

**OPERATING AND SERVICING MANUAL**

**MODEL 712B**  
**POWER SUPPLY**  
**Serial 511 and Above**



**HEWLETT-PACKARD COMPANY**  
275 Page Mill Road • Palo Alto, California, U.S.A.

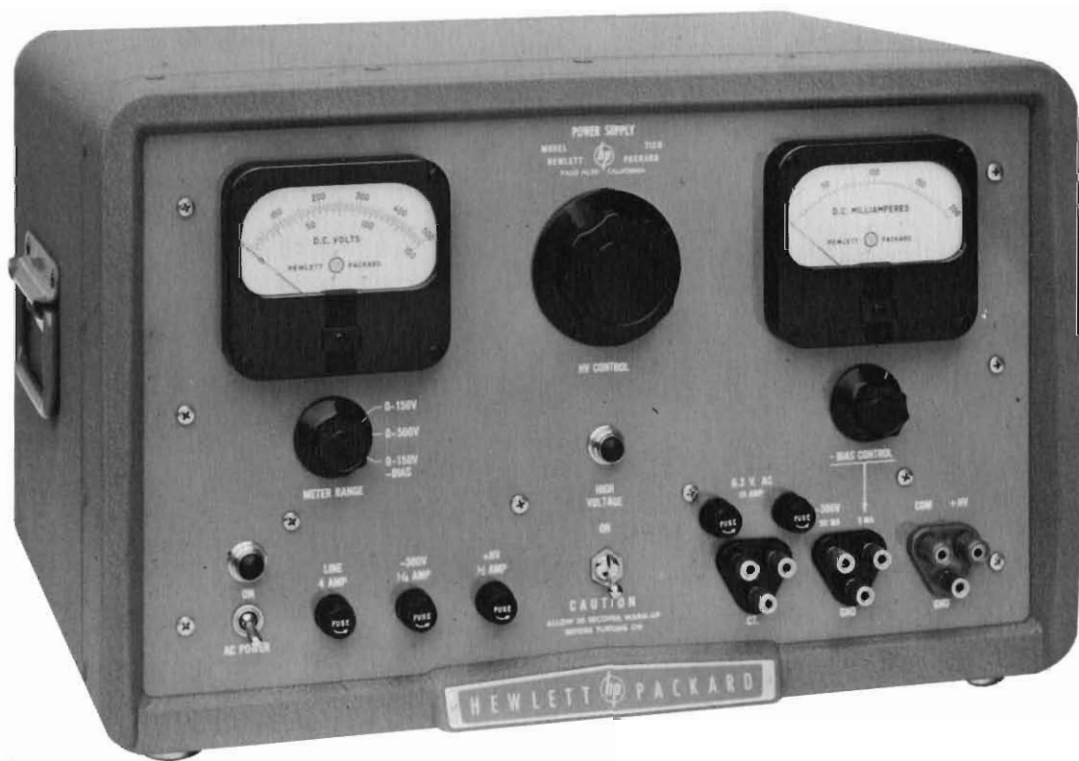
# OPERATING AND SERVICING MANUAL

FOR

MODEL 712B

POWER SUPPLY

Serial 511 and Above



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**275 PAGE MILL ROAD, PALO ALTO, CALIFORNIA, U.S.A.**

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TABLE OF SPECIFICATIONS

OUTPUT VOLTAGES

DC REGULATED HIGH VOLTAGE: 0 to +500 volts (without switching), 200 ma maximum load.  
 DC REGULATED FIXED BIAS: -300 volts, 50 ma maximum load.  
 DC VARIABLE BIAS: 0 to -150 volts, 5 ma maximum load.  
 AC UNREGULATED: 6.3 volts CT, 10 amps maximum load.

OUTPUT VOLTAGE REGULATION (for constant line voltage)

DC REGULATED HIGH VOLTAGE: Less than 50 millivolts change no-load to full-load at any output voltage.  
 DC REGULATED FIXED BIAS: Less than 50 millivolts change no-load to full-load.  
 DC VARIABLE BIAS: Is tied to fixed bias, hence source regulation is same as for fixed bias. Internal impedance 0 to 10,000 ohms, depending on bias control setting.

LINE VOLTAGE REGULATION

Regulated DC output voltages vary less than  $\pm 100$  millivolts for line voltage variations 115 volts  $\pm 10\%$ .

RIPPLE

Less than 500 microvolts.

INTERNAL IMPEDANCE

DC REGULATED HIGH VOLTAGE: (For frequencies above 20 cps.) Full-load: 0.1 ohm in series with 25 microhenries maximum. No-load: 1 ohm in series with 50 microhenries maximum.

RECOVERY TIME

Upon application of full-load: 0.1 millisecond maximum. Upon decrease from full-load to:  
 (a) 0 ma, 0.5 millisecond maximum.  
 (b) 25 ma, 0.1 millisecond maximum.  
 Maximum transient voltage, 1 volt.

METERING

CURRENT METER: 0 to 200 ma. (high voltage only.)  
 VOLTMETER: Three ranges, 0 to +500 volts, 0 to +150 volts and 0 to -150 volts. Panel switch connects meter to DC regulated high voltage or DC variable bias and selects range.

TERMINALS

Either positive or negative DC regulated high voltage terminal may be grounded. Positive terminals of both bias supplies and negative terminals of DC regulated high voltage are common.

OVERLOAD PROTECTION

AC line, DC regulated high voltage, DC regulated fixed bias and filament supply are separately fused. DC regulated high voltage drops to a safe value if bias fuse blows.

POWER SUPPLY

115 volts  $\pm 10\%$ , 50 to 60 cps. Approximately 120 to 450 watts depending on load and line voltage.

DIMENSIONS

Cabinet Mount: 12-1/2" high, 20-1/2" wide, 14-1/4" deep.  
 Rack Mount: Panel 10-1/2" high, 19" wide, 14-1/4" deep.

WEIGHT

Cabinet Mount: 69 lbs. shipping weight approx. 104 lbs.  
 Rack Mount: 62 lbs. shipping weight approx. 98 lbs.

Reference Publications

**SECTION I**  
**GENERAL DESCRIPTION**

**CAUTION**

Voltages which are dangerous to life are present at the terminals and within this instrument.

**CAUTION**

The AC power should be turned on for at least 30 seconds before switching on the high voltage. This allows the regulator circuits to reach their proper operating point and avoids excessive voltage at the high voltage terminals.

**1-1 GENERAL**

The Model 712B Power Supply is a very stable source of continuously variable direct current for plate and bias circuits. It also provides up to 10 amperes, 6.3 volts alternating current for filament circuits. A two-range voltmeter and a milliammeter (high voltage only) are provided to measure the direct current output. This power supply is very useful as a power source for small transmitters, oscillators, complex systems, certain types of klystrons, and general laboratory use.

**1-2 INSPECTION**

This instrument was thoroughly tested and inspected before being shipped and is ready for use when received.

After the instrument is unpacked, it should be inspected for damage received in transit. If any shipping damage is found, follow the procedure outlined in the "Claim for Damage in Shipment" page at the back of this instruction manual.

## SECTION II

### OPERATING INSTRUCTIONS

#### 2-1 CONTROLS AND TERMINALS

##### AC POWER

This toggle switch controls the power supplied to the instrument from the power line. When the switch is in the ON position the red indicator lamp above the switch will glow.

##### LINE 4 AMP

The fuseholder, located on the control panel, contains a 4 ampere cartridge fuse for the protection of the whole instrument. The fuse may be replaced by turning the fuseholder cap, removing the old fuse, and inserting a new fuse. Replacement fuses for this instrument must be of the "Slo-Blo" type as specified in the Replaceable Parts List.

##### -300V 1/16 AMP

The fuseholder, located on the control panel, contains a 1/16 ampere cartridge fuse for the protection of the -300 volt fixed bias supply. The fuse may be replaced by turning the fuseholder cap, removing the old fuse, and inserting a new fuse.

#### NOTE

If this fuse blows, the positive high-voltage regulator circuit will drop the HV voltage level to less than 100 volts, thus protecting external equipment or circuits against the possibility of damage due to loss of bias. When the open fuse is replaced, all circuits restore to normal.

##### +HV 1/2 AMP

The fuseholder, located on the control panel, contains a .5 ampere cartridge fuse for the protection of the high voltage dc circuit. The fuse may be replaced by turning the fuseholder cap, removing the old fuse, and inserting a new fuse.

#### CAUTION

If this fuse blows, immediately turn off the AC POWER switch, and then replace the fuse. Continued operation of the instrument with the +HV 1/2 AMP fuse open will damage the screen grids of the series regulator tubes (V3, V4, V5, V6).

##### HIGH VOLTAGE

This toggle switch turns the high voltage direct current off and on. The switch also controls the red indicator light above it on the control panel. When the switch is on, the indicator lamp glows as a warning that the high voltage is turned on.

##### 6.3V AC, 10 AMP

The two fuseholders, located on the control panel, each contain a 15 ampere cartridge fuse for protection of the 6.3 volt AC filament supply circuit. Each fuse may be replaced by turning its fuseholder cap, removing the old fuse, and inserting a new fuse. Replacement fuses must be of the "Slo-Blo" type as specified in the Replaceable Parts List.

##### 6.3V AC 10 AMP CT

These binding posts are terminals for the unregulated AC filament supply.

##### 6.3V AC 10 AMP

These are the terminals for the 6.3 volt unregulated alternating current.

##### CT

This binding post is the terminal for the center tap of the secondary winding from which the unregulated AC is taken.

##### -300V 50 MA 5 MA GND

These binding posts are terminals for the bias supply output and chassis ground.

##### -300V 50 MA

Output terminal for the fixed -300V regulated voltage supply.

5 MA

Output terminal for the variable (0-150 volt) regulated bias voltage supply.

GND

Terminal for making connection to the chassis. Any one of the output terminals may be connected to the chassis by connection to terminal GND.

COM +HV GND

These binding posts are terminals for the high voltage supply, common conductor, and chassis ground.

+HV

Output terminal for the regulated 0-500 volt voltage supply.

COM

Output terminal common to the HV, 5 MA (variable bias), and -300V 50 MA (fixed bias) circuits.

GND

Terminal for making connection to the chassis.

-BIAS CONTROL

This control varies the output of the regulated bias voltage supply from 0 to 150 volts.

HV CONTROL

This control varies the output of the regulated high voltage supply from 0 to 500 volts.

METER RANGE

This switch connects the regulated high voltage supply circuit to the voltmeter on either the 0-150V or 0-500V range. Operation of the switch to 0-150 -BIAS connects the variable bias supply circuit to the voltmeter.

## 2-2 OPERATION

### CAUTION

Avoid electric shock by turning the high voltage switch to the off position before making any connections to the instrument.

The procedure for operating the Model 712B Power Supply is as follows:

- a. Connect the power cable to a 115V power line and turn the AC POWER switch to ON.

### NOTE

The triple-conductor power cable is supplied with the new NEMA approved three-prong plug. The third conductor provides a chassis ground. An adapter may be obtained to permit use of this plug with two-conductor receptacles.

- b. With the HIGH VOLTAGE switch in the off position, connect the output terminals to the load.
- c. If the bias supply is to be used, set the METER RANGE switch to the 0-150V -BIAS position and adjust the -BIAS CONTROL for the desired voltage.

### NOTE

The internal impedance of the variable bias circuit can be as high as 10,000 ohms, depending on the setting of -BIAS CONTROL.

- d. Set the METER RANGE switch at the 0-150V or 500V position, and adjust the HV CONTROL for the desired output voltage.
- e. Turn the HIGH VOLTAGE switch to ON, check the bias voltage, and readjust -BIAS CONTROL if necessary.
- f. If the Model 712B is to be used for an application which requires a power supply of more than 500 volts, up to 300 volts additional may be made available by connecting the load across +HV and -300V 50 MA. Ground may be connected to either terminal, as desired.

## SECTION III

### CIRCUIT DESCRIPTION

#### 3-1 GENERAL

The Model 712B Power Supply furnishes two separate regulated supplies: a positive high voltage in the 0-500 volt range and a bias voltage. A block diagram of the Model 712B is shown in Figure 1.

Voltage level of the high voltage supply is adjusted by means of a panel knob, HV CONTROL, which controls the setting of variable autotransformer T1. The autotransformer supplies primary voltage to the high voltage power transformer, T2. The comparison voltage in the regulator circuit is adjusted by means of variable resistor R39 which is mechanically coupled to the autotransformer shaft. This arrangement maintains the regulator circuit at its optimum operating point, regardless of output voltage level.

After the high voltage has been rectified (dual diodes V1 and V2) and filtered, it is applied to a group of series regulator tubes (pentodes V3-V6), to the DC milliammeter, and then to the high voltage output terminal, +HV. The conduction of the series regulator tubes is controlled by a cascade differential amplifier (dual triodes V12 and V13). The differential amplifier compares a sample of the output voltage with the voltage developed across voltage reference tube V11; any difference between these voltages is amplified and the conductivity of the series regulator tubes is changed accordingly.

The fixed bias voltage (-300V) supply consists of a conventional power transformer, full-wave rectifier (dual diode V7), and capacitor-input filter. The voltage is regulated by means of a series regulator tube (pentode V8), which is controlled in turn by a cascade differential amplifier (dual triodes V9 and V10). Operation of the regulator circuit is similar to the +HV regulator described above.

A source of variable bias voltage is provided by means of a voltage divider (variable resistor R46) which is connected between the -300V 50 MA terminal and the COM terminal. This voltage is regulated against line voltage variations only. Since the internal impedance

may be as high as 10,000 ohms, depending upon the setting of resistor R46, the voltage will depend upon the actual load current being drawn (5 ma. max.). This voltage can be measured by turning the METER RANGE switch to the -150V -BIAS position.

#### 3-2 HIGH VOLTAGE REGULATOR CIRCUIT

The regulator circuit is so arranged that a slight voltage change in the sampled output in the positive direction will result in a relatively large voltage swing in the negative direction on the grids of the series regulator tubes, and vice versa.

Figure 2 shows the arrangement of dual triodes V13 and V12 which, connected in cascade, form a two stage differential amplifier. In each tube, cathode connections are common for the two sections. Thus any variation in plate current in one section appears across the cathode resistor common to both sections, and results in a difference voltage in each of the output circuits.

In the first stage, a fixed bias supplied by voltage reference tube V11 is applied to one grid of dual triode V13. The bias on the other grid of V13 is a portion of the +HV voltage, sampled with respect to the -300 volt bias supply through a voltage divider. Any variation in the level of the output voltage results in voltage changes in the plate circuits of both sections of V13, and corresponding changes in the biases on the grids of dual triode V12 in the next stage.

For example, if the voltage of the sampled output swings in the positive direction, increased current will flow through the right-hand section of V13, which will raise the cathode voltage and lower the right-hand plate (pin 1) voltage. Since the bias on the grid in the left-hand section of V13 remains fixed, the increased cathode voltage will decrease conduction in the left-hand half of the tube, which result in an increase in voltage on the left-hand plate (pin 6).



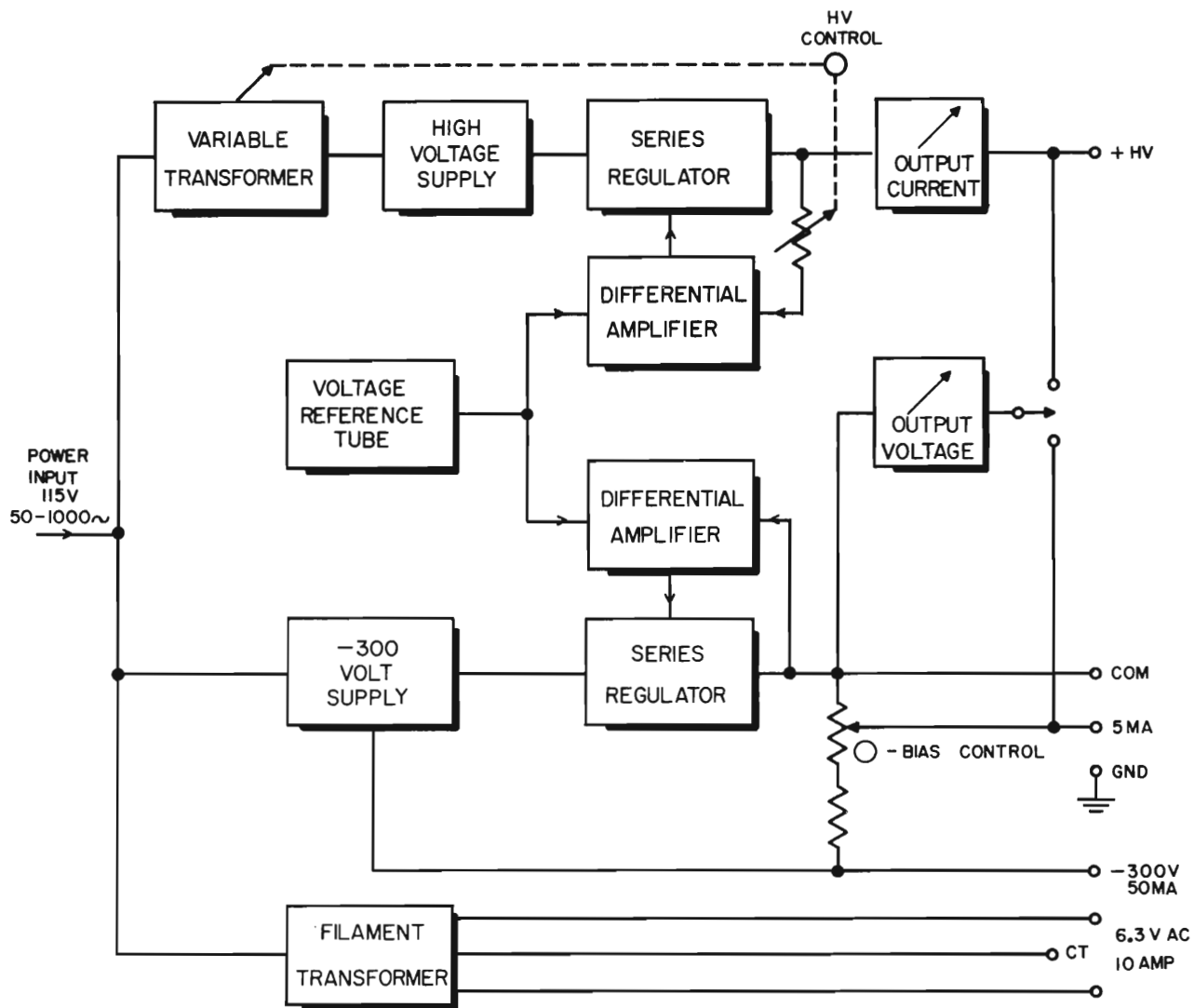


Figure 1. Model 712B Block Diagram

In the second stage, the right-hand section of dual triode V12 acts as a cathode follower to increase the signal on the grid of the left-hand section. The plate circuit in the left-hand section supplies the bias for the grids of the series regulator tubes. The plate circuits of the two sections of V12 are cross-coupled. This arrangement results in greater amplifier gain and sensitivity.

To ensure that the series regulator tubes will have sufficient conductivity to maintain regulation under transient conditions, a separate screen voltage supply from selenium rectifier SR1 is provided for the regulator tubes.

The voltage divider in the voltage comparison circuit provides separate paths to the signal grid of dual triode V13 for high-frequency and low-frequency voltages, to make the response of the regulated supply fast at high frequencies and yet very stable. At about 1,000 cycles, AC components are coupled to the grid via resistor R38 and capacitor C4. DC components pass to the grid through a resistor network (R38, R39, R40, R41).

### 3-3 BIAS SUPPLY CIRCUIT

Arrangement and operation of the regulated bias supply circuit is similar to that of the plate voltage supply circuit except that primary current to the bias supply transformer, T3, is not variable. The bias supply series regulator tube, V8, is controlled by a differential amplifier (dual triodes V10 and V9). The comparison voltage for the circuit is furnished by voltage reference tube V11, and the sample voltage is sampled with respect to COM through a voltage divider which includes variable resistor R24. The fixed bias voltage is brought out to binding post -300V 50 MA on the control panel.

A variable bias voltage is available at binding post 5 MA. The voltage level of the variable bias supply may be adjusted by means of the -BIAS CONTROL knob on the front panel. The control varies the setting of variable resistor R46 in the voltage divider across the bias supply output circuit.

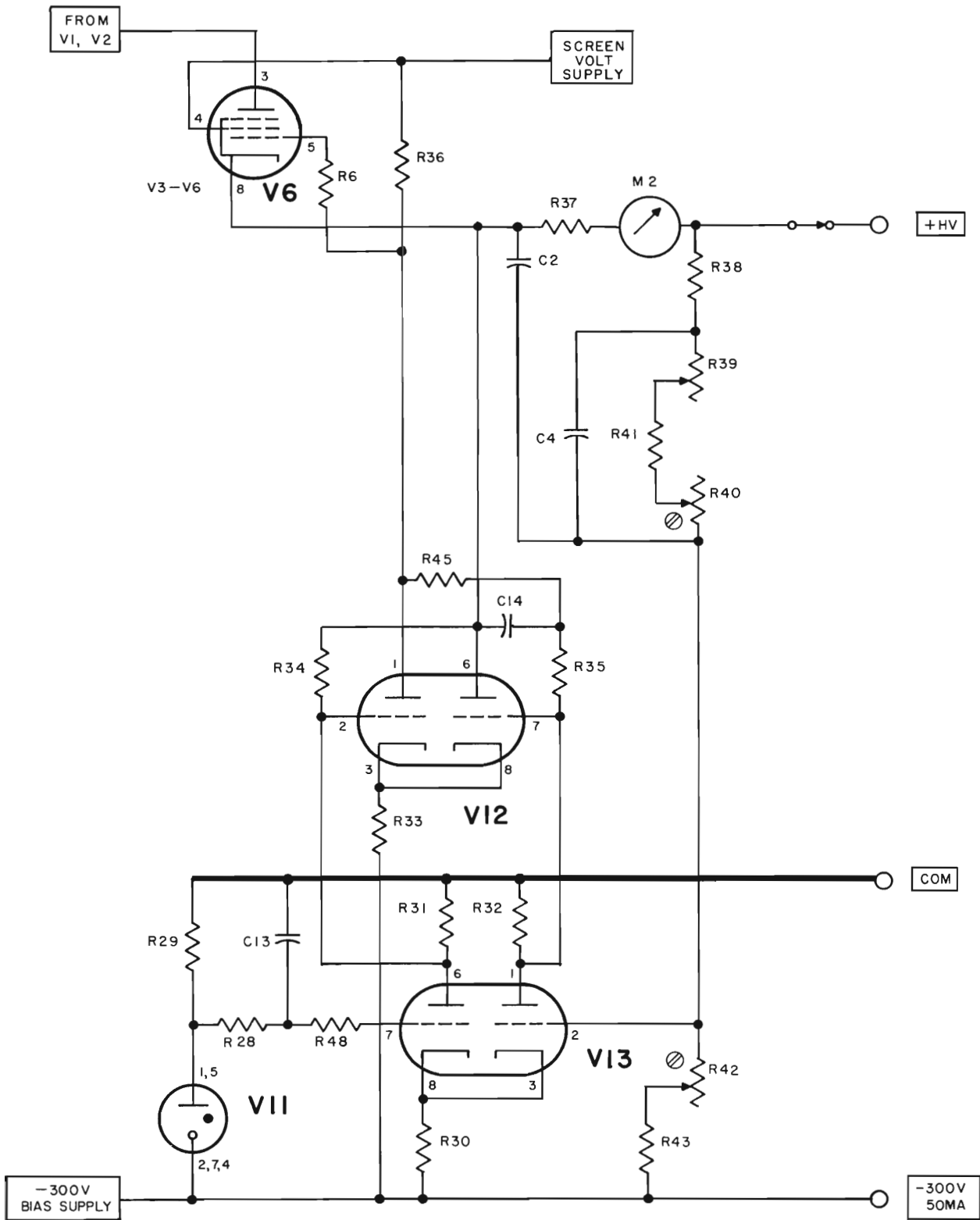


Figure 2. Partial Schematic of High Voltage Supply Regulator Circuit

## SECTION IV

### MAINTENANCE

#### CAUTION

Voltages which are dangerous to life are present within the instrument. Disconnect the power cable from the power line before removing the cover or bottom plate.

#### 4-1 COVER AND BOTTOM PLATE REMOVAL

##### Rack Model

To remove the cover, unscrew the four screws which fasten the cover to the back of the instrument, and slide the cover toward the rear of the instrument. To remove the bottom plate, unscrew the four screws which fasten the plate to the bottom of the instrument, and lift off the plate.

##### Cabinet Model

- a. On the rear of the instrument, remove the four screws which fasten the rear cover to the chassis. Remove the rear cover.
- b. Turn the instrument on its back.
- c. Remove the two 3/16 inch Allen setscrews on the bottom, next to the control panel.
- d. Lift the cabinet off the instrument.

#### 4-2 REPLACEMENTS

##### Variable Transformer Brush

Inspect the brush contact at periodic intervals. If the brush contact on transformer T1 begins to show excessive wear, purchase a new brush assembly, for a Type 20 variable transformer, from the Superior Electric Co., Bristol, Conn. The brush contact is made of special material and ordinary carbon will not function. Fit the brush to the commutator by sanding with fine crocus cloth. Carbon particles must be blown off the commutator after fitting the brush.

##### Tubes

Any tube in the Model 712B may be replaced with a tube having corresponding RETMA standard characteristics.

All tubes are accessible when the cover plate or cabinet is removed. Location of tubes is shown in Figure 3.

Tubes V3, V4, V5, or V6 may be replaced with a 6L6, 6L6-G, 6L6-GB or 5881.

Replacement of tube V11 may make it necessary to readjust the output voltage of the fixed, -300 volt bias supply (see Adjustments, paragraph 4-3).

Replacement of tube V10 may make it necessary to readjust the bias supply line regulation (see Adjustments, paragraph 4-3).

Replacement of tube V13 may make it necessary to readjust the HV supply line regulation (see Adjustments, paragraph 4-3).

If ripple is present in the regulated voltage after replacement of tube V9, V10, V12, or V13, probably it is due to excessive heater-cathode leakage in the replacement tube.

##### Variable Resistors

Connections to all variable resistors are shown in Figure 5.

Resistor R39 is ganged on the shaft with variable transformer T1. Its location, behind the control panel, is shown in Figure 3. The procedure to be followed after a replacement of variable resistor R39 is described under Adjustments, paragraph 4-3. The location of resistor R46, which is adjusted by the -BIAS CONTROL knob, also is shown in Figure 3.

Location of resistors R40, R42, R24, R10, and R8 on the bottom of the instrument are shown in Figure 4.

If resistor R24 is replaced, readjust the level of the fixed -300 volt bias supply (see Adjustments, paragraph 4-3).

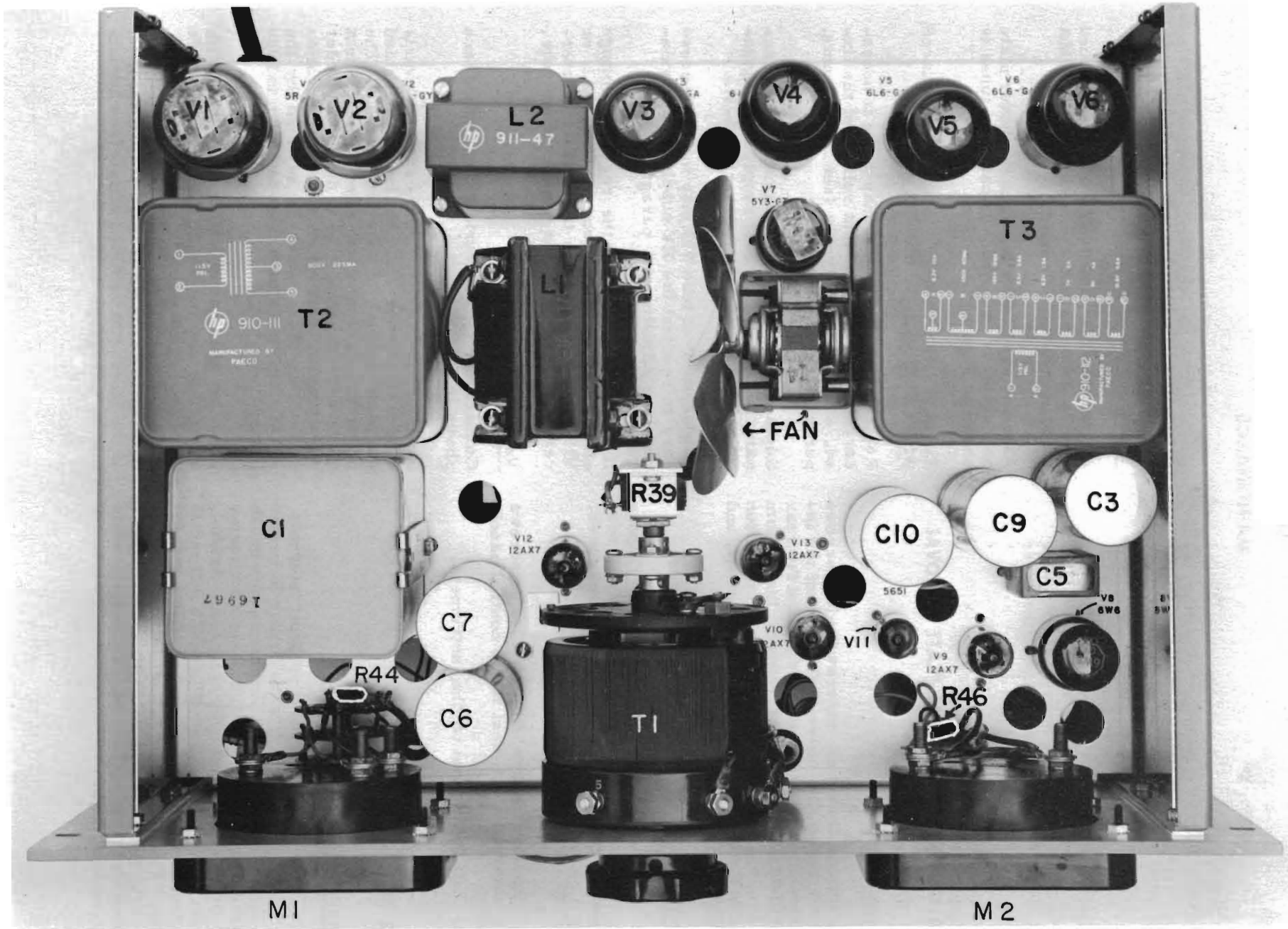


Figure 3. Model 712B Top View Cover Plate Removed

If resistor R42 or resistor R40 is replaced, readjust the maximum and minimum levels of the HV supply output voltage (see Adjustments, paragraph 4-3).

If resistor R8 is replaced, readjust the bias supply line regulation, and if resistor R10 is replaced, readjust the HV supply line regulation (see Adjustments, paragraph 4-3).

#### Lamps

If either the AC POWER or HIGH VOLTAGE lamp should burn out, replace with the 6-volt lamp specified in the Replaceable Parts List. The lamps are of the bayonet type and are plugged into sockets accessible from the front of the control panel. To remove a burned out lamp:

- a. Turning in a counterclockwise direction, unscrew the lamp cap and remove it.
- b. Firmly press the light bulb into the socket, and then give the bulb a twist in the counterclockwise direction to free it. Pick the bulb out of the socket.

### 4-3 ADJUSTMENTS

#### Auxiliary Equipment Required

- |  |  |
|--|--|
| 1 - variable transformer                 | } Hewlett-Packard<br>Model 410B or<br>equal. |
| 1 - AC voltmeter 0-150 volts             |  |
| 1 - DC voltmeter 1000 volt range         |  |
| 1 - High impedance vacuum tube voltmeter |  |
| 1 - 300 volt battery                     |  |

### NOTE

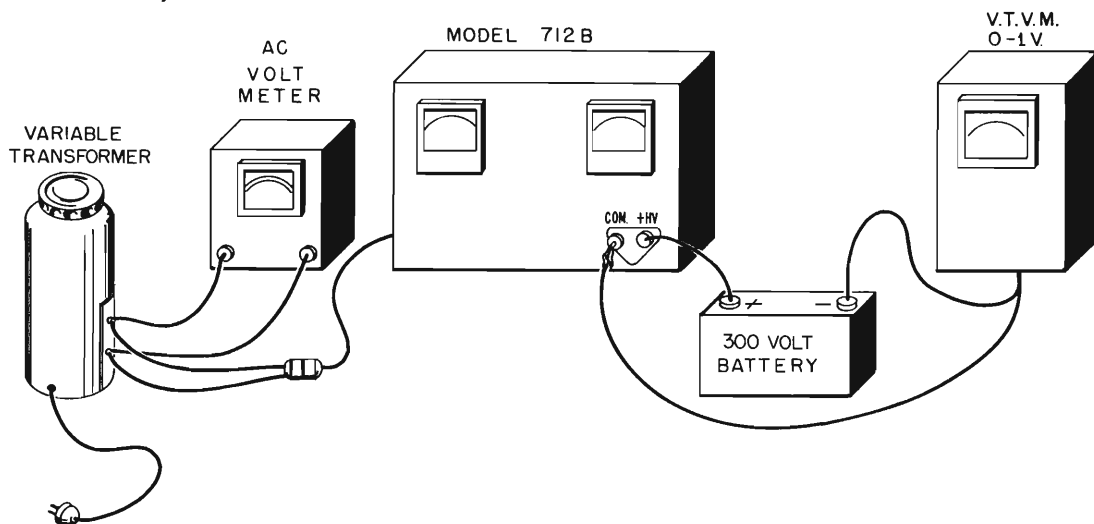
The settings of variable resistor R39 and the HV CONTROL stop are set at the factory, and should never be touched in the field unless transformer T1 or R39 should require replacement. Adjustment procedures to be performed in the event of the replacement of either component are given at the end of this Adjustments paragraph. If either T1 or R39 is replaced, its respective adjustment procedure should be performed before making the line regulation or output voltage adjustments.

### 4-4 LINE REGULATION ADJUSTMENT

To adjust the Model 712B line regulation, it is necessary to have (1) a stable source of DC voltage for comparison purposes, (2) a variable transformer, and (3) a sensitive voltmeter (1.0 volt full scale) with an input resistance of 1 megohm or greater (Model 410B). A convenient test set-up for measuring line regulation is illustrated below. Connections shown at the Model 712B are those used when measuring and adjusting the HV supply line regulation.

#### Adjustment of Bias Supply Line Regulation

- a. Make connections as shown in the test set-up below, except that the positive side of the battery is to be connected to the COM terminal on the Model 712B control panel and the negative terminal of the VTVM is to be connected to the -300V 50 MA terminal.



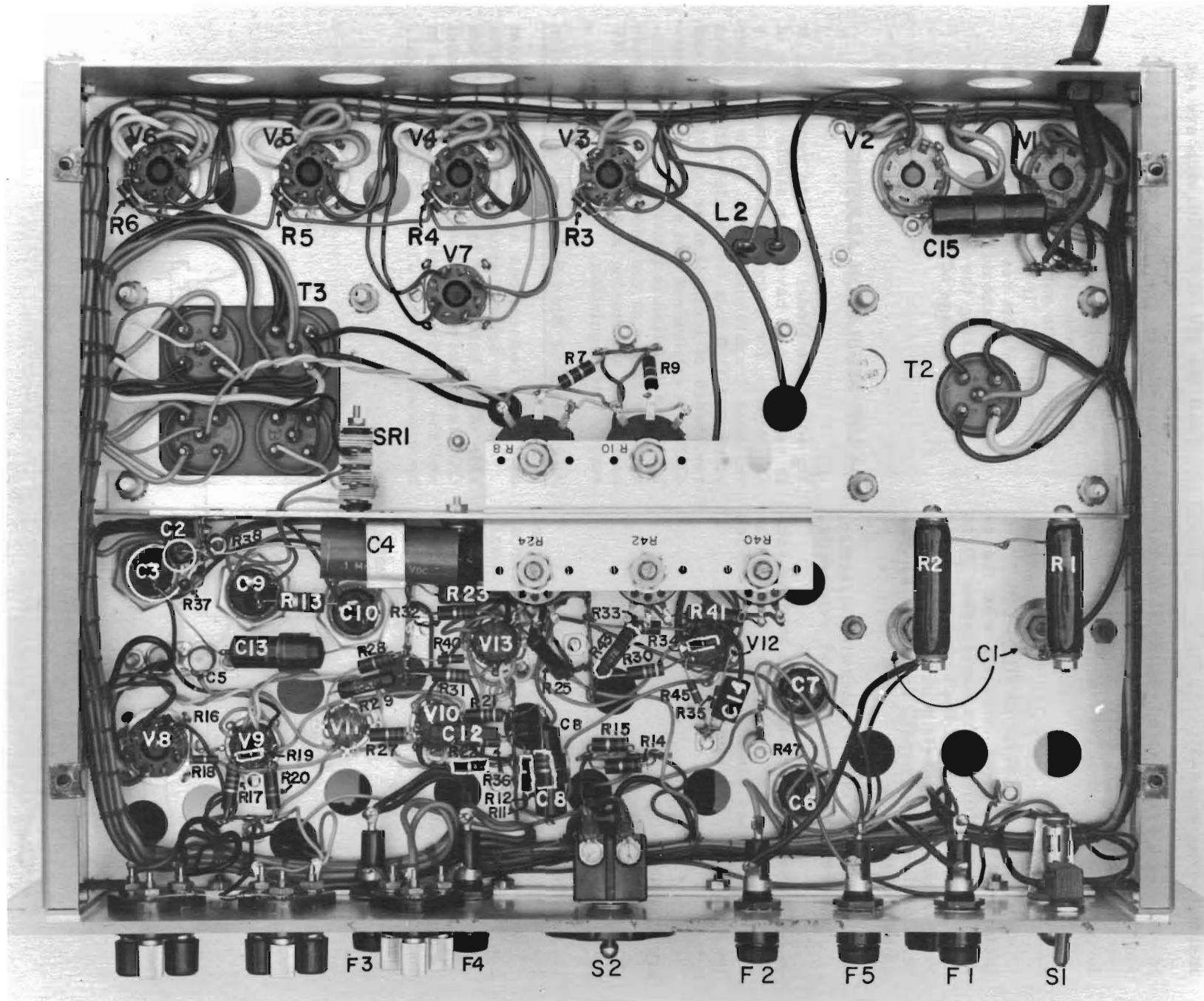


Figure 4. Model 712B Bottom View Bottom Plate Removed

- b. Set the variable transformer to 103 volts and allow about 15 seconds for the circuit to stabilize. Note the reading of the VTVM.
- c. Change the variable setting to 128 volts. After about 5 seconds the VTVM will indicate a temporary slow drift in the -300 volt supply voltage. When the circuit again stabilizes, note the new reading of the VTVM.
- d. If the new reading of the VTVM differs by more than .01 - .02 volt, adjust variable resistor R8 (see Figure 4), and repeat steps b and c.
- f. Repeat steps b - d until the circuit stabilizes to within .01 - .02 volt for line voltage changes of 103-128 volts.

#### Adjustment of HV Supply Line Regulation

- a. Make connections as shown on the suggested test set-up below.
- b. The procedure is the same as for measuring and adjusting the bias supply line regulation except that variable resistor R10 is adjusted to stabilize the HV supply circuit.

#### **4-5 ADJUSTMENT OF FIXED -300 VOLT BIAS SUPPLY OUTPUT VOLTAGE**

- a. Check that the Model 712B power cable is disconnected from the power source. Remove the cover and bottom plates. Place the instrument on its back so that both the front panel and the under side of the instrument will be accessible.
- b. Attach a DC voltmeter (Model 410B) between the COM and -300V 50 MA terminals on the control panel.
- c. Connect a variable transformer between the power source and the Model 712B power cable. Turn the AC POWER switch to ON, and allow the instrument to warm up for about one minute. Adjust the variable transformer so that 115 volts is applied to the Model 712B.
- d. Adjust variable resistor R24 until the test voltmeter reads -300 volts.

#### **4-6 ADJUSTMENT OF HV SUPPLY OUTPUT VOLTAGE**

- a. Set up the instrument as in steps a and c of the previous adjustment procedure.
- b. With the METER RANGE switch in the 0-500V position and the HV CONTROL in its maximum clockwise position, adjust variable resistor R42 (see Figure 4) until the DC voltmeter on the control panel reads +500.
- c. Rotate the HV CONTROL to its maximum counterclockwise position (minimum output) and switch the METER RANGE switch to the 0-150V position. Adjust variable resistor R40 until the DC voltmeter reads 0 volts.
- d. Since the settings of R40 and R42 are interdependent, it may be necessary to repeat steps b and c several times.

#### **NOTE**

The indicated meter zero could be off a volt or so due to change in meter position when instrument is on its back.

#### **4-7 SETTING VARIABLE RESISTOR R39**

This adjustment is to be made only if variable resistor R39 or transformer T1 has been replaced. Resistor R39 is mechanically coupled to the shaft of the variable transformer T1. The assembly is located behind the control panel (see Figure 3) above the deck, and is accessible when the cover plate is removed.

- a. Check that the power cable is disconnected down from the power source.
- b. With an Allen wrench loosen the two set screws which secure the coupling to the transformer shaft. (Do not loosen the set screws which secure the coupling to the resistor shaft.)
- c. Set the HV CONTROL to its maximum counterclockwise position. Set the METER RANGE switch to the 0-150V -BIAS position.
- d. Connect an ohmmeter across the R39 lead.



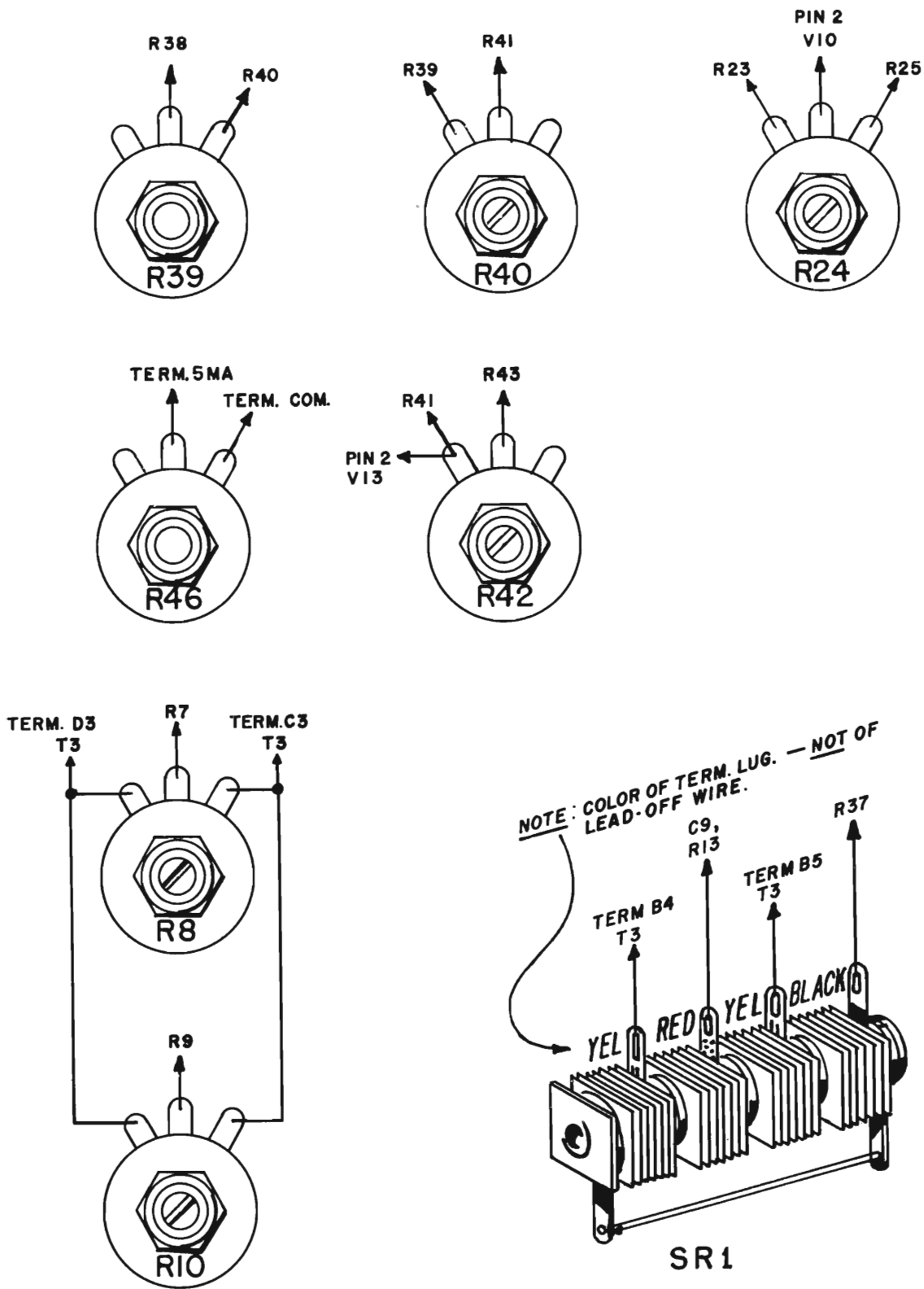


Figure 5. Model 712B Detail of Variable Resistors and Selenium Rectifier

- e. By means of the coupling, adjust the position of the resistor shaft until an ohmmeter reading of 25K ohms is obtained.
- f. Hold the shaft in this position, and tighten the setscrews which secure the coupling to the transformer shaft. Remove the ohmmeter.
- g. Check and if necessary readjust the level of the HV output as described in Adjustment of HV Supply Output Voltage, paragraph 4-6.
- c. Attach a DC voltmeter (Model 410B, 1,000 volt range) between terminal COM on the control panel and socket pin 3 of tube V3.
- d. Plug the Model 712B power cable into a variable transformer set for 115 volts (measured).
- e. Turn off the HIGH VOLTAGE switch. Set the METER RANGE switch at 0-500V and the HV CONTROL to its maximum counterclockwise position. Turn the AC POWER switch to ON, and allow at least a 30-second warm-up.

#### **4-8 SETTING THE STOP ON THE HV CONTROL**

This adjustment is to be made only if variable transformer T1 has been replaced. The movable stop is a small "C" clamp which is attached to the wiper ring on the back of the variable transformer.

- a. Check that the power cable is disconnected from the power source.
- b. Use an Allen wrench to loosen the setscrew which secures the stop to the rim of the transformer wiper ring, and remove the stop.
- f. Advance the HV CONTROL in a clockwise direction until the test voltmeter reads +380 volts.
- g. Turn off the AC POWER switch, disconnect the Model 712B power cable and attach the stop to the transformer wiper ring so that the movable stop rests against the stationary stop in such a manner that the HV CONTROL cannot return in a counterclockwise direction. Note that the stop sets the minimum voltage applied to the series regulator tubes.
- h. Remove the voltmeter.
- i. Check the setting of variable resistor R39, as described above.

TROUBLE SHOOTING CHART

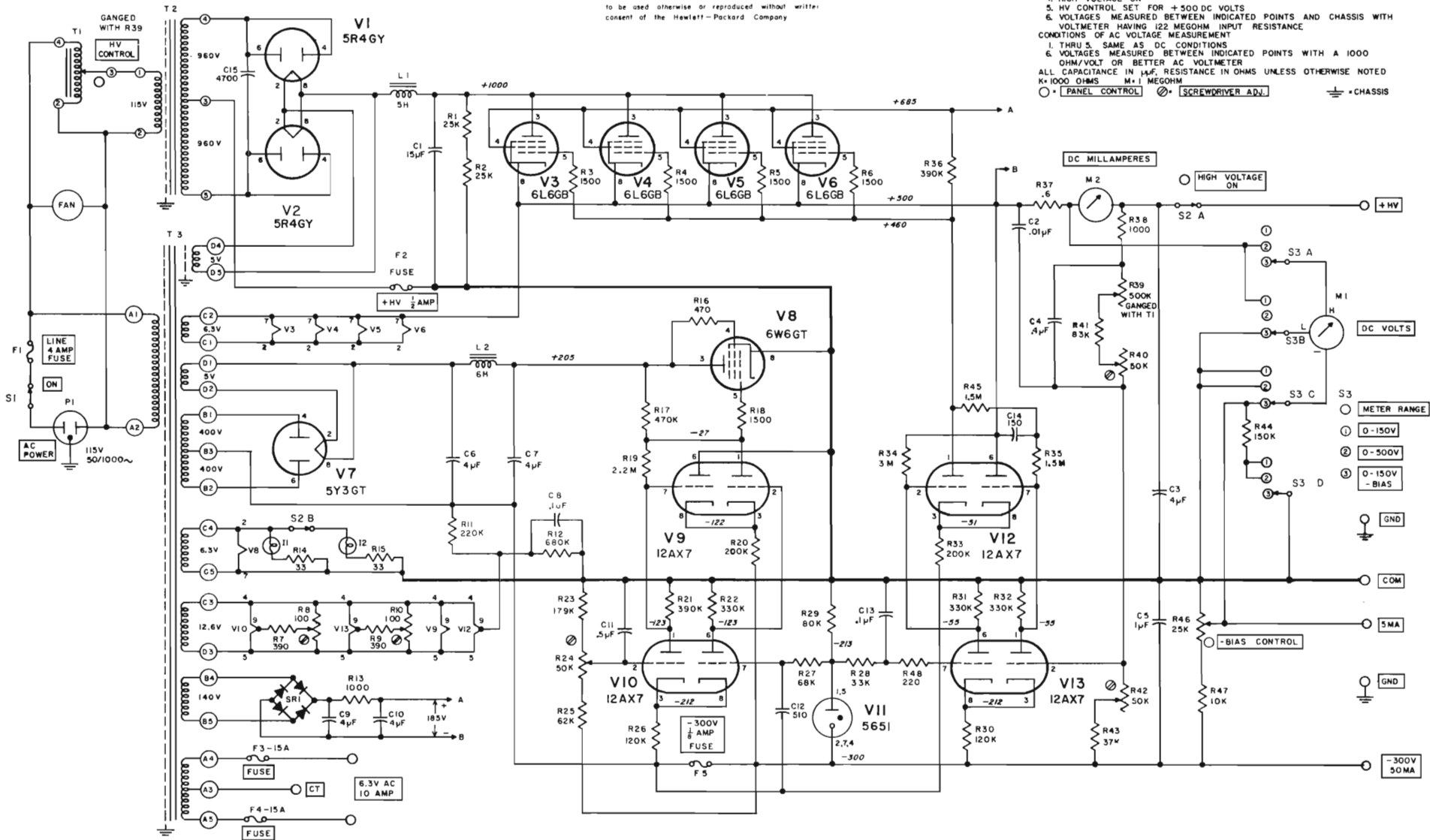
The following information is designed to aid in trouble shooting a defective instrument:

SYMPTOMS	POSSIBLE CAUSE	TEST PROCEDURE	REMEDIES												
Instrument NOT operating, pilot light NOT on.	Line fuse F1 blown due to defective fuse or overload in either power supply.	<p>Replace fuse. If this fuse blows, remove tubes V1, V2, and V7, and again replace fuse F1. If this fuse blows, it indicates:</p> <ol style="list-style-type: none"> <li>1. Short circuit in wiring associated with power transformer T2 or T3.</li> <li>2. Short circuit in filament wiring.</li> <li>3. Transformer T2 or T3 is defective.</li> </ol> <p>If fuse does not blow when rectifying tubes are removed, it indicates:</p> <ol style="list-style-type: none"> <li>1. Defective filter capacitor.</li> <li>2. Short circuit in a tube.</li> <li>3. Short circuit in the direct current wiring.</li> </ol> <p>To localise the circuit in trouble, measure the DC resistance across the output from each of the three rectifiers. Disconnect the instrument from the power line before making the measurements.</p> <p>Normal DC Resistances Across Power Supply Circuits:</p> <table border="0" style="width: 100%;"> <tr> <td style="width: 15%;">Rectifier</td> <td style="width: 45%;">Connect Ohm-meter Across</td> <td style="width: 40%;">Approx. Normal Resist. (Ohms)</td> </tr> <tr> <td>V1, V2</td> <td>Socket pin 8, V1 or V2, and term. COM</td> <td>50K</td> </tr> <tr> <td>V7</td> <td>Socket pin 8 V7, and term. -300V 50 MA</td> <td>2M</td> </tr> <tr> <td>SR1</td> <td>Terms. of capacitor C9 (connect meter neg. lead to junction of C9 and R13)</td> <td>1.5M</td> </tr> </table>	Rectifier	Connect Ohm-meter Across	Approx. Normal Resist. (Ohms)	V1, V2	Socket pin 8, V1 or V2, and term. COM	50K	V7	Socket pin 8 V7, and term. -300V 50 MA	2M	SR1	Terms. of capacitor C9 (connect meter neg. lead to junction of C9 and R13)	1.5M	<ol style="list-style-type: none"> <li>1. Locate and clear short circuit.</li> <li>2. Locate and clear short circuit.</li> <li>3. Replace defective transformer.</li> <li>1. Locate and replace defective capacitor.</li> <li>2. Locate and replace defective tube.</li> <li>3. Locate and clear short circuit.</li> </ol>
Rectifier	Connect Ohm-meter Across	Approx. Normal Resist. (Ohms)													
V1, V2	Socket pin 8, V1 or V2, and term. COM	50K													
V7	Socket pin 8 V7, and term. -300V 50 MA	2M													
SR1	Terms. of capacitor C9 (connect meter neg. lead to junction of C9 and R13)	1.5M													
Instrument NOT operating, pilot light ON.	Defective tube or component causing improper operation.	Set METER RANGE switch at 0-150V -BIAS and turn -BIAS CONTROL to its maximum clockwise position. If voltmeter on control panel does not deflect, or reads less than 150 volts, trouble is in bias supply circuit. Check bias supply DC voltages against those indicated on schematic diagram (should agree within $\pm 10\%$ ).	Locate defective component, and replace.												

SYMPTOMS	POSSIBLE CAUSE	TEST PROCEDURE	REMEDIES
		<p>If voltmeter reads -150 volts or more, trouble probably is in HV supply circuit. Set METER RANGE switch at 0-500V and turn HV CONTROL to maximum clockwise position. If voltmeter does not deflect, trouble is in HV supply circuit, and DC voltages should be checked against those shown on the schematic. If voltmeter reads less than 500 volts, trouble may be in either regulator circuit.</p>	<p>Locate defective component, and replace.</p>
<p>Instrument operating, but output voltage deviates from desired level:</p> <p><u>High Voltage Supply</u> Voltage slightly negative</p> <p>Voltage low</p>	<p>Defective fuse, or defective tube (or associated component) in regulator circuit, as detailed below:</p> <p>Fuse F2 (+HV) blown</p> <p>Fuse F5 (-300V) blown V10 V9 V13</p>	<p>Check for open fuse.</p> <ol style="list-style-type: none"> <li>1. Check for open fuse.</li> <li>2. Check for burned-out tube.</li> <li>3. If all tubes are operating, check defective tube in suspected circuit by substituting tube known to be good.</li> <li>4. Test external components in suspected tube circuit.</li> </ol>	<p>Replace blown fuse.</p> <ol style="list-style-type: none"> <li>1. Replace blown fuse.</li> <li>2. Replace burned-out tube.</li> <li>3. Replace any defective tube.</li> <li>4. Replace any defective component.</li> </ol>
<p>Voltage high</p>	<p>V11 V12 V7 V8</p>	<ol style="list-style-type: none"> <li>1. Check for burned-out tube.</li> <li>2. If all tubes are operating, check for defective tube in suspected circuit by substituting tube known to be good.</li> </ol>	<ol style="list-style-type: none"> <li>1. Replace burned-out tube.</li> <li>2. Replace any defective tube.</li> </ol>
<p><u>-300V Bias Supply</u> Voltage slightly positive</p> <p>Voltage low</p> <p>Voltage high</p>	<p>V8 V7</p> <p>V11</p> <p>V9 V10</p>	<ol style="list-style-type: none"> <li>3. Test external components in suspected tube circuit.</li> </ol>	<ol style="list-style-type: none"> <li>3. Replace any defective component.</li> </ol>

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NOTES  
CONDITIONS OF DC VOLTAGE MEASUREMENT  
1. LINE VOLTAGE AT 115 VOLTS, 50/1000~  
2. NO EXTERNAL LOAD  
3. COM. CONNECTED TO GND.  
4. HIGH VOLTAGE ON  
5. HV CONTROL SET FOR +500 DC VOLTS  
6. VOLTAGES MEASURED BETWEEN INDICATED POINTS AND CHASSIS WITH VOLTMETER HAVING 122 MEGOHM INPUT RESISTANCE  
CONDITIONS OF AC VOLTAGE MEASUREMENT  
1. THRU S. SAME AS DC CONDITIONS  
2. VOLTAGES MEASURED BETWEEN INDICATED POINTS WITH A 1000 OHM/VOLT OR BETTER AC VOLTMETER  
ALL CAPACITANCE IN  $\mu\text{F}$ , RESISTANCE IN OHMS UNLESS OTHERWISE NOTED  
K=1000 OHMS M=1 MEGOHM  
○ PANEL CONTROL ⊗ SCREWDRIVER ADJ.  $\equiv$  CHASSIS



SCHMATIC DIAGRAM OF MODEL 712B  
SERIAL 511 & ABOVE

712B-E-10†

**SECTION V**  
**TABLE OF REPLACEABLE PARTS**

**NOTE**

Any changes in the Table of Replaceable Parts will be listed on a Production Change sheet at the front of this manual.

When ordering parts from the factory always include the following information:

Instrument model number  
Serial number  
-hp- stock number of part  
Description of part

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
C1	Capacitor: fixed, paper, 15 $\mu$ f, +40%, -15%, 1000 vdcw	17-46	CC CP70E1EG156X
C2	Capacitor: fixed, paper, .01 $\mu$ f, $\pm$ 10%, 1600 vdcw	16-56	CC 73P103916
C3	Capacitor: fixed, paper, 4 $\mu$ f, $\pm$ 10%, 600 vdcw	17-10	P T-64
C4	Capacitor: fixed, oil filled paper, .4 $\mu$ f, $\pm$ 10%, 100 vdcw	16-72	P MT-4G
C5	Capacitor: fixed, paper, 1 $\mu$ f, $\pm$ 10%, 600 vdcw	17-12	N 23F467
C6, C7	Capacitor: fixed, paper, 4 $\mu$ f, $\pm$ 10%, 600 vdcw	17-10	P T-64
C8	Capacitor: fixed, paper, .1 $\mu$ f, $\pm$ 10%, 400 vdcw	16-35	CC 67P10494
C9, C10	Capacitor: fixed, paper, 4 $\mu$ f, $\pm$ 10%, 600 vdcw	17-10	P T-64
C11	Capacitor: fixed, paper, .5 $\mu$ f, $\pm$ 10%, 400 vdcw	16-58	Z 300405
C12	Capacitor: fixed, silver mica, 510 $\mu$ mf, $\pm$ 5%, 500 vdcw	15-27	A Type 1479
C13	Capacitor: fixed, paper, .1 $\mu$ f, $\pm$ 10%, 400 vdcw	16-35	CC 67P10494
C14	Capacitor: fixed, mica, 150 $\mu$ mf, $\pm$ 10%, 500 vdcw	14-150	V Type OXM
C15	Capacitor: fixed, paper, .0047 $\mu$ f, $\pm$ 20%, 6000 vdcw	16-75	CC 84P472060
R1, R2	Resistor: fixed, wirewound, 25,000 ohms, $\pm$ 10%, 20 W	27-31	S Type 2R
R3, R4, R5, R6	Resistor: fixed, composition, 1500 ohms, $\pm$ 10%, 1/2 W	23-1500	B EB 1521
R7	Resistor: fixed, composition, 390 ohms, $\pm$ 10%, 1 W	24-390	B GB 3911
R8	Resistor: variable, wirewound, 100 ohms, linear taper	210-4	HP
R9	Resistor: fixed, composition, 390 ohms, $\pm$ 10%, 1 W	24-390	B GB 3911

\*See "List of Manufacturers Code Letters For Replaceable Parts Table."

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
R10	Resistor: variable, wirewound, 100 ohms, linear taper	210-4	HP
R11	Resistor: fixed, composition, 220,000 ohms, $\pm 10\%$ , 1 W	24-220K	B GB 2241
R12	Resistor: fixed, composition, 680,000 ohms, $\pm 10\%$ , 1 W	24-680K	B GB 6841
R13	Resistor: fixed, composition, 1000 ohms, $\pm 10\%$ , 2 W	25-1000	B HB 1021
R14, R15	Resistor: fixed, composition, 33 ohms, $\pm 10\%$ , 1 W	24-33	B GB 3301
R16	Resistor: fixed, composition, 470 ohms, $\pm 10\%$ , 1/2 W	23-470	B EB 4711
R17	Resistor: fixed, composition, 470,000 ohms, $\pm 10\%$ , 1 W	24-470K	B GB 4741
R18	Resistor: fixed, composition, 1500 ohms, $\pm 10\%$ , 1/2 W	23-1500	B EB 1521
R19	Resistor: fixed, composition, 2.2 megohms, $\pm 10\%$ , 1/2 W	23-2.2M	B EB 2251
R20	Resistor: fixed, composition, 200,000 ohms, $\pm 5\%$ , 1 W	24-200K-5	B GB 2045
R21	Resistor: fixed, composition, 390,000 ohms, $\pm 10\%$ , 1 W	24-390K	B GB 3941
R22	Resistor: fixed, composition, 330,000 ohms, $\pm 10\%$ , 1 W	24-330K	B GB 3341
R23	Resistor: fixed, composition, 179,000 ohms, $\pm 1\%$ , 2 W	32-179K	HP
R24	Resistor: variable, composition, 50,000 ohms, $\pm 10\%$ , linear taper	210-36	HP
R25	Resistor: fixed, composition, 62,000 ohms, $\pm 1\%$ , 1 W	31-62K	HP
R26	Resistor: fixed, composition, 120,000 ohms, $\pm 10\%$ , 1 W	24-120K	B GB 1241
R27	Resistor: fixed, composition, 68,000 ohms, $\pm 10\%$ , 1 W	24-68K	B GB 6831
R28	Resistor: fixed, composition, 33,000 ohms, $\pm 10\%$ , 1 W	24-33K	B GB 3331

\*See "List of Manufacturers Code Letters For Replaceable Parts Table."



TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
R29	Resistor: fixed, composition, 80,000 ohms, $\pm 1\%$ , 1 W	31-80K	HP
R30	Resistor: fixed, composition, 120,000 ohms, $\pm 10\%$ , 1 W	24-120K	B GB 1241
R31, R32	Resistor: fixed, composition, 330,000 ohms, $\pm 10\%$ , 1 W	24-330K	B GB 3341
R33	Resistor: fixed, composition, 200,000 ohms, $\pm 5\%$ , 1 W	24-200K-5	B GB 2045
R34	Resistor: fixed, composition, 3 megohms, $\pm 5\%$ , 1/2 W	23-3M-5	B EB 3055
R35	Resistor: fixed, composition, 1.5 megohms, $\pm 5\%$ , 1/2 W	23-1.5M-5	B EB 1551
R36	Resistor: fixed, composition, 390,000 ohms, $\pm 10\%$ , 1 W	24-390K	B GB 3941
R37	Resistor: fixed, wirewound, .6 ohms, $\pm 10\%$ , 2 W	26-39	I Type FYG
R38	Resistor: fixed, composition, 1000 ohms, $\pm 10\%$ , 1 W	24-1000	B GB 1021
R39	Resistor: variable, composition, 500,000 ohms, $\pm 10\%$ , linear taper	210-59	HP
R40	Resistor: variable, composition, 50,000 ohms, $\pm 10\%$ , linear taper	210-36	HP
R41	Resistor: fixed, composition, 83,000 ohms, $\pm 1\%$ , 1 W	31-83K	HP
R42	Resistor: variable, composition, 50,000 ohms, $\pm 10\%$ , linear taper	210-36	HP
R43	Resistor: fixed, composition, 37,000 ohms, $\pm 1\%$ , 1 W	31-37K	HP
R44	Resistor: fixed, composition, 150,000 ohms, $\pm 10\%$ , 1 W	24-150K	B GB 1541
R45	Resistor: fixed, composition, 1.5 megohms, $\pm 5\%$ , 1/2 W	23-1.5M-5	B EB 1551
R46	Resistor: variable, wirewound, 25,000 ohms, $\pm 10\%$ , linear taper	210-10	I 58-25000
R47	Resistor: fixed, wirewound, 10,000 ohms, $\pm 10\%$ , 10 W	26-10	S Type 1-3/4E

\*See "List of Manufacturers Code Letters For Replaceable Parts Table."

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
R48	Resistor: fixed, composition, 220 ohms, ±10%, 1/2 W	23-220	B EB 2211
	Binding Post:	149-4	HP
	Binding Post Nut:	149-5	HP
	Binding Post Cap Insulator	M-58	HP
	Binding Post Insulator, Black	G-83D	HP
	Binding Post Insulator, Red	G-83E	HP
	Flexible Coupling:	M-25	HP
F1	Fuse: 4A, Withstands 200% overload for 12 sec.	211-46	E, MDX-4
F2	Fuse: 0.5A, 3AG	211-42	T, 312.500
F3, F4	Fuse: 15A, Withstands 200% overload for 5 sec. min. to 60 sec. max.	211-64	T, 313015
F5	Fuse: 1/8A, 3AG	211-67	Elmar, #312.125
	Fuseholder:	140-16	T, 342001
	Knob: HV Control	712B-74	HP
	Knob: 1-1/2" diam. meter range -bias control	37-11	HP
I1, I2	Lamp: 6V	211-47	O, #47
FAN	Fan Motor:	314-3	HP
	Fan Blade:	314-7	HP
	Lampholder:	145-2	Signal Indicator #807BS
M1	Meter: 0-150V, 0-500V, DC	112-26	HP
M2	Meter: 0-200MA, DC	112-25	HP
P1	Power Cable:	812-56	HP
L1	Reactor: 5 H @ 225 MA	911-49	HP
L2	Reactor: 6 H @ 125 MA	911-47	HP
S1	Toggle Switch, SPST	310-11	D, 20994-HW
S2	Toggle Switch, DPDT	310-99	D, 80421
S3	Rotary Switch, Assem.	712B-19	HP
SR1	Rectifier, metallic:	212-95	Radio Receptor Type 24Y2
T1	Variable Transformer:	910-71	HP
T2	Power Transformer:	910-111	HP
T3	Power Transformer:	910-112	HP

\*See "List of Manufacturers Code Letters For Replaceable Parts Table."

TABLE OF REPLACEABLE PARTS

Circuit Ref.	Description	-hp- Stock No.	Mfr. * & Mfrs. Designation
V1	Tube: 5R4GY	212-5R4GY	ZZ
V2	Tube: 5R4GY	212-5R4GY	ZZ
V3, V4, V5, V6	Tube: 6L6GB (6L6, 6L6G, or 5881 may be used)	212-6L6GB	ZZ
V7	Tube: 5Y3GT	212-5Y3GT	ZZ
V8	Tube: 6W6GT	212-6W6GT	ZZ
V9	Tube: 12AX7	212-12AX7	ZZ
V10	Tube: 12AX7	212-12AX7	ZZ
V11	Tube: 5651	212-5651	ZZ
V12	Tube: 12AX7	212-12AX7	ZZ
V13	Tube: 12AX7	212-12AX7	ZZ

\*See "List of Manufacturers Code Letters For Replaceable Parts Table."

LIST OF CODE LETTERS USED IN TABLE OF REPLACEABLE PARTS  
TO DESIGNATE THE MANUFACTURERS

<u>Code Letter</u>	<u>Manufacturer</u>	<u>Address</u>
A	Aerovox Corporation	New Bedford, Mass.
B	Allen-Bradley Company	Milwaukee 4, Wis.
C	Amperite Company	New York, N. Y.
D	Arrow, Hart & Hegeman	Hartford, Conn.
E	Bussman Manufacturing Company	St. Louis, Mo.
F	Carborundum Company	Niagara Falls, N. Y.
G	Centralab	Milwaukee 1, Wis.
H	Cinch-Jones Mfg. Company	Chicago 24, Ill.
HP	Hewlett-Packard Company	Palo Alto, Calif.
I	Clarostat Mfg. Company	Dover, N. H.
J	Cornell Dubilier Elec. Company	South Plainfield, N. J.
K	Hi-Q Division of Aerovox	Olean, N. Y.
L	Erie Resistor Corporation	Erie 6, Penn.
M	Fed. Telephone & Radio Corporation	Clifton, N. J.
N	General Electric Company	Schenectady 5, N. Y.
O	General Electric Supply Corporation	San Francisco, Calif.
P	Girard-Hopkins	Oakland, Calif.
Q	Industrial Products Company	Danbury, Conn.
R	International Resistance Company	Philadelphia 8, Penn.
S	Lectrohm Incorporated	Chicago 20, Ill.
T	Littlefuse Incorporated	Des Plaines, Ill.
U	Maguire Industries Incorporated	Greenwich, Conn.
V	Micamold Radio Corporation	Brooklyn 37, N. Y.
W	Oak Manufacturing Company	Chicago 10, Ill.
X	P. R. Mallory Co., Incorporated	Indianapolis, Ind.
Y	Radio Corporation of America	Harrison, N. J.
Z	Sangamo Electric Company	Marion, Ill.
AA	Sarkes Tarzian	Bloomington, Ind.
BB	Signal Indicator Company	Brooklyn 37, N. Y.
CC	Sprague Electric Company	North Adams, Mass.
DD	Stackpole Carbon Company	St. Marys, Penn.
EE	Sylvania Electric Products Company	Warren, Penn.
FF	Western Electric Company	New York 5, N. Y.
GG	Wilkor Products, Incorporated	Cleveland, Ohio
HH	Amphenol	Chicago 50, Ill.
II	Dial Light Co. of America	Brooklyn 37, N. Y.
JJ	Leecraft Manufacturing Company	New York, N. Y.
KK	Switchcraft, Incorporated	Chicago 22, Ill.
LL	Gremer Manufacturing Company	Lynn, Mass.
MM	Carad Corporation	Redwood City, Calif.
NN	Electra Manufacturing Company	Kansas City, Mo.
OO	Acro Manufacturing Company	Columbus 16, Ohio
PP	Alliance Manufacturing Company	Alliance, Ohio
QQ	Arco Electronics, Incorporated	New York 13, N. Y.
RR	Astron Corporation	East Newark, N. J.
SS	Axel Brothers Incorporated	Long Island City, N. Y.
TT	Belden Manufacturing Company	Chicago 44, Ill.
UU	Bird Electronics Corporation	Cleveland 14, Ohio
VV	Barber Colman Company	Rockford, Ill.
WW	Bud Radio Incorporated	Cleveland 3, Ohio
XX	Allen D. Cardwell Mfg. Company	Plainville, Conn.
YY	Cinema Engineering Company	Burbank, Calif.
ZZ	Any brand tube meeting RETMA characteristics.	
AB	Corning Glass Works	Corning, N. Y.
AC	Dale Products, Incorporated	Columbus, Neb.
AD	The Drake Mfg. Company	Chicago 22, Ill.
AE	Elco Corporation	Philadelphia 24, Penn.
AF	Hugh H. Eby Company	Philadelphia 44, Penn.
AG	Thomas A. Edison, Incorporated	West Orange, N. J.
AH	Fansteel Metallurgical Corporation	North Chicago, Ill.

