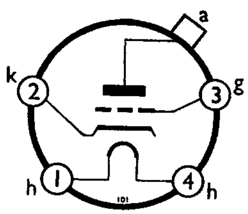
G.E.C. VALVES

OUTPUT TRIODE
7·5V INDIRECTLY HEATED

DA42
JULY, 1956
SECOND EDITION

A power triode designed to operate in pairs at zero grid bias in Class B audio amplifiers.

BASE CONNECTIONS AND VALVE DIMENSIONS



View from underside of base.

Base :	Medium 4 Pin.	
Bulb :	Dome Top Tubular.	
Max overall length :	156	mm.
Max seated length :	141	mm.
Max diameter :	52	mm.
Top Cap :	CT2	

HEATER

V_h	7·5	V
I_h	1·2	A

RATINGS

V_a	1250 max.	V
p_a	40 max.	W

CHARACTERISTICS

V_a	1000	V
I_a	40	mA
g_m	3·0	mA/V
r_a	24	kΩ
μ	72	

CAPACITANCES

c_{g-kh} 5·2 pF c_{a-kh} 1·0 pF c_{g-a} 4·0 pF

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DA42

TYPICAL OPERATION

Push-Pull Class B. Two valves. Data per pair.

V_a	1,000	1250	V
$V_{g\,(o)}$	0	−4	V
$I_{a\,(o)}$	50	40	mA
$I_{a\,(max.\,sig.)}$	275	240	mA
I_g	50	40	mA
$i_{g\,(pk)}$ (per valve)	100	85	mA
$v_{in\,(g\text{-}g)\,(pk)}$	200	200	V
P_{dr}	5	4·5	W
$p_{a\,(o)}$ (per valve)	25	25	W
$p_{a\,(max.\,sig.)}$ (per valve)	50	50	W
$R_{L\,(a\text{-}a)}$	10	13	kΩ
P_{out}	175	200	W
D	6	6	%
$z_{in\,(g\text{-}g)}$	4	4·5	kΩ
z_{out}	15	15	kΩ

The conditions given above apply to normal speech and music only. Continuous 100% tone modulation will result in excessive dissipation and for such applications, $R_{L(a\text{-}a)}$ should be increased by not less than 20%.

GENERAL

The DA42 may be used as a replacement for the DA41 in existing equipment. In such cases, since the heater and cathode of the DA42 are not internally connected it is essential that pin 2 of the valve socket is earthed.

The top cap connector must be changed to the smaller 9mm. type, CT2.

MOUNTING

Vertical with base down.

VENTILATION

No special precautions are necessary. The temperature of the hottest part of the bulb must not exceed 225°C.

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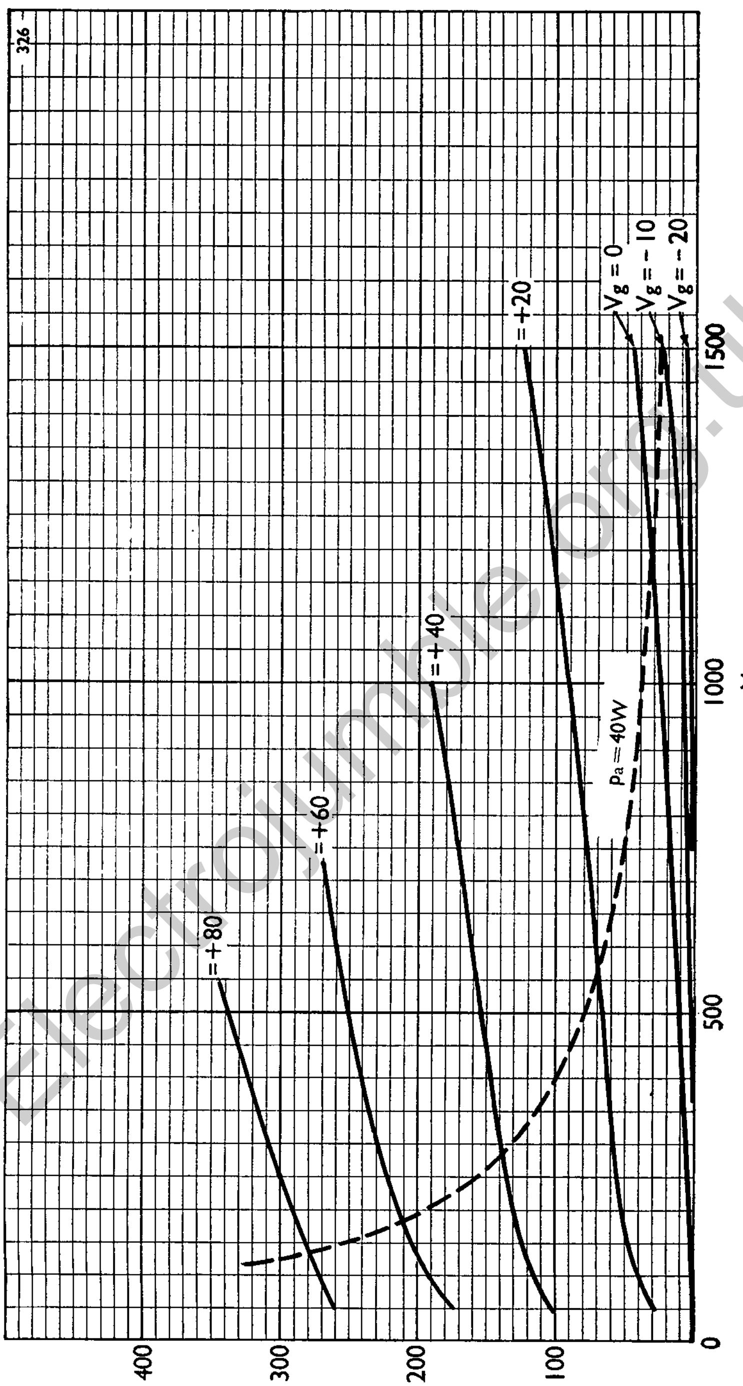

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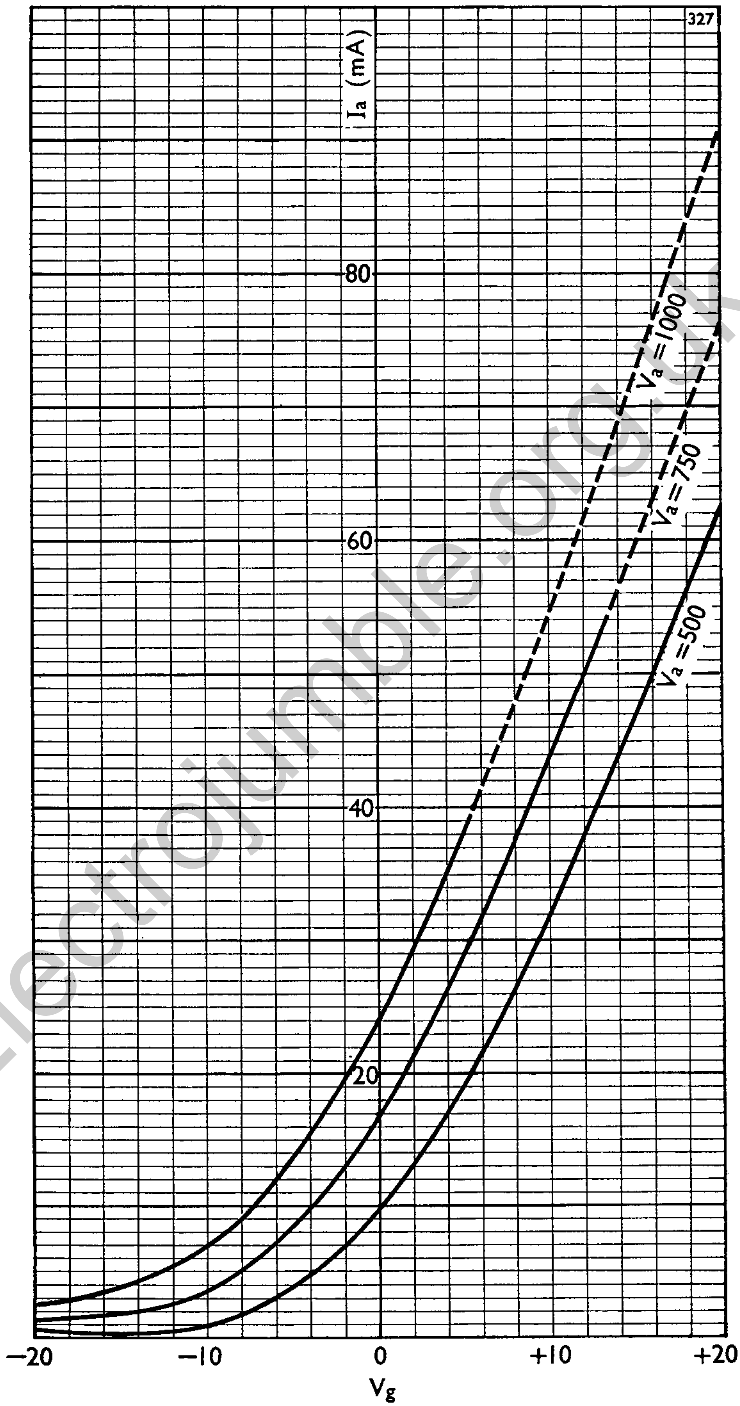
DA42



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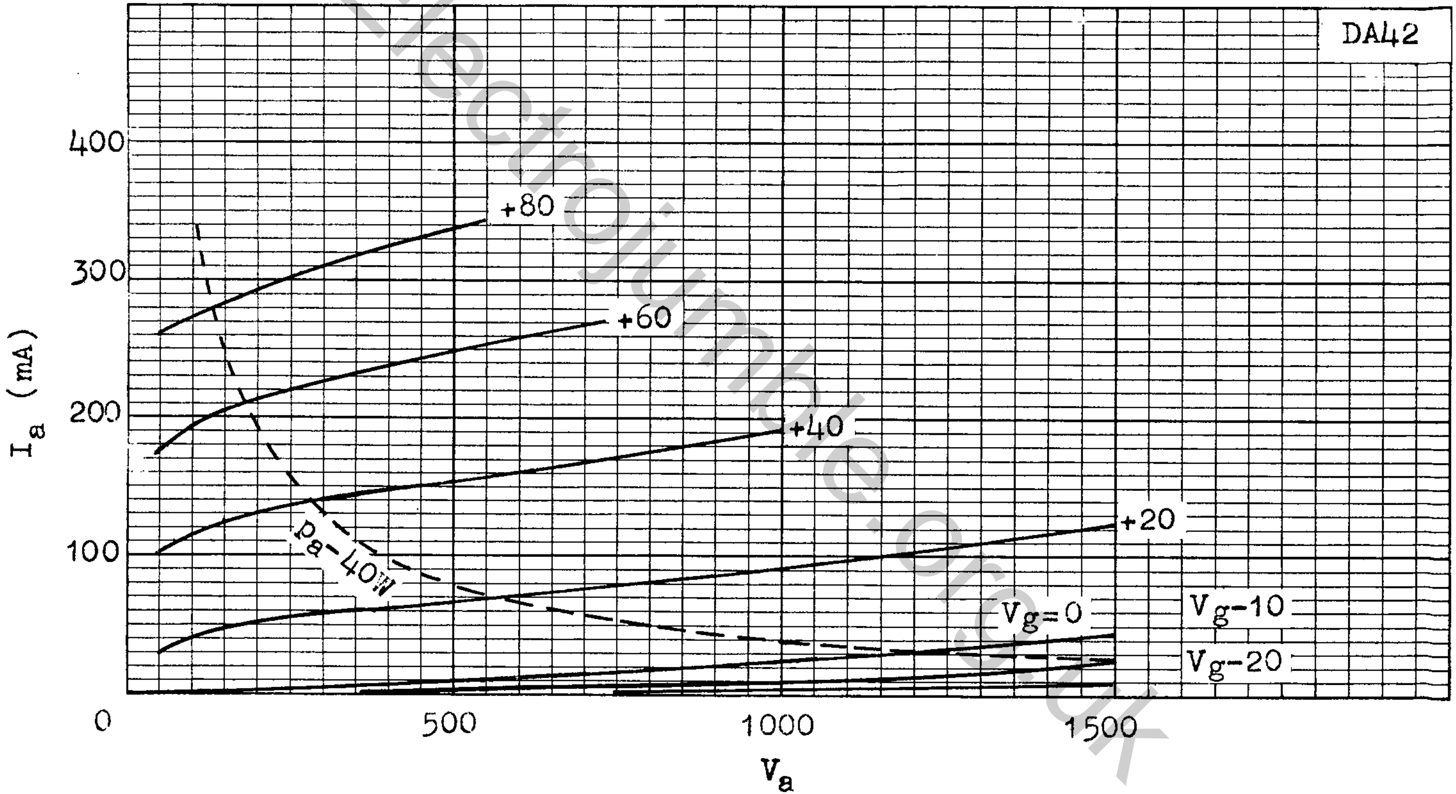
Printed in England. C.



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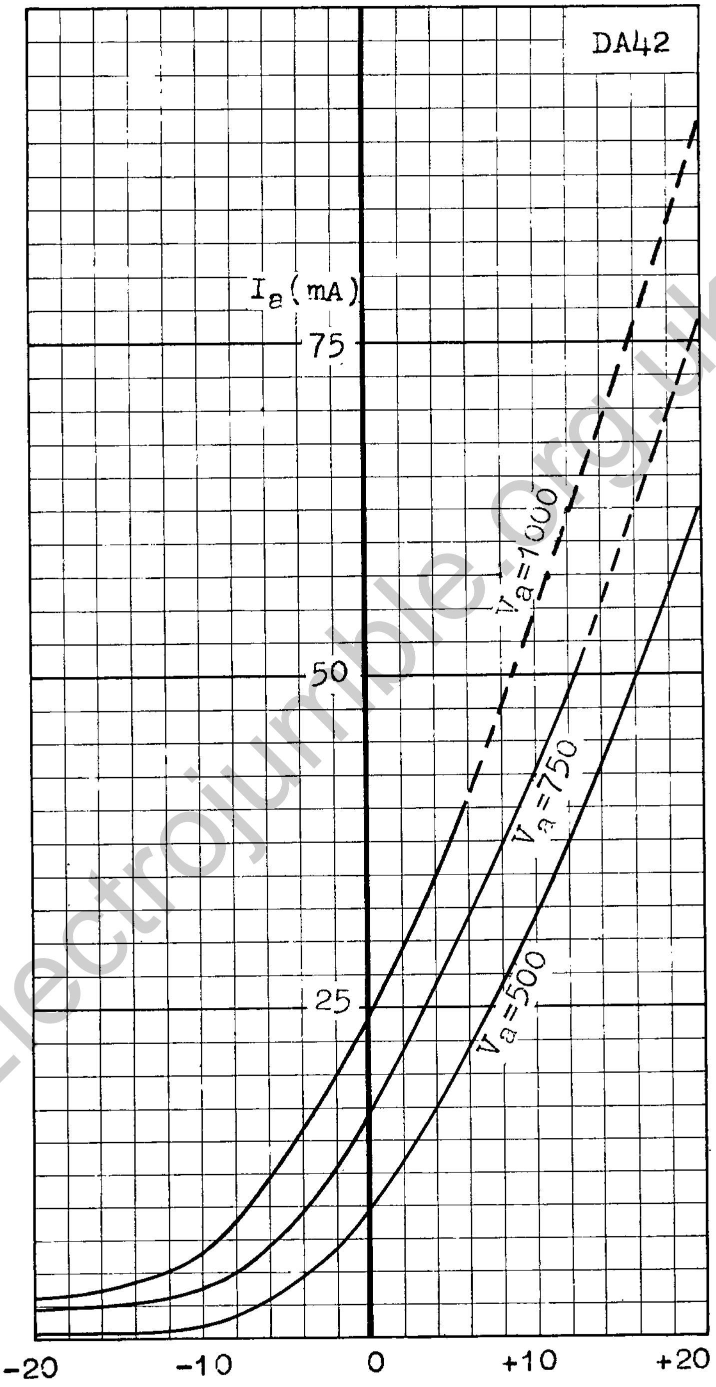

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The Ratings and Characteristics of the DA42 are given in the Technical Data Sheet.

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 also 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.

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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

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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 on effective 50-60μF with a working voltage of 1350. Resistors R30, R31 and R32 equalize 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.

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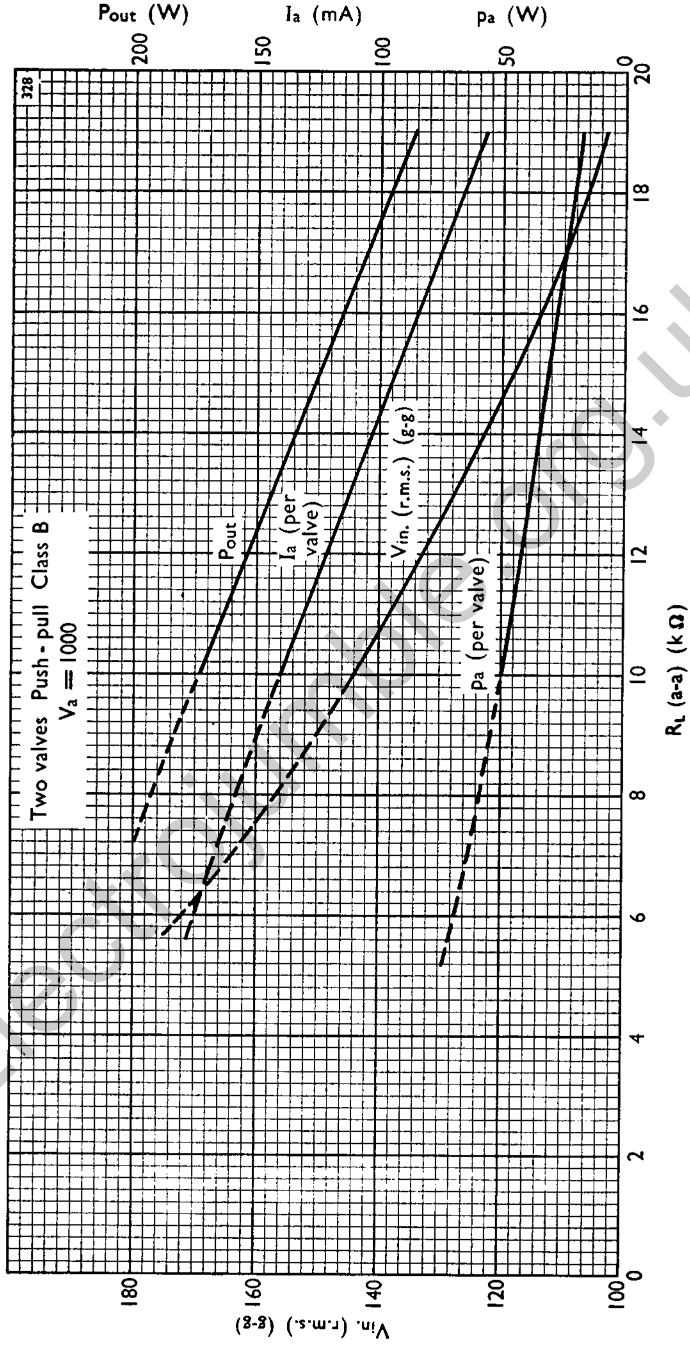

Fig. 1.

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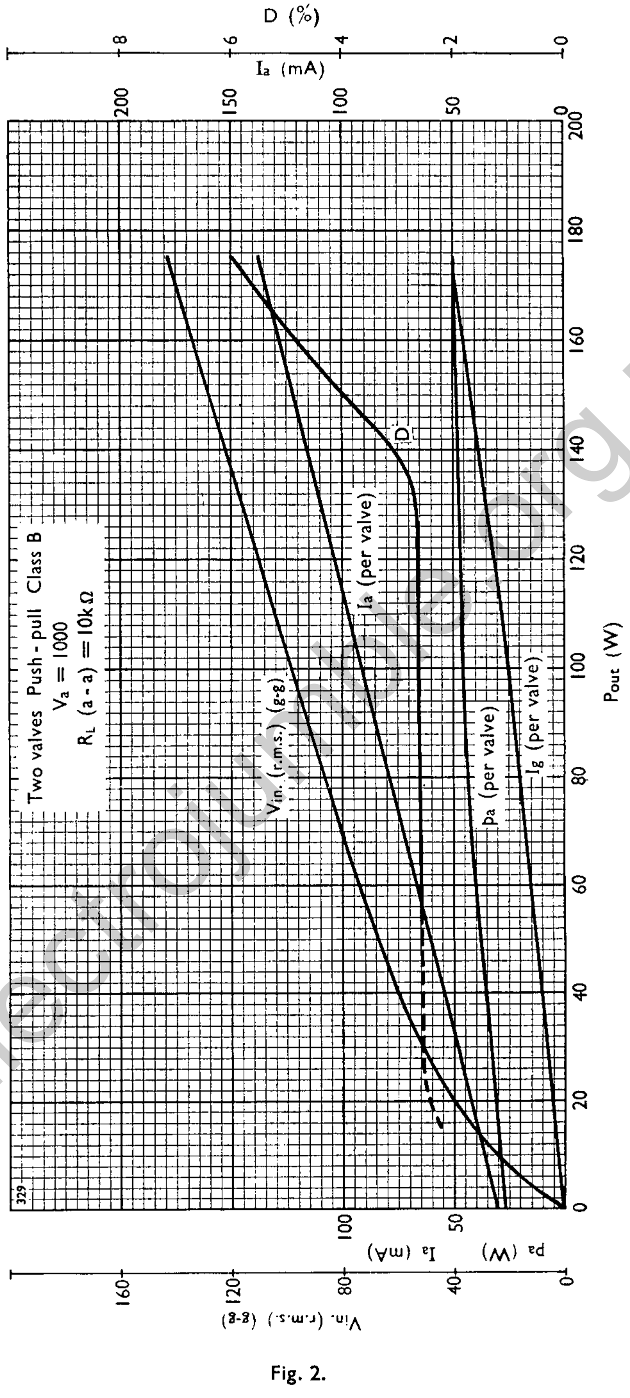

Fig. 2.

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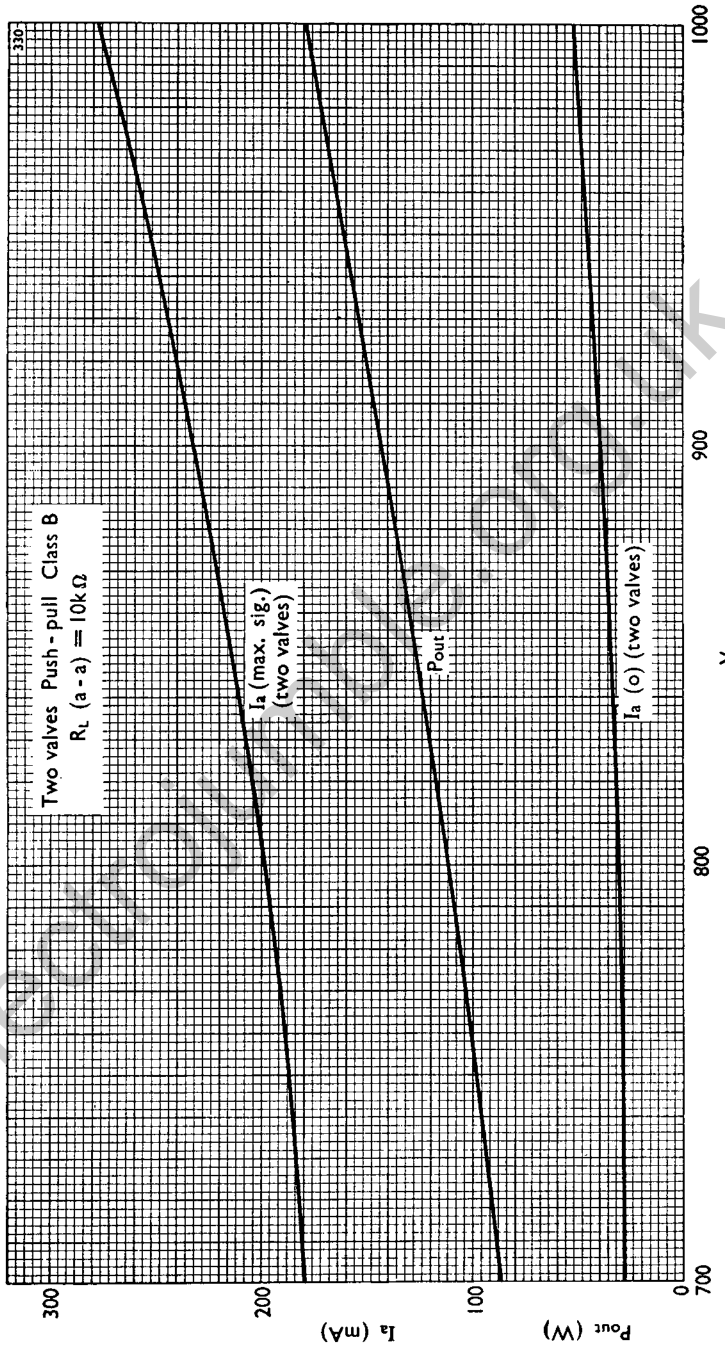
330
Two valves Push-pull Class B
RL (a-a) = 10kΩ
Ia (max. sig.) (two valves)
Pout
Ia (o) (two valves)
1000
900
800
700
Va
300
200
100
0
Ia (mA)
Pout (W)

Fig. 3.

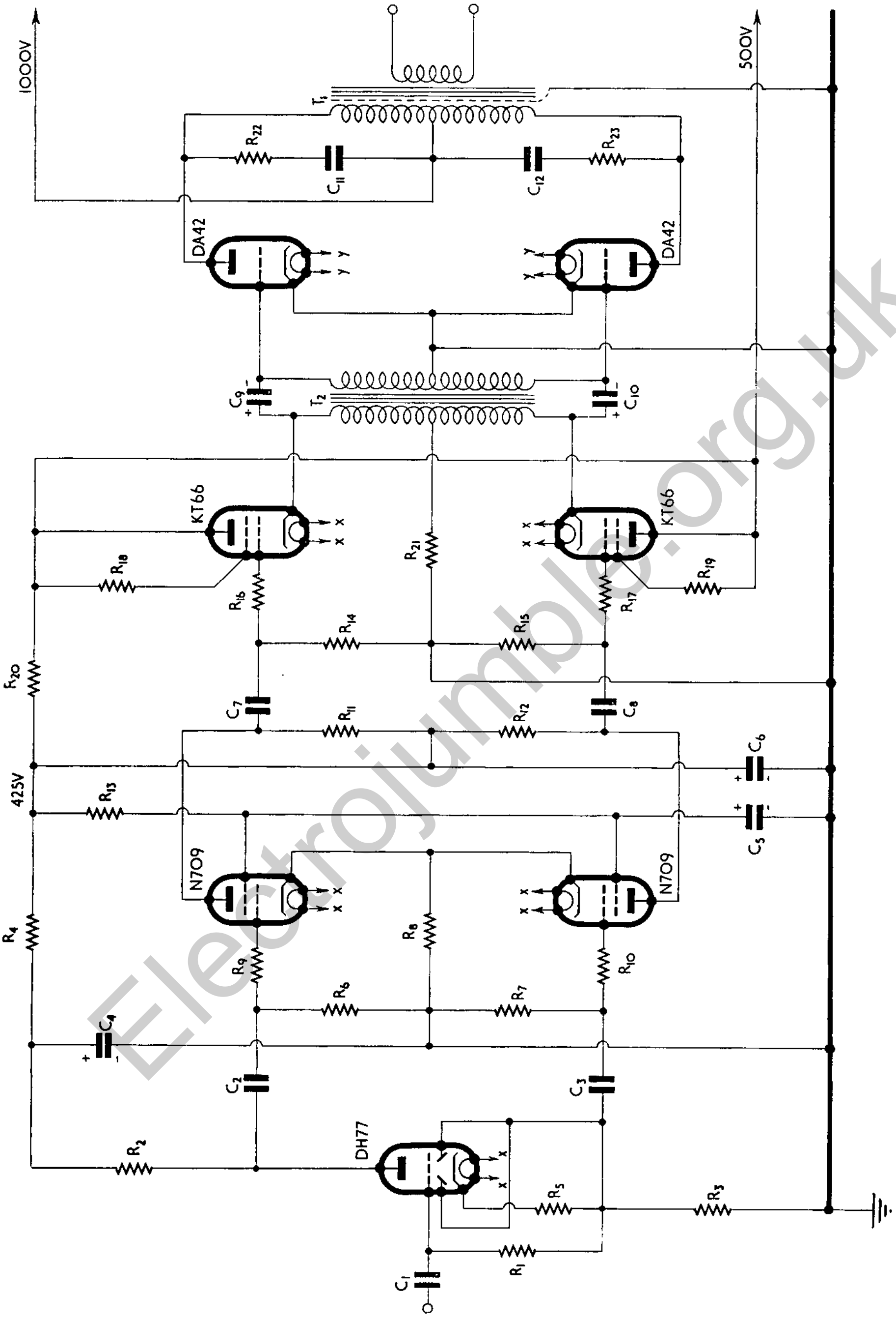

Fig. 4. 175W Class B Amplifier. Component values are given on page 10.

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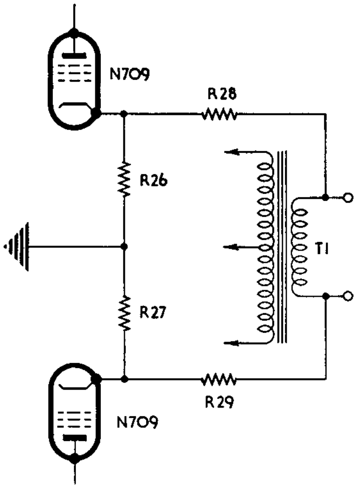

Fig. 5. The addition of degeneration to the circuit of fig. 4, as explained on page 2.

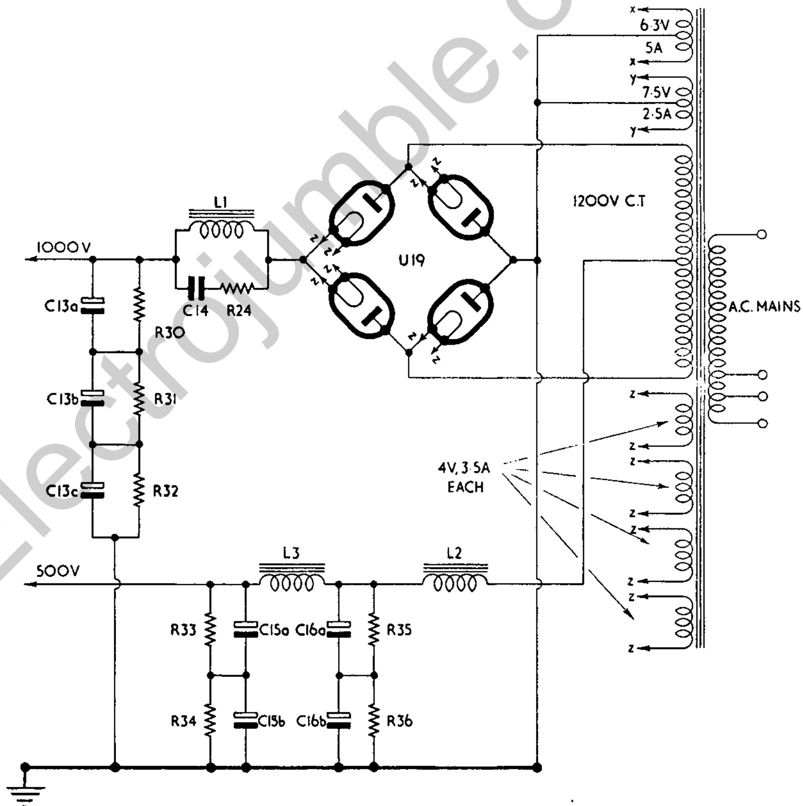

Fig. 6. Power supply unit. Component values are given on page 10.

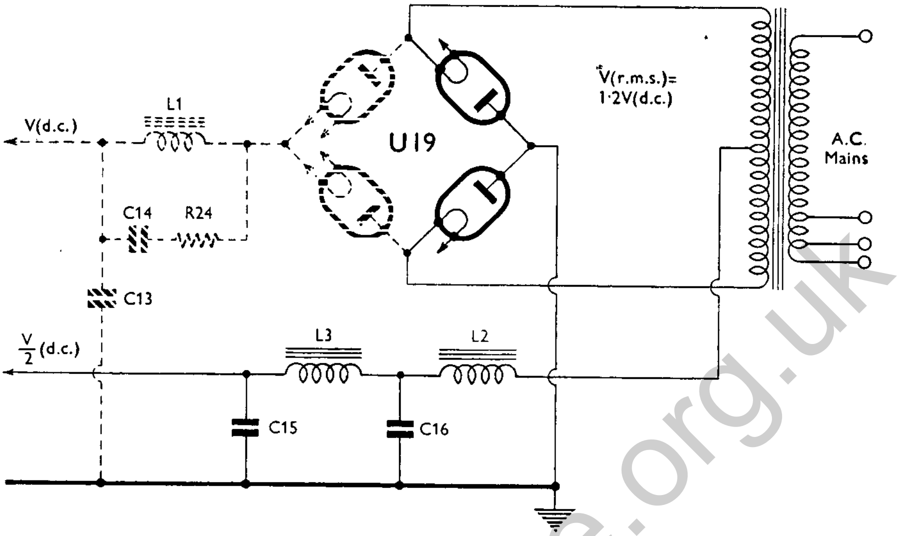

Fig. 7. Operation of the power supply of fig. 6 ; 500V section. See page 2.

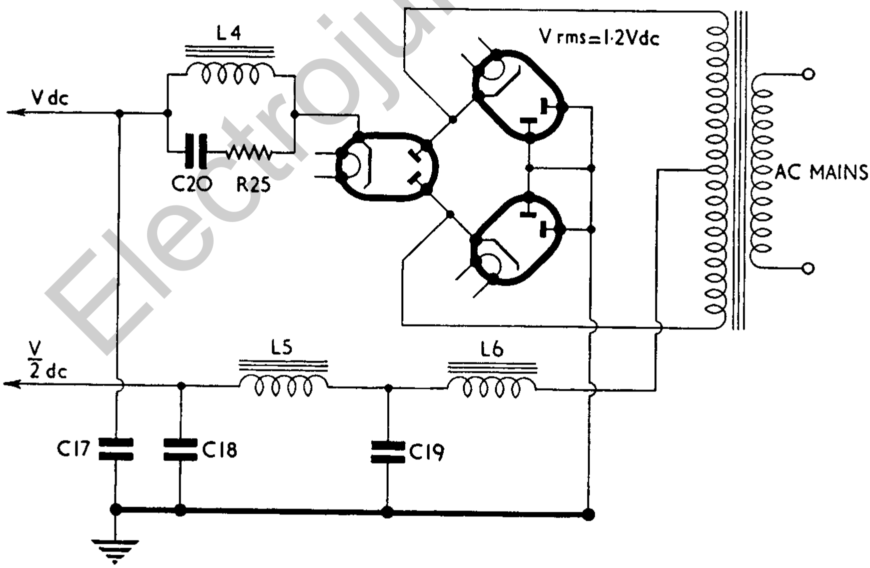

Fig. 8. Using three bi-phase rectifiers to give two output voltages.

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COMPONENT VALUES

RESISTORS (20%, 0·25W unless otherwise indicated)

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

CAPACITORS

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

INDUCTORS

See pages 11 and 12 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	

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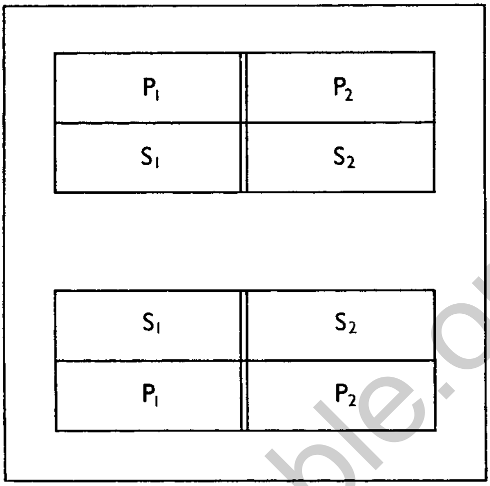

Fig. 9. Design of coupling transformer, T2.

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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.

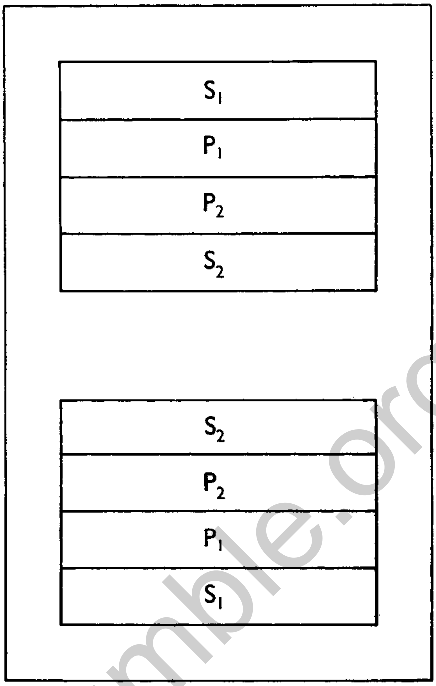

Fig. 10. Design of output transformer, T1.

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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.

A DA42 200W AMPLIFIER

Since publication of the first Circuit Supplement on the DA42, the maximum permitted anode voltage of this valve has been increased from 1000 to 1250 with a consequent raising of power output from 175 to 200 watts. The following design data should be read in conjunction with the first supplement.

The revised operating conditions are as follows (per pair unless otherwise stated) :

V_a	1250	V
$V_{g(o)}$	−4	V
$I_{a(o)}$	40	mA
$I_{a\ (max\ sig)}$	240	mA
P_{out}	200	W
$R_{L(a-a')}$	13	kΩ
$v_{in(g-g)(pk)}$	200	V
I_g	40	mA
$i_{g(pk)}$ (per valve)	85	mA
D	6	%
$p_{a(o)}$	25	W
$p_{a\ (max\ sig)}$	50	W
$z_{in(g-g)}$	4·5	kΩ
z_{out}	15	kΩ
P_{dr}	4·5	W

The above conditions apply only to normal speech and music. Continuous 100% tone modulation will result in excessive dissipation and for such applications the anode to anode load must be increased by not less than 20%.

Full data on the 1250V condition is given by the curves in fig. 12.

The circuit used is as shown in fig. 1 on page 7 of Supplement No. 1 but the centre tap of the secondary of the transformer T2 is taken to a potential of 4V negative. This is necessary in order to reduce the quiescent dissipation but no damage will result if the DA42 valves are operated for short periods without this grid bias. It is convenient to obtain the bias by the insertion of a resistor (R40) in the negative side of the driver stage anode supply, as shown in fig. 11. The value of the resistor will depend on the driver stage total anode current, but it will be about 47 Ω with the arrangement shown.

The bias of 4V negative developed across R40 is measured in the quiescent condition and at full output the voltage will increase to about 5V negative because of the grid current drawn by the DA42 valves. This has little effect on the performance and in normal operation it is partially suppressed by the capacitor C21.

The combined power supply shown in fig. 6 on page 8 of Supplement No. 1 should not be used in this application since the lower voltage supply would be excessive. Two separate supplies are required, one inductance-input supply of 1250V at 240mA for the DA42 stage and one, which may be capacitance-input, of 450-500V for the driver stage. A suggested arrangement for the latter is incorporated in fig. 11.

The circuit information given in this publication does not imply any licence under patents which may be involved.

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COMPONENT VALUES

(See also page 10, Supplement No. 1)

R37	47 kΩ	5W
R38	7·5 kΩ	10W
R39	7·5 kΩ	10W
R40	47 Ω	1W
C21	100 μF	12V
C22	8 μF	Paper
C23	8 μF	Paper
L7	10 H	120mA
T3	30 : 1 for 100V output	

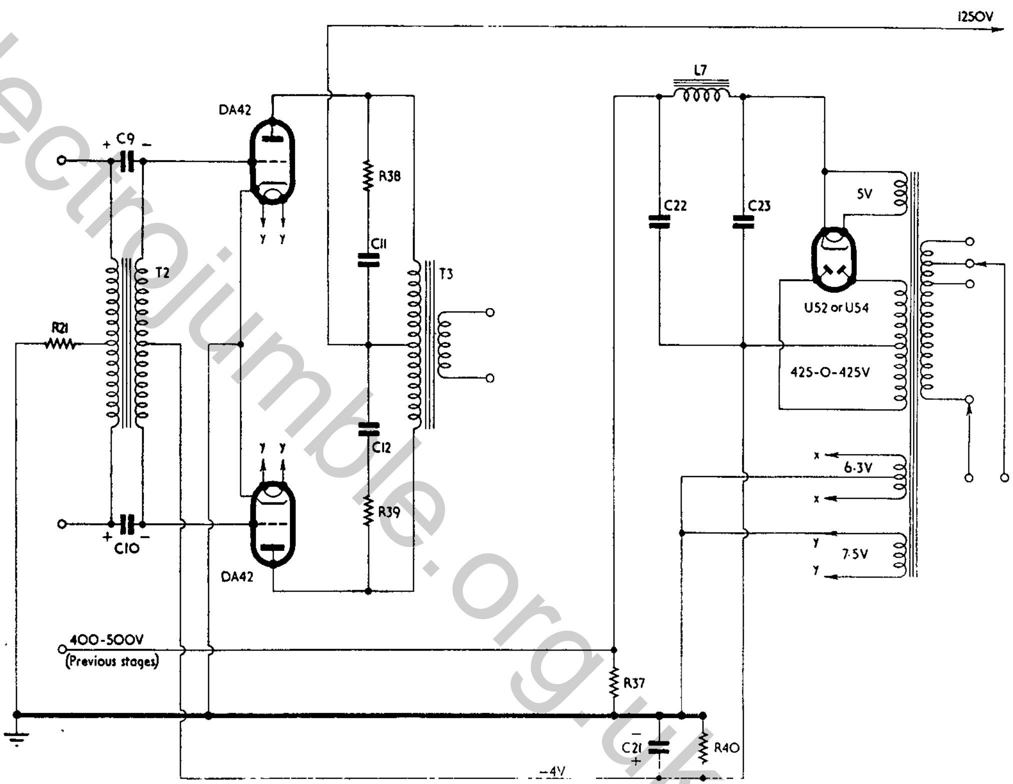

Fig. 11. Circuit of 200W output stage.

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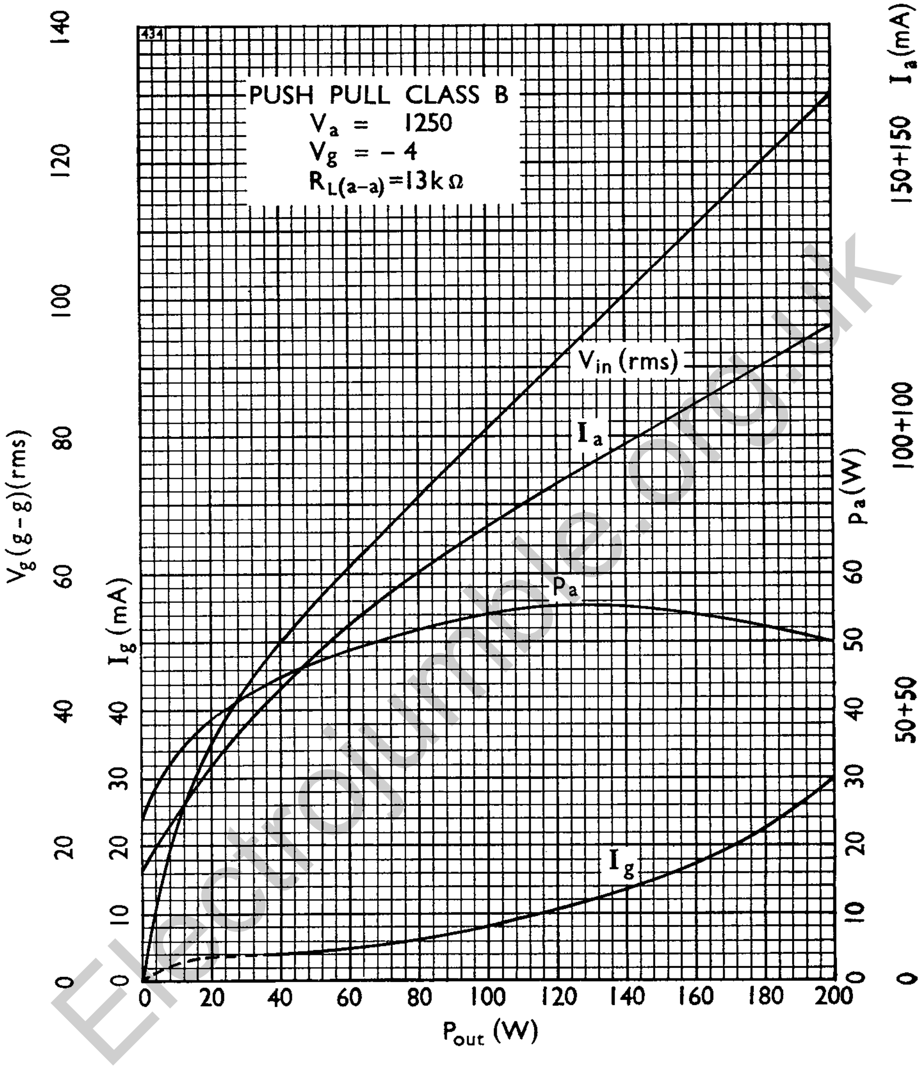

Fig. 12.

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DA42 CIRCUIT SUPPLEMENT No. 2

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