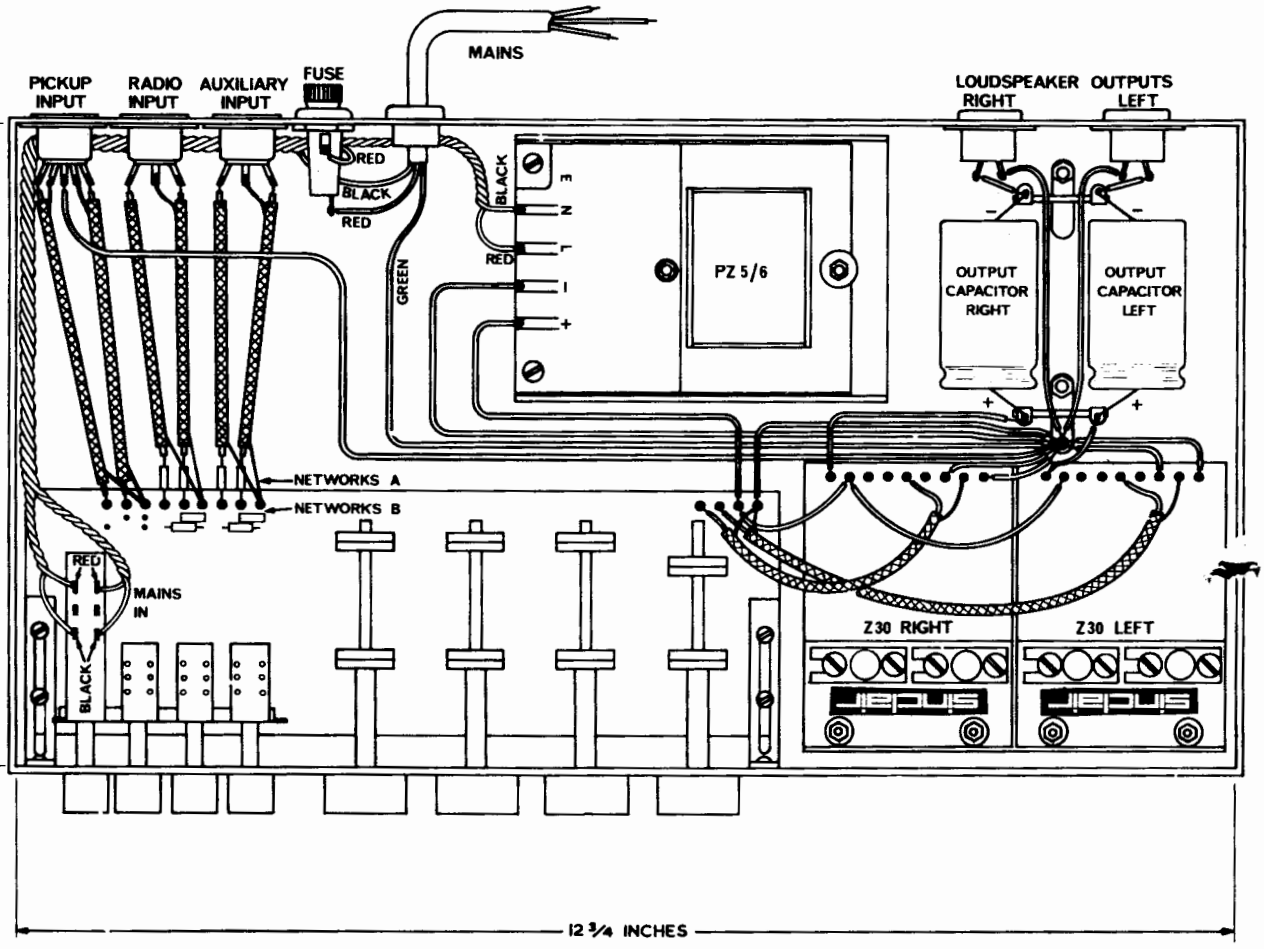
PROJECT 60

sinclair



A suggested layout

Owing to circumstances beyond our control we have done a 'rush job' on this manual and we apologise if any points are not as clear as they could be. We shall however be pleased to consider customers criticisms and suggestions in due course when we reprint. Thank you!

CONTENTS

1. GENERAL INFORMATION

1.1 Introduction

Project 60 is a complete stereo high-fidelity amplifier composed of three separate modules: a stereo preamplifier, a power amplifier (two are required for the complete stereo system) and a power supply which is available in two versions). Not only does it give results far better than have hitherto been obtainable from such a system, but the individual modules can be used for many other applications.

In this manual will be found simple instructions for connecting the modules to form the basic stereo system, with hints on layout and details of many refinements that can be added if required. Then follow sections on Stereo 60, Z.30 and power supplies giving circuit diagrams, descriptions and technical specifications, with many circuits and ideas of how the individual modules can be used independantly for a host of purposes.

1.2 Component values

Throughout the text and diagrams in this manual we have, to avoid the possibility of misreading, adhered to the internationally preferred method of coding component values, as illustrated below

resistors			*capacitors*		
6 E 8	=	6.8Ω	5 p 6	=	5.6 pF
680 E	=	680Ω	5 n 6	=	5,600 pF = 0.0056μF
6 K 8	=	6.8 KΩ	560 n	=	560,000 pF = 0.56μF
6M8	=	6.8 MΩ	5 μ 6	=	5.6μF

1.3 Connections

Whilst standard 0.2" open-ended edge connectors can be used if necessary, we do not normally recommend them since trouble can be encountered from contact resistance.

Our preferred method of connecting is to terminals fitted into the holes provided in the print so that no heat or mechanical strain is imposed on the copper track. Ordinary 1" plated steel dressmaker's pins are quite suitable for this.

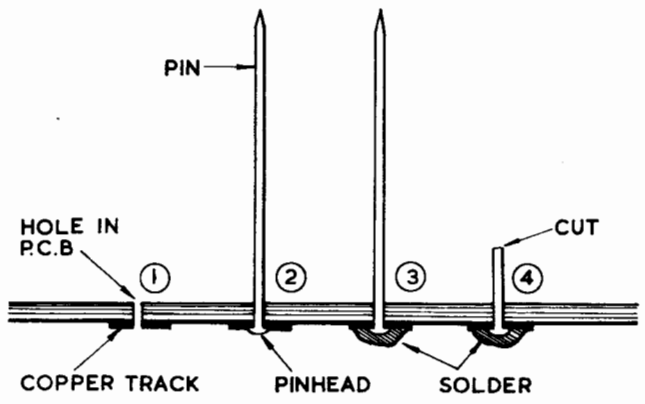


Fig. 1.3.

(1) shows the hole initially.
(2) The pin has been inserted in the hole in the copper and pushed home.
(3) The pin head is now soldered to the copper with sufficient solder to cover the head and make a sound joint.
(4) The shank of the pin is now cut off about 3/8" from the printed circuit board.

Throughout the text and illustrations a square around a number, letter or sign will refer to PZ5/6 connections, a circle to the Stereo 60 and a triangle to the Z.30, thus:

means connection 5 on the Z.30

means connection 5 on the right hand Z.30

means connection + on the PZ5 or 6.

means connection R on the Stereo 60.

Throughout the circuits illustrated resistors can be 1/10w or higher: ¼ or ½w being commonly available. Where higher wattage resistors are needed this is indicated. All resistors can be 10% or 5% tolerance.

Capacitors can all be 12v working or higher unless indicated. Where voltages are indicated this is the minimum allowable and the actual component used may have a working voltage in excess of the indicated value.

1.4 Earth connections.

In any very low distortion amplifier great importance must be placed on the earthing arrangements for the reasons stated in sections 2.4.4 and 4.13.

Throughout the diagrams the connection to the earth point will be marked ⏚ and this should be the only part of the circuit that connects to the metal chassis if used.

1.5 Sensitivities

Throughout the text quoted sensitivities are, unless otherwise stated, those corresponding to an output of 4v r.m.s. from the Z.30, i.e. for a power of approximately 4w into 4Ω, 2w into 8Ω or 1w into 16Ω, (this is the approximate power level available with 17v power supply voltage); measured at a frequency of 1KHZ.

Input impedances quoted are measured or calculated at 1KHZ.

2. ASSEMBLING THE COMPLETE STEREO AMPLIFIER

2.1 Introduction

Project 60 uses the very latest technology to enable the best possible performance to be obtained. In order that its full capabilities can be realized the instructions in this section must be followed accurately. It is realised that in certain applications these cannot be strictly adherred to and general hints are therefore included in the section, with indications as to the possible effects of departure from our recommendations. However, quite large variations are tolerable since most of the symptoms that may result will normally only be detectable on expensive test gear.

2.2 Choice of cabinet for Project 60.

Project 60 is designed to fit as simply as possible into most plinths currently supplied with various record decks and even the slimmest plinths will usually accept the system. If the project is to be fitted to an existing cabinet, box or plinth the remainder of this section does not apply.

In fig. 2.3 we give our own suggestions for a layout which will fit into a metal box of internal dimensions 13" by 6½" by 2" and for those who wish to follow this layout dimensions are given.

It is best to choose a metal box to mount the units in since this provides screening and will enable better hum, noise and distortion performance.

Input and output sockets must be isolated from the chassis and for this reason we recommend continental DIN type plugs and sockets; 3 or 5 pin for the input and two pin speaker sockets for the output. Phono or Jack sockets can be used for the input if mounted on an insulating panel.

DO NOT use output sockets such as jack sockets, which can be short circuited if the plug is withdrawn.

DO NOT use the same socket for inputs and outputs since plugging your expensive new magnetic cartridge into the amplifiers output can ruin it (the pickup)!

Fig. 2.3.

As shown on inside front cover

2.4 A suggested layout

Fig. 2.3 shows in detail one of many possible layouts. Take note of the following points:

1. Input sockets are mounted a good distance from the power supply and are as far from the output as possible, without being too far from the Stereo 60.
2. The wiring between the sockets and the Stereo 60 is screened. One end of all the screening is connected to the earth points on the Stereo 60, but only one screen connects to each earth point on the input sockets.
3. Each input wire is a single core screened wire; the use of screened twin wire for each Stereo input is permissible but it could under certain conditions result in cross-talk.
4. Additional matching components are fitted as near the Stereo 60 as possible. Most of them can actually be mounted on the Stereo 60 printed circuit board.
5. The connections between the Stereo 60 and Z.30's are all as short as possible.
6. Separate wires are run from each earth to the common earth point.
7. The Z.30s and power supply are mounted as far as possible from the Stereo 60's input end and its wiring.
8. The output capacitors and sockets are as far from the input as possible and separate earth wires are used for each channel.
9. The mains wiring is tightly twisted together and runs around the bend in the edge of the chassis, as near to the metal as possible and as far from the input wiring as possible.

2.5 General Considerations in mounting and layout

2.5.1 Positioning of Stereo 60. This is to be fixed onto the front of the cabinet or plinth by means of the L-brackets fitted to it, but its positioning will be affected by other considerations, such as its position relative to the Z.30s and power supply. It should be mounted so that the input selector switch is at least 6" away from the turntable's motor and is not near to any other transformer or motor.

If any part of the wooden cabinet is within 1" of the selector switch on the Stereo 60 this is best earthed by glueing metal foil (cooking foil is suitable) over the woodwork and connecting this, via a screw, a solder tag and a length of wire, to the main earth point. This will reduce hum pickup.

2.5.2 Positioning of Z.30s. The wiring between the Stereo 60 and the Z.30s must be as short as is convenient so that it is advisable to mount the Z.30s near to the right hand side of the Stereo 60. In fig. 2.3 they are shown in line with the Stereo 60, but it is possible to mount them behind, on the right hand side, or they can be mounted one on top of the other to the right of the Stereo 60 or they can be mounted vertically:-

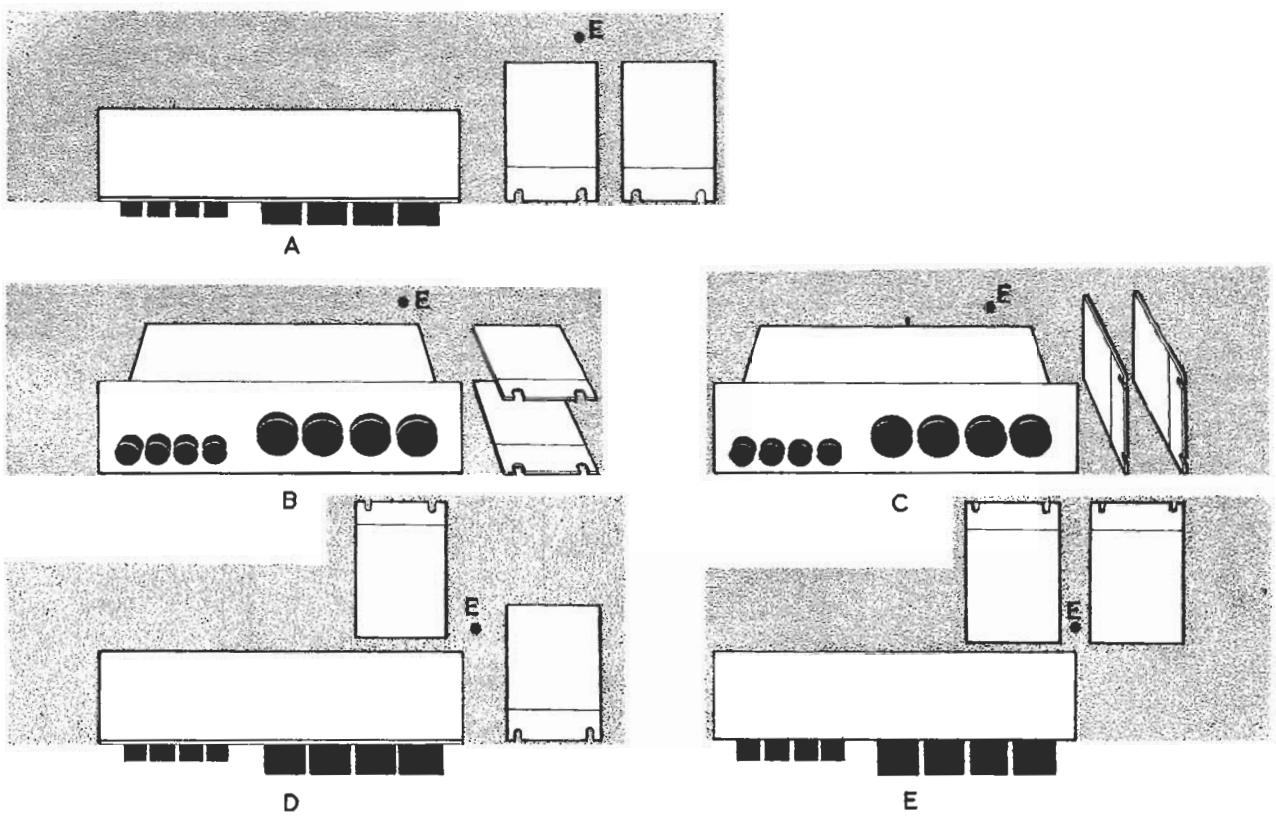


Fig. 2.5.2.

Fig. 2.5.2. a to e illustrated these possibilities. It is generally advisable to keep the Z.30s in the shaded area shown in fig. 2.5.2a.

DO NOT mount the Z.30s anywhere near the left hand end of the Stereo 60, since this will almost certainly cause instability.

DO NOT mount the Z.30s above or below the Stereo 60 for the same reason.

These two 'DO NOT's' will not apply if a metal screen is positioned between the Stereo 60 and the Z.30s. This screen must be electrically connected either to the metal chassis if used, or direct to the earth point.

2.5.3. Positioning of power supply

This can be mounted anywhere convenient, but if the leads from it are longer than about 6" to 8" it is advisable to add a capacitor (a 10nF ceramic disc is suitable) between the earth point and the supplies to the Z.30s and Stereo 60 which will be taken in this instance from this capacitor via short leads and a wire will feed the positive power supply lead to this capacitor, as shown in fig. 2.5.3.

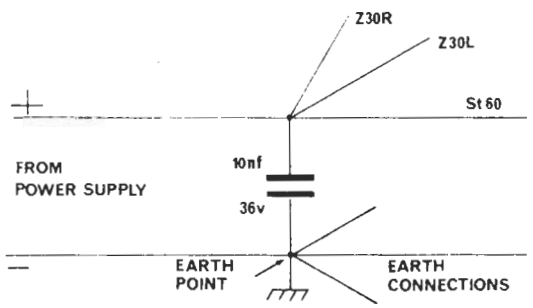


Fig. 2.5.3.

However the power supply must not be mounted near the input (left-hand) end of the Stereo 60, nor must any wires run near to the mains transformer. This is especially important with input wiring to the Stereo 60.

As a general rule no wire must approach the transformer nearer than 3", although 6" is preferable.

If this is unavoidable hum may be present when the volume and bass controls are at maximum and the input is shorted. If such hum is present the power supply can be rotated or moved to reduce it.

2.5.4. The earth point.

In order to realise the full performance of which Project 60 is capable particular attention must be paid to the earth point.

This should be a solder tag or other terminal situated nearly equidistant from, but as near as possible to, the Stereo 60 and both Z.30s. Note the position chosen for this in our layout (fig. 2.3) and those indicated in fig. 2.5.2.

If the system is mounted on an insulating base additional connections should be made from the earth point to any screening used between units, unless instructions in the following text suggests otherwise.

Make sure that one wire, and one wire only, connects to each earthed item, since a loop will result if this is not followed.

If a metal chassis is used, this earth point should be physically mounted on, and electrically connected to, the chassis. Make quite certain that there is no other electrical connection to the chassis: a good way of doing this is to use a large solder tag for the earth point and, when wiring is completed, unscrew the tag so it is not connected to the chassis. On ohmmeter connected between chassis and earth point should, if wiring is correct, indicate an open circuit.

2.6 Wiring

2.6.1 Wiring between Stereo 60, Z30s and PZ5/6

The wiring is shown in fig. 2.6.1. Note that separate wires are to be run from 3 and 1 on each Z30 and from ⊟ on PZ5/6 and Ⓔ on Stereo 60.

Note the use of screened wire for the signal lead to the Z.30s, the screen connecting to terminal 2 and to Ⓔ on the Stereo 60.

The layout of positive wires is not critical. All the wires are visible in our layout fig. 2.3.

We thus have three triple inputs consisting of left channel, right channel and earth. These will be called input 1, input 2 and input 3.

Input 1 is selected by pushing the PU button, input 2 by pushing the Radio button and input 3 by pushing the Aux button.

Input 1 will directly accept a magnetic pickup of any common type giving between 3mV and 10mV output.

Input 2 and 3 will accept directly a magnetic microphone or a radio tuner giving not more than 25mV output.

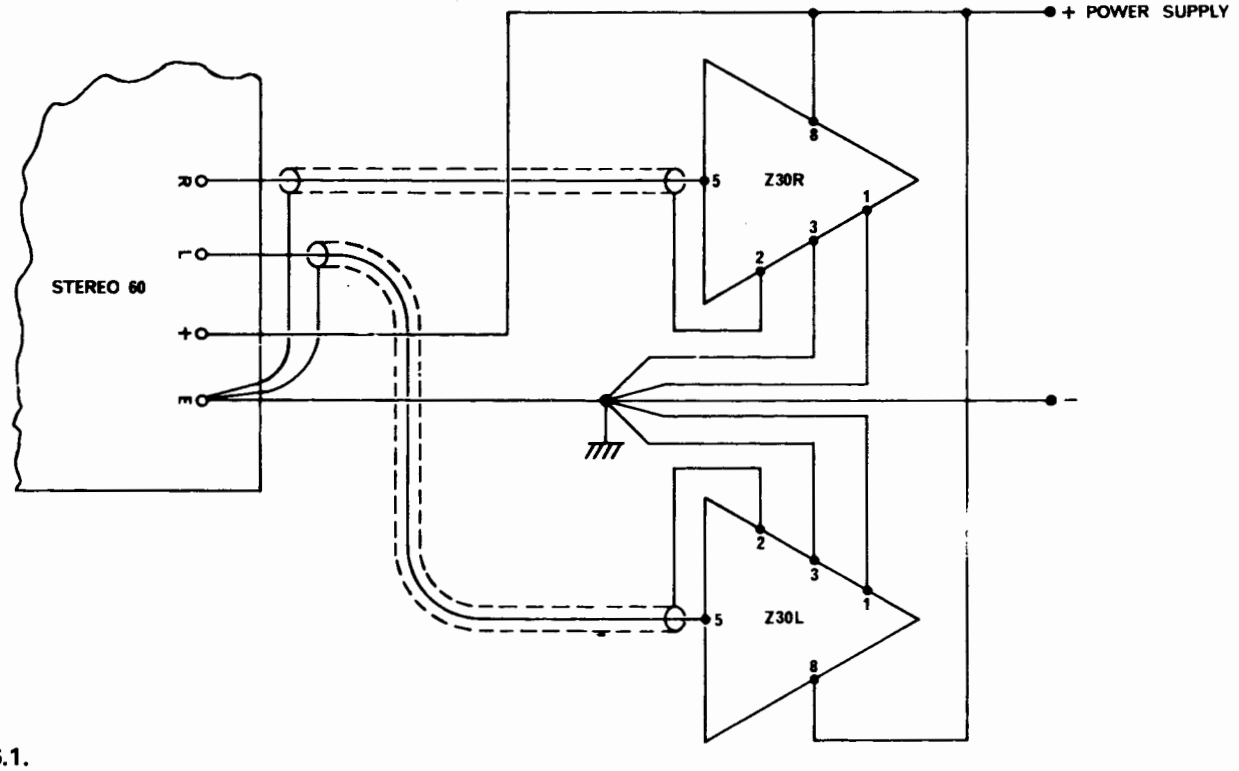


Fig. 2.6.1.

2.6.2 Output wiring

Connect terminal 9R to the positive of a 1000μf 25v capacitor and the negative of this capacitor to the live terminal on the RH output socket.

Connect 9L similarly to another identical capacitor and thence to the LH output socket.

The earthy connections on the output sockets should be separately connected direct to the earth point.

2.6.3. Input Wiring to Stereo 60.

Nine input terminations are provided on the Stereo 60:-

(1 L)	PU Left	
(1 R)	PU Right	Input 1.
(1 E)	Earth	
(2 L)	Radio Left	
(2 R)	Radio Right	Input 2.
(2 E)	Earth	
(3 L)	Aux Left	
(3 R)	Aux Right	Input 3.
(3 E)	Earth	

Two separate screened leads (or a 'figure 8' stereo screened lead) should be used to convey the signal from the pickup or other input to the Stereo 60. Connect the core of the right-hand lead to Ⓡ, the core of the left-han lead to Ⓛ and both screens to Ⓔ of the input chosen.

2.6.4. Connections to pickup.

The other ends of the pickup screened lead should be connected in accordance with the deck manufacturer's instructions. Most common turntables (BSR, Garrard etc.,) are supplied with a 5-way tag strip, with colour coded wires internally to the cartridge.

Connect the live/core of the right hand lead from the Stereo 60 to the tag which already has a red wire connected Connect the screen of the right channel to the tag with the green wire.

Connect the core of the left channel to the white and the screen of the left to the blue.

It is best to run a separate single (stranded) flexible wire from the centre tag to the earth point on the amplifier chassis, making certain that there is no connection from either the green or blue tag to the centre tag, also make sure that all the turntable's metalwork is connected to the centre tag.

The turntable must not be separately connected to the mains earth.

If a plug and socket are required to connect the pickup a 5 pin DIN type is most suitable, since a separate pin can be used for each wire. We have used this in fig. 2.3.

Additional information to enable the user to feed almost any input to the Stereo 60 is given in section 3.7.

2.6.5. Mains Wiring

A 2.pole on/off switch is provided on the Stereo 60, its connections numbered as in fig. 3.3.

Connect the live mains lead to a 0.5a fuse (a panel mounting fuse holder, such as Radiospares Miniature panel fuse holder, is recommended).

Connect the other fuse terminal to contact 1 on the mains switch and the neutral mains wire to contact 3 on the switch. Connect contact 2 on the switch to contact [L] on the PZ5 and contact 4 to contact [N] on the PZ5.

These mains wires should be tightly twisted together and run along the corner of the chassis to give the lowest hum level, as in fig. 2.3.

The mains earth wire should connect direct to the mains earth point.

Contacts 5 and 6 should not be connected at this stage.

3. STEREO 60.

3.1. Technical Description.

The input signal is selected by S2 and S3 from one of three inputs and fed to the base of TR1. TR1 and TR2 are direct coupled with d.c. feedback from Tr2's emitter to TR1's base to provide stability. A.c. feedback is applied at the same time and also, via S4 and associated components, from the collector of TR2 to TR1's emitter in order to give accurately defined gain and frequency response. The combined effect of both feedbacks also controls the input impedance.

The signal is taken from TR2's collector to a Baxendall type control arranged around TR3. Output is taken from TR3's collector via the volume and balance controls.

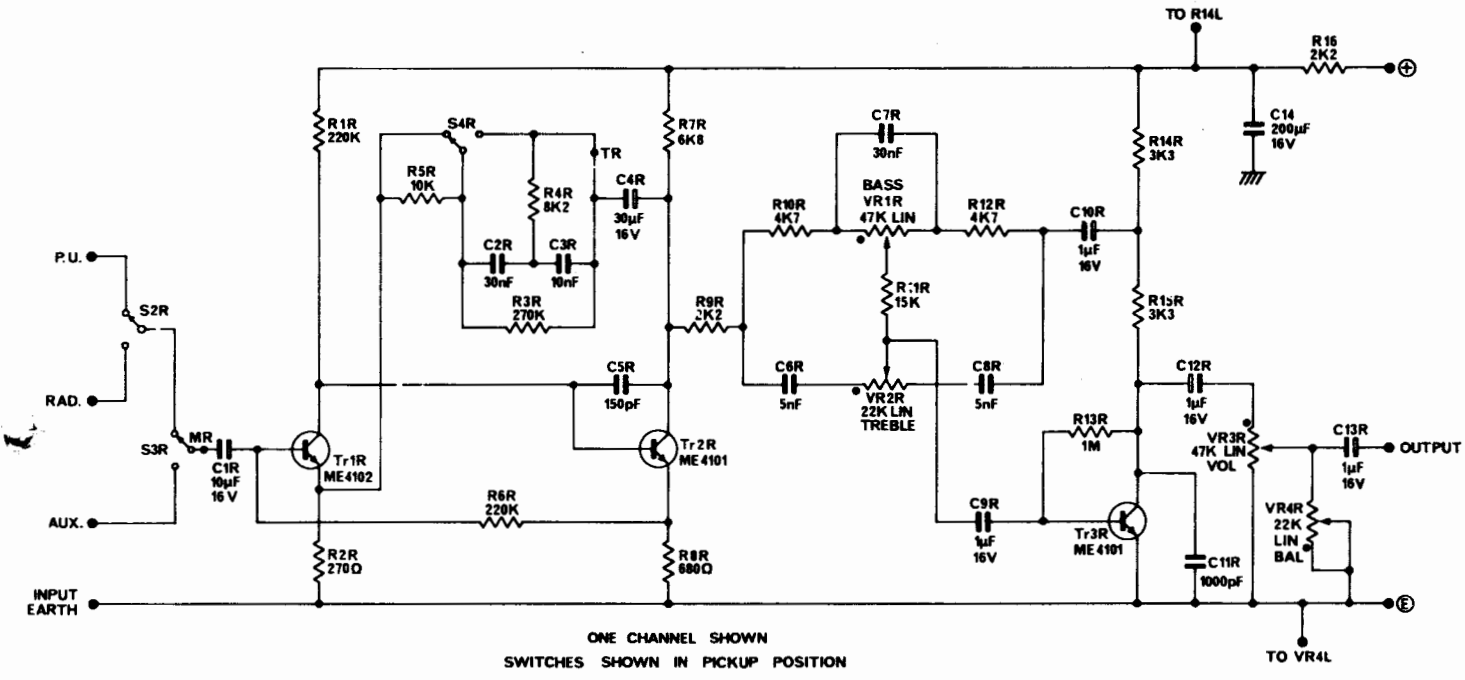


Fig. 3.2. Stereo 60 circuit

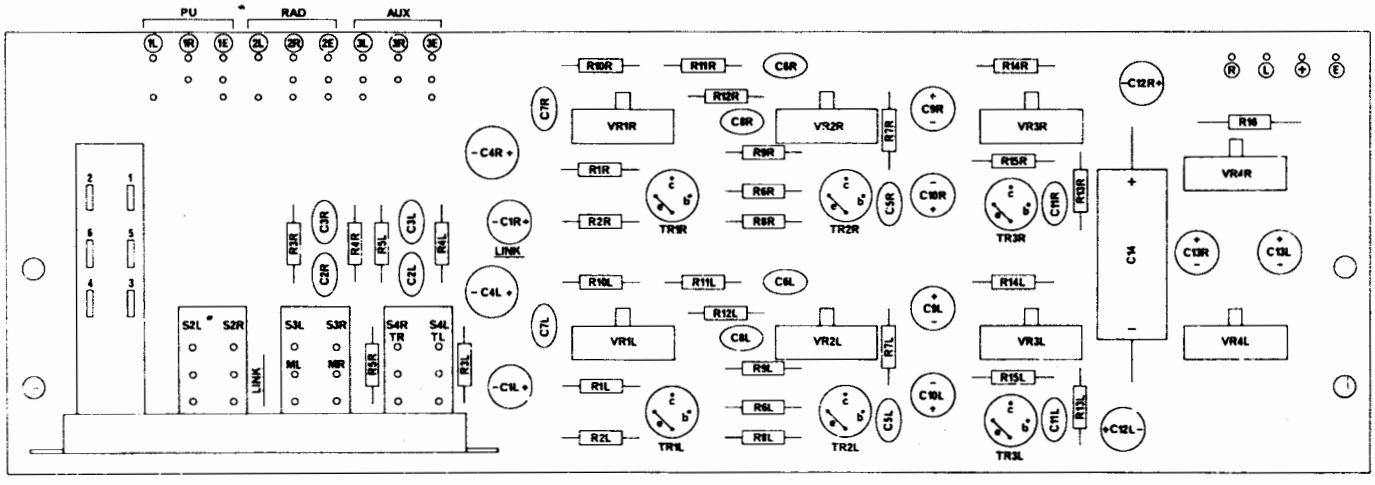


Fig. 3.3. Stereo 60 component layout.

3.4 Typical Performance Specification

Input sensitivity on all inputs at 1 KHz 3mV
Input impedance on all inputs at 1 KHz 50K
Power requirements 15 – 35v at 3 – 10 mA
or 9 – 15v at 3 – 10 mA
equalization (PU input) correct to RIAA curve
±1dB, 20Hz to 25 KHz
frequency response, rad and aux±1dB 20Hz to 25KHz
overload factor 20 dB at 1K Hz on all inputs.
distortion 0.03%
signal to noise ratio –70 dB
treble control±15 dB at 10KHz
bass control±15 dB at 100Hz
output (for 3 Mv input) 250 mV
output load impedance: not less than 25K

3.5 Mounting Stereo 60

Dismantling – grip the control shaft firmly with one hand and pull the control knob off the shaft with the other. In this way all four knobs are removed, taking great care that the metal shaft does not move within the potentiometer bushes.

The front panel can now be removed and the plastic bushes can also be removed if required. These will normally be used between the knob and the panel to give about 1 mm spacing between knob and panel.

In dismantling and reassembly great care should be taken at all times not to put any force on the control potentiometer.

The Stereo 60 is supplied with two mounting brackets so that it can be mounted on the front panel of the cabinet or plinth, this is illustrated in fig. 3.5.1.

First a rectangular hole 7¼" x 1" is cut out in the front panel, as shown in fig. 3.5.1.

With panel thickness up to 3/8" the screws holding the bracket to the PCB should be loosened and the PCB pushed up tight to the wood panel. The control panel should then be mounted on the front of the case and the control knobs pushed home. The PCB of the Stereo 60 can now be withdrawn from the wood panel so that the knobs are flush against the bushes. The Stereo 60 fixing screws should now be tightened.

If a panel thickness greater than 3/8" is used the slots should be cut as shown on the template so that the PCB itself fits into the slots in the wood panel. The brackets can accommodate in this way a thickness of up to ¾".

To mount the front panel peel off the protective paper back to expose the self-adhesive face and press the panel into position.

3.6. Power requirements

Absolute maximum voltage 35 @ 10 mA
minimum voltage 15 @ 3.5 mA
voltages higher than 35 can be used if R16 is increased.

The Stereo 60 can also be run off its own separate battery (9 or 12v) if R16 is short circuited.

Power is fed between ⊕ and Ⓔ shown in fig. 3.3.

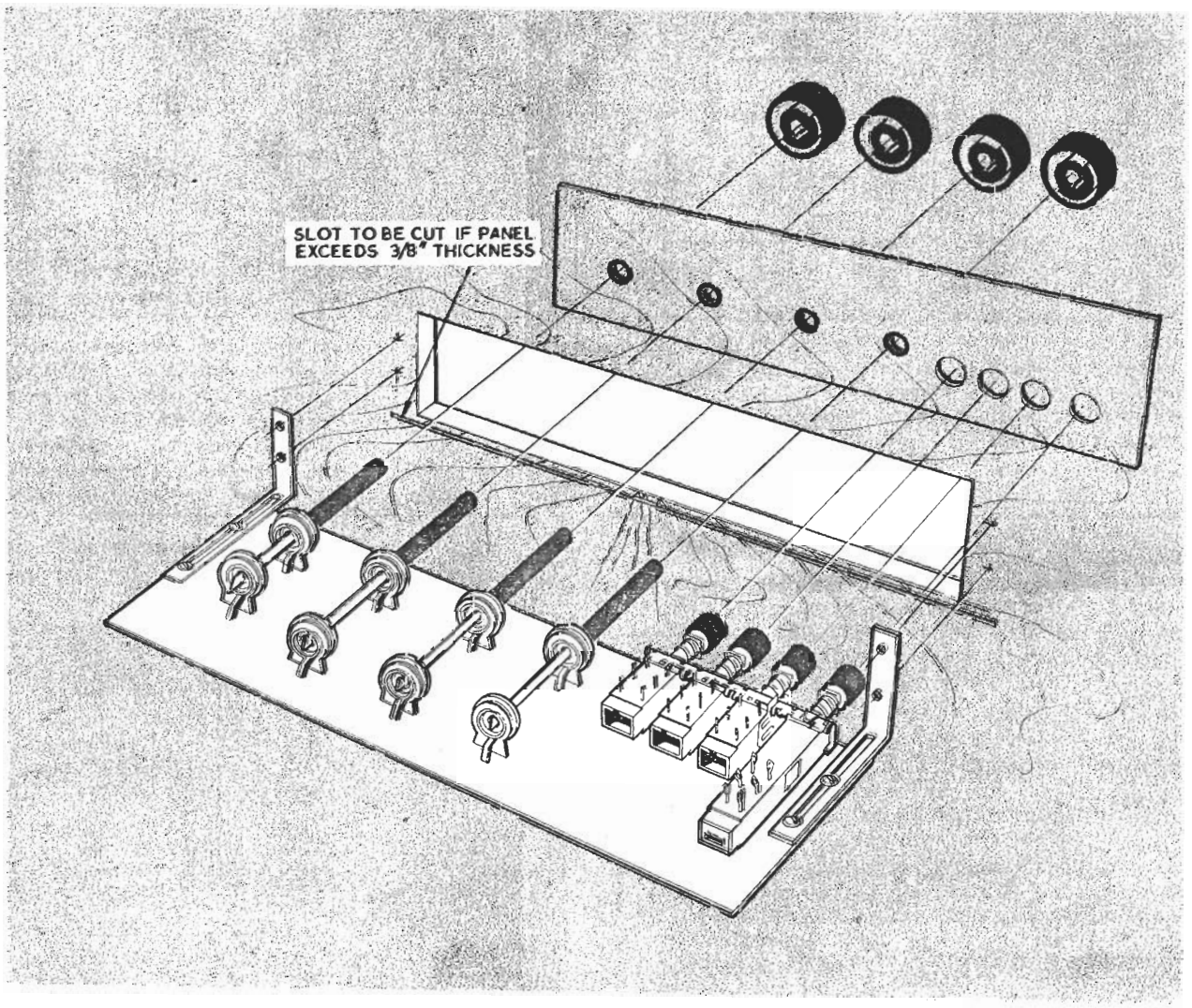


Fig. 3.5.1.

3.7 Output

The Stereo 60 has a voltage gain of approximately 80 so that the output voltage will be 80 times the input voltage, i.e. for 3mV input the Stereo 60 will give approximately 250 mV output.

Output impedance is about 25K and the input impedance of the main amplifier fed from the Stereo 60 should be higher than this.

Outputs are taken from points (L) and (R) in fig. 3.3 each one between (L) (or (R)) and (E)

3.8 Inputs

3.8.1. General

For most inputs other than magnetic microphones and pickups, which can feed direct to the Stereo 60, some input matching network is necessary and this is to be duplicated, one network for the left-hand input and the duplicate for the right-hand input.

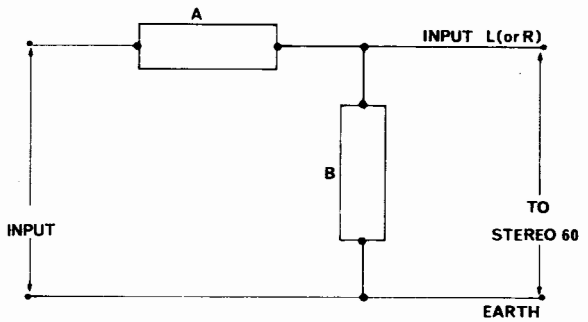


Fig. 3.8.1.

The input components are arranged normally in a potential divider, shown in fig. 3.8.1., usually consisting of two resistors but occasionally capacitors will be used. Network B can normally be mounted on the Stereo 60 in the holes provided near the inputs, network A will be included in series with the live signal lead. The components can be clearly seen in our layout, fig. 2.3.

3.8.2. 'Flat' inputs

Resistors will be used for inputs from radio tuners, other preamplifiers, tape recorders (but not direct from the tapehead) and other devices giving a 'flat' frequency response which does not require equalization. Typical values are shown in the following table.

input sensitivity	A	B
3 mV	0	open-circuit
10 mV	68K	22K
30 mV	100K	10K
100 mV	100K	3K3
300 mV	100K	1K
1 v	100K	330E

These all give an input impedance of 100K, approximately To give an impedance of 200K the values should be doubled etc.

It is of no consequence that the impedance be matched to the tuner, provided the input impedance to the Stereo 60 is greater than the tuner's output impedance. The sensitivity of the Stereo 60 will normally be chosen to be greater than the tuner's output. Thus, with a tuner giving 500 mV at 1K a suitable matching network would be that for 300 mV 100K.

3.8.3. Pickup input.

A crystal or ceramic pickup, when fed into a high impedance, gives a flat frequency response. However, when fed into a low impedance (lower than 1 MΩ or so) the bass is reduced and treble increased. By correct loading it is possible to give a very similar output to that from a magnetic pickup.

There are three basic methods of feeding to the Stereo 60:-

a) Via a 1M or 2M2 resistor (A in fig. 3.8.1) to a flat input, when resistor B is chosen to suit the cartridge's output as follows:-

Cartridges output	30mV	100	300	1v
recommended resistor 'B'	open circuit	33K	10K	3K3

This method is recommended for the cheaper, high output, crystal cartridges when A of 2M2 and B of 4K7 should give good results.

The treble can be increased by fitting a small capacitor (50-200pF) across the 2M2 resistor.

b) Loading with a capacitor. In this case the cartridge is fed direct to a flat input and the capacitor fitted in place of network B (fig. 3.8.1).

This method is recommended for use with the lower output ceramic cartridges, when the capacitor can be about 50n to 100n: the larger it is the better the bass response.

The treble can be increased by fitting a small resistor (100E – 500E) in series with the capacitor.

c) By loading the cartridge to give RIAA response. The cartridge's manufacturer will often be able to recommend a particular loading network, but the table below gives some specific networks.

MAKE	CARTRIDGE	A	B
BSR	C1	47KΩ	∞
DECCA	DERAM	0	22KΩ 10KΩ .01μF
GOLDRING	CS 90	220KΩ 150pF	22 KΩ
SONOTONE	9TAHC	68KΩ .001μF	8·2KΩ

This method is recommended if the cartridge manufacturer gives a specific matching circuit.

However, since ceramic pickups are generally inferior in performance to most magnetic types we recommend the use of a magnetic pickup. Almost all of the magnetic pickups will feed happily into the 50K impedance of the Stereo 60 direct, with no additional matching network.

3.9 Mains Switch

The mains switch fitted to the Stereo 60 makes two connections when in, and makes a third when out, the first being broken.

Contacts are made between terminals 1 and 2 and between 3 and 4 when the switch is in, and between 5 and 6 when out.

The switch is rated at 2a, 250v and can be used to switch the power to the mains power supply as well as to the turntable and other equipment up to 500 VA.

Mains wires to the switch should be twisted together tightly and kept away from any input wiring. More details of this are given in figure 2.3 and section 2.4.

Contacts 5 and 6 are not normally used for switching the mains.

3.10 MONO USE

Mono/Stereo Switching is not strictly necessary since, with a stereo record player, stereo records come through in stereo and mono records will come through in mono. With a stereo tuner switching is normally accomplished by the decoder.

If a mono input is to be fed into the Stereo 60 used with only one Z.30 all connections to the left hand channel of the Stereo 60 and to the left hand Z.30 can be omitted entirely.

If a mono signal is to be fed to both channels input Ⓛ and input Ⓡ should be connected together and the input fed via the appropriate matching network to the combined input, as in section 3.8.

Mono switching can be accomplished by shorting together points MR and ML on the aux., switch, shown in fig. 3.3. If these points are shorted any signal fed into either Ⓛ or Ⓡ input will be amplified by both channels.

If the mains 'on' switch is not required this can be used. Connect contact 5 to MR and contact 6 to ML. DO NOT DO THIS if the switch is used for mains. Otherwise a separate single-pole toggle (or other type) on/off switch can be used.

An alternative, comprehensive, switching circuit is given in section 4.15.6.

3.11 Tape recorder output.

A signal of approximately 120 mV, unaffected by tone and volume controls can be taken from points between TR (or TL) on the pickup switch and earth to feed to a tape recorder. This signal is not suitable for feeding direct to a tapehead.

4. Z.30

4.1. Technical Description

The input signal is fed to the base of TR1 which is one of the long-tailed pair TR1 and TR2. The input signal is compared with the signal on the base of TR2 and any difference in the two is amplified and fed to TR3, which provide the voltage gain necessary to drive the driver and output transistors which provide the required current gain.

Negative feedback is provided via R8 and R7 and because the difference in base signals of TR1 and TR2 can never be large the output voltage is accurately defined as $\frac{R8 + R7}{R7}$, i.e. 40, times.

TR4 and TR5 provides a constant current collector load for TR3 and it is this circuitry that enables the Z30 to give such low distortion. It also means that, since the current through R9, which provides d.c. forward bias for the drivers and output transistors, is constant and independant of the power supply voltage the quiescent current is affected only very slightly by the power supply voltage.

TR1 and TR2 also compare the d.c. voltage on R1/R2 junction with the d.c. voltage at the output so that the output voltage is maintained at approximately half the supply voltage over a wide range.

These factors enable the Z12 to give optimum performance over a voltage range from 9 to 35v.

Fig. 4.3. Components Layout

See overleaf

4.4. Typical performance specification

Maximum supply voltage	35
Maximum supply current	1A
Quiescent current	13 mA at 12v
	15 mA at 25v
	17mA at 35v
Voltage gain	40
Signal to noise ratio	70dB
Minimum load impedance	3Ω
Output impedance	
input sensitivity for	10w, 3Ω load: 125 mV
	10w, 7Ω load: 200 mV
distortion	0.02%
frequency response	20 Hz to 300 KHz ± 1 dB
input impedance	100K and 1nF

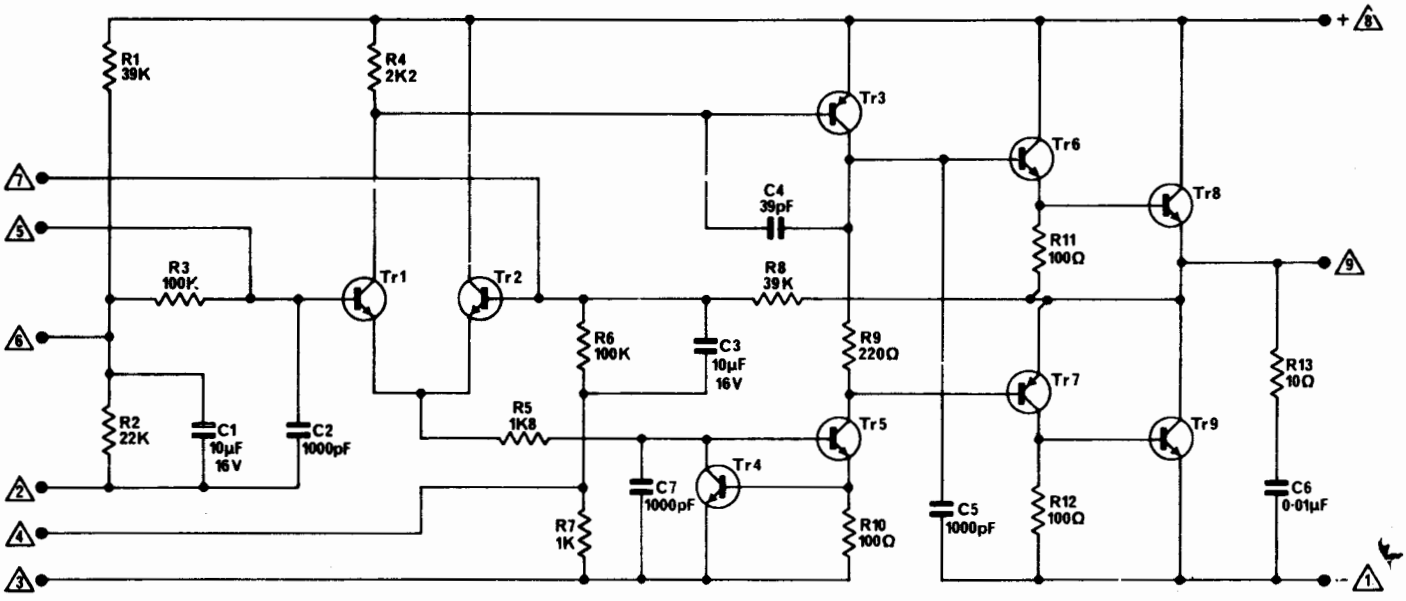


Fig. 4.2. Z.30 Circuit Diagram

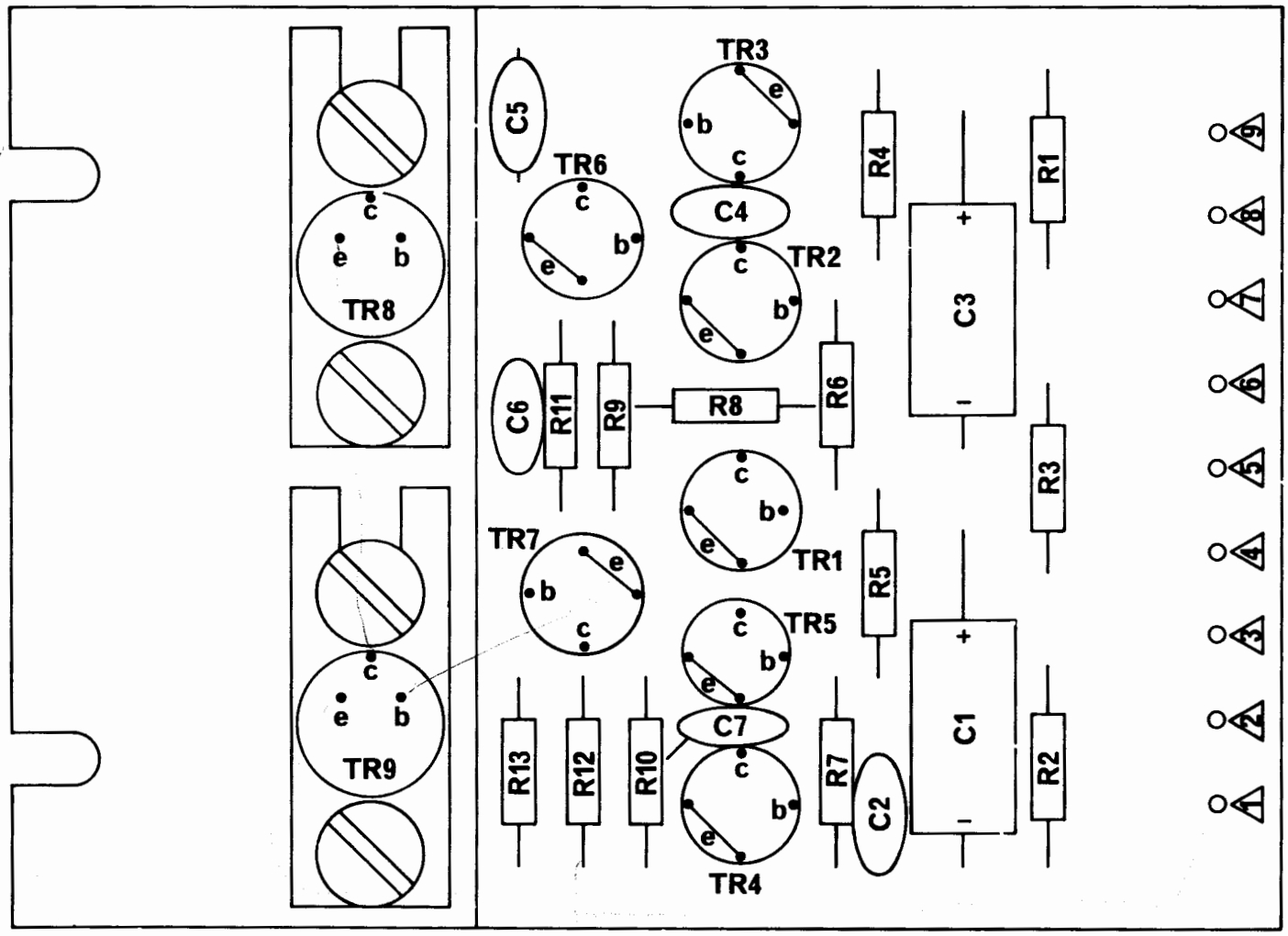


Fig. 4.3. Components Layout

4.5. Factors affecting the output

4.5.1 Power Supply and Loudspeaker impedance effects.

The Z30 acts substantially as a voltage amplifier so that the voltage at the loudspeaker will depend only on the voltage applied to the input, subject to the limitation that the peak-to-peak output voltage can never be greater than the supply voltage and in practise is below this by about 3-5v.

The loudspeaker behaves approximately as a resistor so that the power can be calculated:-

Assuming a sinewave of maximum amplitude V, where V is about 3-5v less than the power supply voltage, the rms output will be $\frac{V}{2\sqrt{2}}$. The output power will be $\frac{V^2}{2\sqrt{2}} R_L$ where R_L is the load impedance.

Therefore maximum power will be given into a low impedance from the higher supply voltages. A typical correlation between available power and power supply voltage is shown in Fig. 4.6.

4.5.2. Gain

The open circuit voltage gain of the amplifier is defined by R7 such that the gain, $A = \frac{R8 + R7}{R7} = 40$

Thus a signal of x volts at the input will produce 40x volts at the output provided the peak to peak voltage at the output does not exceed the maximum voltage swing V (see 4.5.1.)

4.5.3. The above for the non-technical

The Z30 (and any other amplifier) can only increase its signal input (from the pickup etc.), by a certain factor called its gain. If the output is insufficient more input is required, or the amplifier's gain has to be increased.

The output cannot exceed a maximum (even ignoring safety considerations). If too much input cause load passages to sound broken up and scratchy the output is limited and in this case the power supply voltage may be too low or the loudspeaker inefficient or of too high an impedance.

The impedance of the loudspeaker, will affect the 'loudness' of the amplifier but an efficient 16Ω working at 1w can sound louder than an inefficient 3Ω working at 10w.

4.6. Power output and voltage limitations.

Figure 4.6 shows the available power for varying loudspeaker impedances plotted against supply voltage.

Voltage: 35v is the absolute maximum working voltage of the amplifier. 12v is the recommended minimum, since the amplifier will give little power at 9v.

When used with a 3Ω loudspeaker the voltage should not normally be in excess of 25 although 30v is permissible provided adequate heatsinking is used and the switch-on surge reduction circuit (fig. 4.17) is fitted. The Z30 should not be used continuously at this level and any sinewave testing should be of short duration only.

It is dangerous to operate the Z30 with load impedances of less than 3Ω unless the power supply is reduced. The dotted line shows the approximate maximum continuous powers allowable at different voltages.

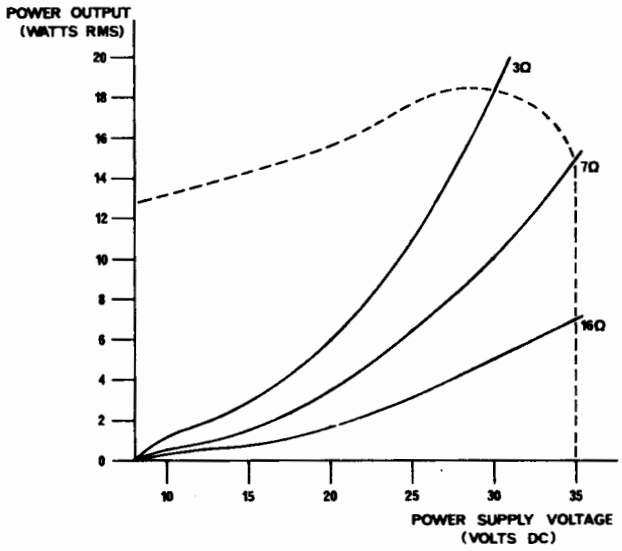


Fig. 4.6.

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The end bearing the connections need not be fixed down and can be left freely floating if desired.

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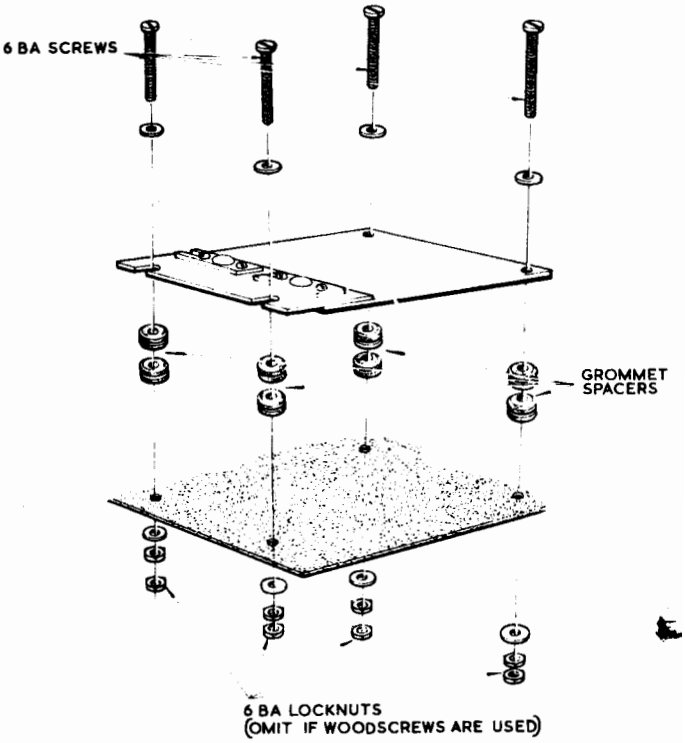
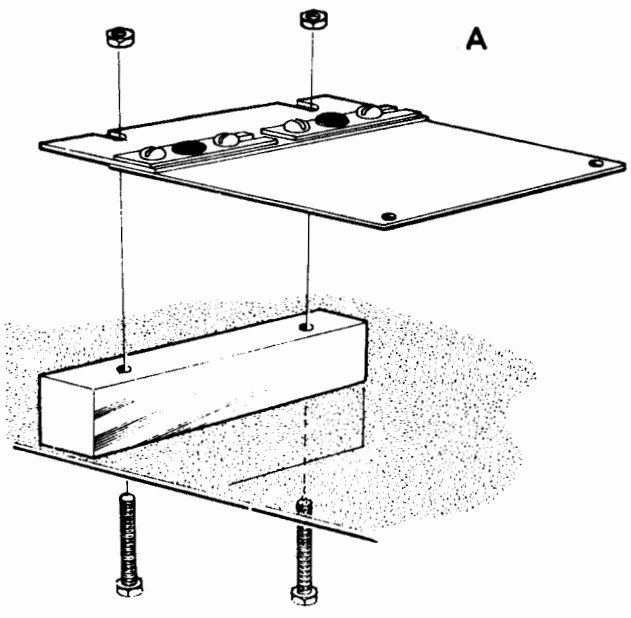


Fig. 4.7.2.



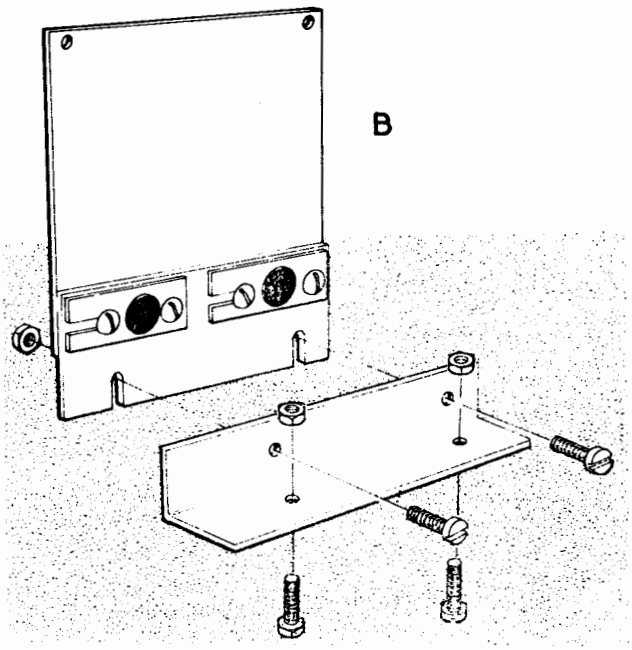


Fig. 4.7.1.

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The table shows typical current consumption, based on sinewave (continuous) levels at various voltages.

	3Ω	7Ω	16Ω
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25	800mA (12w)	400mA (6.5w)	200mA (3w)
20	600mA(6w)	300mA(3.5w)	150mA (1.5w)
15	400mA (3w)	200mA(1.5w)	100mA (3/4w)
12	300mA (2w)	150mA (1w)	75mA (3/4w)

The above figures are a guide only and are generally within 20%.

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Because of the low current consuption batteries are a very suitable power supply; 12v, 18v or 24v are suitable combinations.

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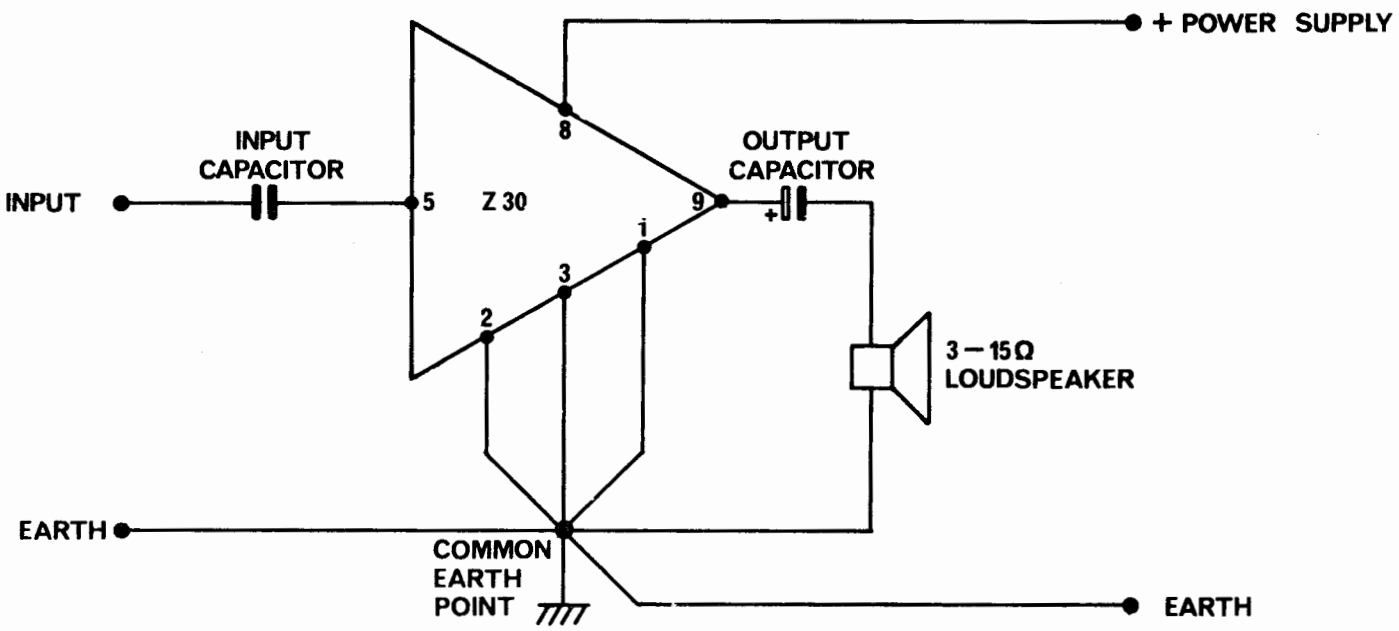

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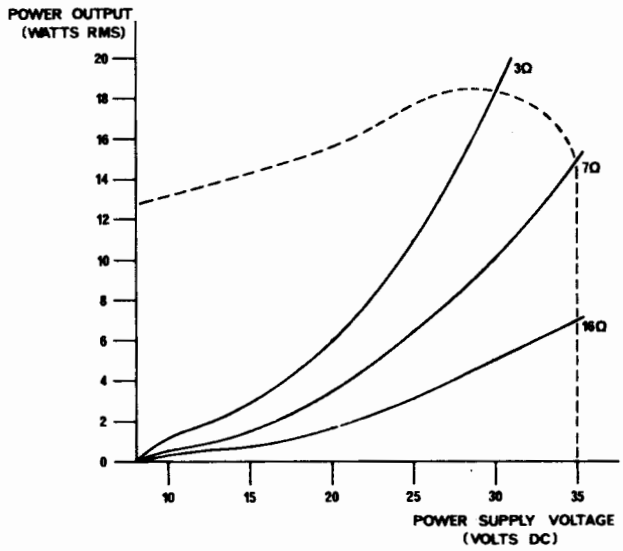

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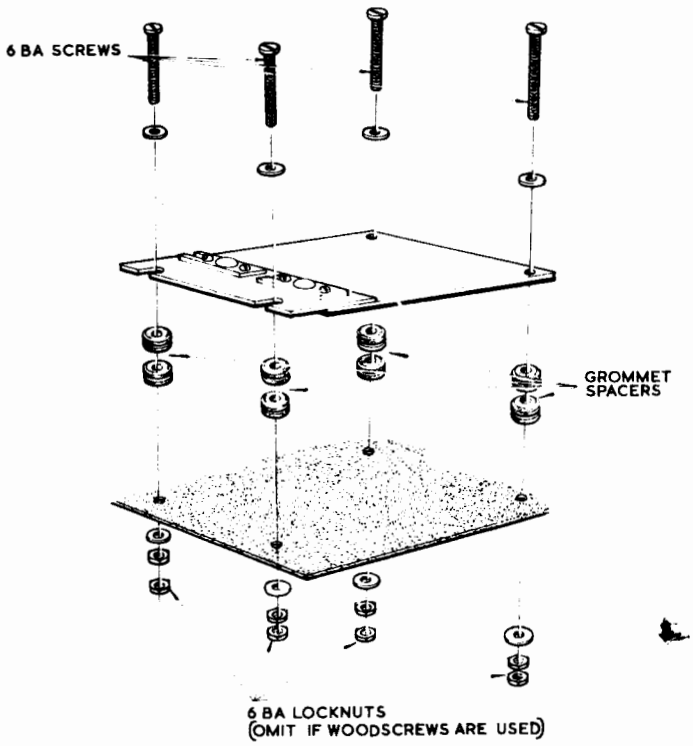

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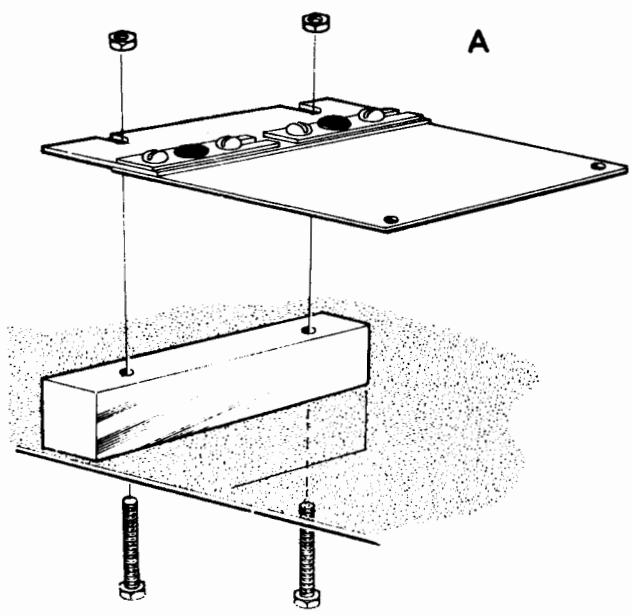

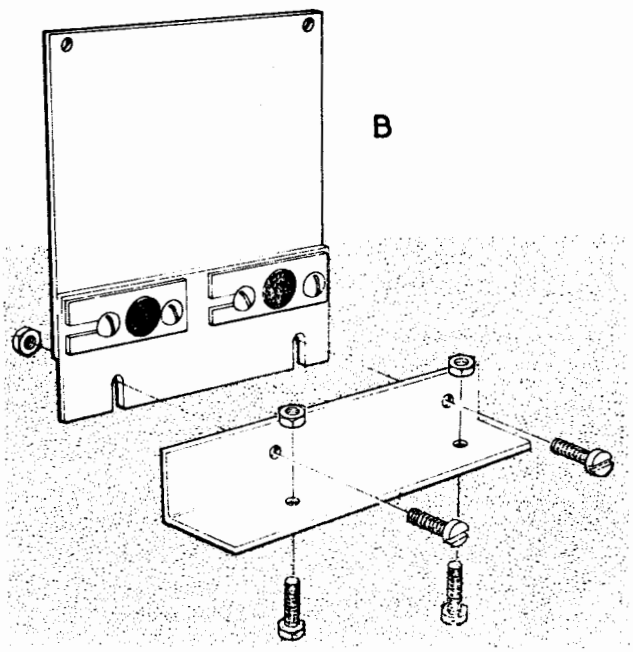

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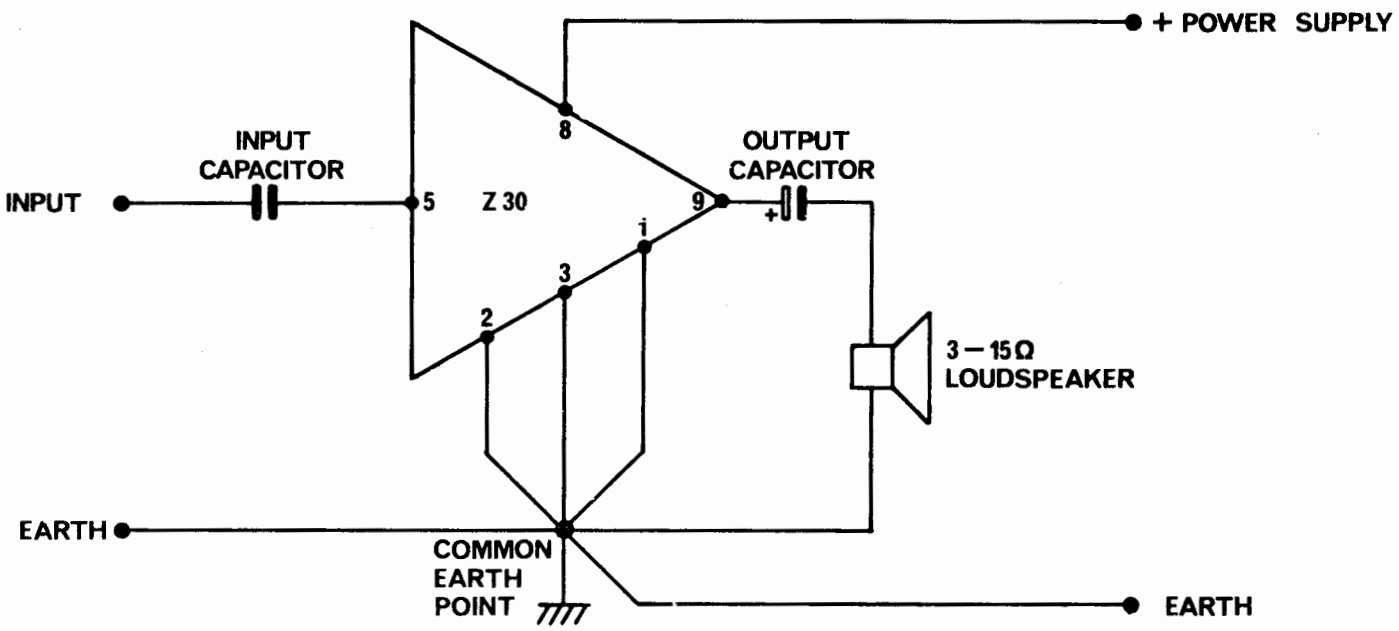

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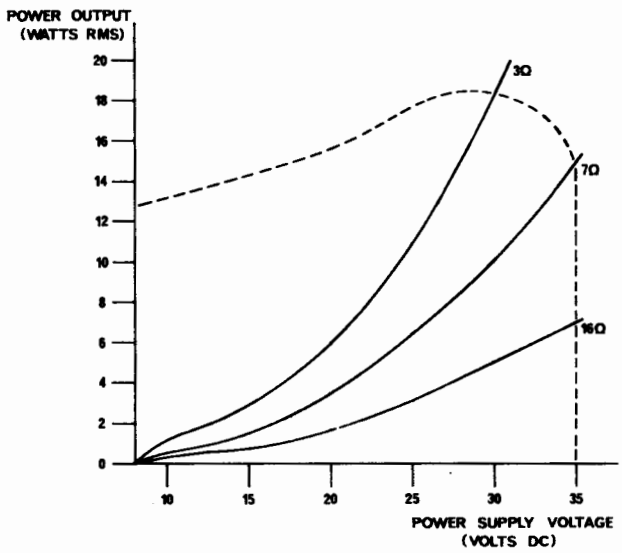

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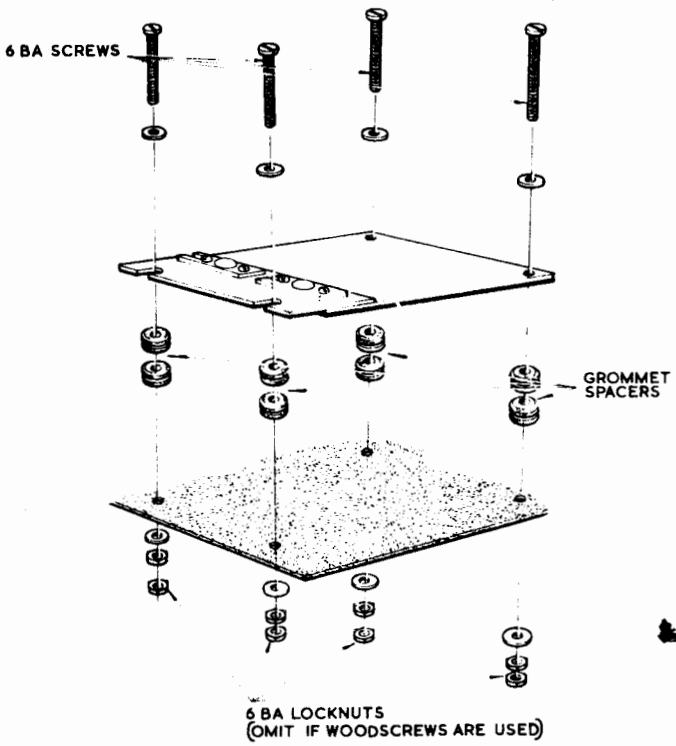

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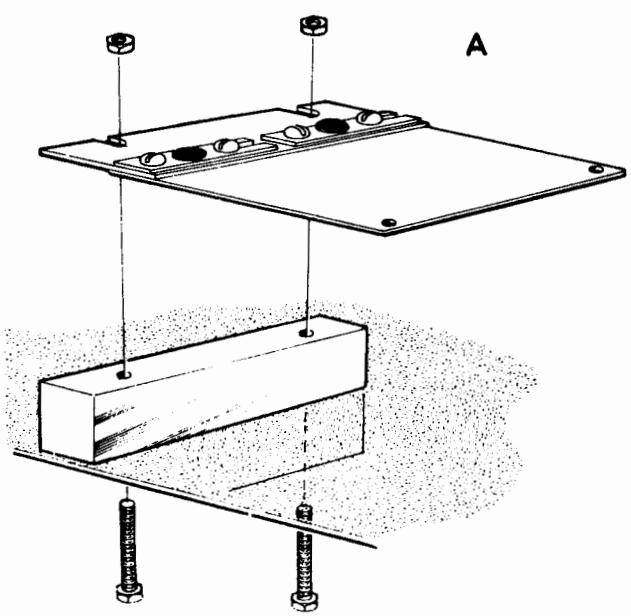

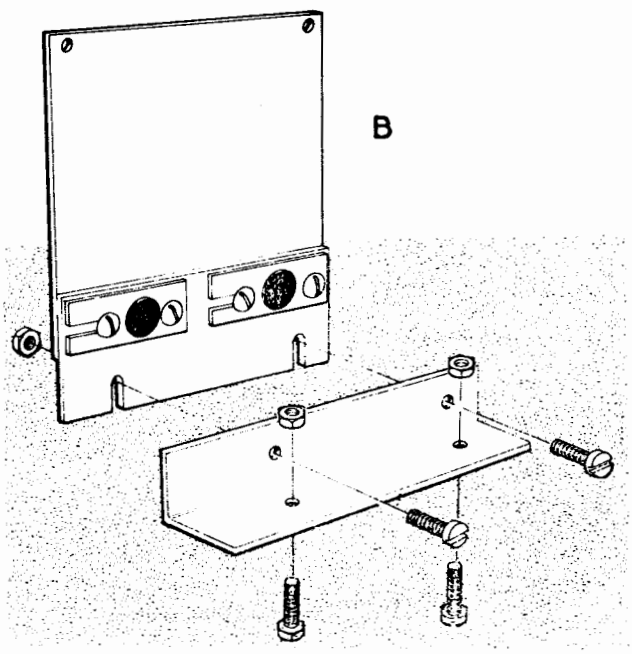

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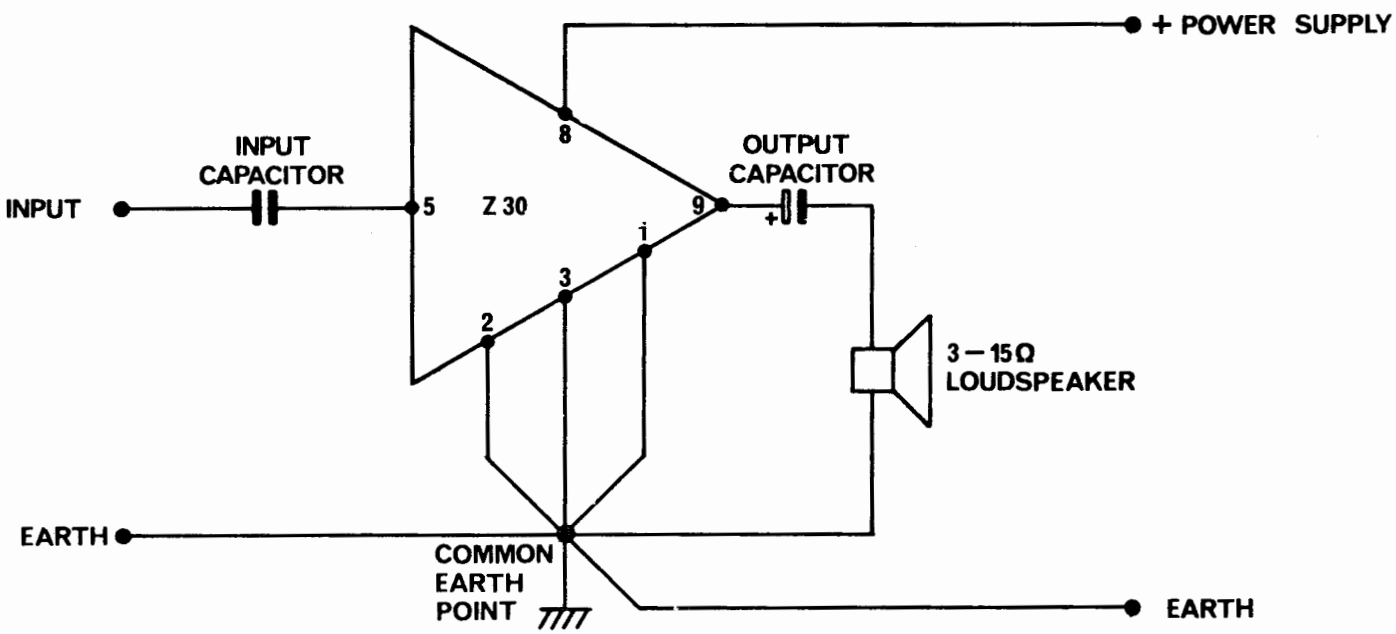

Fig. 4.11.1

UNDER NO CIRCUMSTANCES must the Z30 be run into a normal load without this output capacitor.

The capacitor is to be connected in series with the live loudspeaker lead as shown in fig. 4.11.1.

The recommended value for various load impedances is

500μf	for	15Ω
1000μf	for	8Ω
2000μf	for	3Ω

Use of too small a capacitor will result in loss of bass: the bass response will be -3dB at a frequency, F, where

$$F = \frac{10^6}{2 R_L C}$$

Where F is the frequency in Hz, R_L is the load impedance in ohms and C is the output capacitor in microfarads.

The capacitor should be rated to work at a voltage greater than half the power supply voltage, thus from 35v supply this capacitor must have a voltage rating of at least 18. For safety it is best to close a value above this, i.e. 25v working.

4.12.2 Output to Headphones

The Z30 can be used to drive headphones of any impedance between 10K and 3Ω. The circuit is shown in fig. 4.12.2.

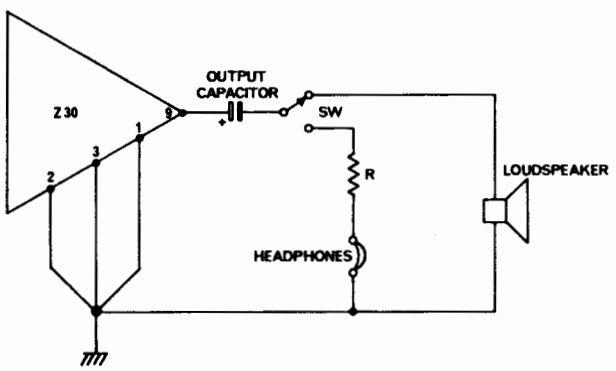

Fig. 4.12.2.a.

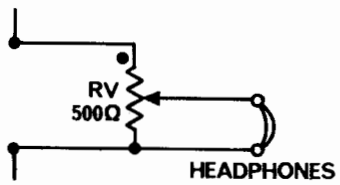

Fig. 4.12.2.b.

C is the output capacitor, as in section 4.12.1., if the Z30 will also be used to drive a loudspeaker.

SW1 is a headphone/loudspeaker switch shown in the loudspeaker position.

R is a resistor of typically 270 E (it may vary between 10 E and 1K depending upon the headphones) which is chosen to give a comfortable earphone volume level at the control setting normally used for loudspeaker listening.

If separate volume control of the headphones is required the circuit of fig. 4.12.2b can be used in place of the headphones in fig. 4.12.2a. Rv is an ordinary wire-wound type.

If the loudspeaker listening is not required SW can be dispensed with and C decreased to 100μ.

4.12.3 Output via transformer

The Z30 can be used via a matching transformer to drive inefficient 15Ω loudspeakers, or it can be used with a 100v line or other matching transformers. However since the primary d.c. resistance of some transformers is low there can be danger to the output transistors from switch-on pulses. The protection circuit of 4.17 must therefore be used and the output capacitor should not be greater than 1000μF.

4.12.4 Electrostatic loudspeakers

No special precaution need be taken with capacitative loads since the Z30 is stable with such loading. However the precautions required for transformer output should be taken: see section 4.7.

4.13 Input

The input between ⑤ and ② has a dc voltage present and therefore an isolating capacitor must be used, this is shown in fig. 4.10.1 and will be included in the circuits given where appropriate. Failure to use this capacitor when necessary will prevent the Z30 functioning at all.

The value of C will again affect the bass response, which will be -3dB where

$$F = \frac{10^6}{2 C \times 10^5}$$

F is the frequency of Hz

C is the value of the input capacitor in F

By a diligent choice of the capacitor and of C in fig. 4.11.2 bass roll-off can be provided of -6 dB per octave, giving a simple rumble filter.

4.14 Increasing the Gain

The voltage gain of the Z30 is controlled by R8 and R7 (see section 4.7). For input devices (pick-up etc), giving too low an output the gain can be increased by fitting a resistor between ③ and ④. This resistor will not normally be less than 100E, although even more gain can be obtained by reducing further. The lower the resistor the greater the gain.

Unfortunately greater gain can only be obtained by increasing the Z30's distortion, but a large increase is possible before this becomes even audible.

4.15 Control Circuits

Throughout these circuits a dot indicates the contact at the clockwise end of the track.

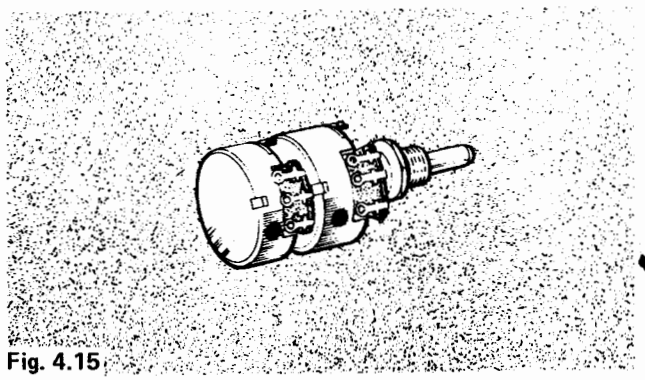

Fig. 4.15

4.15.1. Z.12 Simple Volume Control

The valve of the potentiometer is not important but it should not be higher than 100K.

Suggested values 47K, 22K, 10K or 5K. It should be a logarithmic law, but a sem-log or linear type can be used.

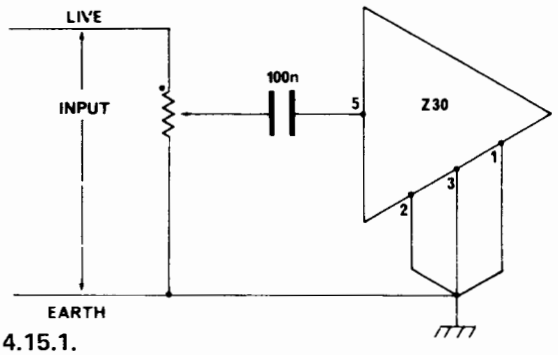

Fig. 4.15.1.

4.15.2 Simple Stereo Volume and Balance Control

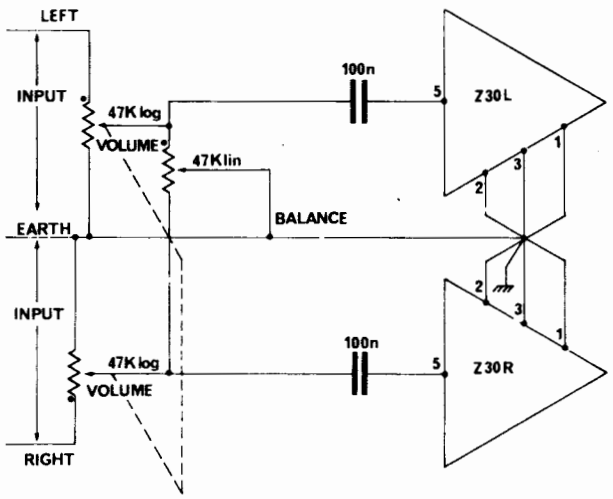

Fig. 4.15.2

4.15.3 Alternative Stereo Volume and Balance

This circuit will result in a small loss of gain with the balance control at mid-rotation.

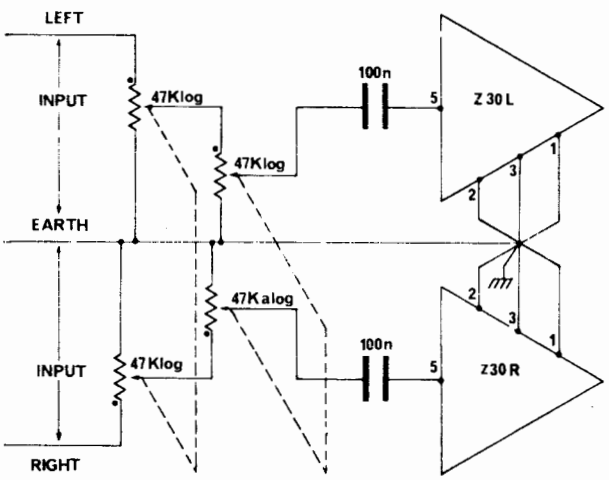

Fig. 4.15.3

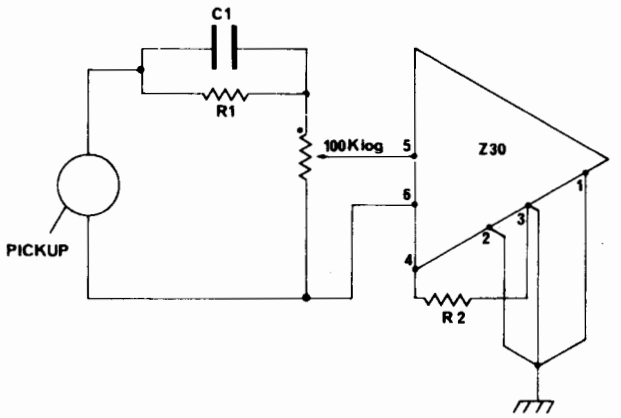

Fig. 4.15.4

R1 should be 330K for most pickups. Increasing R1 will give less gain but will result in an increase in bass response.

C1 should be about 300pF: higher if more treble is needed, lower if less.

R2 is to increase the Z30's gain, its value is between 100E and 1K. The lower it is the greater the gain but it will also increase distortion, although this will not be very noticeable until it is near 100E.

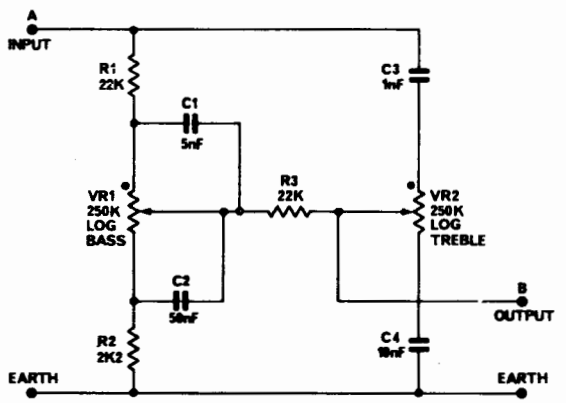

Fig. 4.15.5

Input to the tone controls is between A and E.

Output is from B and E and can be fed via the volume control circuit of 4.15.1.

The circuit gives ± 15 dB at 100Hz and 10KHz. There is some slight attennuation of frequencies above 12KHz when fed into the Z30 without the volume control due to the loading effect of C2 in the Z30.

The tone control cause a voltage loss of about 12, so the sensitivity to point A is approximately 1.2v, which must be fed from a low impedance source, less than 10K. Some tuners and tape recorders will feed the controls satisfactorily and increased gain can be obtained as detailed in section 4.14.

A suitable preamp for a crystal pickup is shown in fig.4.15.6.

Alternative tone controls are available with a preamp for magnetic cartridges as the Stereo 60 (section 3).

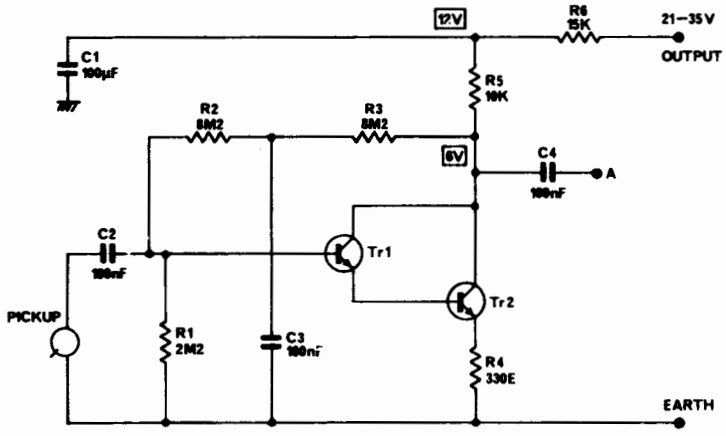

Fig. 4.15.6

Current consumption of the above circuit is approximately 600µA from 21v supply. If the supply voltage is reduced below 21v, R6 should be reduced to keep a voltage of not less than 12 on C1.

R3 can be adjusted if necessary to keep the voltage on point 'A' at about 6v (half C1 voltage).

Input impedance is about 1M5 to 2m and the voltage gain is about 25, giving an input sensitivity when used with 4.16.5 of about 50mV suitable for most ceramic pickups. With the higher output cartridges R4 can be increased to 1K or 2K2 to reduce the gain.

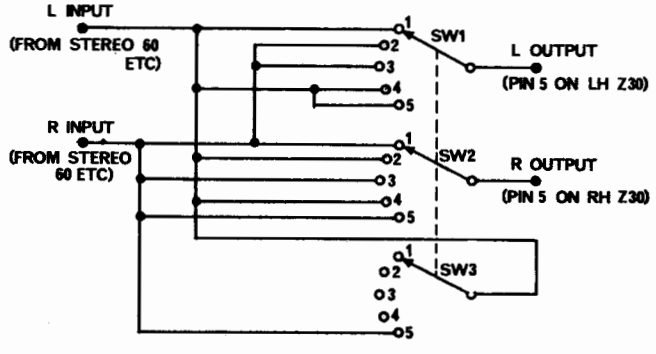

Fig. 4.15.7

Fig. 4.15.7 shows a comprehensive mono/stereo control which can be inserted between the volume control or other input circuit used and terminal (5).

All wires to this should be screened and kept as short as possible.

The balance control will only operate as such when the switch is in the normal stereo mode.

4.16 Application notes

4.16.1 High power low distortion audio oscillator

The output is fed back, via an attenuator consisting of a 6v bulb in series with RV3 and the Wien Bridge consisting of R1, RV1, C1, R2, RV2 and C2 to the input.

In operation the lamp will glow giving a visible indication of operation. If the output increases for any reason the bulb's resistance will increase, reducing the signal fed back and hence stabilizing the output.

With a 6v 0.3a bulb R3 can be 1E5 but a variable resistor can be used if it is required to vary the output. R3 should not be reduced to too low a volume or instability will result. Reducing R3 will cause the bulb to grow dim and if an output below 6v is required a lower voltage bulb should be used, when the value of R3 can be increased.

The frequency is determined by the Wien Bridge network and will be approximately 1K Hz when RV1 + R1 = RV2 + R2 = 10K and C1 = C2 = 15nF.

The circuit will give 15w sinewave, from 35v supply, at 0.15% distortion into 8Ω load, and 1w into 15Ω at 0.05% distortion.

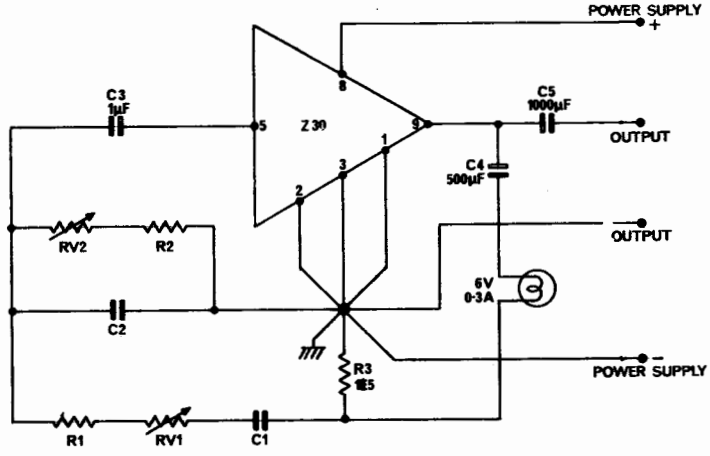

Fig. 4.16.1.a.

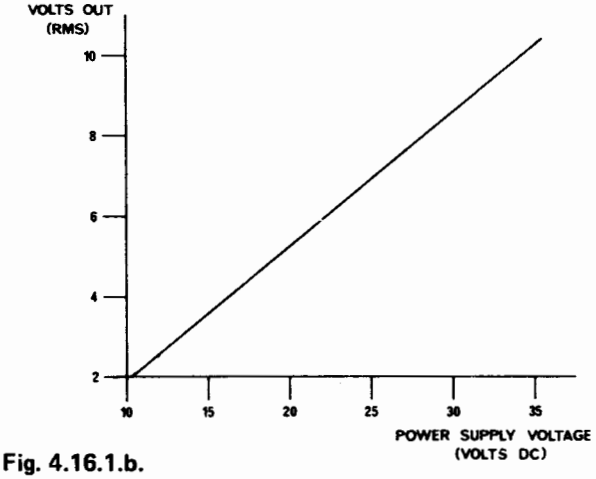

Fig. 4.16.1.b.

Fig. 4.16.1b gives the approximate r.m.s. sinewave voltage obtainable into an 8Ω, 15Ω or greater load at various power voltages.

The circuit will oscillate at up to 200KHz, although the distortion rises considerably at high frequencies.

The circuit can be used for testing loudspeakers, as a general purpose signal generator. It could also be used, via a suitable transformer, to drive a tape erase head or to supply up to 15w power at any audio frequency, to drive a small motor etc.

4.16.2 Full bridge circuit 30w rms amplifier.

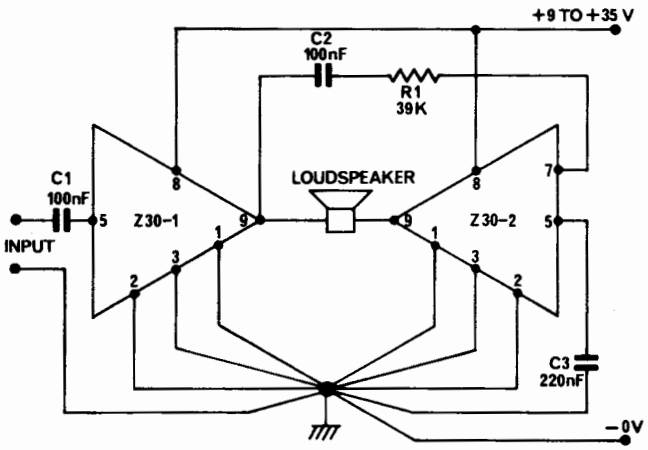

Fig. 4.16.2.

For some purposes where very high power is required or when a large power has to be delivered to a high impedance load the circuit of fig. 4.16.2 can be used. This will deliver approximately twice the power, into 15Ω, that can be delivered into 7.5Ω, by the normal circuit, i.e. 30w rms continuous at 35v or 12w at 24v. It can be used with 7.5Ω load at a maximum of 30v and up to 40w rms output, or about 20w rms from 24v. It is not recommended for operation into 3Ω.

Amplifier 1 is used in the normal mode and a signal is fed from its output to the out-of-phase input (7) on the second Z30, whose in-phase input (5) is earthed. This causes amplifier 2 to give an equal voltage out of phase with amplifier 1. The louspeaker is now connected direct between the outputs. No isolating capacitor is required since the d.c. levels at terminals (8) are identical for both amplifiers. The outputs of the amplifiers are effectively in series, thus doubling the voltage swing available and giving four times the power into the equivalent load.

4.17 Switch on surge

At switch on a large voltage is immediately developed across the loudspeaker, which can be at the least annoying and may be damaging if a 3Ω loudspeaker is used.

Fig. 4.17 illustrates additional components to reduce this surge. A further improvement can be made by fitting a large capacitor (1,000μ) between 6 and the earth point.

The diode can be any silicon type such as Y630, ISJ50, ISJ150 etc.

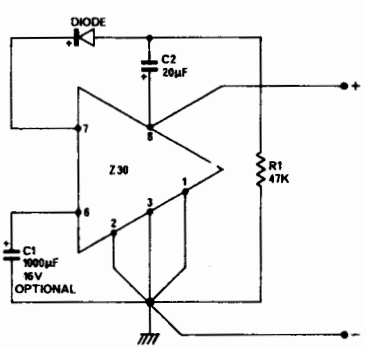

Fig. 4.17

If the Z30 is used with a 3Ω loudspeaker with power supply voltage of 25 or greater this circuit must be used to avoid possible damage to the output transistors.

It must also be used if the Z30 is used with an output transformer of any description.

5. POWER SUPPLIES

5.1 Technical description

PZ5

The PZ5 uses a transformer with two primary windings and two secondary windings. The primaries are connected in parallel for 110-125v or in series for 220-250v. The secondaries giving a nominal 20v are full wave rectified to give a nominal no load 30v (with 250 a.c. input) across the smoothing capacitor. The circuit is shown in fig. 5.2.1.

PZ6

In the PZ6 the same transformer is used with the secondaries in series, bridge rectified to give a no load 60v across the smoothing capacitor. This is then stabilized to 35v at the output.

Since the voltage across the base-emitter junction of a silicon transistor is essentially constant under normal bias conditions, this voltage in Tr 4 is used as the reference and the output voltage stabilizes itself so that the ratio of the output to the voltage across R4 is in proportion to the ratio of R6 to R5. The output voltage can therefore be varied by adjusting R6. The circuit is shown in fig. 5.2.2.

5.2.1. Circuit PZ5

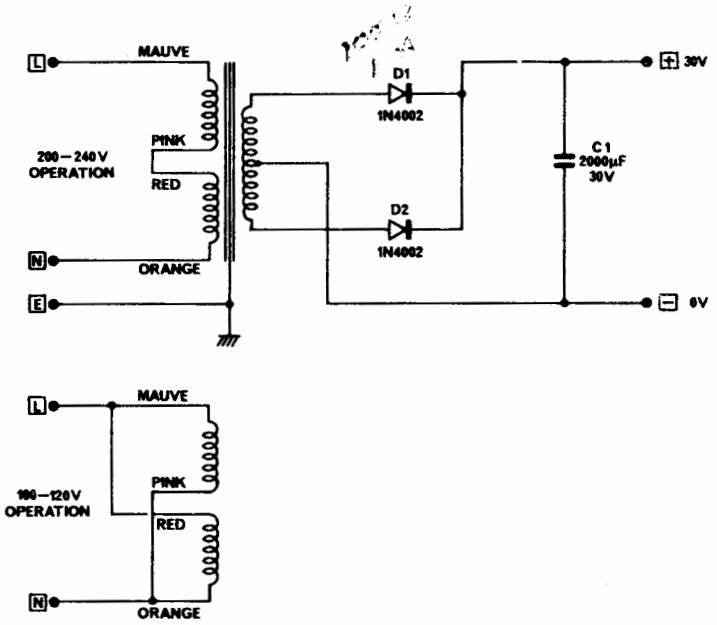

Fig. 5.2.1.

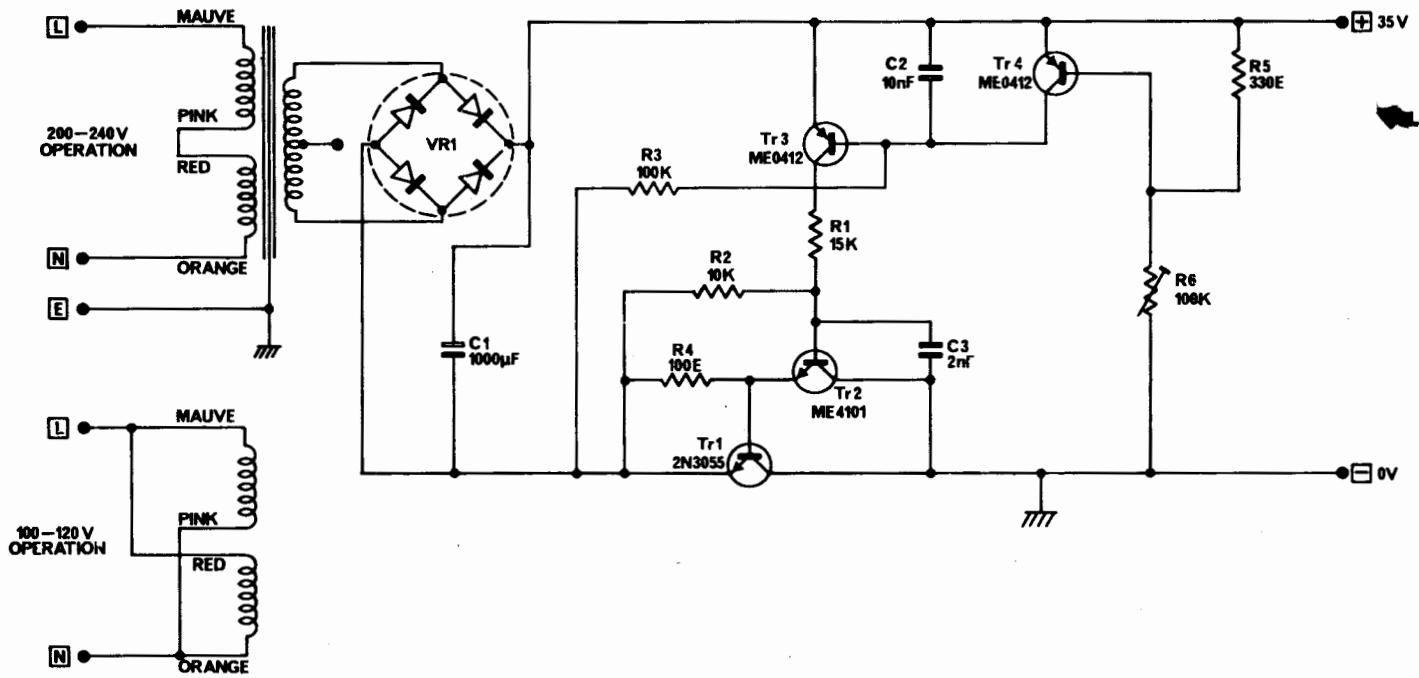

Fig. 5.2.2.

5.3. Mains connections

Mains connections are to be connected via a fuse (500mA or 250mA slow-blow) and a switch, to contacts L and N as shown in fig. 5.3.

The use of a fuse is vital and we will accept no responsibility arising from the omission of this fuse.

A connection E is also provided which connects direct to the chassis of the PZ5/6. If the PZ5 or 6 is not mounted on the same chassis as the rest of the equipment this terminal should be connected to the earth point.

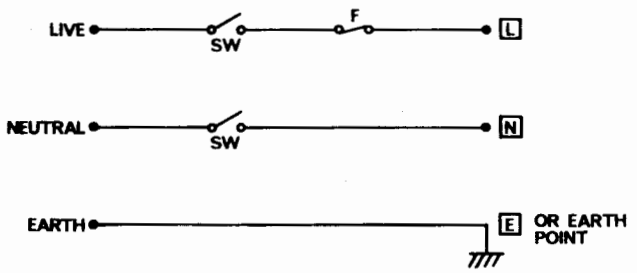

Fig. 5.3.

6. Conditions of guarantee

All units of Plan 60 are covered by 24 months guarantee under which we will rectify at no charge any fault due to defective components or manufacturing defects, subject to the following conditions.

(1) That the item concerned be returned to us separated from all external circuitry, properly packed so as to avoid damage in transit to us. The equipment must be returned direct to us, not through a third party.

(2) That the item has been used in accordance with our instructions and has been subjected to no form of mis-use.

(3) That no damage has been done by inexpert attempts to repair fault(s).

(4) That the equipment be returned with a letter stating:
Date of purchase.
Name and address of supplier.
The nature of the suspected fault.

(5) We cannot replace units which have been in any way used except at our discretion.

Service Outside guarantee period

If the conditions of the guarantee are not met we will repairs the fault or replace the unit at our discretion at a standard charge as follows:-

Z30	– 15/-
Stereo 60	– 20/-
Power Supply	– 20/-

Subject to the following conditions:

(1) That the equipment be packed properly so as to reach us undamaged.

(2) That the appropriate fee is enclosed with the parcel.

(3) That a letter be included stating the nature of the fault.

The standard charge includes components, labour and inland carriage, so we are not prepared to invoice for repairs. On invoiced jobs 5/- extra will be chargèd to cover the extra clerical work involved.

We will normally, if the module returned is in good condition, replace by a reconditioned module in similar condition and the guarantee will be transferred (not renewed). We reserve the right to replace or service items at our own discretion.

Please do not include orders or letters requiring an answer with goods sent for service.

Under no circumstances will we accept equipment back in customers own installations except by prior written agreement to do so.