

# edwin amplifier

This is a design for a high-quality 40 W audio amplifier based on an earlier 20 W design which has proved very popular on the continent. The amplifier embodies some unusual design features and the construction is problem-free due to the small amount of negative feedback employed and to the absence of quiescent current in the output stage.

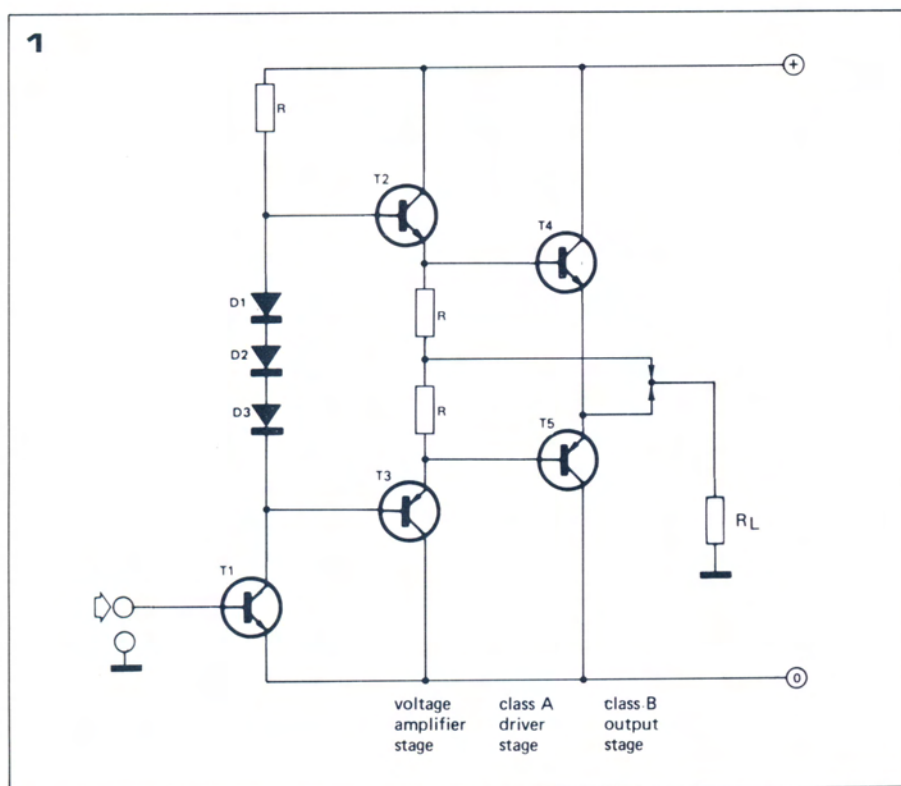
The Edwin amplifier is unusual in that it embodies two types of output stage in one amplifier. A class A output stage handles the low level signals and also serves as a driver for a class B stage which handles the larger outputs.

The principle of operation is shown in figure 1. T2 and T3 are biased on by the voltage drop across the diodes D1-D3. T2 and T3 function as a class A stage at low signal levels supplying current to the load via resistors R. As the signal is increased the voltage drop across these resistors becomes sufficient to cause T4 and T5 to conduct and the class B part of the output stage begins to operate. Crossover distortion is quite low with this type of design.

## The complete circuit

As figure 2 shows, the complete amplifier

circuit consists of a voltage amplifier, a class A driver stage and a class B output stage. The input stage consists of T1 and T2 in a Darlington configuration, resulting in a high input impedance. The signal passes to the base of T3 via the limiting resistor R4. T3 operates as a voltage amplifier and in its collector circuit has T4, which is connected as a simulated zener diode to provide a constant d.c. bias voltage of about 2 V across the bases of the driver transistors T7 and T8. Feedback is applied between the output and the junction of R11 and R12 to provide a high collector impedance so that true current drive is achieved. This helps to reduce crossover distortion still further so that despite the small amount of overall negative feedback and the absence of quiescent current in the output stage the distortion figures are very good.



## features

- output power from 10-40 W depending on power supply.
- high efficiency.
- low crossover distortion.
- short circuit proof.
- no quiescent current in the output transistors.
- output transistors and drivers need not be matched.
- unconditionally stable.

## figures

- Sensitivity:  $\approx 1$  V (RMS).
- Input impedance:  $\approx 45$  k $\Omega$ .
- Distortion: 1 kHz, 30 W: 0.1%, 10 kHz, 30 W: 0.3%.
- Power bandwidth: 20 Hz — 100 kHz.
- S/N ratio:  $> 90$  dB.

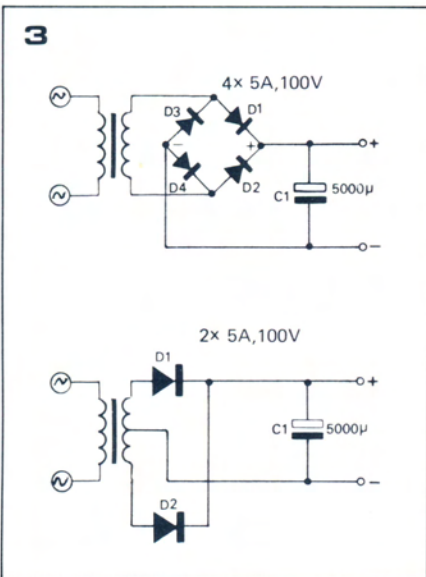
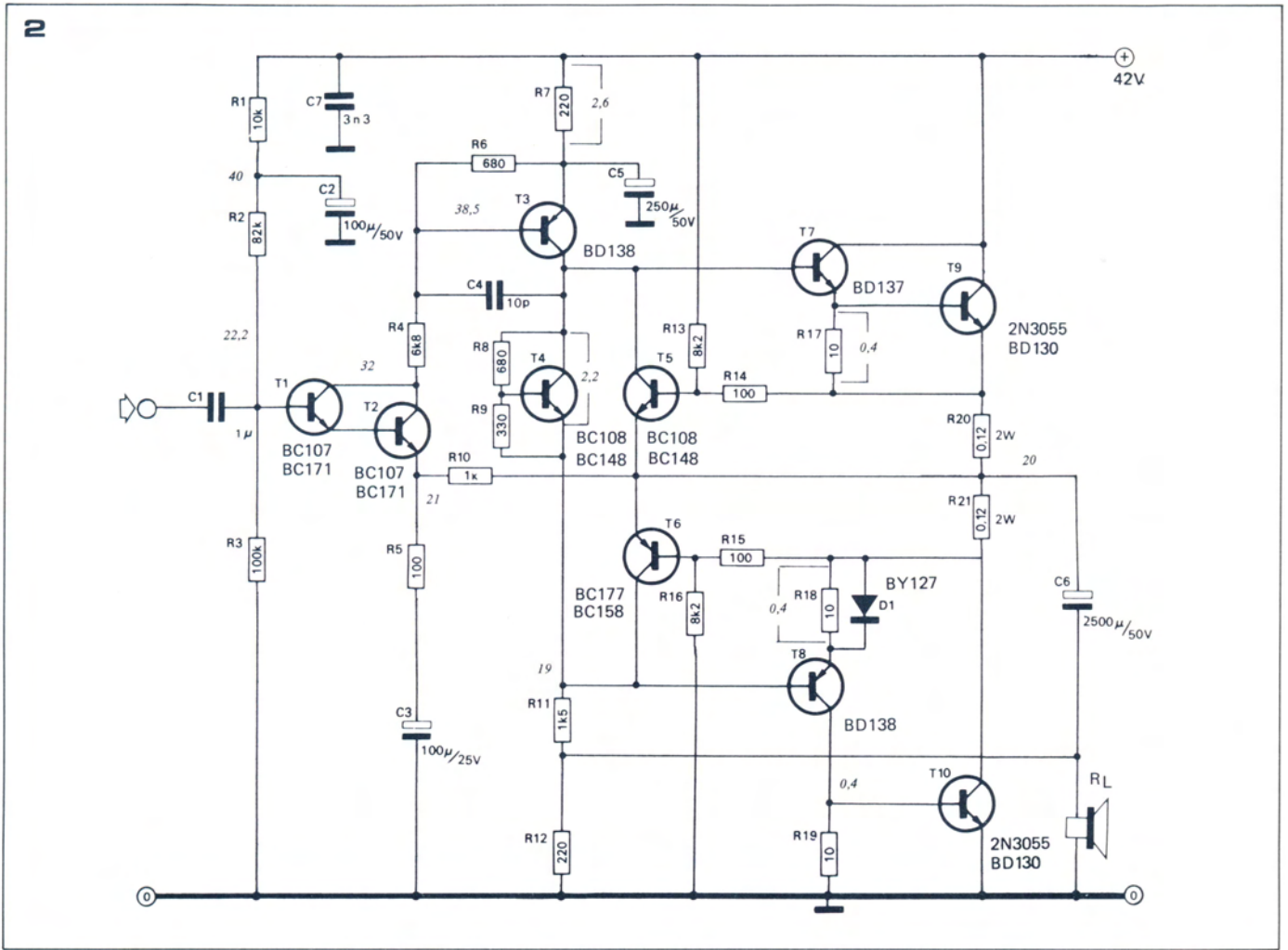
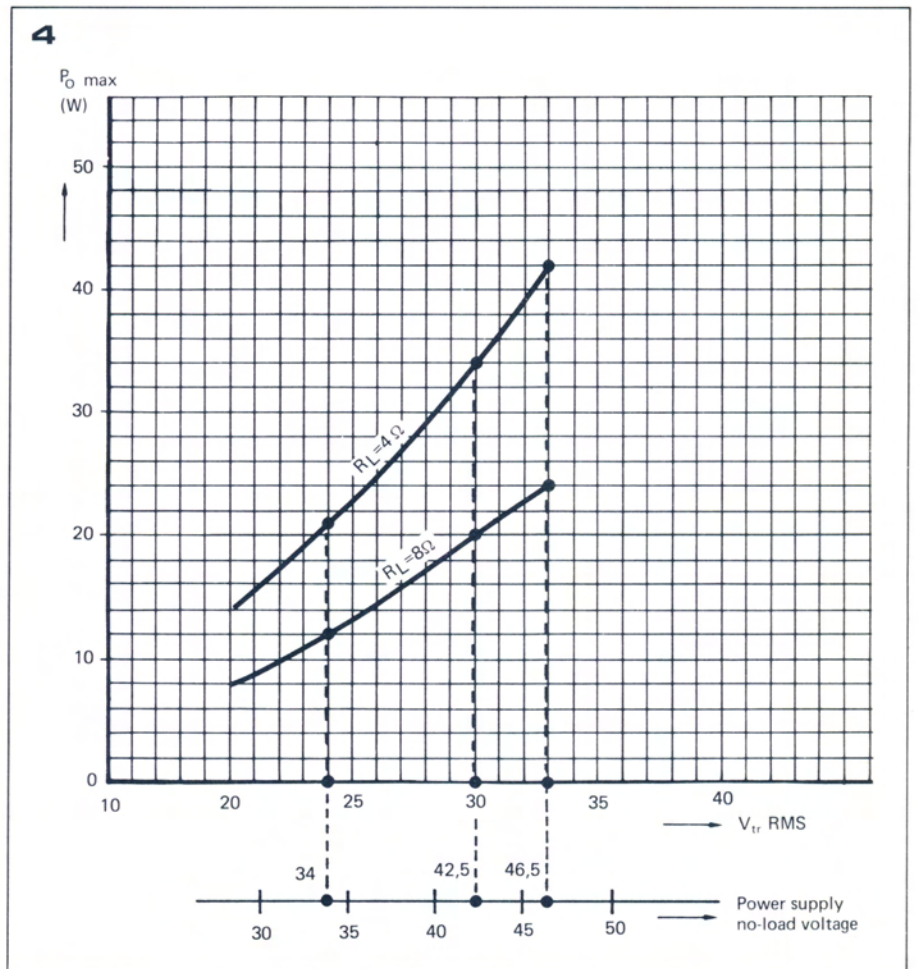


Figure 1. Basic circuit of an Edwin-type output stage.

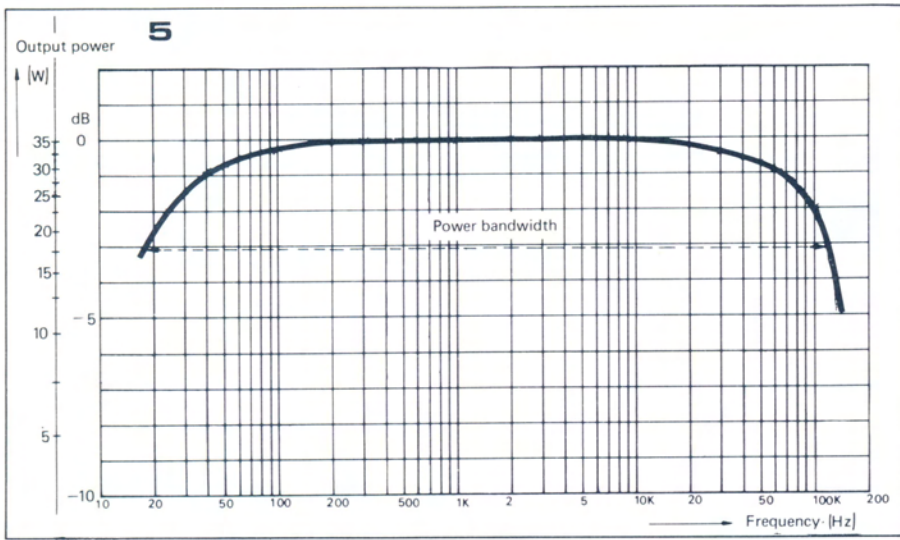
Figure 2. Final circuit of the Edwin amplifier for output powers up to 40 W.

Figure 3. The power supply.

Figure 4. Graph of available output power versus transformer secondary voltage for 4 Ω and 8 Ω loads.







The output stage differs from the configuration shown in figure 1 because it comprises two NPN transistors of the same type and not a complementary pair. To maintain symmetrical operation of the output stage D1 is included across R18. This simulates the base-emitter junction which would be present across R18 if the configuration of figure 1 has been used. The values of R17, R18 and R19 are low (10 Ω) to reduce cross-over distortion.

Overall negative feedback is applied from the output to the emitter of T2. The inclusion of C3 means, that 100% d.c. feedback is applied, which stabilises the d.c. operating point of the output at around half supply voltage over a wide range of supply voltages without the need for adjustment potentiometers.

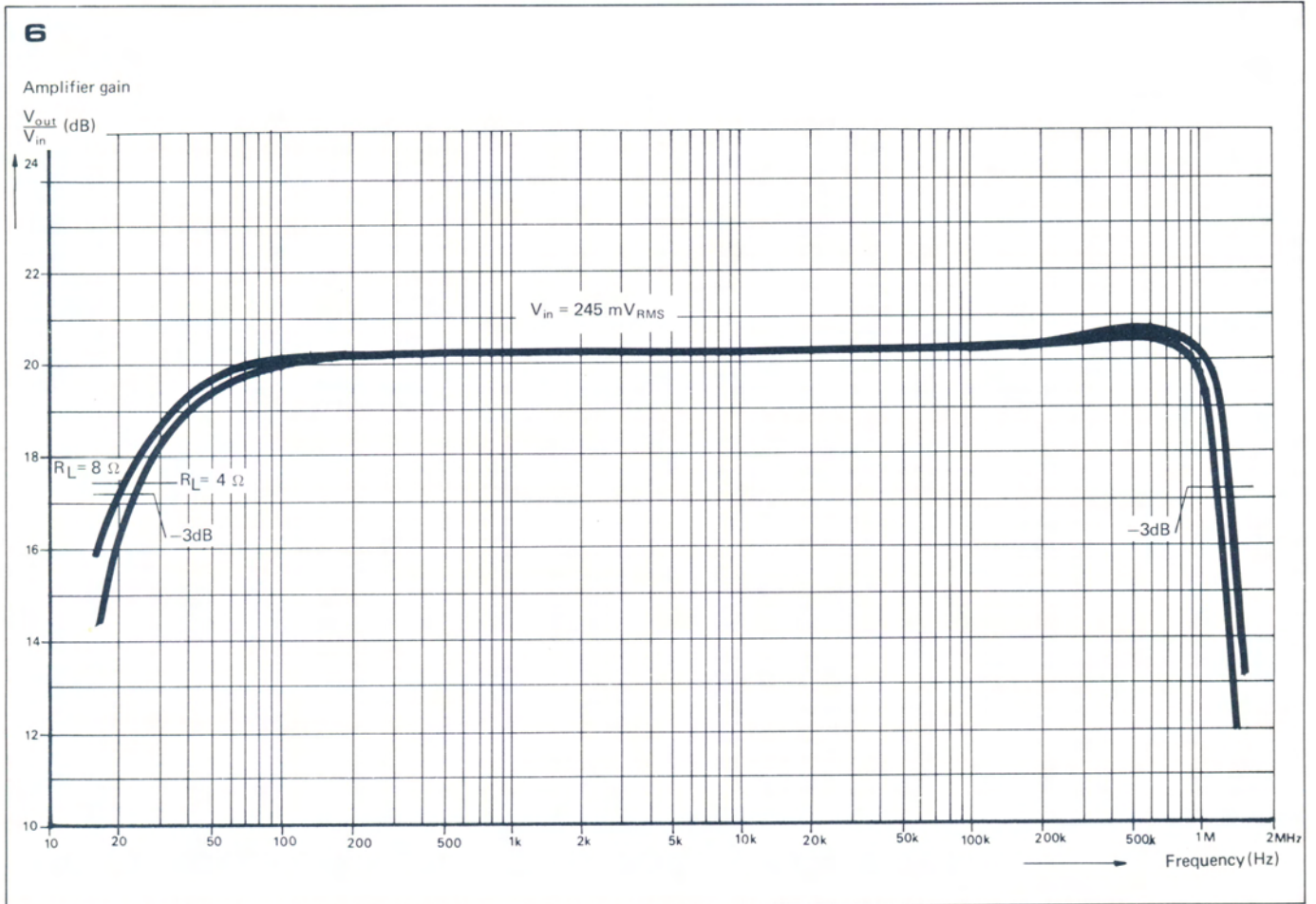
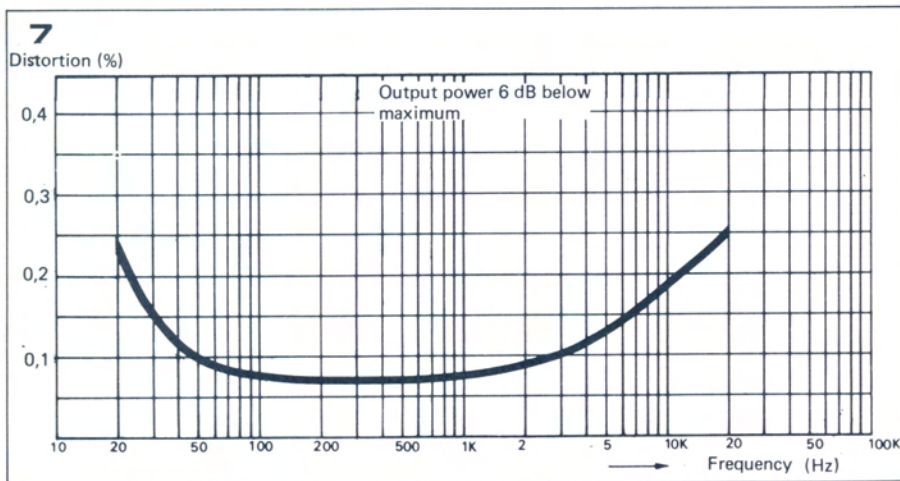


Figure 5. Maximum output power versus frequency.

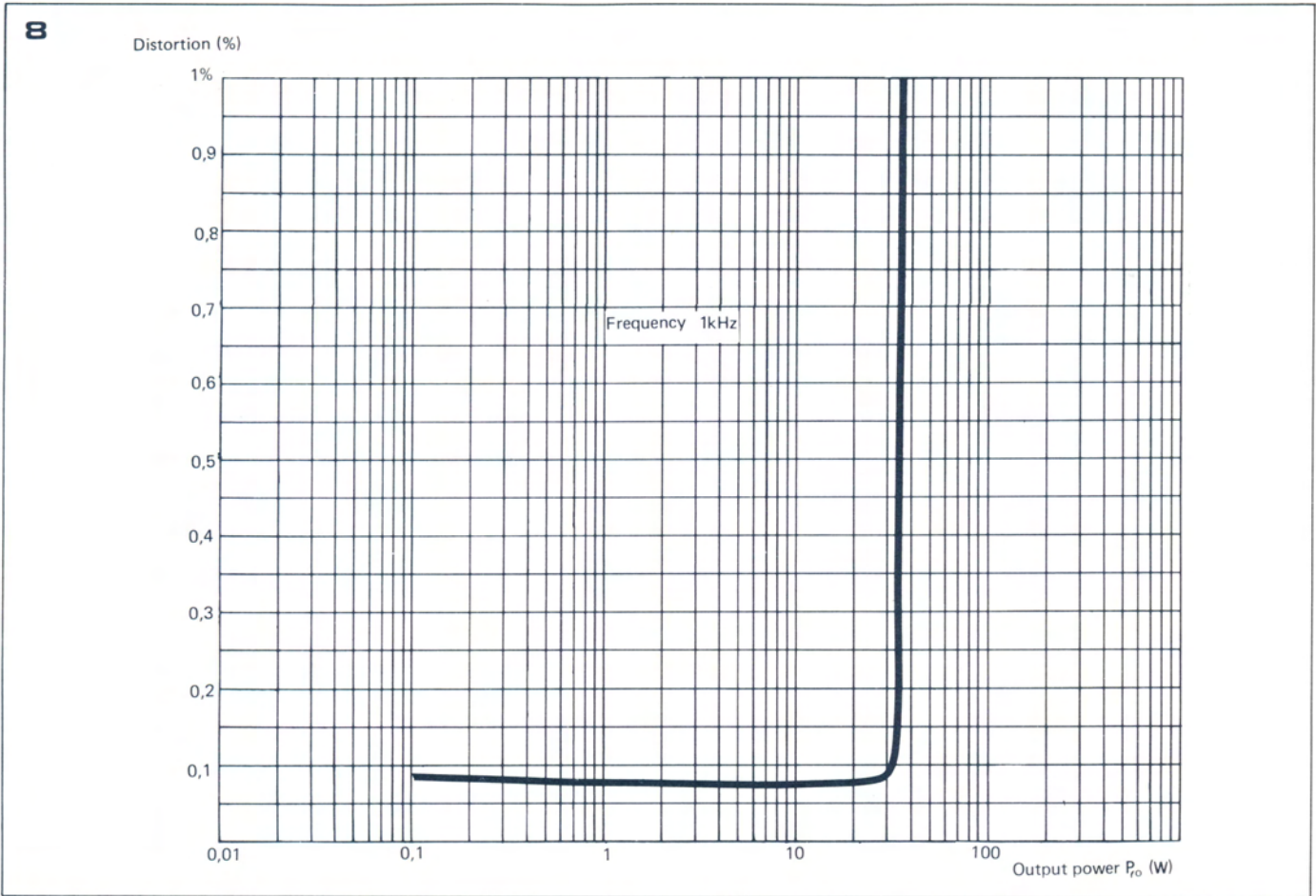
Figure 6. Frequency response.

Figure 7. Distortion versus frequency for output power 6 dB below maximum.

Figure 8. Distortion versus output power.







The a.c. gain of the amplifier is, of course, given by

$$A_v = \frac{V_{Out}}{V_{in}} = \frac{R_{10} + R_5}{R_5}$$

It is worth noting the effect of the combination R7, C5 on the operation of the amplifier. Some amplifiers, when used with an unregulated supply, display ripple on the peaks of the waveform when driven to clipping. This is eliminated by R7 and C5 as follows. When the amplifier is being driven, current flows through R7 and the voltage on C5 is always below the ripple 'troughs' on the supply. The drive voltage available from T3 is limited to the voltage on C5 and the output of the amplifier can never swing into the ripple region of the supply voltage. R7 also limits the current through T3 in the event of an overload.

**Overload protection**

The protection circuit is designed to prevent excessive current peaks from occurring during signal overloads or short-circuiting of the output. The protection circuit consists of transistors T5 and T6. Their base bias is set such that under normal operating conditions the voltage across R20 and R21 is insufficient to turn them on. In the event of excessive output current flowing in R20 or R21, due to a signal overload or a short-circuited output, the voltage across these resistors is sufficient to cause T5 or T6 to conduct. This reduces the drive voltage to the output stage and therefore limits the output current, thus protecting the amplifier.

**Power supply**

A stabilised power supply is unnecessary with the Edwin amplifier, as its performance will not be significantly improved. A simple unregulated supply is quite adequate and two suitable circuits are given in figure 3. Figure 3a shows a supply using a normal full-wave bridge rectifier, whilst figure 3b shows a full-wave rectifier with a centre-tapped transformer.

The component values and specification for supplies suitable for 20, 35 and 40 W versions of the amplifier are given in table 1. Of course any suitable transformer may be used, there is no need to adhere to the exact voltages specified. Figure 4 gives the output power available versus transformer secondary voltage. The only points to watch are that the current rating of the transformer is adequate for the required output power, that the voltage rating of the smoothing

capacitor is sufficient and that the RMS secondary voltage of the transformer does not exceed 33 V on load, otherwise the voltage rating of the transistors may be exceeded.

Over the range of supply voltages given in figure 4 nothing need be changed in the amplifier as the operating point is self-adjusting.

**Performance figures**

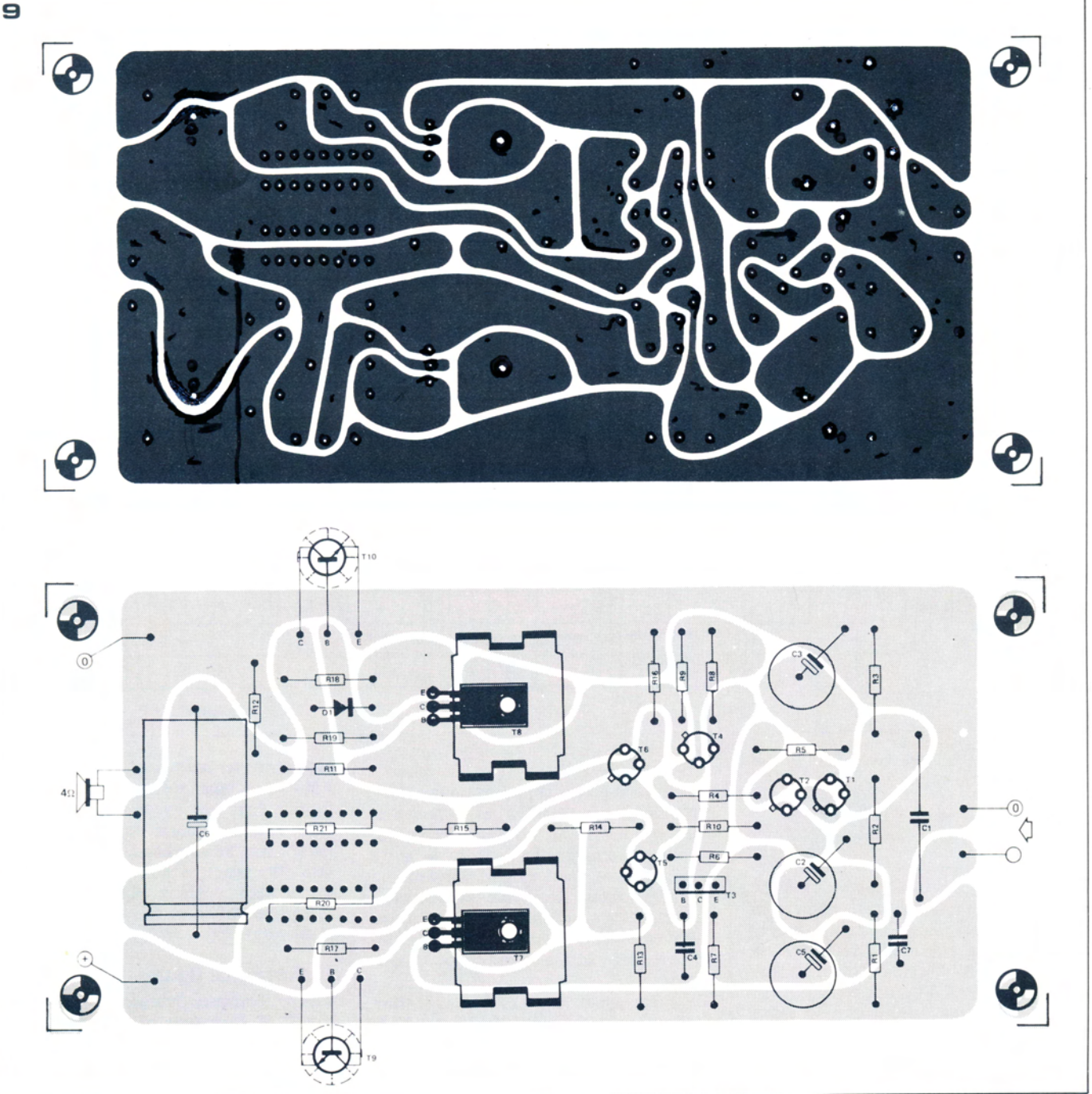
The performance figures, as measured on the 35 W prototype of the amplifier are summarised in table II and displayed graphically in figures 5, 6, 7, and 8. As can be seen they are quite exceptional. Among the outstanding features are the large power bandwidth, good signal to noise ratio, immunity to transients, low distortion and absolute stability, even with large capacitive loads.

Figure 9 shows the printed circuit board and component layout of the amplifier.

**Table I**

P <sub>O</sub> max (W) (R <sub>L</sub> = 4 Ohm)	V <sub>tr</sub> RMS	I <sub>tr</sub> max (A)			C1			Power supply no-load voltage (V)
		figure 3b		figure 3a	μF		working voltage (V)	
		Mono	Stereo	Stereo	Mono	Stereo		
42	33	1,1	2,2	4,5	2500	5000	60	46,5
35	30	1	2	4			50	42,5
21	24	0,8	1,5	3			40	34





#### Components list for figures 2 and 9

##### Resistors:

R1 = 10 k, ¼ W  
 R2 = 82 k, ¼ W  
 R3 = 100 k, ¼ W  
 R4 = 6k8, ¼ W  
 R5, R14, R15 = 100, ¼ W  
 R6, R8 = 680, ¼ W  
 R7, R12 = 220, ¼ W  
 R9 = 330, ¼ W  
 R10 = 1 k, ¼ W  
 R11 = 1k5, ¼ W  
 R13, R16 = 8k2, ¼ W  
 R17, R18, R19 = 10, ¼ W  
 R20, R21 = 0.12, 2 W

##### Capacitors:

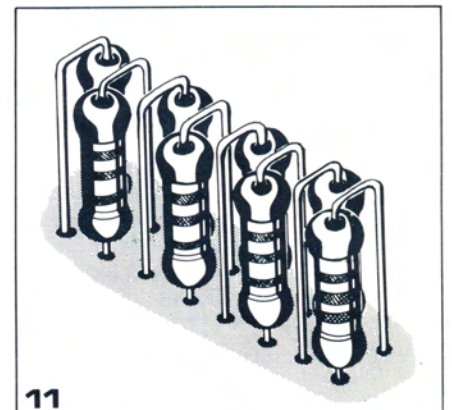
C1 = 1  $\mu$   
 C2 = 100  $\mu$ , 50 V  
 C3 = 100  $\mu$ , 25 V  
 C4 = 10 p ceramic  
 C5 = 250  $\mu$ , 50 V  
 C6 = 2500  $\mu$ , 50 V  
 C7 = 3n3

##### Semiconductors:

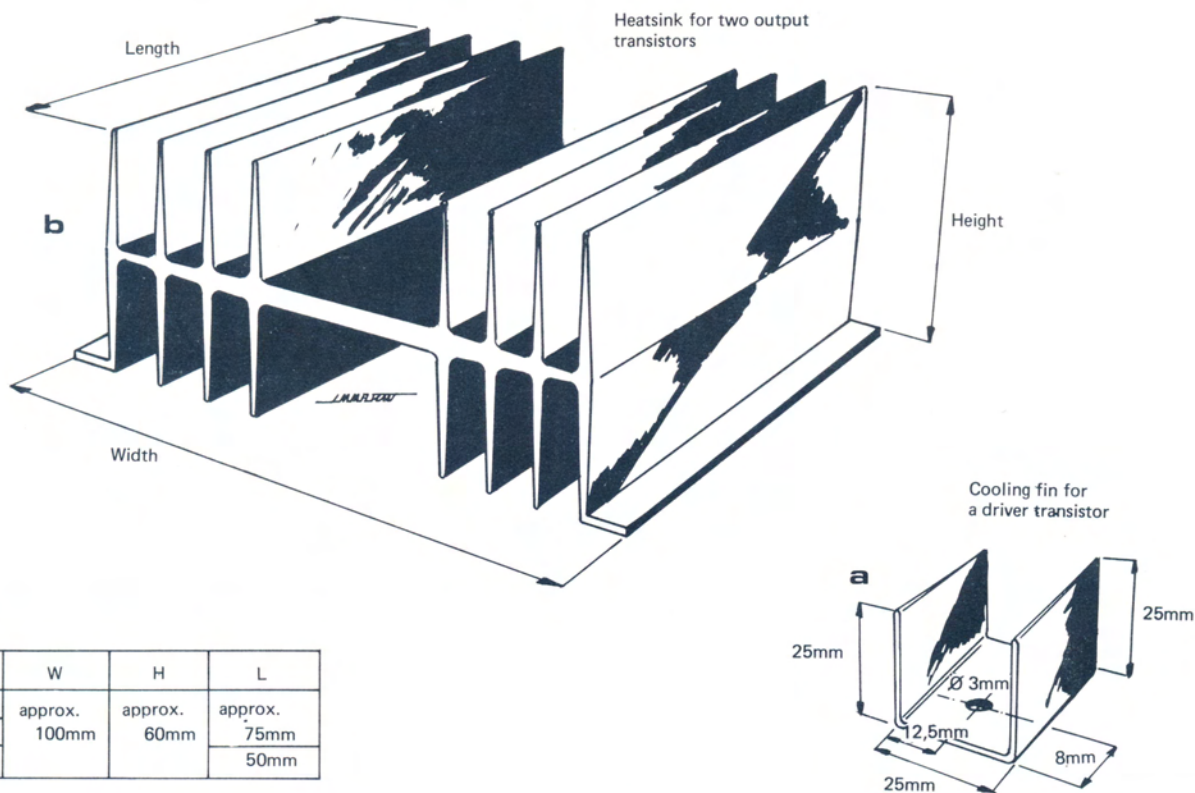
T1, T2 = BC 107, BC 171  
 T4, T5 = BC 108, BC 148  
 T3, T8 = BD 138  
 T6 = BC 178, BC 158  
 T7 = BD 137  
 T9, T10 = 2N3055, BD 130  
 D1 = BY 127

Figure 9. Printed circuit board and component layout.

Figure 10. Heatsink details for the driver and output transistors.







The driver transistors are mounted on the board, with a cooling fin as detailed in figure 10a. The output transistors are mounted on a separate extruded aluminium heatsink, details of which are given in figure 10b and the associated table. Most manufacturers of heatsinks will have something similar to this in their range.

If resistors R20 and R21 are not readily obtainable they may be wound from suitable resistance wire. Alternatively wire eight  $1 \Omega$  0.25 W resistors in parallel, there is plenty of space on the board to mount them vertically (figure 11).

**Concluding remarks**

Whilst the Edwin amplifier meets an exacting specification this is no reason to recommend its construction by the Hi-Fi enthusiast. There are many other designs with similar performance. What makes the amplifier eminently suitable for the amateur is its problem-free construction and virtual (electrical) indestructibility. ■

**Table II**

Performance figures of 35 W version		
Maximum output power	35 W (4 $\Omega$ ); 20 W (8 $\Omega$ ) 45 W (4 $\Omega$ ); 27 W (8 $\Omega$ )	$f = 1$ kHz, THD = 1 % THD = 10%
Efficiency	> 60%	$f = 1$ kHz; $P_o = 35$ W
Load impedance	0 ... $\infty$ (Maximum power into 4 $\Omega$ )	
Overload protection	Proof against long duration short-circuit	
Maximum capacitive load	> 100 $\mu$ F (!)	
Sensitivity	$\approx 1$ V RMS	$f = 1$ kHz, $P_o = 35$ W
Input impedance	$\approx 45$ k $\Omega$	
Distortion	0,1% 0,2% 0,3%	$P_o = 0 \dots 30$ W $f = 1$ kHz $f = 30$ Hz $f = 10$ kHz
Frequency response	25 Hz ... 1,2 MHz (-3 dB) 40 Hz ... 1,0 MHz (-1 dB)	$V_{in} = 245$ mV
Power bandwidth	> 100 kHz (-3 dB)	
Noise rejection	73 dB 93 dB	input open-circuit input short-circuit
Signal to noise ratio	95 dB > 105 dB	input open-circuit input short-circuit
Feedback factor	$\approx 36$ dB	
Stability	unconditional	