service manual

14·15

marantz

model fourteen/fifteen

Solid State Amplifier

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION

This service manual was prepared for use by Authorized Warranty Stations and contains service data for the Marantz Models 14 and 15 Solid State Amplifiers.

Adjustment information and troubleshooting hints included in this manual are intended for use by the knowledgeable and experienced technician only. All instructions should be read carefully and understood fully before proceeding with any service. No attempt should be made to proceed without a good understanding of the Solid State Amplifier operation and an adequate proficiency in the use of the test equipment required for servicing.

Symptoms (and their remedies) listed in the Troubleshooting Section are those which might occur in some units—based upon information derived from a significant sampling of units in the field. As the Marantz Company becomes aware of other field problems, supplementary service bulletins will be issued to all stations. To improve this service, all problems (and their solutions) not covered in this service manual should be brought to the attention of the Service Manager at our New York location.

NOTE

Performance Verification, Output Trimming, and Trouble Analysis Procedures in this manual apply to a Model 14 amplifier or to each of two modules comprising a Model 15 amplifier.

CIRCUIT DESCRIPTION

The signal to be amplified is fed from the input jack through C8 and R14 to the base of Q103. Refer to the schematic diagram of the amplifier, Figure 13. Resistor R14 and capacitor C9 is an R-F filter which bypasses to ground any R-F appearing at the input jack. This eliminates the possibility of detected R-F from reaching the loudspeaker terminals and causing unwanted signals in the loudspeakers. Q103 is one-half of a differential amplifier consisting of Q102 and Q103. The constant current supply for this differential amplifier is Q101. Q101 is biased by a network of resistors, diodes, and a zener diode in order to establish a slow turn-on characteristic, and a constant current of about 4 milli-amperes. Slow turn-on allows all other equipment to be stabilized before sound can be heard from the loudspeakers.

The combination of C1, R1, R2, and R17 comprise a time constant circuit for turning on Q101. If Q101 is not turned on, Q102 through Q106 will not be turned on either, because the drive current for these transistors is derived from Q101. As a result, there will not be any current drive in the printed circuit board. Without current drive there will be no current flowing through Q107 and the bias network. Q108 and Q111 will remain at cut-off, and therefore the output voltage will be at virtual ground or zero.

During turn-on, the voltage present at the junction of C1 and CR104 may be negative. To prevent this from affecting the turn-on time constant, CR104 clamps this point to ground during turn-on. CR104 also provides a discharge path to ground for C1 during turn-off. Rapid discharge of C1 ensures proper functioning of the slow turn-on feature in the event the amplifier is turned-on immediately after it has been turned-off. The network consisting of CR101, CR102, CR103, and R4 insures that Q101 always delivers a constant current of 4 milli-amperes under high or low line voltage conditions.

The differential amplifier consisting of Q102 and Q103 delivers current to a second differential amplifier Q105 and Q106. In order to supply a push-pull drive to drivers Q108 and Q111, current inversion is required. This is accomplished in Q104, a PNP transistor functioning as a current inverter. Q105 delivers current to the base of Q104, which inverts the signal. The collector of Q104 and the collector of Q106 supply the plus and minus drives, respectively. This allows the circuit board to deliver current to drivers Q108 and Q111 in a symmetrical push-pull fashion. Diodes CR106 and CR107 limit the input signal swing into Q105 and Q106 during short circuit conditions in the output.

The Solid State Amplifier uses two full-wave power supplies (separate B+ and B— supplies) and is a complementary-symmetry configuration. The entire amplifier, with the exception of the input network, is direct-coupled.

Resistor R8 (3.3K ohms, 2 watt) shunted by C3 (10UF, 100 volt electrolytic) allows the collector of Q105 to operate at a lower potential, thus reducing its dissipation. (This is essentially a current amplifier rather than a voltage amplifier.)

The D-C balance control R19 sets the output terminals at virtual ground potential (zero D-C). Small tolerances are compensated for by adjusting the D-C operating point of the input differential amplifier Q102 and Q103 so as to establish a zero D-C output reference voltage at the loudspeaker terminals. It is essential that this voltage be kept as low as possible.

D-C feedback from the loudspeaker terminals is applied through resistor R13 (10K-ohms) and R12 (91K ohms) to the base of Q102. The signal at the loudspeaker terminals, therefore, is the source from which the base of Q102 gets its drive. The resistance of this network corresponds to R15 (100K-ohms) from the Q103 base to ground. Thus the differential amplifier sees the same D-C resistance on its bases, and therefore the transistors operate under the same D-C conditions. The A-C gain of the amplifier is established by the combination of resistors R11 and R13. R12 is by-passed by capacitor C5 (.47 UF), so that a-c is not developed across it. Diode CR105 ensures that the voltage across C7, a polarized capacitor, never exceeds —0.7 volt.

Q107 in conjunction with CR110 and control R30 constitute a "variable diode" circuit which enables the proper bias voltage to be set across Q107 collector-to-emitter while still maintaining a logarithmic or diode characteristic. This is the bias setting for the output stages Q110 and Q113.

Drivers Q108 and Q111 deliver current through series regulators Q109 and Q112 to the base of the output transistors Q110 and Q113. The base of the regulators Q109 and Q112 are connected to the plus and minus power supplies through zener diodes CR109 and CR111, respectively. This serves to limit the current through the regulators to the output stages as follows. As the current in the output stages rises, the voltage drop across resistors R27 and R35 (.47-ohm, 10 watt) increases. When this voltage drop plus the voltage drop from base-to-emitter of transistors Q110 and Q113, plus the voltage drop from base-to-emitter of regulators Q108 and Q112 equals the zener voltage, any further increase in current through the regulators to the output stage is limited. In other words, as the current from Q108 or Q111 drivers increases, the tendency of the whole regulator system is to rise even further. However, since the base of the regulators are clamped by the zener diodes to a fixed potential, any further increase in current will be by-passed around the regulators through R24 and R32 (100-ohms, 1 watt) and therefore will not appear at the base of the output devices.

Lamps DS101 and DS102 in the collectors of the output stages serve a dual purpose: (1) they dissipate long term power from the output devices during accidental short circuit which may occur at the loudspeaker terminals or during overload conditions as the amplifier is driven to its clipping point and beyond, (2) They act as overload indicators to signal that the unit is being over driven. They do not dissipate an appreciable amount of instantaneous power.

The stud rectifiers CR112 and CR113 minimize distortion, especially at the high frequency end of the band. Coil L5 shunted by resistor R37 (2.2-ohms, 1 watt) reduce the small amounts of very high frequency excursions that would appear at the loudspeaker terminals.

TECHNICAL SPECIFICATIONS

Input Signal for Rated Power Output	1 volt rms
Input Impedance	100K ohms
Frequency Response	Within 1 db, 10 to 60 KHz.
Power Output, 20 Hz to 20,000 Hz (each channel)	70 watts rms at 4 ohms load 60 watts rms at 8 ohms load 40 watts rms at 16 ohms load
Damping Factor	Greater than 150 with 8-ohm load
Overload Recovery	Instantaneous
Total Harmonic Distortion	Less than 0.1% with 4 to 16 ohm load—typically 0.03% with 8-ohm or higher load—at full rated output, at any frequency from 20 to 20,000 Hz. Distortion decreases as output level is lowered.
Total Noise (shorted input broadband)	Better than 90 dB below 60 watts into 8 ohms
Power Bandwidth*	8 Hz to 60 KHz at 8 ohms
Continuous output at mid-frequencies*	70 watts at 8 ohms
Dynamic (music) output at mid-frequencies*	85 watts at 8 ohms
Difference in frequency response*	±0.05 dB
Power Requirements**	105 to 135 volts 50 to 60 Hz. 240 watts
Dimensions	15-3/8 inches wide 5-3/4 inches high 8 inches deep
Weight (as shipped)	Model 14—18 pounds; Model 15—34 pounds

* From IHF Standard (IHF-A-201 1966)
** Split primary windings permit adaptation to 210-270 volts

Specifications subject to change without notice

TEST EQUIPMENT REQUIRED FOR SERVICING

Table I lists the test equipment required for servicing the Model 14 and 15 Solid State Amplifiers. The trim box listed in the table must be fabricated from the components shown in the schematic diagram, figure 1.

TABLE I. TEST EQUIPMENT REQUIRED

Distortion Analyzer	Hewlett Packard 331A or 333A
Audio Oscillator	Hewlett Packard H20-200CD
Oscilloscope	Tektronix 503 (or equal wideband)
RCA Senior Volt-Ohmyst	WV-98C
2 Load Resistors	Dale NH-250 (8 ohms ±0.5%, 250 watts)
Wattmeter	Simpson Model 390
Trim Box	See figure 1

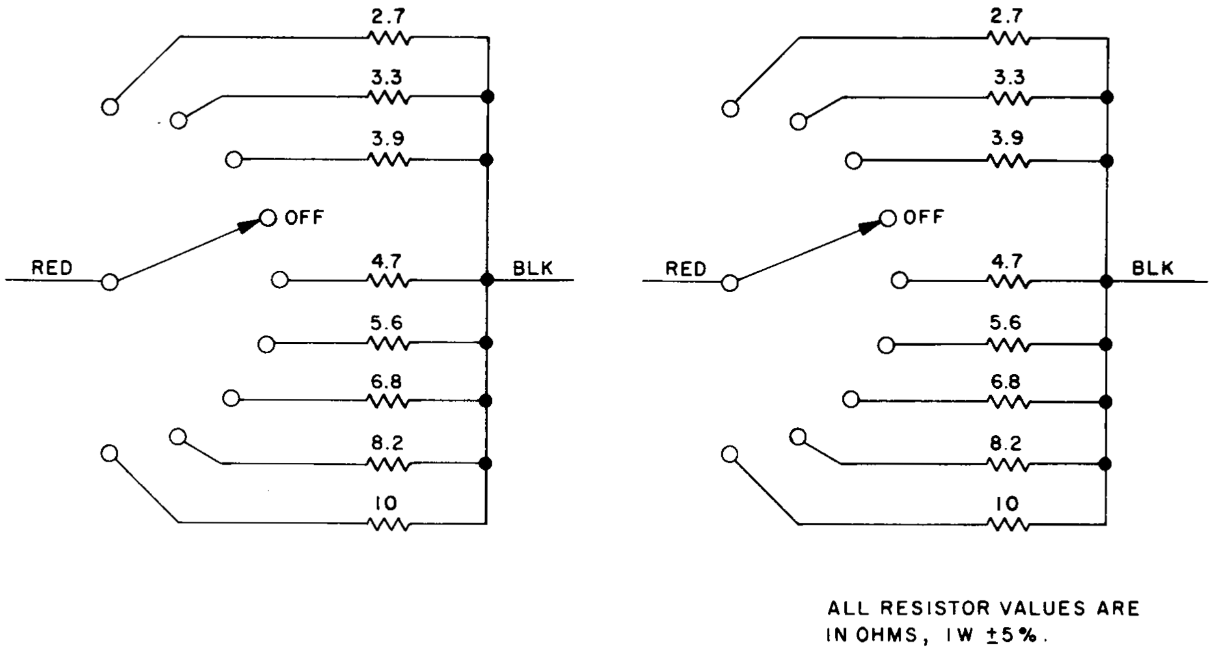


Figure 1. Trim Box Schematic Diagram

CONVERSION TO 240 VOLT OPERATION

To convert the amplifier from 120 Volt operation to 240 Volt operation, proceed as follows. Figure 2 shows the connections for both before and after the conversion.

1. Install a threaded insulated terminal (Marantz part number 87-1020) in the spare hole located near the line cord.
2. Secure the terminal with a 6-32 x 1/4-inch machine screw.
3. Connect the black/white and black/green transformer leads together at this terminal.
4. Change fuse to 1-1/2A, AGC or 3AG.

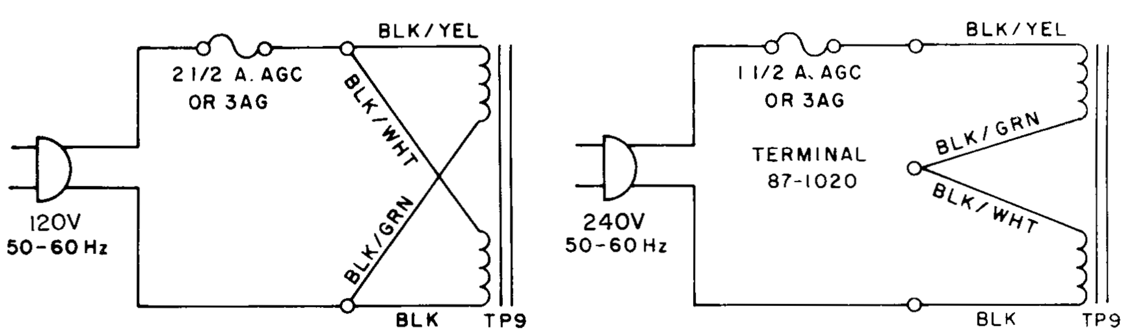


Figure 2. 240 Volt Conversion Diagram

DISASSEMBLY INSTRUCTIONS

MODEL 14. To disassemble the Model 14 Solid State Amplifier for servicing, proceed as follows:

1. Remove the four larger Phillips head screws from the top grill and remove the grill.
2. Remove the rubber feet securing the grill at the bottom of the amplifier. Remove the grill.
3. Remove the four Phillips head screws that secure the rear panel to the main chassis. This will permit access to the printed circuit board.
4. The other components are accessible by removing four Phillips head screws holding the U-shaped extrusion on which the rear panel is mounted. Two of these screws are located at each side of the amplifier.

MODEL 15. To disassemble the Model 15 Solid State Amplifier for servicing, proceed as follows:

1. Disconnect the power cord inter-connecting the two modules.
2. Being very careful not to mar the panel finish or the hex head bolts, remove the four bolts that secure the panel to the amplifier modules.
3. Gently pull the panel forward and disconnect the pilot lamps.
4. Loosen and remove the No. 8 cap screws using a 9/64-inch Allen wrench.
5. Remove the four Phillips head screws from the center plate that holds the two modules together. The plate is at the rear of the amplifier.
6. Separate the modules and proceed with disassembly of the Model 14.

PERFORMANCE VERIFICATION TEST PROCEDURE

A. TEST EQUIPMENT. Refer to Table I for the test equipment required.

B. PRELIMINARY PROCEDURE.

1. Set up the amplifier module to be tested and the test equipment as shown in figure 3.
2. If a Model 15 is to be tested, disconnect the interconnecting power cord between modules and test one module at a time.
3. Make sure that the connections between the the resistive load and the LOUDSPEAKER terminals of the amplifier module have negligible resistance compared with the resistance of the load itself. Appreciable resistance in the wiring adds to the total load, resulting in inaccurate measurement of output power.

C. IDLING CURRENT AND D-C BALANCE TEST.

1. Connect a shorting plug to the INPUT jack of the amplifier module.
2. Make sure that the Variac is set for zero volt before applying line power to the amplifier.
3. Turn up the Variac slowly while observing the voltmeter and the wattmeter. When the line voltage reaches approximately 90 volts, the amplifier should turn on, and the line wattmeter should indicate between 5 and 15 watts. If the wattmeter indicates either zero watt or greater than 100 watts, a defect exists. Turn off the Varaic and refer to the Trouble Analysis section of this manual.
4. Advance the Variac until the voltmeter indicates 120 volts. If the wattmeter does not indicate 30 ± 1 watt, adjust bias potentiometer R30, as follows:
   a. Remove the top grill cover from unit.
   b. Using a long, narrow, insulated screwdriver, adjust bias control R30 until 30 watts is obtained on the wattmeter. The bias control is located in the lower left hand corner of each module.
5. Turn off the Variac (using switch only) and discharge C15 and C21 (the large electrolytics), using a 10-ohm, 1-watt resistor. Do not use a screwdriver to discharge the capacitors.
6. Set the controls of the DC VTVM for plus (+) DC measurement on the 1.5-volt scale. Short the VTVM test leads together and offset the pointer to the zero center of the scale.
7. Connect the negative lead of the VTVM to the ground (gray) LOUDSPEAKER terminal and the positive lead to the hot (red) terminal on the amplifier.

8. Temporarily remove the amplifier line cord from the Variac and turn on and adjust the Variac for 120 volts output. Turn off the Variac, and reconnect the amplifier line cord.
9. Turn on the Variac, applying the full 120-volt line to the amplifier, while observing the VTVM. If the meter pointer swings off-scale in either the positive or negative direction, remove power and refer to the Trouble Analysis Section.
10. If the meter indicates on-scale, but not at the zero center established in step no. 6, remove the access cover screw (See Figure 4) and adjust potentiometer R19, using a small, narrow-blade screwdriver, so that a zero center scale indication is obtained. This represents zero volts, dc.

D. TOTAL HUM AND NOISE TEST

1. Connect a shorting plug to the INPUT jack of amplifier module.
2. Connect an 8-ohm resistive load and a distortion analyzer across the LOUDSPEAKER terminals.
3. Set the distortion analyzer controls for voltage measurement, and apply power to the amplifier.
4. If the analyzer indicates greater than 0.0007 volts (—90 dB), refer to the Trouble Analysis Section. Typical noise values are 0.0002 volt (—100 dB).

E. OUTPUT CLIPPING TEST

1. Connect the audio generator to the INPUT jack of amplifier module. Set frequency to 2000 Hz.
2. Connect the 4-ohm resistive load and the distortion analyzer to the LOUDSPEAKER terminals.
3. Set distortion analyzer controls for voltage measurement on the 30-volt scale.
4. Turn on the amplifier and increase the output of the audio generator, until clipping occurs, as displayed on the oscilloscope. See Figure 5.
5. Vary the output of the audio generator while observing the oscilloscope display. Verify that the distortion analyzer indication is between 17.32 and 18.0 volts at the point where clipping is barely discernible. If the clipping-point voltage is below 17.32 volts or above 18.0 volts, refer to the Output Trimming Procedure Section of this manual.
6. Set the distortion analyzer controls for distortion measurement on the 10% scale, at 2000 Hz.
7. Adjust the controls of distortion analyzer, if required, to obtain an oscilloscope display similar to that shown in Figure 6.
8. Observe the sharp clipping spikes at each end of the pattern. As the audio generator output is varied slightly, the spikes should become visible at the same time, and should have equal amplitudes. If the spikes do not appear simultaneously, or have noticeably different amplitudes, refer to the Output Trimming Procedure.

F. HARMONIC DISTORTION TEST

1. Connect the audio generator to the INPUT jack of the amplifier module.
2. Connect the 4-ohm resistive load and the distortion analyzer to the LOUDSPEAKER terminals.
3. Set the frequency controls of the audio generator and the distortion analyzer to 2000 Hz.
4. Set the controls of the analyzer for voltage measurement on the 30-volt scale.
5. Adjust the generator output level until the analyzer meter indicates 16.73 volts. (This represents 70 watts into a 4-ohm load.)
6. Measure the total harmonic distortion with the analyzer and verify that it is less than 0.1%. See Figure 7.
7. Set the frequency controls of the generator and the analyzer to 20,000 Hz and repeat steps 4, 5, and 6. See Figure 8.
8. Set the frequency controls of the generator and the analyzer to 20 Hz and repeat steps 4, 5, and 6. See Figure 9.

G. PARASITIC OSCILLATION AND SHORT CIRCUIT TEST.

1. Set frequency controls of audio generator and distortion analyzer to 20 Hz.
2. Set distortion analyzer controls for distortion measurement on the 10% scale.
3. Connect the 4-ohm resistive load and the distortion analyzer to the LOUDSPEAKER terminals of the amplifier.
4. Adjust the generator output level until clipping occurs, as displayed by the oscilloscope. See Figure 10.
5. Verify that the display is free of parasitic oscillations. If parasitics appear, as shown in Figure 11, refer to the Trouble Analysis Section.

6. Disconnect the 4-ohm resistive load from the amplifier, but do not disconnect the distortion analyzer.
7. Adjust the generator output level until clipping occurs. See Figure 10.
8. Verify that the display is free of parasitic oscillations. If parasitics appear, under this no-load test condition, refer to Trouble Analysis section.

CAUTION

Do not perform short circuit test if amplifier shows any signs of parasitic oscillation.

9. Connect a short circuit across the amplifier LOUDSPEAKER terminals for about 10 seconds. The overload indicator lamps should light very brightly until the short circuit is removed.

OUTPUT TRIMMING PROCEDURE

1. Set up test equipment and amplifier as in Harmonic Distortion test (paragraph F), steps 1 thru 4.
2. If amplifier starts to clip before 17.32 volts (75 watts) decrease the value of R28 or R36 by shunting with another resistor. The proper value may be determined by connecting the trim box (figure 1) across R28 or R36 and selecting the value that will permit the amplifier to clip symmetrically between 17.32 and 18 volts (75 to 80 watts).
3. In some cases it may be necessary to use two resistors in parallel in order to obtain proper clipping point voltage.
4. If it is not possible to obtain a high enough clipping point voltage with the above method, it will be necessary to try substitution of the output, driver, or regulator transistors.
5. If clipping occurs at a point above 18 volts (80 watts), the value of resistor R28 or R36 should be increased.
6. To increase the value of R28 or R36, remove the black jumper wire connecting one end of the resistor to the socket contact of output transistor Q110 or Q113 (DTM-13 or DTM-14) and substitute a suitable length of resistance wire. Use of 24 gauge, 1/4-ohm per foot wire (approximate requirements) will result in convenient lengths.
7. The length of the resistance wire required must be determined empirically.
8. If the clipping point voltage still remains high, substitute the output, driver, or regulator transistors.

TROUBLE ANALYSIS PROCEDURE

The trouble analysis procedure that follows contains some of the typical trouble symptoms encountered in the field and their remedies. Other field problems will be covered through service bulletins (supplementary to this manual) which will be issued to all stations. Other servicing aids included in this manual are a component location illustration, figure 12, which locates those transistors and diodes commonly requiring servicing in the field, and the schematic diagram of the Solid State Amplifier, figure 13. The schematic diagram contains a Voltage Chart which lists typical voltages taken at various test points in a normally-operating amplifier.

NOTE

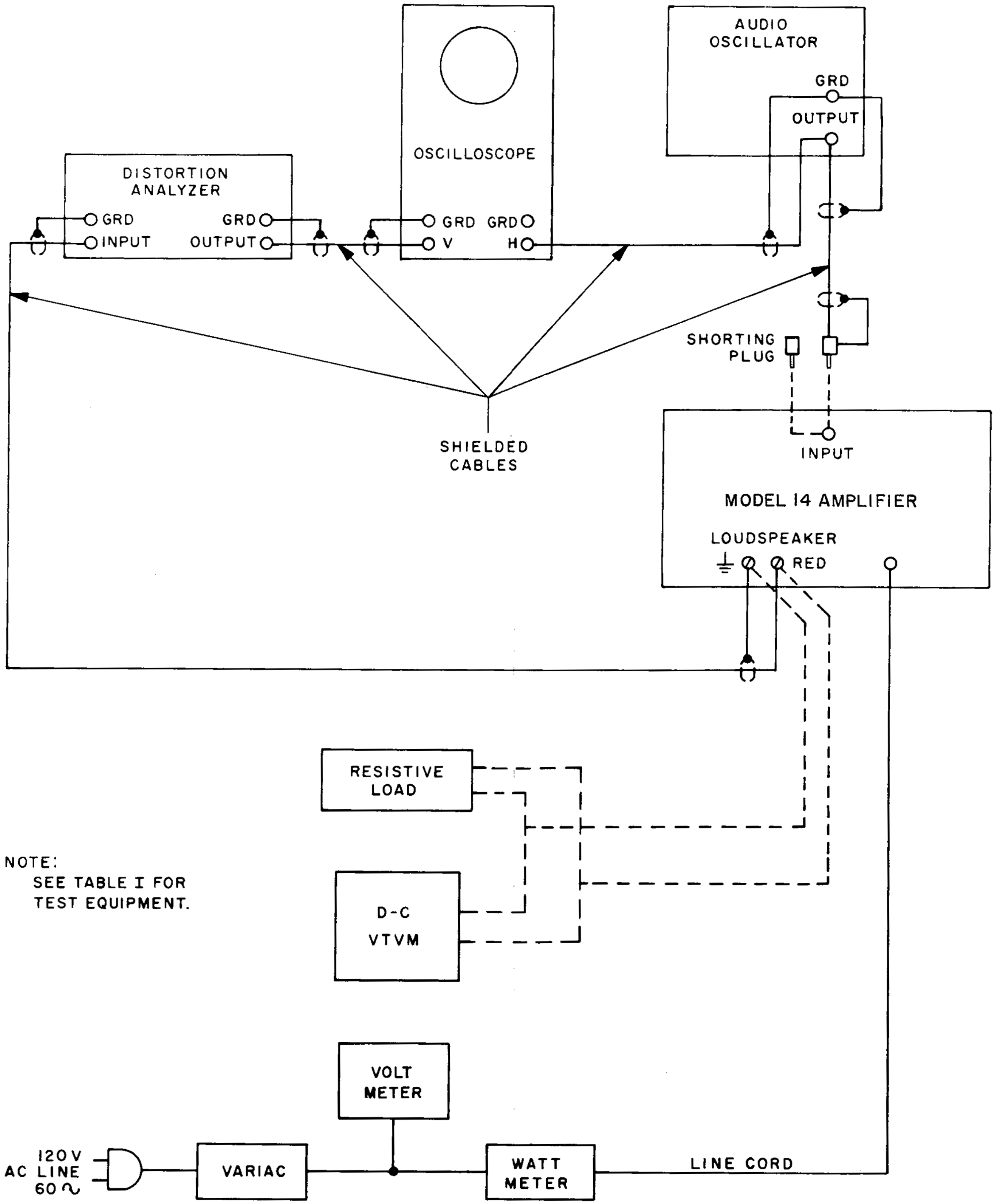
Performance Verification is necessary following any repair.

SYMPTOM	PROCEDURE
1. Excessive line consumption (100 watts or more).	a. Check for shorted rectifiers CR114, CR116 (DHC 200R), CR115, CR117 (DHC 200), C15, C21. b. Check for shorted transistors Q107 through Q113 (DTM10, 11, 12, 13, 14), or zener diodes CR109 or CR111 (DIN4732A). Also check for open lamps DS101, DS102, control R30, and bias diode CR110.

CAUTION

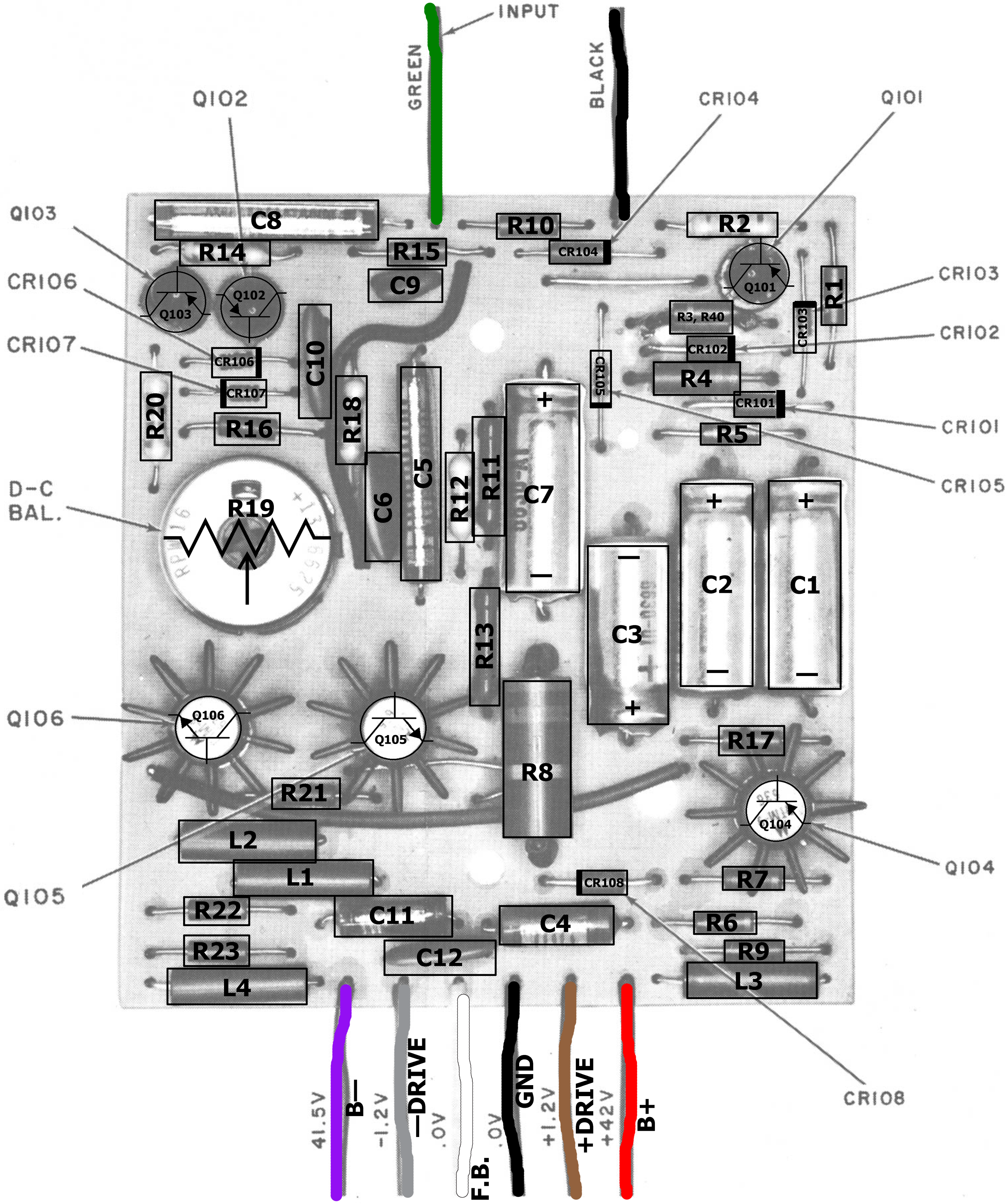
Because the driver and output stages are direct coupled, many components may fail as a direct result of an initial component failure. If a shorted transistor or Zener diode is found, or an open lamp, control or bias diode, be sure to check the remaining driver and output components for short or open circuits before re-energizing the amplifier. After replacement of any of these components, increase the Variac voltage slowly while monitoring the wattmeter as described in paragraph C of Performance Verification.

SYMPTOM	PROCEDURE
2. No line consumption or zero bias.	Check for open fuse, transistors Q101 (DTM6), Q107 through Q113 (DTM10, 11, 12, 13, 14), zener diode CR109 or CR111 (DIN4732A), or overload indicators DS101 and DS102.
3. High d-c voltage at loudspeaker terminals before time delay circuit is deactivated.	Check transistors Q105 and Q106 (DTM8), and Q104 (DTM9) for leakage. Voltage on these transistors should not vary more than 1 volt.
4. High d-c voltage at loudspeaker terminals at all times.	Check for shorted transistors Q104 (DTM9), Q105 or Q106 (DTM8).
5. No D-C Balance.	Check for open transistors Q104 (DTM9), Q105 or Q106 (DTM8).
6. High hum and noise level.	Check by substitution transistors Q101, Q102, and Q103 (DTM6). Note that Q102 and Q103 are a matched pair and must be replaced as a pair.
7. Parasitic Oscillation.	a. Remove capacitors C14 (.22 UF) and C17 (.0047 UF). b. Check by substitution transistors Q113 (DTM13) and Q114 (DTM14).



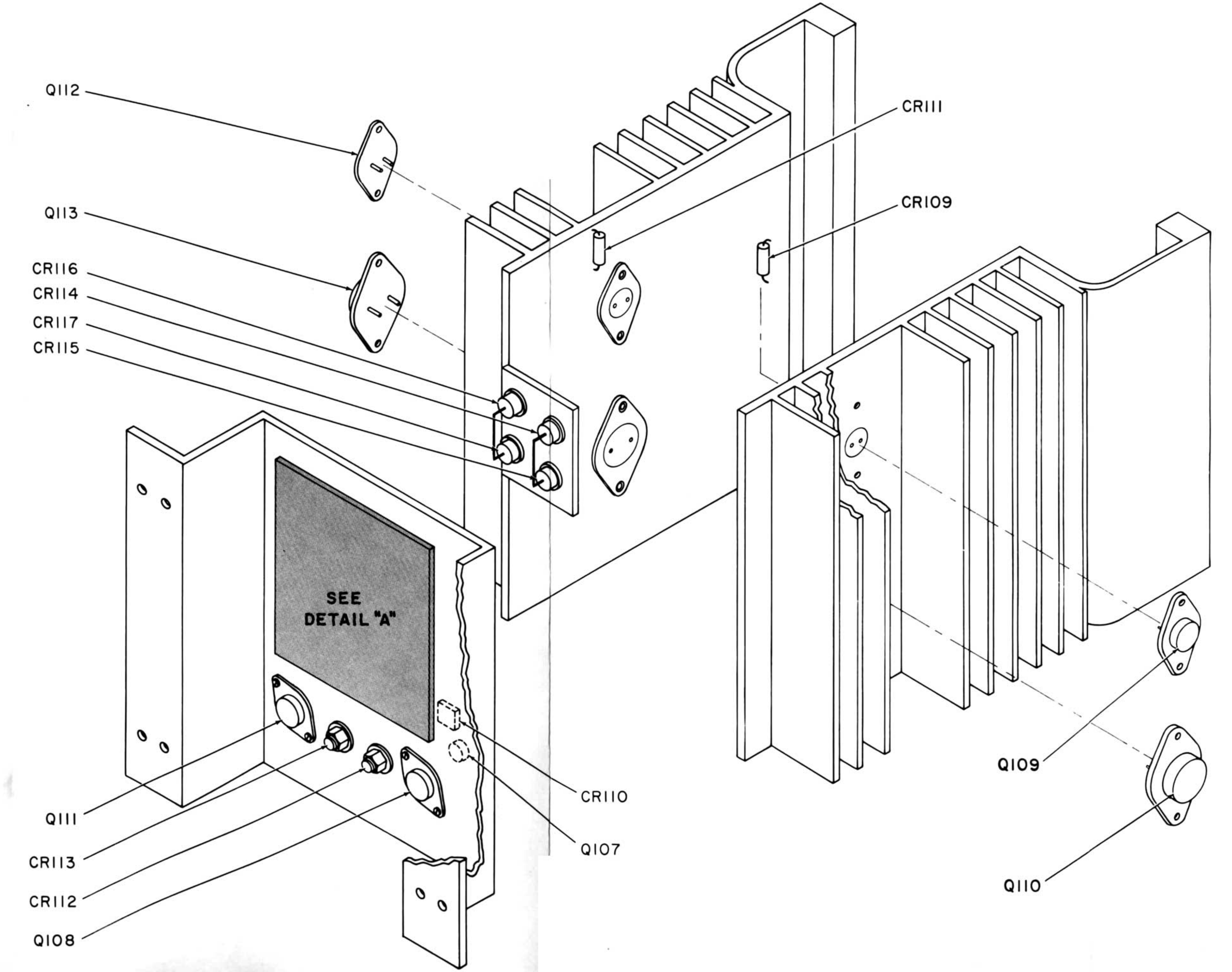
NOTE:
SEE TABLE I FOR TEST EQUIPMENT.

Figure 3. Performance Verification Test Set-Up



DETAIL A

Figure 12. Solid State Amplifier Transistor and Diode Locations


Q112
Q113
CR116
CR114
CR117
CR115
CR111
CR109
SEE
DETAIL "A"
Q111
CR113
CR112
Q108
CR110
Q107
Q109
Q110

NOTES

VOLTAGE CHART

TEST POINT	BASE (V)	EMITTER (V)	COLLECTOR (V)
Q101	+30	+30	+1.34
Q102	+0.7	+1.34	−40
Q103	+0.72	+1.34	−40
Q104	+41	+42	+13
Q105	−40	−41	+1.8
Q106	−40	−41	−1.7
Q107	−0.56	−1.8	+1.3
Q108	+1.33	+0.7	+41
Q109	+41	+42	+41
Q110	+42	+42	+0.8
Q111	−1.2	−0.66	−41
Q112	−41	−42	−41
Q113	−42	−42	−0.8
B+	+42	—	—
B−	−42	—	—

NOTES AND CONDITIONS:

1. All DC voltages ±10%.
2. All voltages measured using a VTVM.
3. All voltages measured while maintaining a 120-volt line input.
4. All voltages measured with input jack shorted.
5. Transistor voltages measured with respect to B−.
6. B+ and B− measured with respect to ground bus.

CIRCUIT NO.	MARANTZ NO.	CIRCUIT NO.	MARANTZ NO.
CR101	D1N4736A	Q101	DTM6
CR102,8	DMR2360	Q102,3	MATCHED DTM6
CR103,5,6,7	DBTR1557	Q104	DTM9
CR104	DX1N457	Q105,6	DTM8
CR109,11	D1N4732A	Q107,	DTM10
CR110	DBTR1559	Q108,12	DTM11
CR112	DMR1120R	Q109,11	DTM12
CR113	DM1120	Q113	DTM13
CR114,116	DHC200R	Q110	DTM14

UNLESS OTHERWISE SPECIFIED: CAPACITORS IN DECIMALS ARE uf
ALL OTHER ARE pf

F DENOTES PRECISION FILM RESISTORS

* DENOTES COMPONENTS SELECTED FOR OPTIMUM CIRCUIT OPERATION.

ALL RESISTORS ARE IN OHMS, 1/4 W EXCEPT AS NOTED.

△ DENOTES COMPONENTS THAT MAY BE OMITTED FROM UNITS.

ALL WAVEFORMS TAKEN WITH OSCILLOSCOPE SENSITIVITY SET AT 10 MV/CM.

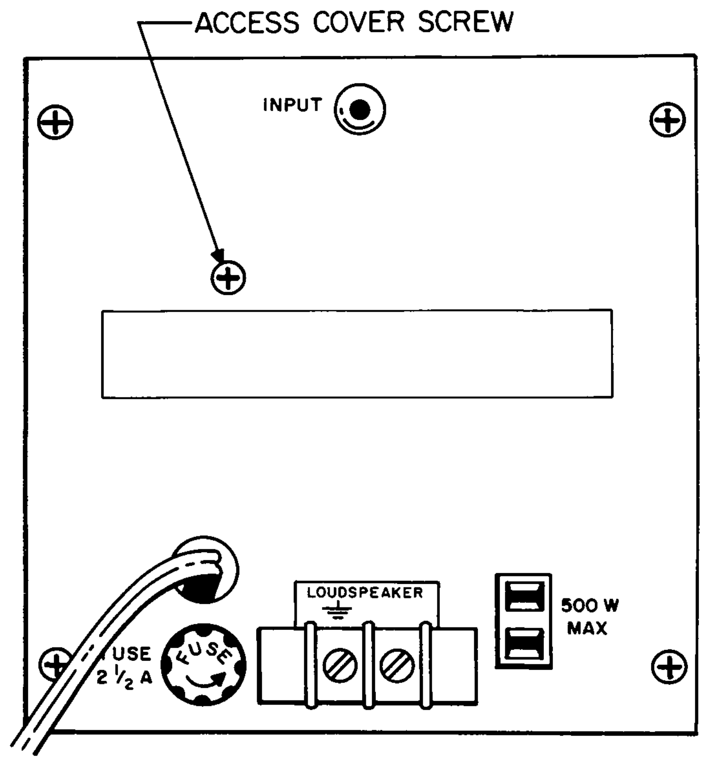


Figure 4. Location of D-C Balance Adjustment

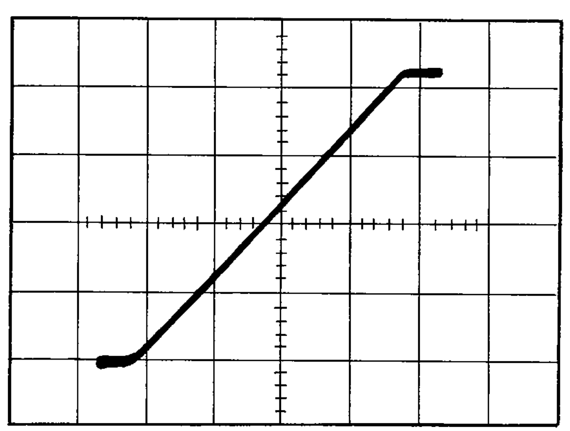


Figure 5. Oscilloscope X-Y Display Showing Clipping

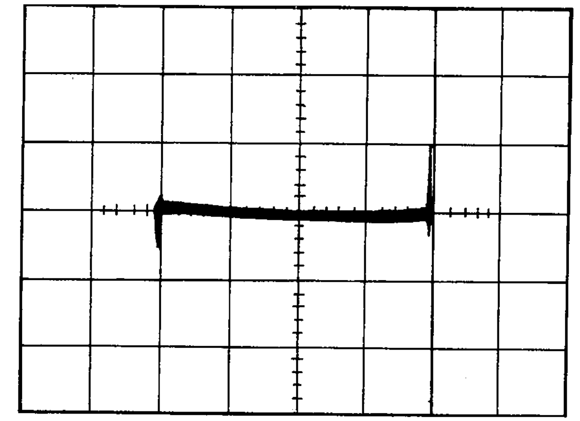


Figure 6. Residual Output of Analyzer Showing Clipping

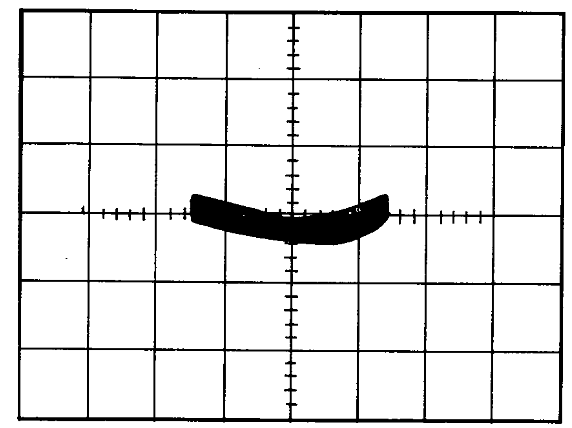


Figure 7. Residual Output of Analyzer, Rated Distortion at 2000 Hz

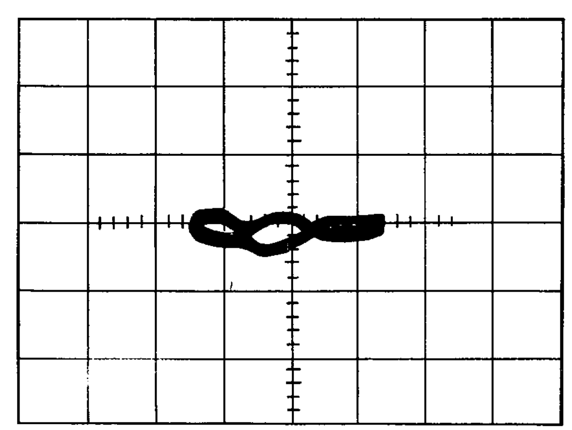


Figure 8. Residual Output of Analyzer, Rated Distortion at 20,000 Hz

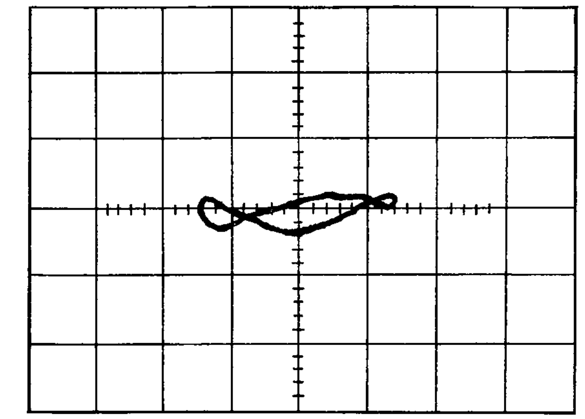


Figure 9. Residual Output of Analyzer, Rated Distortion at 20 Hz

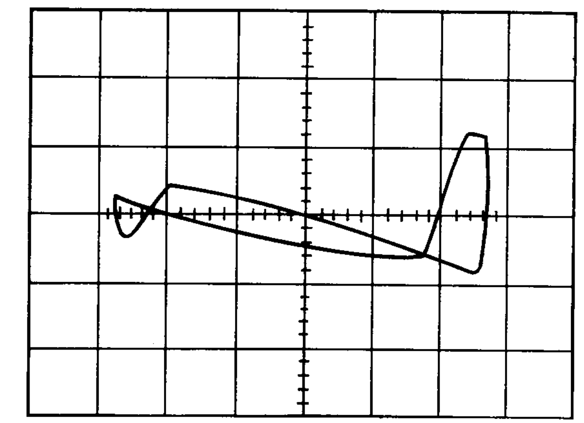


Figure 10. Residual Output of Analyzer at Clipping, Without Evidence of Parasitic Oscillation at 20 Hz

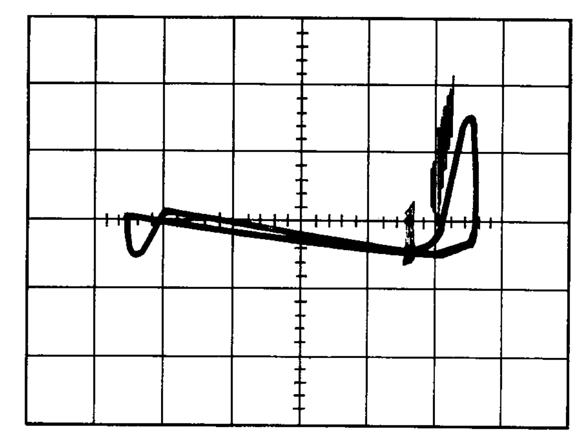


Figure 11. Residual Output of Analyzer at Clipping, With Evidence of Parasitic Oscillation at 20 Hz

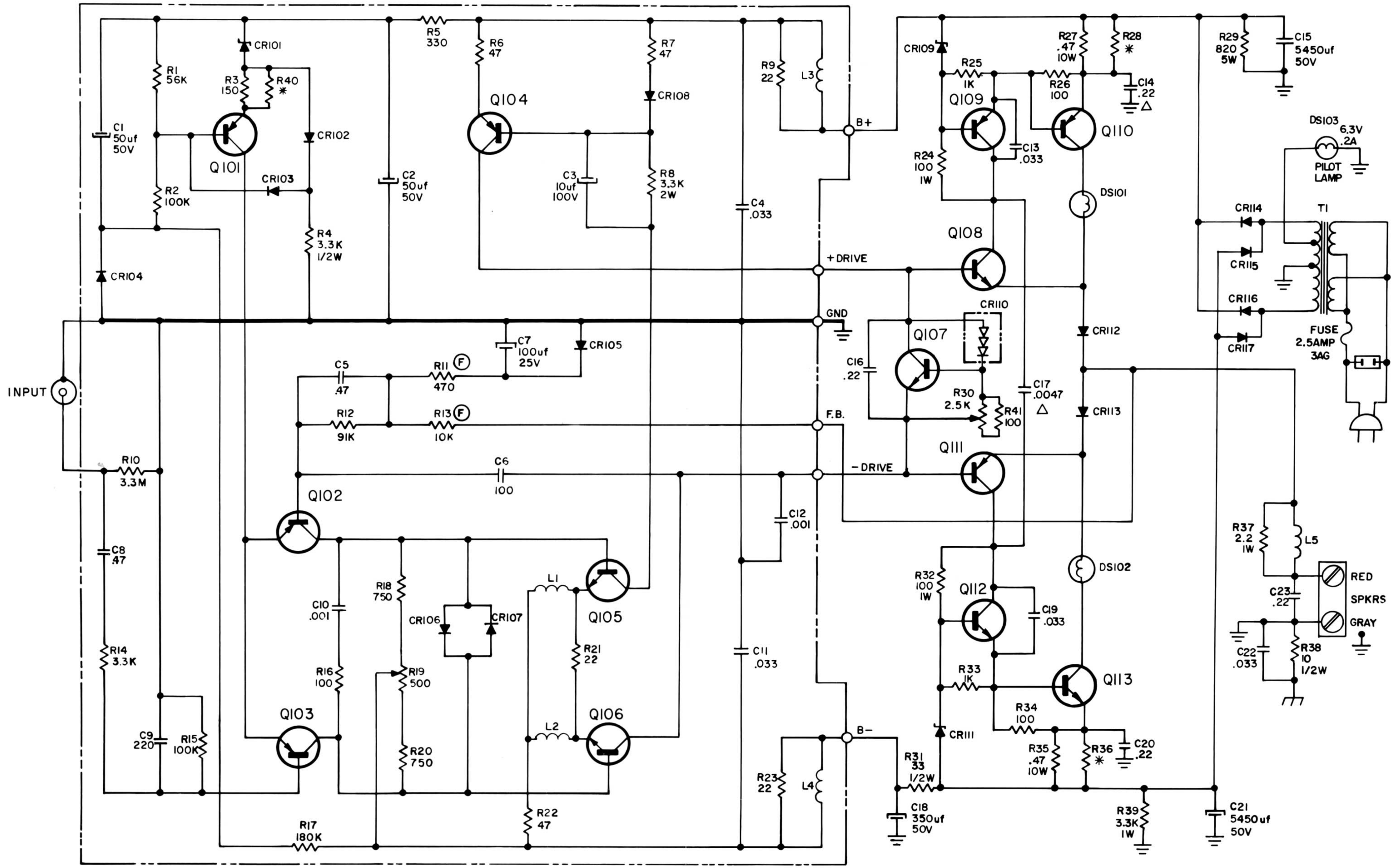


Figure 13. Solid State Amplifier Model 14, Schematic Diagram and Voltage Chart