Triode *Type DA42*

AF AMPLIFIER

General. The DA42 is a power amplifying triode fitted with an indirectly heated cathode. The valve was especially designed to operate in Class B audio amplifiers and a power output of 175 W may be obtained, with low distortion, from a pair of valves arranged in push-pull.

Cooling. The valve must be adequately ventilated although no special precautions are necessary except to ensure that the temperature of the hottest part of the bulb does not exceed 250°C.
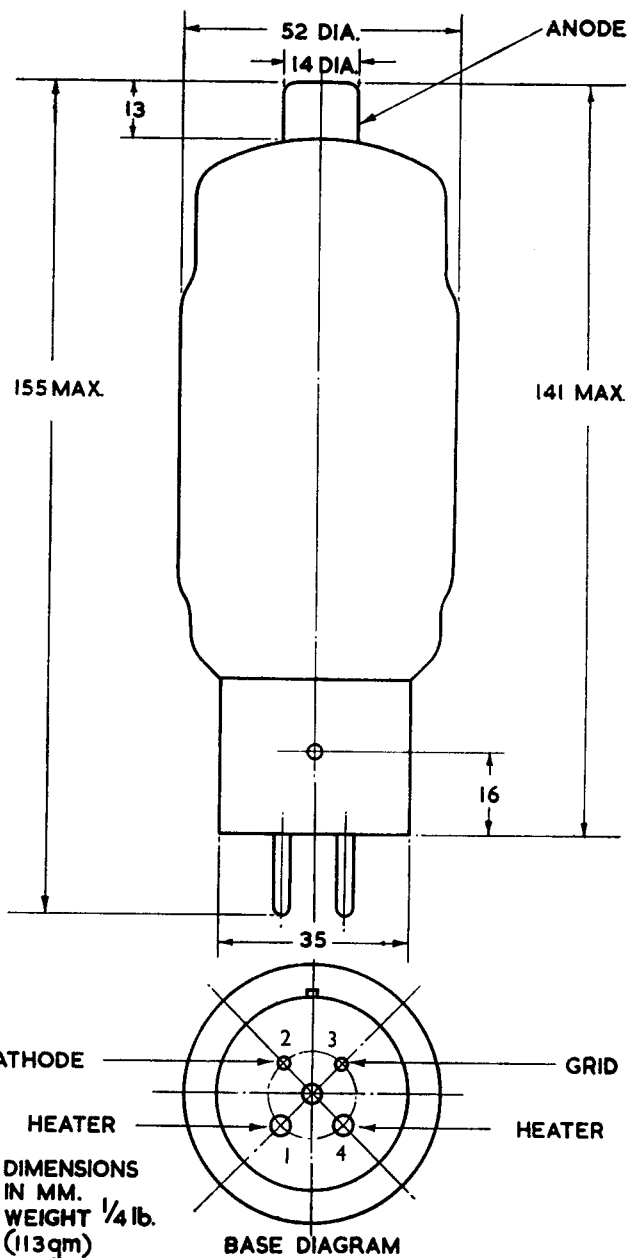
Mounting. The valve should be mounted in a vertical position with the base downwards.

Microphony. The DA42 is free from microphony in normal receiver applications.

APPROXIMATE DATA

V_h		7·5	V
I_h		1·2	A
V_a		1	kV
P_a		40	W
I_a		40	mA
g_m	taken at V_a 1 kV	3	mA/V
r_a	I_a 40 mA	24	kΩ
μ		72	
$C_{a\text{-}gl}$		4	pF
$C_{a\text{-}k}$		1	pF
$C_{gl\text{-}k}$		5·2	pF

52 DIA.
14 DIA
13
ANODE
155 MAX.
141 MAX.
16
35

CATHODE — GRID
HEATER — HEATER
2 3
1 4

DIMENSIONS IN MM.
WEIGHT ¼ lb. (113 gm)

BASE DIAGRAM

Typical Operation

PUSH-PULL AUDIO AMPLIFIER. CLASS B

per pair of valves unless stated otherwise

V_a	1	kV	$R_{L\ (a'-a'')}$	10*	kΩ	
V_{g1}	0	V	$V_{in(pk)\ (g1'-g1'')}$	200	V	←
$I_{a\ (zero-sig)}$	50	mA	$Z_{in\ (g1'-g1'')}$	4	kΩ	
$I_{a\ (max-sig)}$	275	mA	Z_{out}	15	kΩ	
→ $I_{g1\ (max-sig)}$	50	mA	P_{drive}	5	W	
→ $I_{g1\ (pk)}$ per valve	100	mA	P_{out}	175*	W	
			$p_{a\ (zero-sig)}$ per valve	25	W	
			$p_{a\ (max-sig)}$ per valve	50	W	
			D	6	%	

OPERATING NOTES

* The above values apply to normal operating (speech and music) conditions only. Continuous 100% tone modulation will result in excessive dissipation and, for such applications, the anode-anode load, $R_{L(a'-a'')}$, should be increased to 12 kΩ, resulting in a reduction of power output (P_{out}) to 150 W.

Where the valve DA 42 is used to replace a DA 41, it is necessary to earth pin 2.
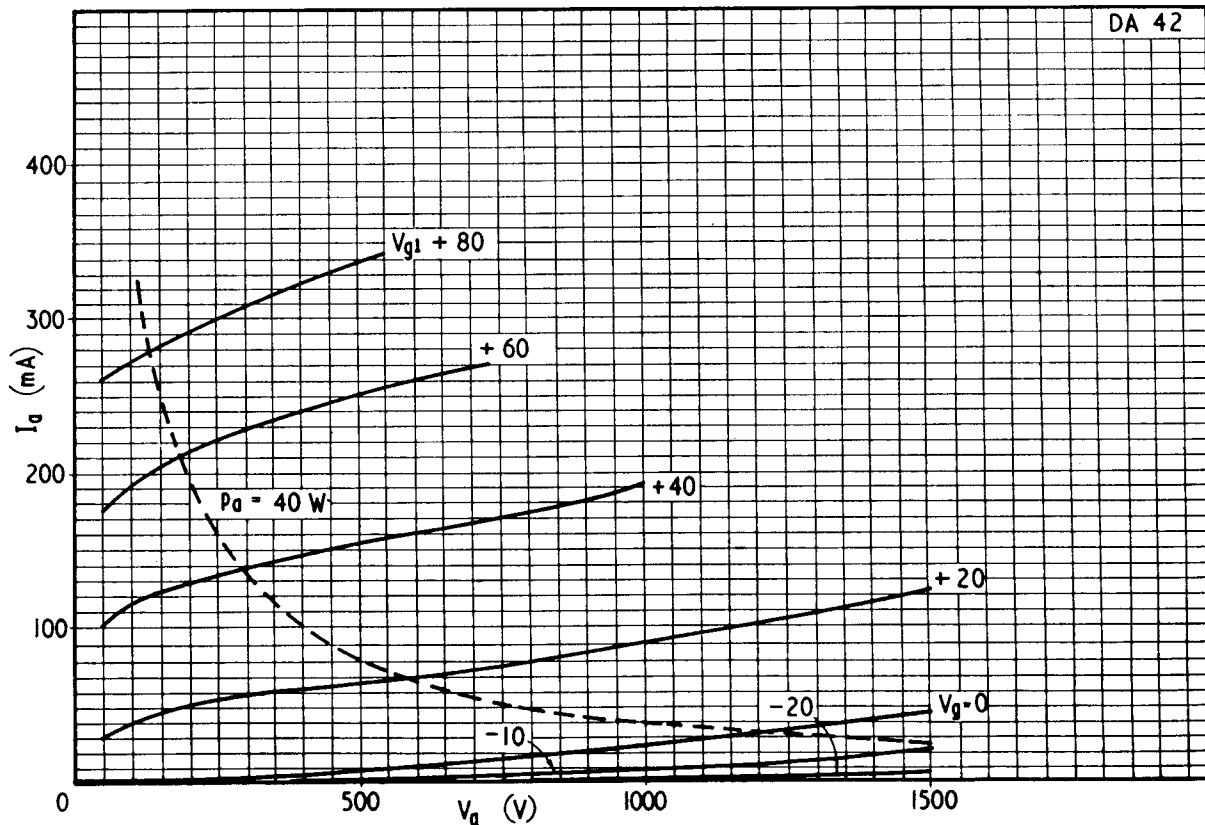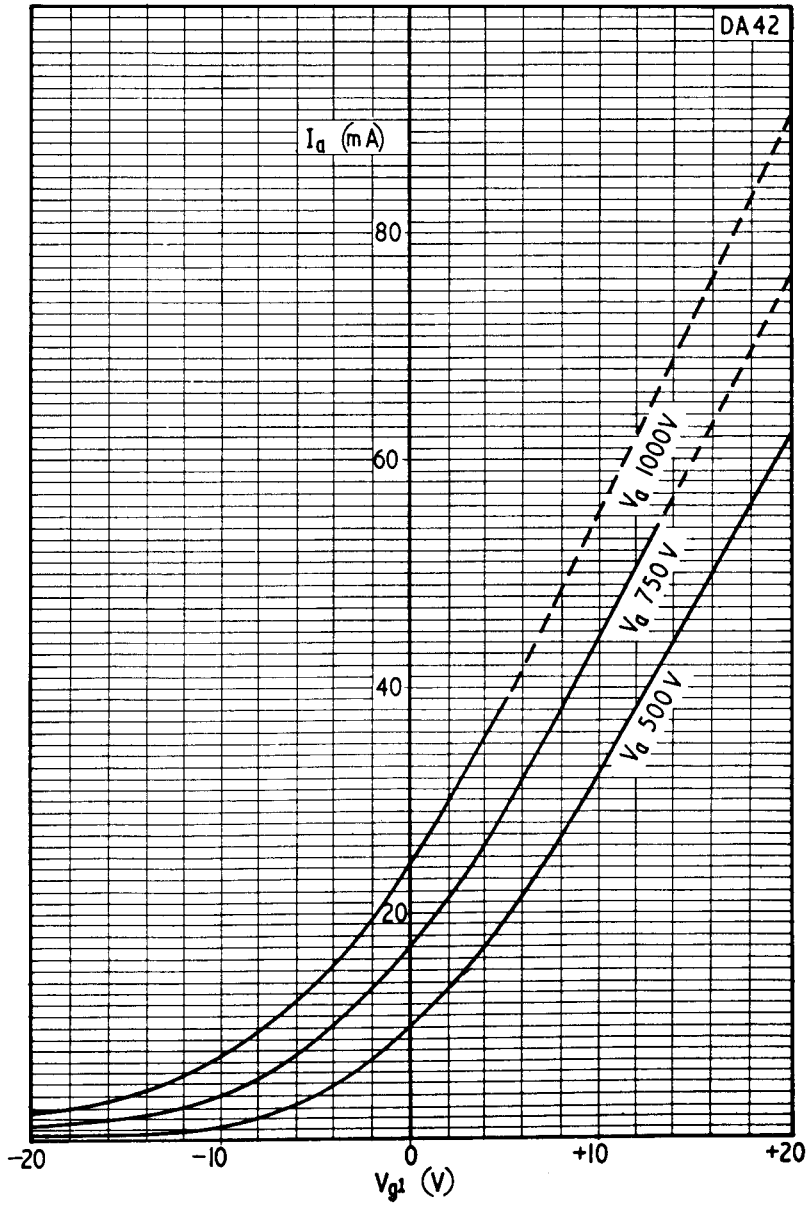
Triode *DA 42*

CIRCUIT SUPPLEMENT No. 1

The DA42 is a triode having an indirectly heated cathode. It is intended for use in pairs in Class B audio amplifiers to provide outputs of 175W.

The DA42 may replace the DA41 in existing equipment with slight wiring changes.

CLASS B AMPLIFIERS

The Class B amplifier is recognised as an economical method of obtaining a high audio output because of its high efficiency and the simplicity of the circuit arrangement. The absence of a grid bias supply renders the valve self-protective and no interlock is required to hold off the anode voltage until the bias voltage is established.

This report covers the design of a 175W amplifier and a simplified arrangement for the d.c. supply voltage is discussed.

The DA42 is normally suitable for use in existing amplifiers using the DA41, if the cathode (pin 2) is connected to earth. The anode connector may require replacement to fit the smaller 9mm. top cap. The separate cathode connection permits individual monitoring with a single heater supply.

TYPICAL OPERATION

Push-Pull Class B   Two Valves   Data per Pair

V_a	1,000	V
V_g	0	V
$I_{a (o)}$	50	mA
$I_{a (max-sig)}$	275	mA
$I_{g (max-sig)}$	50	mA
$V_{in (pk) (g-g)}$	175	V
P_{dr}	5	W
$R_{L (a-a)}$	10	kΩ
P_{out}	170	W
D	6	%
Z_{out}	15	kΩ

The operation is shown in detail in the curves, Figs. 1 and 2. It will be seen from Fig. 1 that the anode dissipation rises if the load is reduced and the valves should not be used in the region shown dotted. Fig. 2 shows the performance at the selected 10kΩ load and Fig. 3 the valve's behaviour at various anode voltages.

CIRCUIT

The recommended circuit is shown in Fig. 4. The two DA42 valves are used in a push-pull Class B amplifier with zero grid bias. A low impedance driver stage is required and two KT66 valves are used in a cathode-coupled circuit with a bridged transformer T2. This arrangement preserves the wave-form in spite of the low and variable load reflected by the DA42.

With a 500V supply for the KT66 valves, a bias voltage of 45 would be required, giving an anode current of 70-80mA per pair. The effective cathode bias resistance per valve would be of the order of 1·2kΩ. A part of this resistance occurs in each half-primary of the transformer T2, but usually an additional resistor, R21, common to both valves, is necessary.

A suitable transformer design is shown in Fig. 9. The half-primary resistance is about 300Ω so that R21 has a value of 440Ω. The secondary resistance should be as low as possible.

The bridging capacitors C9 and C10 are not critical in value, but should be at least 8μF. If the capacitance is too low the distortion will increase.

The output transformer T1 should have low leakage reactance between the two half-primaries and between the primary and secondary. For the usual 100V output line, of 60Ω in this case, the primary-secondary ratio would be 13: 1.

An output voltage from the cathode-coupled stage of 75+75 rms is required to give full output from the DA42. A rather higher input to the cathode-coupled

stage is necessary, and the previous stage is called upon to provide 80+80V with low distortion. This is obtainable from two N709 valves acting as resistance-coupled pentodes, in view of the high anode supply voltage available, if the screen and bias resistors have optimum values.

The combined anode and screen current of each N709 is 6mA, the anode and screen voltages being 150 and 60, respectively. With an input of 1+1V rms an output of 80+80V is given at less than 2% distortion

The stage preceding the N709 voltage amplifiers may utilise any small triode. The DH77 is shown in Fig. 4. The anode current is approximately 1mA.

ADDITION OF DEGENERATION

When an improved performance is required degeneration may be incorporated (Fig. 5). The cathode-coupled, bridged transformer T2 causes negligible phase shift so that the degeneration may be taken from the secondary of the output transformer T1 to the cathodes of the N709 valves. The bias resistor R8 is replaced by two resistors R26, R27, and a resistor is connected to each side of the output transformer (R28, R29).

This arrangement will give 12-14db degeneration which is sufficient to provide a damping factor of about 4·5 to the load connected to the output transformer.

The value of the resistors R28, R29 will depend on the load impedance used, but with the usual 100V output, i.e. 60Ω, the resistors may be 3·3kΩ each.

The overall performance with degeneration is as follows:

Power output	165W
Distortion	≯2%
Input to DH77 stage	5V rms
Damping Factor	4·5 approx.

ANODE SUPPLY UNIT

The anode supply unit, Fig. 6, is somewhat unusual in that one set of rectifiers and one h.t. transformer are used to provide two d.c. voltages, one of which is twice the value of the other. It would seem that this circuit offers certain advantages over the conventional arrangement both in initial cost and in space required. The rectifiers are not equally loaded, two of them having to provide the low voltage current of 100mA in addition to the 275mA at 1000V required at full output. This the U19 is well able to do since its rated maximum in this type of circuit is 500mA at 4kV d.c. The operation of this circuit is shown more clearly in Fig. 7. Two of the U19 and the components shown dotted take no part in the low voltage supply and the circuit resolves into a two-valve, biphase half-wave arrangement with the valves inverted. The high voltage supply utilises the four U19 valves, but the components L2, L3, C15 and C16 take no part in the operation. The input choke L2 must not be omitted. Series-connected capacitors are recommended for C13 (a, b and c) and for C15 (a and b). In a Class B amplifier a very large variation of anode current occurs with a change in input signal. As the internal impedance of the power supply causes some interaction between the 1000V and 500V supplies, a sudden demand for maximum current would cause a reaction in the 500V supply if the conventional 4μF or 8μF capacitors were used for C13. The specified capacitor has a value of 160μF (450V) and three of these in series provide an effective 50-60μF with a working voltage of 1350. Resistors R30, R31 and R32 equalise the applied voltage. C15a and b are similar capacitors.

An interesting circuit developed from this arrangement is shown in Fig. 8 where three biphase rectifying valves are used. If the high and low d.c. outputs are similar each valve anode is equally loaded. Three U52 valves would provide 250mA at each of two voltages.
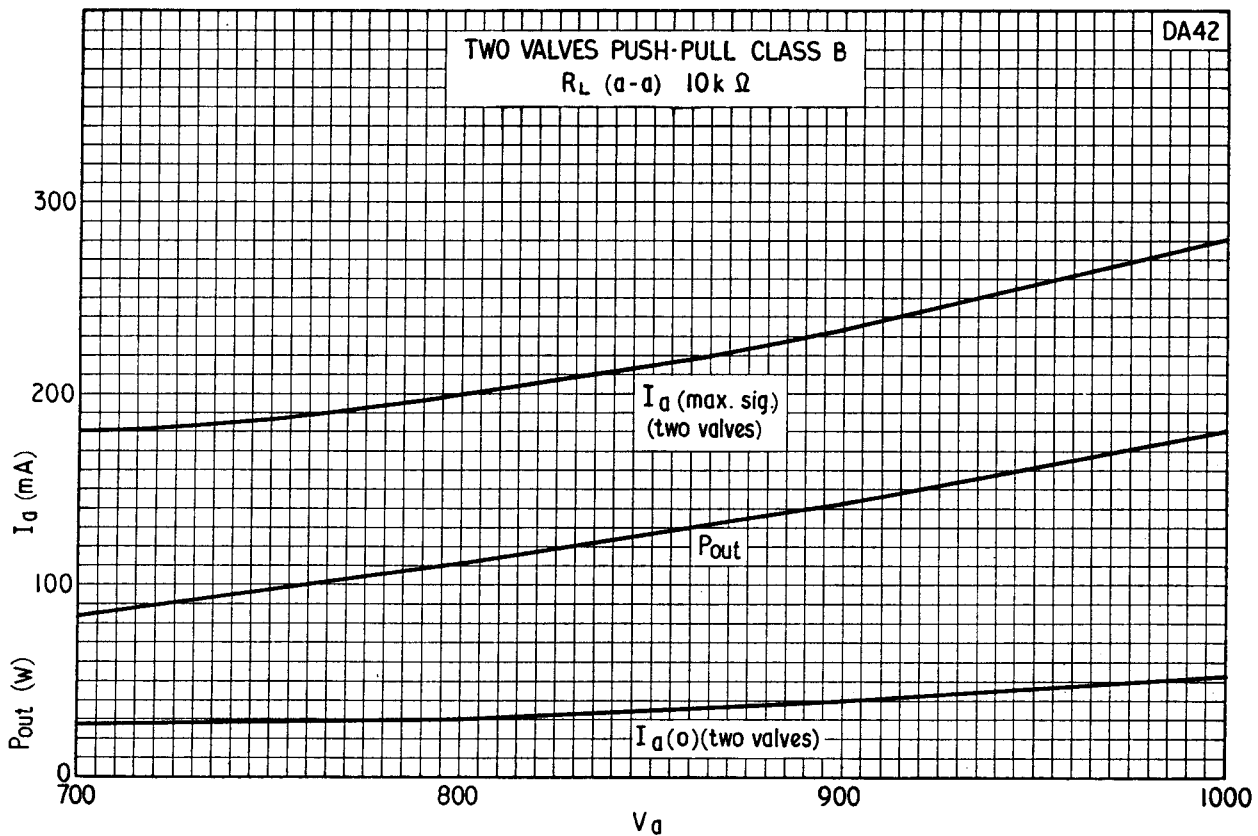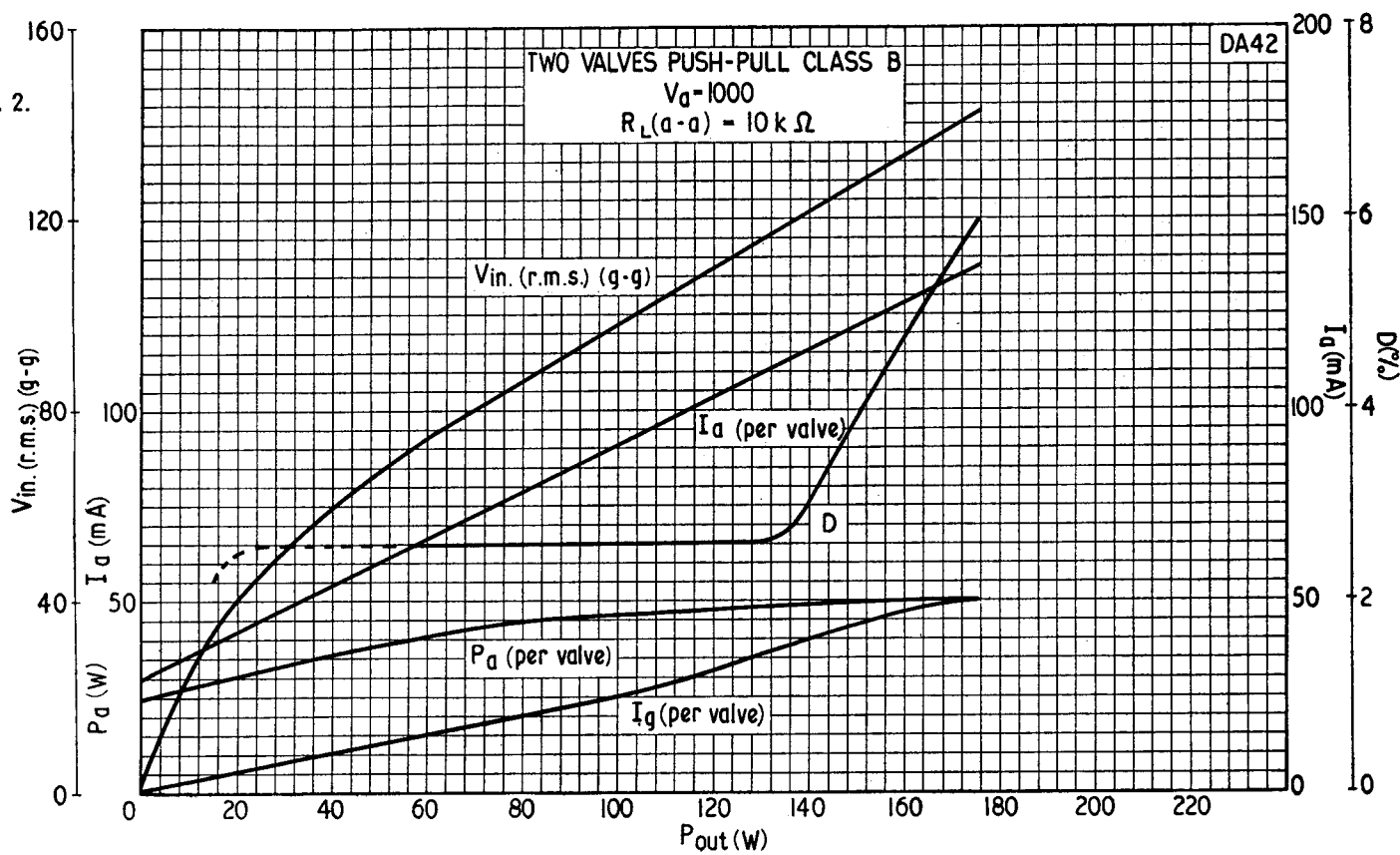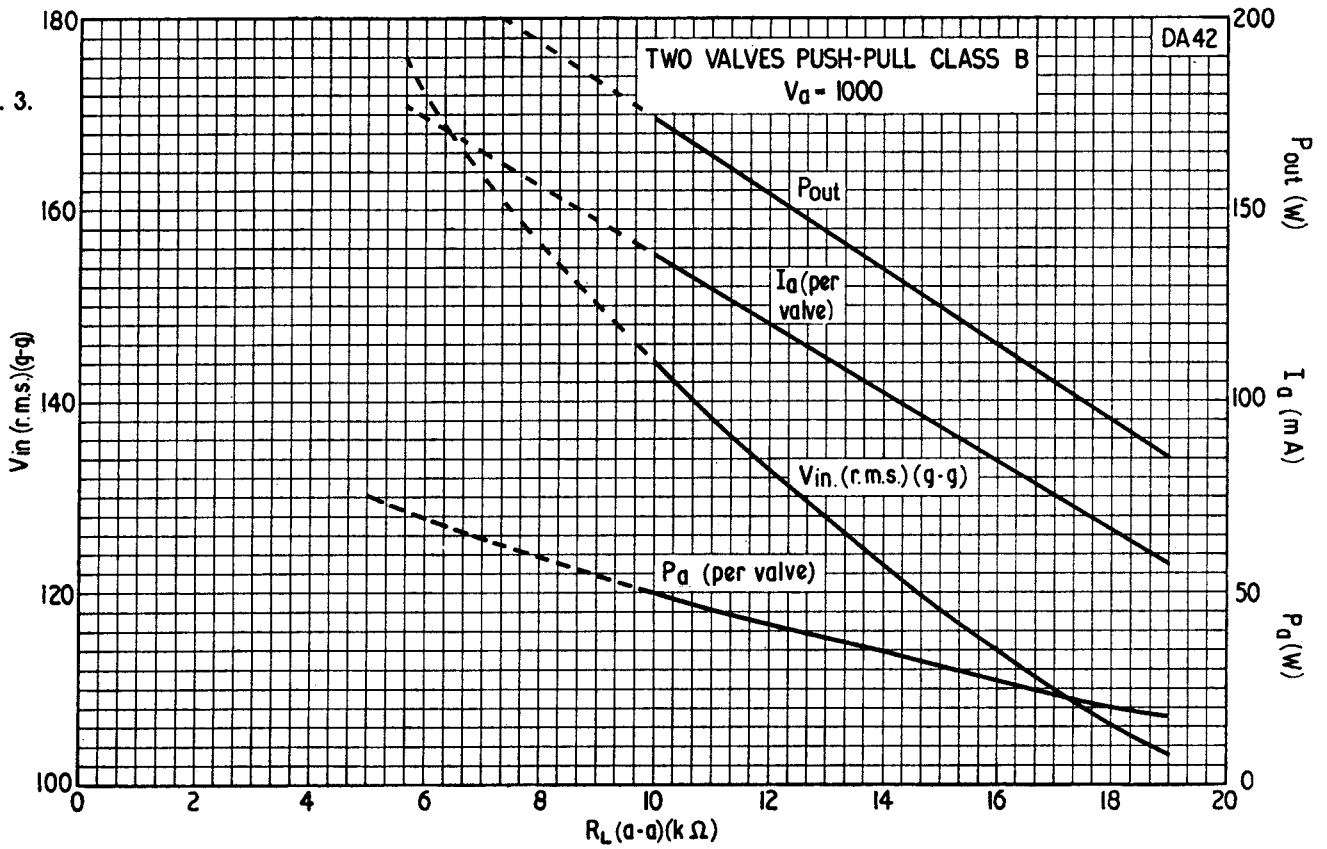
Fig. 1.

TWO VALVES PUSH-PULL CLASS B
R_L (a-a) 10 k Ω

DA42

I_a (mA)

P_{out} (W)

V_a

I_a (max. sig.) (two valves)

P_{out}

$I_{a(o)}$ (two valves)

Fig. 2.

TWO VALVES PUSH-PULL CLASS B
V_a = 1000
R_L(a-a) = 10 k Ω

DA42

$V_{in.}$ (r.m.s.) (g-g)

I_a (mA)

P_a (W)

I_a (mA)

D(%)

$V_{in.}$ (r.m.s.) (g-g)

I_a (per valve)

D

P_a (per valve)

I_g (per valve)

P_{out} (W)

3

Fig. 3.
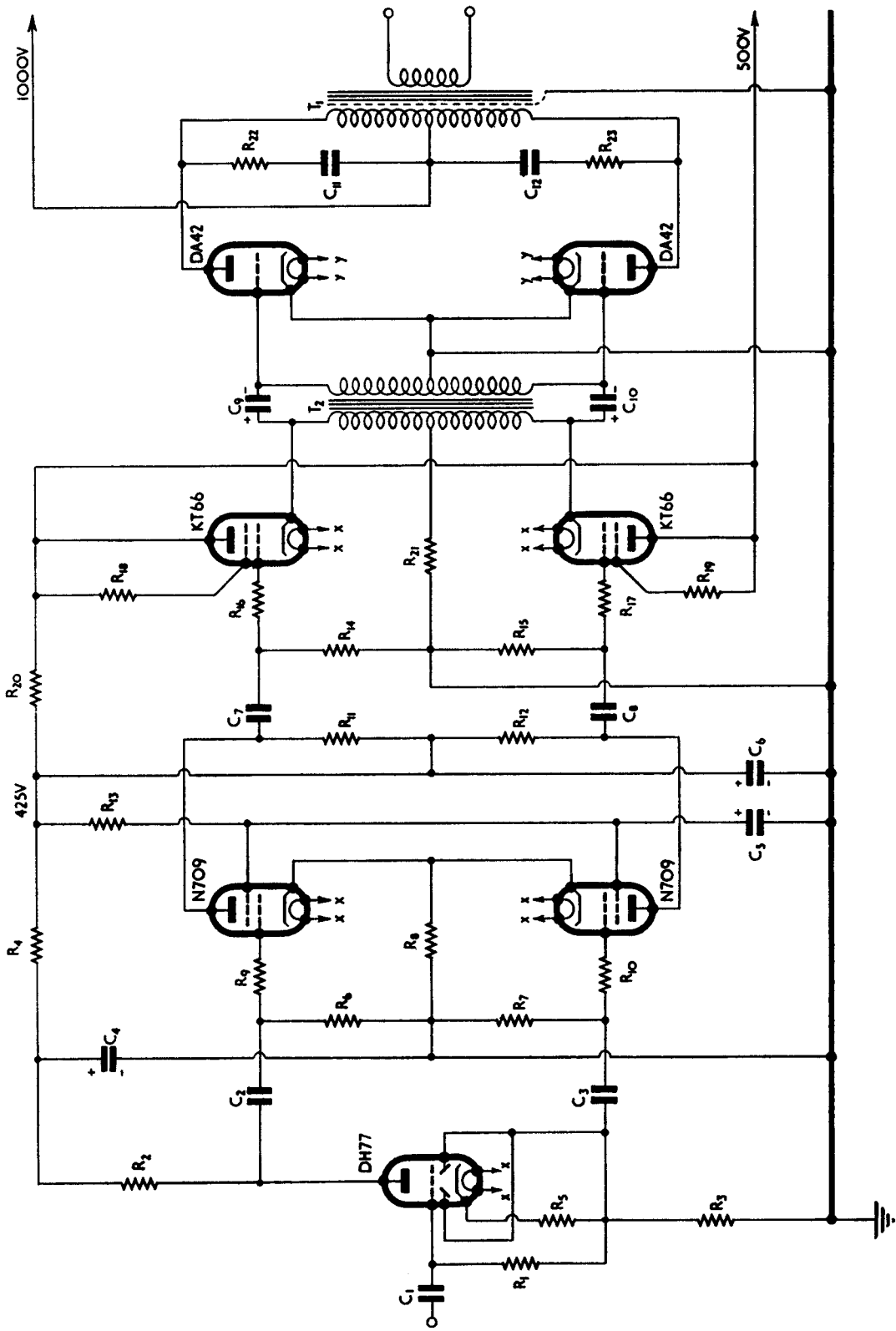
TWO VALVES PUSH-PULL CLASS B
$V_a = 1000$

DA 42

4

Fig. 4. 175W Class B Amplifier. Component values are given on page 8

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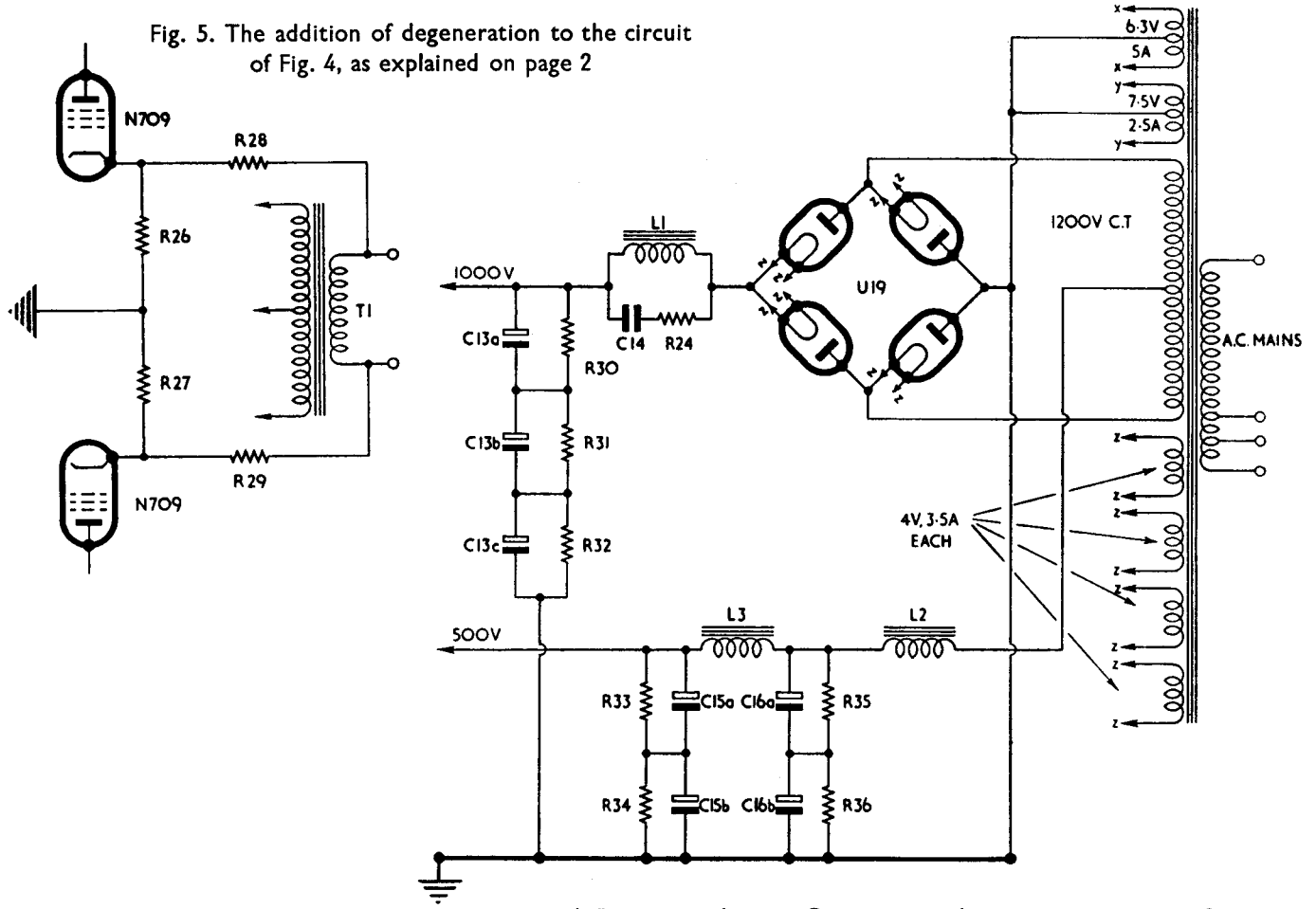Fig. 5. The addition of degeneration to the circuit of Fig. 4, as explained on page 2

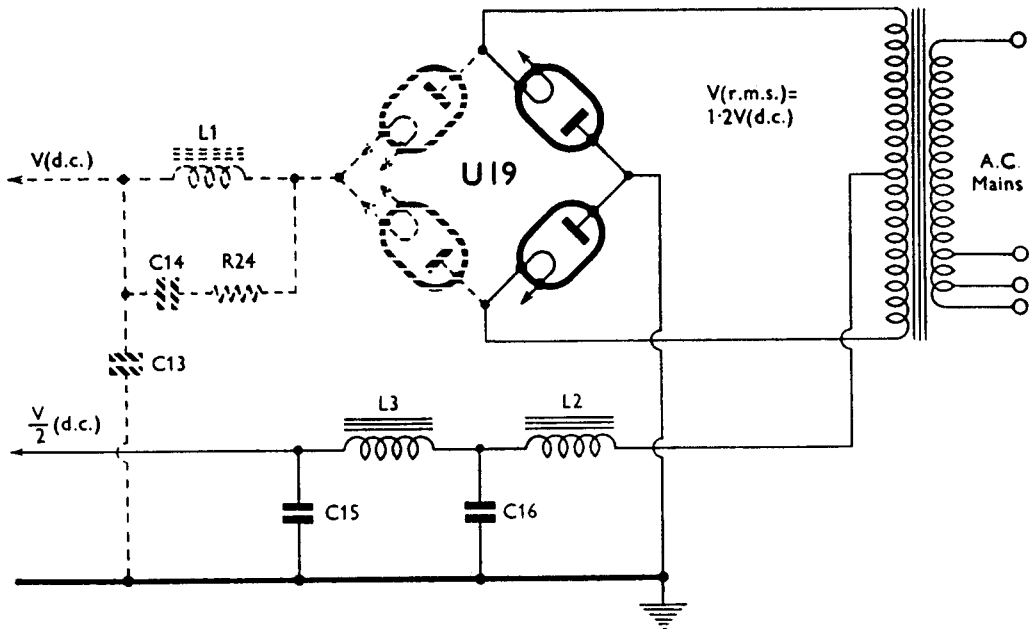Fig. 6. Power supply unit. Component values are given on page 8

Fig. 7. Operation of the power supply of Fig. 6; 500V section.
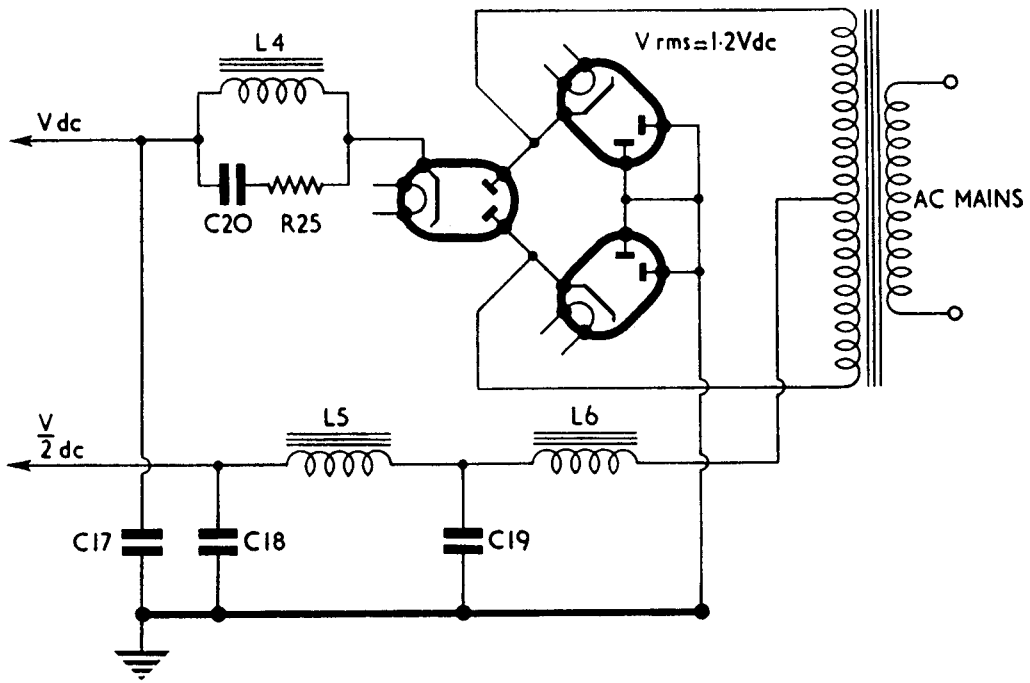See page 2

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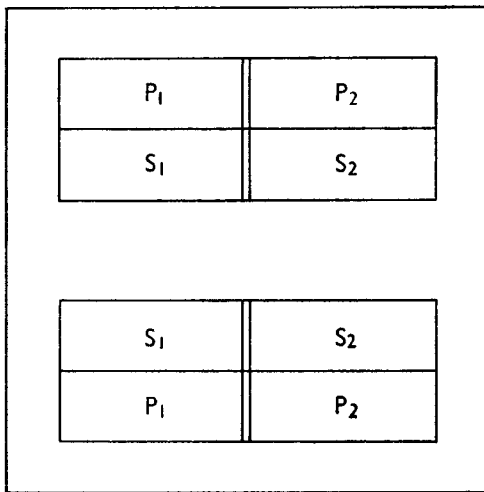Fig. 8. Using three bi-phase rectifiers to give two output voltages

Fig. 9. Design of coupling transformer, T2

Core: Stalloy No. 4 square section, no gap.

Primary: 2000+2000 turns, 38 swg.

Secondary: 2000+2000 turns, 30 swg.

The two half-primary and secondary windings, P1, S1, are wound in the opposite direction to P2, S2, so that when the two inner connections are joined, the windings are series aiding. The number of turns must be identical in each of the four sections.
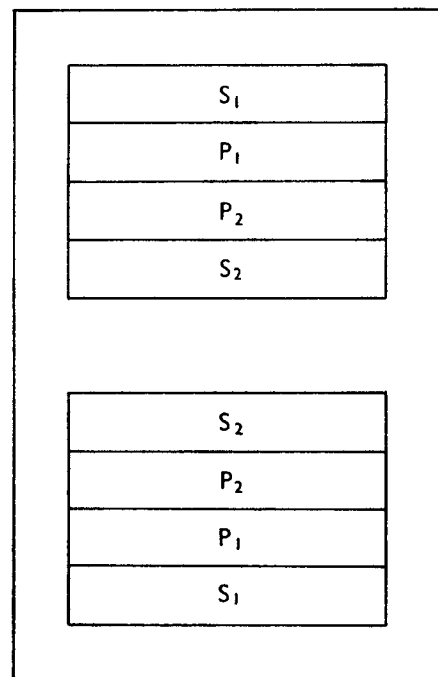

Fig. 10. Design of output transformer, T1

This transformer is suitable for a 60Ω line at 100V.

Core: Stalloy No. 66, square section, no gap.

Primary: 1250+1250 turns, 28 swg.

Secondary: 100+100 turns, 18 swg.

All windings are wound in the same direction. The secondary is connected in series aiding.

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COMPONENT VALUES

Resistors (20% 0·25W unless otherwise indicated)

R1	470kΩ			R19	100kΩ	
R2	100kΩ	} 0·5W, matched		R20	4·7kΩ	10%, 1W
R3	100kΩ	} within 5%		R21	440Ω	10%, 5W (see text page 1)
R4	47kΩ	0·5W		R22	5kΩ	10%, 10W
R5	1·5kΩ			R23	5kΩ	10%, 10W
R6	470kΩ	10%		R24	10kΩ	10%, 2W
R7	470kΩ	10%		R25	10kΩ	10%
R8	150kΩ	10%, 0·5W		R26	330Ω	10%, 0·5W
R9	10kΩ			R27	330Ω	10%, 0·5W
R10	10kΩ			R28	3·3kΩ	10%, 1W
R11	47kΩ	5%, 5W wirewound		R29	3·3kΩ	10%, 1W
R12	47kΩ	5%, 5W wirewound		R30	100kΩ	10%, 1W
R13	470kΩ	10%, 1W		R31	100kΩ	10%, 1W
R14	470kΩ			R32	100kΩ	10%, 1W
R15	470kΩ			R33	100kΩ	10%, 1W
R16	10kΩ			R34	100kΩ	10%, 1W
R17	10kΩ			R35	100kΩ	10%, 1W
R18	100kΩ			R36	100kΩ	10%, 1W

Capacitors

C1	0·01μF	500V	Paper		C13a	160μF	450V	Electrolytic
C2	0·01μF	500V	Paper		C13b	160μF	450V	Electrolytic
C3	0·01μF	500V	Paper		C13c	160μF	450V	Electrolytic
C4	4μF	450V	Electrolytic		C14	0·01μF	1500V	Paper
C5	1μF	350V	Paper		C15a	160μF	450V	Electrolytic
C6	160μF	450V	Electrolytic		C15b	160μF	450V	Electrolytic
C7	0·05μF	500V	Paper		C16a	160μF	450V	Electrolytic
C8	0·05μF	500V	Paper		C16b	160μF	450V	Electrolytic
C9	16μF	100V	Electrolytic		C17	—		
C10	16μF	100V	Electrolytic		C18	—		} Capacitance and rating
C11	0·002μF	1000V	Paper		C19	—		according to circuit
C12	0·002μF	1000V	Paper		C20	0·01μF		requirements.

Inductors

See page 7 for details of T1 and T2.

L1	10H	275mA
L2	10-20H	100mA
L3	10-20H	100mA
L4	10H	
L5	10-20H	
L6	10-20H	