SECTION 12

AMPLIFIER MPA/1

General Description

The amplifier MPA/1 was designed to meet the need for a loudspeaker amplifier having a better performance than existing types. It is suitable for monitoring purposes in Control Rooms and Recording Rooms and may also be used for feeding ring mains.

A stage of voltage amplification with current feedback precedes a push-pull output stage, with voltage feedback, which delivers 10 watts to the output load. An input level of − 5 dB is required for maximum power output. The amplifier incorporates its own mains-supply equipment. The mechanical construction is such that the amplifier may be rack-mounted or used in conjunction with an R.K. loudspeaker in a Howe-type box baffle.

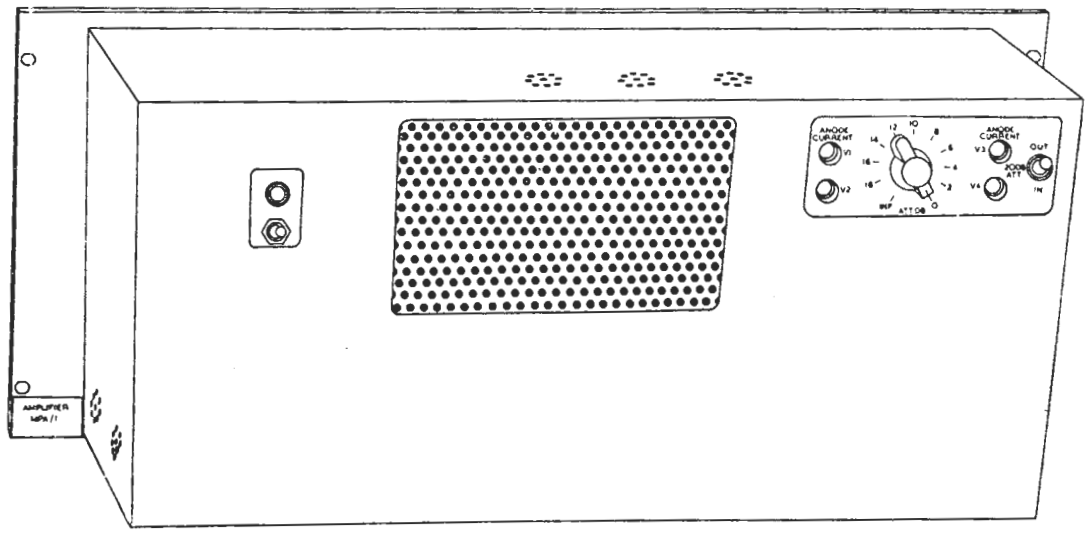


Fig. 12.1. MPA/1. Front View

Electrical Design Considerations

The required power output of 10 watts is obtained from two Type AL60 pentodes operating in push-pull. To avoid running these valves continuously at their maximum rated anode dissipation, they are biased near to the point of anode current cut-off. The input signal to the output stage is not allowed to produce grid current so that these valves operate under Class AB1 conditions. As the anode current varies during operation, grid bias cannot be obtained by means of the usual cathode resistor. Grid bias voltage is obtained from a separate winding on the mains transformer and rectified by a metal rectifier. Very good voltage regulation is necessary in the h.t. supply unit as distortion would be caused if the h.t. voltage fluctuated with the current drawn from it; a choke input filter is therefore used.

A very low impedance is required to provide adequate damping of the loudspeaker, and a value of rather less than 2 ohms at the secondary of the output transformer is obtained by using about 25 dB voltage feedback. This involves the use of a stage of high voltage amplification previous to the output valves. Phase-splitting is achieved by means of an AC/SP3B, used as a triode.

Mechanical Design Considerations

In common with other post-war designs, the amplifier is constructed on a standard panel of folded construction, measuring 22⅛ inches by 9 inches. All the bulky components are mounted on the face of this panel. The space occupied by the small components at the rear of the panel is less than 1½ inches deep, so that two of these amplifiers can be mounted back to back on the same bay. If necessary, and without alteration in component layout, the amplifier can be constructed on a panel measuring 19 inches by 8½ inches for use on 19-inch bays.

The following controls are mounted on two sub-panels and appear at the front of the amplifier when it is used on a bay :—Mains on-off switch ; Indicator lamp ; Gain control ; Feed jacks. A perspective drawing of the front of the amplifier is given in Fig. 12.1.

When the amplifier is used in a box baffle it is necessary that the controls should be accessible from the front of the baffle and that the dust cover should be removable from the rear. Accordingly, a duplicate mains on-off switch and indicator lamp are provided at the back of the amplifier, and the gain control is mounted so that it can easily be reversed on its bracket without disconnecting any wires. A perspective drawing of the back of the amplifier is given in Fig. 12.2.

The input and output circuits and the a.c. mains supply are connected to the amplifier by a single multi-point plug and socket. This plug may be inserted or withdrawn from the front of the amplifier, the plug and cables passing through an opening in the panel from the rear.

Circuit Description (Fig. 32)

General

A simplified circuit diagram of the amplifier is given in Fig. 12.3, and the complete circuit in Fig. 32. The input signal is fed to the primary of the screened input transformer T1 via two resistors R1 and R2. By operating the switch S3 it is possible to connect the resistor R22 in parallel with the primary of T1, where it becomes part of a fixed balanced potential divider with an attenuation of 20 db. T1 has a turns ratio of 1 : 5 and the total resistance on the secondary side is roughly 250,000 ohms, so that the input impedance of the amplifier is approximately 10,000 ohms. This value is maintained in both positions of the switch S3. The input impedance has been made high in order that the amplifier may be connected across 300-ohm or 600-ohm circuits without appreciably reducing the level thereon.

The gain control consists of the resistors R28-R37 selected by a Yaxley-type switch with 11 positions, giving attenuations of between 1 and 19 dB in 2-dB steps. Position 11 gives infinite attenuation, while the maximum position gives an overall amplifier voltage gain of 28 dB. The scale of the gain control is calibrated in 2-dB steps from 0 to −18 dB, the zero indication corresponding to the position of the Yaxley switch which gives 1-dB attenuation and brings the overall gain of the amplifier to an even number of dB.

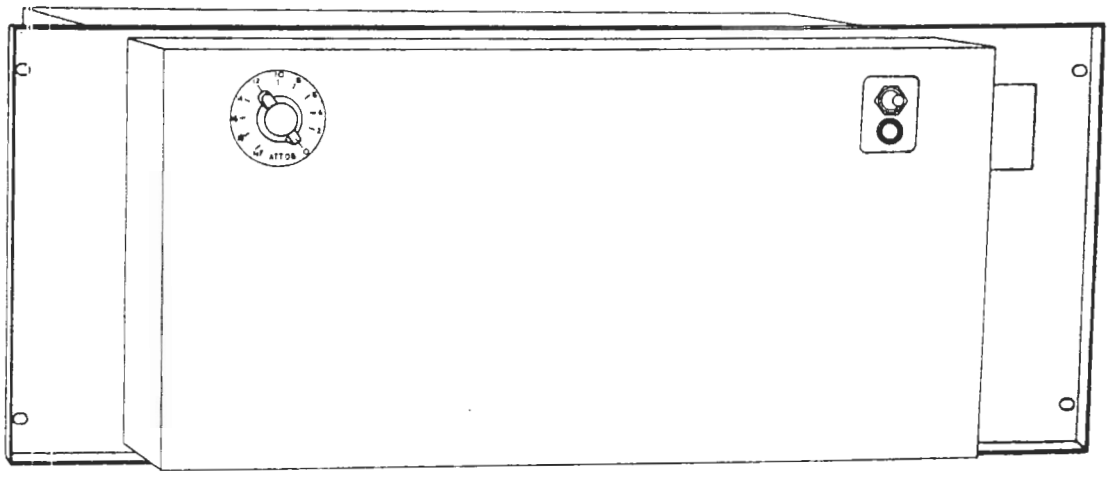


Fig. 12.2. MPA/1. Back View

In conjunction with the fixed 20-dB attenuator S3 it is thus possible to vary the output volume in 2-dB steps over a total range of 38 dB.

The first stage of amplification consists of an AC/SP3B valve, V1, which gives considerable voltage gain. R3 not only provides automatic bias but also 12-dB current feedback, as the capacitor C1 is too small to have any effect at audio frequencies. (The reason for its inclusion in the circuit will be given later.) V1 is RC coupled to the phase-splitting valve, V2. This is an full-wave copper-oxide rectifier. The smoothing circuit for the grid-bias supply includes two 250-μF capacitors C13 and C8 and a 1,200-ohm resistor R26. R21 is a pre-set potentiometer, which provides a differential control of the grid bias applied to the two output valves. It is adjusted to obtain equality in the anode currents of the two AL60's under static conditions, and is only accessible from the inside of the unit.

The mains unit includes a full-wave rectifying valve V5, Type UU4, with a smoothing circuit

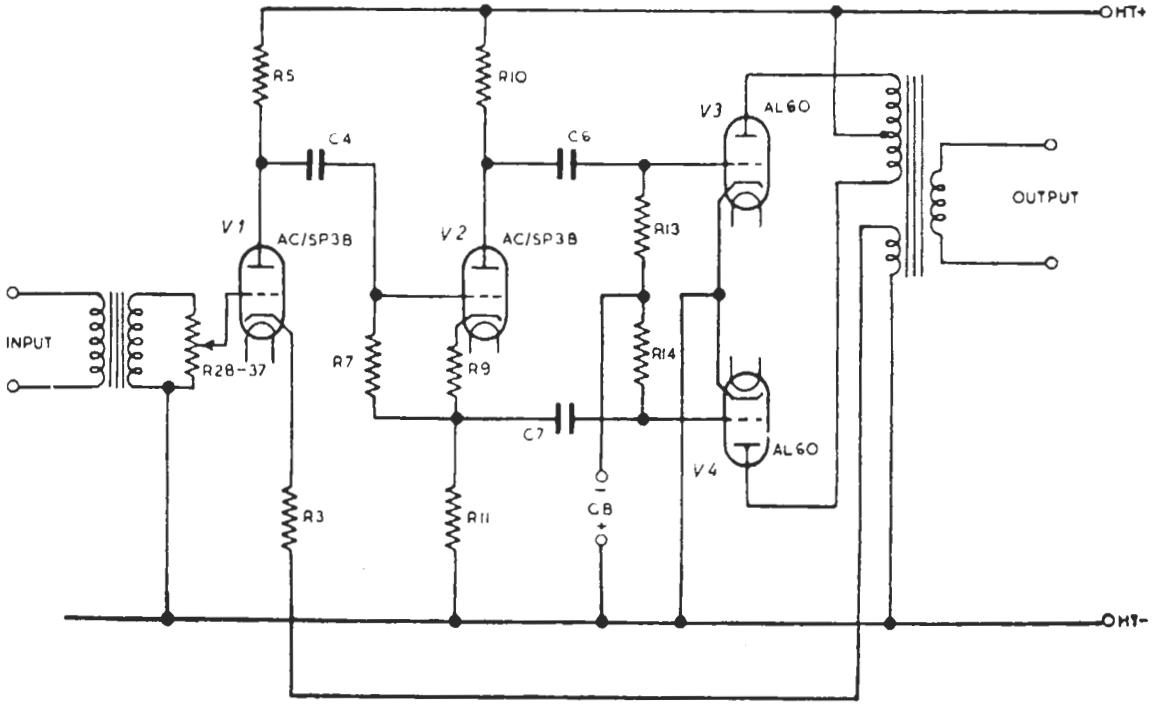


Fig. 12.3. MPA/1. Simplified Circuit

AC/SP3B connected as a triode, and having equal anode and cathode loads of 56,000 ohms (R10 and R11 respectively). The anti-phase outputs developed across these loads are applied to the output pentodes by means of the capacitors C6 and C7. The two secondary windings of T2 may be connected in parallel when the amplifier is required to work into a load of 3 ohms. When the secondaries are connected in series as in Fig. 30, the correct load is 12 ohms, approximately the impedance of an R.K. Senior loudspeaker. The cathodes of the AL60's are earthed and grid bias is introduced by means of the network R21, R38 and R39, the necessary d.c. being obtained from a special winding on the mains transformer T3, and a which includes a choke input to give good voltage regulation. The two double-pole on-off switches S1 and S2 in the primary circuit of the mains transformer are provided so that the amplifier can be switched on or off either from the front or the rear of the unit.

Feedback Circuit

The amplifier incorporates both current and voltage feedback. Current feedback is applied to V1 by making the reactance of C1 very great at audio frequencies compared with the value of R3.

A special winding on the output transformer T2 is used to provide voltage feedback, which is

injected into the cathode circuit of V1. In an amplifier where a considerable amount of feedback is applied, acting over several stages of amplification, instability frequently results due to the feedback voltage becoming positive at a very low or supersonic frequency while the overall gain of the loop is still greater than unity To prevent this instability, it is necessary to make the response of the amplifier, without feedback, fall off in a controlled manner at very low and very high frequencies. The frequency response of the MPA/1 is controlled from 1 c/s to 100 kc/s. Control of bass attenuation is obtained chiefly by suitable choice of inductance in the output transformer primaries, by the use of a small decoupling capacitor for the screen, of V1 and by the network R7, R8, C10. The required high-frequency response is obtained by the use of the 0·003-μF capacitors C15 and C16 which resonate with the primaries of T2 at about 15 kc/s and by the use of the circuit C1, R3, which limits the sharpness of cut-off above 15 kc/s. This frequency correction ensures that the application of feedback will not cause instability and that the amplifier will have a level frequency response over the required range.

Valve Data

Valve	*Anode Potential*	*Anode Current*	*Screen Potential*	*Screen Current*	*Fil. Potential*	*Fil. Current*
Stage 1, AC/SP3B	90V.	1·5mA	80V.	0·5mA	4V.	1A
Stage 2, AC/SP3B	60V.*	1·7mA	(connected as triode)		4V.	1A
Stage 3, AL.60	285V.	13mA†	260V.	1·6mA†	4V.	2·1A
Stage 4, AL.60	285V.	13mA†	260V.	1·6mA†	4V.	2·1A
Stage 5, UU4					4V.	2·2A

* Anode to cathode potential.
† Measured under static conditions.

General Data

	No. of Studs	*Loss per Stud*	*Loss on Lowest stud*
Variable Gain Control	11	2	Infinity

Yaxley type switch, Type A, 1-pole, 11-position, 1-bank.

Fixed Gain Control S3 20-**dB** attenuation Arrow Type No. 20905.

Mains On-off Switches S1, S2 Arrow type No. 20905.

Balance Control R21 1,000 Ω. Reliance Type TW.

Indicator Lamps. P.O No. 2. 4 V.

Combined Input, Output and Mains Socket :— Films and Equipment Ltd. Type EP-8-14S (light pressure).

Impedances

Normal source Z = 300 Ω.
Input Z = 10,000 Ω (balanced).
Output Z = 1·1 to 3·0 Ω over most of the audio-frequency range.
Normal load Z = 12 Ω (or 3 Ω balanced).

Normal Working Volume

Input zero (minimum line-up level for peak volume output = − 13 **dB**).
Output zero, + 4 **dB** or + 10 **dB** (voltage level on 12-Ω load).

Maximum Gain at 1,000 *c/s*

G = 28 **dB.**

Frequency Characteristic

± 0·25 **dB** from 50 c/s to 8,000 c/s.
± 1 **dB** from 30 c/s to 15,000 c/s.

Total Percentage Harmonic Content

Frequency	+ 15-*dB Output Voltage Level*	+ 23-*dB Output Voltage Level*
50 c/s	< 1	< 2
1,000 c/s	< 0·5	< 1

Noise Level

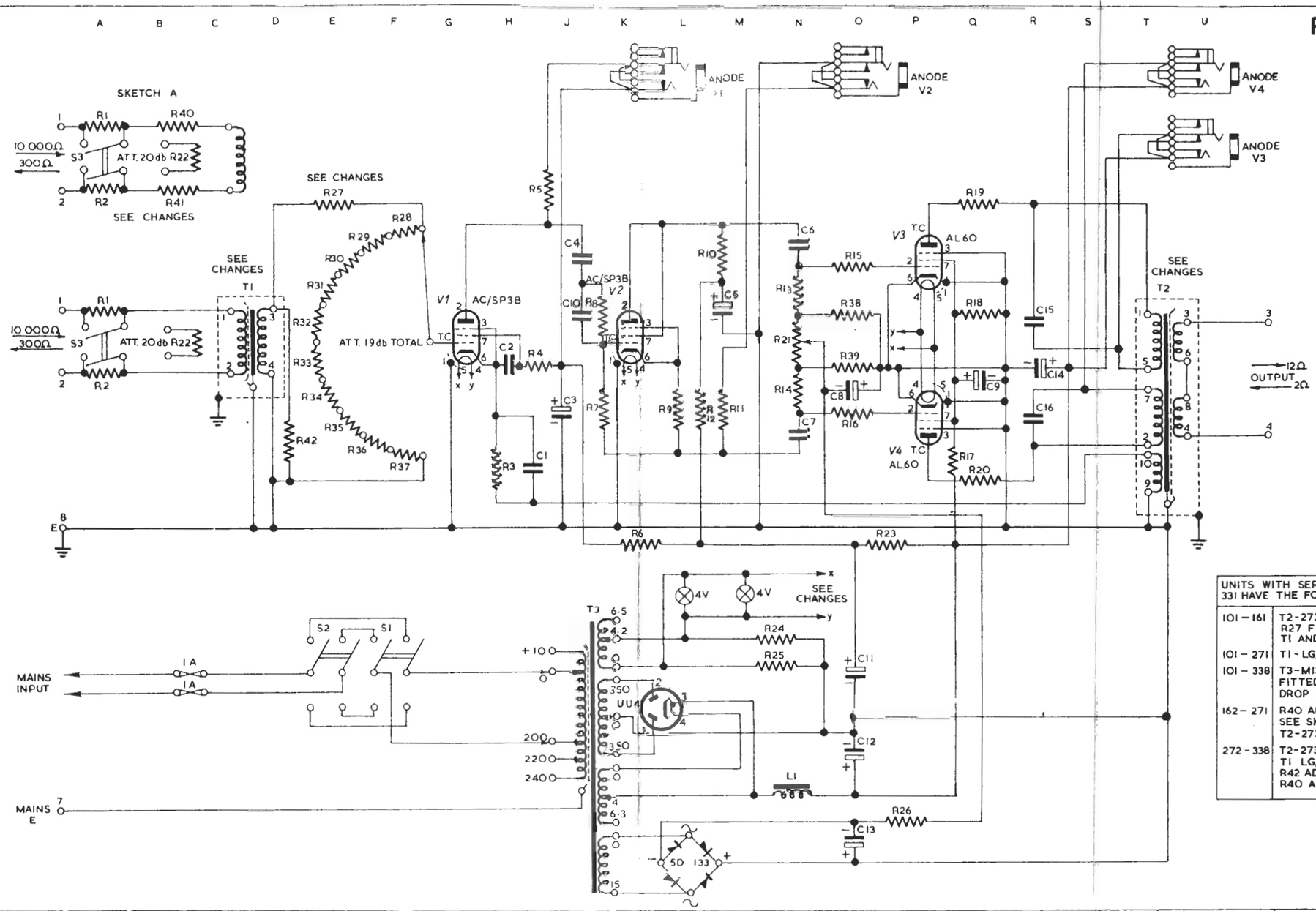
Less than −70 **dB** compared with normal output level

Modifications

The following modifications have been made to MPA/1 amplifiers with serial numbers S162-271 inclusive.

(*a*) The 27,000-ohm resistor R27 connected between the input transformer secondary and the variable potentiometer is omitted.
(*b*) Two 500-ohm resistors are inserted, one in each of the input leads to terminals 1 and 2 of the primary of the input transformer.

These changes have no effect upon the overall performance of the amplifier but compensate for certain variations in the input transformer.



UNITS WITH SERIAL NUMBERS 101 TO 331 HAVE THE FOLLOWING DIFFERENCES:-	
101 – 161	T2-273C OLD STYLE R27 FITTED BETWEEN TAG 3 OF T1 AND R28
101 – 271	T1 - LG/26RB
101 – 338	T3-M127 WITH RESISTOR FITTED IN HEATER CIRCUIT TO DROP VOLTAGE TO 4V
162 – 271	R40 AND R41 ADDED (500Ω) SEE SKETCH 'A' T2-273C STYLE 3
272 – 338	T2-273C STYLE 3 T1 LG/35RB R42 ADDED R40 AND R41 CHANGED TO 560Ω

COMP	LOC	VALUE	TYPE
C1	H7	0·0005 ±20%	J.S.C.
C2	H5	0·1 "	"
C3	J6	16	CE15129 B.E.C.
C4	J3	0·1 ±20%	J.S.C.
C5	M4	16	CE15129 B.E.C.
C6,7	N3,7	0·5 ±20%	J.S.C.
C8	O6	250	CE10730 B.E.C.
C9	Q6	16	CE15129 "
C10	J4	0·001 ±20%	J.S.C.
C11,12	O10,12	16	CE15129 B.E.C.
C13	O14	250	CE10730 "
C14	R5	16	CE15129 "
C15,16	R4,6	0·003	MATCHED TO ±5% @ 1 S.C.

COMP	LOC	VALUE	TYPE
L1	N12	14 H	C6A
R1,2	A4,5	4·5K ±10%	ERIE 0·25W
R3	H7	1K "	" 0·5 "
R4	H5	390K "	" " "
R5	J2	100K "	" 1 "
R6	K8	22K "	" 0·5 "
R7	K6	470K "	" 0·25 "
R8	K5	3·3M "	" " "
R9	L6	6·8K "	" 0·5 "
R10,11	M3,6	55K ±20%	" " "
R12	L6	110K ±10%	" " "
R13,14	N4,6	220K ± 5%	" 0·25 "

COMP	LOC	VALUE	TYPE
R15,16	O4,6	5·6K ±10%	ERIE 0·25W
R17	Q7	1·2K "	PAINTON 3W 301
R18	Q5	12K "	" 7·5W 302
R19,20	Q2,7	100 ±10%	ERIE 0·25W
R21	N5	1K "	VARIABLE TW RELIANCE
R22	C5	11·1K ±10%	ERIE 0·25W
R23	O8	4·7K "	" 0·5 "
R24,25	N10	10 "	" " "
R26	P13	1·2K "	" " "
R27	E2	27K "	" 0·25 "
R28	F3	46K "	" " "
R29	E3	31·6K "	" " "
R30	E8	29·2K "	" " "

COMP	LOC	VALUE	TYPE
R31	E4	23·1K ±10%	ERIE 0·25W
R32	E5	18·3K "	" "
R33	E5	14·5K "	" "
R34	E6	11·5K "	" "
R35	E6	9·2K "	" "
R36	F7	7·1K "	" "
R37	F7	28·1K "	" "
R38,39	O4	5·6K "	" "
R40,41	A1,2	560 "	
R42	E7	2·2M "	
T1	E5		LG/35RB
T2	T6	20·3 : 1	273C
T3	K12		M127

MISCELLANEOUS POWER AMPLIFIER MPA/1