

Note: Before removing each part or replacing parts, disconnect the power plug in advance.

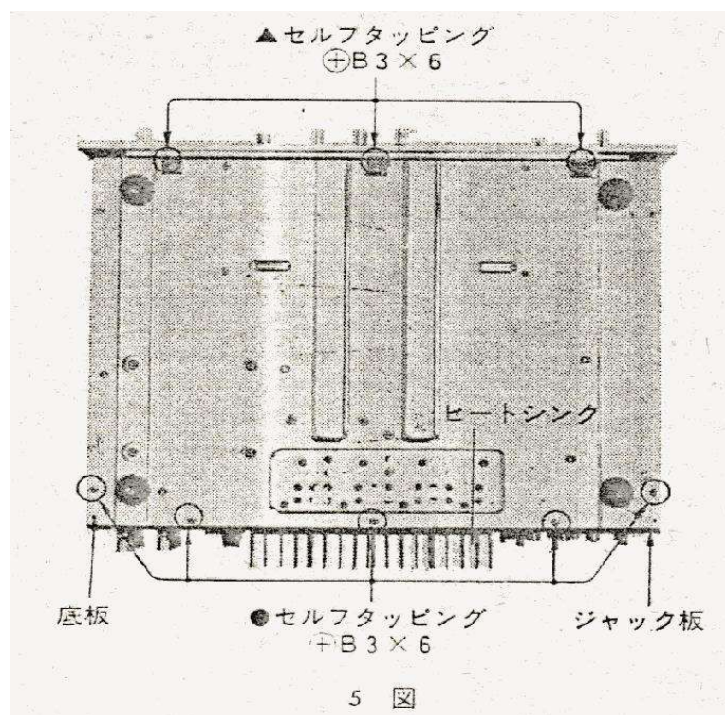
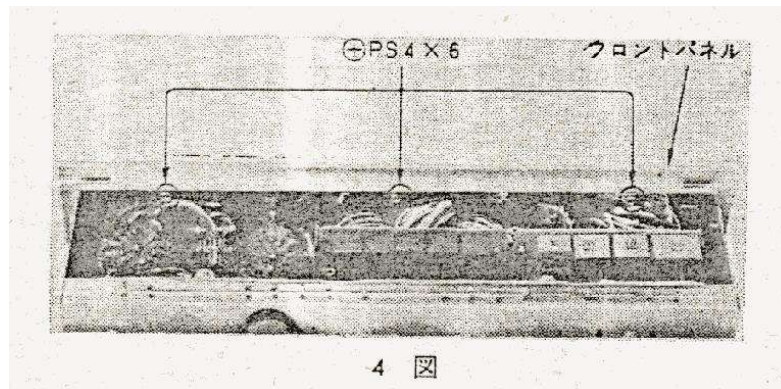
[How to remove the case]

- 1) Take out four case set screws on both sides of the set.
- 2) Lift the case straight up and remove it.

[How to remove the front panel] See Figures 4 to 5

With the case removed, proceed as follows.

- 1) Remove the knobs on the panel (FUNCTION SW, MODE SW, TONE CONTROL SW, BALANCE CONTROL, VOLUME CONTROL, SPEAKER SW Loosen the setscrews to remove each knob, and pull the knobs to remove)
- 2) Remove the three screws shown in Fig. 4.
- 3) Remove the three ▲ mark screws shown in Fig. 5 to remove the front panel towards you.



[How to remove the jack plate] See Fig. 5.

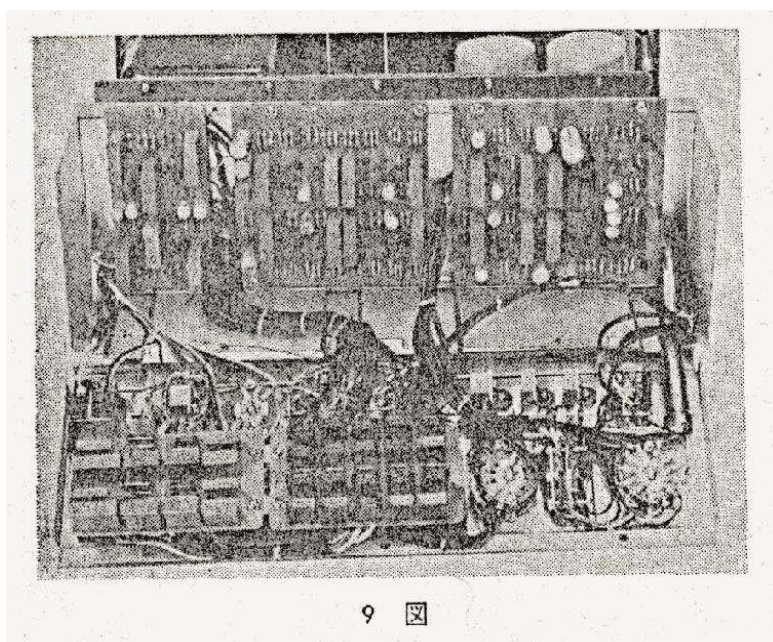
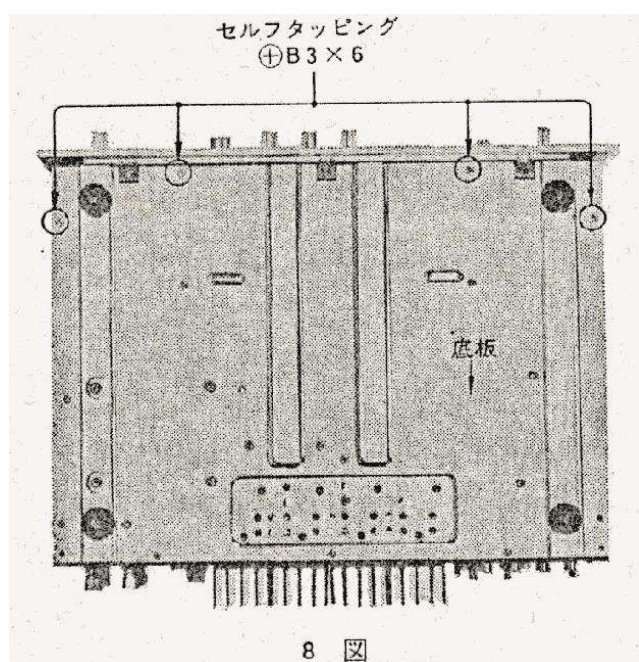
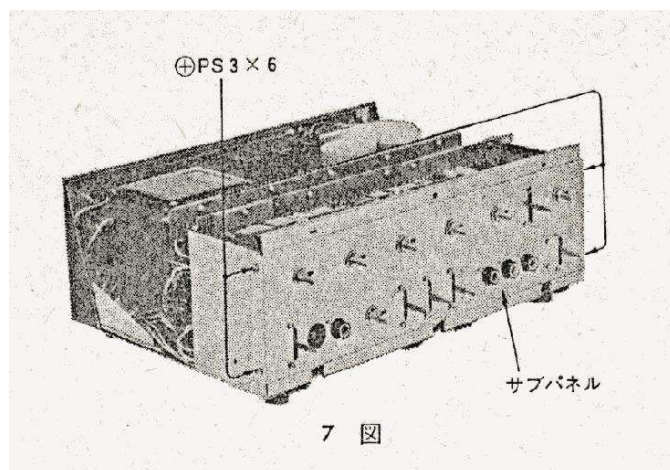
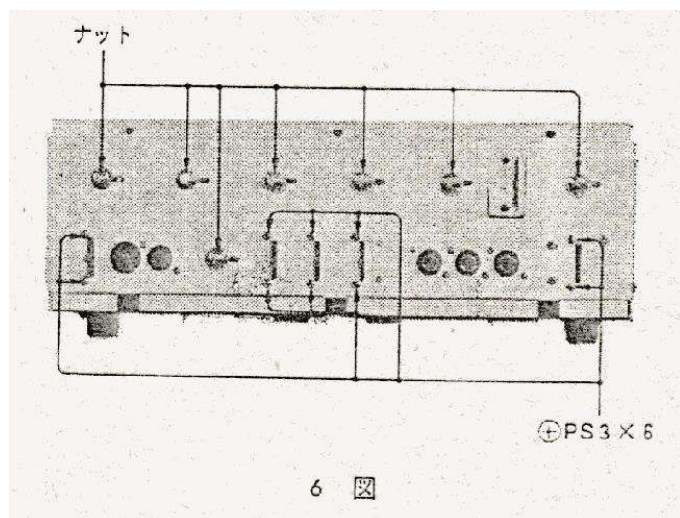
With the case removed, proceed as follows.

- 1) Take out the five ● marked screws shown in Fig. 5.
- 2) Remove the jack plate so as not to damage the heat sink.

[How to replace each volume, switch, and jack] See Figures 6-9

Refer to the above items, remove the case, remove the front panel, and then proceed as follows.

- 1) Remove the nuts and screws holding each volume and switch shown in Fig. 6.
- 2) Take the four screws shown in Figure 7.
- 3) Take the four screws shown in Figure 8.
- 4) Bring the sub-panel forward as shown in the figure 9.
- 5) Remove the TONE BASS board and TONE TREBLE board for the volume control knob, the balance control knob, and the tone control switch, and replace them by removing the lead wires.
- 6) Replace the other switches by removing their lead wires.
- 7) Replace the jacks by removing the two setscrews (⊕ PS 3 X 6) from the back side and the lead wires respectively.



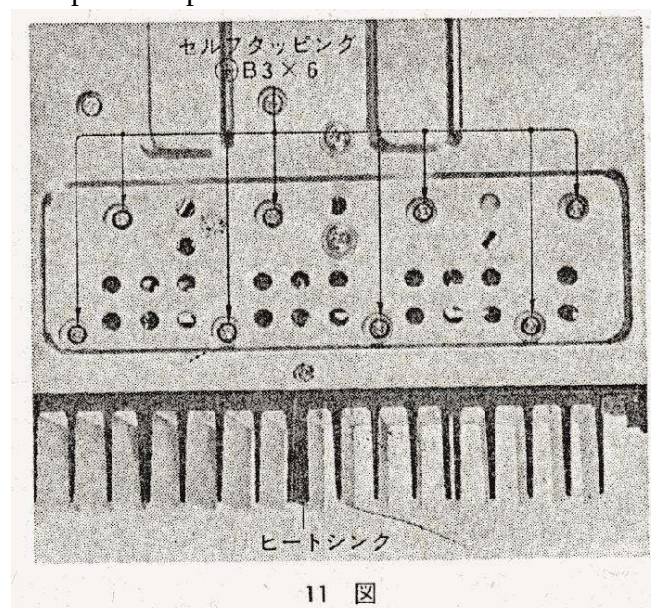
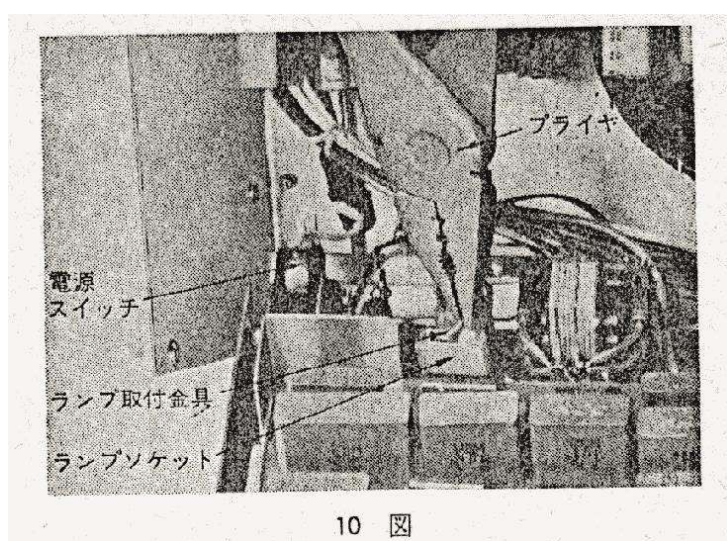
[How to replace the power transistor] See Fig. 11.

Refer to the above item, remove the jack plate, and proceed as follows.

- 1) Take out the screw (self-tapping \oplus B 3 X 6) that is fixing the heat sink in Fig. 11.
- 2) Take out the heat sink, desolder the leads of the transistor, and then remove the set screw (\oplus T 3X14) to replace it.
- 3) When installing the power transistor, apply a thin layer of silicon grease on both sides of the mica pad, and wipe off excess grease that has squeezed out when tightening the screw with a cloth.

[How to replace the pilot lamp] See Fig. 10

Remove the case and front panel by referring to the above items, and then tilt the sub panel to the front and perform the following steps. 1) As shown in Fig. 10, flatten the lamp mounting bracket with pliers, 2) remove the lamp socket, 3) and replace the pilot lamp.



Adjustment Method

Note: Be sure to make this adjustment after replacing the power transistor. The left and right channels use the same amplifier, so only the left channel will be described here. Do the same for the right channel and the left channel. The adjustment points for the right channel are also shown in (). In addition, adjust the DC bias and DC offset, and repeat 2-3 times. After adjusting the DC bias and DC offset, lock each VR with some lock glue.

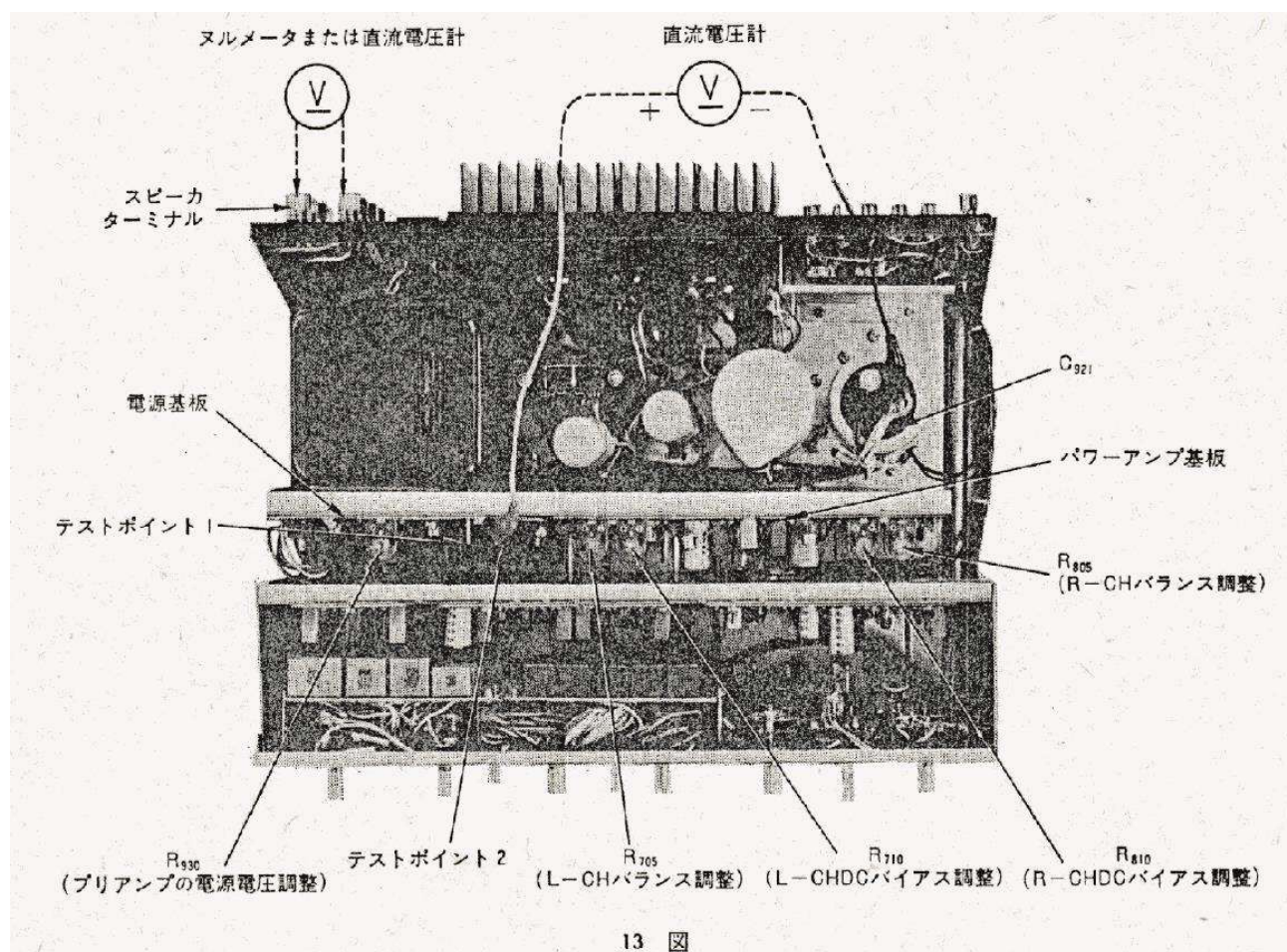
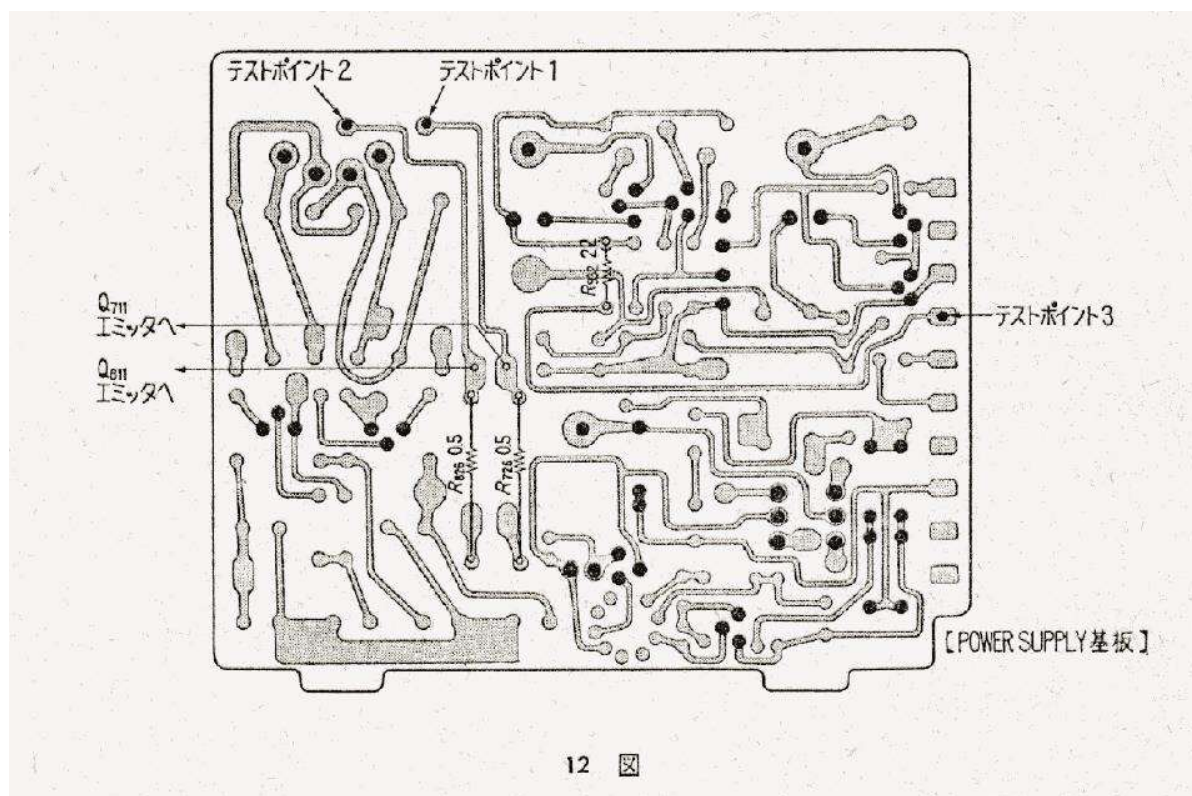
[DC Bias Adjustment] See Figures 12 to 13.

In order to prevent an accident, if this adjustment is performed after replacing the power transistor, gradually increase the AC voltage via the Variac without adding the Unit's rated voltage to the Unit directly, and adjust according to the table below. Make sure that the voltage across R726 (R826) does not exceed 25 mV under the condition of Preparation for Adjustment 2).

Required equipment:

- 1) DC voltmeter (measuring 25 mV)
- 2) Variac
- 3) Adjustment screwdriver (< 3 mm)

Preparation for Adjustment	Measuring Instrument Connection	Adjustment Points	Adjustment Procedure
1) Remove the case 2) Upper half on power amp board Set VR (see Fig. 13) Set as follows. R710 (DC bias) ... Turn it all the way to the left R810 (DC bias). ... Turn it all the way to the right R705, R805 (DC offset) ... Center	1) Connect the Unit to the power supply via the Variac 2) Connect the DC voltmeter with the positive probe to Test Point 1 (2) and the negative probe to the negative side of C921 as shown in Fig. 13. Note: The Test Point is the connection point of Q711 (Q811) and R726 (R826). See Figure 12.	R710 (R810)	1) Keep the output of the Variac to a minimum. 2) Turn on the power switch of the Unit and turn the Variac gradually to the Unit's rated voltage. 3) Adjust R710 (R810) shown in Fig. 13 so that the meter reading is 25mV.

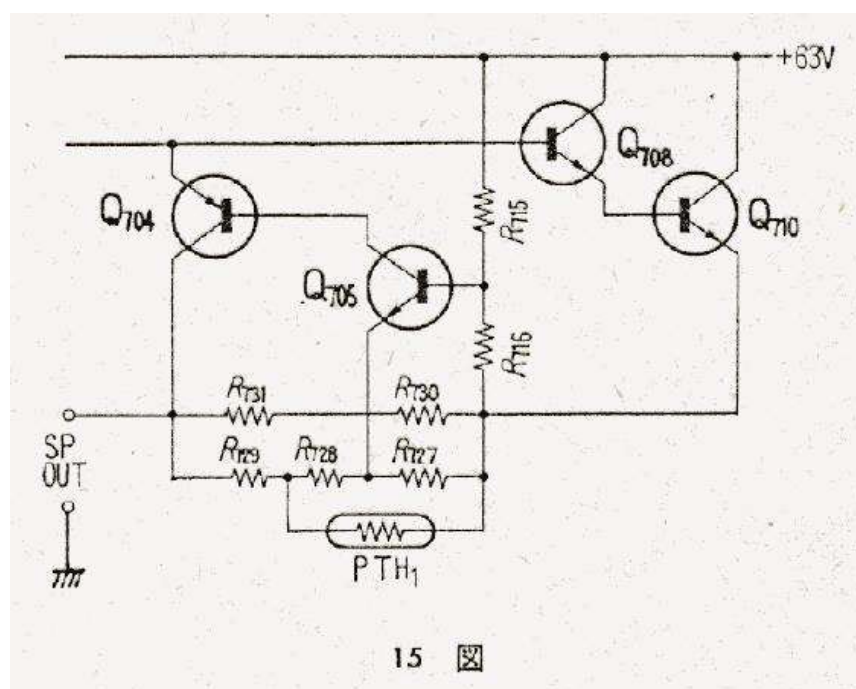
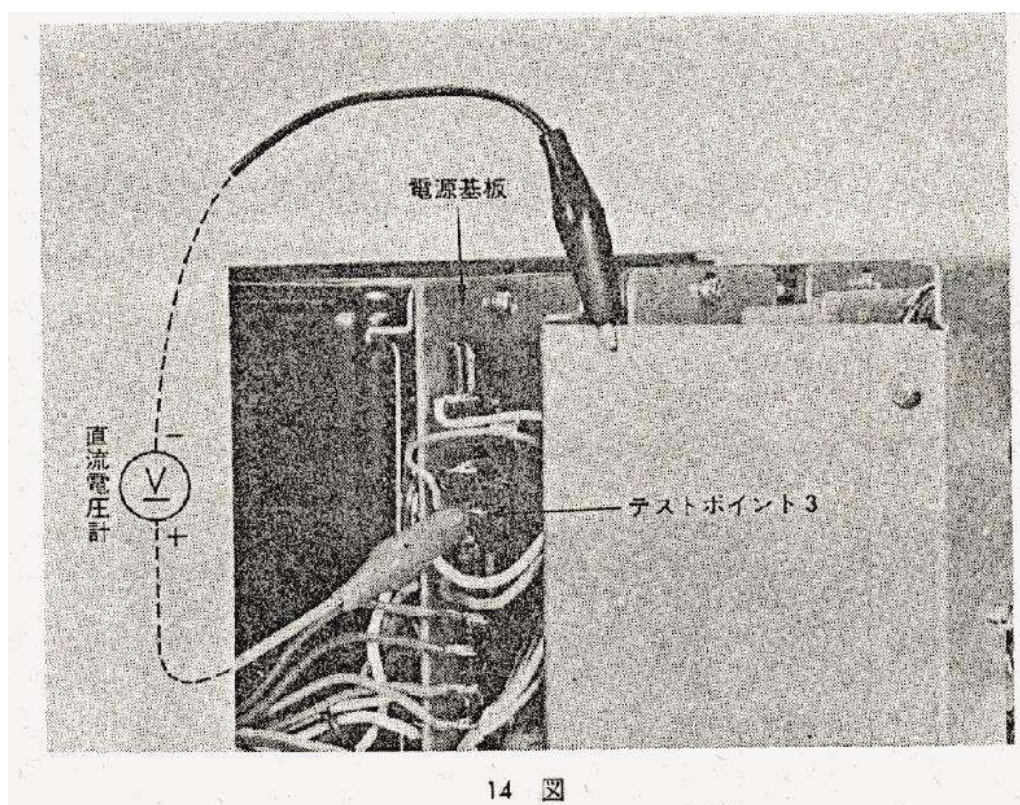


[DC Offset Adjustment] See Fig. 13.

Note: Perform after DC bias adjustment Required equipment: 1) Null meter or DC voltmeter 2) Adjustment driver (< 3 mm)			
Preparation for Adjustment	Measuring Instrument Connection	Adjustment Points	Adjustment Procedure
1) Remove the case 2) Set the speaker switch to MAIN.	Connect the DC voltmeter to the MAIN speaker terminals. Note the polarity. See Fig. 13.	R705 (R805)	1) Turn on the power switch 2) Adjust R705 (R805) to get zero readings on the meter. When using a voltmeter, change the polarity when the meter needle swings backwards, and reduce the meter range so that the meter reading is zero.

[Adjustment of preamplifier power supply voltage] See Figures 12 to 14.

Required equipment: 1) DC voltmeter (measuring 27V) 2) Variac			
Preparation for Adjustment	Measuring Instrument Connection	Adjustment Points	Adjustment Procedure
1) Remove the case	1) Connect the voltmeter between the POWER SUPPLY board Test Point 3 and Ground. 2) Via the Variac, connect the Unit to power.	R930	1) Keep the output of the Variac to a minimum. 2) Turn R930 counterclockwise. 3) Turn on the Unit. 4) Increase AC voltage of the Variac to the Unit's rated Voltage. 5) Adjust R930 shown in Fig. 13 so that the voltmeter indicates 27V.



Circuit Description

This chapter describes the functions of each stage and main parts. The explanation is given according to the flow of signals.

Note that the audio amplification section consists of two identical circuits, so only the left channel is described.

See Pages 13 and 15 for the schematics.

[Preamplifier part]

1) About MIC amplifier (Q101, Q102)

The signal from the MIC jack (J103) is guided to the two transistors directly connected.

The transistors are operating with emitter grounding, and R105 and R107 are used as load resistors to obtain the required voltage gain. The output voltage is available at the collector of Q102.

Then, a part of the output is fed back to the emitter of Q101 by the feedback element R106 R103.

C103 is used as a measure against external noise (noise when turning ON / OFF electric appliances or buzz in strong electric field).

Since the emitter resistance R104 of Q101 uses a relatively large resistance, it operates very stably in terms of direct current, and the impedance of C102 rises even at low frequencies of the signal. The feedback rate increases, and stable operation is achieved even in the extremely low frequency range.

2) About equalizer amplifier (Q103 ~ Q109)

This differential amplifier consisting of seven transistors works as an equalizer amplifier with RIAA characteristics. The input impedance of this amplifier is the FET's in the first stage, so R151 and R152 are connected in parallel (Input impedance approx. 50 k Ω), which receives the cartridge output.

The input signal from PHONO1 and PHONO2 is added to the gate of Q103, while the feedback signal from the output is added to the gate of Q104. The difference between the two becomes the input of the differential amplifier, which is swallowed and appears as the opposite phase to the drain of each FET.

R154 is the load of Q103 and R156 is the load of Q104. Both signals are sent to the equivalent base of two equivalent PNP type transistors (Q106, Q108 and Q107, Q109) connected in Sziklai connection and mixed at their emitters. Here, just like the principle of a class B push-pull amplifier, even harmonics are canceled. Therefore, even harmonics are not included in the output signal, which contributes to further reduction of harmonic distortion.

R165 and R167 are the load of each equivalent PNP transistor.

Q105 is used as the constant current source of the FET's to obtain infinite impedance to the input signal of the differential amplifier. A relatively large drain current flows through the FET's at this stage for the sound quality, and the power supply voltage is fixed, so a transistor is used instead of a large source resistance here.

Furthermore, at the base of Q105, the feedback from the emitter of the equivalent PNP type transistor is applied by R158 and R159 to stabilize the circuit.

The equalizer characteristics as a record amplifier are obtained by using a feedback element (C154 R161 R162 C153 R160 R163 C155) to feed back the voltage from the output to the gate of Q104.

3) Tone control amplifier (Q301 to Q306)

This amplifier compensates the loss in the attenuation type tone control so that there is no level fluctuation at 1kHz when the TONE CANCEL switch is turned ON / OFF.

Here, the differential amplifier is used as well as the equalizer amplifier. The input signal goes into the gate of Q301, while the feedback signal from the output goes into the gate of Q302. Therefore, the difference between the two becomes the input of the differential amplifier, which is amplified and appears in the drains of the FET's in opposite phases.

R304 is the load of Q301, and R306 is the load of Q302. In this case, the output resistance of the FET amplifier is larger than that of the equalizer amplifier (think about R304 R306), so Q303 Q304 are used as an emitter follower so that the next stage does not become a load.

The signal from emitter follower is sent to the base of Q305 Q306, and mixed by the emitter to cancel the even harmonics. In addition, Q306 uses R314 as a load to obtain the required gain and sends the signal to the next stage. Since the collector of Q305 does not need to obtain the output voltage, it is grounded. Therefore, the V_{ce} of Q305 is half the V_{ce} of Q306.

The collector resistors R310 and R315 of Q303 and Q304 are for phase correction at high frequencies, and the voltage generated at the collector is negatively fed back to the base by using the collector capacitance of the transistor.

Since the drain current of FET is smaller than that of the equalizer amplifier, the source resistance R307 can be made large and sufficient constant current characteristics can be obtained.

R313 and R308 are negative feedback elements and apply voltage feedback from the output to the gate of Q302.

C303 is used as a measure against external noise (noise during ON / OFF of electric appliances or buzz in strong electric field).

4) Flat amplifier (Q307 ~ Q312)

All input signals are amplified by this amplifier and sent to the filter circuit. The configuration of the amplifier is exactly the same as the tone control amplifier described above, so it is omitted.

5) Filter amplifier (Q501 to Q502)

Both transistors in this stage operate as emitter followers, and have the role of active elements for buffer amplifiers and filters.

The RC network of C502, R526, C503, and R524 for low filters has a characteristic of 12dB/oct, but since R526 is connected to the emitter of Q501, positive feedback is applied and the shoulder characteristics of the filter are improved.

The RC network of R529, C505, R530, and C506 for high filters has a characteristic of 12 dB/oct. In this case as well as with the low filter, positive feedback is applied from the emitter of Q502 through C505, so the filter shoulder characteristics are improved. The cutoff frequencies are 50Hz and 9kHz.

[Power amplifier part]

1) About the first stage amplifier (Q701)

The signal from the preamplifier is guided to the base of Q701 through the coupling capacitor C701.

R707 becomes the load of Q701, and the signal appears at the collector of Q701.

The D701, which is inserted in series with the load (R707), has the same characteristics between B-E of the next stage Q702, and is also subject to the temperature compensation of Q702.

On the other hand, R705 which is in the emitter of Q701 is a potentiometer for DC offset adjustment, and it is adjusted so that the speaker terminal becomes zero potential when there is no signal. At this time, the emitter of Q701 also becomes zero potential.

The D704, which is inserted between B and E of Q701, prevents the B-E junction of Q701 from being broken by the reverse voltage applied between B and E at the time of high input.

C702 with R706 is an AC bypass element for the emitter circuit, but R706 divides the output voltage with R732, which will be described later, to determine the voltage feedback amount.

2) In the drive stage (Q702)

The signal sent to the base of Q702 is amplified and comes out to the collector. The load at this stage is R711.

C705 is a shunt resonator that prevents the DC bias resistor R709 R710 from entering the load of the excitation stage.

3) Complementary circuit (Q708 Q709) and output transistor (Q710 Q711)

The complementary composed of a NPN transistor and a PNP transistor is further connected to the output transistors Q710 and Q711 in Darlington and Sziklai connections to become a quasi-complementary stage and operates in the SEPP circuit. The transistor is functionally acting as an emitter follower.

4) About the negative feedback circuit (R732 C712)

Negative feedback is applied from the output circuit to the emitter of the first stage amplifier through the R732 C712 to obtain circuit stability and distortion reduction.

5) DC bias circuit (Q703 R710 D702 D703)

In order to eliminate crossover distortion of push-pull amplifier, DC bias current is sent to Q708 Q709 Q710 Q711. As this power supply, Q703, D702, and D703 are put in the collector circuit of Q702 and the voltage drop is used. In addition, the resistors R709 and R710 that determine the operating point of Q703 are in the collector of Q702, but since they are AC shunted by C705, they do not become the load of Q702.

The D702 and D703 in the Q703 emitter circuit are biased in the forward direction, and the output transistor is thermally coupled to these diodes, so the bias current in the power stage is compensated.

6) Power limiter (Q704 Q705 Q706 Q707) See Fig. 15

An input limiter using transistors is provided to prevent damage to the output transistors due to short-circuiting of the speaker terminals during operation. There are two sets of this limiter to operate in both positive and negative cycles. Q704 and Q705 are in Sziklai connection and work for positive half cycle, and similarly, Q706 and Q707 work for negative half cycle.

The operation of this limiter is as follows. Generally, the breakdown of the output transistor occurs because it exceeds the collector loss. Therefore, in this circuit, the loss of the output transistor is detected in advance and the limiter transistor is activated.

The collector voltage applied to the power transistor Q710 is divided by R715 and R716, and the trigger signal from the both ends of R716 to the limiter is taken out.

On the other hand, the collector current of Q710 is considered to be the current that flows in the output circuit, so a low resistance R730 R731 for detection is placed in the output circuit to convert it into a voltage component. This voltage is divided by R727 R728 R729 and extracted from both

ends of R727 as a trigger signal. Then, the signal is added to the trigger signal from the collector voltage described above and sent between B and E of Q705.

When this trigger signal reaches the operation start voltage of Q705 (about 0.6V), Q705 turns on, Q704 also turns on, and its E-C connection is conducted. Since the emitter of Q704 is connected to the base of Q708 and the collector of Q704 is connected to the output circuit, the input of the upper half of the quasi-complementary circuit is short-circuited, and the input is not added in the positive half cycle. Similarly, in the lower half, R717 detects the voltage component and R727 and R728 detect the current component, triggers Q707, and shorts the input with Q706.

7) About fuses (F2 F3)

This fuse is blown by rush current due to accident such as short circuit of output transistor to protect the set. In addition, the speaker terminal is connected to the speaker in a direct current manner, so it also serves to protect the speaker.

8) Protection circuit (Q905 D914)

If an accident such as disconnection occurs in the circuit of the preamplifier, the DC offset may be lost and a DC voltage may be generated at the output. To eliminate this voltage, a protection circuit using an SCR is provided.

The operation of the protection circuit is as follows. As mentioned above, a DC voltage appears at the output terminal due to the imbalance between the audio signal and the circuit. However, since the audio signal is not required here, it is removed by the RC filter of R921 C926 C927.

On the other hand, the DC voltage may be either positive or negative, but this voltage is sent to the bridge circuit (D906 ~ D909) through R921. Here, a DC voltage is generated across the filter capacitor C928 by the same principle as AC bridge rectification. Q905 is a Hartley oscillator circuit that uses this voltage as a power source and oscillates at approximately 80 kHz. This high frequency is taken out to the secondary side of the oscillation transformer TOSC, rectified by diode D915 to a positive voltage, further filtered by C937, and guided to the gate of SCR (D914).

When the voltage applied to the bridge circuit reaches about 4V, this SCR turns on, and the base of Q708 drops to ground through D912, SCR, D911. Similarly, the base of Q709 also falls to the ground through D913, SCR, D910. Therefore, the input of the output stage is grounded, so the DC imbalance that occurred in the previous stage does not appear in the output.

9) Balance stabilization circuit

If the positive and negative B voltages are out of balance due to fluctuations in the line voltage, a DC component appears at the output terminals of the dual power supply system. A compensation circuit is provided to eliminate this DC component.

Since this is a direct connection amplifier from the coupling capacitor C701 to Q701 and to the speaker terminal, it is possible to compensate by applying DC negative feedback to the input.

The operation of the balance stabilization circuit is as follows. The imbalance between positive and negative B voltages is detected by dividing the voltage with R913 and R914 connected between the two B voltages. The difference between R913 and R914 is to detect this imbalance. The voltage detected here is further divided by R912 and R911, and is fed back to the base of the first-stage amplifier Q701 via R702 and R703 to compensate the imbalance.

Diodes D902 to D904 are reverse-biased and inserted in R914. This is to make the anode side of D902 negative. On the other hand, the ratio of R913 and R914 is determined for imbalance detection, and in order to satisfy both of them, this diode effectively reduces the voltage on the + B side by a fixed value (about 33V).

The D901 is biased in the forward direction, but this is the temperature compensation for the Q701.

【Power supply part】

1) About rectifier (D905)

The D905, which is composed of four rectifying elements, forms a bridge circuit, but the center tap of the power transformer secondary winding is grounded to obtain both positive and negative DC voltages. The direct current obtained here is filtered by C920 C921 and sent to the quasi-complementary circuit. The capacitors C922, C923, C924, C925, which are connected in parallel with each diode, have the role of absorbing the noise generated by the diodes.

2) Ripple filter (Q903 Q904 C915 C917)

A filter that uses a transistor is provided to send positive and negative filtered direct current to the first stage of the power amplifier.

The capacitors C915 C917 in the base of the transistors Q903 Q904 act in their emitters, with effective capacitance multiplied by hFE .

3) About constant voltage power supply for preamplifier (Q906 to Q911)

The constant voltage power supply for positive voltage operates in the same way as general ones, but the one for negative voltage delays the rise time to prevent noise when the power switch is turned on.

The delay operation is as follows. When the power switch is turned on, the positive output voltage gradually rises, but at this initial stage, the voltage enough to turn on D916 has not yet been obtained, and D916 is off. Therefore, the base of Q911 is pulled in the negative direction and Q911 turns on. Therefore, the equivalent bases of the Q910 and Q909 connected in Sziklai connection are pulled to the ground and turned off. Since Q909 and Q910 are off until D916 turns on, a negative DC output voltage cannot be obtained. However, after D916 turns ON, the DC voltage is supplied to the preamplifier by the same operation as the general constant voltage circuit for both the positive and negative power supplies.

When the power switch is turned off, the negative voltage ripple filter Q902 (preamplifier section) base is grounded by the switch S12 that works in conjunction with this to turn off the power to the preamplifier and turn off the sound. Therefore, it is possible to prevent the residual sound after turning off the power switch.