KT88 CIRCUIT SUPPLEMENT

A 30W ULTRA-LINEAR AMPLIFIER

With negative feedback, this amplifier (fig. 4) will give 32W output with about 0·25% distortion at an anode potential of 335V. The input signal to the first stage of the amplifier for full output is 500mV. Even when negative feedback is omitted the amplifier has only 1% distortion at 32W output and requires an input of 100mV. As the KT88 valves are conservatively run in this circuit they will have a long life.

Circuit Description

The output stage is preceded by a conventional double triode voltage amplifier V2 which is fed by a triode phase-splitter comprising one half of a further double triode V1. The first half of this valve is the input stage voltage amplifier, which is directly coupled to the phase-splitter. R8, in the cathode circuit of V2, reduces any signal unbalance in the phase-splitter and lowers intermodulation distortion.

Depending upon the particular characteristics of the output transformer, it may be necessary to prevent instability by connecting capacitors and resistors across part of each output transformer half-primary and " stopper " resistors in series with the grids and screens of the output stage. The curves of fig. 5 illustrate the performance of the output stage of this amplifier without feedback.

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COMPONENT VALUES FOR FIG. 4

30W ULTRA-LINEAR AMPLIFIER

G.E.C. VALVES

V1	B65/6SN7
V2	B65/6SN7
V3	KT88
V4	KT88
V5	U54

RESISTORS

(20%, 0·25W unless otherwise shown)

R1	1MΩ Log.
R2*	$225\sqrt{\text{speech coil impedance}}$
R3	1kΩ
R4	22Ω
R5	100kΩ
R6	15kΩ 0·5W } Matched to 5%
R7	15kΩ 0·5W } Matched to 5%
R8	4·7kΩ
R9	470kΩ 10%
R10	470kΩ 10%
R11	1kΩ
R12	1kΩ
R13	33kΩ 10% 1W
R14	33kΩ 10% 1W
R15	220kΩ
R16	220kΩ
R17	10kΩ
R18	10kΩ
R19	4·7kΩ 1W
R20	400Ω 5% 5W
R21	400Ω 5% 5W
R22	270Ω 0·5W
R23	270Ω 0·5W
R24	470-1500Ω 0·5W
R25	470-1500Ω 0·5W

***For 14db feedback.*

CAPACITORS

C1	50μF 12V
C2	0·05μF
C3	0·05μF
C4	8μF 350V
C5	8μF 450V
C6	0·05μF
C7	0·05μF
C8	50μF 50V
C9	50μF 50V
C10	8μF 500V
C11	1000pF
C12	1000pF
C13	8μF 500V

MISCELLANEOUS

L1 10H 200mA

T1 35W Ultra-linear transformer
- 6kΩ anode-anode
- †Primary Inductance : ≮50H
- *Leakage inductances :*
  - †Prim.—sec. : ≯10mH
  - †½ prim.—UL tap : ≯10mH

T2 Mains transformer
- Secondaries :
  - 375—0—375V 200mA
  - 6·3V 5A CT
  - 5V 3A

†With these values, R24, R25 and C11, C12 may be omitted.

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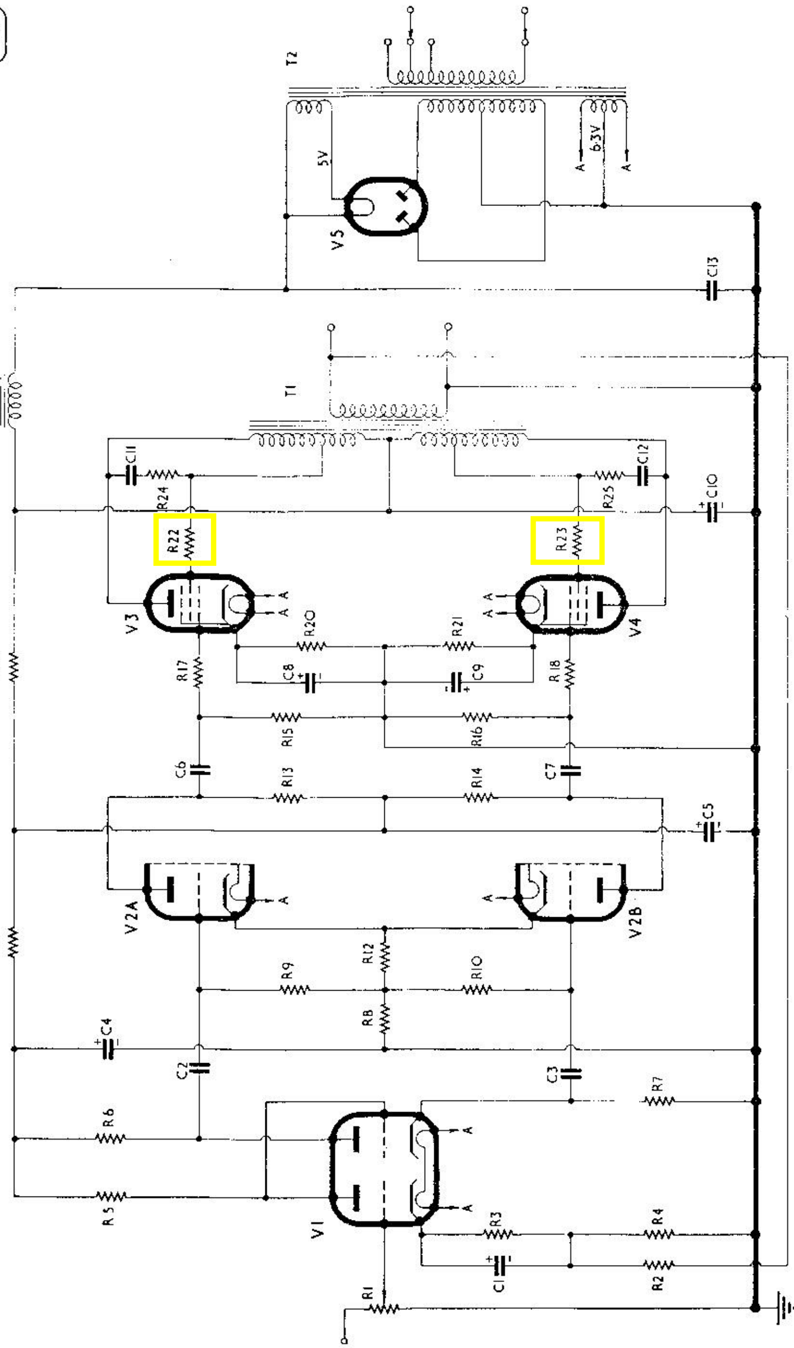

Fig. 4. Circuit diagram of the KT88 30W ultra-linear amplifier. The components list is given opposite.

The negative feedback network shown in fig. 4 provides 14db of feedback and this is adequate for all normal purposes. This value reduces the output impedance, distortion and sensitivity of the basic amplifier by a factor of 5.

Feedback from the output transformer secondary is introduced into the cathode circuit of the first stage via R2. Since the sensitivity of the amplifier without feedback is approximately 100mV, a feedback voltage of about 500mV is required for 14db feedback. As the voltage across the output transformer secondary for 32W is about 21·5 for a 15Ω load and about 11 for a load of 4Ω, the resistors R2 and R4 are chosen so that 500 mV will exist at their junction at full output. Assuming R4 to be 22Ω, R2 is given by $225\sqrt{Z_o}$ (where Z_o = the loudspeaker impedance) and the nearest standard value may be used. If $Z_o = 15\Omega$, R2 should be 1kΩ and if $Z_o = 4\Omega$, R2 should be 470Ω.

The operating conditions for the output stage of the amplifier of fig. 4 are given in Table I.

TABLE I

30W ULTRA-LINEAR AMPLIFIER

Operating Conditions

(Fig. 4)

$V_{a(b)}$	375	V
$V_{a,g2}$	335	V
$I_{a+g2(o)}$	2×80	mA
$I_{a+g2(max\ sig)}$	2×85	mA
$p_{a+g2(o)}$	2×27	W
$p_{a+g2(max\ sig)}$	2×12	W
R_k	2×400	Ω
V_g (approx)	−32	V
P_{out}	30	W
$R_{L(a-a)}$	5	kΩ
z_{out}	1	kΩ
D	0·25	%
$V_{in(rms)\ (approx)}$ (to first stage)	500	mV

If negative feedback is omitted, the last three values are as follows :

z_{out}	4·5	kΩ
D	1	%
$V_{in(rms)\ (approx)}$ (to first stage)	100	mV

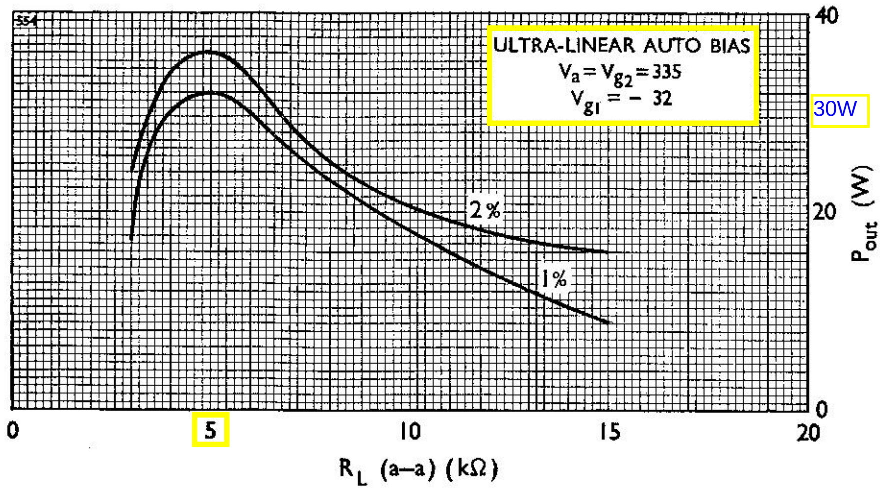

Fig. 5. Performance of the KT88 30W ultra-linear amplifier of fig. 4.

A 50W ULTRA-LINEAR AMPLIFIER

This section describes the use of the KT88 in a design for an ultra-linear amplifier with cathode bias giving 50W output at 0·2% distortion.

Circuit Description

The circuit of the complete amplifier is given in fig. 6. The design is similar to that of the 30W amplifier except for the type of input stage and the inclusion of the networks consisting of C6, R10 and C7, R11 between the first two stages. These networks reduce the amount of overshoot and consequent " ringing " in the output transformer.

The first double triode, V1, is arranged as a self-balancing floating paraphase phase nverter which feeds V2, the following push-pull voltage amplifier. Potentiometer R22 allows the signal input to the output stage to be adjusted for output stage dynamic balance.

The power supply incorporates a thermistor in the h.t. output line in order to reduce the surge from the directly heated rectifier while the remaining valves are warming up. The performance of this amplifier is illustrated in fig. 7 and the output stage operating data are given in Table II.