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Phase Linear
700
700 B

SERVICE MANUAL



700/700B
SERVICE MANUAL

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THIS MANUAL IS INTENDED FOR USE ONLY BY QUALIFIED SERVICE PERSONNEL. HAZARDOUS VOLTAGES MAY BE ENCOUNTERED IN THE SERVICING OF A MODEL 700/700B AMPLIFIER. USE EXTREME CAUTION AND READ ALL INSTRUCTIONS CAREFULLY.

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prepared 6/76
revised 2/81

1-0. TECHNICAL SPECIFICATIONS

POWER OUTPUT: 345 WATTS PER CHANNEL MINIMUM
RMS AT 8 OHMS FROM 20-20kHz WITH NO MORE
THAN 0.25% TOTAL HARMONIC DISTORTION.

TYPICAL THD: 0.01% at rated power into 8 ohms.

IM DISTORTION(60Hz:7kHz=4:1): less than 0.25%
into 8-ohms at rated power.

SIGNAL-TO-NOISE RATIO: greater than 100dB below
rated output.

INPUT IMPEDANCE: 100k-ohms nominal; reduces to
10k-ohms with input sensitivity controls
shorted(fully CW).

DAMPING FACTOR: 1000:1 @ 1kHz

SLEW RATE: greater than 11 volts/microsecond

RISE TIME: less than 1.6 microseconds(small signal)

POWER BANDWIDTH: 12Hz-40kHz, +0-1dB

PHASE SHIFT: 0 degrees at 20Hz, lagging 10 degrees
at 20kHz.

INPUT SENSITIVITY: 1.75v for rated output into
8 ohms.

2-0. OPERATING INSTRUCTIONS

2-1. Inputs

The model 700 or 700B can be operated in either the "normal" or direct coupled input modes. For high fidelity home use the unit should be operated in the NORMAL mode. This provides for AC coupling at the inputs which has a subsonic frequency rolloff of 6dB/octave with a corner frequency of about 15Hz. This can be effective in preventing loudspeaker woofer damage from DC or subsonics passed to the amplifier from a unit "upstream" in the signal path.

In the DIRECT coupled mode frequencies are amplified down to DC, at which there is a gain of 1. In some sound reinforcement applications it may be desirable to operate the unit in the DIRECT coupled mode.

The front panel LEVEL controls are merely sensitivity controls which affect only the input signal. They are not connected to the amplifier output stage and do not affect amplifier gain.

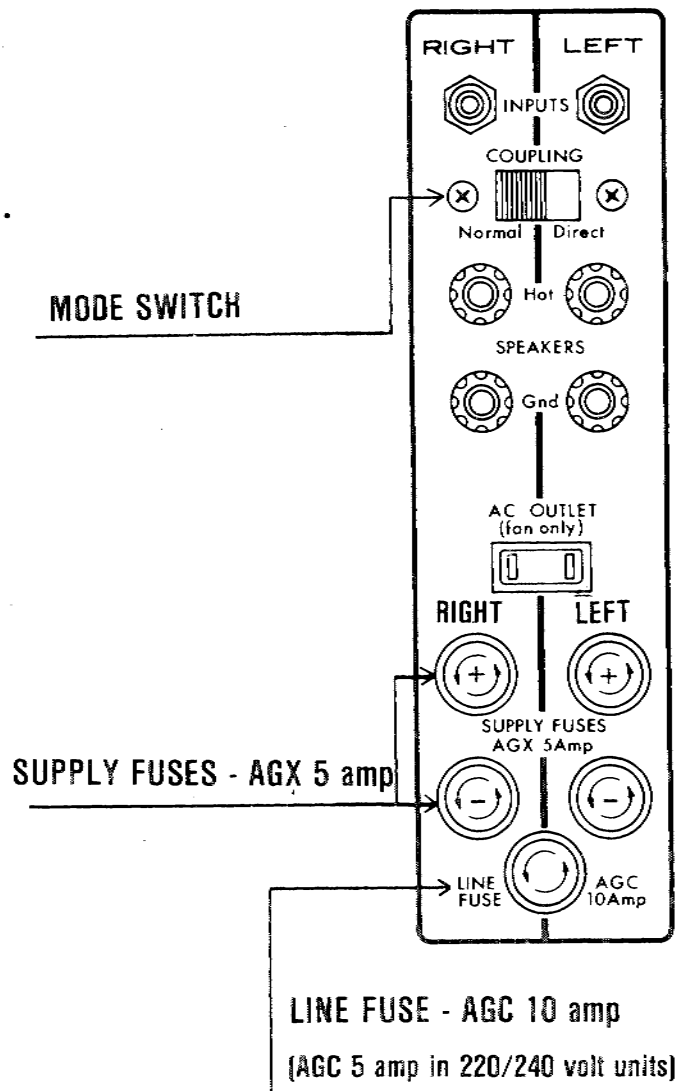
2-2. Speaker Impedance

The model 700/700B amplifier was designed to drive a speaker load impedance from 4-ohms to infinity. DO NOT DRIVE A SPEAKER LOAD OF LESS THAN 4-OHMS NOMINAL IMPEDANCE. It is permissible to drive the amplifier into an open load (nothing connected to the amplifier outputs).

Multiple speaker connections can be made to the 700/700B provided that the final nominal load impedance presented to the amplifier is not less than 4-ohms.

2-3. Thermal Protection

The 700/700B amplifier is equipped with a thermal cut-out switch in each channel. The switch activates at approximately $90^{\circ}\text{C} \pm 5^{\circ}$. If the amplifier overheats and shuts down it is advisable to turn the POWER switch off to insure that the thermal switch contacts will not be subjected to the large current surge associated with turn-on.



2-4. Amplifier Fusing

The 700/700B amplifiers are factory-fitted with AGX-5 amp fuses in the supply and AGC-10 amp fuse in the line. AGX fuses can be substituted with any 1" ($\pm 1/8$ ") fast-blow fuse of the same current rating. AGC can be substituted with a $1\frac{1}{4}$ " ($\pm 1/8$ ") fast-blow fuse of the same rating.

For operation of the amplifier other than home-use high fidelity, it is recommended that the AGX-5 amp supply fuses be replaced with AGX-8 amp fuses. This may be necessary if the amplifier is being used in a sound reinforcement application, for sine wave bench testing or if driving a nominal speaker load impedance of less than 8-ohms.

NOTE: NEVER USE GREATER THAN AN 8-AMP FUSE FOR SUPPLY FUSING.

2-5. Speaker Fusing

With the use of a high-powered amplifier it is important to realize the necessity for proper in-line loudspeaker fusing as an added measure of speaker protection. THE SUPPLY FUSES IN THE MODEL 700/700B ARE PRIMARILY FOR PROTECTION OF THE AMPLIFIER TO MINIMIZE DAMAGE TO THE AMPLIFIER SHOULD A MALFUNCTION OCCUR. Speaker protection is secondary and the amplifier supply fusing should not be relied on as a primary means of protecting the loudspeakers in the event of a malfunction.

PHASE LINEAR HIGHLY RECOMMENDS AND ENCOURAGES THE USE OF ADDITIONAL IN-LINE FUSES FOR OPTIMUM SPEAKER PROTECTION.

Fusing information should be available from each loudspeaker manufacturer for each model produced. If fusing information is not available from the manufacturer the following equation is recommended for determining the correct speaker protection fuse:

$$I = \sqrt{\frac{P}{4R}}$$

where I is the current rating of the fuse in amperes, P is the maximum recommended peak power handling capability of the loudspeaker in watts, and R is the nominal speaker impedance in ohms. For example, an 8-ohm speaker capable of handling 200 watts of peak power should be protected with a 2.5-amp fast-blow fuse. NEVER USE SLOW-BLOW FUSES FOR SPEAKER PROTECTION.

The fuse should be placed in series with either the positive or negative speaker wire on each channel.

2-6. Sound Reinforcement/Commercial Use

Although not designed either electrically or physically for commercial use, the 700/700B amplifier can be used providing that the following precautions are taken:

1. The unit should be fan-cooled.
2. A speaker load impedance of greater than 4-ohms must be used. DO NOT DRIVE THE AMPLIFIER INTO A LOAD IMPEDANCE OF LESS THAN 4-OHMS! Serious damage to the output stage of the unit can result.

3. Do not exceed the recommended supply and line fuse values. It is recommended that for commercial applications the AGX5 supply fuses be replaced with AGX8 amp fuses. If, at continued high power levels the AGC10 line fuse continues to blow it is permissible to replace this with a AGC15-amp fuse. USE ONLY FAST-BLOW FUSES!
4. If the amplifier is to be rack-mounted it is important that additional support be provided for the power transformer. If the unit is rack-mounted by the front panel alone the chassis "ears" to which the aluminum front panel is bolted may tear away from the chassis. If this occurs it may be necessary to provide additional reinforcement to the chassis by mounting an L-bracket behind each chassis "ear". Chassis replacements are not cheap!

2-7. General No-No's

NEVER DRIVE THE AMPLIFIER INTO A SPEAKER LOAD IMPEDANCE OF LESS THAN 4-OHMS NOMINAL.

NEVER EXCEED THE RECOMMENDED SUPPLY AND LINE FUSE RATINGS.

NEVER EVER EVEN BEGIN TO THINK ABOUT PARALLELING THE TWO CHANNEL OUTPUTS TOGETHER TO FORM A MONO AMP. YOU'LL ONLY MAKE A MESS OF THE OUTPUT STAGE. AND A MESS OF YOUR HEAD AND POCKETBOOK. (The amplifier can be bridged at the inputs to form a mono amp provided the speaker load driven is greater than 8-ohms. Contact the factory for details.)

NEVER RACK-MOUNT THE AMPLIFIER WITHOUT PROVIDING ADDITIONAL SUPPORT FOR THE POWER TRANSFORMER.

And finally, a word about turn-off noise...

It is a characteristic of the 700 and 700B amps to display a delayed turn-off thump a few seconds after the unit is turned off. This is caused by the power supply discharging through the front end differential transistors. It should, however, be a fairly low level noise(it's not always a thump). If it is extremely loud and threatens loudspeakers refer to section 6-8.4 on page 26. Also be sure the speakers are externally fused per section 2-5 on the opposite page.

3-0. CIRCUIT DESCRIPTIONS

3-1. PL0171 Drive PC Board(Model 700)

Input signal is applied to the base of Q2 from one of two switch-selectable sources(S2). S2 applies the output of emitter follower Q1 or a signal applied from the DIRECT input jack. The RC combination in the emitter of Q1 serves as a time delay circuit to prevent turn-on transients from reaching the base of transistor Q2 for approximately one-half second. The output of the differential pair comprised of Q2 and Q3 is applied to a second differential pair, Q4 and Q5. Differential amplifier Q4 and Q5 provide single-ended output which is applied to the base of Q9. Q9 provides the final voltage gain to drive the predriver transistors Q10 and Q17. The PNP predriver Q17 serves as a phase inverter to drive the negative output driver transistor Q18. The emitter of Q18 drives the paralleled emitter follower output transistors Q19, Q20, Q21, Q22 and Q23. The positive half of the signal is amplified by emitter follower Q10, which in turn drives the paralleled outputs Q11, Q12, Q13, Q14, Q15 and Q16.

Level control R4 controls the input signal applied to the base of Q2. It is operational only when the signal is received on the normal input jacks. R7 and R17 are D.C. offset adjustments which serve to null out small V_{be} differences between Q2 and Q3.

Diodes D5, D6 and D7 provide forward bias to the bias regulator transistor Q6. R36 adjusts the slight amount of forward bias necessary to provide a few milliamps of idling current in the driver transistors. This prevents crossover distortion.

The patented protection circuit consists of Q7, Q8 and their associated RC and diode networks. If the output current flowing through R48 and R69 becomes dangerously high, capacitors C19 and C20 acquire a voltage through R43 and R54 to cause Q7 and Q8 to turn on. Q7 and Q8 then cause D10 and D11 to also turn on. Drive current is shunted through D10 and Q11 around the predriver Q10, preventing an uncontrolled increase in output current. Diodes D10 and D11 prevent activation of the protection circuits when the amplifier is driving a reactive load. D12 and D13 are flyback diodes which prevent reverse overvoltage from appearing across the output transistors in the event an inductive load is switched.

S2 and S3 are switches designed to thermally activate(open)if the heat sinks become too hot for safe operation. They automatically close again once the temperature returns to the safe region.

3-2. PL14 and PL20 Drive PC Board(Model 700B)

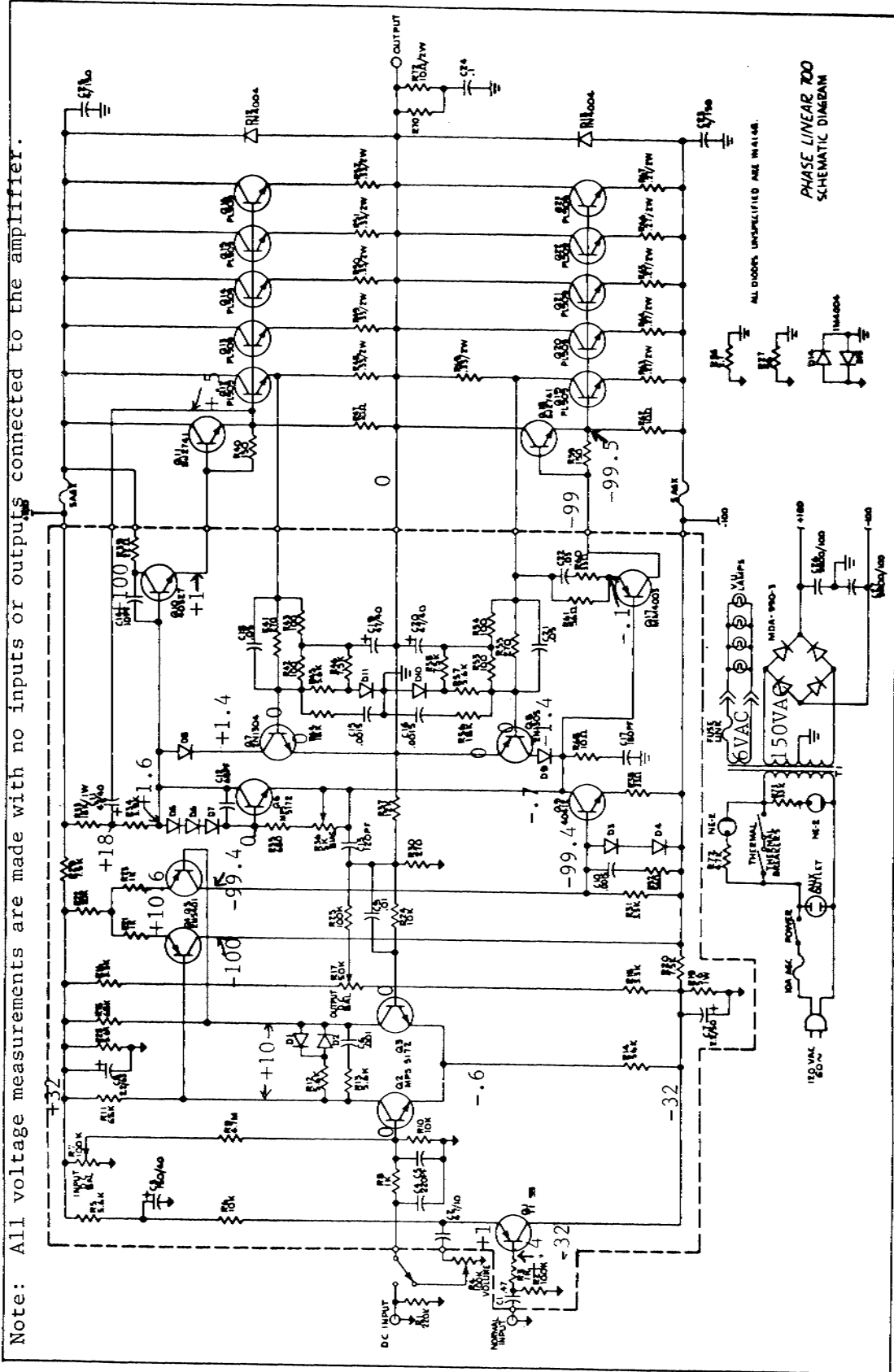
Input signal is applied to the base of Q1. The output of the differential pair comprised of Q1 and Q2 is applied to the second differential pair Q3 and Q4. This second differential provides single-ended output which is applied to the base of Q5. Q5 provides the final voltage gain to drive the predriver transistors Q7 and Q10. The PNP predriver serves as a phase inverter to drive the negative output driver transistor Q12. The emitter of Q12

drives the paralleled emitter follower output transistors Q14, Q16, Q18, etc. The positive half of the signal from Q5 is amplified by emitter follower Q10, which in turn drives the paralleled outputs Q13, Q15, Q17, etc. through output driver Q11.

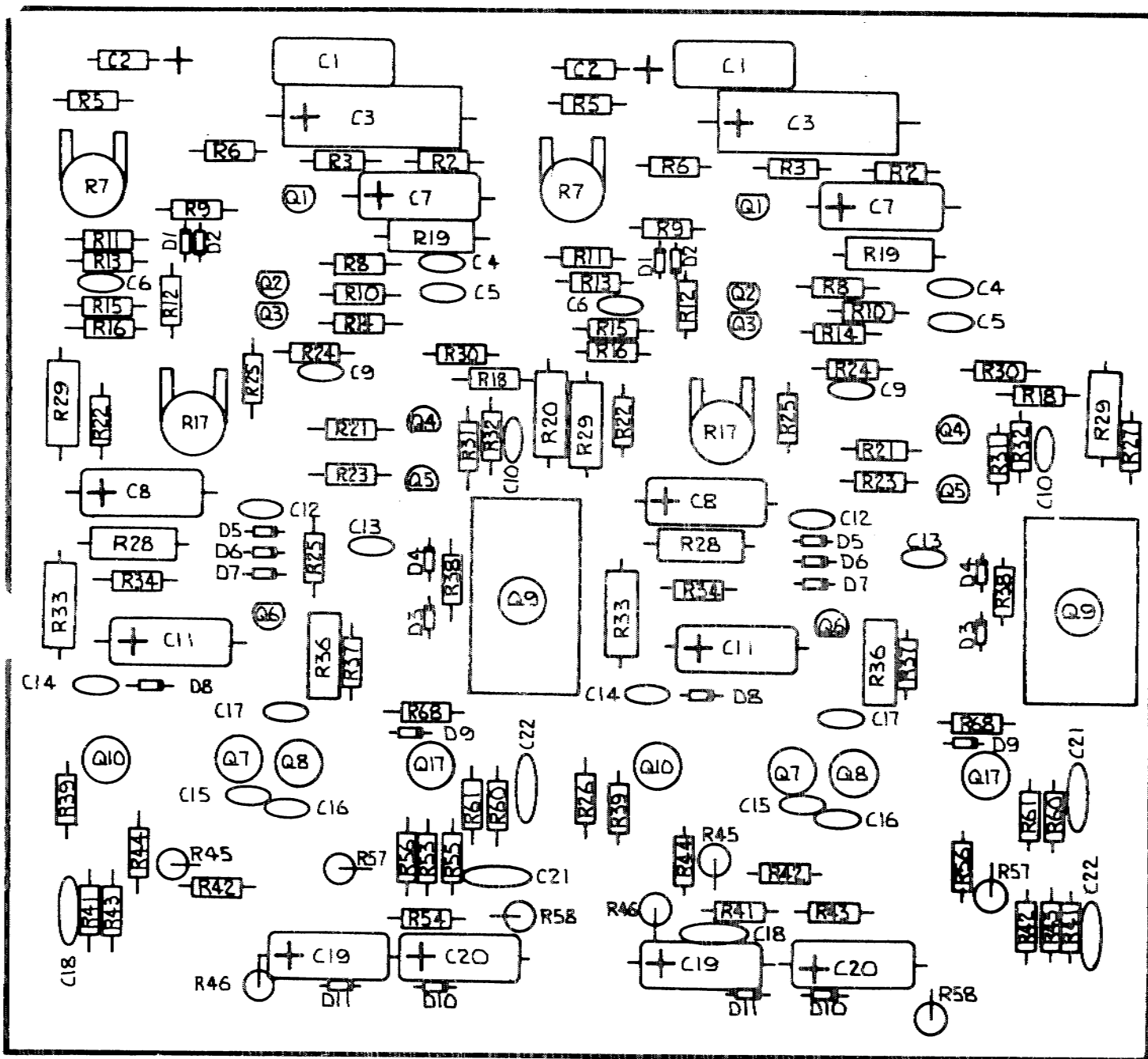
Diodes D6, D7 and D8 provide forward bias to the output bias regulator transistor Q6. R20 adjusts the slight amount of idle current in the driver transistors, which minimizes crossover distortion.

The protection circuits and thermal switches operate the same as discussed earlier with the PL0171 PC drive board.

4-0.	SCHEMATIC and ASSEMBLY DIAGRAMS	P.
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	Wire Point PCB Connection Diagram, PL20	18

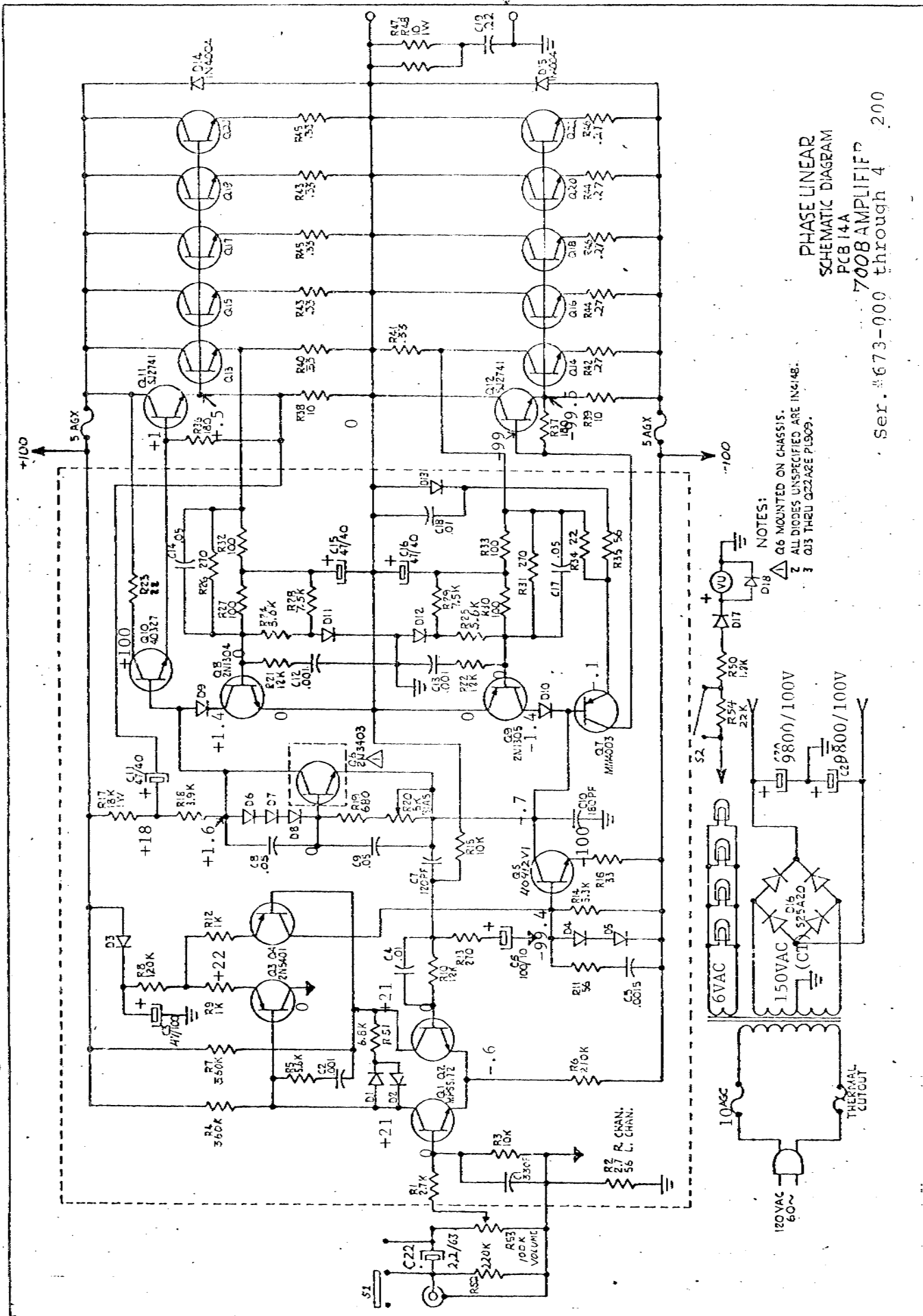


Schematic Diagram, PL 0171 PCB(700)



Assembly Diagram, PL0171 PCB (Model 700)

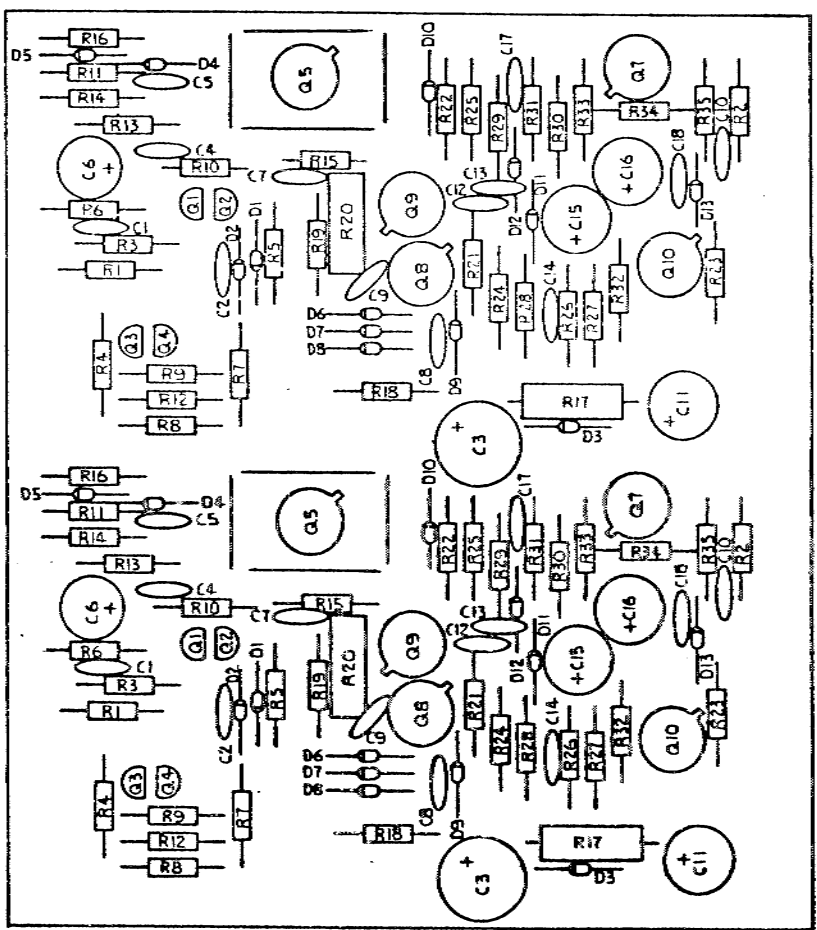
Note: All voltage measurements are made with no inputs or outputs connected to the amplifier.

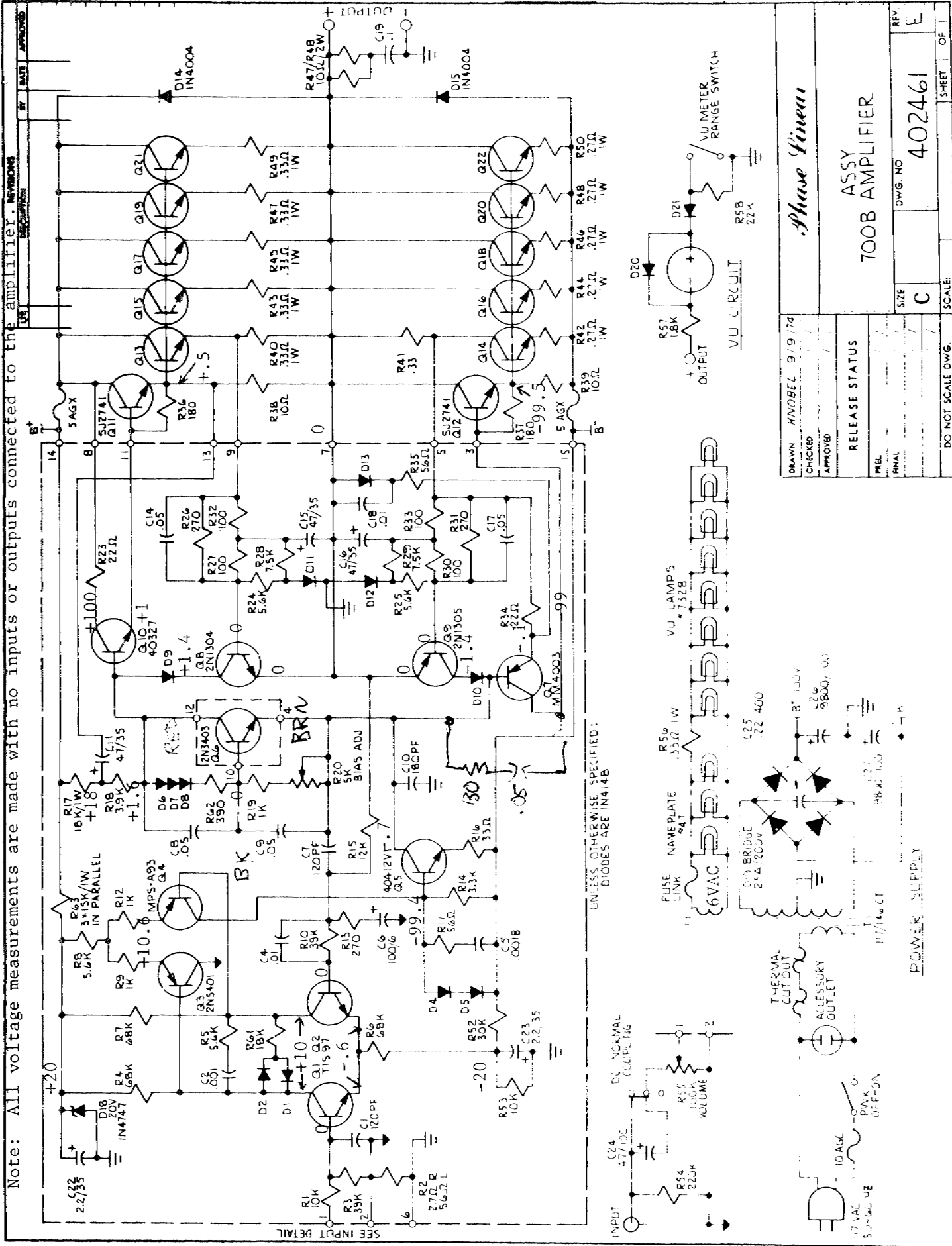


PHASE LINEAR
SCHEMATIC DIAGRAM
PCB 14A
700B AMPLIFIER

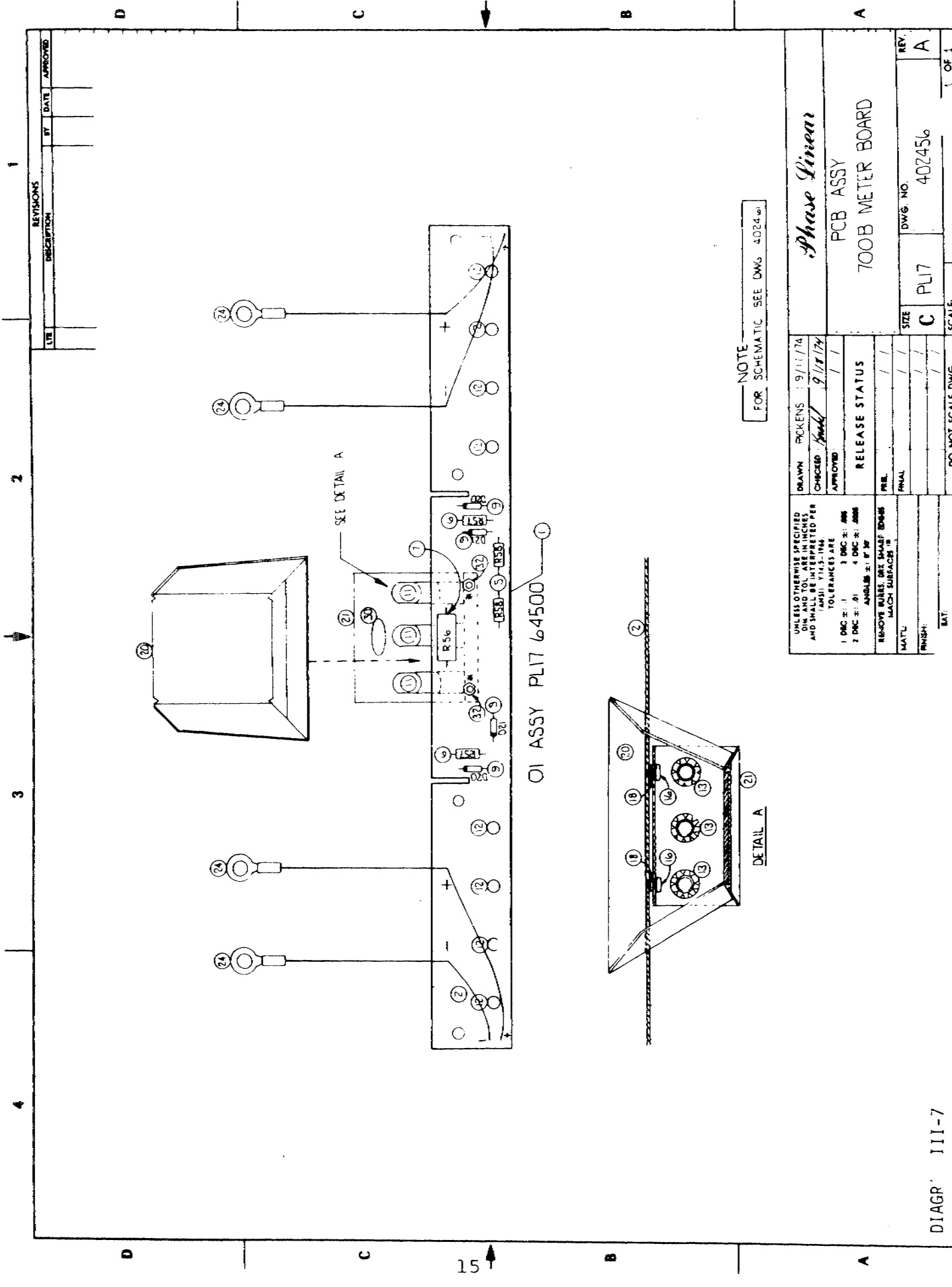
Ser. #673-000 through 4 200

NOTES:
1 G6 MOUNTED ON CHASSIS.
2 ALL DIODES UNSPECIFIED ARE IN148.
3 Q13 THRU Q22 ARE 1N509.





Schematic Diagram, Mode 1 700B PL20 PCB Ser.#574-000 through 574 0, and #1000 through 70

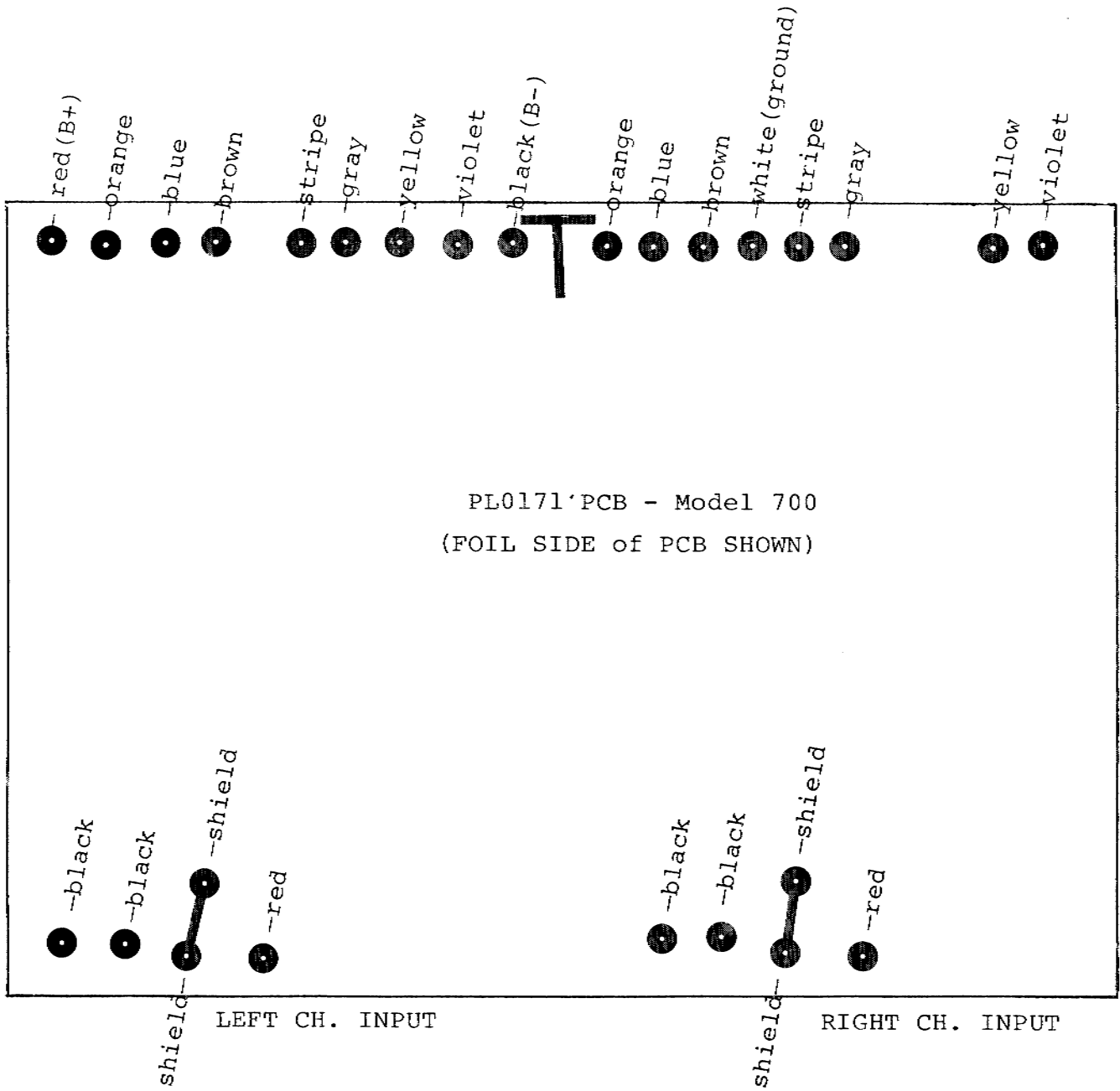


REV. NO.	DESCRIPTION	BY	DATE	APPROVED
1				

NOTE
FOR SCHEMATIC SEE DWG 402456

UNLESS OTHERWISE SPECIFIED DIMENSIONS SHALL BE IN MILLIMETERS AND SHALL BE INTERPRETED PER (ANSI) Y14.5-1984		DRAWN	PICKENS	9/11/74
TOLERANCES ARE		CHECKER	Frank	9/18/74
1 DEC ± .1		APPROVED		
2 DEC ± .01		RELEASE STATUS		
3 DEC ± .005		PRL		
4 DEC ± .0025		FINAL		
5 DEC ± .0015		SCALE		
6 DEC ± .001		DO NOT SCALE DWG.		
REMOVE BURRS, DEBurr EDGES MATCH SURFACES		DATE		
MATERIAL		SIZE		
FINISH		C PL17		
		DWG. NO. 402456		
		REV. A		
		1 OF 1		

Phase Linear
PCB ASSY
700B METER BOARD



Wire Harness Connection Point Diagram,
PL0171 (Model 700, all serial numbers)

5-0. TEST PROCEDURE

Required test equipment:

Audio Sine Wave Generator
VOM or DVM
High-impedance oscilloscope
THD Analyzer
250-watt 8-ohm test load resistor
Variable Line Transformer(VARIAC)

- 5-1. Power supply. Before plugging in the AC line cord check all fuses. Verify AGX5-8 amp(or equivalent)fuses for the four supply fuses and AGC10 amp(or equivalent)fuse for the line. If the unit is wired for 220-240V operation verify AGC5 amp line fuse; the supply fuses should be the same as for 117V operation.

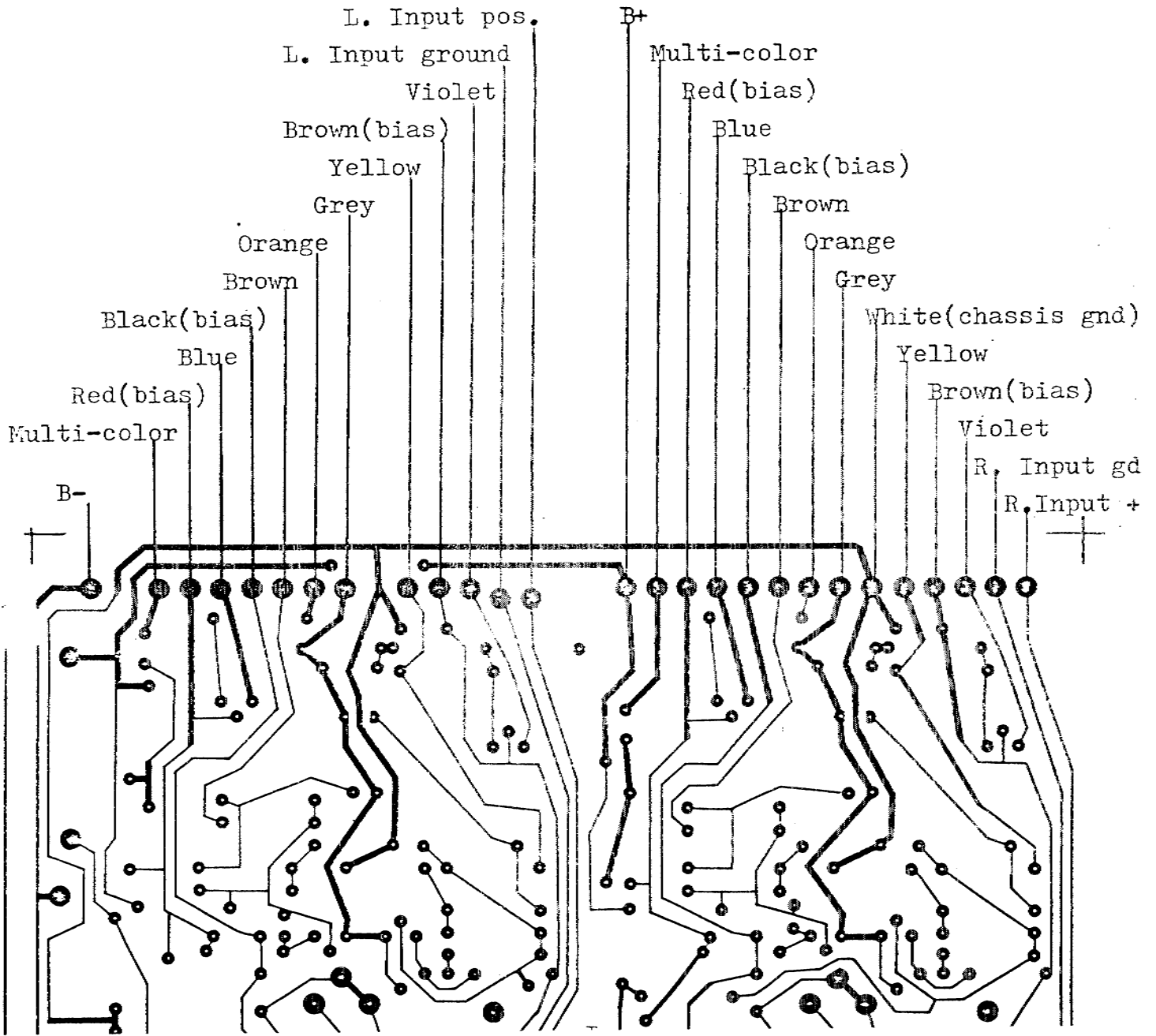
CAUTION: If any fuse is discovered blown, do not energize the amplifier, even after replacing the blown fuse(s). Refer to section 6-1 to properly energize the unit without causing possible further damage to the output stage.

- 5-2. Energizing the unit. Plug the line cord into a variable line transformer(VARIAC)and slowly turn it up to 117VAC(or 220VAC)as required. If a line transformer is not available it will be necessary to plug the unit directly into a working AC outlet and hope for the best. Verify that the power on indicator(center display script window on the 700B)and meter lamps illuminate.

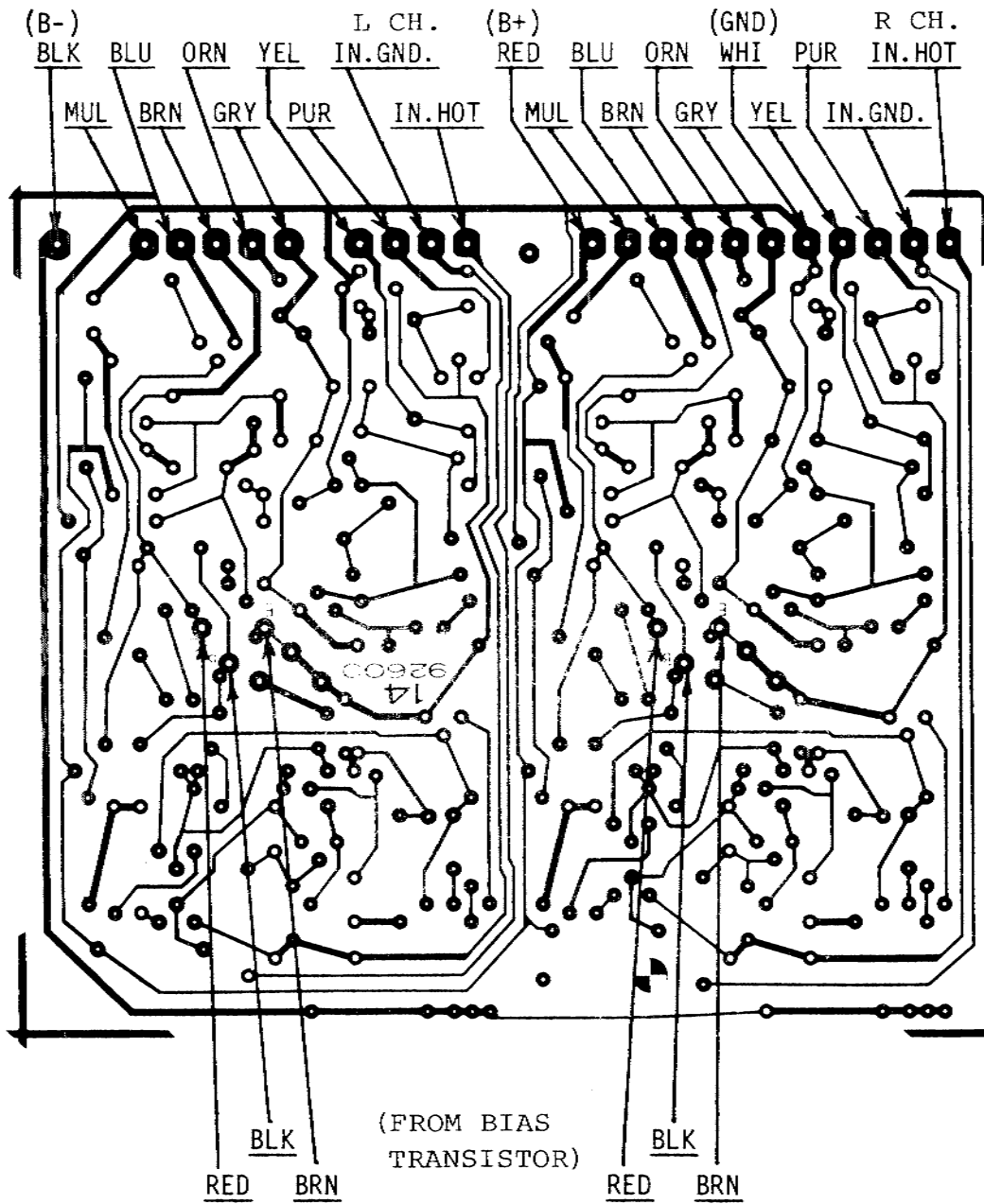
NOTE: The display meters may "jump" when the unit is turned on but should immediately settle. This is a normal condition.

- 5-3. Output signal with no load. Monitor the left channel output with the scope and AC voltmeter. DO NOT connect any other load to the outputs at this time. Drive the left channel input with a 2kHz sine wave until the output wave form is well into clipping. Verify that the clipping is symmetrical on both halves of the wave form. Repeat for the right channel.
- 5-4. Output with 8 ohm load. Connect an 8-ohm 250-watt test load resistor to the left channel output terminals and monitor the left channel output. Apply a 2kHz signal to the left channel input and verify an RMS output of at least 53 volts before clipping. Repeat at 20Hz, 200Hz, and 20kHz for both channels.
- 5-5. Distortion. Monitor the left channel output with a THD analyzer. With an 8-ohm load connected also to the left channel output, drive the left channel to 53VRMS and verify a THD +N of less than 0.25%. Repeat this procedure with the right channel. This same procedure may be used to measure for IM distortion of 0.25% or less.

NOTE: It may be necessary to utilize the high filter in the THD analyzer if it is so equipped.



Wire Harness Connection Point Diagram,
 PL20 PCB(Model 700B, Ser.#574-000 through
 574-200, and Ser.#1000 through 7000)



Wire Harness Connection Point
 Diagram, PL14 PCB (Model 700B,
 Ser.#673-000 through 474-200)

5-6. Offset. With no inputs connected to the amplifier, measure across the output terminals of each channel for presence of DC offset voltage and verify less than $\pm 50\text{mV}$.

5-7. Short circuit test. Drive the left channel with a 200Hz signal to an output level of 53VRMS. Now short the output terminals with a jumper wire for 2 to 4 seconds. Remove the jumper wire and verify that the amplifier resumes normal operation. Repeat for the right channel.

6-0. TROUBLESHOOTING AND ALIGNMENT PROCEDURES

NOTE: Most transistors and diodes in the 700/700B can be checked in-circuit using an ohmmeter on the Rx1, Rx10 or 2K scale. With the 700 UNPLUGGED from the line voltage source, measure the forward-biased resistance of the particular diode or transistor junction and verify a reading of 400-700 ohms on a typical DVM for a good device. Actual readings will vary from meter to meter, and some meters do not have sufficient test voltage to turn on a semiconductor. Nevertheless the shorted or open device is usually revealed quickly using this in-circuit method.

CAUTION: BEFORE MAKING ANY MEASUREMENTS INTERNAL TO THE 700 UNLESS OTHERWISE SPECIFIED, BE SURE THAT THE LINE CORD IS UNPLUGGED AND THE POWER SUPPLY CAPACITORS ARE DISCHARGED. WAIT AT LEAST FIVE MINUTES AFTER UNPLUGGING THE AMPLIFIER TO ENSURE THAT THESE CAPACITORS ARE DISCHARGED, OR DISCHARGE THEM BY PLACING A 5-20 OHM (MINIMUM 5-WATT RATING) RESISTOR ACROSS THE CAPACITOR TERMINALS.

ONLY QUALIFIED PERSONNEL WITH PROPERLY INSULATED AND PROTECTED EQUIPMENT SHOULD ATTEMPT SERVICING OF THE 700 WITH THE POWER ON.

6-1. POWER SUPPLY MALFUNCTION

6-1.1. Blown line fuse.

a) Disconnect the positive and negative leads of the bridge rectifier (either at the rectifier or at the filter capacitor terminals) and measure for shorted diodes.

b) Check for shorted power supply filter capacitor.

c) Disconnect the power transformer secondary leads from the bridge rectifier and measure the transformer for primary-to-secondary short. This, incidently, is an extremely rare occurrence.

6-1.2. Blown supply fuse(s).

NOTE: If any of the supply fuses open by a simple break in the filament, replace the fuse(s) and retest the amplifier. If the fuse displays any remote trace of a black or silver vaporized appearance on the glass wall DO NOT REPLACE THE

FUSE(S) AND ENERGIZE THE UNIT AT THIS POINT since this may only cause further damage to the output stage.

First, perform the following test to check for defective output transistors:

IT IS NOT NECESSARY TO REMOVE EACH AND EVERY OUTPUT TRANSISTOR OR OUTPUT DRIVER TO LOCATE A SHORTED DEVICE.

Use a DVM or VOM set to the lowest resistance scale. Connect the negative lead to the collector bus wire of the suspected bank of output devices. Starting with the top transistor, measure the resistance at its emitter with the positive lead. If the outputs in that bank are good you will get a reading just slightly lower than a typical semiconductor junction reading, and you can go on to the next bank of output devices.

If that transistor, or any in that bank of transistors is shorted, the meter will indicate a fraction of an ohm. Note the resistance and proceed from emitter to emitter (in that bank) testing in turn each device. The meter will indicate a fraction of an ohm on each emitter because the transistors are connected in parallel through their emitter resistors. However, when the defective one is tested, the meter will indicate slightly less (about .5 ohm) than it did on the good transistors.

If all transistor emitters in a bank have the same identical reading, suspect the output driver transistor as being shorted. Also, if an analog ohmmeter is being used care is required in reading the meter to spot the small differential in the shorted output emitter reading.

IMPORTANT: WHENEVER ANY OUTPUT TRANSISTOR HAS BEEN REPLACED IT IS NECESSARY TO PERFORM STEP 6-1.3 TO VERIFY PROPER CURRENT SHARING OF ALL OUTPUT TRANSISTORS.

WHEN REPLACING OUTPUT TRANSISTORS IT IS IMPORTANT THAT ONLY THE SAME MAKE AND NUMBER BE INSTALLED IN ANY ONE CHANNEL. PLEASE REVIEW SERVICE BULLETIN 1-80 IN THE BACK OF THIS MANUAL.

6-1.3. Current sharing test. This test is necessary to verify that ALL output transistors are operating properly, ensuring a permanent repair. Although the amplifier will probably meet all specs without all outputs operational, increased current loading of the remaining outputs will result in a significant reduction in reliability and thermal stability.

a) With an 8-ohm test load connected to the output terminals of the left channel, drive the left input with a 200Hz signal to obtain a 53VRMS output. Turn down the line voltage on the VARIAC to about 75-80V. (If a VARIAC is not available, drive the inputs such that the amplifier is well into clipping.)

- b) Using a DC voltmeter measure the voltage drop across the output transistor emitter resistors in each output bank. Verify that there is between 140 and 180mV DC across each emitter resistor (this number may be higher in some early 700's which have three output transistors per bank, or if no VARIAC is being used to drop the line voltage).
- c) Replace any output transistor whose emitter resistor voltage reading varies more than $\pm 20\%$ from the typical. Also verify that the emitter resistor itself is not defective.

6-2. UNIT WILL NOT ENERGIZE PROPERLY

Occasionally when a 700/700B is turned on there may be a condition where there is sufficient leakage in an output transistor or it may short out in such a way that the supply fuse(s) may not blow, passing the 100V supply voltage to the speakers. The display meter(s) for the defective channel will usually peg at full output deflection. This symptom should be troubleshot as if a shorted output transistor condition existed. This also reinforces the need for external speaker fusing as described on page 5.

6-3. OUTPUT MALFUNCTION - NO LOAD CONNECTED

6-3.1 No output, one or both channels.

- a) Check for blown supply or line fuse(s); refer to section 6-1, page 20.
- b) With line cord disconnected from AC outlet, check all PC board semiconductors as described under heading 6-0 on page 20.

6-3.2 Excessive current drawn when voltage applied to the line cord.

- a) Check the bias transistors carefully (Q6); replace if in doubt.
- b) Check output transistors and output drivers, section 6-1.
- c) Check all PCB semiconductors as per heading 6-0, page 20.
- d) Isolate protection circuit as outlined in section 6-3.3 below.

6-3.3 Truncated or asymmetrical wave form output.

- a) Verify matched power supply voltage readings at the filter capacitors in the power supply. There should be no more than 1 volt difference between the positive and negative supply readings. Typical supply voltage will be 100-105V.
- b) Protection circuit isolation: disconnect one end of diodes D9 and D10 (D8 and D9 on PL0171 PCB) and repeat the test. If the problem is now removed check and replace D9, D10, Q8, Q9, Q13 and Q14 (D8, D9, Q7, Q8, Q12 and Q19 on PL0171 PCB-700).
- c) Check predrivers Q10 and Q7 (Q10 and Q17 on PL0171 PCB), and check output drivers Q11 and Q12 (Q11 and Q18 on PL0171).

d) Possible defective Class A stage; check Q5, D4 and D5 (Q9, D3 and D4 on PL0171 PCB).

6-3.4 Oscillations. (Also see PROTECTION CIRCUIT, page 25.

a) Check RC output pole network R47/48,C19 (R70/72,C24 on model 700). Replace if doubtful.

b) Replace predrivers Q7 and Q10 (Q10 and Q17 on PL0171 PCB).

c) Replace output drivers Q11 and Q12 (Q11 and Q18 on 700).

d) Check output transistor insulators. Occasionally the output transistor can pinch through the insulator as a result of thermal cycling, overtightening or previous replacement in which screw or socket metal particles become pinched between the insulator and heatsink. If this is found to be a trouble spot and the insulators used are the rubber (pink or gray) self-lubricating type it is recommended that these be replaced with the mica type with thermal compound applied to them.

e) If oscillations (bursts) occur just before rated output at low test frequencies, be sure that line voltage at the line plug is maintained at 117-120VAC.

NOTE: On some model 700B amplifiers several ferrite beads are positioned on the output stage buss wiring. These are placed at the factory on a per-unit basis for maximum high frequency stability and it is recommended that they not be removed or altered in location.

On 700 amplifiers which oscillate it may be necessary to place ferrite beads on the output buss wiring (usually the output base buss wire). These are placed by experimental location.

6-4. OUTPUT MALFUNCTION INTO A LOAD

6-4.1 Unit will not deliver 53VRMS into 8-ohm load.

a) Check for line or VARIAC voltage sag; voltage at the line plug must be at least 117VAC when delivering full output.

b) Possible defective output transistor or output driver; see section 6-1, page 20-21.

6-4.2 Asymmetrically or truncated wave form output.

a) Isolate protection circuit as outlined in section section 6-3.3 b) on page 22.

b) Check for balanced power supply voltages as described in section 6-3.3 a) on page 22.

c) Check for defective output transistor emitter resistors and/or open output transistors; see section 6-1.2 on page 20 and section 6-1.3 on page 21.

6-5. EXCESSIVE DISTORTION

6-5.1 Bias adjustment. Check and adjust the pre-driver bias as follows:

a) Allow the unit to warm up sufficiently. Ideally, the bias should be adjusted after the unit has achieved normal operating temperature.

b) Remove all input and output connections to the amplifier. Locate R38 and R39 (10-ohm, $\frac{1}{2}$ -watt) in each output bank (R47 and R62 on model 700's).

c) Measure the DC voltage drop across R38 (R47 on a 700); verify a reading of 300-400mV DC and adjust R20 on the PC board (R36 on a 700 PL0171 PCB) to obtain this reading. Once this measurement is obtained measure the DC voltage drop across R39 (R62 on model 700) and verify that it is within 20% of R38 (or R47 on the 700).

NOTE: For amplifiers used in sound reinforcement or commercial use it is recommended that the bias be adjusted closer to 300mV across R38 (R47). This will increase distortion only slightly, but will provide for much cooler operating temperatures. The cooling fan is still recommended, however.

6-5.2 THD analyzer adjustments.

a) Activate the 80kHz filter on the analyzer if it is so equipped and repeat THD measurement.

b) Examine test bench grounding system for possible ground loops. Ground the analyzer directly to the 700 output ground, not to the load, scope or meter grounds. Use 16 gauge wire for the ground system.

c) Reverse the line cord polarity by removing the line plug from the AC outlet, reversing it and plugging it in again.

6-5.3 Defective protection circuit.

Refer to section 6-3.3 b) on page 22.

6-6. EXCESSIVE DC OFFSET VOLTAGE

Model 700:

a) Remove all inputs to the amplifier. Monitor the offset voltage at the output of the left channel. With front panel input sensitivity controls closed (fully CCW) adjust DC offset by R17 on the PC board. Then with the front panel input control open (fully CW) adjust offset by R7 on the PC board. It may be necessary to repeat the adjustments since one will slightly affect the other. Repeat the procedure for the right channel. Offset should be less than 50mV at any level position.

b) If DC offset cannot be zeroed (less than 50mV) using the above procedure replace differential pairs Q4/Q5 or Q2/Q3 and readjust as per the above step a).

Model 700B:

a) The DC offset in the PL14 or PL20 PC boards is determined by matching of the first differential pairs in each channel. If DC offset measures more than 50mV replace Q1 and/or Q2. Occasionally Q3 and/or Q4 may affect offset as well.

6-7. PROTECTION CIRCUIT MALFUNCTION

6-7.1 Supply fuses open when amplifier outputs are shorted.

This indicates that the protection circuit is not shunting drive current properly.

- a) Check/replace Q8, Q9 and D9-D12 (Q7, Q8, D8-D11 on PL0171 PCB).
- b) Check/replace R40-R42, Q14 and Q13 (R63, R69, R48, Q12 and Q19 for a model 700).
- c) Perform step 5-7 on page 20 after defective devices have been replaced to verify proper protection circuit operation.

6-8. MISCELLANEOUS MALFUNCTIONS

6-8.1 Low output at low frequencies.

This is usually caused by a defective capacitor or resistor in the negative feedback loop. Replace C6 (100/10v electrolytic), R13 and/or C4.

6-8.2 Hum.

a) If hum is heard through loudspeakers in a home system be sure that the preamp is not stacked directly above or beneath the power amp. The 700/700B power transformer radiates a very large hum field which can be picked up by poor or non-shielded high-gain circuitry.

Also, fluorescent lighting in the vicinity of the power amp can inject hum into the power supply as can AC line rheostats ("dimmer switches").

b) Remove the line plug from the AC outlet and reverse the polarity by turning the plug over and plugging it back into the AC outlet.

c) Tighten the 7/16" power transformer bolts since a loose lamination can vibrate at line frequency and be transmitted into the signal.

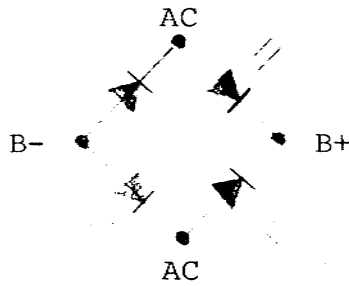
d) Be sure the terminals at the power supply filter capacitors are tight.

e) Tighten the 1/2" nuts which attach the input jacks to the chassis (this can be done externally on the 700B; on the 700 the top cover must be removed and the jacks tightened from inside).

6-8.3 Radio Frequency Interference (RFI).

Most RFI from a 700/700B is radiated by the bridge rectifier in the power supply.

a) Connect four .01/1000v ceramic or mylar capacitors across each terminal of the bridge rectifier as shown:



b) If existing rectifier used is a Sensitron device it can be replaced with a Motorola (MDA-990) type which characteristically has lower RF radiation.

c) Contact the Phase Linear Service Department for further RFI countermeasures.

6-8.4 Turn-off noise.

A delayed turn-off noise (usually a thump) is characteristic of the 700 and 700B amplifiers. This is caused by the power supply voltage discharging through the front end differential transistors, and should be a fairly low level noise. If the noise is extremely loud and poses a possible threat to the loudspeakers connected to the amp the following measures, applicable only to the model 700B, should be observed:

- a) Replace D3 in the defective channel and check C3.
- b) Check/replace Q1 and/or Q2.
- c) Check/replace Q3 and/or Q4.

The model 700 has very little that can be done about turn-off noise aside from experimental matching of the front end differential transistors.

An alternative to any of the above procedures for both the 700 and 700B is the installation of an output relay which insures elimination of any turn-off noise. The associated PC board which accompanies the relay also provides a delayed voltage to the relay coil to eliminate any turn-on noise, and also incorporates subsonic and DC frequency protection. Contact the factory service department for details and availability.

7-0. SERVICE BULLETINS and SUPPLEMENTS

The following section is devoted to the inclusion of any factory bulletins pertaining to the models 700 and 700B.



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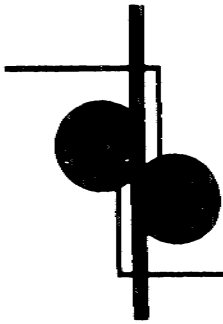
SERVICE BULLETIN #7721

Subject: 700B protection circuit

During the protection circuit test (page 15, Step #8 of 700(B) Service Manual) some 700B amplifiers may exhibit severe high-frequency oscillation in the short-circuit mode, often accompanied by the opening of the negative supply fuse. Any 700B which exhibits this problem should be modified as follows:

- 1) Desolder C17 (.05 mf ceramic) and discard.
- 2) Obtain a 130/ $\frac{1}{2}$ watt resistor and a .005/100 v. capacitor.
- 3) Solder the series RC network across the base-collector junction of Q9 (2N1305) on the foil side of the PC board as shown in the diagram below.
- 4) Perform the protection circuit test once again and verify the proper operation of the modified protection circuit.

Note: 700B's with serial number greater than 4250 contain the above modification already.



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SERVICE BULLETIN

1-80

IMPORTANT!! ALL PHASE LINEAR PRODUCT SERVICING PERSONNEL PLEASE READ...

SUBJECT: Models 400 Series, 700 Series, and D-500 amplifier output transistors and output driver transistors.

Since Phase Linear amplifiers began production several years ago we have incorporated several different types of output transistors and a few variations on output driver transistors. *Only* those which we have used in the past have been tested and approved by our engineering department for use in Phase Linear amplifiers. It is very important that **ALL OUTPUT TRANSISTORS USED IN PHASE LINEAR AMPLIFIERS BE THE SAME IN EACH CHANNEL**, that is, they must match by make and device number. Mixing output transistors in the same channel will adversely affect performance, reliability, and/or thermal stability. Therefore when replacing defective output transistors be sure to use only the same make and number used in that particular channel.

The following is a list of output transistors used in the past and their disposition. *Only* these devices have been approved for use in any of the 400 or 700 series amplifiers. Do not attempt to cross-reference these devices to another type of output transistor (2N, Sylvania ECG, etc.) since in the past the use of these devices has resulted in various kinds of amplifier malfunctions or direct failures. Also notice that the model Series Two D-500 uses *only one type* of output transistor (TP9054).

TP9054 (Motorola) - used in some production runs of Series Two model 400II and 700II. This is a higher voltage (and subsequently more expensive) device than the other output transistors. The model D-500 uses TP9054's *exclusively*; no other output transistor should be used in this amplifier. TP9054 is our own number stamped on Motorola MJ15024 devices. If MJ15024's are available locally they may be mixed with TP9054's in the same channel; this is one of *only two* exceptions to the mixed output rule (see XPL909).

XPL909 (Delco) - used in original 400's and 700's to the present. Some early XPL909's were marked PL909 and should not be confused with the Fairchild PL909 transistor. Delco PL909's are marked with *blue* ink and should be considered as XPL909 when ordering replacements. XPL909 is our own number stamped on selected Delco DTS411 devices. If DTS411's are available locally they may be mixed with XPL909's in the same channel. This is one of *only two* exceptions to the mixed output rule (see TP9054). XPL909's are no longer used or stocked as replacement parts.

F

PL909 or FPL909 (Fairchild) - notice the 'F' above PL909. This is how the number appears on the device. Do not confuse Fairchild PL909's with early Delco PL909's. All Fairchild PL909's are marked with *black* ink and should be considered as FPL909 when ordering replacements.

XPL910 (Delco) - these are power Darlington devices and are no longer used in production. Be sure not to confuse or mix these with XPL909's since the design markings on both devices are identical.

1B05 (RCA) - this is RCA's number and these should be available locally. They are no longer used in production.

MJ15011 (Motorola) - this is Motorola's number and these should be available locally. They are no longer used in production.

SE230 (Sensitron) - may be found only on very early model 400's. This is Sensitron's number and these may be available locally.

(cont.)

PL909A (Motorola) - notice the 'A' suffix. These may be found only on very early model 400's and possibly an early 700. These were found to have inconsistent reliability traits and should *all* be replaced in the amplifier whether good or defective. See exchange policy below.

2SD555 (NEC) - was never used in production runs of 400 or 700 series but is a suitable replacement transistor and is slightly more expensive than other outputs. These should be available locally.

Exchange Policy. Since some of the approved output devices have been dropped from our production runs and others are no longer stocked it may be necessary to replace all of the output transistors in one channel of an amplifier if duplicate replacements are not available.

We will be glad to exchange good (non-defective) output transistors for what we have currently available in stock at no charge *providing that* there be included with the transistors returned a note or letter stating the reason for the return and that the transistors being returned are not defective. Also you may wish to state a preference for which devices you would like to receive as replacements, though we cannot always honor your request since we are limited to what we have in stock at the time. Due to the higher cost, TP9054 or 2SD555 devices cannot be sent as direct replacements.

Output Drivers. We have used only two types of output drivers in the past though three different types may be used (see below). The output driver is the *bottom* transistor in each of the output banks of the amplifier. OUTPUT DRIVERS MUST NOT BE USED AS OUTPUT TRANSISTOR SUBSTITUTES AND VICE VERSA. Output drivers *may* be mixed in the same channel without adversely affecting performance or reliability.

66546 (RCA) - this is our own number stamped on RCA 410 devices which may be available locally.

SJ2741 (Motorola) - found on early model 400's and 700 series amplifiers. May also be listed by Motorola as MJ2741 and should be available locally.

MJ1800 (Motorola) - standard Motorola number and should be available locally.

SPECIAL NOTE

We occasionally receive comments from field technicians that our output transistors read "leaky" on transistor testers and therefore cannot be used in a Phase Linear amplifier. Our engineering department has determined that due to the low gain/high current characteristics of these devices, standard transistor testers are *totally invalid* in checking for bad outputs in this application.

The only valid test we have found is an in-circuit operational test with the amplifier on and loaded. This test procedure can be found in any of the amplifier service manuals in the Troubleshooting Guide section under "Current Sharing Test" or "Operational Output Transistor Test".

Phase Linear

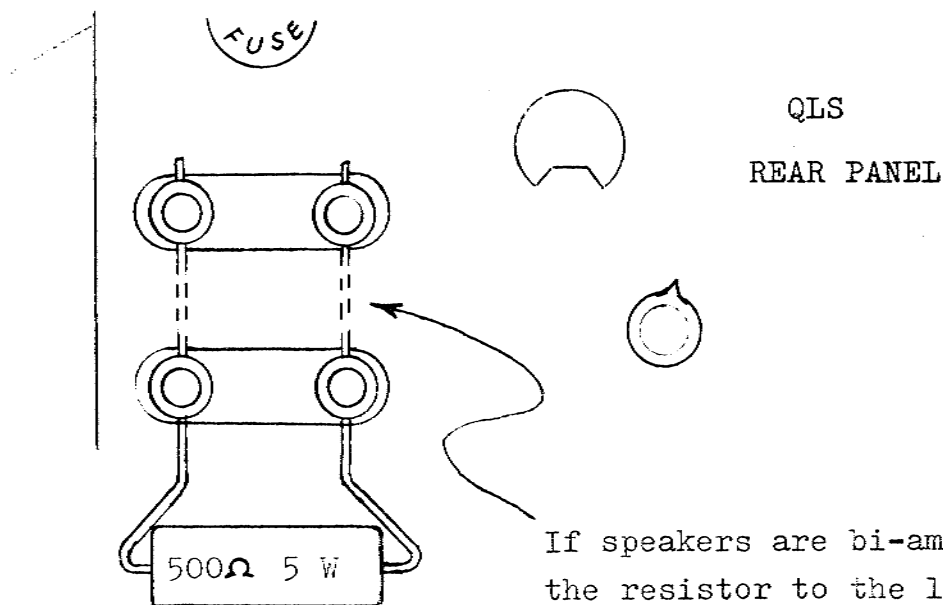
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BULLETIN

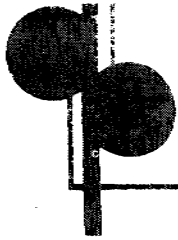
SUBJECT: INFINITY QUANTUM LINE SOURCE SPEAKERS COUPLED WITH PHASE LINEAR POWER AMPLIFIERS

Recent field reports have shown an abnormally high failure rate on various power amplifiers coupled with any of the Infinity Quantum Line Source Speakers, among these the Phase Linear Model 400 and 700(B) amplifiers. After obtaining a set of QLS speakers here at the factory, our tests revealed that the 3000 mfd coupling capacitors in these speakers created a potentially hazardous condition to the power amp when switching the power off and then back on again before these large capacitors have fully discharged. We have discussed our findings with Infinity who has officially authorized our proposed modification which will eliminate the interface problem.

BEFORE OPERATING OR CONTINUING TO OPERATE ANY OF THE QLS SPEAKERS WITH PHASE LINEAR OR OTHER AMPLIFIERS, IT IS RECOMMENDED THAT AN APPROXIMATELY 500 OHM 5 WATT RESISTOR BE INSTALLED ACROSS THE TERMINALS OF EACH SPEAKER AS SHOWN IN THE DIAGRAM BELOW.



If speakers are bi-amped, connect the resistor to the low frequency input only.



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SERVICE BULLETIN

SUBJECT: GES 97 pin out change.

GE has recently discontinued the triangular or off-set pin configuration (TO-18) used on their GES 97 transistor and changed it to the in-line pin configuration (TO-92). The GES 93 will also be changed in the future. The two versions look identical except for the pin out so be sure to check the pin configuration before installing a GES 97 or GES 93 in one of our products.

BOTTOM VIEW



TRIANGULAR (TO-18)

GES 97
TIS 97
GES 93
TIS 93
KA 1778*



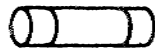
IN-LINE (TO-92)

GES 97
TIS 97
2N5401
MPS A-42
MPS A-55
MPS A-93
MPS 5172
MPS 8599
FPN 3569
FPN 4355
KA 1778*

*The in-line version of the KA 1778 has the same pin out as triangular package.

EARLY 700 METER LAMP REPLACEMENT

A few of the very early 700 units are equipped with VU meters which contain small fuse-type lamps mounted inside the meter.



Small fuse-type lamp (actual size)

Unfortunately we have been unable to obtain any replacement lamps from the manufacturer. If you encounter a unit in which one or more of these lamps is burnt out, use the following procedure to restore proper meter lighting.

- 1) Remove all four of the fuse-type lamps from the meters
- 2) Obtain four #1784 meter lamps, supplied with the repair kits or obtainable from the factory on request.
- 3) Wrap and solder the leads of the #1784 lamps to the meter clips as shown in the diagram below.

Be sure to replace all four of the fuse-type lamps, for the #1784 lamps are significantly brighter.

