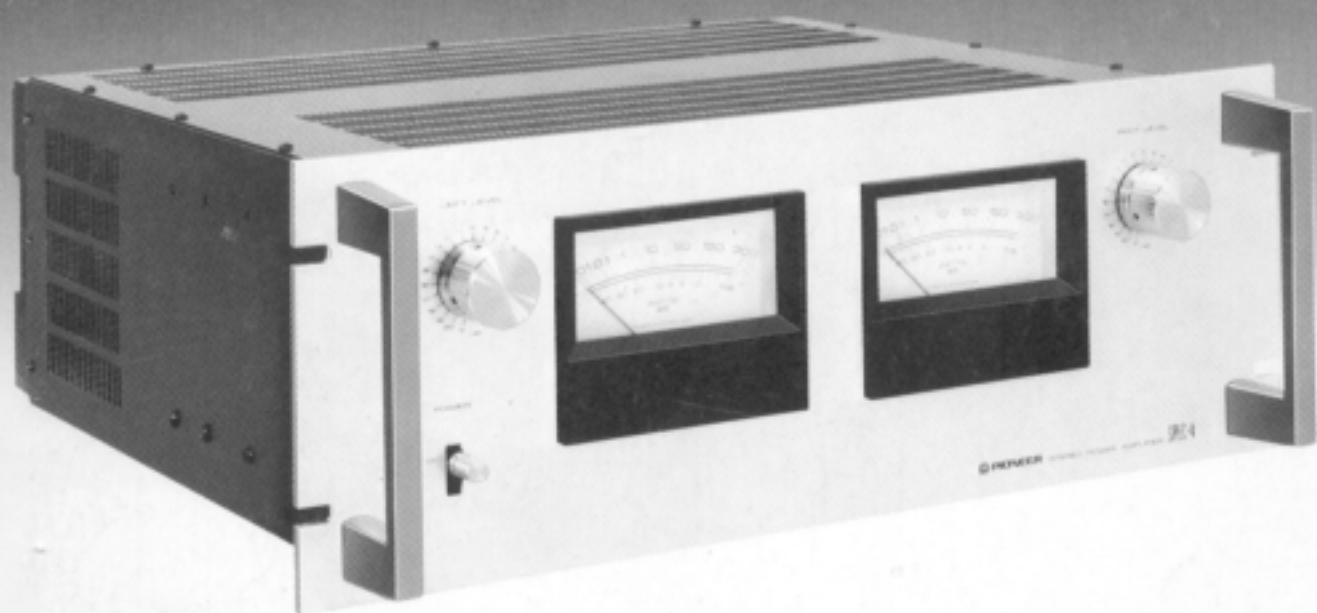


STEREO POWER AMPLIFIER

SPEC-4

SERVICE MANUAL



MODEL SPEC-4 COMES IN TWO VERSIONS DISTINGUISHED AS FOLLOWS:

Type	Voltage	Remarks
KU	120V only	U. S. A. model
S	110V, 120V, 220V and 240V (Switchable)	General export model

- This service manual is applicable to KU(p2-p40) and S(p41-p48) types.
- For servicing of S type please refer to KU type with the exception of descriptions in the Additional Service Manual (p41-p48).

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1. SPECIFICATIONS

Semiconductors

ICs	2
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Power Amplifier

Circuitry Current mirror loaded differential Amplifier,
3-stage darlington parallel push-pull, direct-coupled OCL.

Continuous Power Output from 20 Hertz to 20,000 Hertz
(Both channels driven) . . . 180 watts per channel (4 ohms)
150 watts per channel (8 ohms)

Total Harmonic Distortion (20 Hertz to 20,000 Hertz, 8 ohms)
Continuous rated power output 0.01%
75 watts per channel power output 0.01%
1 watt per channel power output 0.01%
Intermodulation Distortion (50 Hertz: 7,000 Hertz=4:1, 8 ohms)
Continuous rated power output 0.01%
75 watts per channel power output 0.005%
1 watt per channel power output 0.005%

Frequency Response 5 Hertz to 100,000 Hertz ± 1 dB
Input (Sensitivity/Impedance) 1V/50k ohms

Output

Speaker 4 ohms to 16 ohms
Damping Factor (20 Hertz to 20,000 Hertz, 8 ohms) 100
Hum and Noise (IHF, short-circuited, A network) 11.5dB

Miscellaneous

Power Requirements AC 120V 60 Hertz
Power Consumption 760 watts (UL)
Dimensions 480(W) x 187(H) x 445(D) mm
18-7/8 x 7-3/8 x 17-7/16 in
Weight: Without Package 24.5kg; 53lb 14oz

Furnished Parts

Connection Cord with Pin Plugs 1
Operating Instructions 1

NOTE:

Specifications and the design subject to possible modification without notice due to improvements.

2. FRONT PANEL FACILITIES

POWER SWITCH

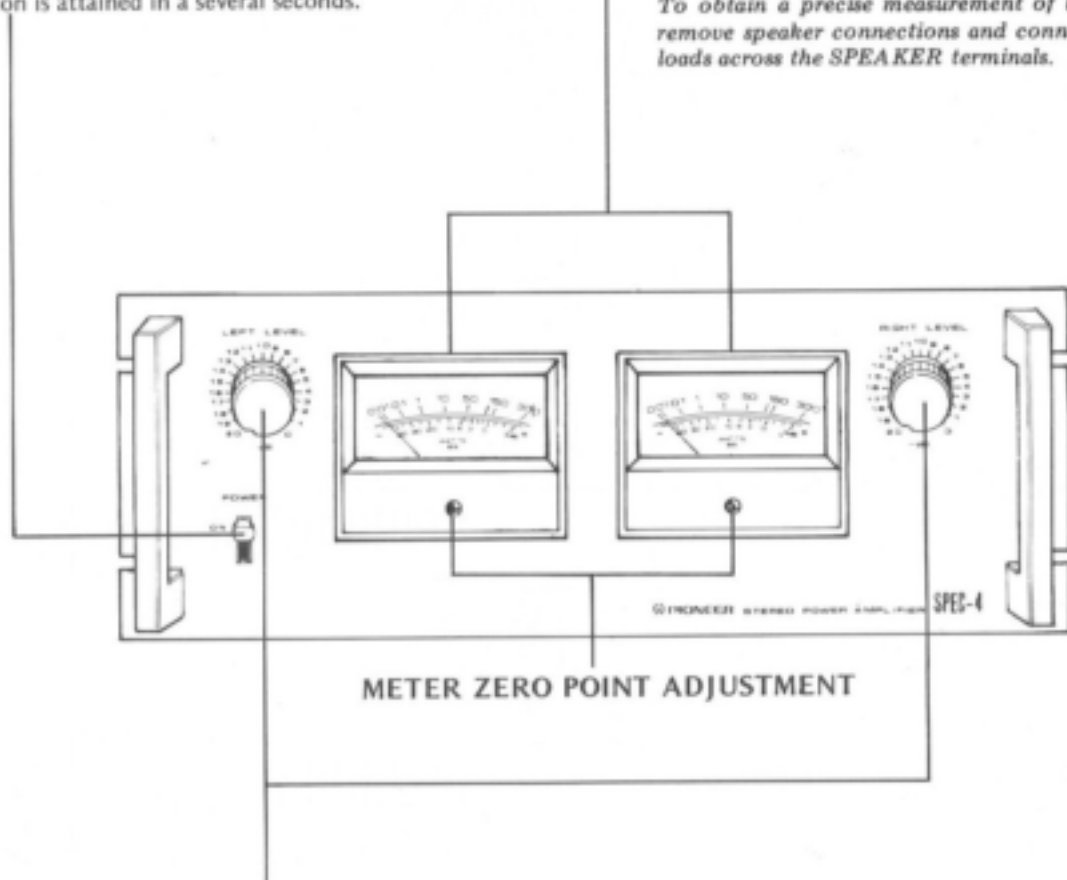
Set to ON position to energize SPEC-4. After setting to ON, there is a brief delay before sound is obtained. This is due to the operation of the muting circuit which prevents noise when the POWER is switched. This function does not indicate difficulty and normal operating condition is attained in a several seconds.

PEAK LEVEL METERS

When speaker systems of 8ohm nominal impedance are connected, these provide direct readout of the peak output power in Watts.

NOTE:

Speaker system impedance varies according to frequency. To obtain a precise measurement of the output power, remove speaker connections and connect 8ohm dummy loads across the SPEAKER terminals.



INPUT LEVEL CONTROLS (LEFT & RIGHT)

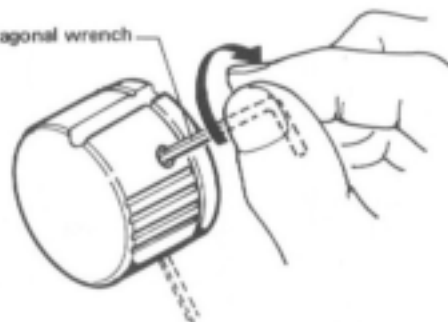
Adjust the LEFT and RIGHT controls according to the output level (voltage) of the preamplifier connected to the SPEC-4's INPUT (L, R) terminals. If the controls are turned fully to the right (to the "0dB" position), then the rated input will be 1V. Conversely, if they are turned to the left, this will yield an attenuation equal to the graduations, and the rated power output can be varied. Standard input voltages are: 0dB = 1V, -6dB = 2V, -10dB = 3V, -12dB = 4V, and -14dB = 5V.

NOTE:

Turn the controls counterclockwise to the 0dB position if you are using a preamplifier with a maximum output voltage of less than 1V. In such cases, it will not be possible to yield the rated power output listed in the SPEC-4's specifications. (For example one-quarter of the power output is obtained with a preamplifier having a maximum output of 0.5V.)

HEXAGONAL WRENCH

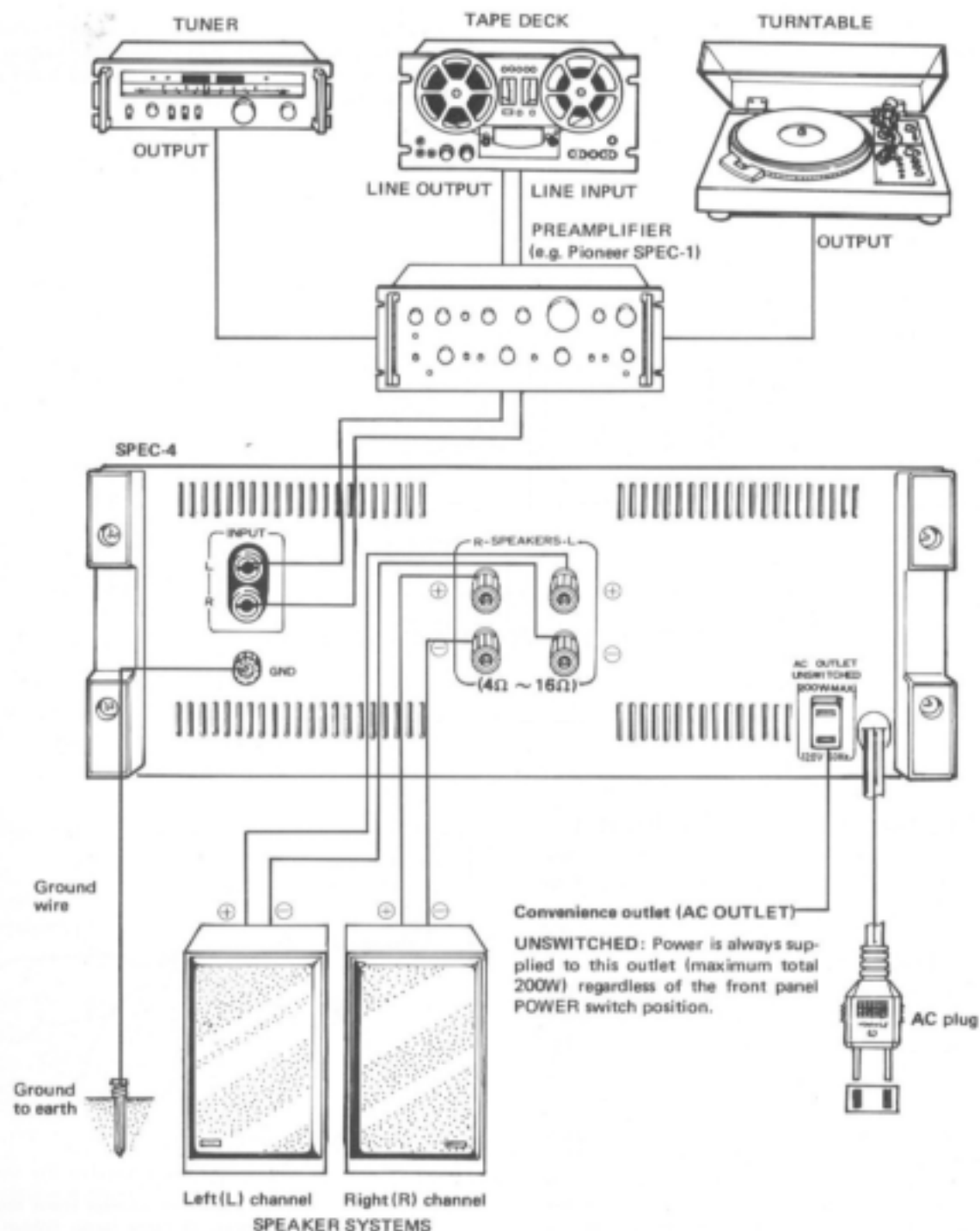
Hexagonal wrench



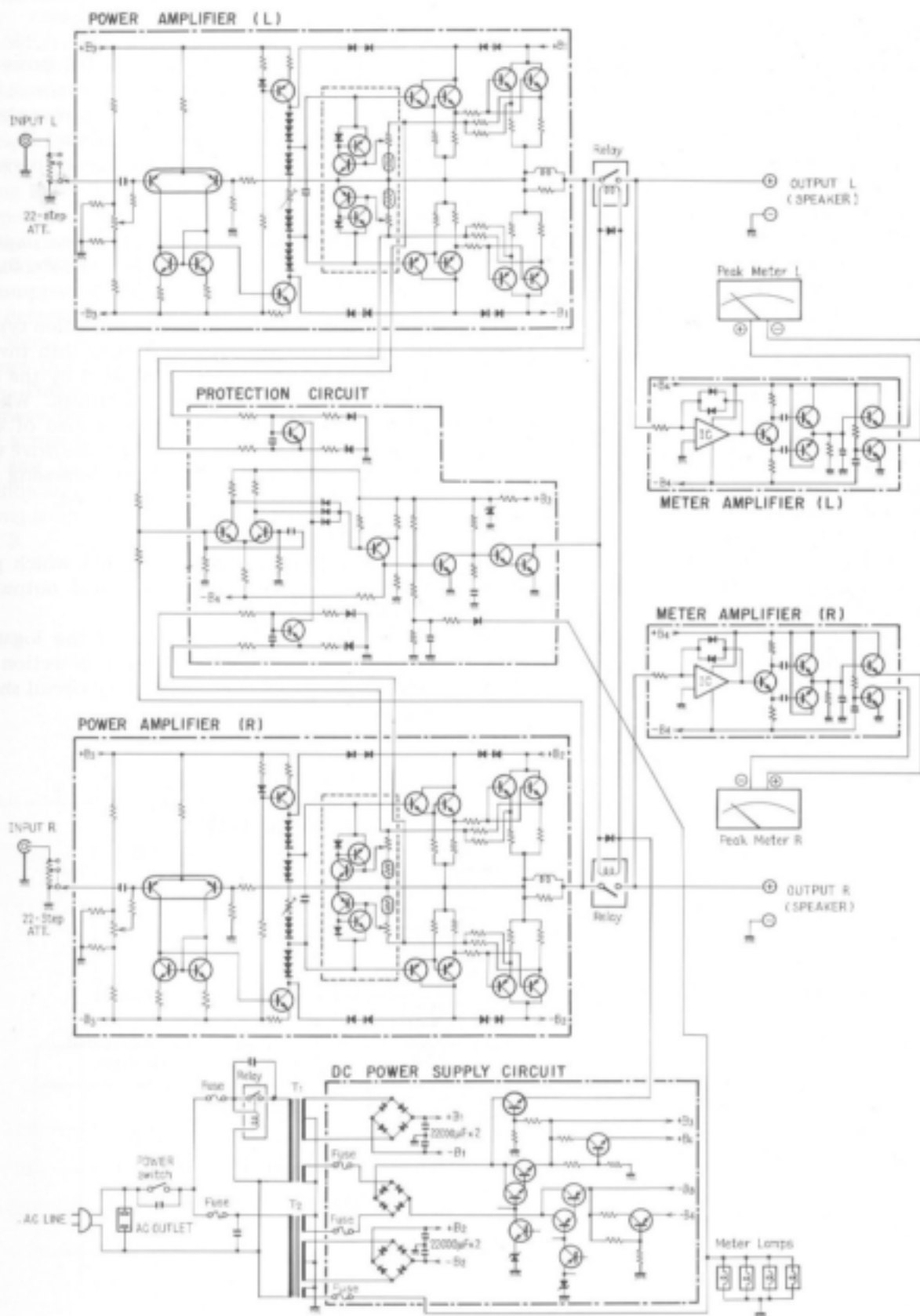
If any of the control knobs should happen to come loose, tighten by means of the hexagonal wrench.

3. CONNECTION DIAGRAM

Before making the connections, check that the power is off. Also, make sure that you turn the power off if you want to change over the connections when the components are operating.



4 BLOCK DIAGRAM



5. CIRCUIT DESCRIPTION

5.1 POWER AMPLIFIER

This unit is a DC amplifier with an input coupling capacitor. Generally, in direct coupled amplifiers, 100% NFB is applied at the DC stage. This technique provides a DC gain of 1 and stabilizes the circuit. The operation is performed by giving the NFB circuit a time constant. However, this adversely affects the low range phase characteristics in the audio frequency range.

Careful consideration has been given to stability in the circuit design of this unit; the time constant of the low range of the NFB circuit has been eliminated, and amplification is performed up to the DC stage. This improves the low range phase characteristics and tonal quality. Moreover, the low range frequency response is determined by the time constant of the input coupling section.

The first stage is a PNP dual transistor differential amplifier with a current mirror circuit, which enables stable operation and provides high gain from the DC to the ultrahigh frequency range.

The second stage (pre-driver stage) is a Class A amplifier. High voltage gain is obtained by inserting a constant current circuit for the load (voltage gain is necessary at this stage because the voltage gain of the power stage is zero). The power stage is a 3-stage Darlington connection and the final stage is a parallel SEPP.

A power limiter circuit protects the power stage. D_1, D_2, D_3 and D_4, D_5, D_6 are drive voltage limiters which prevent overdriving of the power stage. D_3, D_6 shift the DC level of the signal and D_1, D_2, D_4, D_5 conduct the overdrive voltage to prevent the power stage being overdriven.

NOTE:

Since the power supply voltage of the power stage is lower than that of the drive stage at high outputs, D_1, D_2 and D_4, D_5 conduct the overdrive voltage.

The power limiter is a current-detection type. This limiter detects the current forced thru the power transistor by the voltage generated by the emitter resistance of the power transistors. When the output has exceeded 180W at a load of 4 ohms or less, $Q_{13} - Q_{16}$ operate to limit the drive voltage. This prevents the output from increasing even if an input greater than this is applied.

5.2 METER AMPLIFIER

A peak output meter is provided which permits direct reading of an 8 ohms load output from 0.01W to 300W.

The meter amplifier consists of the logarithmic compression circuit, absolute value detection circuit, peak hold circuit, and meter drive circuit shown in Fig. 2.

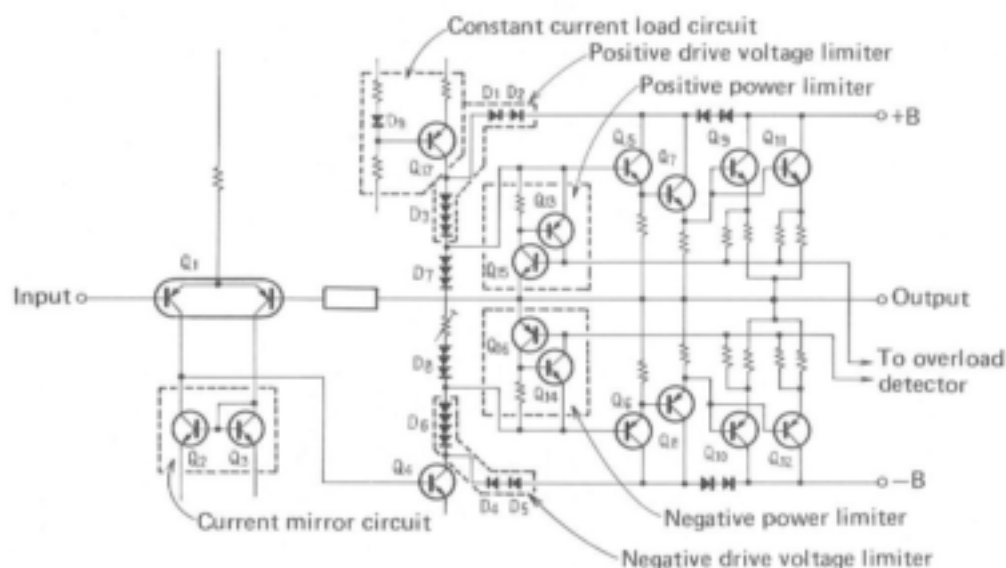


Fig. 1 Power amplifier circuit

The input signal is divided by R_1 , R_2 and sent to the logarithmic compression circuit. The logarithmic compression circuit is an audio IC (TA7136P2) and utilizes the rise characteristic of diodes D_1 , D_2 in the NFB loop to reduce the dynamic range of the signal. This creates an input/output characteristic which attenuates low level inputs very little and high level inputs substantially. The characteristic is compensated by inserting R_4 in parallel with D_1 , D_2 and the circuit is temperature compensated with a thermistor so that the meter scale is almost logarithmically graduated from 0.01W to 300W.

The compressed signal is applied to the absolute value detector. This circuit produces a reverse phase signal by means of Q_2 and extracts and combines the positive half cycle by means of Q_3 and Q_4 . This signal charges C_1 up to the peak value and drives the meter by means of Q_5 , Q_6 . The charge across C_1 is discharged at the time constant of C_1 and R_5 to determine the fall time of the peak indication of the meter.

The frequency response of the peak meter is given in Fig. 3.

5.3 PROTECTION CIRCUIT

This circuit protects the power transistors in case of overload, the speakers in case of power amplifier malfunction, and also performs a muting function when the power supply is turned ON or OFF. The protection circuit is composed of three sections (Fig. 4).

1. Relay Driver Circuit (Fig. 5)

The relay which connects the output circuits is driven by this circuit. It also performs a muting function to prevent unpleasant noise during ON-OFF operation of the power supply as well as opening the output circuit on command from the detector circuits.

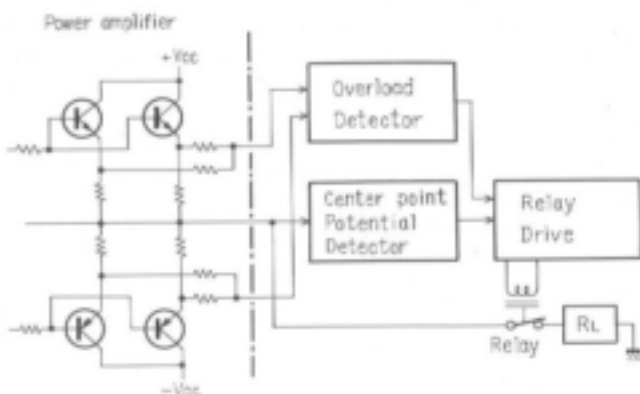


Fig. 4 Block diagram of protection circuit

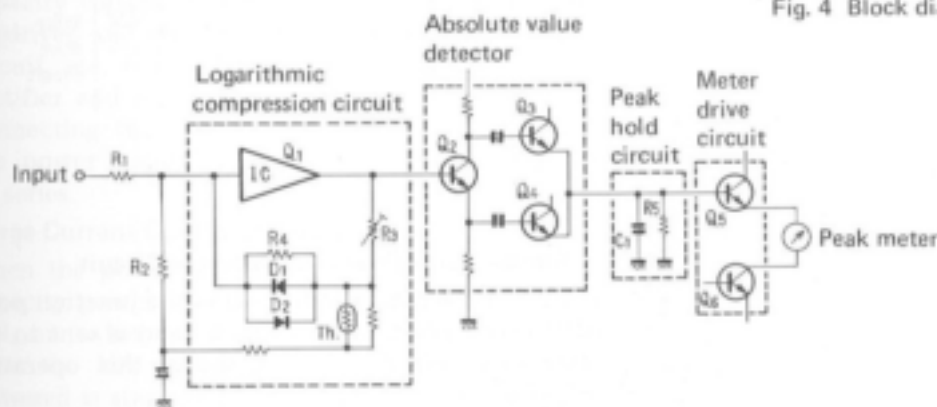


Fig. 2 Meter amplifier circuit

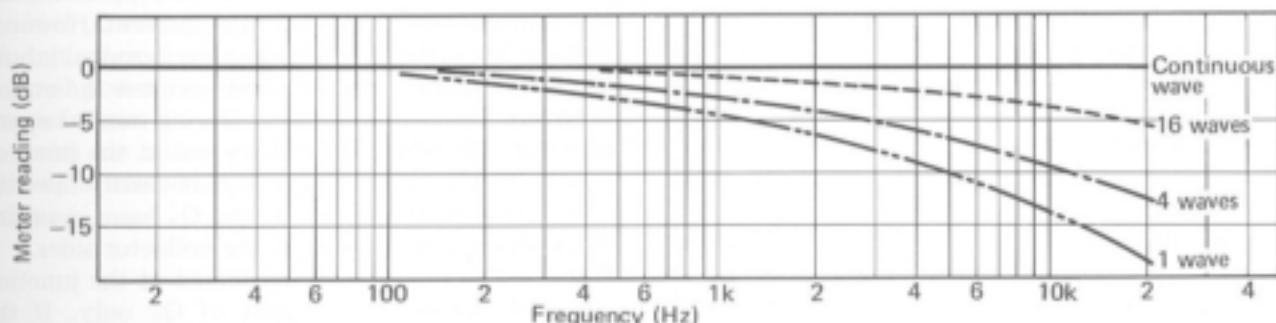


Fig. 3 Frequency response of the peak meter

Muting Operation

When the power supply is turned ON, Q_{11} base is reverse biased through D_2 and R_{22} , turning Q_{11} OFF. Q_{12} base potential rises as C_1 charges through R_1 & R_2 , and Q_{12} & Q_{13} turn ON several seconds later. The collector current of Q_{13} then flows through the relay coil, operating the relay to turn on the power amplifier output circuit. The reverse bias of Q_{11} base from D_2 & R_{22} disappears when the power supply is set from ON to OFF. Q_{11} remains ON however, due to the residual power supply voltage. C_1 very rapidly discharges, Q_{12} base potential drops and Q_{12} & Q_{13} turn OFF. The relay releases and the power amplifier output circuit turns OFF.

NOTE:

Q_{10} is normally OFF due to base bias and does not participate in the muting operation.

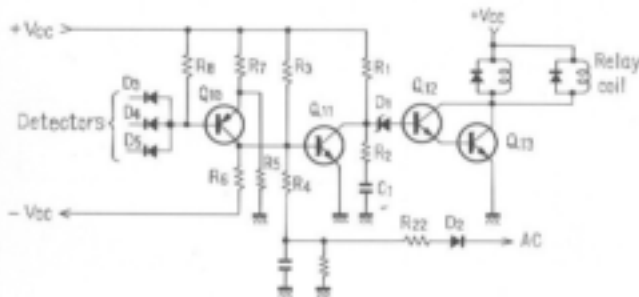


Fig. 5 Relay drive circuit

Operation by Detector Circuit Command

Command from the detector circuits pass through one of D_3 , D_4 or D_5 and are applied in the form of a current flow. Q_{10} is normally reverse biased through R_8 , but when a large current flows through one of these diodes, Q_{10} base potential declines according to the voltage drop at R_8 . Q_{10} then turns ON, Q_{11} base potential rises and Q_{11} turns ON. C_1 rapidly discharges and Q_{12} base potential drops, turning Q_{12} & Q_{13} OFF. The relay releases and the power amplifier output circuit becomes cut off.

2. Overload Detector Circuit

Shorting of the power amplifier load or a load impedance below the specified value causes a command to be sent to the relay drive circuit. This is illustrated in Fig. 6.

With the output stage in class B operation, when Q_a is operating in the positive half cycle, Q_b becomes cut off and the signal current flows as indicated by the solid arrows in Fig. 6. Point D potential at this time is the point A potential divided by R_{49} and R_{50} . Also, point C potential is

the point A potential divided by R_{e1} and R_L (load). Point D is connected to Q_{12} base and point C to Q_{12} emitter through R_{48} and R_{e2} . When R_L is extremely small, the point C potential becomes considerably lower than point D. This potential difference forward biases Q_{12} . Q_{12} turns ON and current flows in D_3 .

Q_b operates in the negative half cycle and Q_a becomes cut off. The signal flows is indicated by the broken line arrows in the center of Fig. 6. Q_{12} is biased by the potential difference between point C and point E. If R_L is extremely small, the point C potential becomes considerably higher than that of point E. Q_{12} turns ON and current flows in D_3 .

If large current flows in Q_a and Q_b , Q_{12} becomes ON due to the R_{e1} and R_{e2} voltage drops, and current flows in D_3 . C_{24} prevents faulty operation due to external noise.

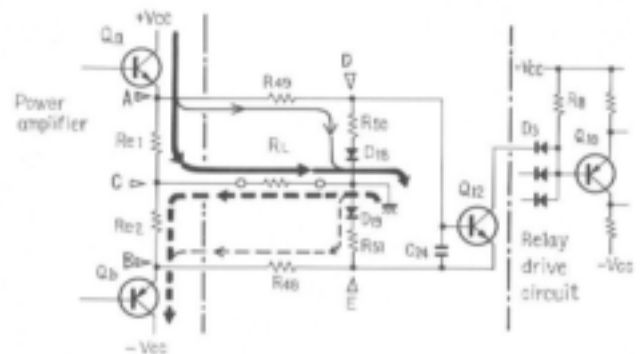


Fig. 6 Overload detector

3. Center Point Potential Detector Circuit

If a DC potential is produced at the junction point of the power amplifier, a command is sent to the relay drive circuit. Fig. 7 shows this operating principle.

Q_8 and Q_9 compose a differential amplifier. When the same input is applied to both input terminals (Q_8 and Q_9 bases), no output is present. However, if there is a difference between the terminal inputs, the difference is amplified and becomes the output between the two collectors. During normal operation, an AC signal only is present at the junction point. As C_3 , C_4 reactance is sufficiently low, the same signal is applied to Q_8 and Q_9 bases, resulting in an absence of output at the collector sides.

When a DC potential is produced at the junction point, it becomes the input of Q_9 only. If the voltage is negative, Q_9 collector current declines.

and at Q_8 the collector current increases and the potential drops, causing current to flow through D_5 .

If the DC voltage is positive, Q_9 collector current increases and the potential drops, while at Q_8 the collector current decreases and the potential rises. Current therefore flows through D_4 .

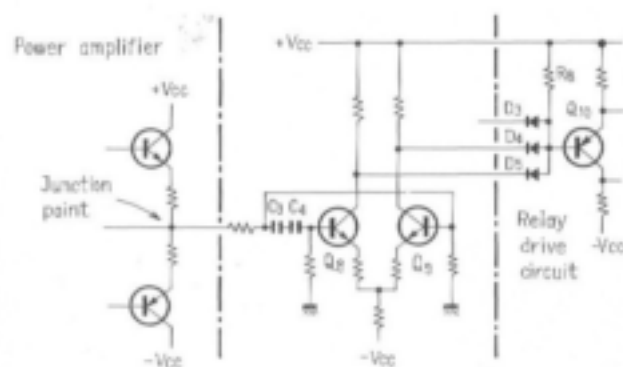


Fig. 7 Center point potential detector

5.3 POWER SUPPLY CIRCUIT

Two power transformers are used. The left channel and right channel power stage power supplies are independent. Power is supplied to each channel by a bridge rectifier and two 22,000 μ F high capacity capacitors. The power supply before the predriver and for the main amplifier, protection circuit, etc. is supplied to each part thru a bridge rectifier and minus and plus voltage regulators by connecting the windings (different from that of the power stage) of the two power transformers in series.

Surge Current Countermeasures

When the power of an amplifier having two high capacity power supplies such as this unit is turned ON, an extremely large rush current flows. The time the left and right power transformers are powered is staggered somewhat in this amplifier to reduce this rush current to a minimum.

When the power switch is turned ON, T_2 (right channel power transformer) is immediately powered, but since the relay contacts are open, T_1 (left channel power transformer) is not powered. When current flows in the coil of the relay, the relay contacts are closed and T_1 is powered. The rush current is reduced by one half during this 7–9msec delay.

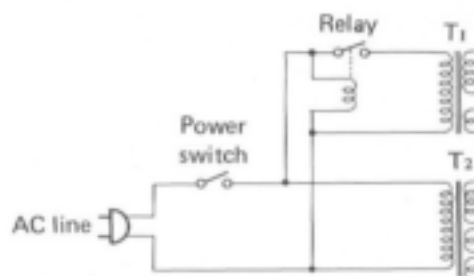


Fig. 8

5.5 OTHERS

The electrolytic capacitor ground connection is a 20mm x 2mm copper plate.

A cord (inner conductor 2.03 ϕ , 0.254 ϕ x 41 stands) having a DC resistance of about 1/4 that of common electric wire is used in the power supply, output, and ground circuits.

The input attenuator covers the 0 to -20dB range in 22 steps. The final position is $-\infty$.

6. DISASSEMBLY

Top cover

Remove the 12 screws(A) to detach the top cover.

Front panel

Loosen the set screws of the 2 LEVEL knobs with an hexagonal wrench and remove all the knobs.

Remove the 8 screws(B) and 2 nuts(D) to detach the front panel.

Bottom plate

Remove the 17 screws(C) at the bottom plate and lift off the bottom plate.

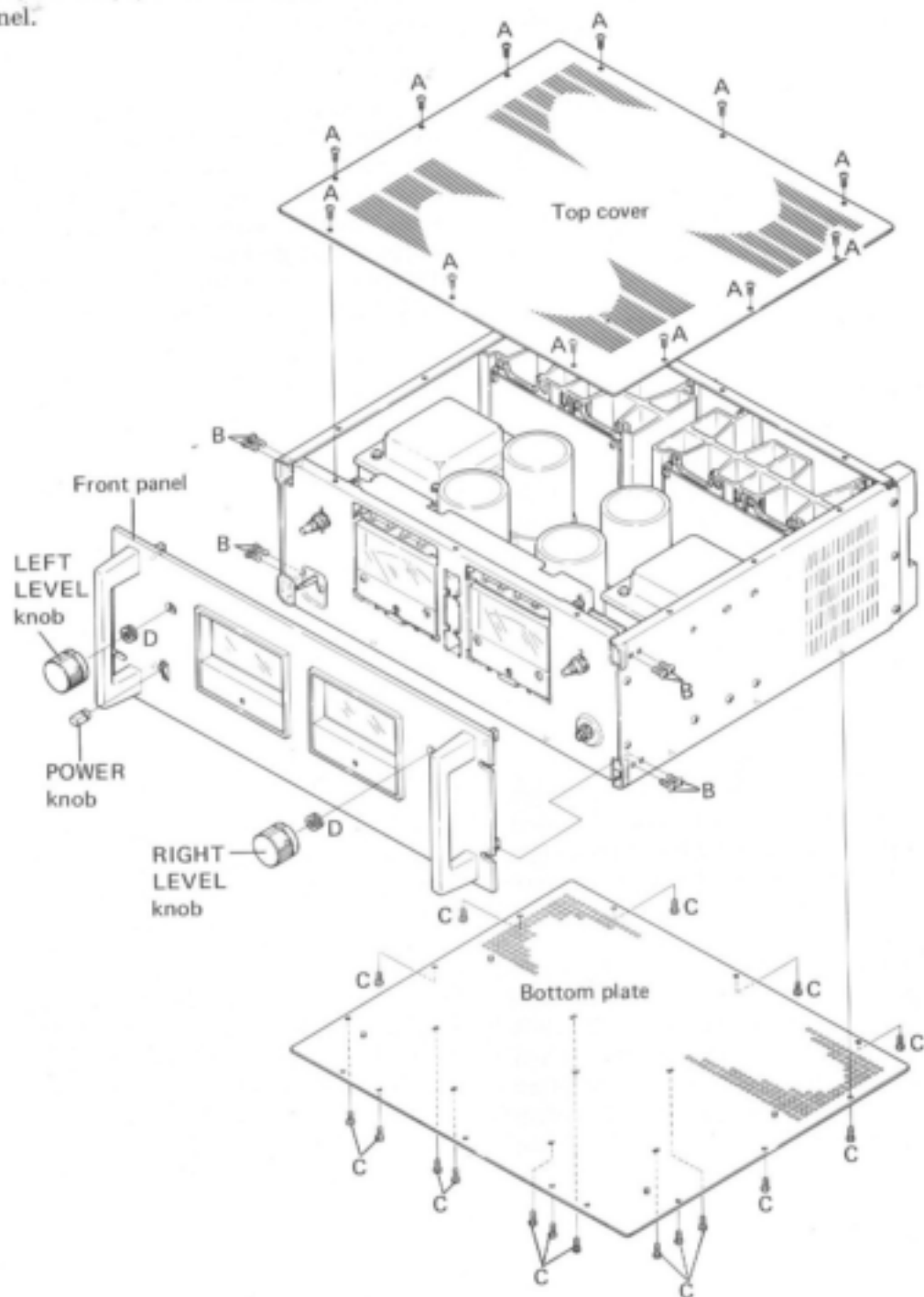
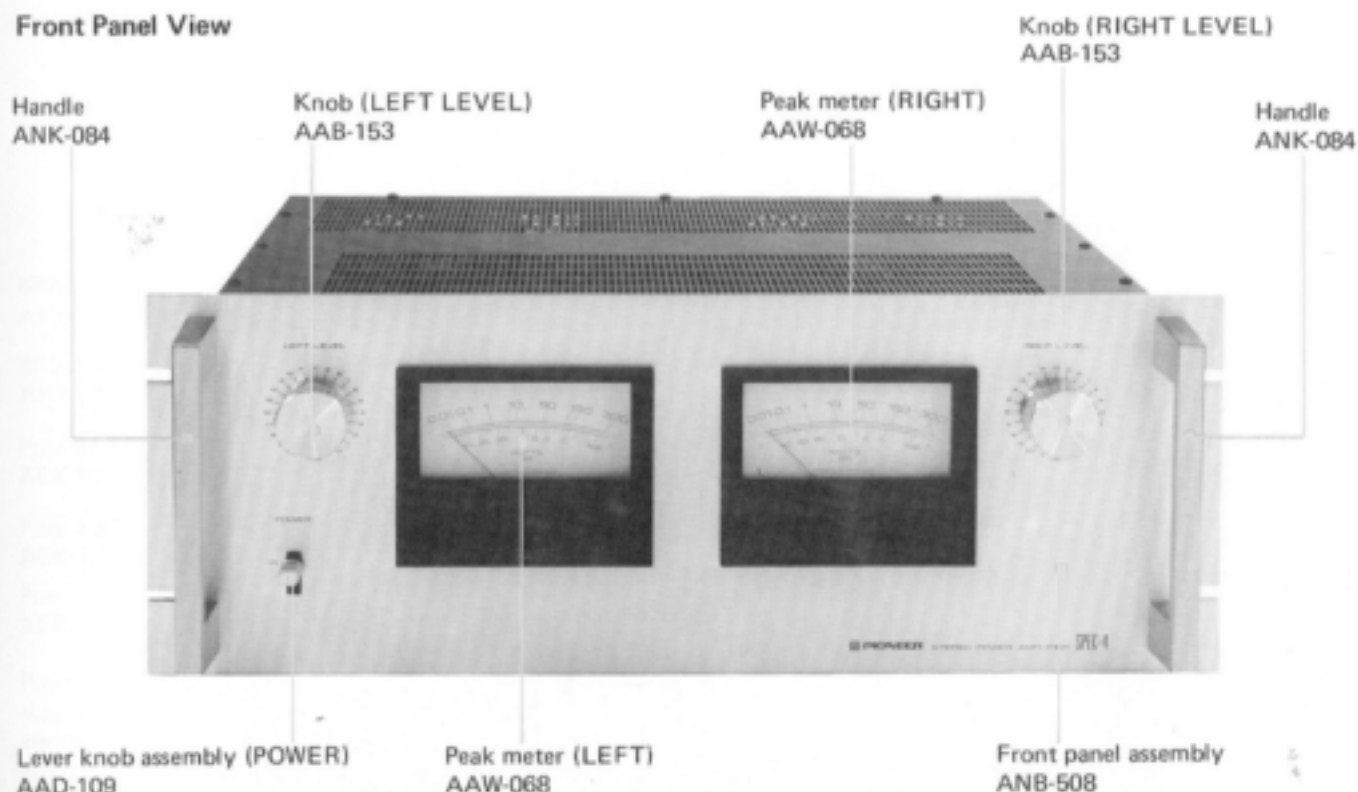


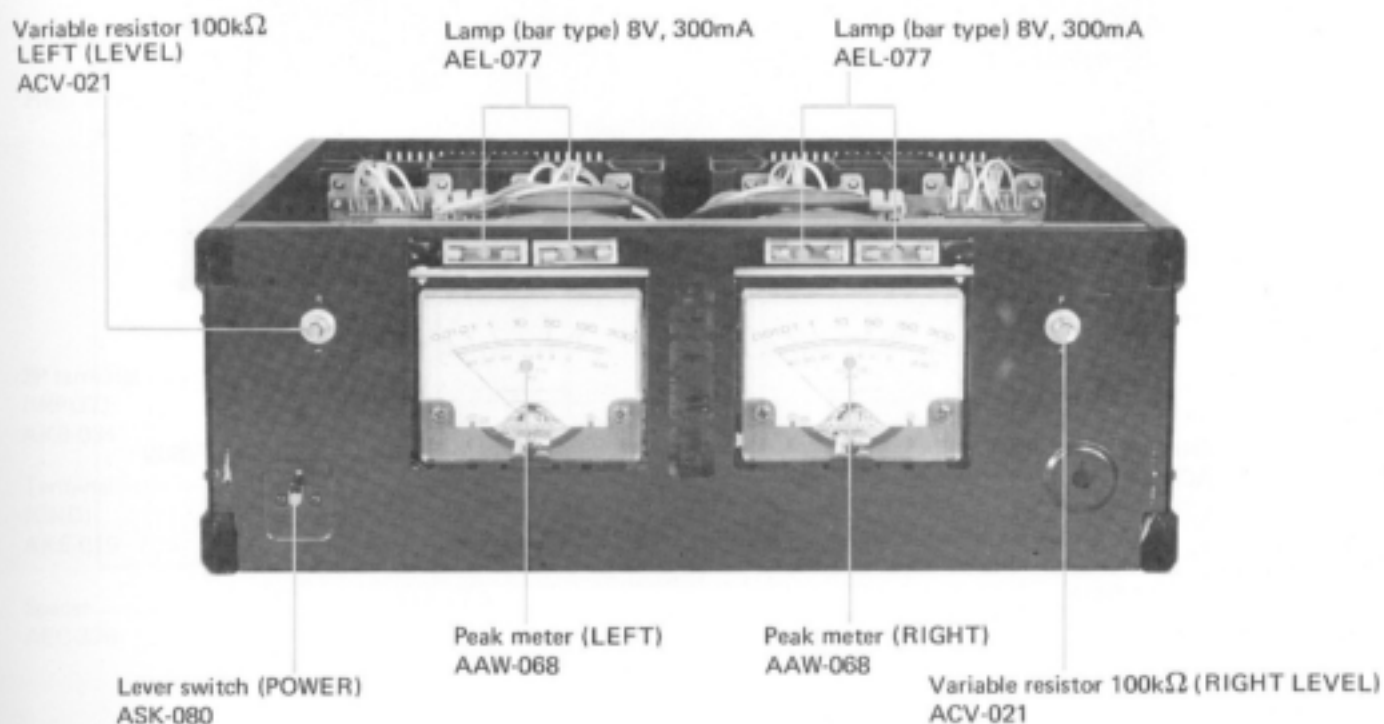
Fig. 9

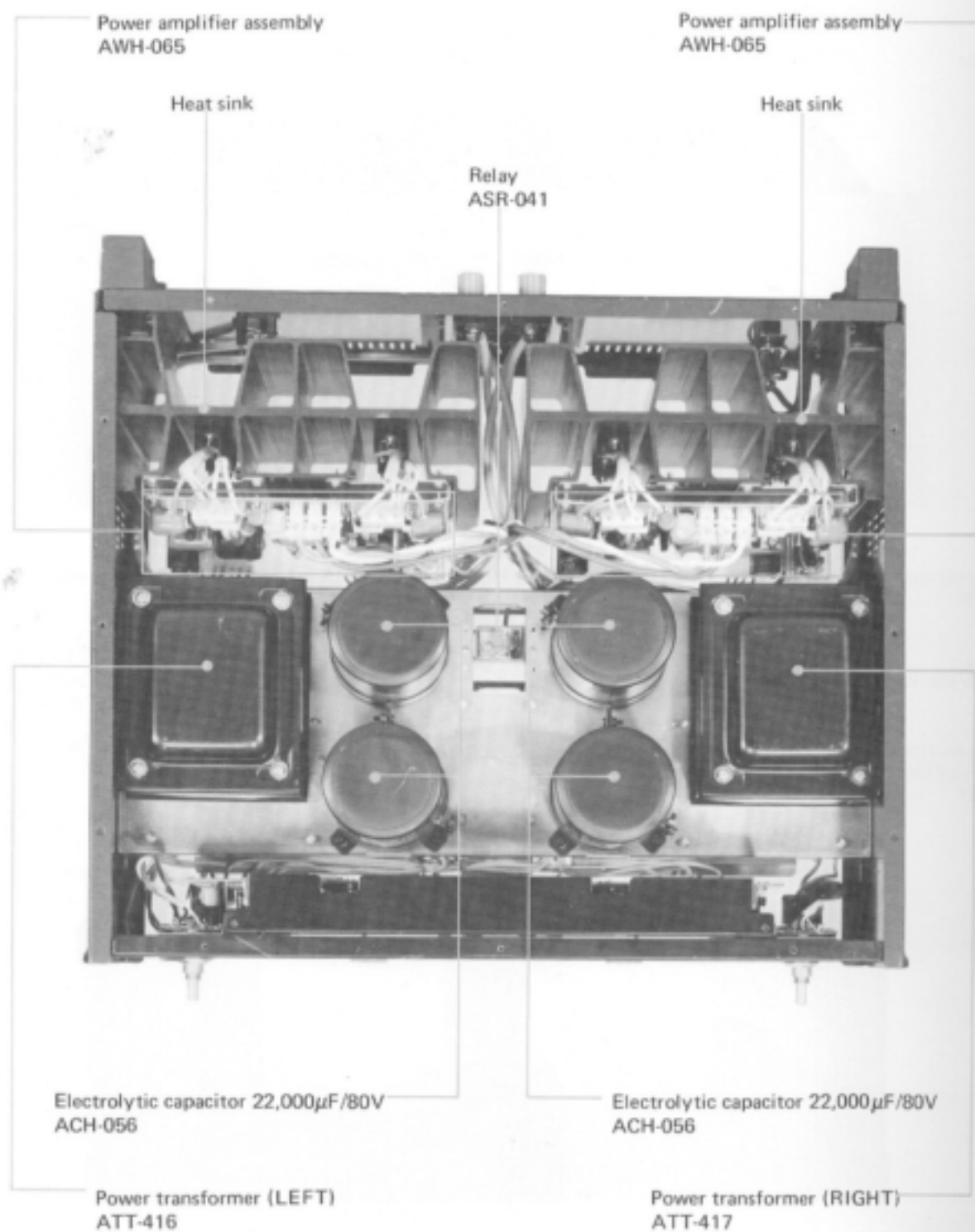
7. PARTS LOCATION

Front Panel View

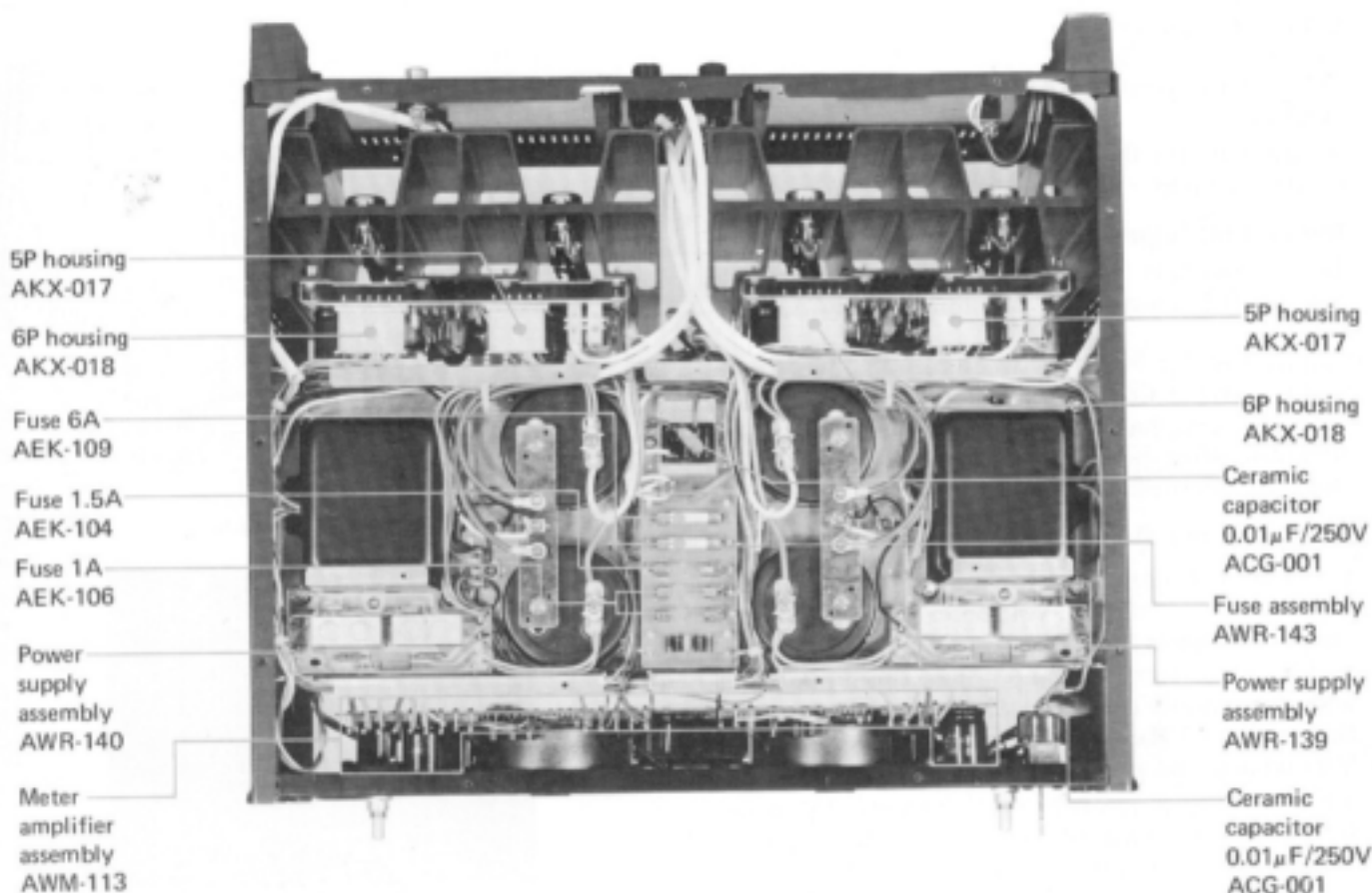


Front View with Panel Removed

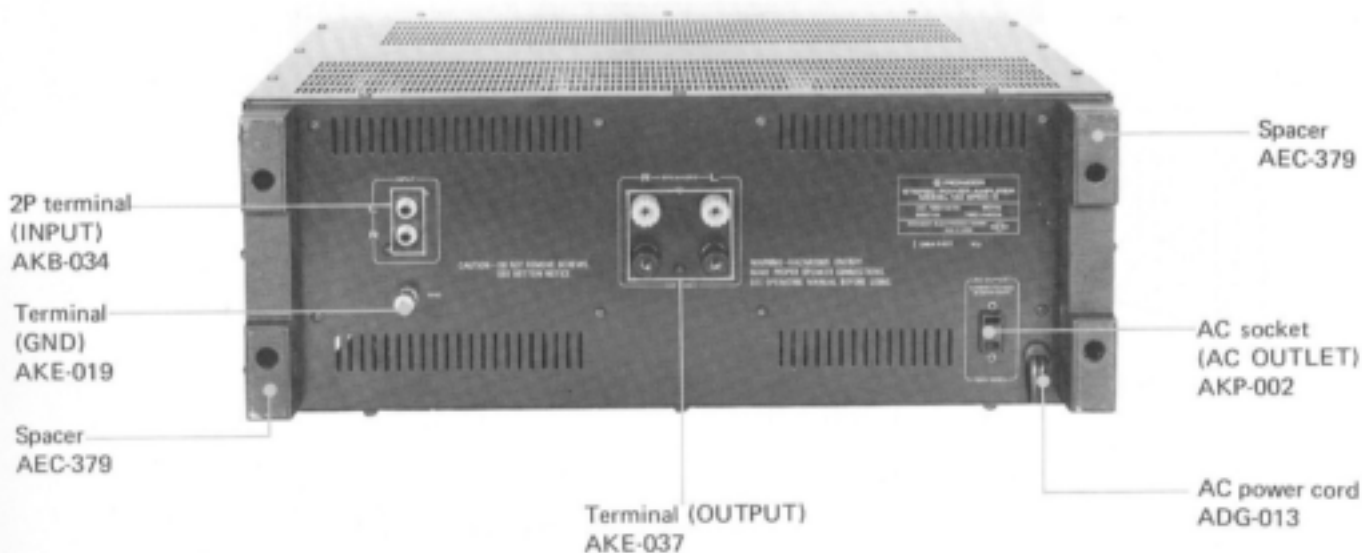




Bottom View



Rear Panel View



8. ADJUSTMENTS

8.1 POWER AMPLIFIER

DC Balance Adjustment

Do not connect load to speaker output terminals. Set LEVEL control to minimum (fully counter-clockwise).

Adjust VR₁ for 0V at the speaker output terminals (between + and -):

Idle current Adjustment

Do not connect load to speaker output terminals. Set LEVEL control to minimum (fully counter-clockwise).

Adjust VR₂ for 50mV between terminal No. 26 (+) and No. 16 (-). Confirm that 50mV ± 10mV appears between terminals No. 25 (+) and No. 17 (-). Readjust after power has been applied for more than 10 minutes.

Power Limiter Adjustment

Connect a 4 ohms resistor and distortion meter, oscilloscope, and AC voltmeter to the speaker output terminals (See Fig. 11). Apply a 1kHz signal to the input terminals and adjust the input signal level for a 200W (28.29V/4Ω) output. At the same time, adjust VR₃, VR₄ for a distortion of 0.03%. VR₄ adjusts the positive half cycle limiter and VR₃ adjusts the negative half cycle. Observe the waveform with the oscilloscope and adjust so that the waveform is symmetrical.

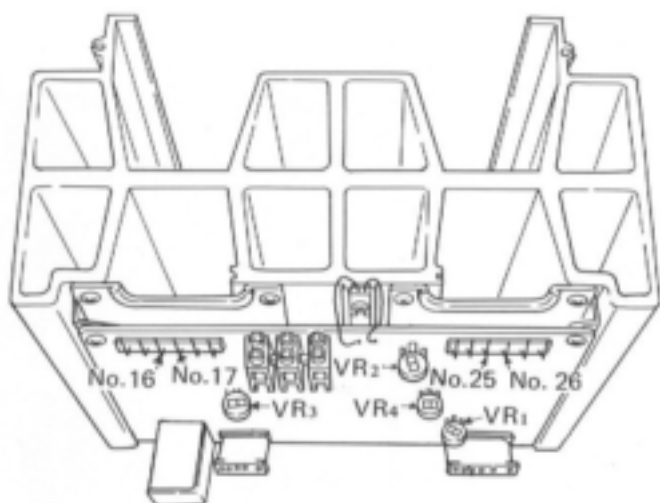


Fig. 10 Power amplifier

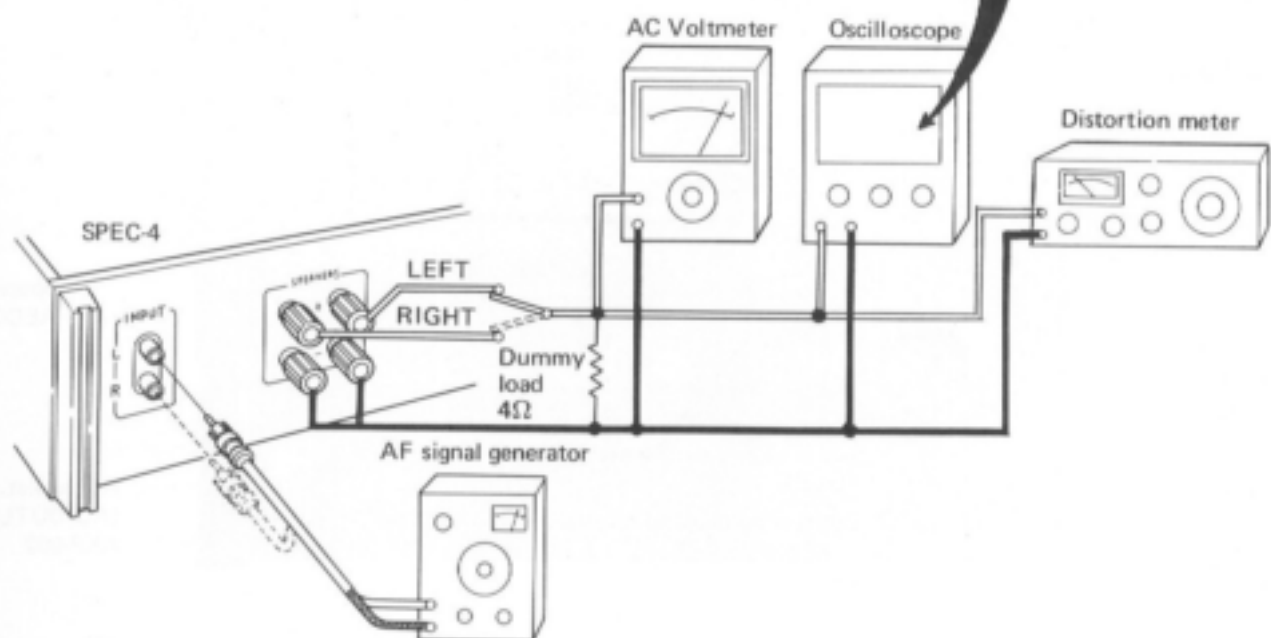
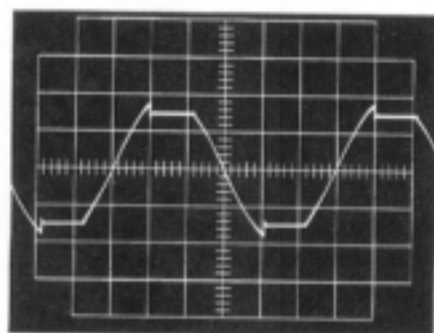


Fig. 11 Connection diagram for power limiter adjustment

8.2 METER AMPLIFIER

Connect an AC voltmeter to the speaker output terminals and apply a 1kHz signal to the input terminals and adjust the input signal level so that the voltmeter indicates 34.64V. At the same time, adjust VR₁ (R channel) and VR₂ (L channel) so that the output meter indicates 0dB.

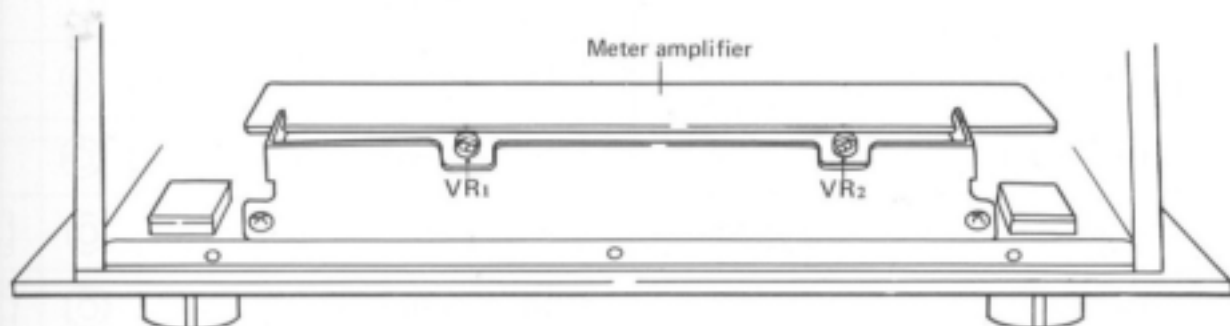


Fig. 12 The position of VR₁ and VR₂

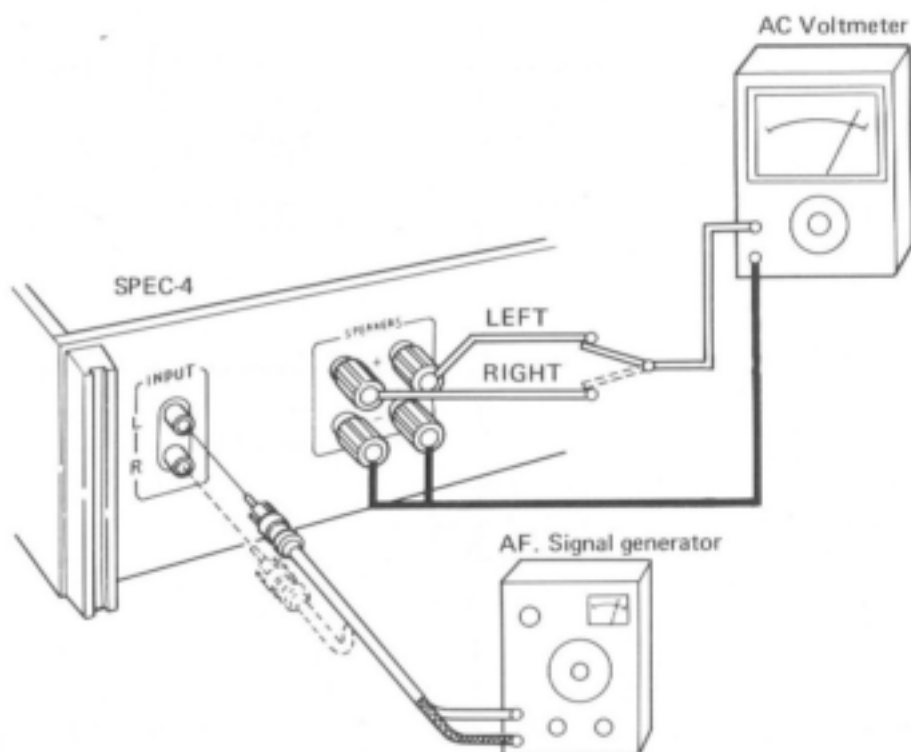

















Fig. 13 Connection diagram for meter amplifier adjustment

9. EXPLODED VIEWS

NOMENCLATURE OF SCREWS, WASHERS AND NUTS

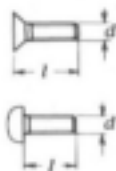
The following symbols stand for screws, washers and nuts as shown in exploded view.

Symbol	Description	Shape
RT	Brazier head tapping screw	
PT	Pan head tapping screw	
BT	Binding head tapping screw	
CT	Countersunk head tapping screw	
TT	Truss head tapping screw	
OCT	Oval countersunk head tapping screw	
PM	Pan head machine screw	
CM	Countersunk head machine screw	
OCM	Oval countersunk head machine screw	
TM	Truss head machine screw	
BM	Binding head machine screw	
PSA	Pan head screw with spring lock washer	
PSB	Pan head screw with spring lock washer and flat washer	
PSF	Pan head screw with flat washer	

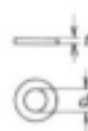
Symbol	Description	Shape
EW	E type washer	
FW	Flat washer	
SW	Spring lock washer	
N	Nut	
WN	Washer faced nut	
ITW	Internal toothed lock washer	
OTW	Outernal toothed lock washer	
SC	Slotted set screw (Cone point)	
SF	Slotted set screw (Flat point)	
HS	Hexagon socket headless set screw	
OCW	Oval countersunk head wood screw	
CW	Countersunk head wood screw	
RW	Round head wood screw	

EXAMPLE

PM · 3x8
 length in mm (l)
 diameter in mm (d)
 Symbol

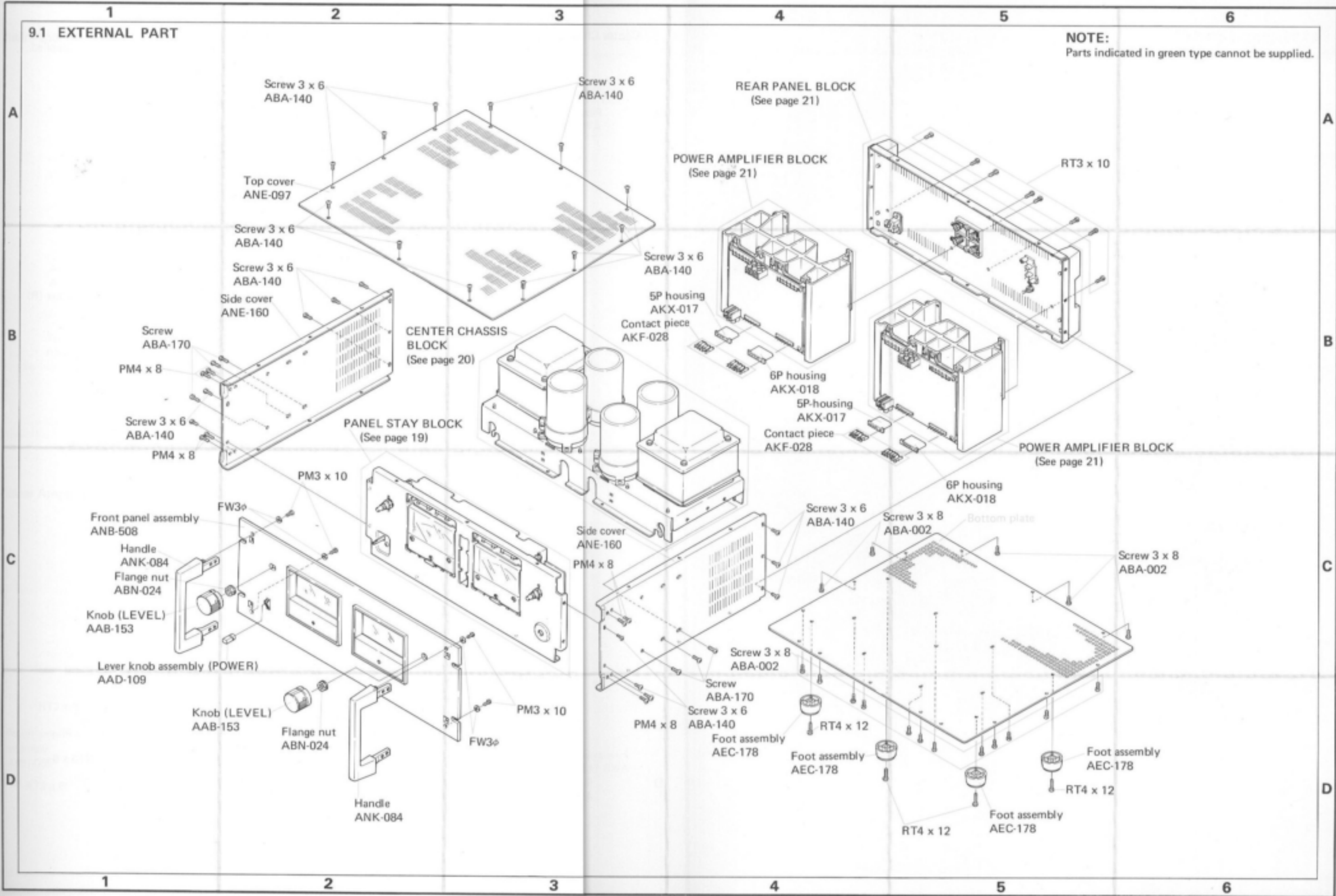


FW · 9φ x 1^r
 thickness in mm (t)
 diameter in mm (d)
 Symbol



9.1 EXTERNAL PART

NOTE:
Parts indicated in green type cannot be supplied.

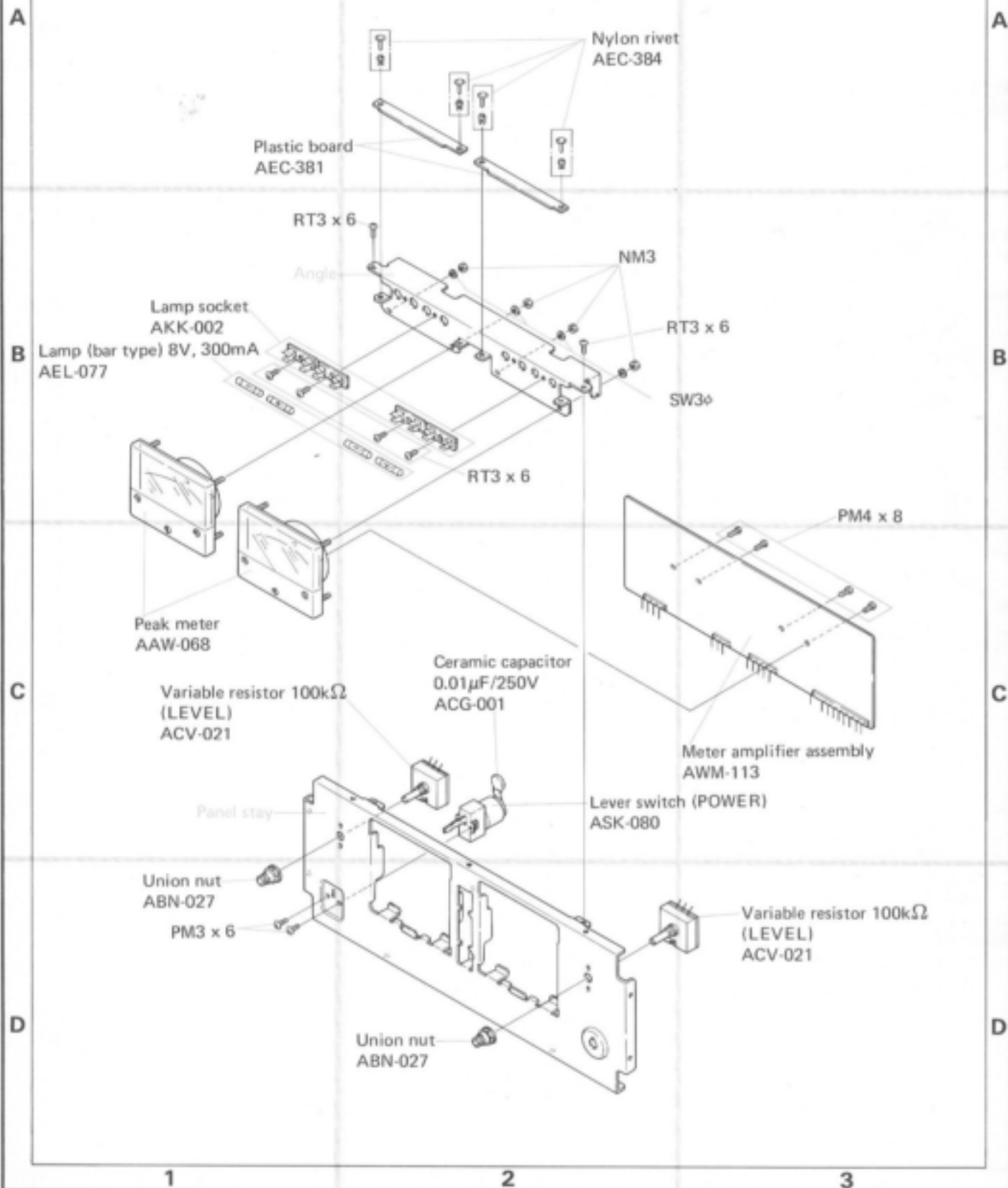


9.2 INTERNAL PART

Panel Stay Block

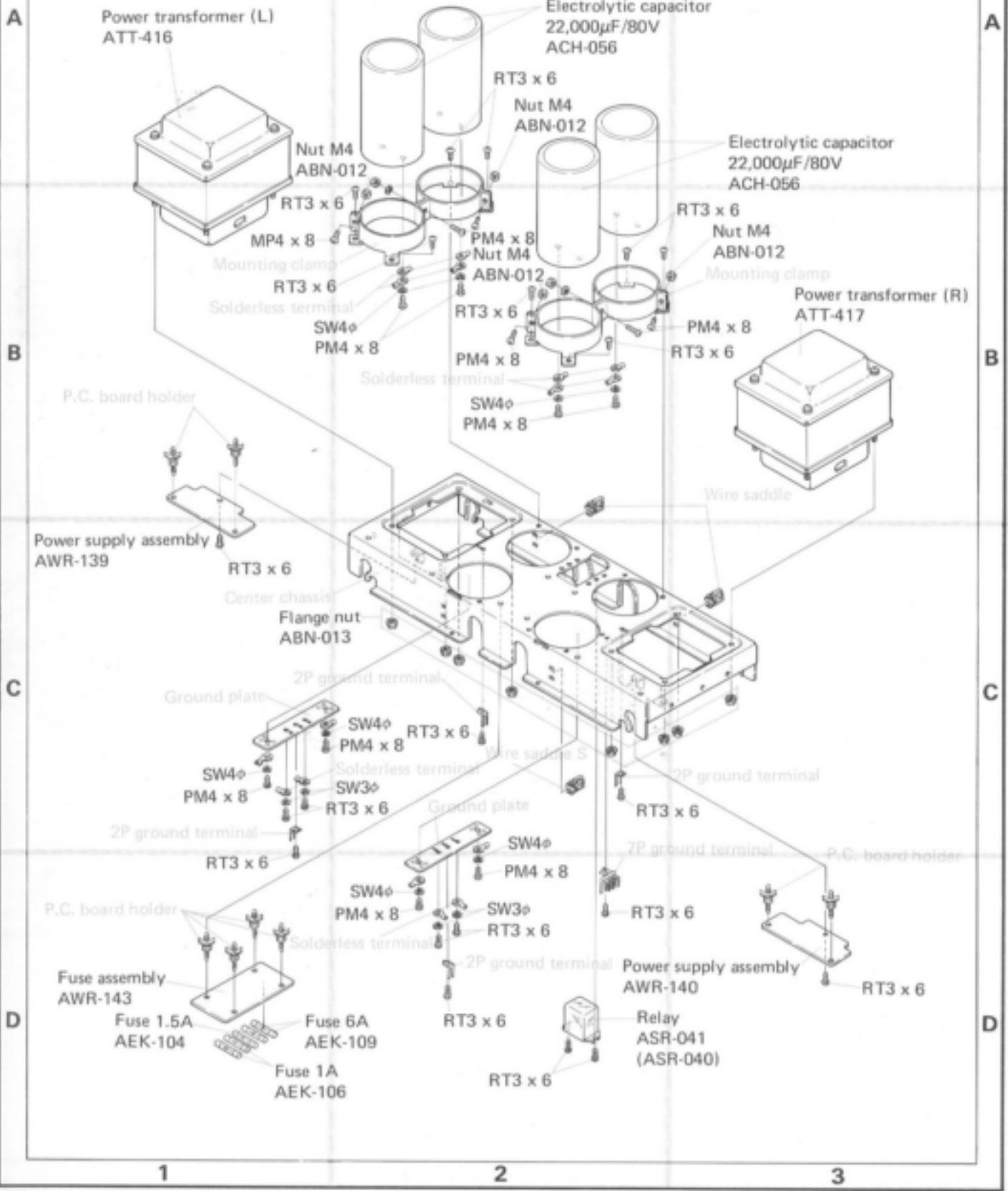
NOTE:

Parts indicated in green type cannot be supplied.



Center Chassis Block

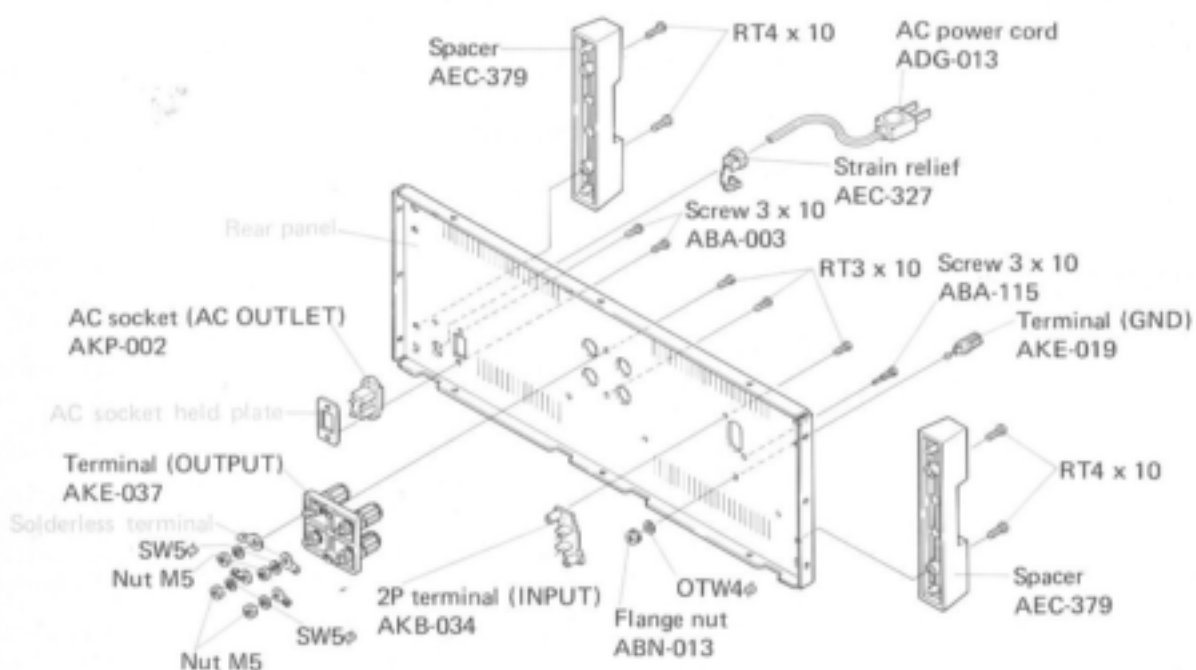
NOTE:
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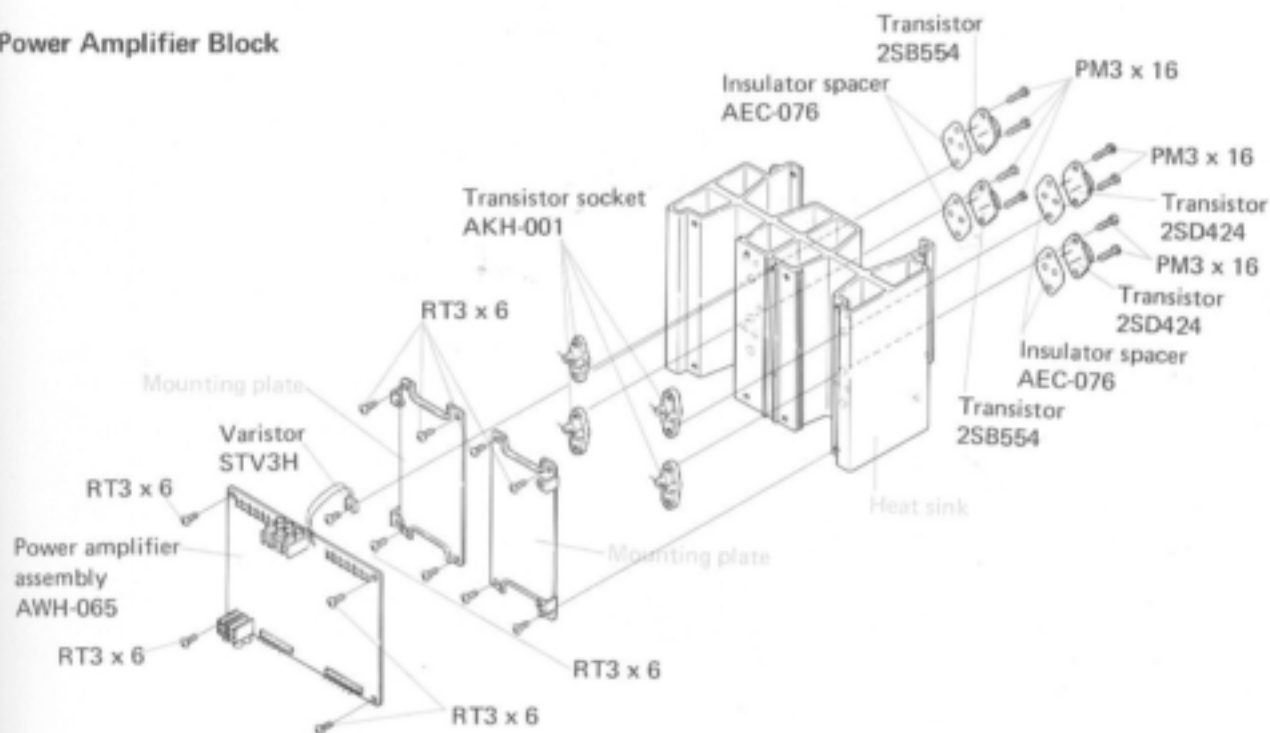
Rear Panel Block

NOTE:

Parts indicated in green type cannot be supplied.



Power Amplifier Block



10. SCHEMATIC DIAGRAMS, P. C. BOARD PATTERNS AND PARTS LIST

10.1 SCHEMATIC DIAGRAM AND MISCELLANEOUS PARTS

Miscellaneous Parts List

SWITCHES

Symbol	Description	Part No.
S1	Lever switch (POWER)	ASK-080
S2	Relay	ASR-041

LAMPS AND FUSES

Symbol	Description	Part No.
PL1	Lamp (bar type) 8V, 300mA	AEL-077
PL2	Lamp (bar type) 8V, 300mA	AEL-077
PL3	Lamp (bar type) 8V, 300mA	AEL-077
PL4	Lamp (bar type) 8V, 300mA	AEL-077
FU1	Fuse 6A	AEK-109
FU2	Fuse 6A	AEK-109
FU3	Fuse 1.5A	AEK-104
FU4	Fuse 1A	AEK-106
FU5	Fuse 1A	AEK-106

TRANSFORMERS

Symbol	Description	Part No.
T1	Power transformer (L)	ATT-416
T2	Power transformer (R)	ATT-417

POTENTIOMETERS

Symbol	Description	Part No.
VR1	Variable resistor 100k Ω (LEVEL)	ACV-021
VR2	Variable resistor 100k Ω (LEVEL)	ACV-021

CAPACITORS

Symbol	Description	Part No.
C1	Electrolytic 22,000 80V	ACH-056
C2	Electrolytic 22,000 80V	ACH-056
C3	Electrolytic 22,000 80V	ACH-056
C4	Electrolytic 22,000 80V	ACH-056
C5	Ceramic 0.01 250V	ACG-001
C6	Polypropylene 33p 50V	CQSB 330K 50
C7	Polypropylene 68p 50V	CQSB 680K 50
C8
C9	Ceramic 0.01 250V	ACG-001

NOTE:

- Capacitors: in μF unless otherwise noted p:pF
- Resistors: in Ω , $\frac{1}{2}W$ unless otherwise noted k:k Ω , M:M Ω

SEMICONDUCTORS

Symbol	Description	Part No.
Q1	Transistor	2SD424-R or O (2SD555-R or S)
Q2	Transistor	2SD424-R or O (2SD555-R or S)
Q3	Transistor	2SB554-R or O (2SB600-R or S)
Q4	Transistor	2SB554-R or O (2SB600-R or S)
Q5	Transistor	2SD424-R or O (2SD555-R or S)
Q6	Transistor	2SD424-R or O (2SD555-R or S)
Q7	Transistor	2SB554-R or O (2SB600-R or S)
Q8	Transistor	2SB554-R or O (2SB600-R or S)

* hfe of these transistors (Q1 ~ Q8) should have the same value.

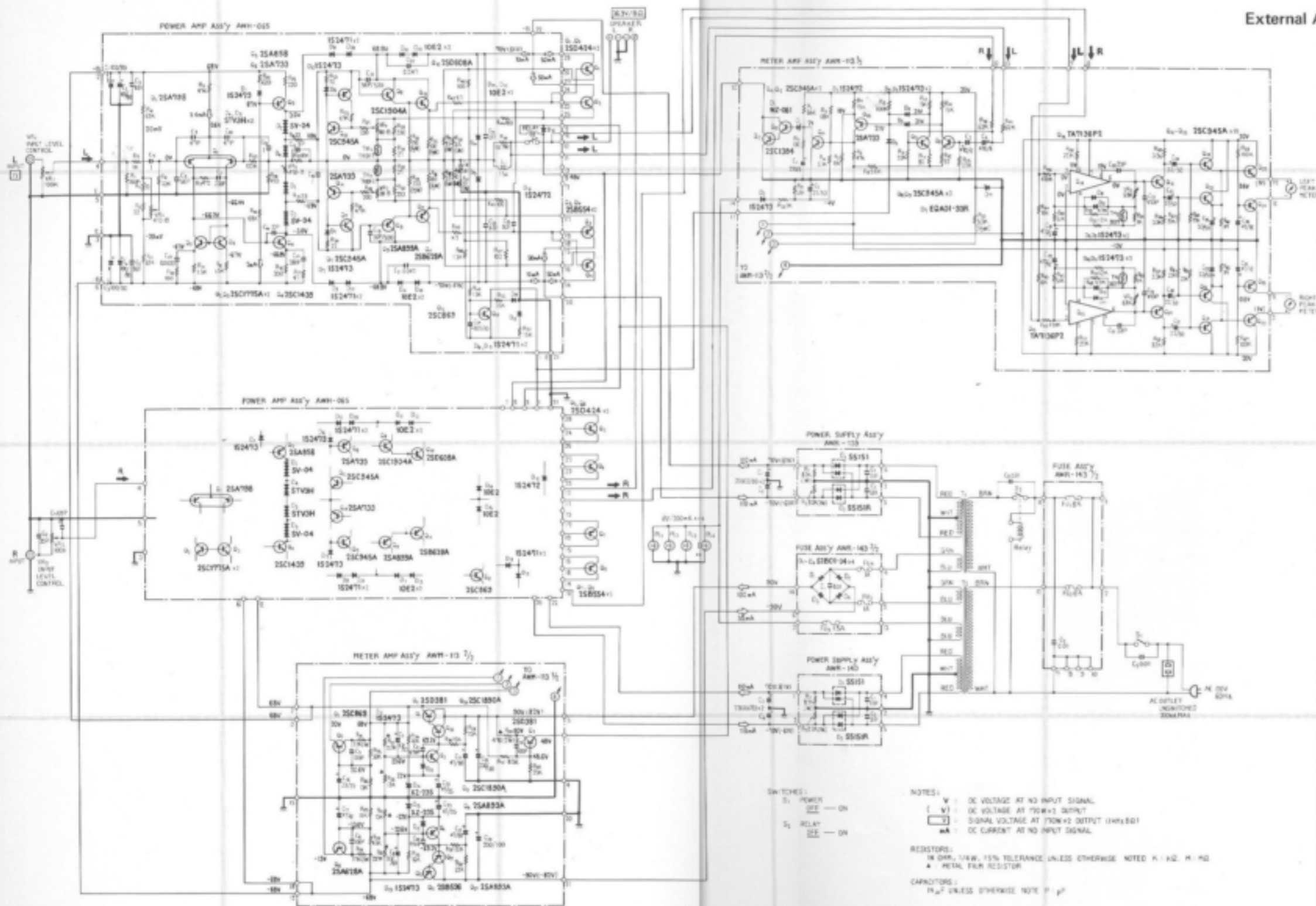
OTHERS

Symbol	Description	Part No.
	Power amplifier assembly	AWH-065
	Meter amplifier assembly	AWM-113
	Power supply assembly	AWR-139
	Power supply assembly	AWR-140
	Fuse assembly	AWR-143
	Peak meter	AAW-068
	AC socket (AC OUTLET)	AKP-002
	Terminal (OUTPUT)	AKE-037
	2P terminal (INPUT)	AKB-034
	Terminal (GND)	AKE-019
	5P housing	AKX-017
	6P housing	AKX-018
	Contact piece	AKF-028
	AC power cord	ADG-013
	Lamp socket	AKK-002

Schematic Diagram

NOTE:
The indicated semiconductors are representative ones only. Other alternative semiconductors may be used and are listed in the parts list.

External Appearance of Transistors and IC



- 2SD424 (2SD555) 2SB554 (2SB600)
- 2SB628A 2SB536 2SD608A 2SD381
- 2SA858 2SA893A (2SA834) 2SC1775A 2SC1890A 2SC1439 (2SC1649) 2SA733 2SC1904A
- 2SA899A 2SC1904A
- 2SC869 2SA628A
- 2SC1384
- TA7136P2
- (2SC1166)
- 2SA798

SWITCHES:
S₁ POWER ON
S₂ RELAY ON

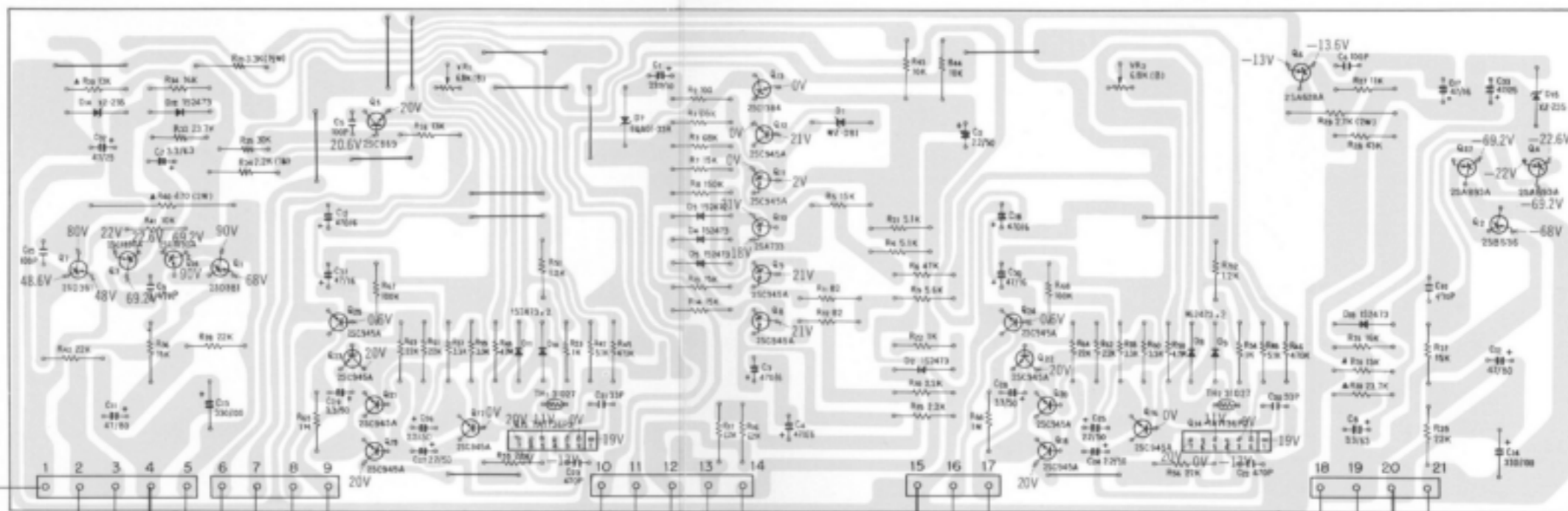
NOTES:
V = DC VOLTAGE AT NO INPUT SIGNAL
V₁ = DC VOLTAGE AT 700Hz INPUT
V₂ = SIGNAL VOLTAGE AT 700Hz OUTPUT (400Hz)
mA = DC CURRENT AT NO INPUT SIGNAL

RESISTORS:
Ω OHM, 1/4W, 1% TOLERANCE UNLESS OTHERWISE NOTED K = KΩ, M = MΩ
▲ METAL FILM RESISTOR

CAPACITORS:
pF UNLESS OTHERWISE NOTE P = pF

10.2 METER AMPLIFIER ASSEMBLY (AWM-113)

Foil side



AWH-065, No. 9 (Lch and Rch)

AWH-065, No. 2 (Rch)

AWH-065, No. 2 (Lch)

AWR-143, No. 14

AWH-065, No. 10 (Rch)

AWH-065, No. 10 (Lch)



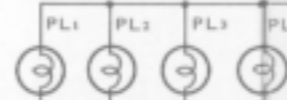
▲ METAL FILM RESISTOR

AWH-065, No. 8 (Lch and Rch)

AWH-065, No. 1 (Lch and Rch)

AWH-065, No. 11 (Rch)

AWH-065, No. 11 (Lch)

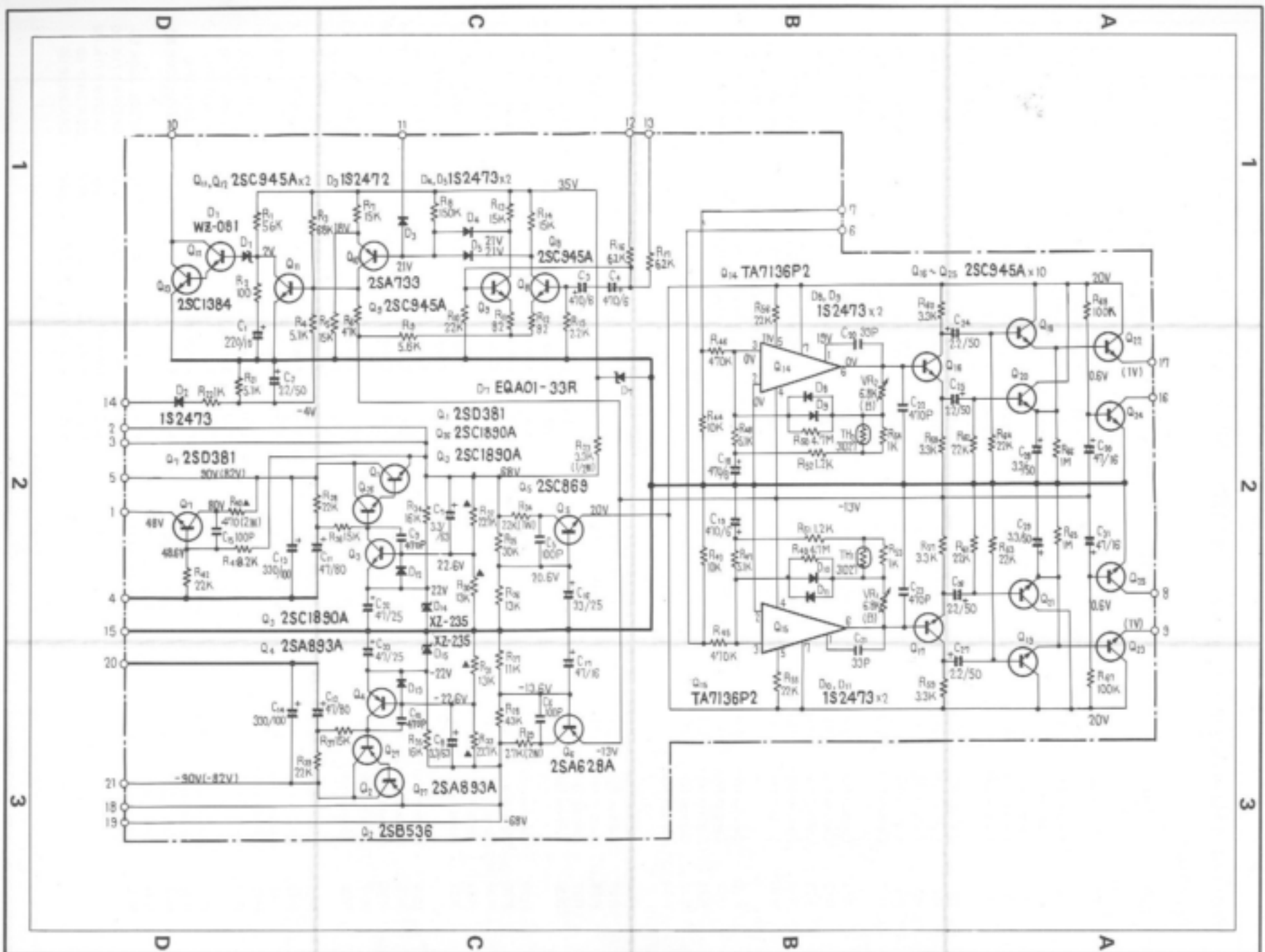


AWR-143, No. 3

AWH-065, No. 6 (Rch)

AWH-065, No. 6 (Lch)

AWR-143, No. 6



Parts List of Meter Amplifier Assembly (AWM-113)

RESISTORS

Symbol	Description	Part No.	Symbol	Description	Part No.		
VR1	Semi-fixed	6.8k-B	ACP-060	Carbon film	4.7M	RD%PS 475J	
VR2	Semi-fixed	6.8k-B	ACP-060	Carbon film	4.7M	RD%PS 475J	
R1	Carbon film	56k	RD%PS 563J	Carbon film	1.2k	RD%PS 122J	
R2	Carbon film	100	RD%PS 101J	Carbon film	1.2k	RD%PS 122J	
R3	Carbon film	68k	RD%PS 683J	Carbon film	1k	RD%PS 102J	
R4	Carbon film	5.1k	RD%PS 512J	R54	Carbon film	1k	RD%PS 102J
R5	Carbon film	15k	RD%PS 153J	R55	Carbon film	22k	RD%PS 223J
R6	Carbon film	47k	RD%PS 473J	R56	Carbon film	22k	RD%PS 223J
R7	Carbon film	15k	RD%PS 153J	R57	Carbon film	3.3k	RD%PS 332J
R8	Carbon film	150k	RD%PS 154J	R58	Carbon film	3.3k	RD%PS 332J
R9	Carbon film	5.6k	RD%PS 562J	R59	Carbon film	3.3k	RD%PS 332J
R10	Carbon film	2.2k	RD%PS 222J	R60	Carbon film	3.3k	RD%PS 332J
R11	Carbon film	82	RD%PS 820J	R61	Carbon film	22k	RD%PS 223J
R12	Carbon film	82	RD%PS 820J	R62	Carbon film	22k	RD%PS 223J
R13	Carbon film	15k	RD%PS 153J	R63	Carbon film	22k	RD%PS 223J
R14	Carbon film	15k	RD%PS 153J	R64	Carbon film	22k	RD%PS 223J
R15	Carbon film	2.2k	RD%PS 222J	R65	Carbon film	1M	RD%PS 105J
R16	Carbon film	62k	RD%PS 623J	R66	Carbon film	1M	RD%PS 105J
R17	Carbon film	62k	RD%PS 623J	R67	Carbon film	100k	RD%PS 104J
R21	Carbon film	5.1k	RD%PS 512J	R68	Carbon film	100k	RD%PS 104J
R22	Carbon film	1k	RD%PS 102J				
R23	Carbon film	3.3k	1/2W RD%PSF 332J				
R24	Metal oxide	2.2k	1W RS1P 222J	CAPACITORS			
R25	Carbon film	30k	RD%PS 303J				
R26	Carbon film	13k	RD%PS 133J	Symbol	Description	Part No.	
R27	Carbon film	11k	RD%PS 113J	C1	Electrolytic	220 10V	CEA 221P 10
R28	Carbon film	43k	RD%PS 433J	C2	Electrolytic	2.2 50V	ACH-317
R29	Metal oxide	2.7k	2W RS2P 272J	C3	Electrolytic	470 6V	CEA 471P 6
R30	Metal film	13k	1/5W RN1/5SQ 1302F	C4	Electrolytic	470 6V	CEA 471P 6
R31	Metal film	13k	1/5W RN1/5SQ 1302F	C5	Ceramic	100p 50V	CCDSL 101K 50
R32	Metal film	23.7k	1/5W RN1/5SQ 2372F	C6	Ceramic	100p 50V	CCDSL 101K 50
R33	Metal film	23.7k	1/5W RN1/5SQ 2372F	C7	Electrolytic	3.3 63V	CEA 3R3P 63
R34	Carbon film	16k	RD%PS 163J	C8	Electrolytic	3.3 63V	CEA 3R3P 63
R35	Carbon film	16k	RD%PS 163J	C9	Ceramic	470p 50V	CKDYB 471K 50
R36	Carbon film	15k	RD%PS 153J	C10	Ceramic	470p 50V	CKDYB 471K 50
R37	Carbon film	15k	RD%PS 153J	C11	Electrolytic	47 80V	CEA 470P 80
R38	Carbon film	22k	RD%PS 223J	C12	Electrolytic	47 80V	CEA 470P 80
R39	Carbon film	22k	RD%PS 223J	C13	Electrolytic	330 100V	ACH-076
R40	Metal oxide	470	2W RS2P 471J	C14	Electrolytic	330 100V	ACH-076
R41	Carbon film	8.2k	RD%PS 822J	C15	Ceramic	100p 50V	CCDSL 101K 50
R42	Carbon film	22k	RD%PS 223J	C16	Electrolytic	33 25V	CEA 330P 25
R43	Carbon film	10k	RD%PS 103J	C17	Electrolytic	47 16V	CEA 470P 16
R44	Carbon film	10k	RD%PS 103J	C18	Electrolytic	470 6V	CEA 471P 6
R45	Carbon film	470k	RD%PS 474J	C19	Electrolytic	470 6V	CEA 471P 6
R46	Carbon film	470k	RD%PS 474J	C20	Ceramic	33p 50V	CCDSL 330K 50
R47	Carbon film	5.1k	RD%PS 512J	C21	Ceramic	33p 50V	CCDSL 330K 50
R48	Carbon film	5.1k	RD%PS 512J	C22	Ceramic	470p 50V	CKDYB 471K 50
				C23	Ceramic	470p 50V	CKDYB 471K 50
				C24	Electrolytic	2.2 50V	CEA 2R2P 50
				C25	Electrolytic	2.2 50V	CEA 2R2P 50

Symbol	Description			Part No.	Symbol	Description	Part No.
C26	Electrolytic	2.2	50V	CEA 2R2P 50	Q13	Transistor	25C1384-R (25C1384-Q) (25C1166-Y) (25C1166-O)
C27	Electrolytic	2.2	50V	CEA 2R2P 50			
C28	Electrolytic	3.3	50V	CEA 3R3P 50			
C29	Electrolytic	3.3	50V	CEA 3R3P 50			
C30	Electrolytic	47	16V	CEA 470P 16	Q14	IC	TA7136P2
					Q15	IC	TA7136P2
C31	Electrolytic	47	16V	CEA 470P 16	Q16	Transistor	25C945A-Q (25C945A-R)
C32	Electrolytic	47	25V	CEA 470P 25			
C33	Electrolytic	47	25V	CEA 470P 25	Q17	Transistor	25C945A-Q (25C945A-R)

SEMICONDUCTORS

Symbol	Description	Part No.	Symbol	Description	Part No.
Q1	Transistor	25D381-N (25D381-M) (25D381-L)	Q20	Transistor	25C945A-Q (25C945A-R)
Q2	Transistor	25B536-N (25B536-M) (25B536-L)	Q21	Transistor	25C945A-Q (25C945A-R)
Q3	Transistor	25C1890A-E (25C1890A-F) (25C869-D) (25C869-C)	Q22	Transistor	25C945A-Q (25C945A-R)
Q4	Transistor	25A893A-D (25A893A-E) (25A628A-D) (25A628A-C)	Q23	Transistor	25C945A-Q (25C945A-R)
Q5	Transistor	25C869-D (25C869-C) (25C1649-N) (25C1649-M)	Q24	Transistor	25C945A-Q (25C945A-R)
Q6	Transistor	25A628A-D (25A628A-C) (25A834-N) (25A834-M)	Q25	Transistor	25C945A-Q (25C945A-R)
Q7	Transistor	25D381-L	Q26	Transistor	25C1890A-E (25C1890A-F) (25C869-D) (25C869-C)
Q8	Transistor	25C945A-Q (25C945A-R)	Q27	Transistor	25A893A-D (25A893A-E) (25A628A-D) (25A628A-C)
Q9	Transistor	25C945A-Q (25C945A-R)	D1	Zener diode	WZ-081
Q10	Transistor	25A733-Q (25A733-R)	D2	Diode	1S2473 (1S1555)
Q11	Transistor	25C945A-Q (25C945A-R)	D3	Diode	1S2472 (1S1554)
Q12	Transistor	25C945A-Q (25C945A-R)	D4	Diode	1S2473 (1S1555)
			D5	Diode	1S2473 (1S1555)
			D7	Diode	EQA01-33R (1S1554)
			D8	Diode	1S2473 (1S1555)
			D9	Diode	1S2473 (1S1555)
			D10	Diode	1S2473 (1S1555)
			D11	Diode	1S2473 (1S1555)

* Ife of these transistors (Q8, Q9, Q11, Q12) should have the same value.

<u>Symbol</u>	<u>Description</u>	<u>Part No.</u>
D12	Diode	1S2473 (1S1555)
D13	Diode	1S2473 (1S1555)
D14	Zener diode	XZ-235
D15	Zener diode	XZ-235
TH1	Thermistor	31D27
TH2	Thermistor	31D27

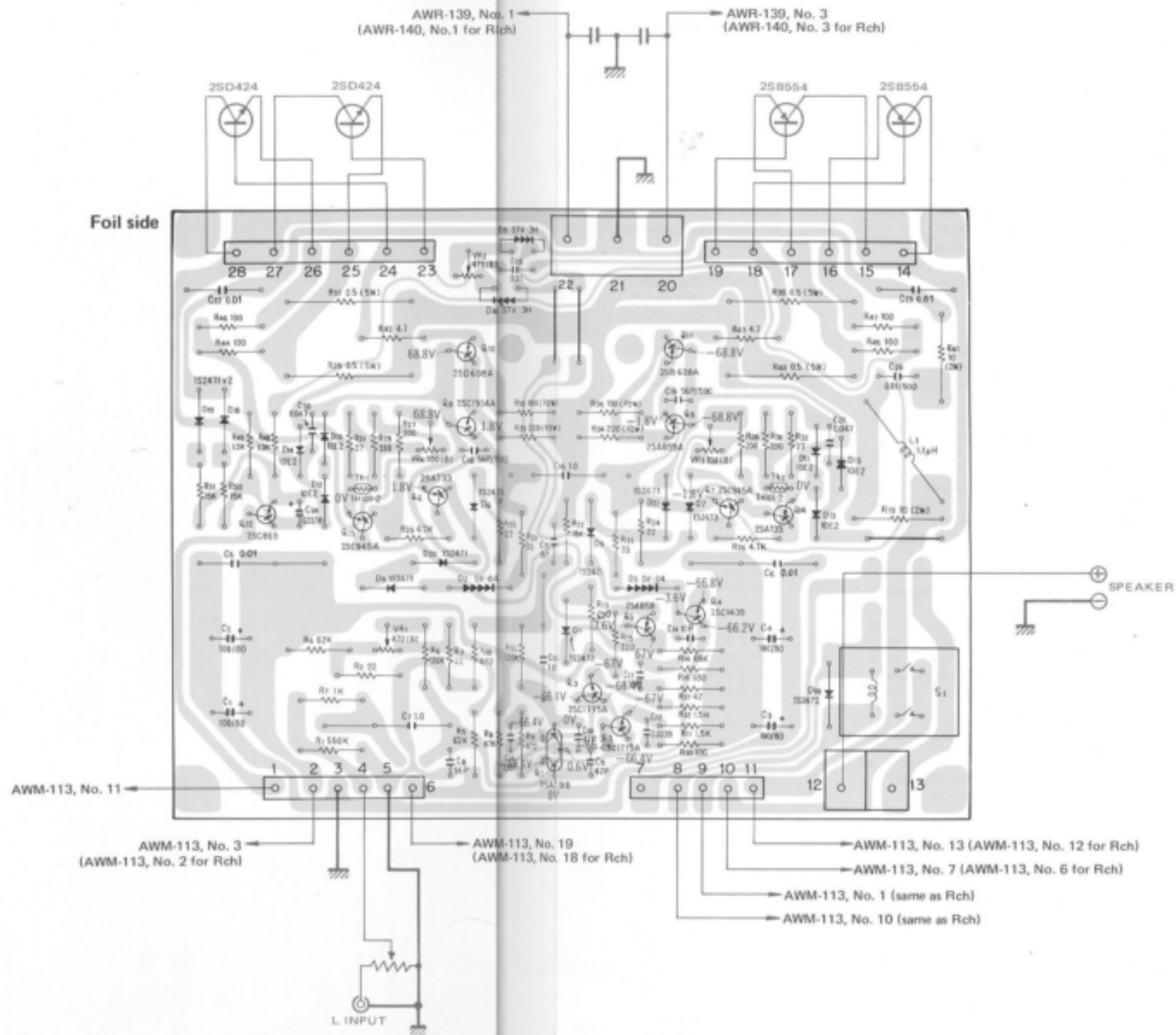
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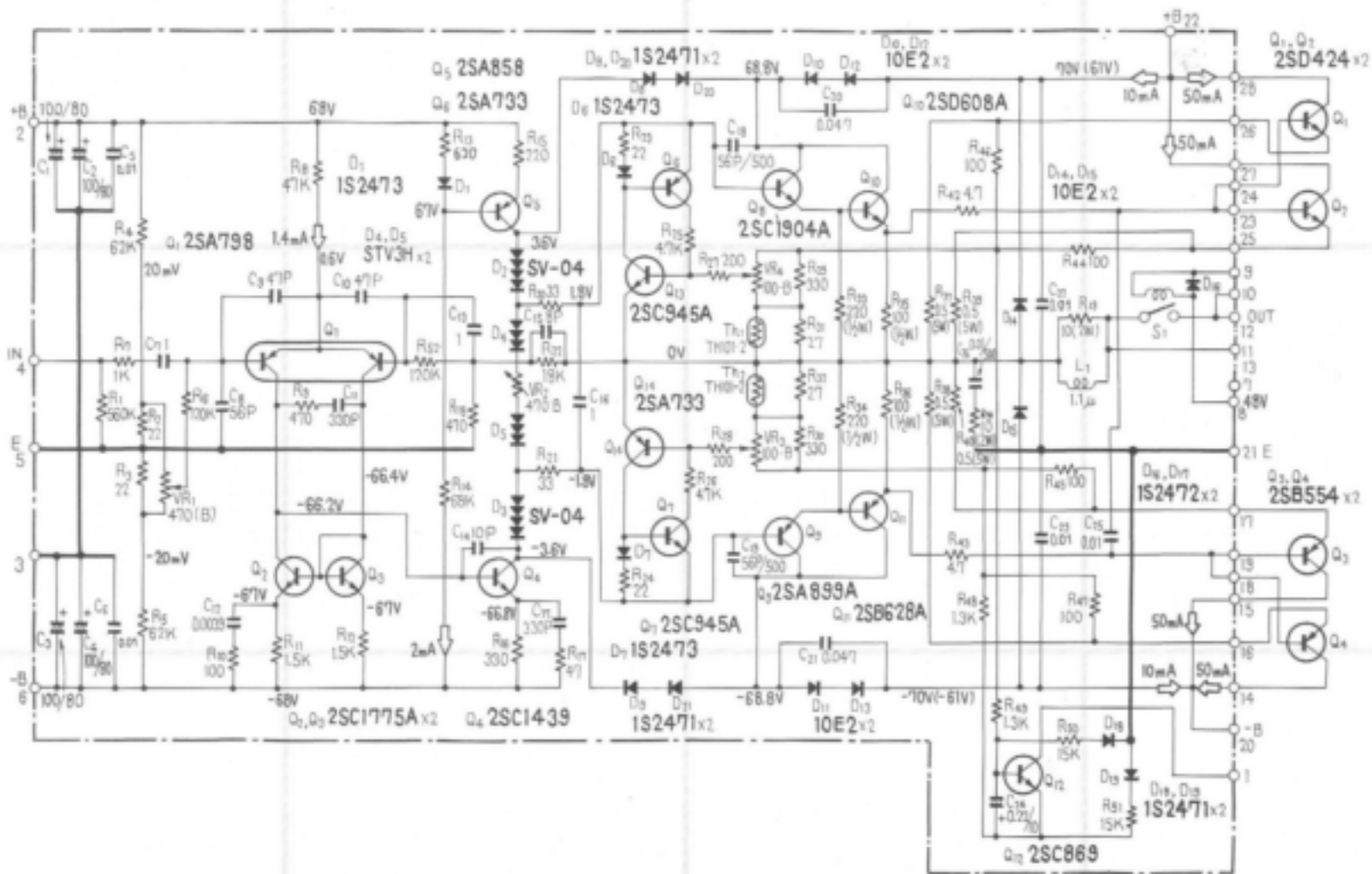
<u>Symbol</u>	<u>Description</u>	<u>Part No.</u>
	Heat sink	ANH-117

List of Changed Parts for Factory Modification

<u>Symbol</u>	<u>Description</u>	<u>Part No.</u>

10.3 POWER AMPLIFIER ASSEMBLY (AWH-065)





Parts List of Power Amplifier Assembly (AWH-065)

RESISTORS AND POTENTIOMETERS

Symbol	Description	Part No.	Symbol	Description	Part No.
TH1	Thermistor	TH101-2	R41	Metal oxide	10 2W RS2P 100J
TH2	Thermistor	TH101-2	R42	Carbon film	4.7 RD%PSF 4R7J
VR1	Semi-fixed	470-B ACP-033	R43	Carbon film	4.7 RD%PSF 4R7J
VR2	Semi-fixed	470-B ACP-033	R44	Carbon film	100 RD%PSF 101J
VR3	Semi-fixed	100-B ACP-032	R45	Carbon film	100 RD%PSF 101J
VR4	Semi-fixed	100-B ACP-032	R46	Carbon film	100 RD%PSF 101J
R1	Carbon film	560k RD%PS 564J	R47	Carbon film	100 RD%PSF 101J
R2	Carbon film	22 RD%PS 220J	R48	Carbon film	1.3k RD%PS 132J
R3	Carbon film	22 RD%PS 220J	R49	Carbon film	1.3k RD%PS 132J
R4	Carbon film	62k RD%PS 623J	R50	Carbon film	15k RD%PS 153J
R5	Carbon film	62k RD%PS 623J	R51	Carbon film	15k RD%PS 153J
R6	Carbon film	120k RD%PS 124J	R52	Carbon film	120k RD%PS 124J
R7	Carbon film	1k RD%PS 102J			
R8	Carbon film	47k RD%PS 473J			
R9	Carbon film	470 RD%PS 471J			
R10	Carbon film	100 RD%PS 101J			
R11	Carbon film	1.5k RD%PSF 152J			
R12	Carbon film	1.5k RD%PSF 152J			
R13	Carbon film	620 RD%PSF 621J			
R14	Carbon film	68k RD%PS 683J			
R15	Carbon film	220 RD%PSF 221J			
R16	Carbon film	330 RD%PSF 331J			
R17	Carbon film	47 RD%PS 470J			
R18	Carbon film	470 RD%PS 471J			
R19	Metal oxide	10 2W RS2P 100J			
R20	Carbon film	33 RD%PSF 330J			
R21	Carbon film	33 RD%PSF 330J			
R22	Carbon film	18k RD%PS 183J			
R23	Carbon film	22 RD%PSF 220J			
R24	Carbon film	22 RD%PSF 220J			
R25	Carbon film	4.7k RD%PS 472J			
R26	Carbon film	4.7k RD%PS 472J			
R27	Carbon film	200 RD%PSF 201J			
R28	Carbon film	200 RD%PSF 201J			
R29	Carbon film	330 RD%PSF 331J			
R30	Carbon film	330 RD%PSF 331J			
R31	Carbon film	27 RD%PS 270J			
R32	Carbon film	27 RD%PS 270J			
R33	Carbon film	220 1/2W RD%PSF 221J			
R34	Carbon film	220 1/2W RD%PSF 221J			
R35	Carbon film	100 1/2W RD%PSF 101J			
R36	Carbon film	100 1/2W RD%PSF 101J			
R37	Wire wound	0.5 5W RT5B 0R5K			
R38	Wire wound	0.5 5W RT5B 0R5K			
R39	Wire wound	0.5 5W RT5B 0R5K			
R40	Wire wound	0.5 5W RT5B 0R5K			

CAPACITORS

Symbol	Description	Part No.
C1	Electrolytic	100 80V CEA 101P 80
C2	Electrolytic	100 80V CEA 101P 80
C3	Electrolytic	100 80V CEA 101P 80
C4	Electrolytic	100 80V CEA 101P 80
C5	Ceramic	0.01 150V ACG-004
C6	Ceramic	0.01 150V ACG-004
C7	Polyester	1 250V CQEA 105K 250
C8	Polystyrene	56p 50V CQSH 560K 50
C9	Ceramic	47p 50V CCDSL 470K 50
C10	Ceramic	47p 50V CCDSL 470K 50
C11	Ceramic	330p 50V CKDYB 331K 50
C12	Ceramic	3900p 50V CKDYB 392K 50
C13	Polyester	1 250V CQEA 105K 250
C14	Ceramic	10p 50V CCDSL 100F 50
C15	Ceramic	8p 50V CCDSL 080F 50
C16	Polyester	1 250V CQEA 105K 250
C17	Ceramic	330p 50V CKDYB 331K 50
C18	Ceramic	56p 500V CCDSL 560K 500
C19	Ceramic	56p 500V CCDSL 560K 500
C20	Ceramic	0.047 50V CKDYF 4732 50
C21	Ceramic	0.047 50V CKDYF 4732 50
C22	Ceramic	0.01 150V ACG-004
C23	Ceramic	0.01 150V ACG-004
C24	Electrolytic	0.22 10V CSSA R22M 10
C25	Mylar	0.01 400V CQMA 103K 400
C26	Ceramic	0.01 150V ACG-004

SEMICONDUCTORS

Symbol	Description	Part No.
Q1	Transistor	2SA798-G
Q2	Transistor	2SC1775A-E (2SC1775A-D)
Q3	Transistor	2SC1775A-E (2SC1775A-D)
* hfe of these transistors (Q2, Q3) should have the same value.		
Q4	Transistor	2SC1439-V (2SC1439-B)
Q5	Transistor	2SA858-V (2SA858-B)
Q6	Transistor	2SA733-Q (2SA733-R)
Q7	Transistor	2SC945A-Q (2SC945A-P)
Q8	Transistor	2SC1904A-V (2SC1904A-B)
Q9	Transistor	2SA899A-V (2SA899A-B)
* hfe of these transistors (Q8, Q9) should have the same value.		
Q10	Transistor	2SD608A-R (2SD608A-S) (2SD608A-Q)
Q11	Transistor	2SB628A-R (2SB628A-S) (2SB628A-Q)
* hfe of these transistors (Q10, Q11) should have the same value.		
Q12	Transistor	2SC869-C (2SC869-D)
Q13	Transistor	2SC945A-Q (2SC945A-P)
Q14	Transistor	2SA733-Q (2SA733-R)
D1	Diode	1S2473
D2	Varistor	SV-04
D3	Varistor	SV-04
D4	Varistor	STV3H-G
D5	Varistor	STV3H-G
D6	Diode	1S2473
D7	Diode	1S2473
D8	Diode	1S2471
D9	Diode	1S2471
D10	Diode	10E2 (1S1886)
D11	Diode	10E2 (1S1886)
D12	Diode	10E2 (1S1886)
D13	Diode	10E2 (1S1886)
D14	Diode	10E2 (1S1886)
D15	Diode	10E2 (1S1886)
D16	Diode	1S2472
D18	Diode	1S2471
D19	Diode	1S2471
D20	Diode	1S2471
D21	Diode	1S2471

OTHERS

Symbol	Description	Part No.
L1	AF choke coil 1.1 μ H	ATH-012
S1	Relay	ASR-035
	Heat sink	ANH-340
	5P plug	AKM-019
	6P plug	AKM-020
	Screw 3 x 10	ABA-144

List of Changed Parts for Factory Modification

Symbol	Description	Part No.

10.4 FUSE ASSEMBLY (AWR-143)

A

B

C

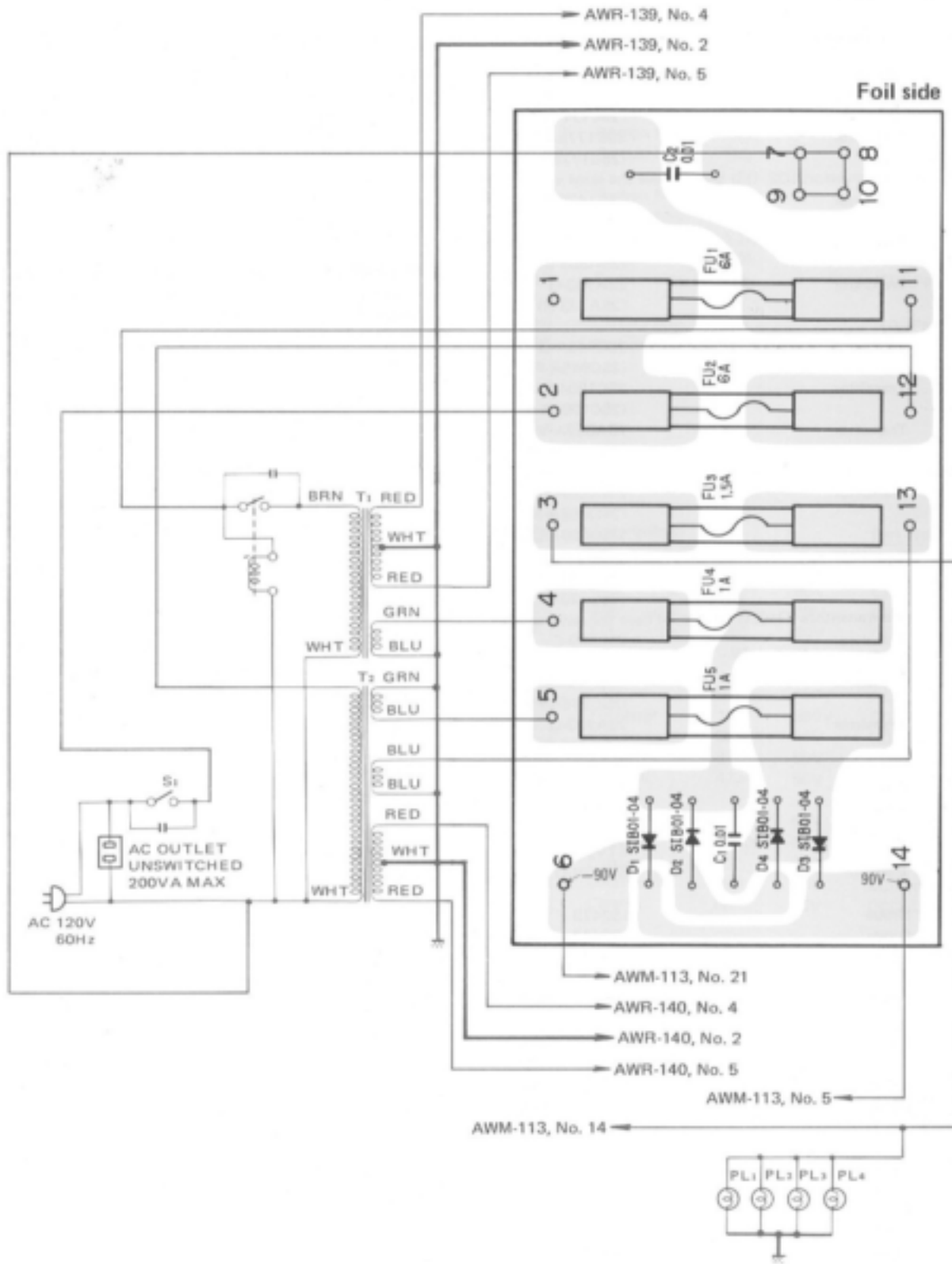
D

A

B

C

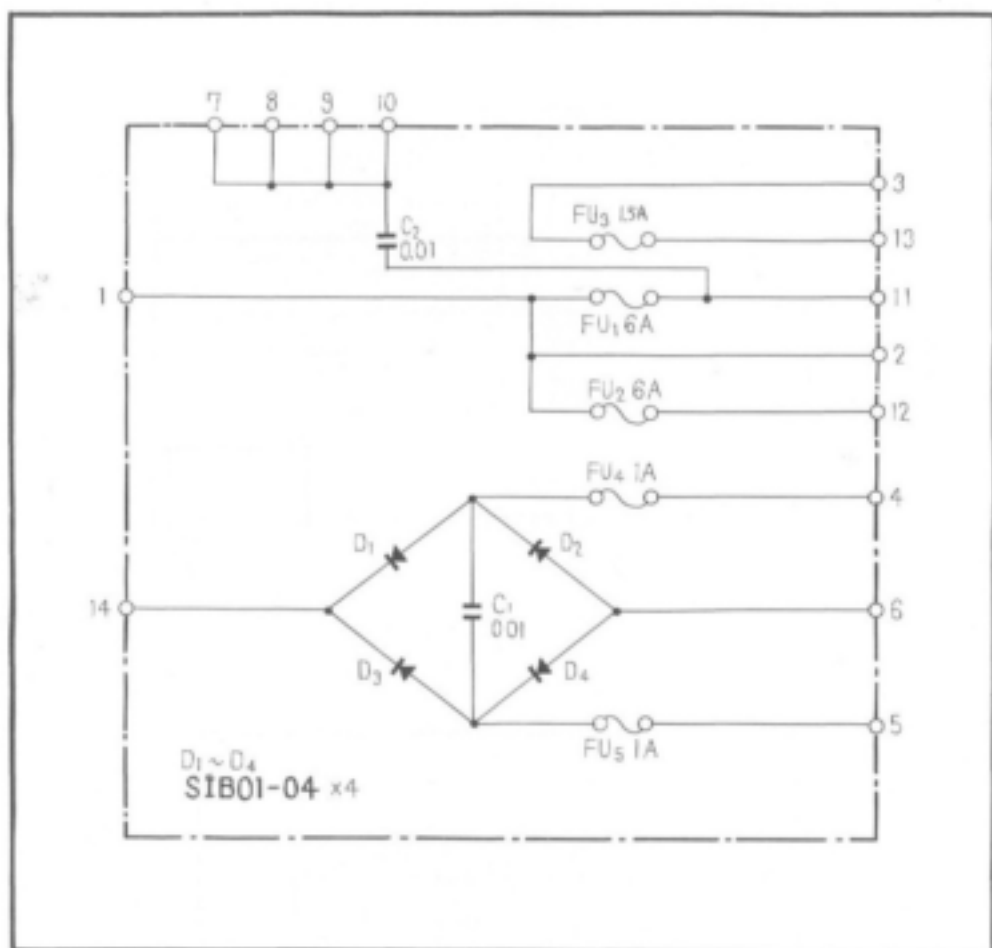
D



1

2

3



Parts List of Fuse Assembly (AWR-143)

CAPACITORS

Symbol	Description	Part No.
C1	Mylar 0.01 400V	QOMA 103K 400
C2	Ceramic 0.01 125V	ACG-003

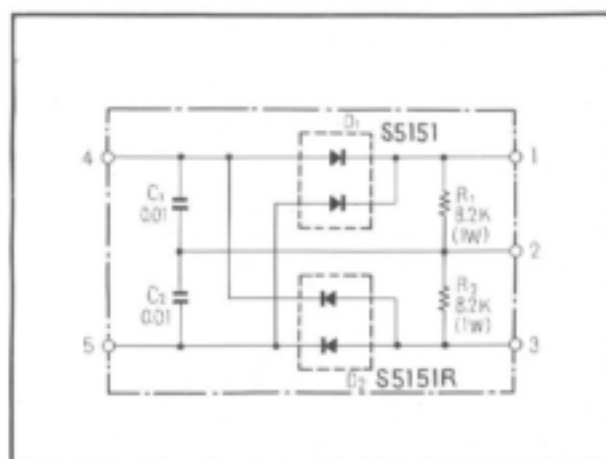
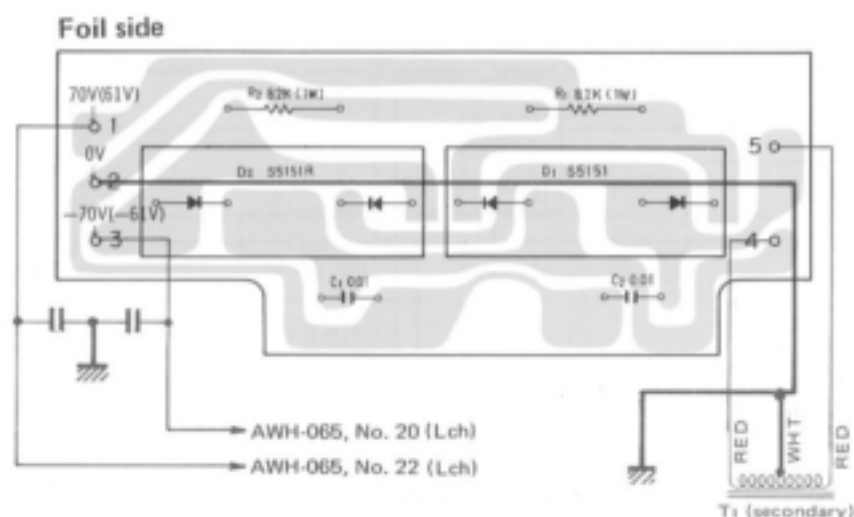
SEMICONDUCTORS

Symbol	Description	Part No.
D1	Diode	SIB01-04
D2	Diode	SIB01-04
D3	Diode	SIB01-04
D4	Diode	SIB01-04

OTHERS

Symbol	Description	Part No.
	Fuse clip	AKR-013
	Fuse clip	AKR-030

10.5 POWER SUPPLY ASSEMBLY (AWR-139)



Parts List of Power Supply Assembly (AWR-139)

RESISTORS

Symbol	Description	Part No.
R1	Metal film 8.2k 1W	RS1P 822J
R2	Metal film 8.2k 1W	RS1P 822J

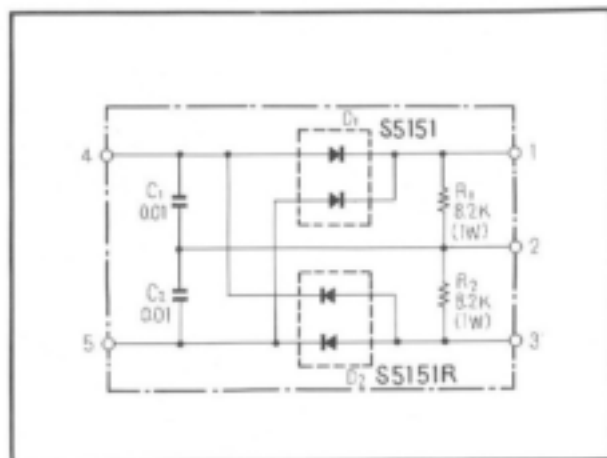
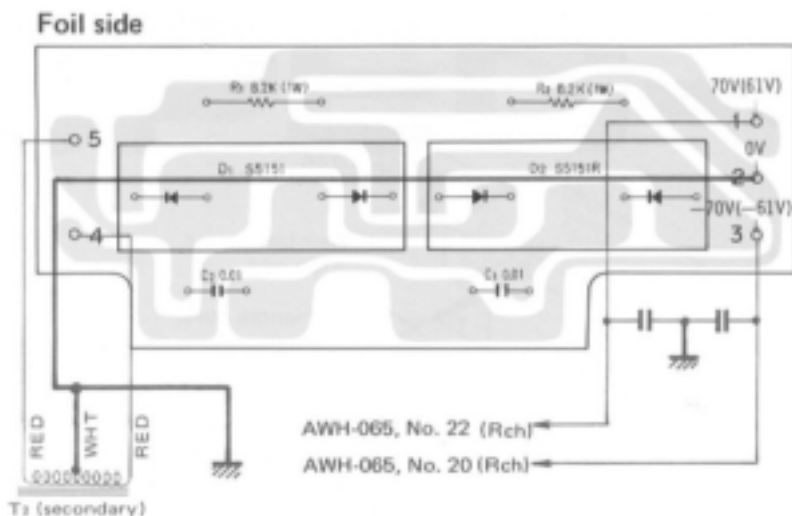
SEMICONDUCTORS

Symbol	Description	Part No.
D1	Diode	S5151 (S55)
D2	Diode	S5151R (S55R)

CAPACITORS

Symbol	Description	Part No.
C1	Mylar 0.01 400V	CQMA 103K 400
C2	Mylar 0.01 400V	CQMA 103K 400

10.6 POWER SUPPLY ASSEMBLY (AWR-140)



Parts List of Power Supply Assembly (AWR-140)

RESISTORS

Symbol	Description	Part No.
R1	Metal film 8.2k 1W	RS1P 822J
R2	Metal film 8.2k 1W	RS1P 822J

SEMICONDUCTORS

Symbol	Description	Part No.
D1	Diode	SS151 (SS5)
D2	Diode	SS151R (SS5R)

CAPACITORS

Symbol	Description	Part No.
C1	Mylar 0.01 400V	CQMA 103K 400
C2	Mylar 0.01 400V	CQMA 103K 400

11. PACKING

