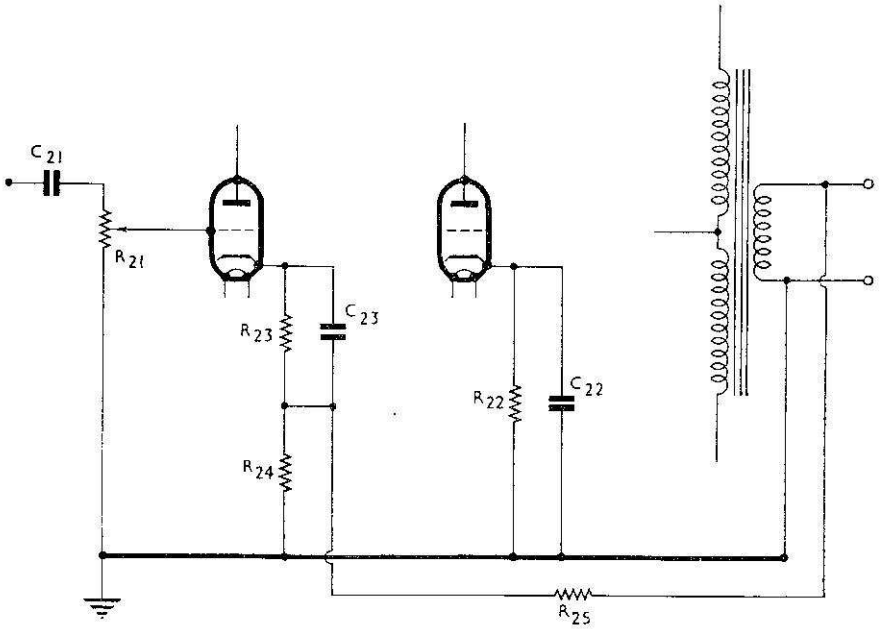

Fig. 4. The addition of negative feedback to the amplifier of fig. 1. See pages 8 and 9 for component values.

A 50W ULTRA LINEAR AMPLIFIER

When the maximum output is required from a pair of KT66 valves they may be used with fixed bias in the ultra-linear circuit. The operating conditions are given below and the recommended circuit is shown in fig. 5.

Per Pair of Valves	*Quiescent*	*Max. Signal*	
$V_{a,g2}$	525	500	V
I_{a+g2}	70	160	mA
V_{g1}	−50/−65	−50/−65	V
†$R_{L(a-a)}$	—	8	kΩ
P_{out}	—	50	W
*D	—	2	%
P_{a+g2} (per valve)	18	15	W
z_{out}	—	6	kΩ
$V_{in(g1-g1)}$ (rms)	—	90	V
V_{in} (to amplifier in fig. 5)	—	2·5	V

†An output transformer having a ratio of 6 : 1 would be suitable for 105V output, 225 Ω.

*The distortion will vary from 1% to 3% with different valves. The performance is displayed graphically in figs. 7 and 8.

Circuit Notes.

The two KT66 valves are set to a similar quiescent current, which may be between 30 and 40mA, using the meter M and the meter shunts R46, R47. A negative bias voltage range of 50 to 65 is provided by the controls R53, R54. A quiescent current below 30mA will increase the distortion.

The bias voltage is derived from a U50 connected to the 600-0-600V transformer via the capacitors C42, C43. The resistors R55, R56, R57, R58, not only smooth the supply in conjunction with C44 but also reduce the voltage to the appropriate value. The resistors R52 to R58, associated with the bias supply, are generously rated to maintain a stable voltage.

R64 is adjusted, at about 90% of full output, to give equal cathode currents in the two output valves. It is capable of compensating for inequality of output from the driver stage and also for variations between the two output valves. When the two cathode currents are equal the distortion is at a minimum.

The anode supply is provided with an inductance filter L1, C31, C32. Due to the large variation in current with input signal the effective capacitance of C31, C32 has been made 80μF. The working voltage is excessive for a single electrolytic and C31, C32 are, therefore, connected in series to give a rated voltage of 900. This single section filter provides a ripple-free anode current. If a lower capacitance were used in place of C31, C32, an additional filter section would be required to reduce the ripple to a reasonable value, and the lower capacitance would be incapable of supplying the peak current required by a transient input signal.

At lower anode voltages the following results are obtainable. No circuit modifications are needed, the bias supply being a function of the anode voltage.

DC voltage	350	425	V
Quiescent current	25+25	30+30	mA
Max. signal current	55+55	65+65	mA
Power output	20	30	W
Anode to anode load	8	8	kΩ

The value of the components C40, C41, C45 and R59 will depend to some extent on the output transformer. R59 and C45 are optional and are used to suppress ringing. The most satisfactory method of selecting the value of these four components is by the use of a square wave generator, but an audio oscillator extending to, say, 50kc/s may be used to detect a peak in the supersonic region. C40 and C41 may be unnecessary with some types of transformer.

With the transformer used, the values shown gave a fall in output of 3db at 18-20kc/s with a load resistance of 15Ω.

Protection Against Bias Failure.

In common with other amplifiers which derive the bias potential from a separate supply instead of a cathode resistor, the 50W amplifier is rendered inoperative should the bias supply fail. Furthermore, the KT66 anode current would rise to an excessive value. The U50 is run at a very low anode current, a few milliamperes, and will, of course, have a long life.

A simple device which permits the amplifier to function with cathode bias in case of failure of the bias supply is shown in fig. 6. A triode, which could be one half of a B65 substituted for the L63 in the first stage, is connected in series with a relay across the 500V supply. The grid is taken to the bias supply. Normally the anode current is cut off and the relay short-circuits the resistor R60 connected in the cathode circuit of the KT66 valves. Should the bias fail, the relay will be energised, the relay contacts will open and the bias resistor R60 will allow the amplifier to function at about half maximum output.

COMPONENT VALUES

RESISTORS

(0·25W, 20% unless otherwise shown)

R1	500kΩ		
R2	750Ω		
R3	33kΩ	1W	10%
R4	33kΩ	1W	10%
R5	270kΩ } matched to		
R6	270kΩ } 5%		
R7	270kΩ		10%
R8	750Ω		10%
R9	33kΩ	1W	10%
R10	33kΩ	1W	10%
R11	560Ω	5W w.w.	5%
R12	560Ω	5W w.w.	5%
R13	270kΩ		10%
R14	270kΩ		10%
R15	10kΩ		
R16	10kΩ		
R17	220Ω		
R18	220Ω		
R19	10kΩ	0·5W	
R20	5·6kΩ	1W	
R21	500kΩ		
R22	750Ω		
R23	750Ω		

R24, R25		sec p. 3		
R31		1MΩ		
R32		33kΩ	0·5W matched to	5%
R33		33kΩ	0·5W matched to	5%
R34		1·5kΩ		
R35		1kΩ		
R36		22kΩ	0·5W	
R37		1MΩ		
R38		1MΩ		
R39		47kΩ	1W	10%
R40		47kΩ	1W	10%
R41		150kΩ		10%
R42		150kΩ		10%
R43		10kΩ	1W	10%
R44		10kΩ		
R45		10kΩ		
R46, R47	Meter shunts	10Ω		
R48		100Ω		
R49		100Ω		
R50		100kΩ	1W	10%
R51		100kΩ	1W	10%
R52	(see fig. 6)	22kΩ	1W	10%
R53		20kΩ	w.w.	
R54		20kΩ	w.w.	
R55		220kΩ	1W	10%
R56		220kΩ	1W	10%
R57		220kΩ	1W	10%
R58		220kΩ	1W	10%
R59		220kΩ	1W	10%
R60	(see fig. 6)	330Ω	5W w.w.	10%
R61	(see fig. 6)	6·6 kΩ	0·5W	10%
R62		15kΩ	0·5W	10%
R63		0·65Ω	5W	
R64		20kΩ		

CAPACITORS

C1	0·01μF	350V	
C2	50μF	12V	Electrolytic
C3	0·1μF	500V	
C4	0·1μF	500V	
C5	100pF	250V	
C6	100pF	250V	
C7	8μF	450V	Electrolytic
C8	8μF	450V	Electrolytic
C9	0·02μF	500V	
C10	0·02μF	500V	
C11	50μF	50V	Electrolytic
C12	50μF	50V	Electrolytic
C13	2000pF	500V	
C14	2000pF	500V	
C15	8μF	450V	Electrolytic
C16	8μF	450V	Electrolytic
C21	0·01μF	350V	
C22	50μF	12V	Electrolytic
C23	50μF	12V	Electrolytic
C31	160μF	450V	Electrolytic
C32	160μF	450V	
C33	8μF	450V	
C34	8μF	450V	
C35	0·01μF	350V	
C36	0·01μF	500V	
C37	0·01μF	500V	
C38	0·05μF	750V	
C39	0·05μF	750V	
C40	0·001μF	300V AC	
C41	0·001μF	300V AC	
C42	0·025μF	600V AC	
C43	0·025μF	600V AC	
C44	4μF	200V	
C45	0·001μF	440V AC	

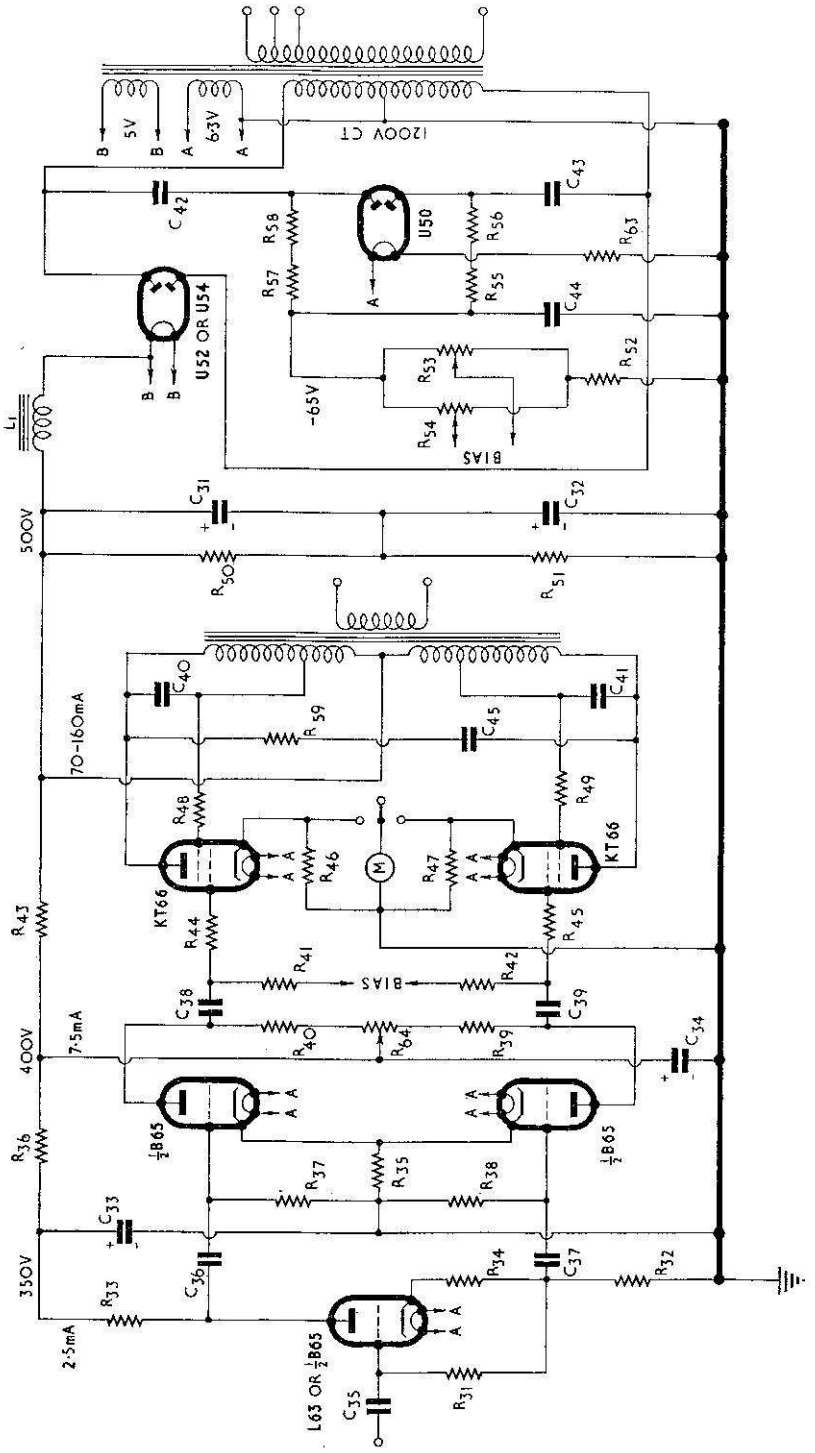

Fig. 5. A 50W ultra linear amplifier. See pages 8 and 9 for component values.

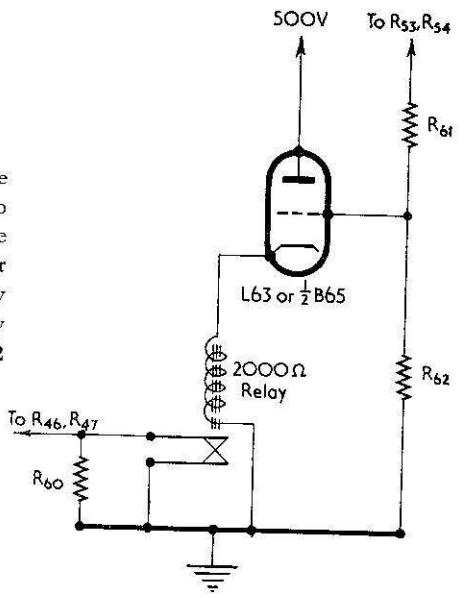

Fig. 6. This circuit may be added to the 50W amplifier to protect the KT66 valves in the event of bias failure. The resistor R60, normally short-circuited by the relay, provides an emergency cathode bias. R61 and R62 replace R52.

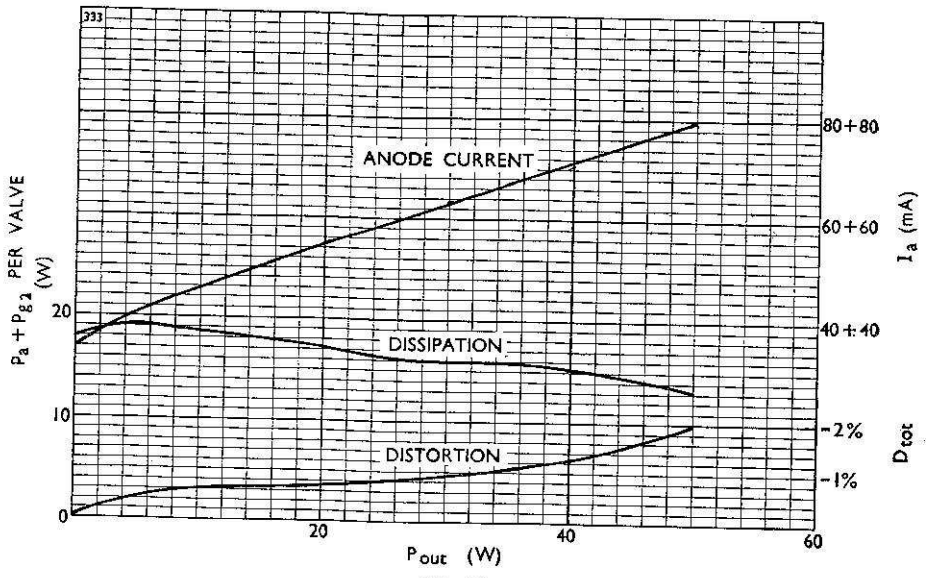

Fig. 7.

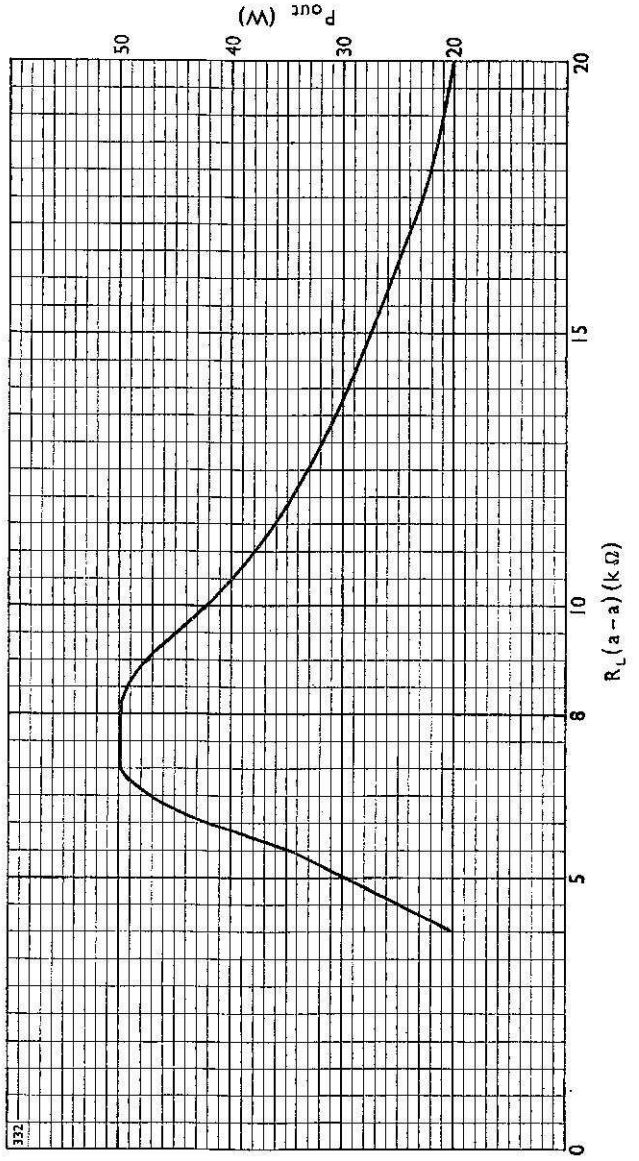

Fig. 8.

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