Technical Service Manual

lecron

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AP3 and AP3 Mk 2 POWER AMPLIFIERS

1.0 General Instructions.

The AP3 is a high powered direct-coupled audio power amplifier enclosed in a black anodised aluminium extruded case which also acts as the heat sink.

The AP3 Mk 2 amplifier differs from the Mk 1 in that it is fitted with a toroidal mains transformer giving higher power output and reduces hum and noise.

A brief technical specification is:-

Input Sensitivity:		550 mVrms input for 100W output into 8 Ohms (1 KHz)
Output:-	Minimum	100W per channel into 8 Ohms
	Typical	
	AP3A	120W per channel into 8 Ohms
	AP3 Mk 2	140W per channel into 8 Ohms
Total Harmonic Distortion:		Less than 0.05% at all Power Levels up to 100W in the 20Hz-10KHz frequency band.

2.0 Mechanical Details.

2.1 The AP3 is constructed in a similar manner to the AP1. The major mechanical differences are:-

i) The top circular plate carries a small fan.

ii) The power supply reservoir capacitors are mounted on the same side as the mains transformer.

iii) The base plate carries the protection circuit P.C.B.

2.2 Dismantling.

i) Switch the unit off, ISOLATE FROM THE MAINS SUPPLY.

ii) Pull off the perspex top disc.

iii) Remove the six pozidrive screws from the top plate which may now be pulled to one side. Take care not to strain the wires connected to the fan.

iv) Remove the six pozidrive screws from the base plate.

v) With the base plate still in its normal position, invert the unit and slide the free extrusion half about one inch upwards. The unit can then be separately in halves and can be laid out flat on the bench.

NOTE: The Mains Supply must be OFF during the dismantling process as a precaution against short circuits.

2.3 Removing a Power Board.

With the amplifier laid flat in its opened state;

i) Remove chassis mounted 10 amp 1¼ inch fuses.

ii) Disconnect the two input wires making note of their polarity.

iii) Disconnect the speaker ouput cable and the red and black supply leads.

iv) Remove the four pozidrive bolts. The board can now be removed.

2.4 Re-Assembly.

Proceed in the reverse order of the dismantling instructions. If the power boards have been worked on or exchanged it will be necessary to re-adjust them. See section 4.

3.0 Circuit Description.

3.1 Power Supply.

Refer to Figure 1.

The mains supply primary circuit includes a thermal cut-out switch and a 2.5 amp Slo-Blo (2,5AT) 20mm fuse. The transformer has a dual 120 volt primary which is connected in series or parallel by the voltage selector switch.

The secondary circuit is a conventional full-wave bridge rectifier supply nominally of ± 59 volts dc (AP3 Mk 2 ± 63 volts dc).

The supply rails are connected to the power boards through four 10 amp 1¼ inch fuses.

3.2 Protection Board.

1. Early Production Batch.

Refer to figures 2 and 3.

A PCB is mounted on the base plate. This board carries the Zobel Networks; Output Chokes; Headphone Attenuators and also the relay and its drive circuitry. The protection circuit works as follows:-

The output of each power amplifier is summed via R1 and R2. Resistor R3 and capacitors C1 and C2 form a low-pass filter so that only dc and sub-sonic voltages remain. (Back to back Zener diodes Z1 and Z2 are arranged to limit such voltages to around 5.5 volts). Any remaining voltage will effectively be a dc offset voltage on the output of one power amplifier. This voltage is steered via diodes D1-D4 (arranged as a bridge onto the bases of transistors Q1 and Q2, e.g. negative potential on the base of Q1 and positive potential on the base of Q2.

Thus transistors Q1 and Q2 turn ON and so energise the Relay which then disconnects the output lines thereby protecting the loudspeakers.

It should be noted that resistors R1 and R2 are deliberately made unequal. This is to prevent the rare possibility of an equal but opposite polarity offset being on the output of the two channels and thus cancelling out.

3. 2. 2. Modified Protection System.

Refer to Figures 4, 5 and 6.

A PCB is mounted on the base plate. This board carries the Zobel Network; Output Chokes; Headphone Attenuators and also the Relay. The relay drive circuitry is mounted on a separate PCB which is mounted on the side of the mains transformer.

3. 2. 3. The relay drive circuit has two functions:-

i) to turn the relay on after a short time delay following the amplifier being switched on

ii) to turn the relay off in the event of a dc offset voltage being present on the output of either power amplifier.

The circuit works as follows:-

When the amplifier is first switched on the FET Q3 is turned OFF by a negative potential on its gate. The negative potential is derived via D6 from the transformer secondary ac voltage. In this way the voltage is generated almost instantaneously without waiting for the reservoir capacitors to charge up.

When the amplifier is first switched on transistor Q5 is OFF. Capacitor C3 is charged up through R20; these two components forming a time delay of several seconds before a negative potential builds up on the base of Q5 thus turning it ON. When Q5 turns ON so does Q4 and these two transistors work in parallel to sink the current through the relay coil.
Thus it can be seen that when the amplifier is first switched on the relay remains OFF for several seconds and then comes on to connect the speakers after dc conditions have stabilised.
The dc offset protection works as in the earlier design although some component values have been altered. R3 and C1 form the Low-Pass filter and again transistors Q1 and Q2 turn ON in the event of a dc (or subsonic)offset on the output of either power amplifier. When this occurs the voltage on the collector of Q2 goes more positive and so (through D7) FET Q3 is turned ON. The base of Q5 is then effectively grounded turning Q5 OFF and so de-energising the relay.

3.3 Cooling Fan Circuit.

Refer to figure 1.

A thermal switch (closes at 45°C) is mounted on the heatsink extrusion.
When this switch closes the fan is switched on. A thermistor THZA is in circuit to provide a "safe" start without a large current surge with could interfere with the audio. The Zener Diode Z3 again suppresses voltage peaks.

During normal operation there should be about 9 volts across the fan.

3.4 Power Amplifier Boards.

Refer to figure 7

The amplifier is a directly coupled Class B circuit using a fully complementary out-put stage of series connected Darlington power transistors.

Transistors Q1 and Q2 form a conventional (long tailed pair) differential amplifier. The input (and the feedback) is connected to the inverting transistor (Q1). The non-inverting transistor (Q2) is connected to an adjustable potential divider (VR1) which sets the output dc offset.

The bi-phase outputs of the long tailed pair feed a second differential amplifier Q3 and Q7. Transistor Q3 has a constant current load Q4 whilst transistor Q7 is terminated by a current mirror Q5 and Q6.

Transistor Q6 will always deliver the same current as transistor Q5 hence the term "Current Mirror". Functionally however, Q6 can be considered as an active load, whilst Q7 is a voltage amplifier from whose collector the drive to the output stage is taken.

Transistor Q9, Q11, Q15, Q10, Q12 and Q16 respectively form conventional Darlington emitter follower stages. Each stage is series connected to further power transistors (Q13, Q17 and Q14, Q18) respectively which are permanently biased ON. Their emitter voltages are determined by the ratio of the base potential dividers.

$$\text{EG.} \quad \frac{R32}{R33+R34}$$

This ratio has been chosen such that Q13 and Q15 each have half the supply rail across them.

Quiescent current is set by the voltage across Q8 and is pre-set by VR2. Q8 is mounted adjacent to the output stage for good thermal stability.

The whole power amplifier is used in the inverting mode with overall shunt feedback through R3 and C3.

4.0 Testing Procedures.

4.1 Complete Amplifiers.

i) As a complete amplifier the unit is tested in the normal way. An input signal fed into the 7 pin DIN socket of 550mV will give an output of 28 volts rms.

Input Connections are LEFT Pin 6
RIGHT Pin 1
GROUND Pin 4

ii) Check that the output is at least 120 Watts into 8 Ohms with both channels driven to clipping with a 1KHz sine wave signal.

iii) Check that the distortion is within the rated limits at 100 Watts output.

iv) Check that the static dc offset is below 100mV

4.2 Board Testing.

Where a board is definately blown then faulty components can be identified with use of a multimeter whilst the amplifier is switched off.
Other faults can be found by static voltage checks or signal tracing with reference to the circuit diagrams.
The power amplifier can be treated as conventional except that it is important to ensure that the voltages on the collectors of Q15 and Q16 are +30 $\pm$ 4 volts and - 30 $\pm$ 4 volts respectively (no signal conditions) that this voltage follows the output signal with half the magnitude.

4.3 Setting the Quiescent Current

With the amplifier laid out as follows: (refer to section 2.2)

1. Remove all four 10 amp 1¼ inch fuses.

ii) For each channel measure with an ammeter the current drawn by the positive and negative supplies in turn by bridging the fuseholder with the meter. Ensure that each is less than 25mA. (No load connected)

iii) Fit a 10 Amp fuse to the positive supply and measure the current drawn from the negative supply. Adjust VR2 to set this to 40 mA.

iv) Measure the dc voltage at the output using a volt meter Adjust this to 0 volts using VR1.

4.4 Known Faults

Likely failures will be similar to those on the AP1 but in addition;

i) Protection circuit will render the output distorted if the output transistors Q13-Q16 do not share the voltage evenly.

Check the dc at the collectors of Q15 and Q16 is 30^{+}_{-} 4 volts.

ii) When the power transistors fail they tend to fail collector - emitter open circuit.

22nd May 1978.

AP3(MK2)

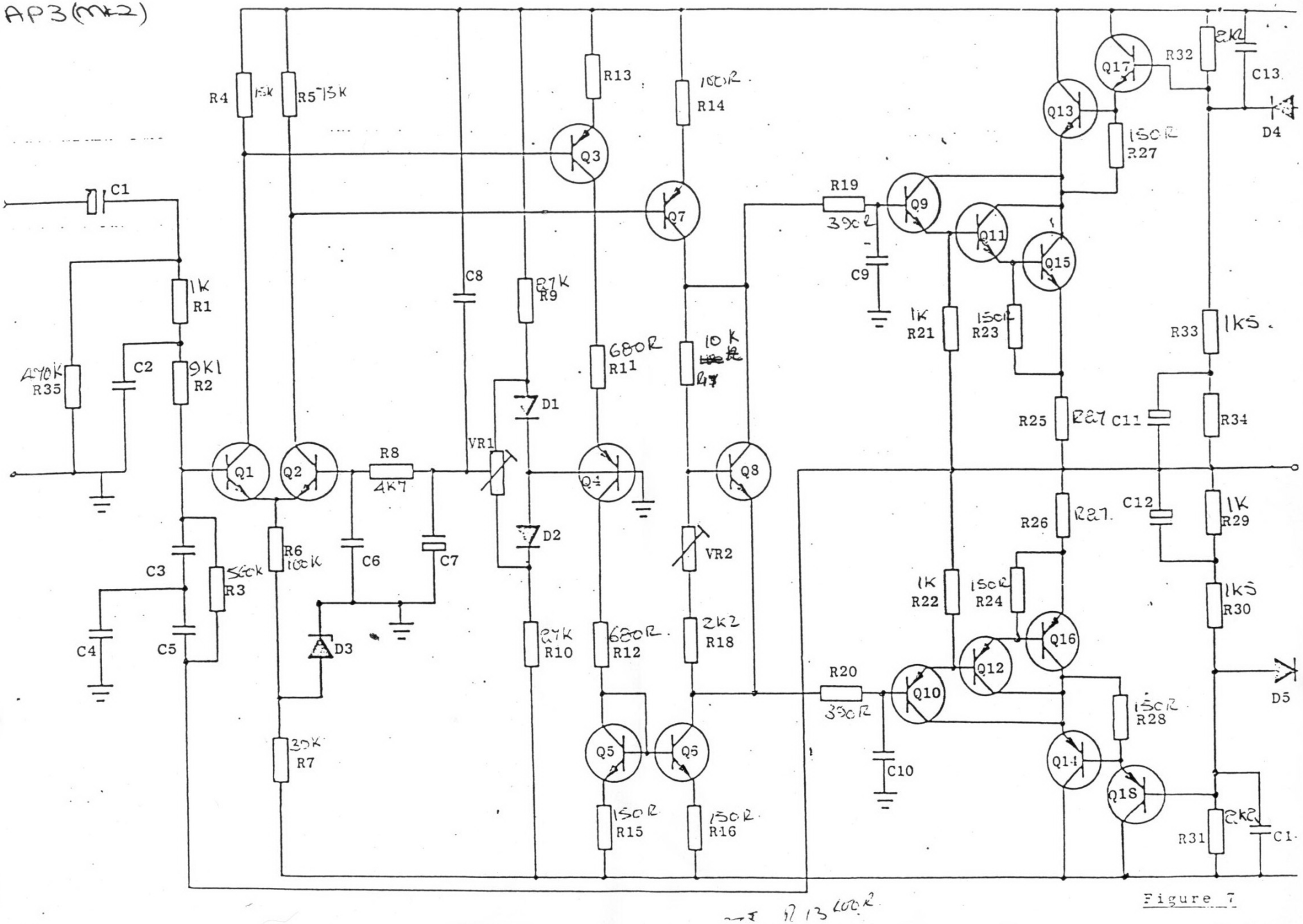
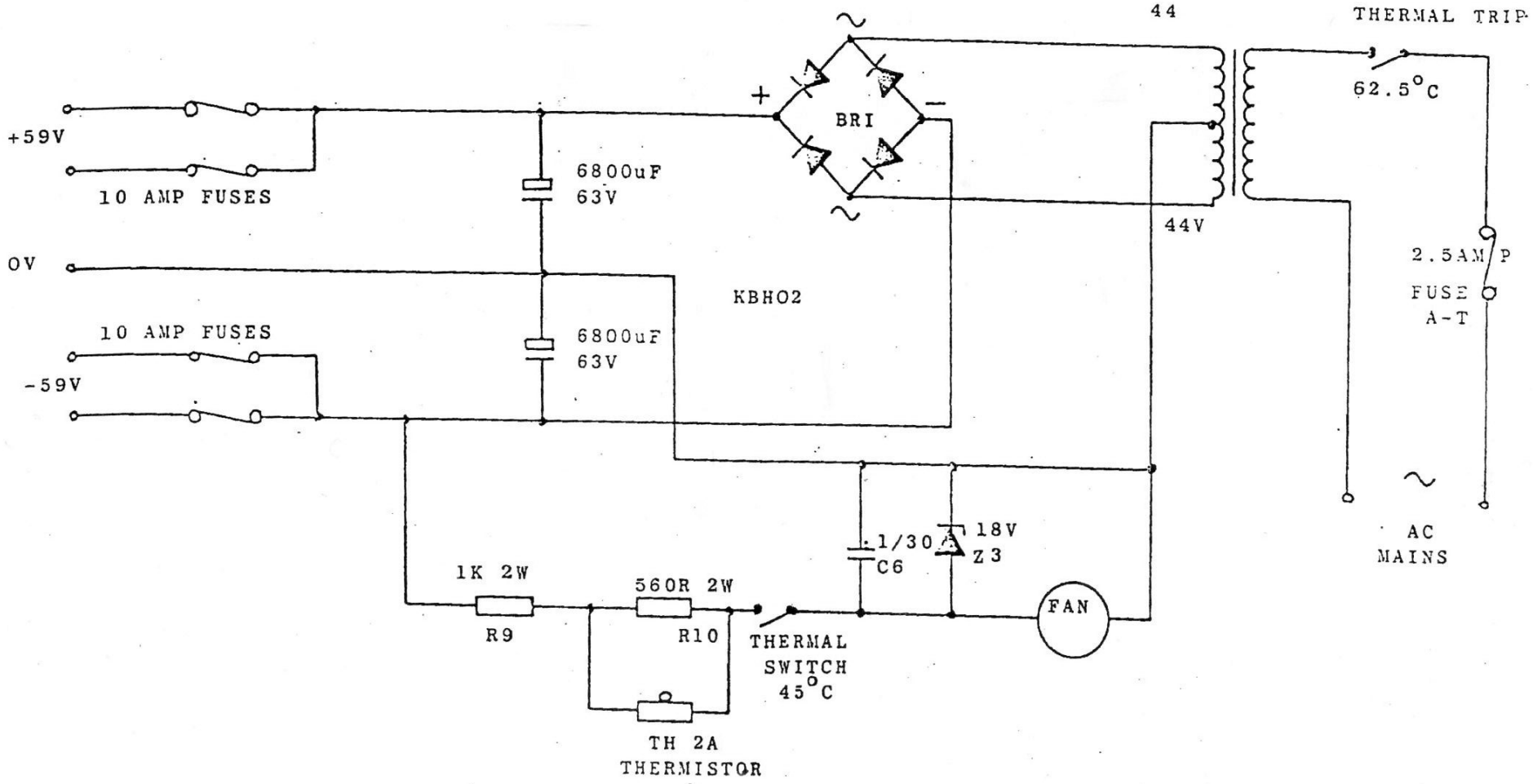
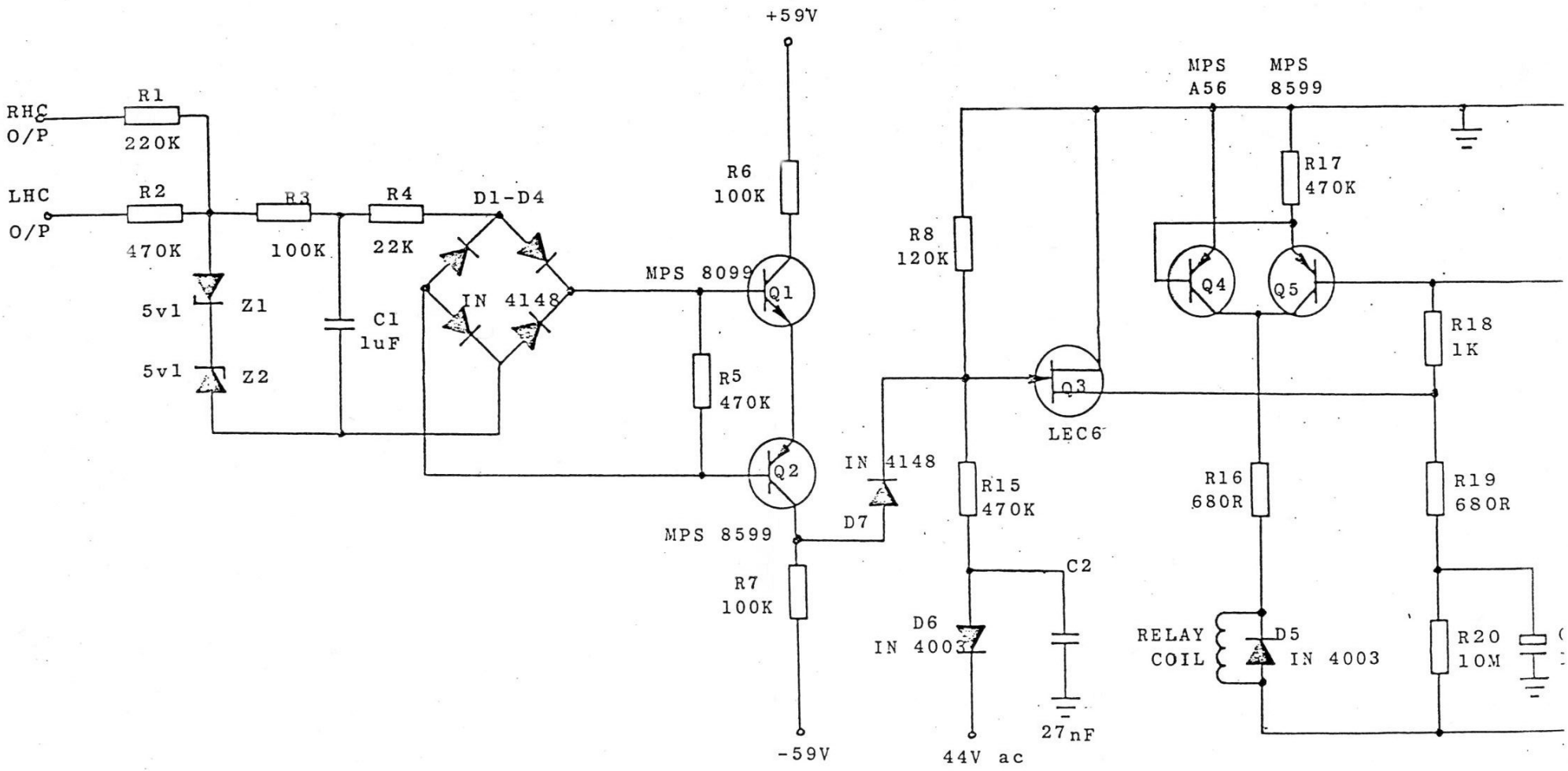


Figure 7



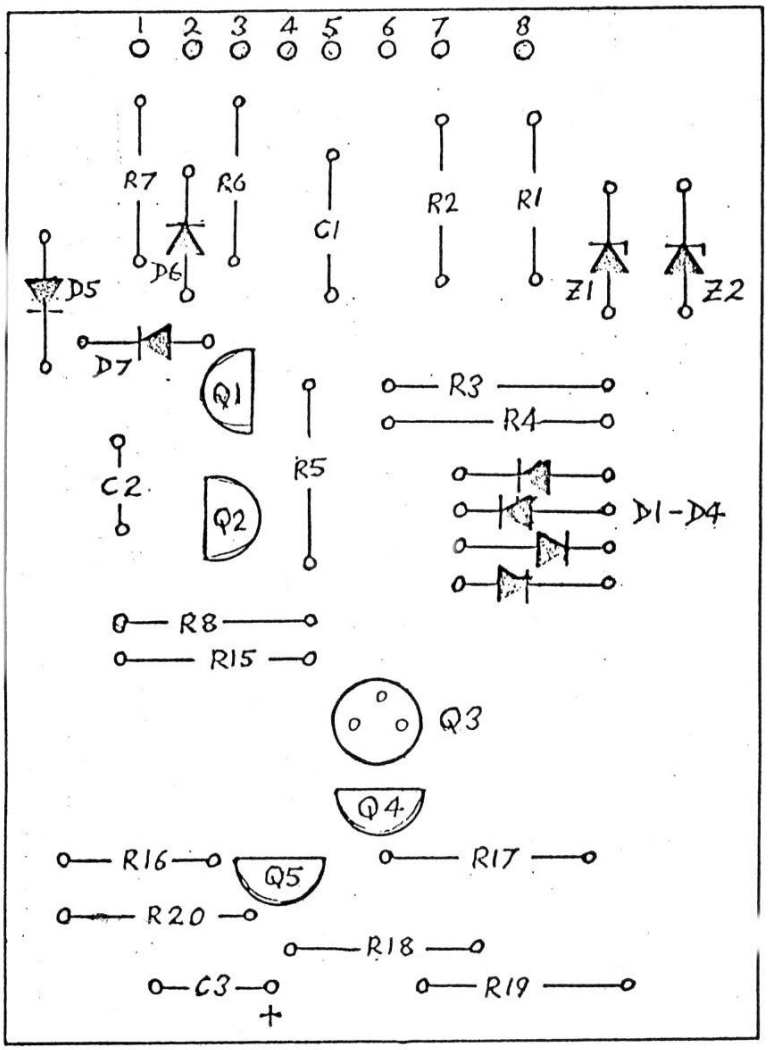
POWER SUPPLIES CIRCUIT

FIGURE 1



AP3 and AP3 MkII LATER TYPE PROTECTION CIRCUIT

Figure 4



Terminals:

1 −59 v
2 Relay Coil
3 + 59v
4 44 v a.c.
5 GND.
6 LHC o/p
7 RHC o/p
8 MUTE SIGNAL.

figure.6. Later Type Protection Board Layout.

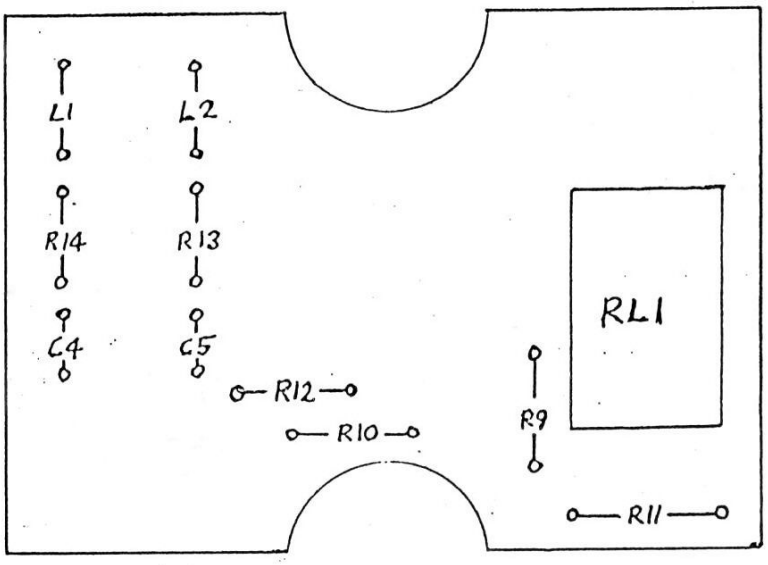


figure.5. Later Type Relay PCB

COMPONENT LIST

AP3 MK II POWER BOARD — ISSUE 1

Q1, Q2, Q5, Q8, Q9	MPSA06
Q3, Q4, Q10	MPSA56
Q6	MPSA43
Q7	BF398
Q11, Q17	BSS15
Q12, Q18	BSS17
Q13, Q15	MJ802
Q14, Q16	MJ4502

C1, C7, C11, C12	10/25 T
C2, C8	2n2
C3, C4, C5	10pF
C6	33pF
C9, C10	180pF
C13, C14	100pF

D1, D2, D4, D5	IN4148
D3	BZY88 C18

R1, R21, R22, R29, R34	1K
R2	9K1
R3	560K
R4, R5	15K
R6	100K
R7	39K
R8	4K7
R9, R10	27K
R11, R12	680R
R13, R14	100R
R15, R16, R23, R24, R27, R28	150R
R17	10K
R18, R31, R32	2K2
R19, R20	390R
R25, R26	R27
R30, R33	1K5
R35	470K

VR1, VR2	2K2

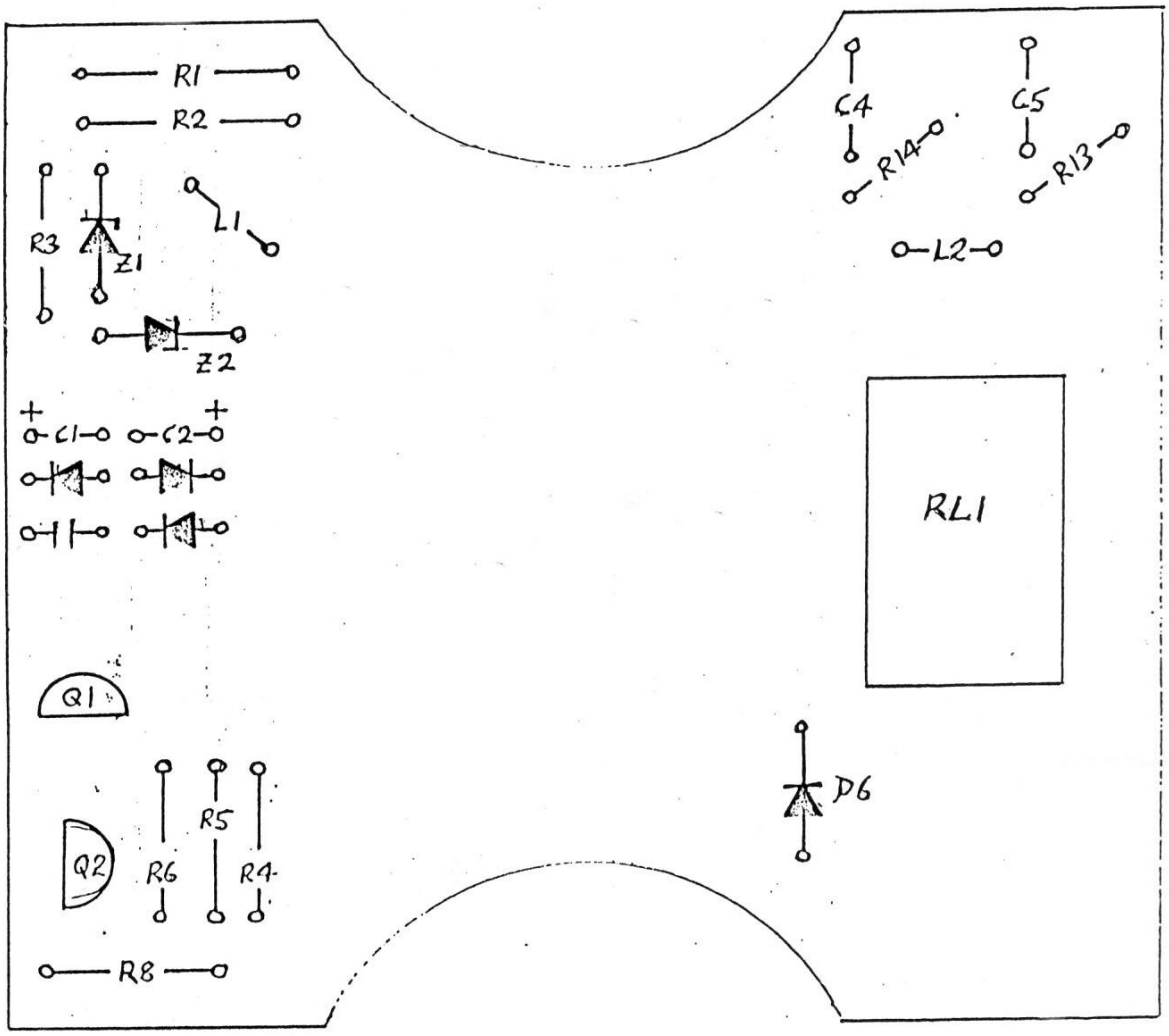


Figure. 3. Early Type Relay Board Layout.