STABILISED POWER SUPPLY

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An unstabilised power supply is usually not suitable for driving a power amplifier since the current taken by such an amplifier varies greatly with the signal input. (Here we are assuming a class B output, as is common with transistor amplifiers.) Because of the current variation the voltage supplied from an unstabilised unit will vary with signal amplitude, resulting in distortion.

STABILISATION

The stabilisation of the supply keeps the voltage to the amplifier almost constant no matter what current is drawn, that is it gives the supply a very low internal resistance which is comparable to, or better than, that of a battery.

Fig. 1 shows the poor regulation of an unstabilised supply (initial internal resistance about 45 ohms). The stabilisation applied in this unit reduces the internal resistance to only 1·8 ohms (0·9V drop in supply voltage at 500mA).

The basic method of stabilisation is the use of a Zener diode. This is a special silicon diode biased in reverse. The voltage across it is always fixed by this diode at a characteristic value, provided the supply voltage is greater. To limit the current through the

SPECIFICATION

Input: 200-250V a.c.

Output 1: 13V d.c. 0-500mA
(internal resistance 1·8 ohms)

Output 2: 9V d.c. 0-50mA

The power unit described here has outputs chosen so that the unit is suitable for supplying a transistor radio tuner or pre-amplifier (9V supply) and a transistor power amplifier delivering up to 4 watts (13V supply). The ripple content is negligible and is inaudible in the output of an amplifier powered by the unit.

It is suitable not only for powering existing equipment but for providing stable experimental supplies. Details are given for modifications.

Zener diode a series resistor, such as R1 and R2 in this unit (see Fig. 2) is needed. The internal resistance measured across the diode is equal to the dynamic resistance of the device. This method of regulation is used for the 9V supply.

An extension of the basic method is used for the 13V supply. The transistor base voltage is fixed by D2 and so the emitter voltage is only about 0·2V less than the characteristic voltage of D2 no matter what the current. The transistor has the effect of reducing the internal resistance of the circuit even more, here, for the 13V supply, to 1·8 ohms.

Such stabilised supplies are not dependent to any great extent on input voltage. This unit has been operated on both 210V and 240V mains with only a minimal difference in output voltage.

SUPPRESSION OF RIPPLE

Because the output voltage depends to a slight extent on input voltage, ripple is automatically suppressed. The capacitors C2, C3 and C4 incorporated here reduce any remaining ripple to an almost undetectable level. The values of these capacitors might possibly be reduced without a significant increase in ripple, but they are readily obtainable at the values quoted at low prices and are recommended.

COMPONENTS . . .

Resistors
R1 1·2k 10% ½ watt carbon
R2 470Ω 10% ½ watt carbon

Capacitors
C1 2000μF elect. 50V
C2, C3, C4 5000μF elect. 15V
C5 2500μF elect. 12V

Diodes and Transistor
D1 BYZ 13
D2 OAZ 213 (12 volts nominal, ½ watt)
D3 ZS 9·1 or OAZ 292 (9·1 volts nominal, 7 watt)
TR1 XC 142 (Ediswan)
(All available from Henry's Radio and other stockists)

Transformer
T1 Primary 240V a.c. mains, Secondary 24V 1A, type 23 or equivalent (see text) (Samson's Electronics Ltd., 9 Chapel Street, London, N.W.1.)

Fuse
FS1 1A cartridge fuse and holder

Switch
S1 Double pole on/off (mains rating), slide or toggle switch

Miscellaneous
Two B7G valveholders and plugs. Four wander plugs and sockets. P.V.C. covered wire, mains cable and anchoring clip. Mica washer, 4B.A. nylon screws, and silicon grease for transistor insulation. Aluminium sheet 16 s.w.g. for chassis 5½in × 4½in × 2½in. Plywood for box 6¾in × 5in × 3½in.

CONSTRUCTION OF THE UNIT

The prototype was built on a chassis of heavy gauge aluminium. The layout used can be seen from Fig. 3, but this can be varied according to personal choice. It is essential, however, that the transistor is given an adequate heat sink, which is insulated from the chassis, since it must dissipate several watts when the unit is supplying a high current. In the prototype the chassis is used as the heat sink with particular care paid to insulation. A mica washer is used to insulate; silicon grease was applied to the surfaces first. Nylon or similar non-conducting screws are essential for fixing. The diode D1 should also be given a heat sink; here it is insulated from the chassis with plastic bushes. Heat sinks are not necessary for D2 and D3 with the values of components as given, but if run near to their maximum power ratings (½ and 7 watts respectively) then a heat sink is advisable.

The original unit used a Zener diode type VA9-B which is rated at 2½ watts although it tended to get warm on test. It was decided to replace this with a Brush Crystal Zener type ZS 9·1 which is rated at 7 watts and should suit the application just as well.

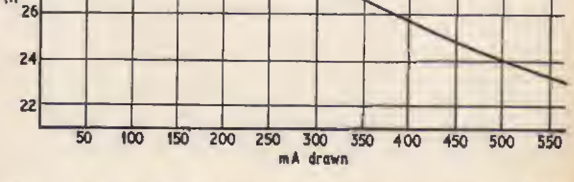

Fig. 1. Graph of the load characteristic—output voltage against load current for a typical low voltage unstabilised d.c. power supply circuit

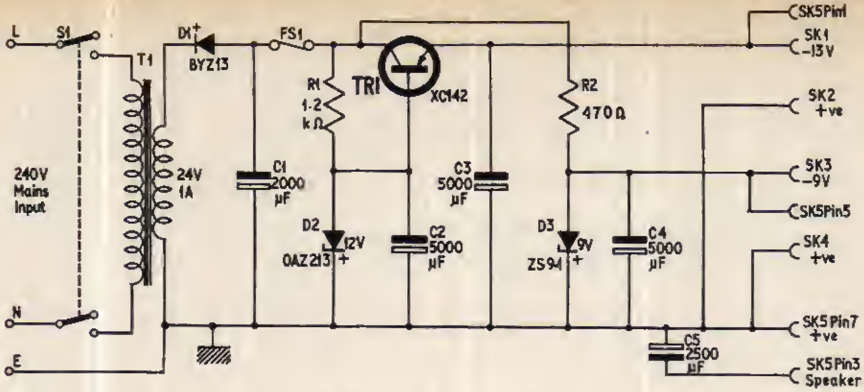

Fig. 2. Circuit diagram of the stabilised power unit

The transformer is described in the components list. If an alternative component is used make sure that the secondary has a minimum resistance of 1½ ohms; if not make up to this value with a fixed series resistor. With this value the diode D1 will not be destroyed by the surge current when the unit is switched on.

A slide or toggle switch may be used, preferably two-pole for safety. If the former is employed as on the prototype ensure that it is suitably rated for mains operation; some are not. Bare terminals should be covered with insulation tape or sleeving. As a further precaution provide an anchorage point inside the cabinet for the mains cable in order to avoid pull on the switch terminals if the cable is tugged.

The capacitor C5 is used between the loudspeaker of the power amplifier and "earth" in transformerless output amplifiers where one side of the loudspeaker would normally be connected to the centre-tap of a battery. This capacitor can be omitted if the amplifier to be powered is not of this type.

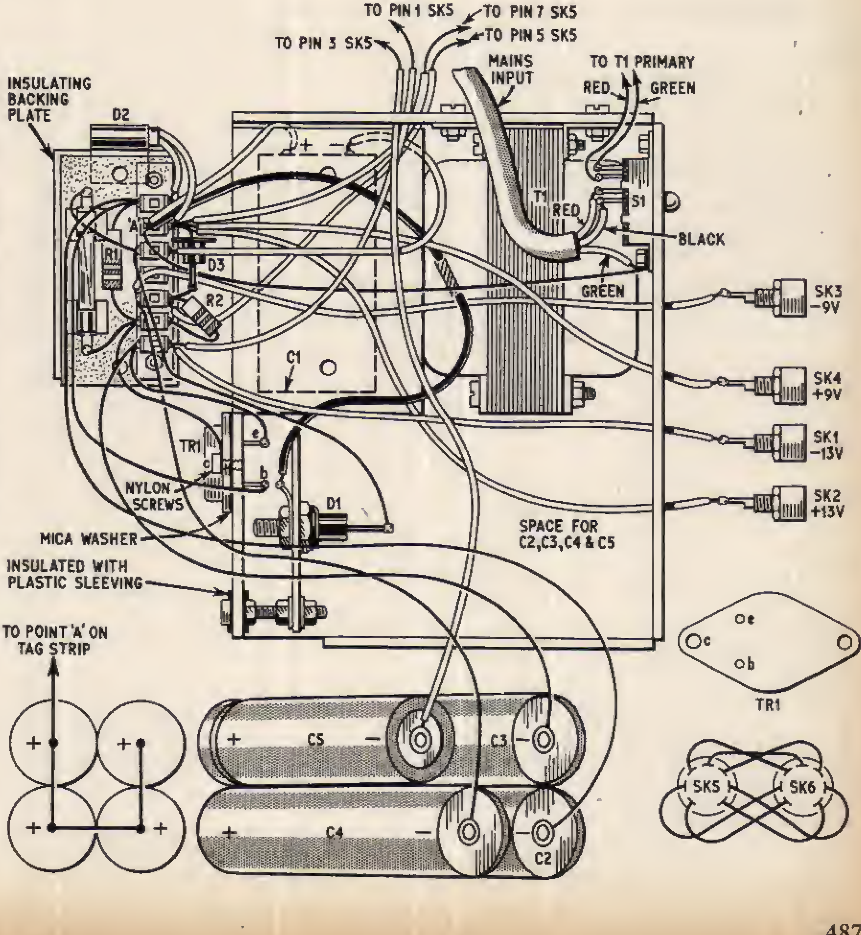

Fig. 3. Layout and wiring of the power unit. The small component board on the left and the capacitors C2, C3, C4 and C5 have been moved for clarity. The connections of TR1 are shown looking at the pin side of the transistor. Notice the insulation for TR1 and the heat sink fixing bolt for D1. Sockets SK5 and SK6 are shown diagrammatically; the tags are numbered in a clockwise direction looking at the undersides. D1 positive (cathode) is connected to the stud which should be electrically insulated from its heat sink

In the prototype the outputs were connected to B7G type valve sockets; a B7G plug and multicore cable connects the unit to the tuner and amplifier. A second socket for further developments and wander-plug sockets to provide supplies for experimental purposes were also included.

ALTERATION OF OUTPUT VOLTAGES AND CURRENT RATINGS

The unit can be easily modified provided certain precautions are taken. To alter an output voltage substitute a Zener diode of appropriate voltage and alter the series resistor so that the current through it is either (a) equal to the maximum current needed plus about 1–2mA (D3 and R2), or (b) equal to the maximum base current needed plus 1–2mA (D2 and R1). The maximum base current can be taken as roughly $1/\beta$ of the maximum current which you wish to draw from the supply. For this transistor $\beta = 62{\cdot}5$. As an example, suppose we require the unit to provide 13V at 500mA.

Fig. 1 shows that at 500mA the transistor collector is at 24V relative to "earth". There is thus:

$$24 - 13 = 11 \text{ volts across R1.}$$

Now the maximum base current is

$$I_b \simeq \frac{500}{62{\cdot}5}\text{ mA}$$

$$\simeq 8\text{ mA}$$

so R1 should carry 1–2mA more than this, say 9mA. Therefore R1 should carry 11/9 kilohms. The nearest preferred value is 1·2 kilohms.

To alter the output current keep the Zener diodes as specified and alter the series resistors as described above, but in all such cases ensure that the wattage ratings of the Zener diodes or the transistor (11W) are not exceeded. ★

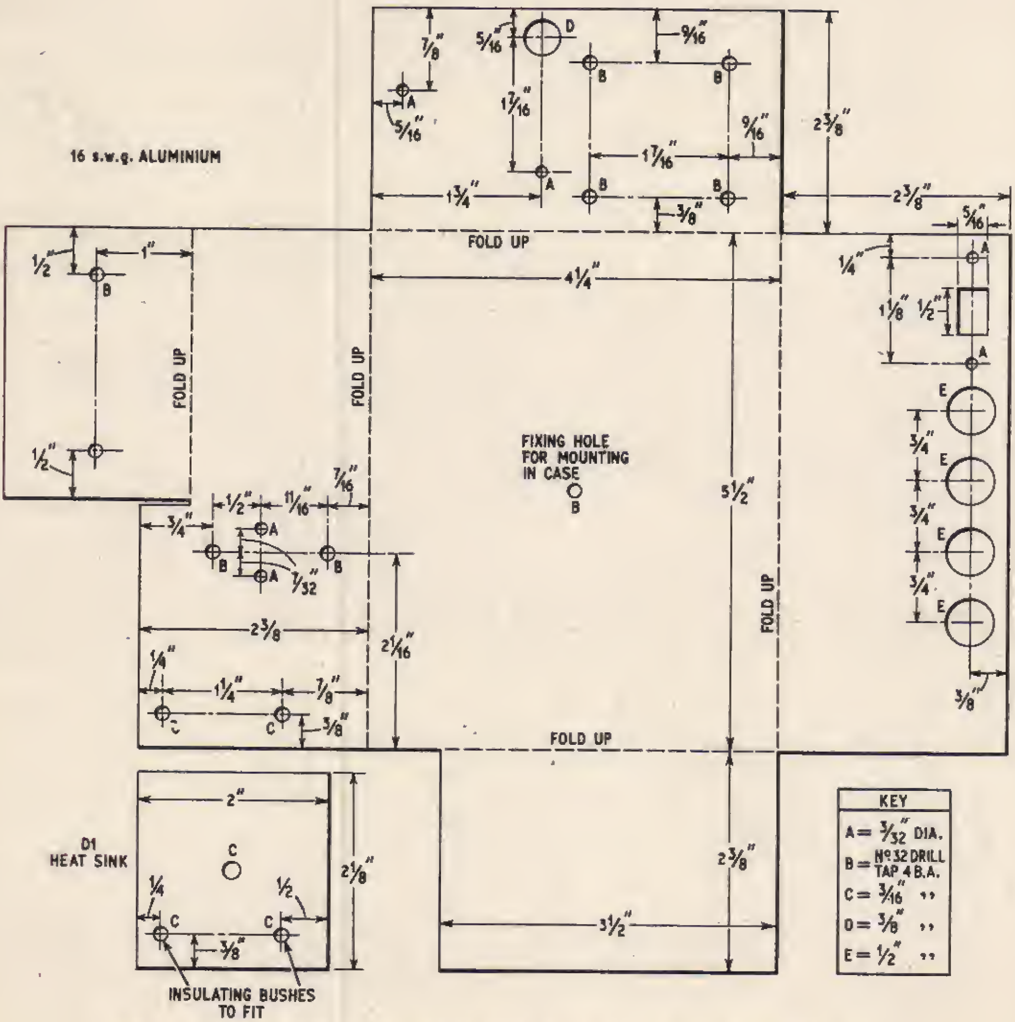

Fig. 4. Drilling details of the chassis made from 16 s.w.g. aluminium. The left-hand flange is folded twice so that part of it is U-shaped. A grommet should be fitted to hole "D" for the wires to SK5 and SK6