to be defective (par. 69).
DC MICROAMMETER shows no reading on ua and ma ranges.	12-volt storage battery improperly connected to binding posts E3 and E1 (fig. 25).	Check battery connections (figs. 6 and 34, par. 13*b*). Reverse polarity if necessary.
	Meter defective (fig. 25)	Check meter (fig. 31, par. 66*k*). Replace if defective (par. 70*a*).
	Overload relay K5 defective, out of adjustment, or has dirty contacts (fig. 25).	Check relay K5 (fig. 35, par. 66*g*). Clean (par. 75) and adjust (par. 76) or replace if defective (par. 74).
DC MILLIAMMETER shows no reading on any dc ampere range.	12-volt storage battery improperly connected to binding posts E3 and E4 (figs. 17–23).	Check battery connections (figs. 6 and 34, par. 13*b*). Reverse polarity if necessary.
	Meter defective (figs. 17–23)	Check meter (fig. 31, par. 66*k*). Replace if defective (par. 70*a*).
	Overload relay K5 defective, out of adjustment, or has dirty contacts (figs. 18–24).	Check relay K5 (fig. 35, par. 66*g*). Clean (par. 75) and adjust (par. 76), or replace if defective (par. 74).
Overload relay K5 operates in all positions of selector switch S6.	Rheostat R70 defective (figs. 17–23)	Check rheostat R70 (fig. 35, par. 66*h*. Adjust (par. 76), or replace if defective (par. 69).
	Resistor R71 defective (figs. 17–23)	Check resistor R71 (fig. 35, par. 66*c*). Replace if defective (par. 69).
	Rheostat R61 defective (figs. 17–23)	Check each section of rheostat R61 (fig. 35, par. 66*h*). Replace if defective (par. 72*b*).
Dc output cannot be varied with DIRECT CURRENT COARSE CONTROL rheostat R61.	Rheostat R61 defective (figs. 17–24 and 26).	Check each section of rheostat R61 (fig. 35, par. 66*h*). Replace if defective par. 72*b*).
Dc output cannot be varied with DIRECT CURRENT FINE CONTROL, rheostat R94.	Rheostat R94 defective (figs. 20, 22, and 23).	Check rheostat R94 (fig. 34, par. 66*h*). Replace if defective (par. 72*b*).

b. Dc Voltmeter Test Circuits (par. 56).

Symptom	Probable trouble	Corrective measures
AC LINE lamp E1 does not light	Ac power cord defective	Check power cord (par. 44). Repair or replace cord if defective.
	5-ampere fuse F1 or F2 burned out	Check fuses F1 and F2 (figs. 3 and 34, par. 44). Replace if burned out (par. 45*c*).
	Lamp E1 defective	Check lamp E1 (fig. 34, par. 46*a*). Replace if defective (par. 45).
	AC LINE switch S4 defective	Check switch S4 (fig. 34, par. 66*e*). Replace if defective (par. 72*a*).
	Transformer T2 defective (fig. 26)	Check transformer T2 (fig. 34, par. 66*i*). Replace if defective (par. 78*a*).

Symptom	Probale trouble	Corrective measures
No dc voltage output at jacks J13 through J23.	Rectifier tube V2 defective (fig. 26)	Test tube V2 (fig. 34, par. 66*a*). Replace if defective (par. 45).
	Powerstat T3 defective	Check powerstat T3 (fig. 34, par. 66*i*). Replace if defective (par. 78*c*).
	Rheostat R91 defective	Check rheostat R91 (fig. 35, par. 66). Replace if defective (par. 72*b*).
	Transformer T2 defective	Check transformer T2 (fig. 34, par. 66*i*). Replace if defective (par. 78*a*).
	Transformer T4 defective	Check transformer T4 (fig. 35, par. 66*i*). Replace if defective (par. 78*a*).
	Selector switch S1 defective (fig. 26)	Check switch S1 (fig. 34, par. 66*e*). Replace if defective (par. 72).
	Resistor or resistors R22 through R27 defective (fig. 26).	Check resistors R22 through R27 (fig. 39, par. 66*c*). Replace if defective (par. 79)
	Filter capacitor C19 or C20 defective (fig. 27).	Check capacitors C19 and C20 (figs. 38 and 39, par. 66*d*). Replace if defective (par. 69).
	Filter choke L1 defective (fig. 26)	Check filter choke L1 (figs. 38 and 39, par. 66*f*). Replace if defective (par. 69).
No dc voltage at jack J12	Rectifier tube V1 defective (fig. 26)	Test tube V1 (fig. 34, par. 66*a*). Replace if defective (par. 45*a*).
	Winding 4–5 (2.5 volts) of transformer T2 defective (fig. 26).	Check winding 4–5 of transformer T2 (fig. 34, par. 66*i*). Replace transformer if defective (par. 78*a*).
	Resistor R1 or R2 defective (fig. 26)	Check resistors R1 and R2 (fig. 40, par. 66*c*). Replace defective resistor (par. 69).
	Jack J12 defective (fig. 26)	Check jack J12 (fig. 33, par. 66*l*). Replace if defective (par. 71*a*).
	Selector switch S1 defective (fig. 26)	Check switch S1 (fig. 34, par. 66*e*). Replace if defective (par. 72*a*).
No dc voltage at jack J13	Jack J13 defective (fig. 26)	Check jack J13 (fig. 33, par. 66*l*). Replace if defective (par. 71).
	Selector switch S1 defective (fig. 26)	Check switch S1 (fig. 34, par. 66*e*). Replace if defective (par. 72*a*).
No dc voltage at jacks J14 through J23.	Resistor or resistors R4 through R21 defective (fig. 26).	Check resistors R4 through R21 (figs. 39 and 40, par. 66*c*). Replace defective resistor or resistors (par. 69).
Incorrect dc voltage at any jack J14 through J23.	Resistor or resistors R4 through R21 defective (fig. 26).	Check resistors R4 through R21 (figs. 39 and 40, par. 66*c*). Replace defective resistor or resistors (par. 69).
Unable to vary dc voltage output on all dc ranges.	Powerstat T3 defective	Check powerstat T3 (fig. 34, par. 66*i*). Replace if defective (par. 78*c*).
	Rheostat R91 defective	Check rheostat R91 (fig. 34, par. 66*h*). Replace if defective (par. 72*b*).
No reading on dc microammeter	Selector switch S1 defective (fig. 26)	Check switch S1 (fig. 34, par. 66*e*). Replace if defective (par. 72*a*).
	Meter defective	Check meter (fig. 31, par. 66*k*). Replace if defective (par. 70*a*).
No reading on dc millivoltmeter	Selector switch S1 defective (fig. 26)	Check switch S1 (fig. 34, par. 66*e*). Replace if defective (par. 72*a*).
	Meter defective	Check meter (fig. 31, par. 66*k*). Replace if defective (par. 70*a*).
Excessive voltage at jacks J12 and J13 for normal rotation of DC VOLTS COARSE CONTROL, powerstat T3.	Resistor or resistors R22 through R27 defective (fig. 26).	Check resistors R22 through R27 (fig. 39, par. 66*c*). Replace defective resistor or resistors (par. 69).

c. Ac Ammeter Test Circuit (pars. 58 and 59).

Symptom	Probable trouble	Corrective measures
No output at jacks J36 through J42 and binding posts E7 through E9.	Selector switch S1, S6, or S7 defective.	Check switches S1, S6, and S7 (fig. 34, par. 66*e*). Replace defective switch (par. 72*a*).
	Powerstat T3 defective (fig. 27).	Check powerstat T3 (fig. 34, par. 66*i*). Replace if defective (par. 68*c*).
	Transformer T4 defective (fig. 27).	Check transformer T4 (fig. 39, par. 66*i*). Replace if defective (par. 68*a*).
	Defect in ac meter amplifier.	See *e* below.
No control of current output.	Powerstat T3 defective (fig. 27).	Check powerstat T3 (fig. 34, par. 66*i*). Replace if defective (par. 68*c*).
	Rheostat R61 defective.	Check rheostat R61 (fig. 34, par. 66*h*). Replace if defective (par. 72*b*).
No output at jacks J32 through J39 and binding posts E7 through E9.	Transformer T6 defective (fig. 27).	Check transformer T6 (fig. 34, par. 66*i*). Replace if defective (par. 78*a*).
	Resistor R121 or R122 defective (fig. 22).	Check resistors R121 and R122 (fig. 35, par. 66*c*). Replace if defective (par. 69).
No output at jacks J40, J41, or J42.	Transformer T7 defective (fig. 27).	Check transformer T7 (fig. 34, par. 66*i*). Replace if defective (par. 78*a*).
	Selector switch S1, S6, or S7 defective.	Check switches S1, S6, and S7 (fig. 34, par. 66*e*). Replace if defective (par. 72*a*).
No output on any one of jacks J36 through J39 or binding posts E7, E8, and E9.	Shunt in group R138 through R144 defective (fig. 27).	Check shunts R138 through R144 (fig. 38, par. 66*j*). Replace if defective (par. 69).
	Resistor R123 through R128 defective (fig. 27).	Check resistors R123 through R128 (fig. 35, par. 66*e*). Replace defective resistor or resistors (par. 69).
No control of current output.	Powerstat T3 defective (fig. 27).	Check powerstat T3 (fig. 34, par. 66*i*). Replace if defective (par. 78*c*).
	Transformer T4 defective (fig. 27).	Check transformer T4 (fig. 34, par. 66*i*). Replace if defective (par. 68*a*).
	Rheostat R91 defective.	Check rheostat R91 (fig. 34, par. 66*h*). Replace if defective (par. 72*b*).
Meter M3 shows no deflection.	.15-ampere fuse F3 defective.	Check fuse F3 (fig. 34, par. 46*a*). Replace if defective (par. 45*c*).
	Selector switch S1, S6, or S7 defective.	Check switches S1, S6, and S7 (fig. 34, par. 66*e*). Replace defective switch (par. 72*a*).
	AC MILLIAMMETER defective (figs. 27 and 28).	Check meter (fig. 31, par. 66*k*). Replace if defective (par. 70*a*).
	Defect in ac meter amplifier.	See *e* below.
	Transformer T1 defective.	Check transformer T1 (fig. 39, par. 66*i*). Replace if defective (par. 78*a*).
	Defect in ac meter amplifier.	See *e* below.
No control of ac voltage output.	Powerstat T3 defective.	Check powerstat T3 (fig. 34, par. 66*i*). Replace if defective (par. 78*c*).
	Rheostat R91 defective.	Check rheostat R91 (fig. 34, par. 66*h*). Replace if defective (par. 72*b*).
No reading on ac milliammeter.	Selector switch S1, S6, or S7 defective.	Check switches S1, S6, and S7 (fig. 34, par. 63*e*). Replace if defective (par. 72*a*).
	Meter defective (fig. 29).	Check meter M3 (fig. 31, par. 66*k*). Replace if defective (par. 70*a*).
	.15-ampere fuse F3 burned out.	Check fuse F3 (fig. 34, par. 46*a*). Replace if defective (par. 45*c*).
	Defect in ac meter amplifier.	See *e* below.
Incorrect voltage or no voltage on any jack J1 through J11.	Secondary of transformer T1 defective (fig. 29).	Check transformer T1 (fig. 39, par. 66*i*). Replace if secondary is defective (par. 78*a*).
	Defect in ac meter amplifier.	See *e* below.

d. Ac Voltmeter Test Circuits (par. 59).

Symptom	Probable trouble	Corrective measures
No ac voltage output at jacks J1 through J11.	Ac power cord defective	Check power cord. Repair or replace if necessary.
	Selector switch S1, S6, or S7 defective.	Check switches S1, S6, and S7 (fig. 34, par. 66*e*). Replace defective switch (par. 72*b*).
	Transformer T4 defective	Check transformer T4 (fig. 35, par. 64*i*). Replace if defective (par. 78*a*).
	Powerstat T3 defective	Check powerstat T3 (fig. 34, par. 66*i*). Replace if defective (par. 78*c*).
	Rheostat R91 defective	Check rheostat R91 (fig. 34, par. 66*h*). Replace if defective (par. 72*b*).

e. Ac Meter Amplifier Circuits (pars. 52 and 53).

Symptom	Probable trouble	Corrective measures
Meter does not deflect and indicator lamp V8 lights as soon as attempt is made to obtain an ouptut.	.15-ampere fuse F3 burned out.	Check fuse F3 (fig. 34, par. 46*a*). Replace if defective (par. 45*c*).
	Tube V3, V4, V5, or V1 defective (fig. 15).	Test tubes V3, V4, V5, and V1 (fig. 34, par. 66*a*). Replace defective tube (par. 45*a*).
	Ac milliammeter open or defective (figs. 15 and 16).	Check meter (fig. 31, par. 66*k*). Repair open or replace meter (par. 70*a*).
Ac milliammeter deflects normally but indicator lamp V8 lighted all the time.	Tube V6 or V7 defective (fig. 16).	Test tubes V6 and V7 (fig. 34, par. 66*a*). Replace defective tube (par. 45*a*).
	Capacitor C16 leaky (fig. 16)	Check capacitor C16 (par. 66*d*). Replace if defective (par. 69).
Ac milliammeter deflects; indicator lamp V8 lights as output is increased.	Amplifier gain low; tube V1, V2, V3, V4, or V5 defective (figs. 15 and 17).	Test tubes V1, V2, V3, V4, and V5 (fig. 24, par. 66*a*). Replace defective tube (par. 45*a*).
Ac milliammeter does not deflect; indicator lamp V8 does not light.	Tube V2 defective (fig. 30)	Test tube V2 (fig. 34, par. 66*a*). Replace if defective (par. 45*a*).
	Selector switch S1 defective	Check switch S1 (fig. 34, par. 66*e*). Replace if defective (par. 72).
Ac milliammeter partially deflects; indicator lamp V8 does not light.	Capacitor C11 leaky (fig. 16)	Check capacitor C11 (par. 66*d*). Replace if defective (par. 69).
	Tube V3, V4, or V5 defective (fig. 15)	Test tubes V3, V4, and V5 (fig. 34, par. 66*a*). Replace defective tube (par. 45*a*).
Ac milliammeter deflects normally; indicator lamp V8 does not light when AMPLIFIER TEST switch S2 is depressed.	Tube V6, V7, or V8 defective (fig. 16).	Test tubes V6, V7, and V8 (fig. 34, par. 66*a*). Replace defective tube (par. 45*a*).

Section III. REPAIRS

69. General Instructions and Precautions

a. For all routine servicing and most trouble-shooting and repair, remove only the back and bottom panels of the test set, with the equipment resting on one end.

b. Many parts in the test set have smaller tolerances than those used in most radio equipment. Always consult the schematic diagram (fig. 45) when replacing parts; be sure to use an exact duplicate of the part removed. If a part with a slightly different value is used, the calibration of the test set will become inaccurate.

c. Never change the location of parts or wiring leads. Never substitute a longer lead, a lead of different material, or a lead of different gage.

d. If it is necessary to disconnect a number of leads to replace a defective part, tag each lead so that it will be placed on the proper terminal when the equipment is reassembled.

e. Always use the correct tools when disassembling any part of the equipment.

70. Removing Meters and Replacing Dial Lamps

a. Remove the inclined phenolic panel on the front of the test set (fig. 2) by removing the two flathead screws at each end on the panel.

b. Remove the metal cover plate on the meter box by removing the 38 machine screws (fig. 31).

c. Remove the meter to be serviced or replaced from the phenolic tray on which it rests. The meter leads are long enough to permit access to the feed through terminals at the rear of the meter housing for complete removal of the meters.

d. Figure 32 is a schematic diagram of the meter dial illumination circuit and shows the relationship of lamps I1 through I6 to all the meters. These lamps are incandescent lamps with bayonet-type bases. With the phenolic panel and the meter box cover plate removed, replace burned-out lamps as directed in paragraph 45*b*.

71. Removing Jacks and Binding Posts

a. Jacks. The location of the test set jacks with their reference symbol designations is shown in figure 33. The jacks are mounted on four separate phenolic panels which, in turn, are mounted on the frame of the test set. To remove a jack, remove the output control knobs and the U-shaped phenolic panel on the front of the test set (fig. 2). Then remove the screws that hold the panel on which the jack to be replaced is mounted to the framework.

b. Binding Posts. To remove a binding post (fig. 33), place the test set on one end and remove the bottom plate. The binding post connections can be reached easily with the test set in this position.

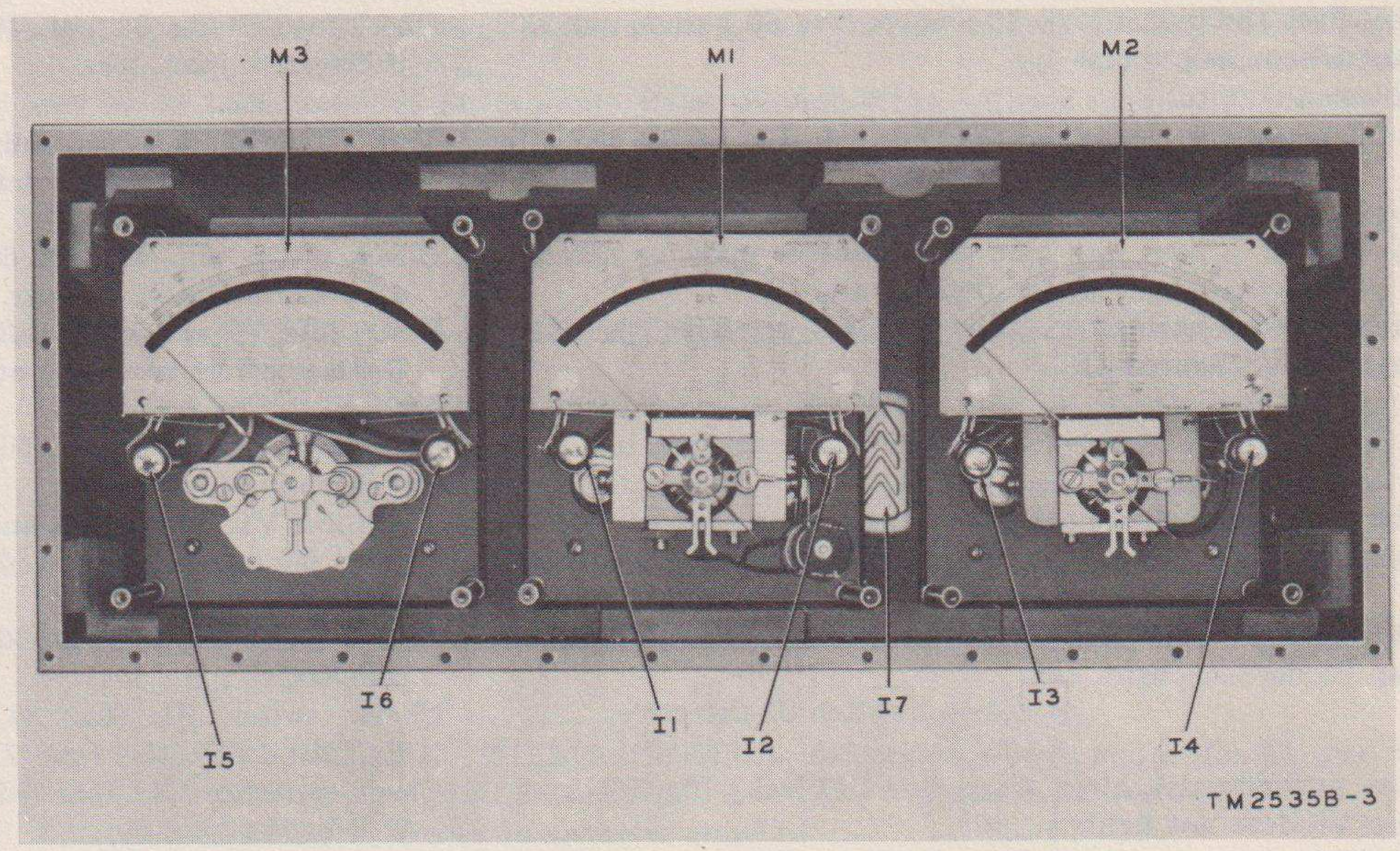


Figure 31. Meter panel of test set, cover removed, front view.

72. Removing Switches and Output Controls

a. Switches. The switches are located on the recessed panel of the test set (fig. 2). All the switches can be reached for removal by removing the top panel of the test set (fig. 34).

b. Output Controls. The output controls are located on either side of the U-shaped panel on the front of the test set (fig. 2). To replace any one of these controls, remove the top and rear panels. Output controls R61, R94 and R97, R91, and T3 are shown in figures 34 and 35.

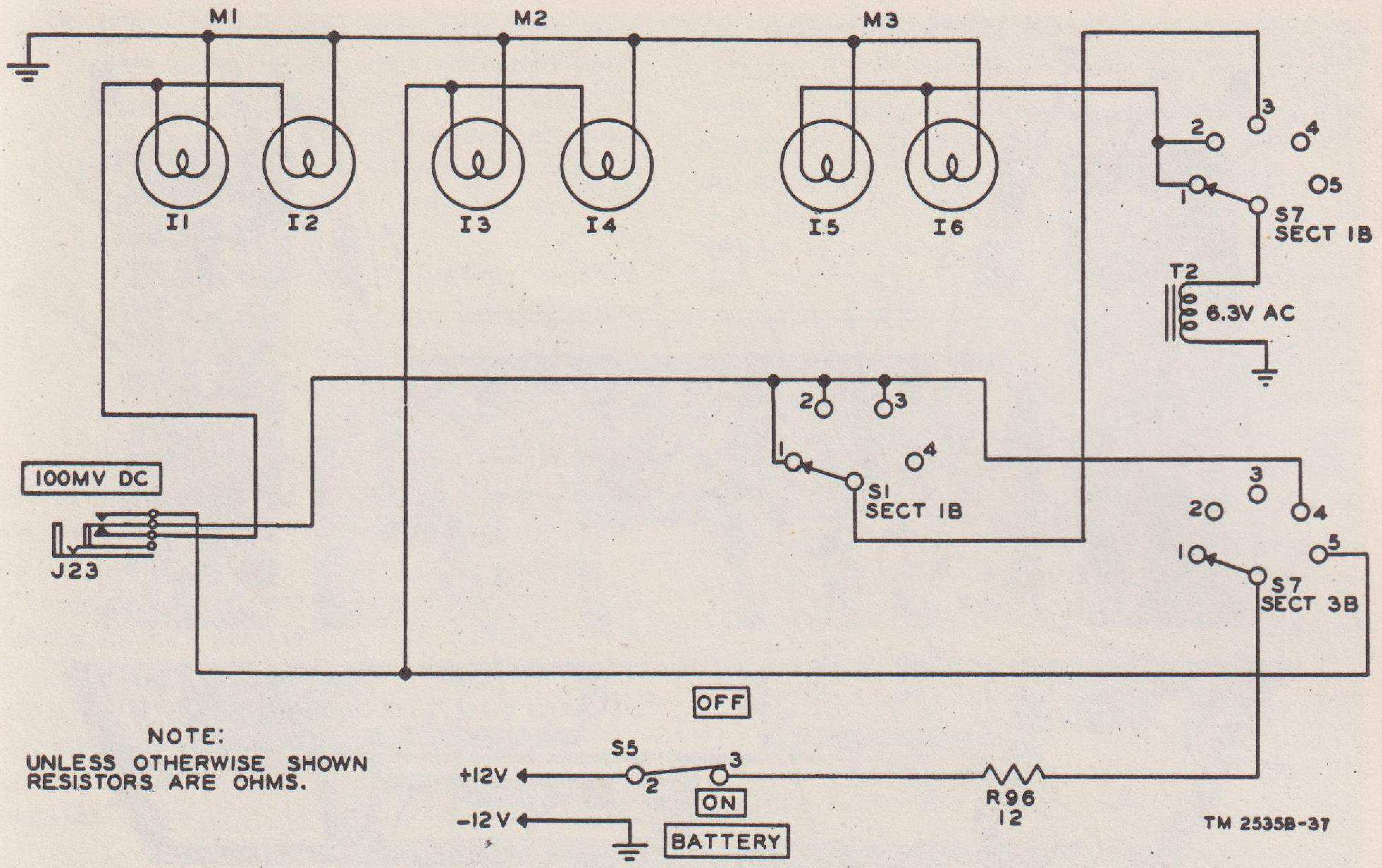


Figure 32. Meter dial illumination circuit, schematic diagram.

73. Removing Ac Meter Amplifier and Dc Voltage Power Supply

a. Ac Meter Amplifier. The ac meter amplifier chassis is located just inside the rear panel of the test set on a shelf below the selector switches (fig. 35). Before removing the chassis, remove tube V5 (6AS7G) from its socket. Then remove the thumbscrews that mount the chassis on its mounting brackets and carefully pull the amplifier from the framework as far as the wiring harness will allow. In this position, the components mounted on the underside of the amplifier chassis can be reached (fig. 36). All tubes can be removed for replacement without disturbing the chassis (par. 45*a*).

b. Dc Voltage Power Supply. The dc voltage power supply chassis is located near the amplifier chassis at the rear of the test set (fig. 35). It may be removed for troubleshooting and repair in the same manner as the ac meter amplifier

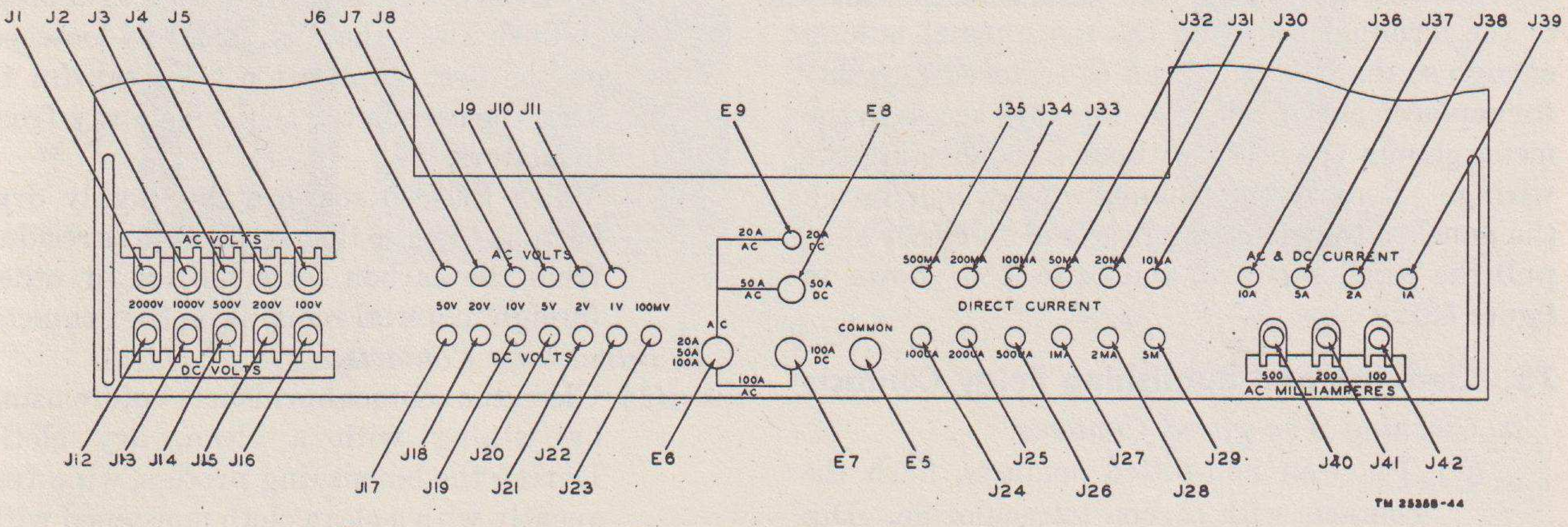


Figure 33. Jack and binding post panel of test set, location of parts.

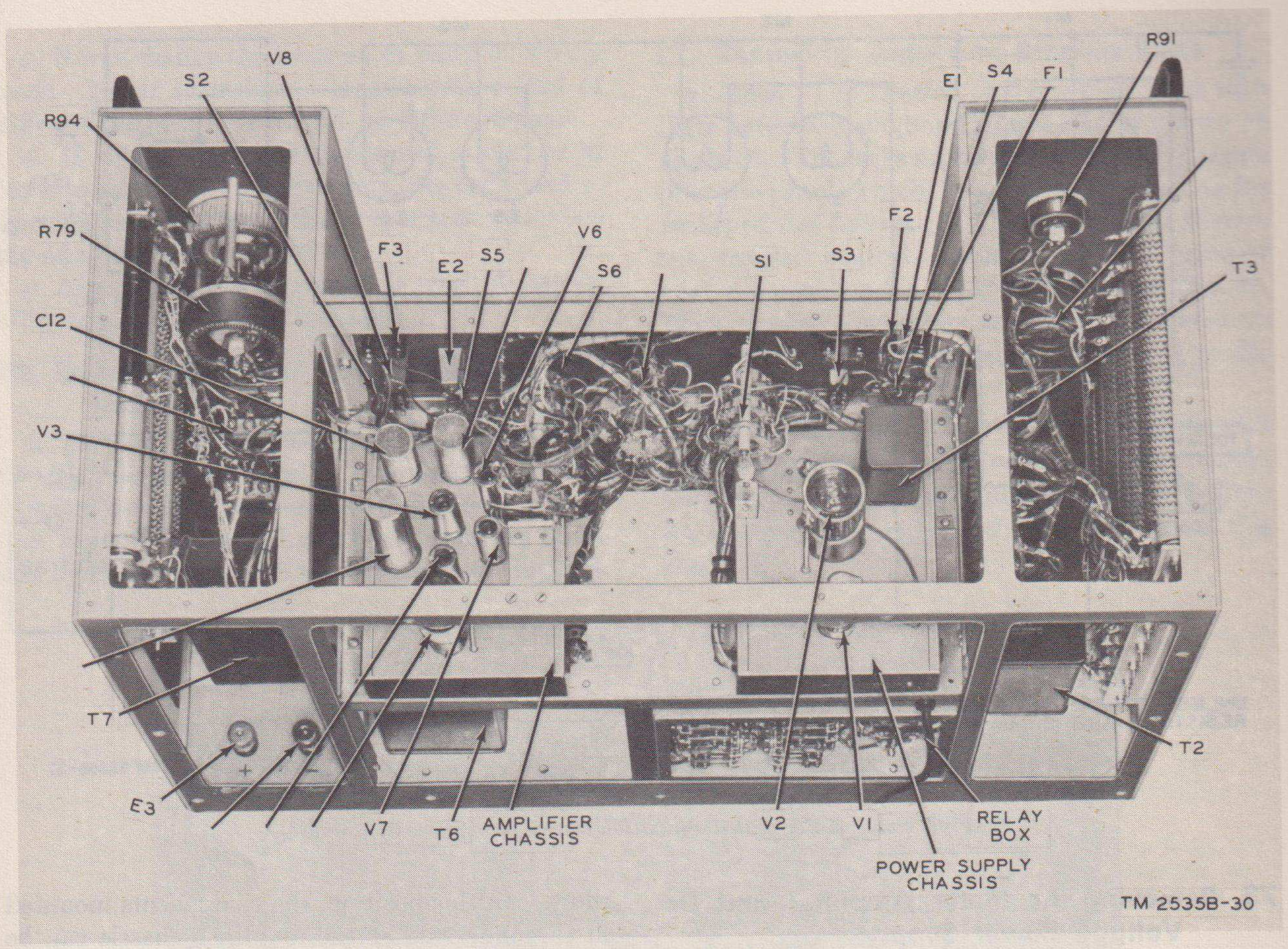


Figure 34. Top of test set, top and rear panels removed.

chassis (*a* above). Figure 37 shows the components mounted on the underside of the power supply chassis.

74. Removing Relay Panel

The switching and overload relay panel is mounted vertically just inside the rear panel of the test set (figs. 34 and 35). The wiring harness to the terminal strips on the relay panel is long enough so that the panel can be removed (fig. 38) for replacement of relays and to gain access to the meter shunts (par. 77) without disconnecting the wiring. Remove the thumbscrews which fasten the panel to the mounting brackets on either side, pull the panel forward, and raise it as shown in figure 38.

75. Cleaning and Burnishing Relay Contacts

a. Cleaning Non-pitted Contacts.

(1) To clean non-pitted contacts, flush the contacts with carbon tetrachloride. Dip the flat end of a clean toothpick into the carbon tetrachloride to a depth of about one-half inch and deposit the liquid on the contacts without rubbing. Hold normally closed contacts separated during this operation.

(2) Dip the flat end of another toothpick into the carbon tetrachloride and deposit it on the contacts, again without rubbing, to flush away the dirt that was loosened on the first application. Be careful to keep the carbon tetrachloride away from insulators.

(3) When the contacts are thoroughly dry, burnish them so that no deposit or residue from the carbon tetrachloride or other foreign material remains on the contacts.

b. Burnishing Contacts.

(1) Clean the contact burnishers before using by wiping with a clean, dry cloth. During the burnishing process, wipe frequently with a clean cloth moistened with carbon tetrachloride.

(2) When burnishings normally open contacts, press the contacts together by hand to give a slight pressure on the blade of the burnisher. When contacts are normally closed, the tension of the springs usually will furnish sufficient pressure against the burnisher.

(3) Rub the burnisher back and forth against the contacts two or three times. When contacts are pitted, additional strokes of the burnisher may be required. Do not use abrasives other than the burnisher blade.

c. Cleaning Pole and Armature Faces. Relay pole faces and armature faces, the surfaces of the core and armature which touch each other when the relay operates, must be cleaned if a relay tends to stick during operation. Clean with a contact burnisher and carbon tetrachloride, or insert a strip of bond paper between the armature and the core, hold the contacts closed, and withdraw the paper. Repeat this process with clean paper until the paper shows no evidence of dirt.

76. Adjusting Relay K5

Relay K5 closes when voltages in excess of 7 volts are applied across its coil circuit. The operating voltage is varied by including or excluding resistor R71 as a coarse adjustment and rheostat R70 as a fine adjustment. Follow the procedure outlined below:

a. The two lugs of the terminal strip mounted between relay K5 (fig. 35) and rheostat R70 are connected to resistor R71 by two blue leads. A green lead also is tied to one lug of this terminal strip. With the green lead connected to the upper tie point and rheostat R70 fully counterclockwise, connect Multimeter TS–352/U or TS–352A/U between the lower end of the relay coil and the upper tie point on the terminal strip.

b. Operate selector switch S7 to the DC MA and UA position.

c. Operate selector switch S6 to the AC and DC MA and UA position.

d. Operate BATTERY switch S5 to the ON position.

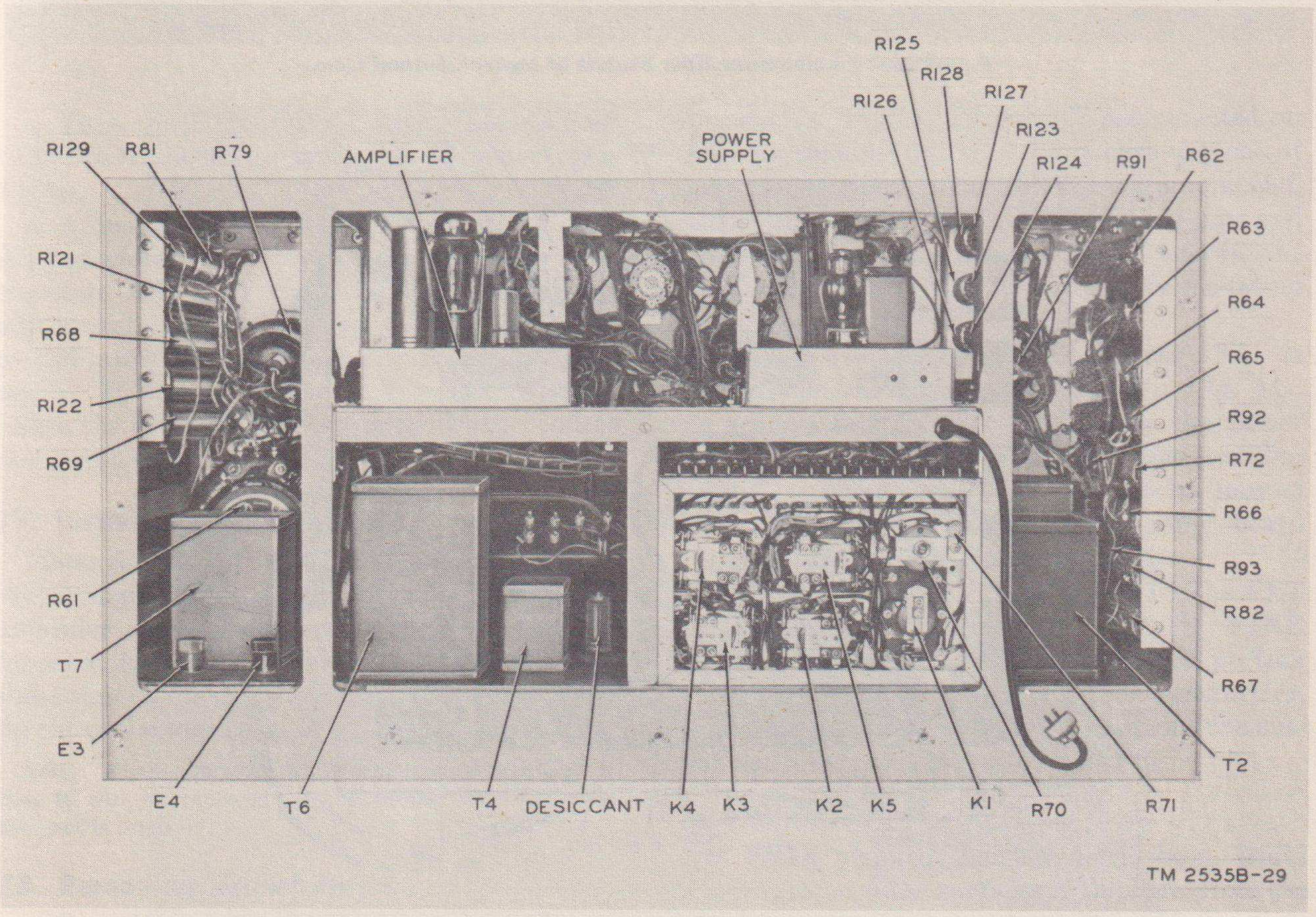


Figure 35. Rear of test set, rear panel removed.

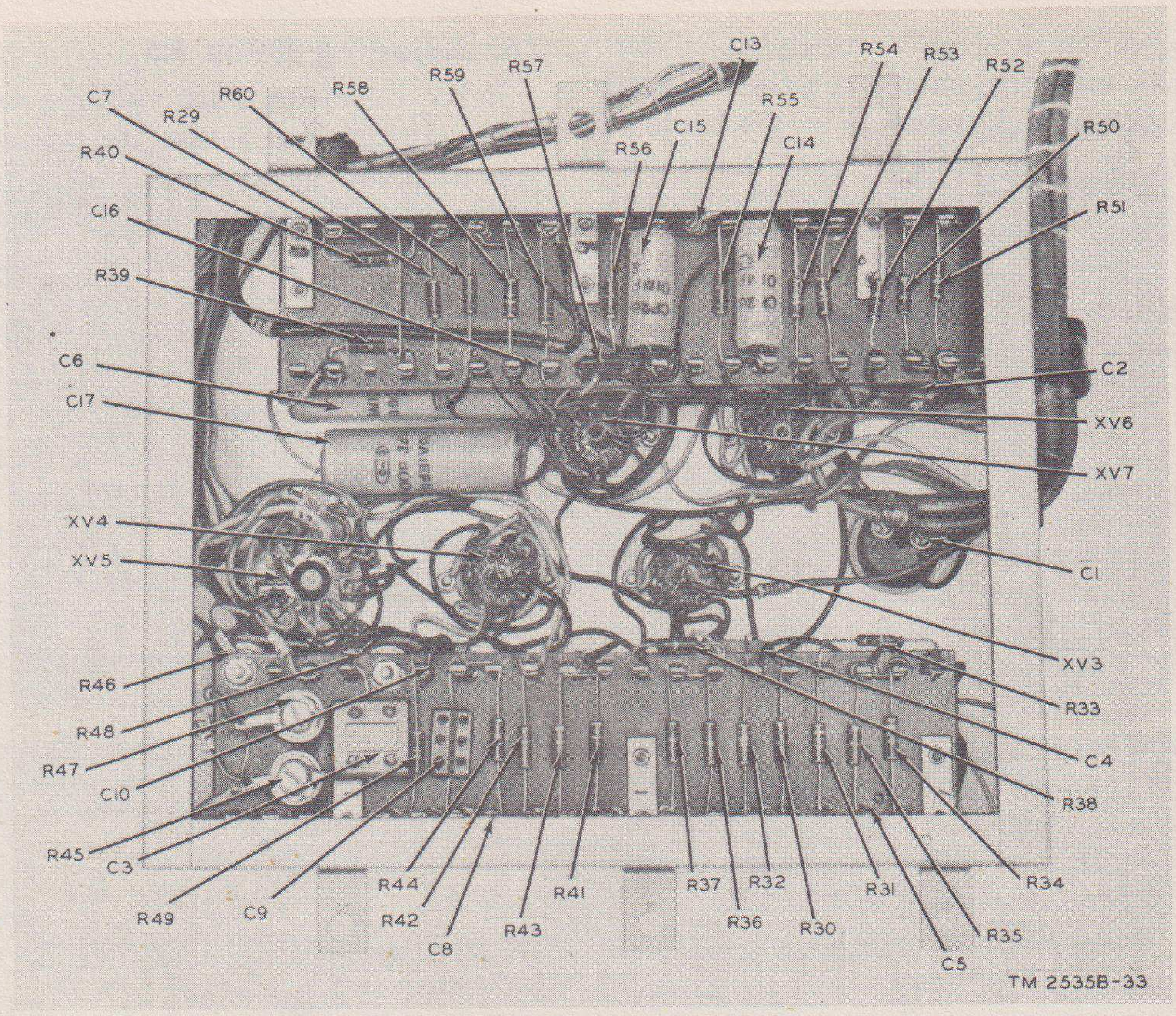


Figure 36. Ac meter amplifier chassis of test set, bottom view.

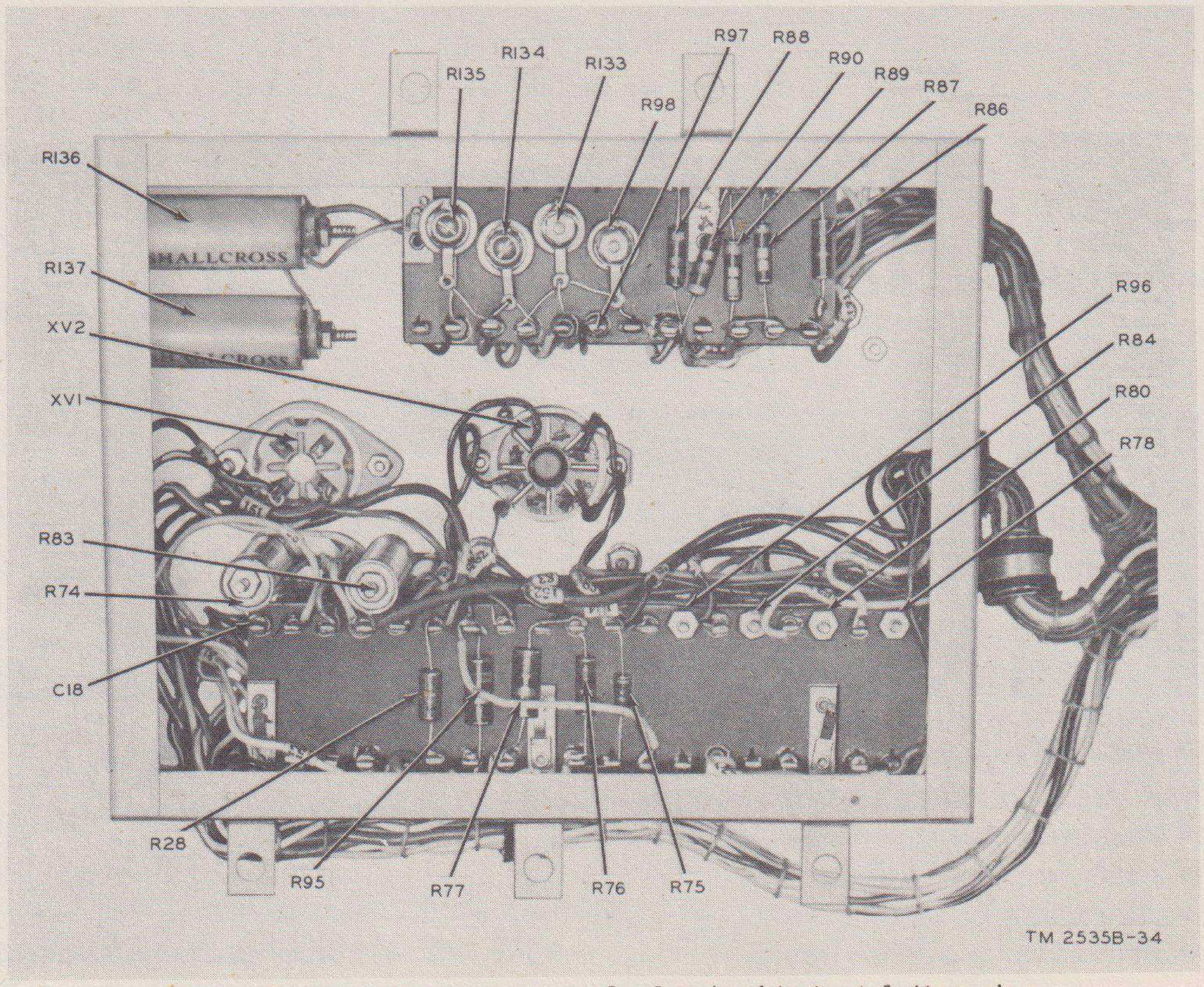


Figure 37. Dc voltage power supply chassis of test set, bottom view.

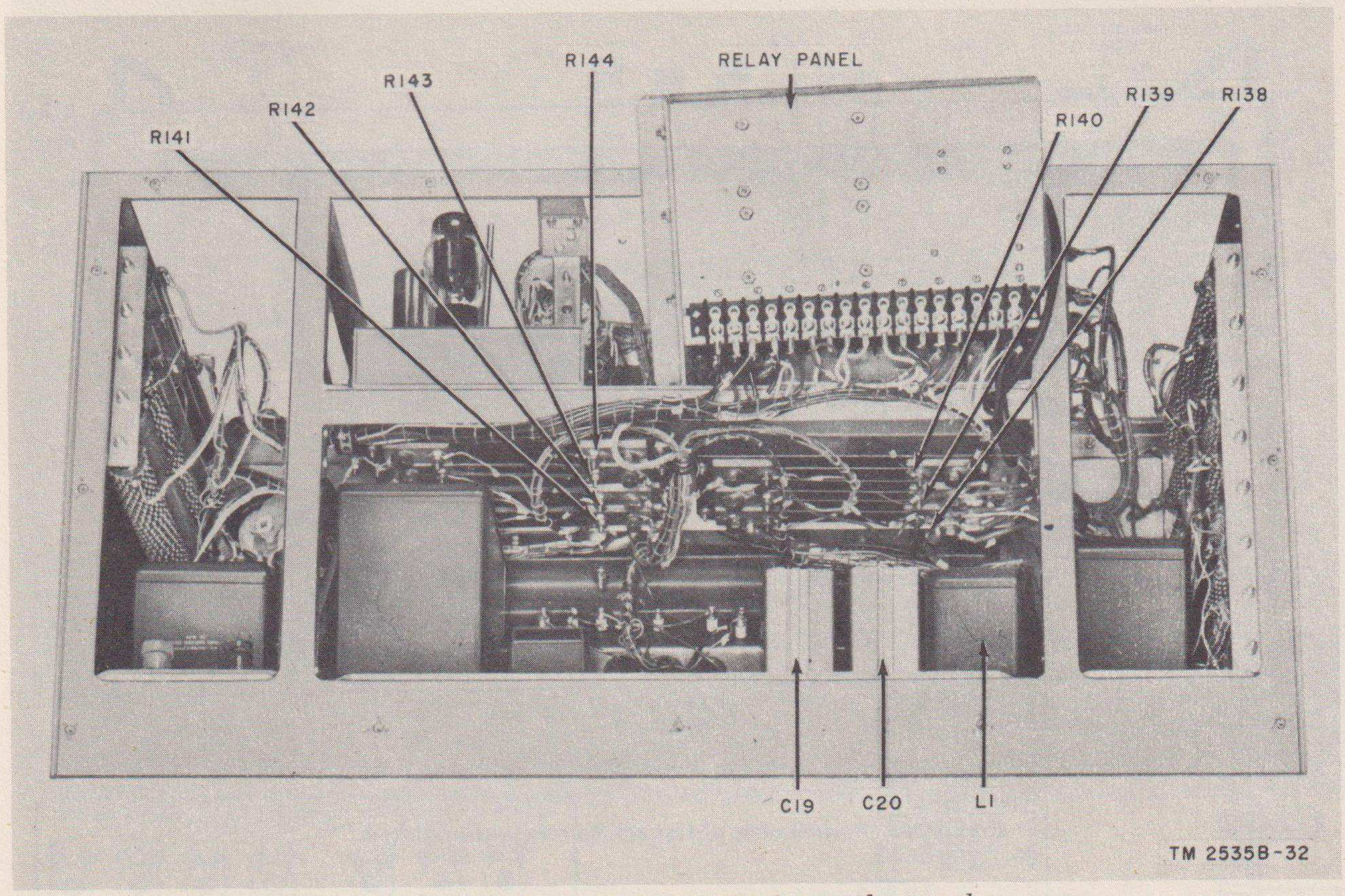


Figure 38. Rear of test set with relay panel removed.

e. Turn the DIRECT CURRENT COARSE CONTROL clockwise until the voltmeter reads 7 volts.

f. Adjust rheostat R70 to the point where relay K5 just closes. If relay K5 does not close with rheostate R70 fully clockwise, move the coarse adjustment (green) lead and the voltmeter lead to the lower tie point and adjust rheostat R70 again. If the adjustment still cannot be made, loosen the spring tension on relay K5 by bending the spring tang.

77. Inspecting and Removing Meter Shunts

Meter shunts R138 through R144 are located on the underside of the aluminum plate on which the amplifier chassis and power supply chassis are mounted (fig. 38). To inspect or remove any of these shunts, remove the relay panel and swing it up out of the way (par. 74).

Note. When removing transformers, tag each lead so that it will be replaced on the proper terminal when the part is replaced.

78. Removing Transformers

a. Transformers T1, T2, T4, T6, and T7. Transformers T1, T2, T4, T6, and T7 are mounted on the main chassis (fig. 39). To remove any one of these transformers, place the test set on one end, remove the bottom plate, remove the lug nuts and the wiring to each terminal, and remove the mounting nuts and bolts that secure the mounting brackets to the chassis.

b. Transformer T5. Transformer T5 is mounted on the power supply chassis (fig. 34). To remove this transformer, remove the power supply chassis (par. 73*b*), remove the four lug nuts and the mounting nuts and bolts located underneath the small resistor mounting board (fig. 37), and remove the transformer.

c. Transformer T3. Transformer T3, the ALT CURRENT-AC VOLTS-DC VOLTS FINE CONTROL, is located on the **U**-shaped portion of the front panel. To remove this transformer, follow the general directions for removing the output controls (par. 72*b*).

79. Refinishing

a. When painted finishes have been badly marred, retouch the surfaces if the bare parts are restricted to small areas (par. 39). If the dam-

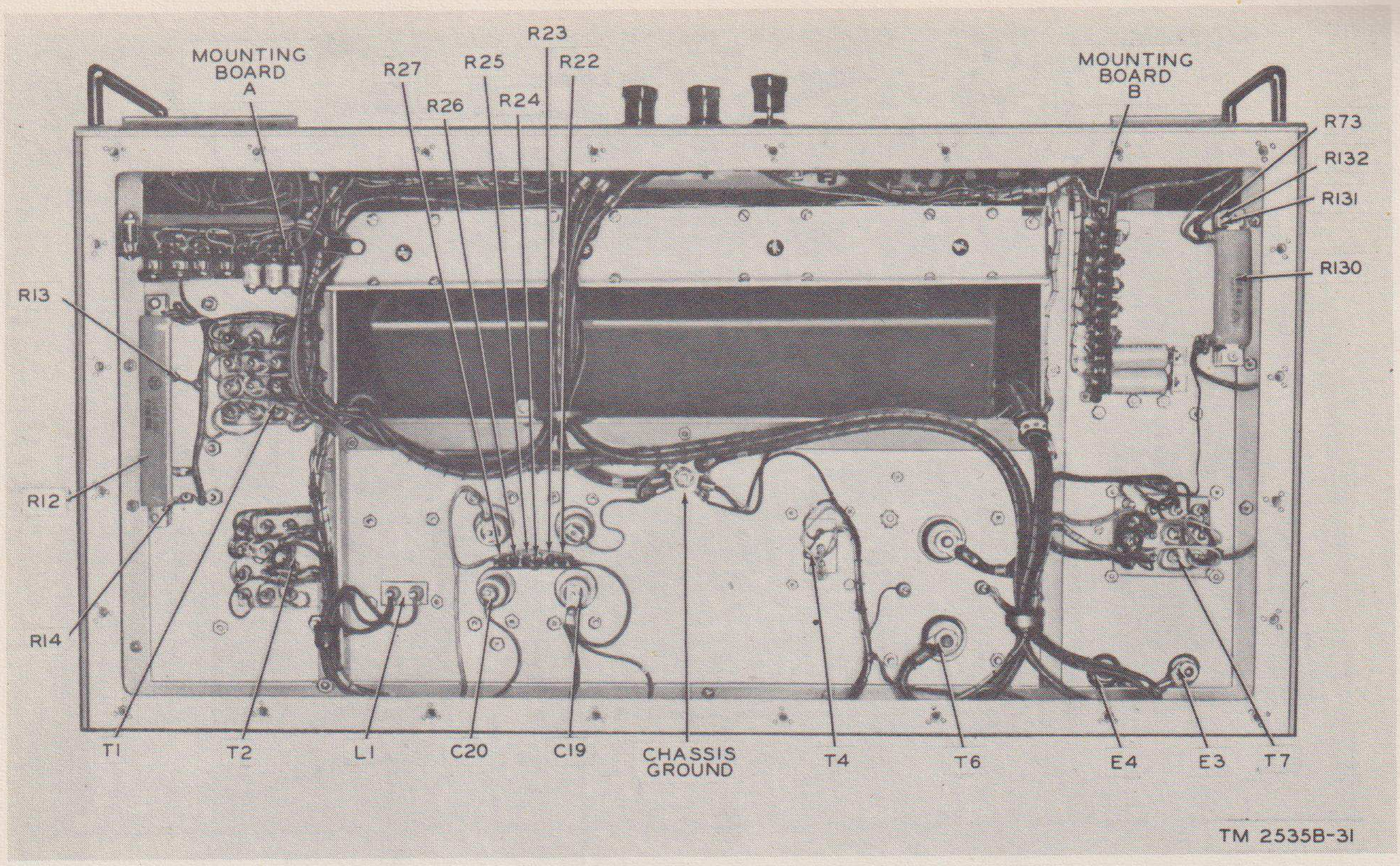


Figure 39. Bottom view of test set, bottom plate removed.

aged areas are large, however, refinish the entire case or the panels of the test set.

b. Use No. 000 sandpaper to clean painted metal surfaces down to the base metal. Refinish affected surfaces to match the original finish; apply one coat of enamel or paint. Remove paint from phenolic panels with a thinner, such as naphtha or gasoline, which will not attack the phenolic. Apply matching paint with a spray gun. Use authorized paint, consistent with existing regulations.

Caution: Gasoline is a volatile, inflammable liquid. Use only in the open air or in a well-ventilated room.

Section IV. FINAL TESTING

80. General

After the test set has been repaired, check it for satisfactory operation. The test should be performed by experienced maintenance personnel provided with adequate test equipment. A repaired test set which meets test requirements is capable of performance equal to that of new equipment.

81. Test Equipment Required for Final Testing

The test equipment required for final testing is Electrical Meter Standards AN/GSN-4. The AN/GSN-4 has the standards necessary to check the accuracy of the test set.

82. Procedure for Final Testing

Checking the test set for accuracy on the various ranges requires that the outputs as indicated on all the meters be checked against laboratory standard current and voltage measuring equipment of .1 percent accuracy or better. Operate the test set as described in paragraphs 17 through 24, using the measuring equipment (par. 81) as external standards. Check all ranges on all points shown on the calibration data charts.

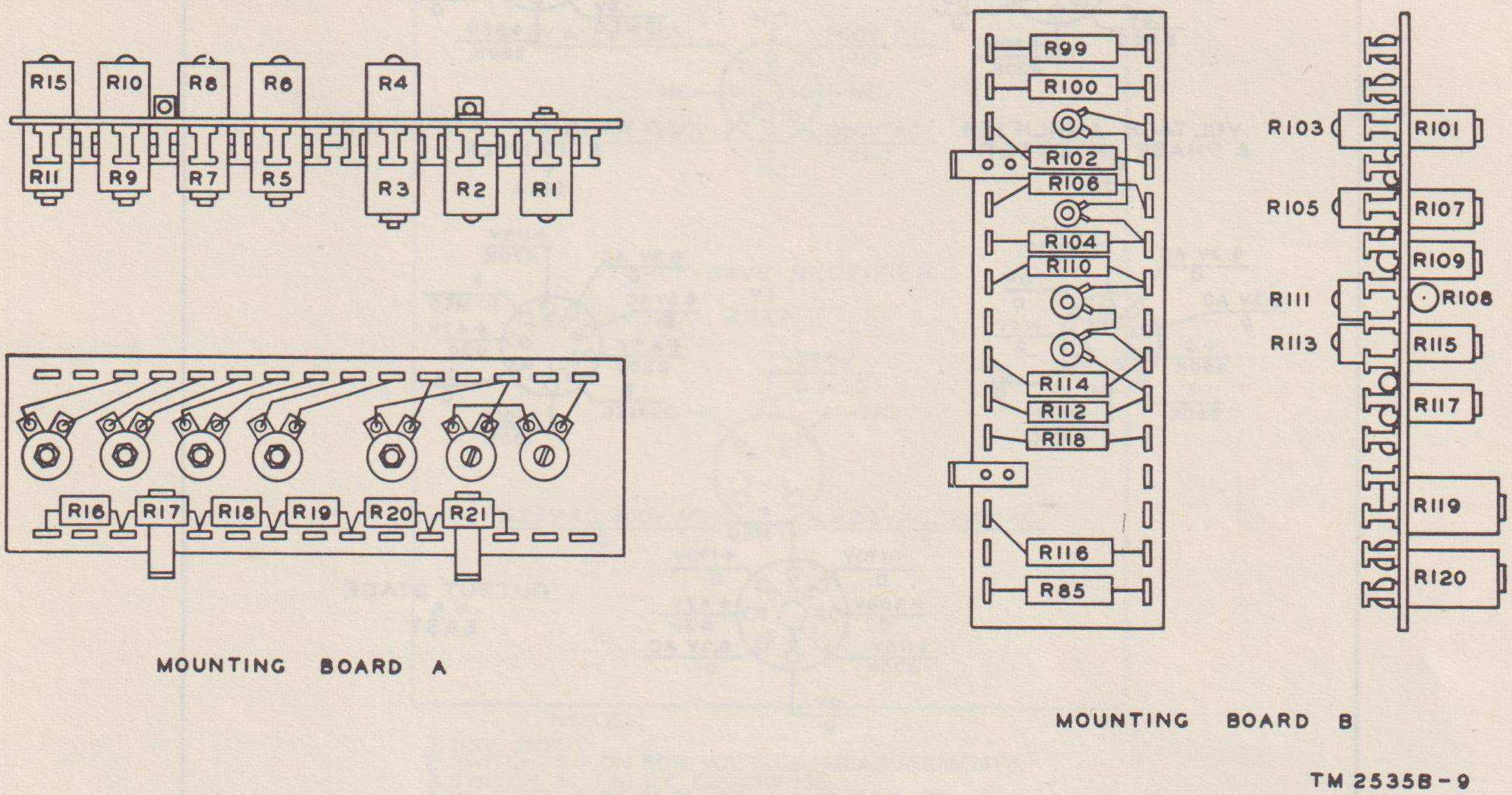
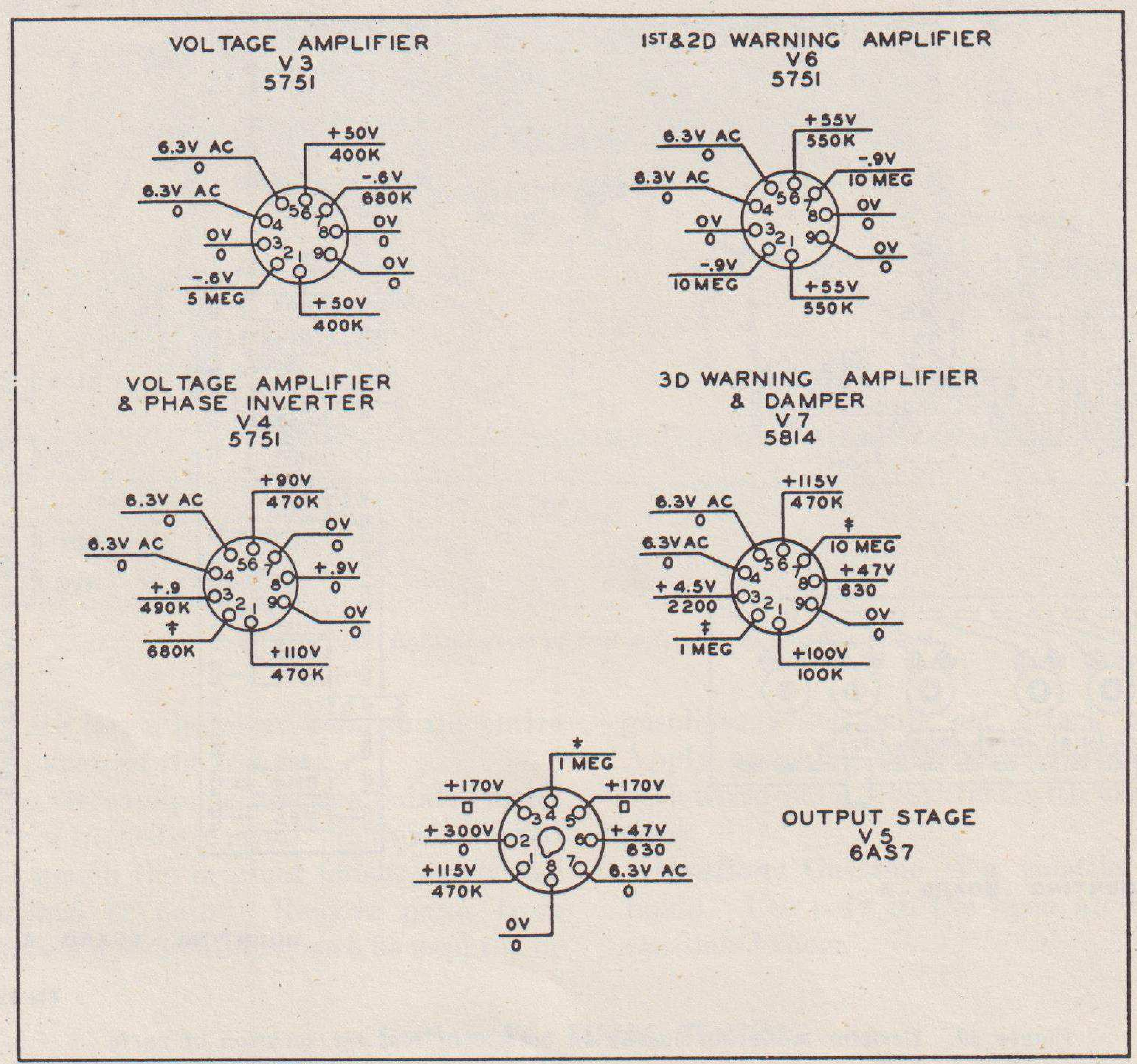
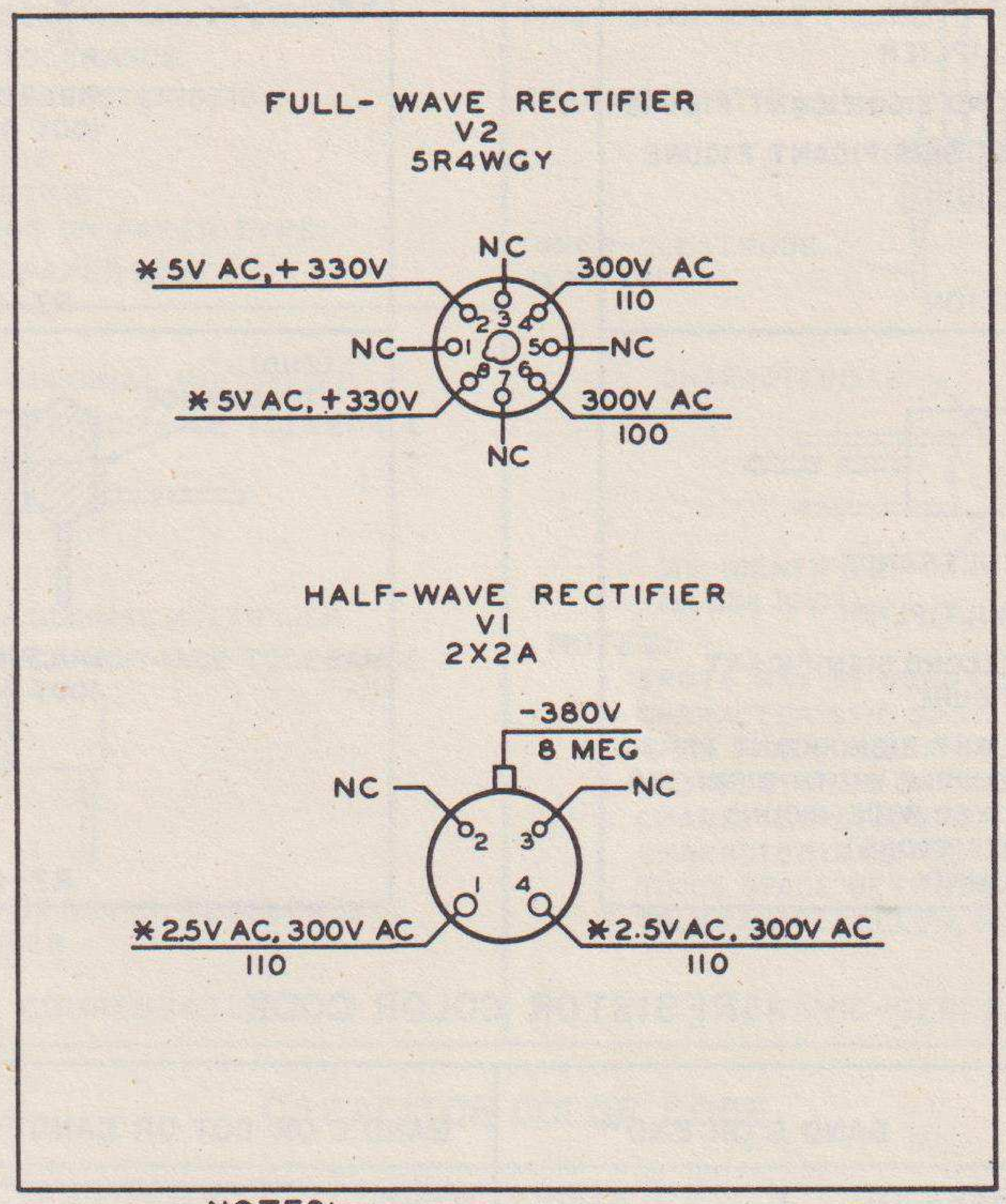


Figure 40. Resistor mounting boards on bottom of test set, location of parts.



NOTES:
1. 115V INPUT.
2. SWITCH S4 ON FOR VOLTAGE MEASUREMENTS.
3. SWITCH S1 FULLY CLOCKWISE.
4. VOLTAGE & RESISTANCE MEASURED TO GROUND WITH A VTVM.
5. NC INDICATES NO CONNECTION.
6. ‡ INDICATES A SLIGHT POSITIVE OR NEGATIVE VOLTAGE.
7. VOLTAGE READINGS ABOVE LINE RESISTANCE READINGS BELOW LINE.
8. FOR RESISTANCE MEASUREMENTS, GROUND JUNCTION OF R39 & R40 & POSITIVE TERMINAL OF C1.
9. ◻ INDICATES HIGH VALUE, AFFECTED BY CAPACITORS IN THE CIRCUIT.

Figure 41. Amplifier chassis, tube socket voltage and resistance diagram.



NOTES:

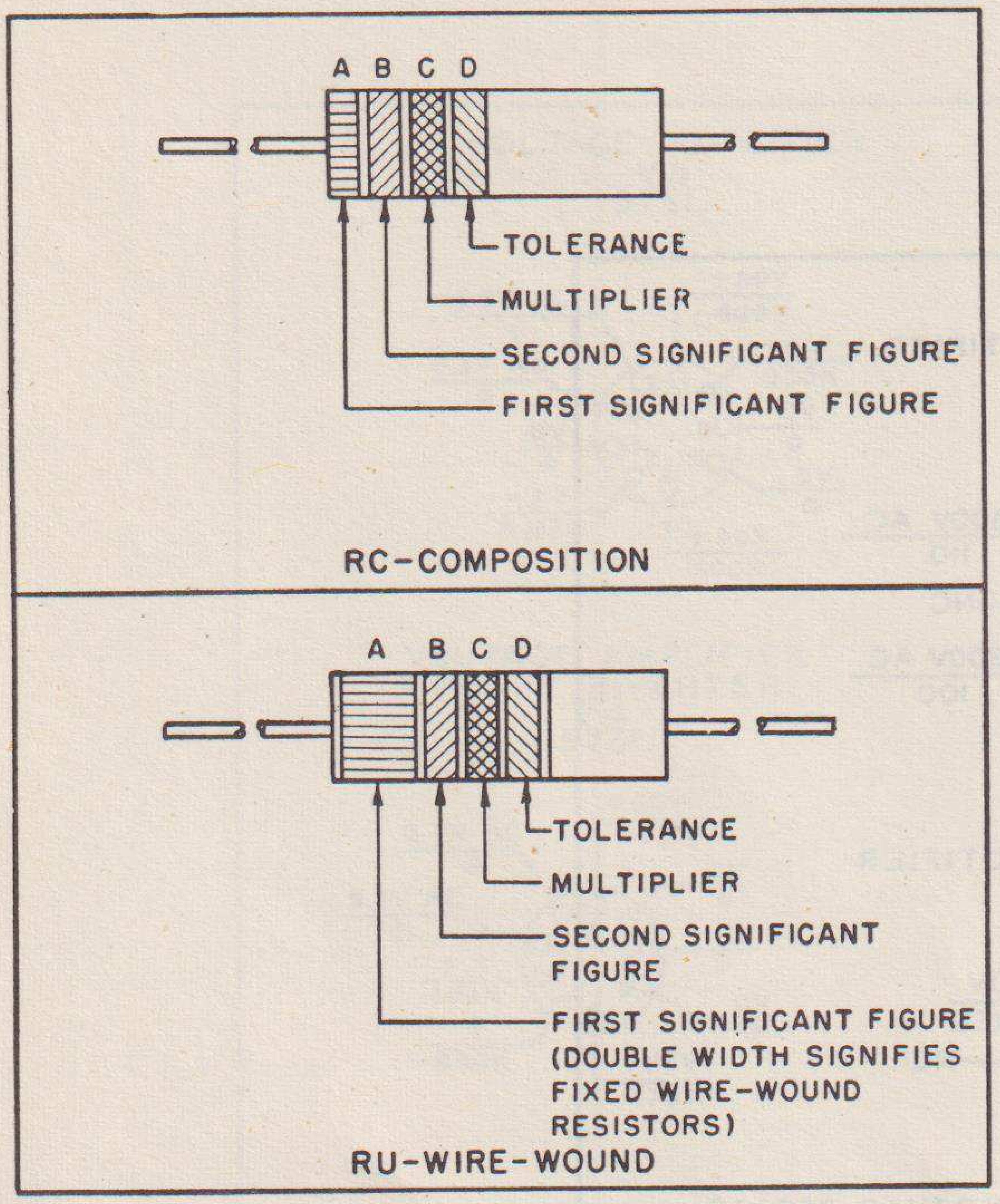
1. 115V INPUT.
2. SWITCH S4 ON FOR VOLTAGE MEASUREMENTS.
3. SWITCH S1 FULLY CLOCKWISE.
4. VOLTAGE & RESISTANCE MEASURED TO GROUND WITH A VTVM.
5. NC INDICATES NO CONNECTION.
6. *INDICATES MEASUREMENTS ACROSS FILAMENTS.
7. VOLTAGE READINGS ABOVE LINE RESISTANCE READINGS BELOW LINE.

TM 2535B-36

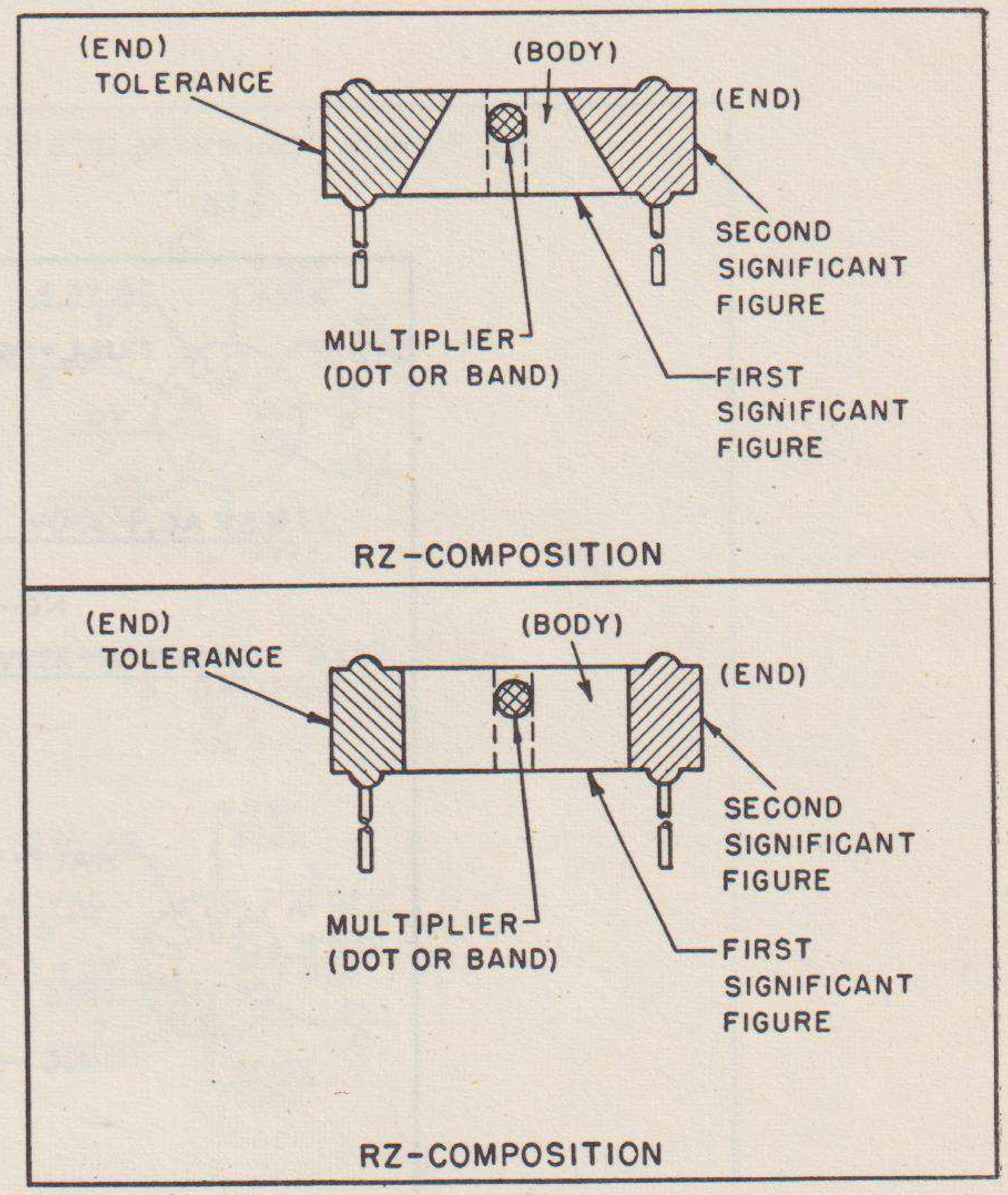
Figure 42. Power supply chassis, tube socket voltage and resistance diagram.

RESISTOR COLOR CODE MARKING
(MIL-STD RESISTORS)

AXIAL-LEAD RESISTORS (INSULATED)



RADIAL-LEAD RESISTORS (UNINSULATED)



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.

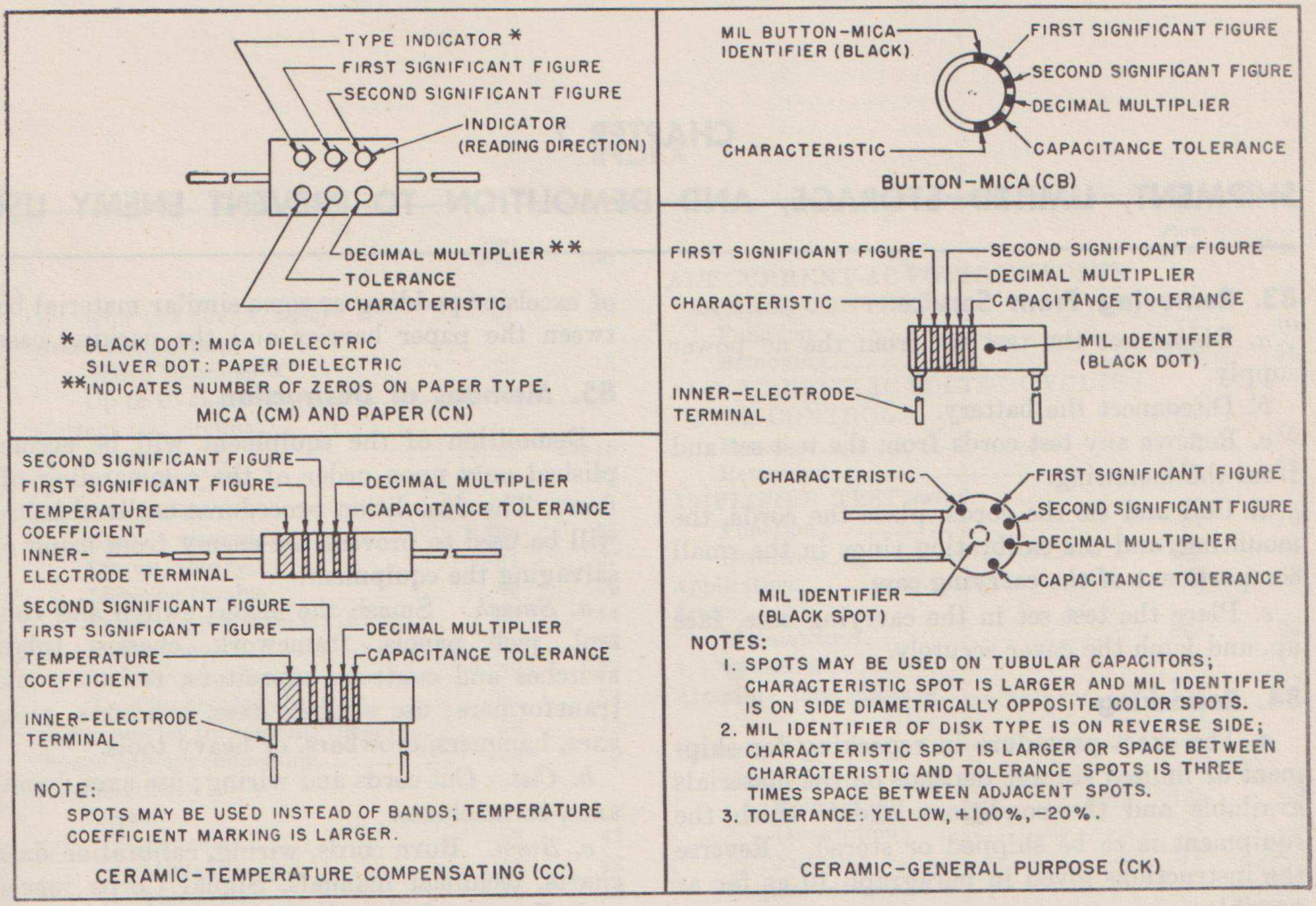
EXAMPLES (BAND MARKING):
10 OHMS ±20 PERCENT: BROWN BAND A; BLACK BAND B; BLACK BAND C; NO BAND D.
4.7 OHMS ±5 PERCENT: YELLOW BAND A; PURPLE BAND B; GOLD BAND C; GOLD BAND D.

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 43. Resistor color codes.

CAPACITOR COLOR CODE MARKING
(MIL-STD CAPACITORS)



CAPACITOR COLOR CODE

COLOR	SIG FIG.	MULTIPLIER: DECIMAL	MULTIPLIER: NUMBER OF ZEROS	CHARACTERISTIC[1]: CM	CHARACTERISTIC[1]: CN	CHARACTERISTIC[1]: CB	CHARACTERISTIC[1]: CK	TOLERANCE[2]: CM	TOLERANCE[2]: CN	TOLERANCE[2]: CB	TOLERANCE[2]: CC OVER 10UUF	TOLERANCE[2]: CC 10UUF OR LESS	TEMPERATURE COEFFICIENT (UUF/UF/°C) 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-C1

Figure 44. Capacitor color codes.

CHAPTER 7

SHIPMENT, LIMITED STORAGE, AND DEMOLITION TO PREVENT ENEMY USE

83. Removing From Service

a. Disconnect the test set from the ac power supply.

b. Disconnect the battery.

c. Remove any test cords from the test set and from the mounting.

d. Coil and tie the cords, place the cords, the mounting, and the calibration rings in the small compartment of the carrying case.

e. Place the test set in the carrying case, face up, and latch the cover securely.

84. Repacking

a. The exact procedure in repacking for shipment or limited storage depends on the materials available and the conditions under which the equipment is to be shipped or stored. Reverse the instructions given in paragraph 10 as far as possible.

b. Whenever practicable, place a desiccant, such as silica gel, inside the inner box. Protect the box with a waterproof paper barrier. Seal the seams of the paper barrier with waterproof sealing compound or tape. Pack the protected inner box in a padded packing case, providing at least 3 inches of excelsior padding or some similar material between the paper barrier and the packing case.

85. Methods of Destruction

Demolition of the equipment will be accomplished only upon order of the commanding officer. The demolition procedures outlined below will be used to prevent the enemy from using or salvaging the equipment.

a. Smash. Smash the meter, switch and control, jack panels, framework, chassis, tubes, switches and controls, capacitors, resistors, and transformers; use sledges, axes, handaxes, pickaxes, hammers, crowbars, or heavy tools.

b. Cut. Cut cords and wiring; use axes, handaxes, or machetes.

c. Burn. Burn cords, wiring, calibration data charts, technical manuals, Signal Corps forms, and office records; use gasoline, kerosene, oil, flame throwers, or incendiary grenades.

d. Bend. Bend panels, case, and chassis.

e. Disposal. Burn or scatter the destroyed parts in slit trenches, foxholes, or other holes, or throw into streams.

f. Destroy. Destroy everything.

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Dc	55	34
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Ac	59	43
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Organizational maintenance	32c	18
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Field maintenance	62b	46
Organizational maintenance	48	25
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Procedures:		
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Description	7b	5
Function	3, 7a	2, 5
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Field maintenance	66a	47
Organizational maintenance	46c	24
Testing:		
Ammeters:		
Above 10 amperes:		
Ac	22	15
Dc	24	16

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Dc	23	15
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Dc	20	13
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Checking	66*i*	48
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Tropical:		
Maintenance	38*b*	20
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Chart, field maintenance	68	49
Field maintenance:		
Checking circuit parts	66	47
Data	63	46
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Procedures	61	46
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Inspection:		
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Visual	44	24
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TM 11–2535B/TO 33A1–3–4–11 METER TEST SET TS–682A/GSM–1—1955

RAMMELOO

METER TEST SET TS-628A/GSM-1

TM 11-2535B
TO 33A1-3-5-1
CHANGES No. 1

DEPARTMENTS OF THE ARMY
AND THE AIR FORCE
WASHINGTON 25, D.C., *9 January 1959*

TM 11-2535B, 6 July 1955, is changed as follows:

Page 40, figure 25. Change the value of resistor R118 from "7500" to 7.5.

Page 60, paragraph 81, lines 2 and 3. Change "AN/GSN-4" to AN/GSM-4.

Page 66, figure 45 (fold-out). In the RELAY UNIT at the top of the schematic diagram, change the value of resistors R61A, R61B, R61C, and R61D from "4700" to 4.7.

Change the value of resistor R188, located at the right hand side, from "7500" to 7.5.

[AG 413.6 (9 Dec 58)]

BY ORDER OF THE SECRETARIES OF THE ARMY AND THE AIR FORCE:

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Sector Comd, USA Corps (Res) (1)
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Units organized under following
  TOE's:
  5-278 (2)
  11-7 (2)
  11-15 (2)
  11-16 (2)
  11-57 (2)
  11-500 (AA-AE) (2)
  11-557 (2)
  11-587 (2)
  11-592 (2)
  11-597 (2)
  55-56 (2)

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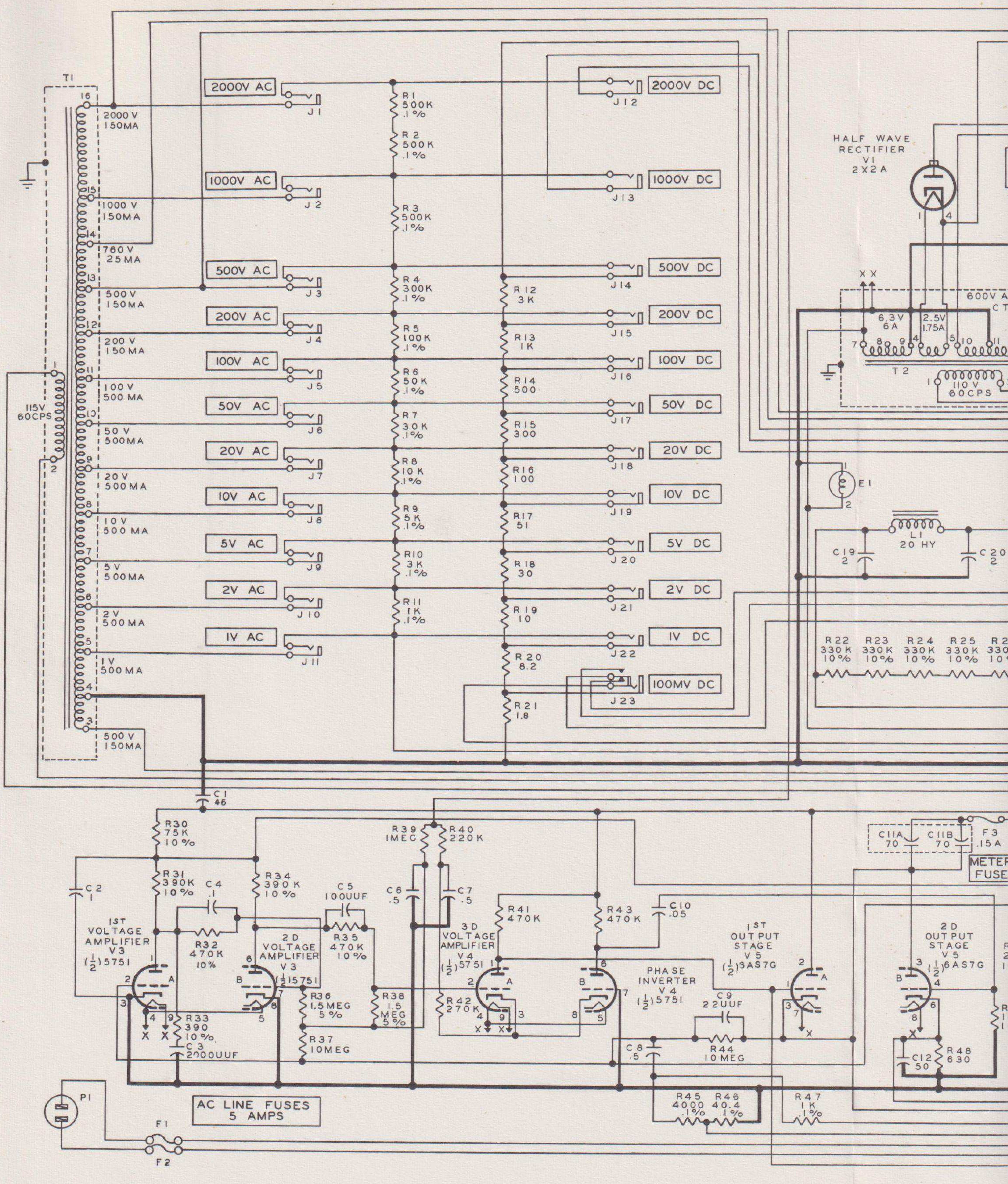
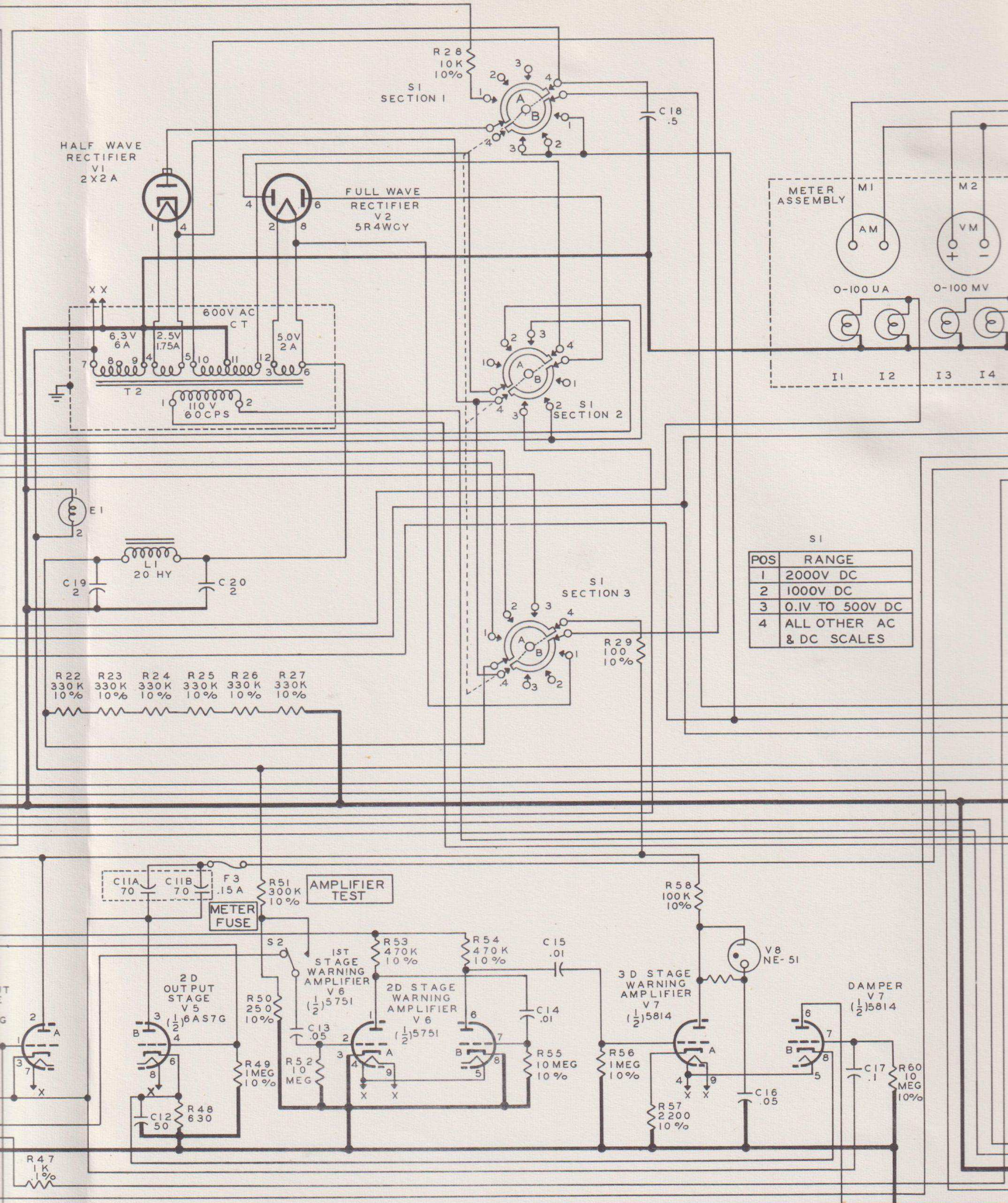


T1
115V 60CPS
2000 V 150MA
1000 V 150MA
760 V 25MA
500 V 150MA
200 V 150MA
100 V 500 MA
50 V 500MA
20 V 500MA
10 V 500 MA
5 V 500MA
2 V 500MA
1 V 500MA
500 V 150MA
2000V AC
1000V AC
500V AC
200V AC
100V AC
50V AC
20V AC
10V AC
5V AC
2V AC
1V AC
J1
J2
J3
J4
J5
J6
J7
J8
J9
J10
J11
R1 500K .1%
R2 500K .1%
R3 500K .1%
R4 300K .1%
R5 100K .1%
R6 50K .1%
R7 30K .1%
R8 10K .1%
R9 5K .1%
R10 3K .1%
R11 1K .1%
R12 3K
R13 1K
R14 500
R15 300
R16 100
R17 51
R18 30
R19 10
R20 8.2
R21 1.8
2000V DC
1000V DC
500V DC
200V DC
100V DC
50V DC
20V DC
10V DC
5V DC
2V DC
1V DC
100MV DC
J12
J13
J14
J15
J16
J17
J18
J19
J20
J21
J22
J23
HALF WAVE RECTIFIER V1 2X2A
XX
600V A
CT
6.3V 6A
2.5V 1.75A
T2
110 V 60CPS
E1
L1 20 HY
C19 2
C20 2
R22 330K 10%
R23 330K 10%
R24 330K 10%
R25 330K 10%
C1 46
R30 75K 10%
C2 1
R31 390K 10%
C4 .1
R32 470K 10%
1ST VOLTAGE AMPLIFIER V3 (1/2)5751
R33 390 10%
C3 2000UUF
R34 390K 10%
2D VOLTAGE AMPLIFIER V3 (1/2)5751
C5 100UUF
R35 470K 10%
R36 1.5MEG 5%
R37 10MEG
R38 1.5 MEG 5%
R39 1MEG
R40 220K
C6 .5
C7 .5
R41 470K
3D VOLTAGE AMPLIFIER V4 (1/2)5751
R42 270K
R43 470K
C10 .05
PHASE INVERTER V4 (1/2)5751
C9 22UUF
R44 10MEG
C8 .5
1ST OUTPUT STAGE V5 (1/2)6AS7G
R45 4000 .1%
R46 40.4 .1%
R47 1K .1%
C11A 70
C11B 70
F3 .15A
METER FUSE
2D OUTPUT STAGE V5 (1/2)6AS7G
C12 50
R48 630
P1
F1
F2
AC LINE FUSES 5 AMPS



S1

POS	RANGE
1	2000V DC
2	1000V DC
3	0.1V TO 500V DC
4	ALL OTHER AC & DC SCALES

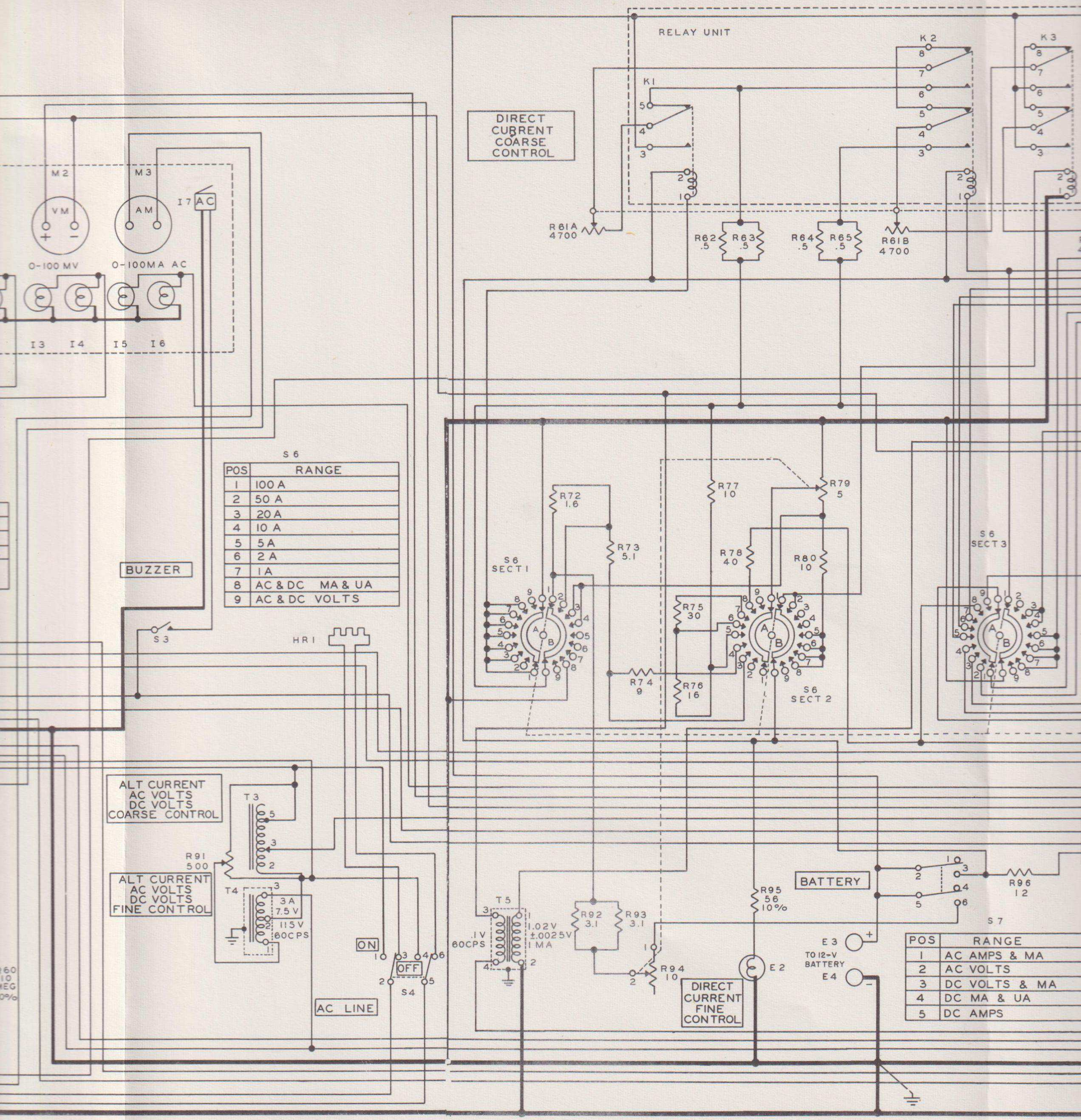
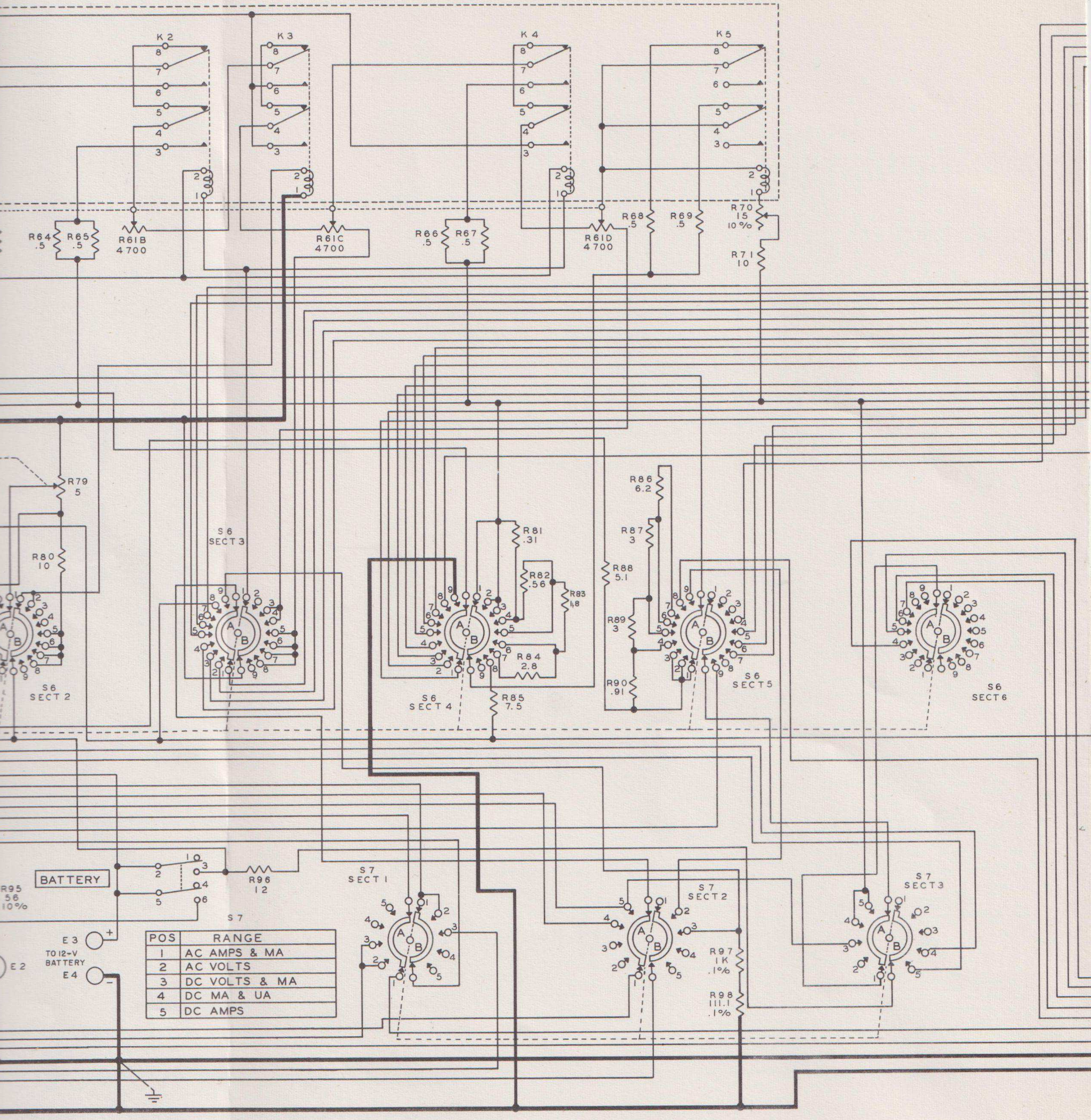
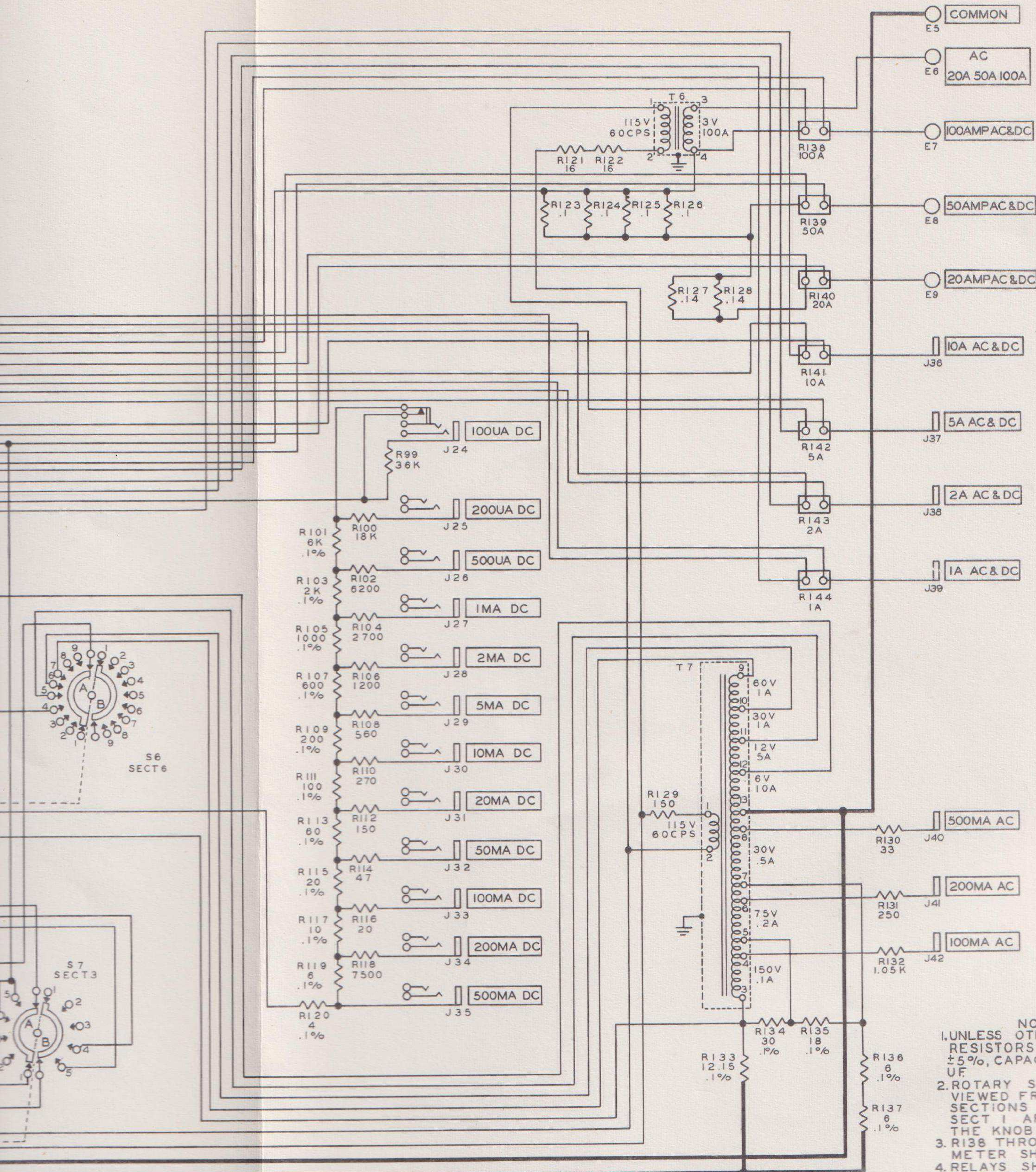


Figure 45. Test set, schematic diagram.



S7

POS	RANGE
1	AC AMPS & MA
2	AC VOLTS
3	DC VOLTS & MA
4	DC MA & UA
5	DC AMPS

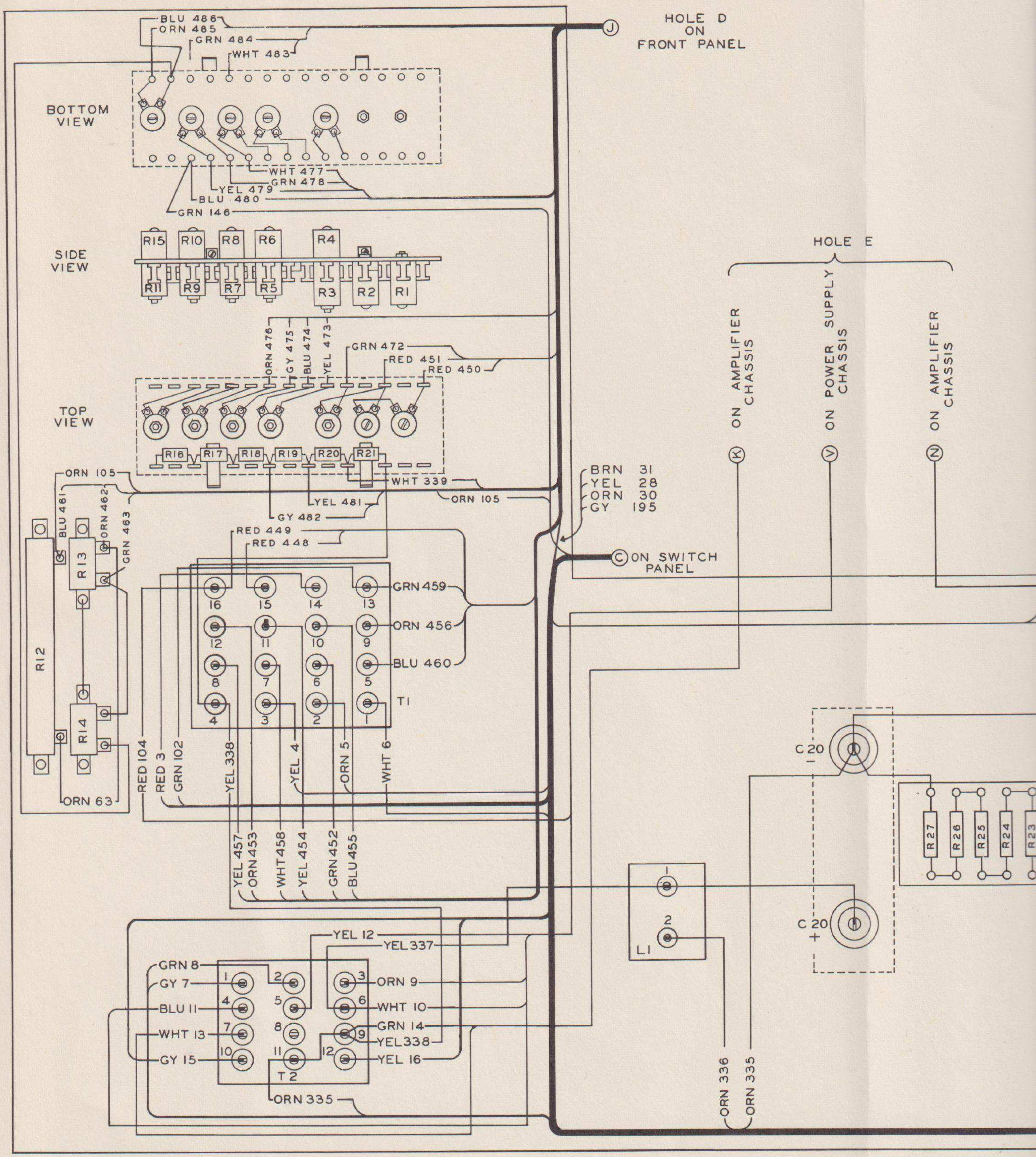


NOTES:

1. UNLESS OTHERWISE SHOWN RESISTORS ARE IN OHMS ±5%, CAPACITORS ARE IN UF.
2. ROTARY SWITCHES ARE VIEWED FROM THE FRONT. SECTIONS DESIGNATED SECT 1 ARE NEAREST THE KNOB END.
3. R138 THROUGH R144 ARE METER SHUNTS.
4. RELAYS SHOWN IN DE-ENERGIZED POSITION.

TM 2535B-38

347335 O - 55 (Face p. 66) No. 1



HOLE D
ON
FRONT PANEL
BLU 486
ORN 485
GRN 484
WHT 483
BOTTOM
VIEW
WHT 477
GRN 478
YEL 479
BLU 480
GRN 146
SIDE
VIEW
R15
R10
R8
R6
R4
R11
R9
R7
R5
R3
R2
R1
ORN 476
GY 475
BLU 474
YEL 473
GRN 472
RED 451
RED 450
TOP
VIEW
R16
R17
R18
R19
R20
R21
ORN 105
WHT 339
ORN 105
YEL 481
GY 482
BRN 31
YEL 28
ORN 30
GY 195
BLU 461
ORN 462
GRN 463
R13
R12
R14
ORN 63
RED 449
RED 448
C ON SWITCH
PANEL
GRN 459
ORN 456
BLU 460
T1
RED 104
RED 3
GRN 102
YEL 338
YEL 4
ORN 5
WHT 6
YEL 457
ORN 453
WHT 458
YEL 454
GRN 452
BLU 455
HOLE E
ON AMPLIFIER
CHASSIS
ON POWER SUPPLY
CHASSIS
ON AMPLIFIER
CHASSIS
C 20
R 27
R 26
R 25
R 24
R 23
L1
YEL 12
YEL 337
GRN 8
GY 7
BLU 11
WHT 13
GY 15
ORN 9
WHT 10
GRN 14
YEL 338
YEL 16
T 2
ORN 335
ORN 336
ORN 335

F

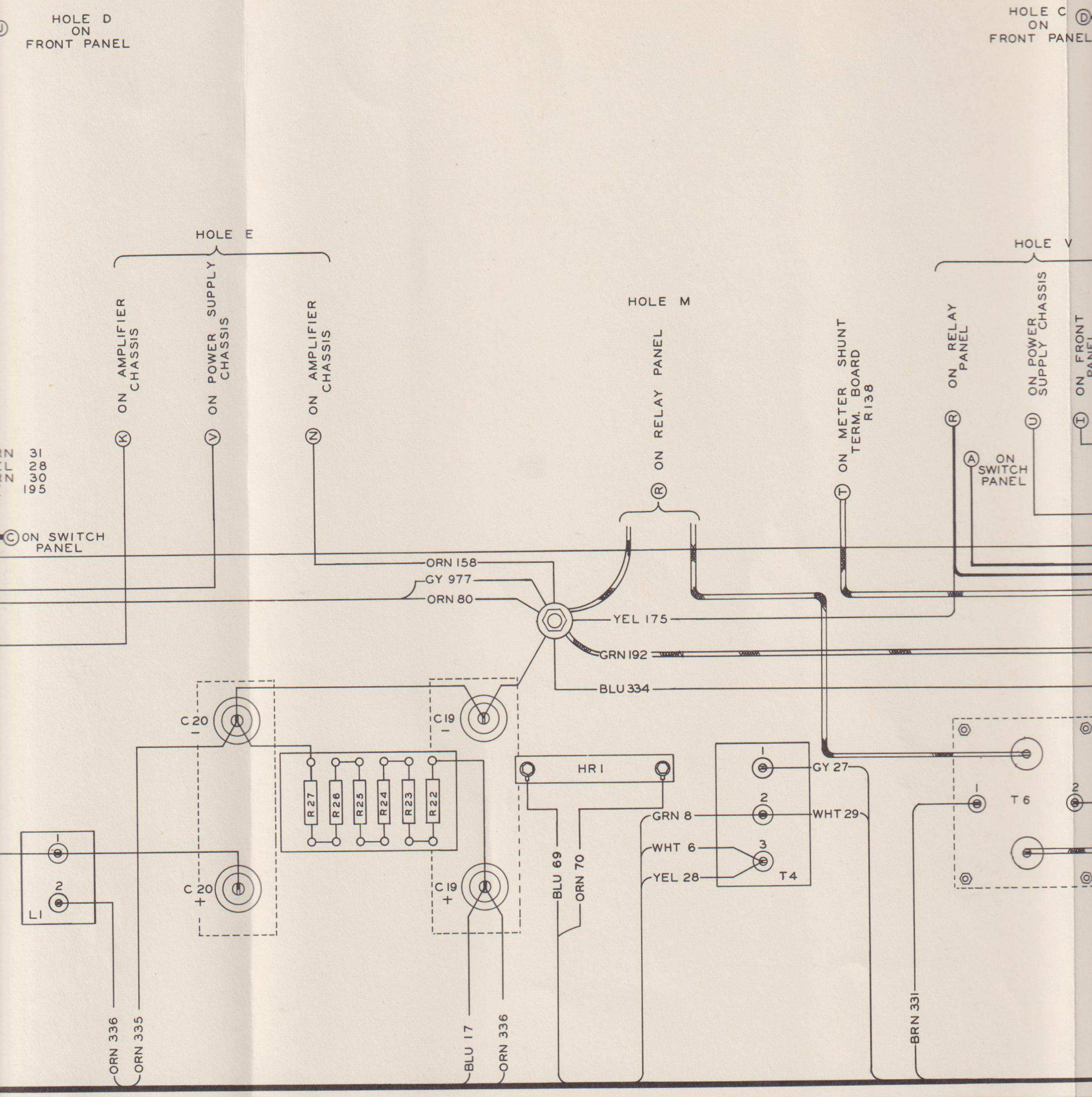
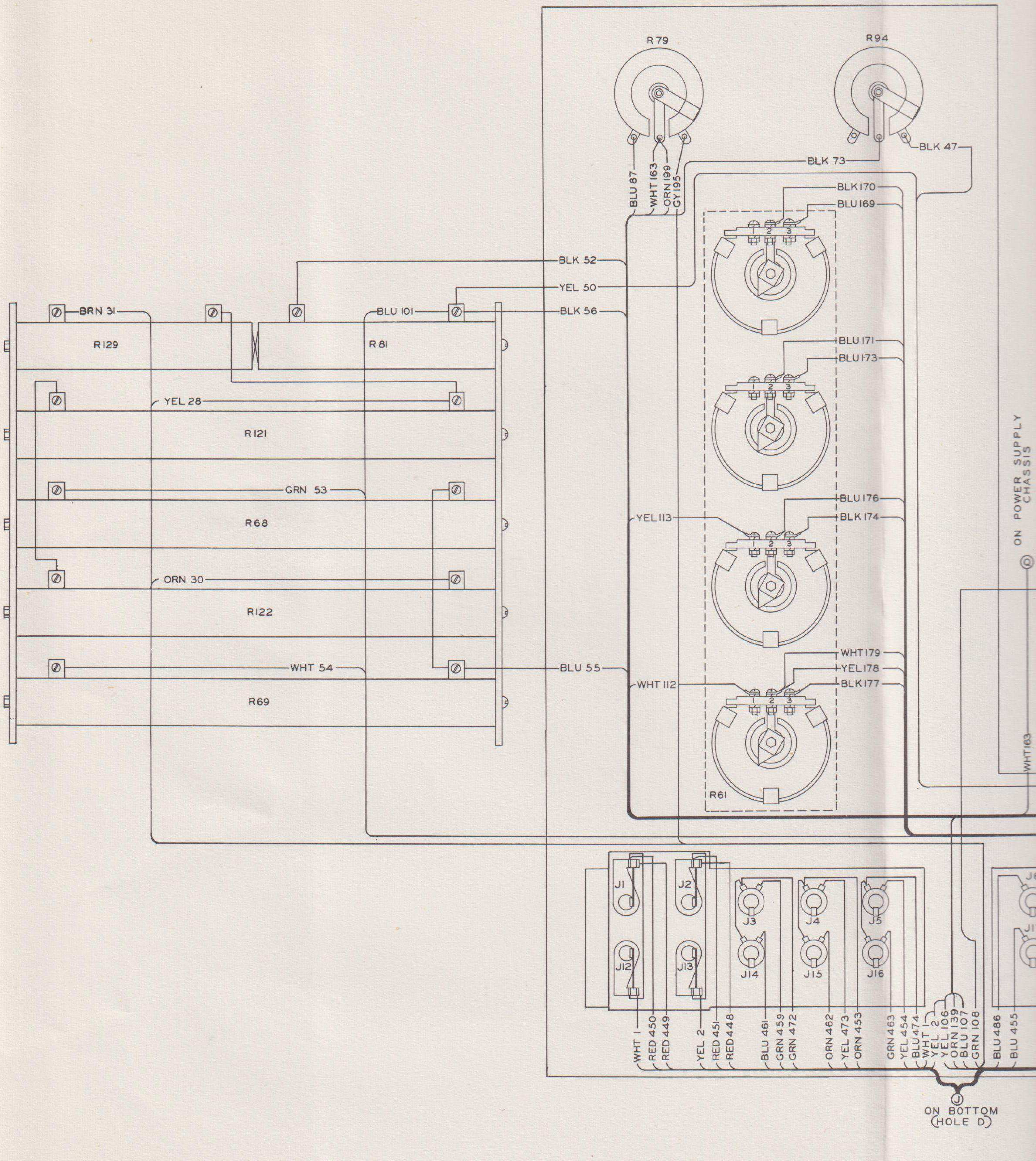


Figure 46. Bottom of test set, wiring diagram.

TM 2535B-39

347335 O - 55 (Face p. 66) No. 2


R79
R94
BLU 87
WHT 163
ORN 199
GY 195
BLK 73
BLK 47
BLK 170
BLU 169
BLK 52
YEL 50
BLK 56
BRN 31
BLU 101
R129
R81
YEL 28
R121
GRN 53
R68
ORN 30
R122
WHT 54
BLU 55
R69
BLU 171
BLU 173
BLU 176
BLK 174
YEL 113
WHT 179
YEL 178
BLK 177
WHT 112
R61
ON POWER SUPPLY CHASSIS
WHT 163
J1
J2
J3
J4
J5
J12
J13
J14
J15
J16
WHT 1
RED 450
RED 449
YEL 2
RED 451
RED 448
BLU 461
GRN 459
GRN 472
ORN 462
YEL 473
ORN 453
GRN 463
YEL 454
BLU 474
WHT 1
YEL 2
YEL 106
ORN 139
BLU 107
GRN 108
BLU 486
BLU 455
ON BOTTOM (HOLE D)

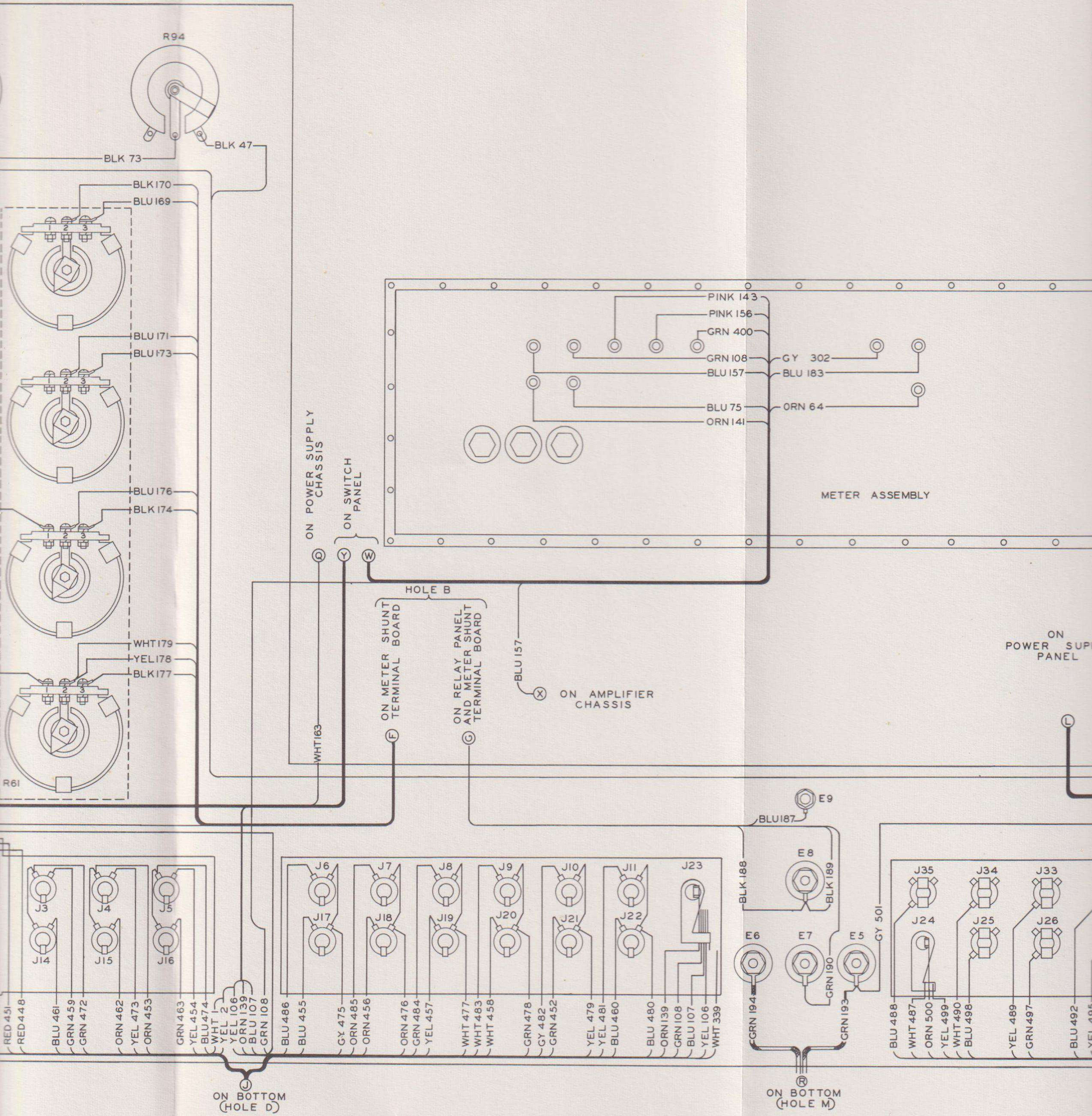


Figure 47. Front panel of test set, wiring diagram.

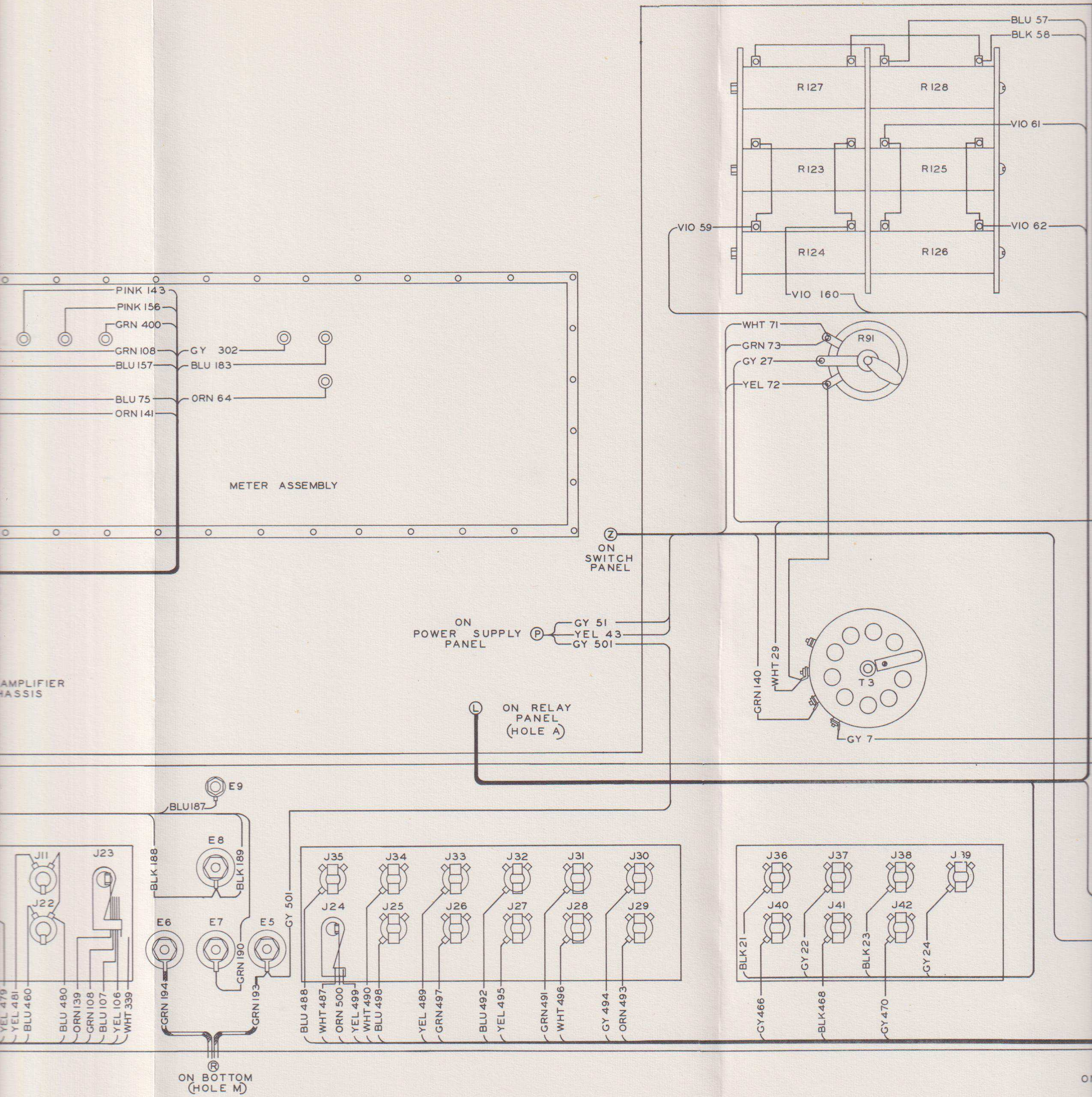
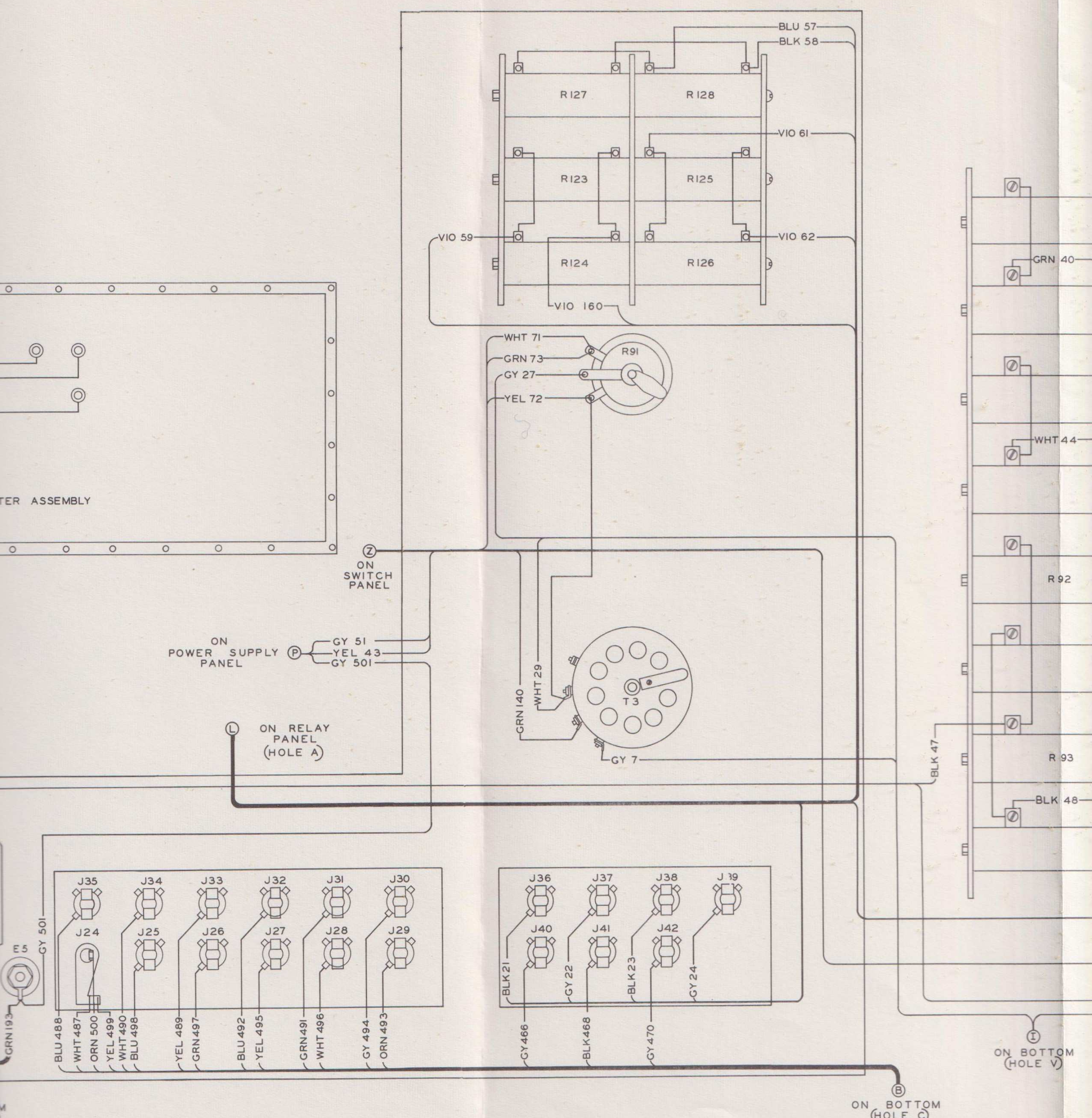
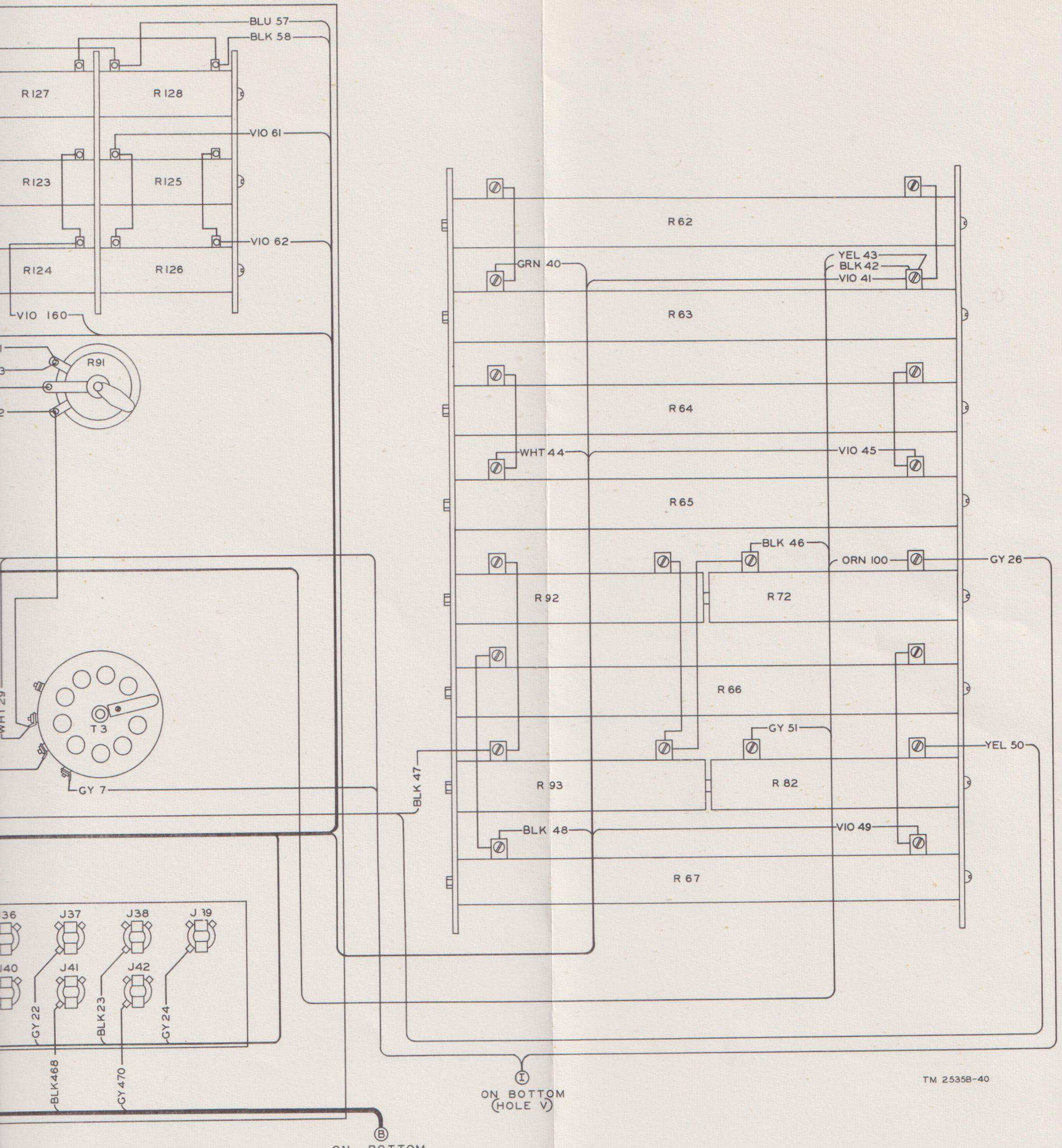
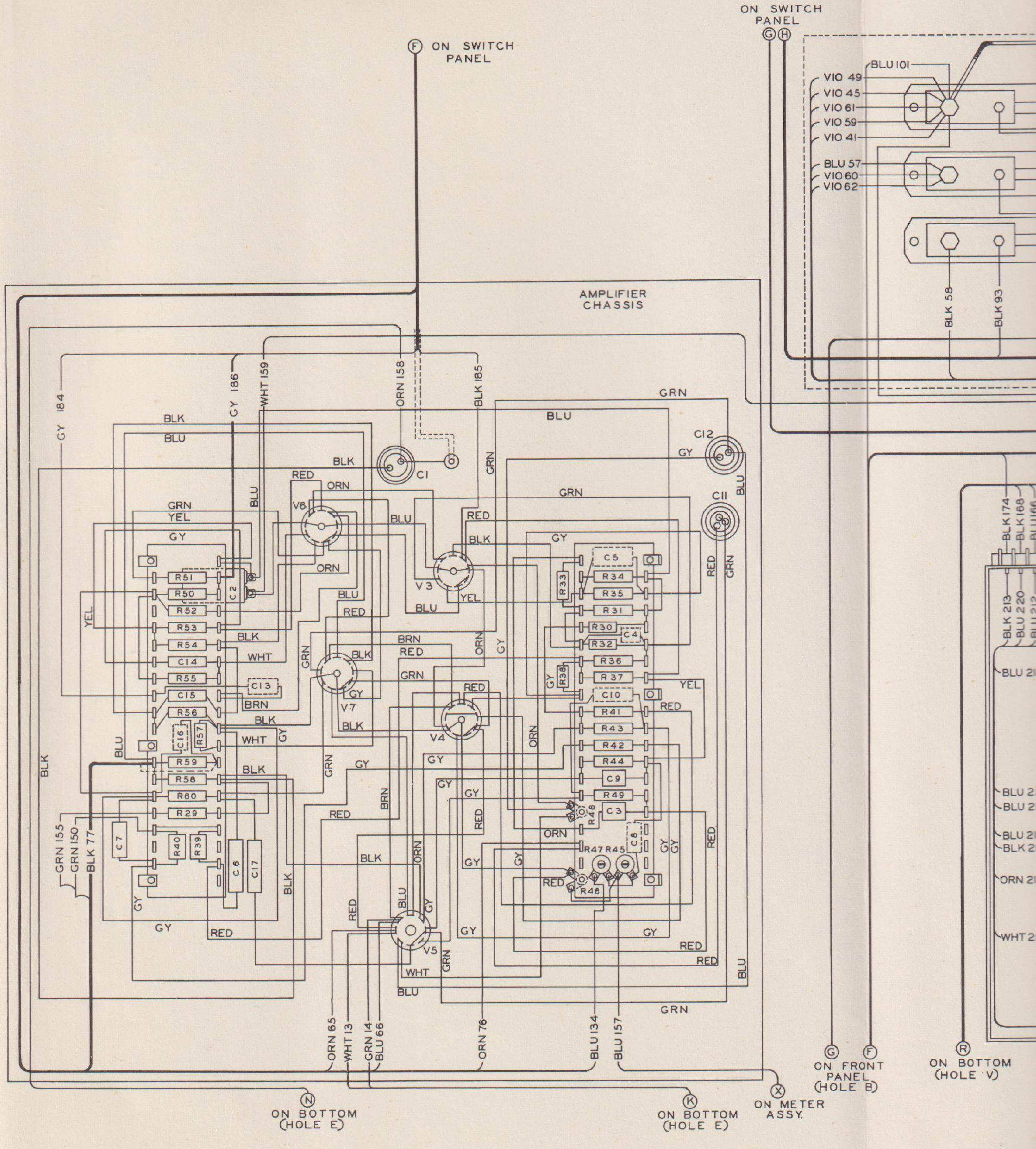


Figure 47. Front panel of test set, wiring diagram.



test set, wiring diagram.


BLU 57
BLK 58
R127
R128
VIO 61
R123
R125
VIO 62
R124
R126
VIO 160
R91
WHT 29
T3
GY 7
J36
J37
J38
J39
J40
J41
J42
GY 22
BLK 23
GY 24
BLK468
GY470
R62
YEL 43
BLK 42
VIO 41
GRN 40
R63
R64
WHT 44
VIO 45
R65
BLK 46
ORN 100
GY 26
R92
R72
R66
GY 51
YEL 50
BLK 47
R93
R82
BLK 48
VIO 49
R67
ON BOTTOM (HOLE V)
ON BOTTOM
TM 2535B-40



F ON SWITCH PANEL
ON SWITCH PANEL
G H
AMPLIFIER CHASSIS
VIO 49
VIO 45
VIO 61
VIO 59
VIO 41
BLU 101
BLU 57
VIO 60
VIO 62
BLK 58
BLK 93
GY 184
GY 186
WHT 159
ORN 158
BLK 185
C1
C2
C3
C4
C5
C6
C7
C8
C9
C10
C11
C12
C13
C14
C15
C16
C17
V3
V4
V5
V6
V7
R29
R30
R31
R32
R33
R34
R35
R36
R37
R38
R39
R40
R41
R42
R43
R44
R45
R46
R47
R48
R49
R50
R51
R52
R53
R54
R55
R56
R57
R58
R59
R60
GRN 155
GRN 150
BLK 77
ORN 65
WHT 13
GRN 14
BLU 66
ORN 76
BLU 134
BLU 157
BLK 174
BLK 168
BLK 213
BLU 220
N ON BOTTOM (HOLE E)
K ON BOTTOM (HOLE E)
X ON METER ASSY.
G ON FRONT PANEL (HOLE B)
F
R ON BOTTOM (HOLE V)

Figure

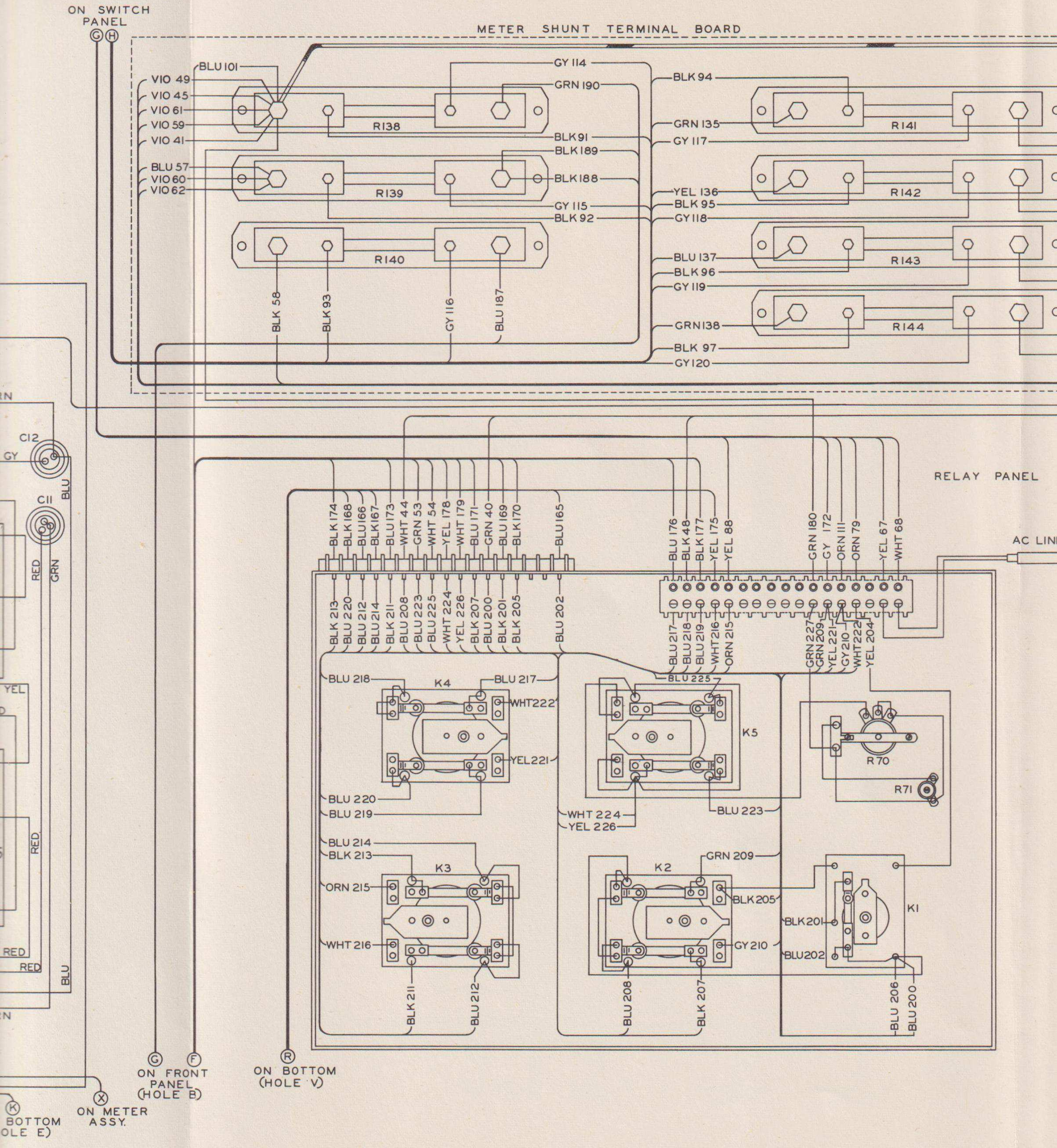
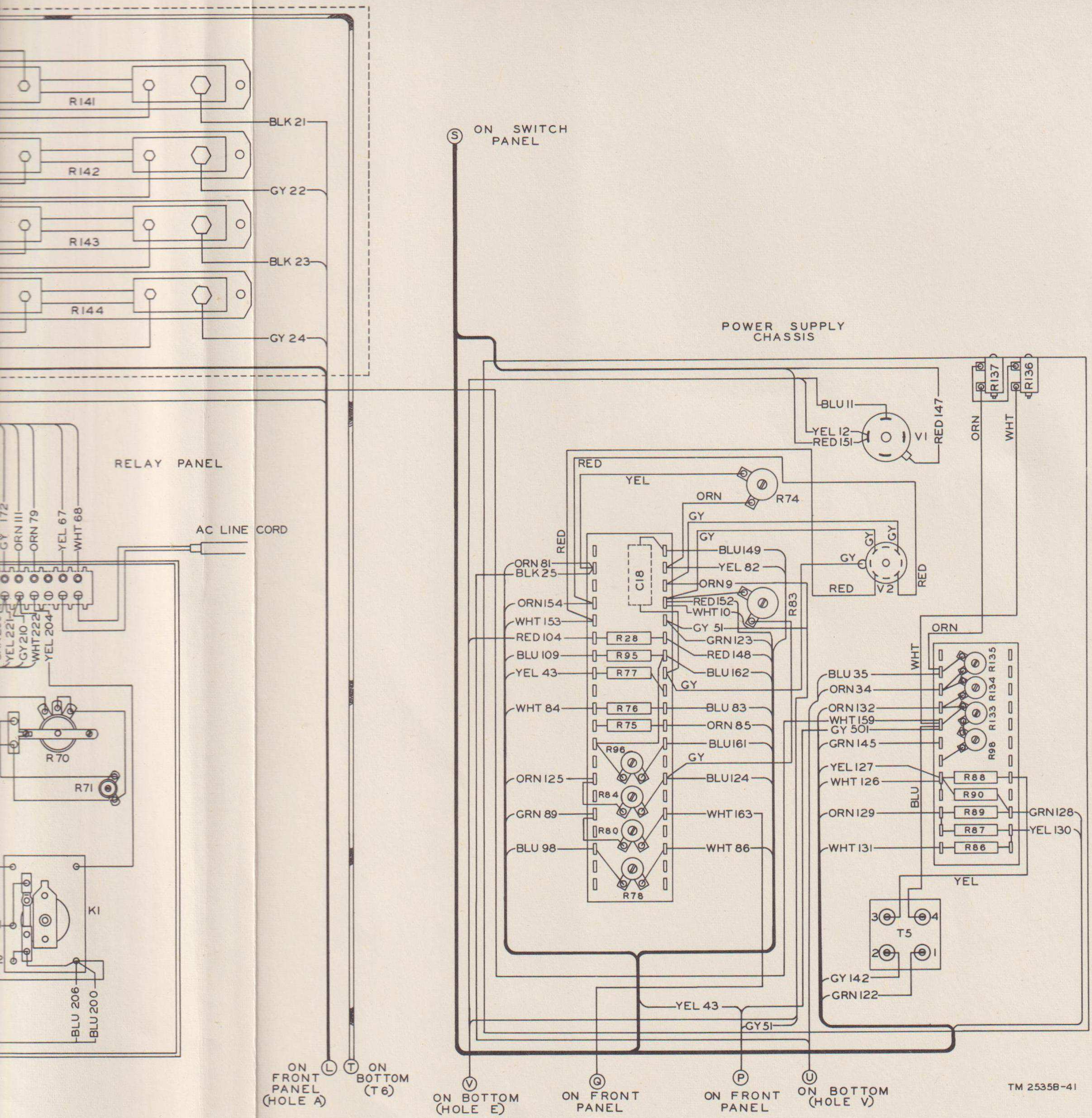
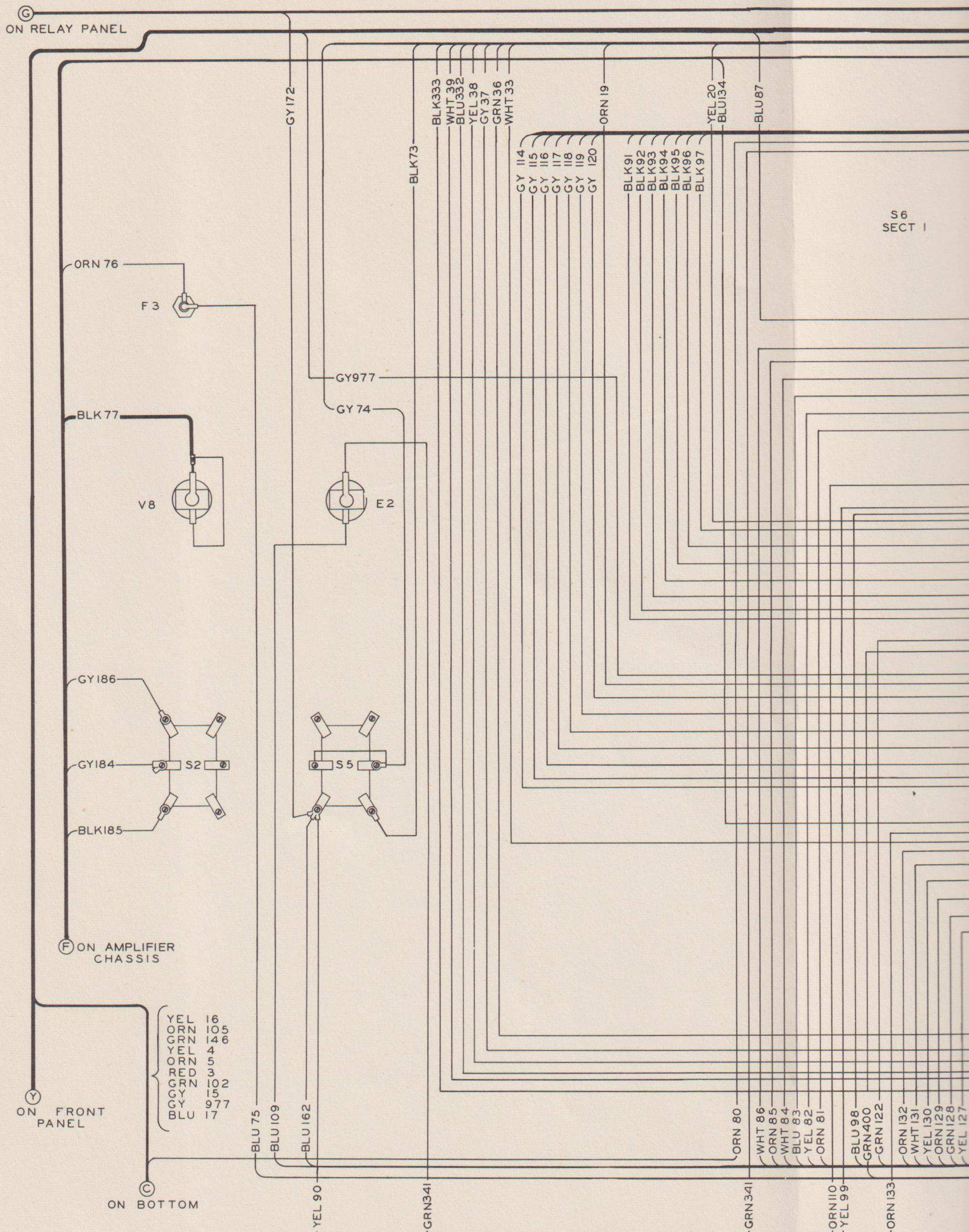


Figure 48. Amplifier chassis, power supply chassis, relay panel, and meter shunt terminal board of test set, wiring diagram.


R141
R142
R143
R144
BLK 21
GY 22
BLK 23
GY 24
ON SWITCH PANEL
POWER SUPPLY CHASSIS
RELAY PANEL
AC LINE CORD
GY 172
ORN 111
ORN 79
YEL 67
WHT 68
YEL 221
GY 210
WHT 222
YEL 204
R70
R71
K1
BLU 206
BLU 200
BLU 11
YEL 12
RED 151
V1
RED 147
R137
R136
ORN
WHT
RED
YEL
ORN
R74
GY
GY
BLU 149
YEL 82
ORN 9
RED 152
WHT 10
GY 51
GRN 123
RED 148
BLU 162
GY
BLU 83
ORN 85
BLU 161
GY
BLU 124
WHT 163
WHT 86
C18
R83
V2
RED
RED
ORN 81
BLK 25
ORN 154
WHT 153
RED 104
BLU 109
YEL 43
WHT 84
ORN 125
GRN 89
BLU 98
R28
R95
R77
R76
R75
R96
R84
R80
R78
ORN
WHT
BLU 35
ORN 34
ORN 132
WHT 159
GY 501
GRN 145
YEL 127
WHT 126
ORN 129
WHT 131
R135
R134
R133
R98
R88
R90
R89
R87
R86
BLU
GRN 128
YEL 130
YEL
T5
GY 142
GRN 122
YEL 43
GY 51
ON FRONT PANEL (HOLE A)
ON BOTTOM (T6)
ON BOTTOM (HOLE E)
ON FRONT PANEL
ON FRONT PANEL
ON BOTTOM (HOLE V)
TM 2535B-41

…eter shunt



G ON RELAY PANEL
GY172
BLK73
BLK333
WHT 39
BLU332
YEL 38
GY 37
GRN36
WHT 33
ORN 19
YEL 20
BLU134
BLU 87
GY 114
GY 115
GY 116
GY 117
GY 118
GY 119
GY 120
BLK91
BLK92
BLK93
BLK94
BLK95
BLK96
BLK97
S6
SECT 1
ORN 76
F3
GY977
GY 74
BLK 77
V8
E2
GY186
GY184
S2
S5
BLK185
F ON AMPLIFIER CHASSIS
YEL 16
ORN 105
GRN 146
YEL 4
ORN 5
RED 3
GRN 102
GY 15
GY 977
BLU 17
Y ON FRONT PANEL
C ON BOTTOM
BLU 75
BLU 109
BLU 162
YEL 90
GRN341
ORN 80
WHT 86
ORN 85
WHT 84
BLU 83
YEL 82
ORN 81
ORN110
YEL 99
BLU98
GRN400
GRN 122
ORN133
ORN 132
WHT 131
YEL 130
ORN 129
GRN 128
YEL 127

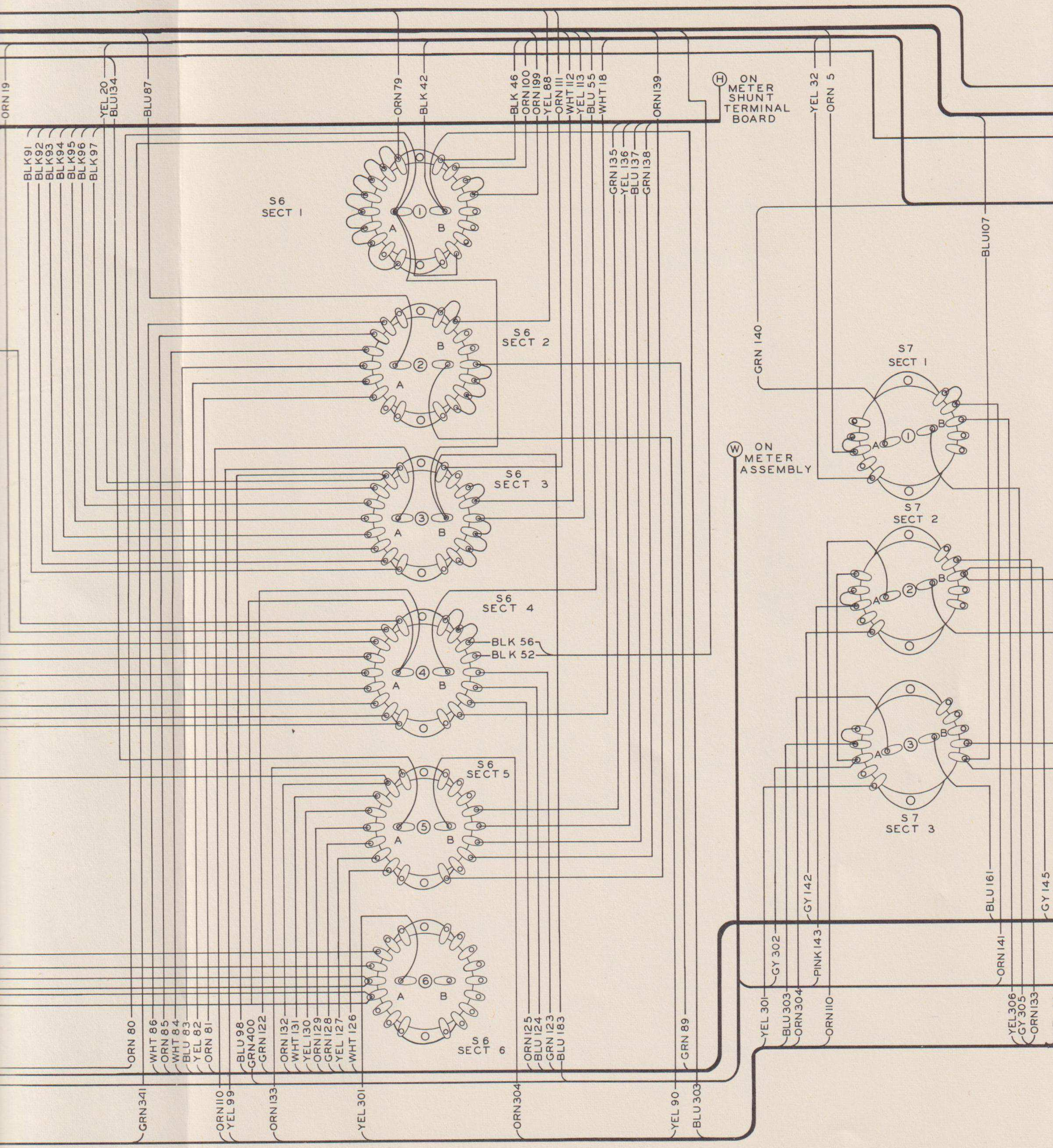
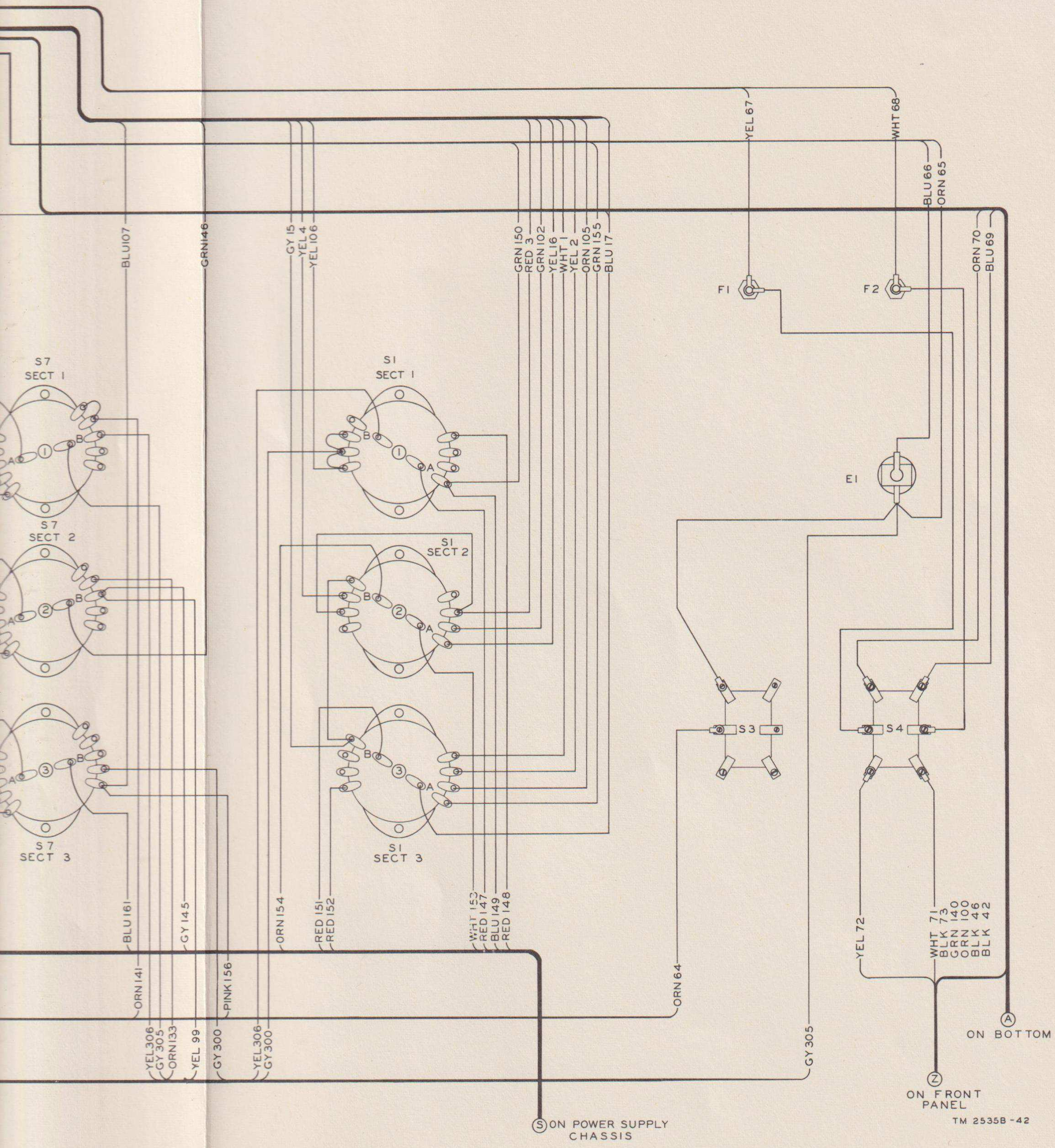


Figure 49. Switch panel of test set, wiring diagram



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