Vol 20 No 5

THE

RADIO CONSTRUCTOR

DECEMBER 1966

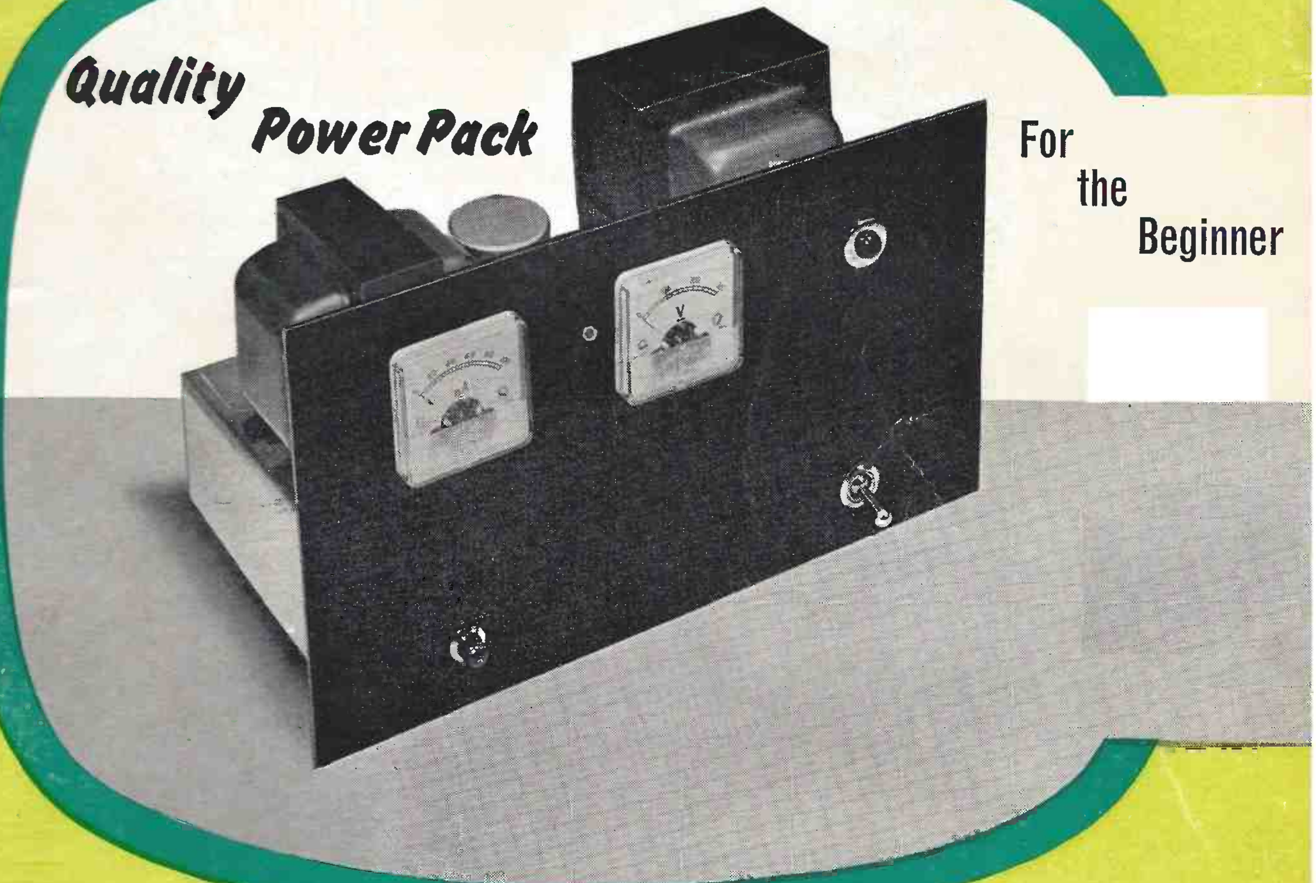
2/6

A DATA PUBLICATION

RADIO · TELEVISION
ELECTRONICS · AUDIO

Quality Power Pack

For the Beginner



In this issue 7 Silicon N.P.N. Planar Transistor Designs

- Square Wave Generator
- Capacitance Meter
- Simple Gas Lighter

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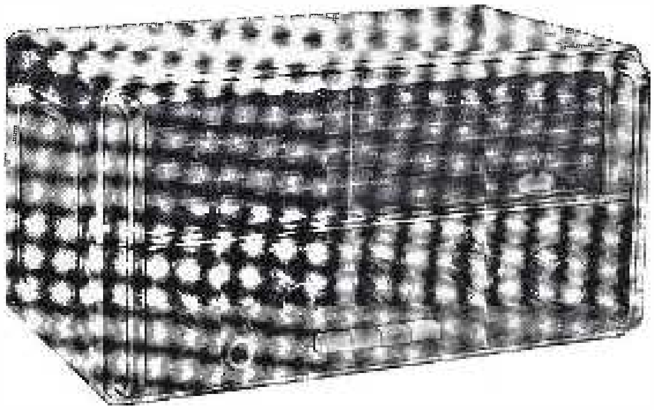

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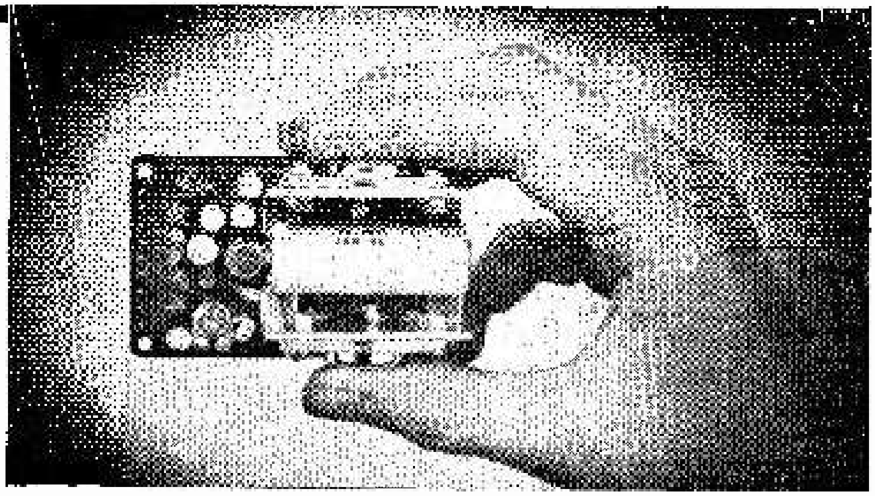

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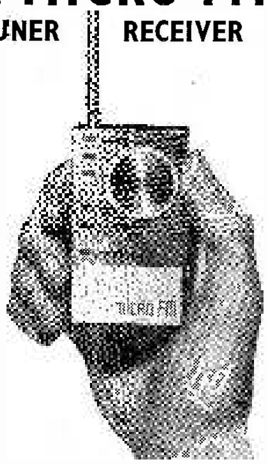

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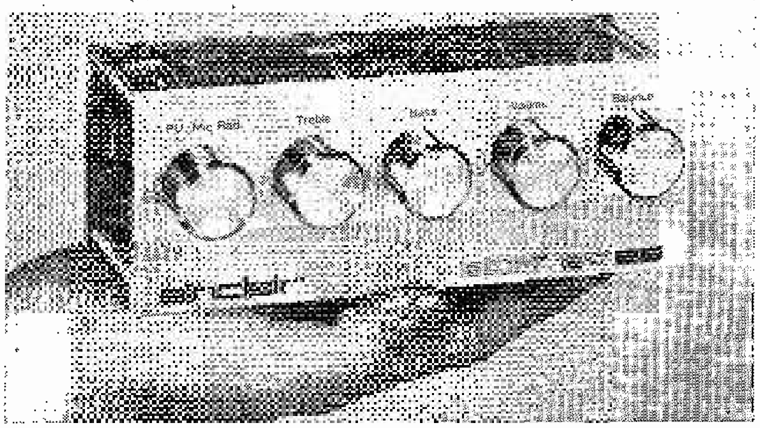
59/6



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★

Square Wave Generator for Audio Amplifiers

by A. Foord

Full constructional details of a simple two-frequency square wave generator, together with instructions on its use

SQUARE WAVES AFFORD A SIMPLE AND RAPID means of checking the performance of audio amplifiers. In this article a square wave generator built and employed by the author is described, after which details are given of square wave distortion by an amplifier having a poor characteristic.

Fig. 1 gives the circuit of the generator, and it will be seen that this consists of two transistors, TR_1 and TR_2, which form a multivibrator, and an emitter-follower, TR_3, to provide a low output impedance without loading TR_2. The signal at the emitter of TR_3 is some 7 volts peak-to-peak, which is in excess of any signal that would normally be required—even by a power amplifier. The signal is, therefore, "potted down" by R_5 and VR_1, so that about 3 volts peak-to-peak would appear at the upper end of VR_1 if diodes D_1 and D_2 were not in circuit. However, when the voltage across VR_1 reaches approximately 1.4 volts the diodes conduct (i.e. at about 0.7+0.7 volts with the silicon diodes employed) and limit the waveform to approximately 1.4 volts peak-to-peak. This circuit has the advantage of offering an output voltage independent of small changes of rail voltage, and also results in an excellent square wave. VR_1 thus gives an output variable from zero to about 1.4 volts peak-to-peak.

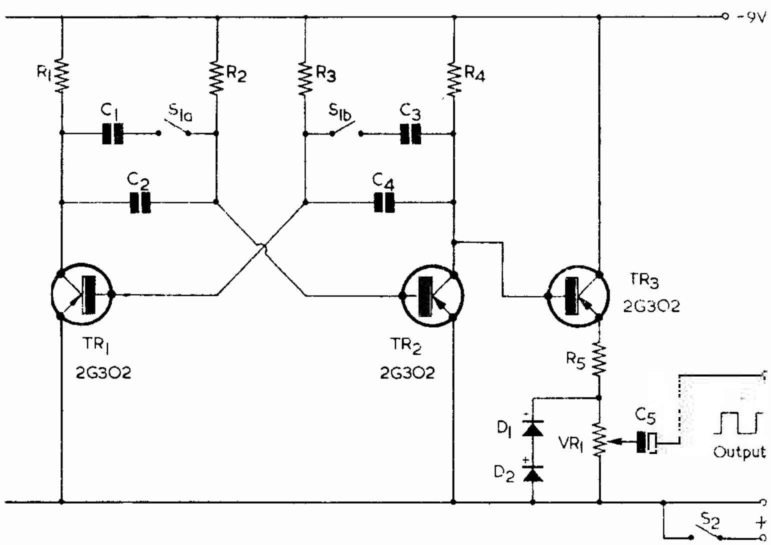


Fig. 1. Circuit diagram of the square wave generator

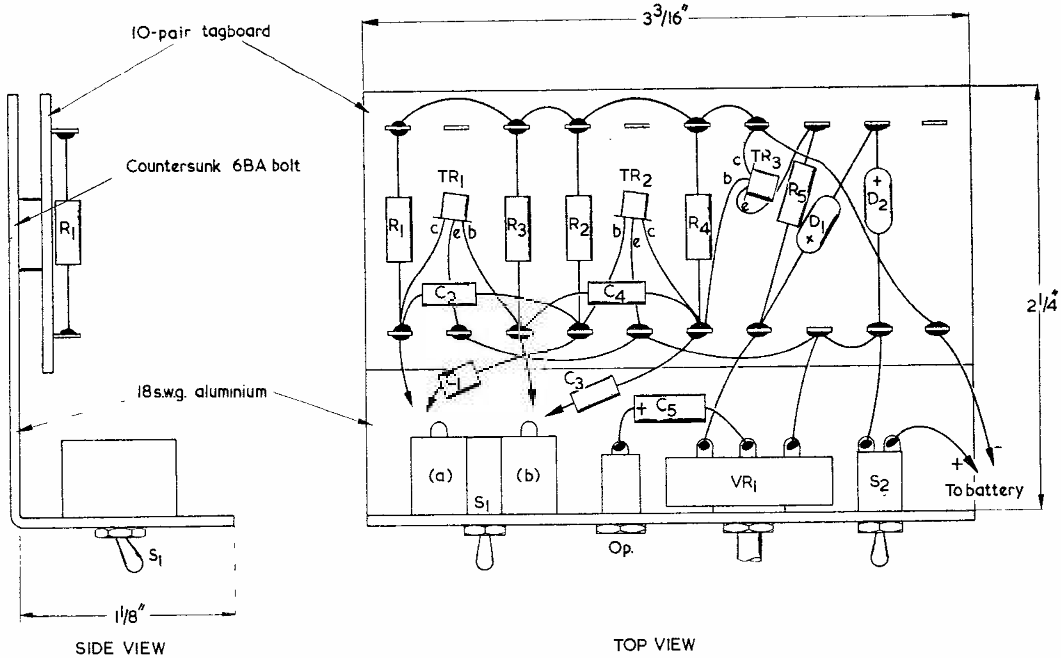


Fig. 2. Wiring and component layout

Two Frequencies

It is usual to test at two frequencies, a high and a low, and the author chose 140 c/s and 2 kc/s. The frequency of oscillation of the multivibrator with S_1 open is given, in c/s, by:

$$f = \frac{1}{0.7(C_2R_2)+0.7(C_4R_3)}$$

When S_1 is closed, the values of capacitor used in the formula consist of the parallel capacitance of (C_1+C_2) and (C_3+C_4).

To generate a wave with a 1 : 1 mark-space ratio, R_2 should be equal to R_3 and C_1 should be equal to C_3 (assuming S_1 is open). The formula then becomes:

$$f = \frac{1}{1.4\ CR}$$

The resistor values were fixed by the bias requirements for the transistors, and the capacitors were then chosen to give frequencies of 140 c/s and 2 kc/s. With S_1 open the capacitor value is 0.003μF, whereupon:

$$f = \frac{1}{1.4 \times 0.003 \times 10^{-6} \times 120 \times 10^3}$$
$$= 2 \text{ kc/s.}$$

With S_1 closed the capacitor value is 0.043μF

COMPONENTS

Resistors
(All resistors $\frac{1}{8}$ watt 10%)
- $R_{1,4}$ 8.2kΩ
- $R_{2,3}$ 120kΩ
- R_5 1.2kΩ
- VR_1 1kΩ wirewound

Switches
- S_1 d.p.s.t. toggle
- S_2 s.p.s.t. toggle

Capacitors
- $C_{1,3}$ 0.04μF paper
- $C_{2,4}$ 0.003μF paper
- C_5 25μF, electrolytic, 12V wkg.

Semiconductors
- $TR_{1,2,3}$ 2G302 (Texas Instruments) or OC75 Mullard)
- $D_{1,2}$ OA200 (Mullard)

Miscellaneous
- Miniature 10-way tagboard, type C125 (Bulgin)
- 2 insulated sockets, with plugs
- 1 9V battery

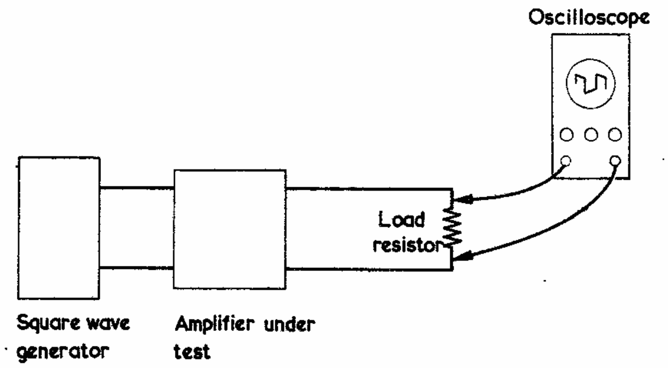


Fig. 3. Using the generator for checking audio amplifiers

in parallel with $0.04\mu F$) and:

$$f=\frac{1}{1.4\times 0.043\times 10^{-6}\times 120\times 10^{3}}$$
$$=140 \text{ c/s.}$$

The measured frequencies actually obtained with the prototype were 130 c/s and 1.8 kc/s, these being a little on the low side. This was to be expected, as paper capacitors are normally low tolerance components, and the error between calculated and measured frequencies is only 7% and 10% respectively in this case. For the testing purposes envisaged, it is not important to have exact frequencies.

Fig. 2 gives the layout and wiring diagram for the unit. A small 10-pair tagboard accommodates the components, and is secured to an L-section piece of aluminium which also takes the panel controls and output sockets.

Amplifier Testing

Fig. 3 shows how the square wave generator is used. A square wave is applied to the amplifier

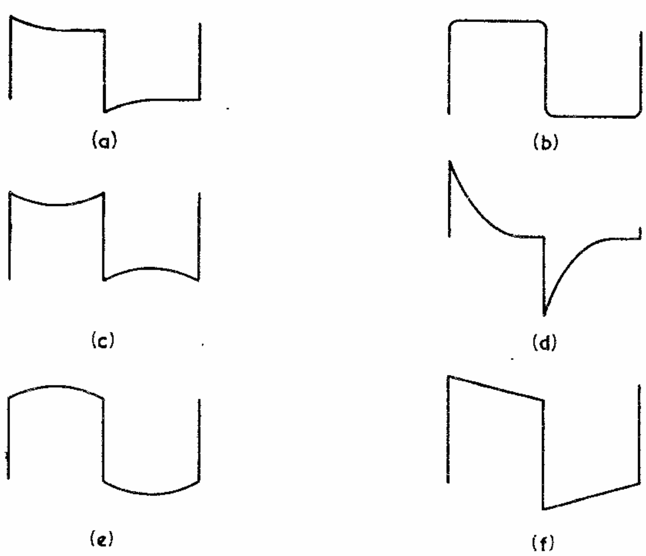
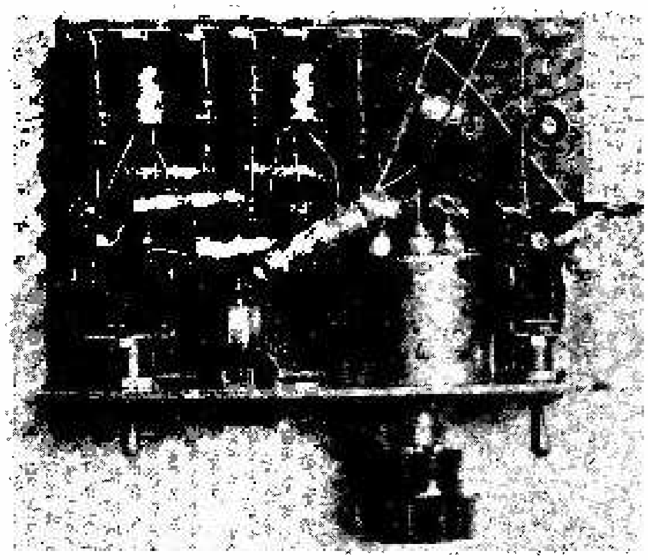


Fig. 4. Some of the waveforms likely to be encountered when a low frequency square wave is applied to an amplifier. The text discusses how these may be interpreted



A neat and tidy layout can easily be obtained, as is well demonstrated by this top view of the author's prototype generator

to be tested (which must be correctly terminated) and the output is viewed on an oscilloscope. The vertical amplifier of the oscilloscope must have a far better frequency response than the amplifier under test, and the oscilloscope sweep should be set to display a few cycles of waveform.

If the amplifier performance is good, both from the gain and phase shift point of view, then its output signal will be an excellent square wave. At the same time, defective or poor performance will be indicated by distortion of the square wave. A square wave contains many harmonics in addition to the basic frequency, so the amplifier is, in effect, tested simultaneously at a large number of frequencies. Only odd harmonics appear in a square wave. If the fundamental is considered as having an amplitude of 100%, then the amplitudes of the harmonics are as follows:

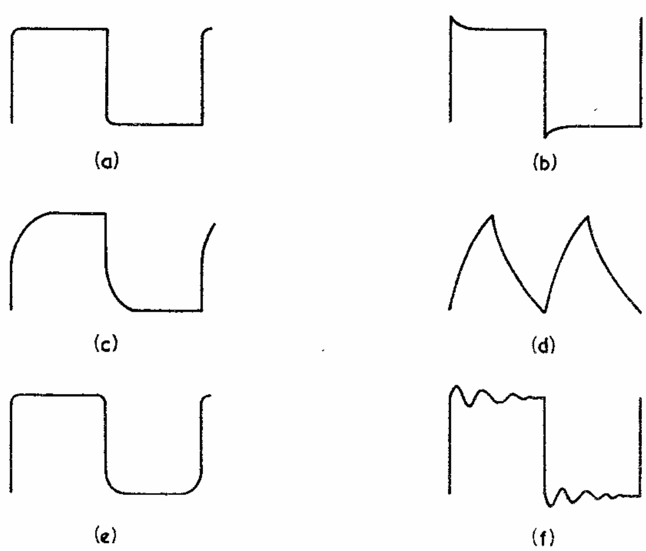


Fig. 5. Results with a high frequency square wave input

fundamental f—100%
3f—33.3%
5f—20%
7f—14%
9f—11%
and so on.

Phase shift of some of the frequency components in the square wave with respect to others, or unequal amplification across the band, causes characteristic changes in the resulting output waveform. This testing method is much faster than plotting a frequency response curve, but it does not give a quantitive measurement. On the other hand it does show the effect of transients, which sine wave testing cannot do.

Figs. 4 and 5 show the effect of various conditions in the amplifier. Fig. 4 is for the low frequency square wave input, and Fig. 4 (*a*) and (*b*) show an acceptable amplifier; (*c*) shows a low 1.f gain; (*d*) shows a very poor, unacceptable, l.f. response; (*e*) shows an emphasised l.f. gain, i.e. a peak in the frequency response curve; whilst (*f*) shows an excessive phase lead at low frequencies in the amplifier.

Fig. 5 shows typical results given by the high frequency square wave input. Figs. 5 (*a*) and (*b*) illustrate good acceptable h.f. responses; (*c*) shows an excessive phase shift at h.f.; (*d*) shows both excessive phase shift and low gain at h.f., and is a more severe condition of (*c*); (*e*) shows a low gain at h.f.; whilst (*f*) shows a ringing at h.f. Ringing is a tendency to oscillation usually observed in an incorrectly designed feedback amplifier, and can be corrected by modifying the feedback network to increase the gain and phase margins.

S.W.G. MEASUREMENT

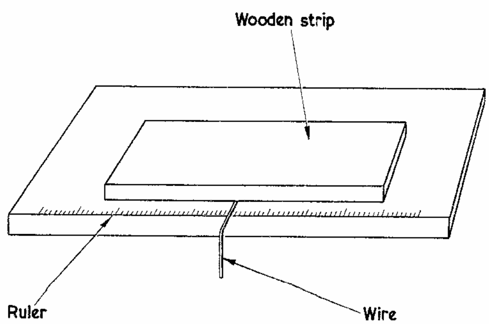
by C. P. Finn

THERE ARE MANY OCCASIONS ON WHICH THE constructor needs to find the s.w.g. figure for a piece of wire. Not possessing a micrometer screw gauge, the author devised the method to be described: the only requirements are a small flat household ruler and a strip of wood of similar size.

A small sample of the wire, say 2in, is cut off and bent into an 'L' shape. This is 'sandwiched' in between the ruler and the strip of wood as shown in the accompanying diagram. The wire is placed over one of the main divisions on the ruler.

With the aid of the wood strip, the wire is then rolled along the ruler for a distance of exactly one inch, and the number of turns and fractions of a turn which the wire makes, is counted with the aid of the short protruding arm of the 'L'.

From this number, the diameter of the wire may be readily calculated from the formula, $D = \frac{1}{\pi N}$,

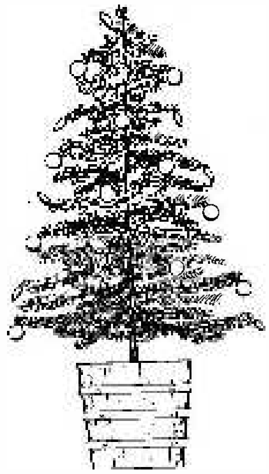


where D = diameter of wire, and N = number of turns. For ready reference, the author has calculated values for N over a range of s.w.g. sizes, these being shown in the table.

TABLE

S.W.G.	*D*	*N*
10	0.128in.	2.5
12	0.104	3.0
14	0.080	4.0
16	0.064	5.0
18	0.048	6.6
20	0.036	8.8
21	0.032	9.9
22	0.028	11.4
23	0.024	13.3
24	0.022	14.4
25	0.020	15.9
26	0.018	17.7
27	0.0164	19.4
28	0.0148	21.5
29	0.0136	23.4
30	0.0124	25.7
32	0.0108	29.4
34	0.0092	34.6
36	0.0076	41.8
38	0.0060	53.0
40	0.0048	66.2

The figures given in the Table for D represent the nominal diameter of the bare copper wire. Slight discrepancies will occur due to tolerances on diameter and to enamel coverings, but it should still be possible to arrive at the nearest s.w.g. number.—EDITOR.



Multivibrator With Single Resistance Control

SUGGESTED CIRCUIT No. 193

By G. A. FRENCH

It is sometimes necessary to be able to continuously vary the frequency of operation of a multivibrator whilst still retaining the mark-space ratio of its waveform. A typical instance is given when a multivibrator with a 50 : 50 mark-space ratio is employed as a tone generator. It would, in this case, be undesirable to employ a device such as a single variable resistor to control the period of one half of the cycle only, as occurs in a television timebase. Either a two-gang variable resistor or, if the charging capacitance values are sufficiently low, a two-gang variable capacitor, is required to effect a continuously variable change in frequency without altering the mark-space ratio.

With normal multivibrator component values, the charging capacitances are too high to allow the use of a two-gang variable capacitor. At the same time, it may be difficult to obtain a two-gang variable resistor of the value needed to change multivibrator frequency over the range required.

This month's Suggested Circuit demonstrates a method of control which enables the frequency of a multivibrator to be continually varied over a wide range by means of a single variable resistor, this being done without altering the mark-space ratio. The main purpose of this contribution is to introduce the basic circuitry involved. Since, however, the article is appearing in the December issue, some notes on employing the circuit for a Christmas party novelty device are also given.

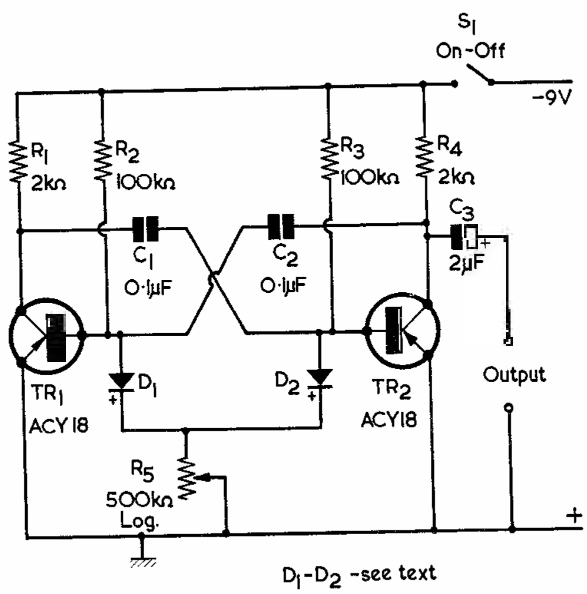


Fig. 1. The basic multivibrator circuit. Multivibrator frequency is controlled by R_5 without altering mark-space ratio

The Circuit

A circuit demonstrating the basic principle of multivibrator operation with a single resistance frequency control is shown in Fig. 1, this having been made up by the writer to check the practicability of the idea. The circuit is for a tone generator offering basic frequencies ranging from about 70 c/s to several kilocycles per second at a mark-space ratio of 50 : 50.

Fig. 1 should first be examined by assuming that diodes D_1 and D_2, and variable resistor R_5 are out of circuit. The diagram then represents a symmetrical free-running multivibrator in which the components controlling frequency are the base resistors R_2 and R_3, and the collector-base capacitors C_1 and C_2. The values of these components are such that a 50 : 50 waveform of about 70 c/s appears in the multivibrator. It will be appreciated that the period in the cycle over which either transistor is off (i.e. non-conductive) depends upon the values of the associated base capacitor and resistor. When, for instance, TR_1 becomes non-conductive its base initially has a potential which is about 9 volts positive of the positive supply line. The charge in capacitor C_2 then decreases as current flows in R_2, until the base of TR_1 is at the same potential as the positive supply line. At this stage multivibrator action occurs, resulting in TR_1 becoming conductive and TR_2 non-conductive. Under these conditions, a continuously variable control of frequency, whilst retaining the 50 : 50 waveform, could be given by fitting a two-gang variable resistor in place of R_2 and R_3.

Let us now examine the operation of Fig. 1 with D_1, D_2 and R_5 in circuit. At the instant when TR_1 becomes non-conductive, its base goes about 9 volts positive of the positive supply line. At once, diode D_1 conducts, causing the resistance inserted by R_5 to appear between TR_1 base and the positive supply line. Capacitor C_2 now discharges by way of two circuit paths, the first being via R_2 to the negative supply line and the second being via R_5 to the positive supply line. It will be apparent that the period needed for C_2 to discharge sufficiently far for TR_1 base to be at the same potential as the positive supply line may be controlled by R_5.

Whilst TR_1 is off, TR_2 is on (i.e. conductive). Since TR_2 base is at approximately the same potential as the positive supply line D_2 does not conduct. After the changeover given by multivibrator action, TR_2 will, however, become non-conductive. Its base then goes positive of the positive supply line and diode D_2 conducts. The period during which TR_2 is off depends on the rate of discharge in C_1 and this can similarly be controlled by R_5.

Thus, the single resistor R_5 controls the off-period of either transistor, it being brought into circuit, during the particular off-period, by way of D_1 or D_2 as applicable. Since the component values are symmetrical, variations in R_5 will not upset the 50 : 50 waveform offered by the multivibrator.

Provided that the base resistors (R_2 and R_3 in Fig. 1) have the same value, the basic circuit arrangement of Fig. 1 could also be employed for multivibrators offering output waveforms with a mark-space ratio other than 50 : 50. The mark-space ratio would then have to be provided by different values in the collector-base capacitors (C_1 and C_2 in Fig. 1). The discharge time of each collector-base capacitor depends upon the current flowing to the negative supply line via the appropriate base resistor, and to the positive supply line via the variable resistor. Since, during each half-cycle, the discharge resistance is the same, it follows that the mark-space ratio should be maintained for any value in the variable resistor.

It is assumed, in this theoretical discussion, that the forward resistances presented by D_1 and D_2 are equal and have low values.

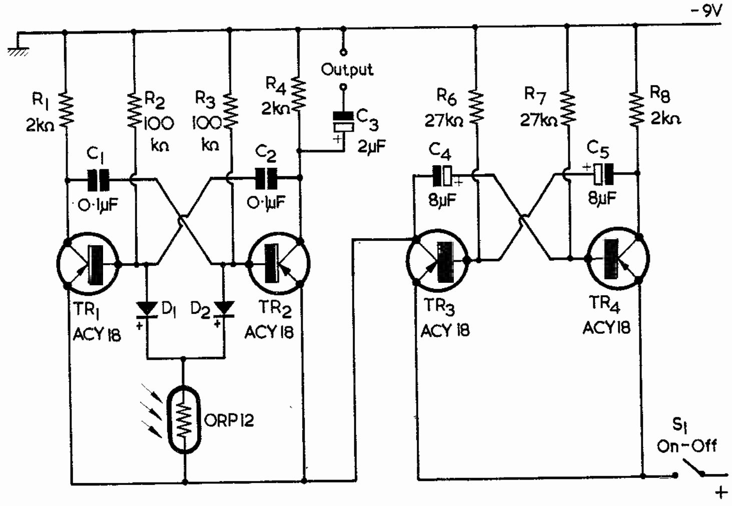


Fig. 2. A circuit which provides a "bleep bleep" output, the audio frequency in each "bleep" varying according to the illumination of the ORP12

Otherwise, the mark-space ratio may become altered for very low values in the variable resistor.

Practical Points

As was stated earlier, the circuit of Fig. 1 was made up by the writer to check operation in practice. This circuit is presented as an a.f. tone generator, but alternative applications may readily present themselves to readers. The frequencies offered by the circuit were capable of variation, by adjustment of R_5, from about 70 c/s to some 2 kc/s or more.

With R_5 set to insert zero resistance, it was found possible to obtain a higher multivibrator frequency by using germanium diodes in the D_1 and D_2 positions than by using silicon diodes. It is assumed that this effect is due to the fact that a germanium diode becomes conductive at a relatively low forward voltage, whereas a silicon diode requires a forward voltage of around 0.4 before it commences to conduct. Germanium diodes will, in consequence, present a discharge resistance to the collector-base capacitors almost to the end of the off-period of the associated transistor, and will thereby enable higher frequencies to be achieved and a greater range of control to be exerted by the variable resistor. Any germanium diode (OA70, OA71, etc.) may be employed in the D_1 and D_2 positions. If the 50 : 50 waveform is to be maintained for very low values of resistance in R_5, the two diodes should be matched for forward resistance.

The control of frequency offered by R_5 is markedly non-linear. A fairly smooth control is provided by using a component with a log track, this being connected such that frequency increases (i.e. the resistance inserted by the control decreases) as it is rotated anti-clockwise. If increase in frequency with clockwise rotation is desired, R_5 may be a component with an anti-log track. Whilst the use of potentiometers with tapered tracks provides a fairly smooth control of frequency, there is still a little cramping at the high frequency end of the range. Nevertheless, the control is quite adequate for a.f. tone generator applications.

With the values shown for R_1 to R_4, transistors TR_1 and TR_2 require a gain of at least 50. The writer employed transistors type ACY18 here, but any other similar type which meets the gain requirement could be employed instead.

At low frequencies the current drawn from the 9 volt supply was 4.5mA, this gradually increasing, with frequency, to 6.5mA when R_5 inserted zero resistance. The increased current at the higher frequencies is due to the greater average charging current in C_1 and C_2. The peak-to-peak value of the output waveform remained substantially constant, at 8.8 volts, for all frequencies.

The output of the multivibrator may be fed to any following circuit, such as an amplifier, having an

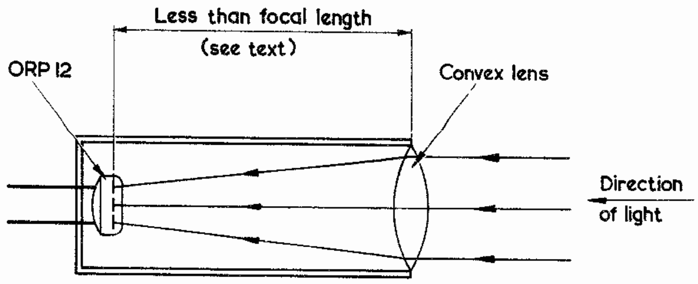


Fig. 3. The ORP12 may be mounted in a tube with a convex lens at the open end, as shown here. The inside walls of the tube should, preferably, be painted matt black

input impedance greater than 10kΩ. For high input impedances, such as would be given by a valve amplifier, C_3 could be reduced to 0.1μF.

"Bleep-Bleep" Circuit

Control of frequency by a single resistance offers a number of interesting applications. The single resistance could, for instance, be a photoconductive cell such as the ORP12. Frequency will then increase with the intensity of the light falling upon the cell.

This idea is exploited, as a novelty device, in the circuit shown in Fig. 2. In this diagram the circuitry around TR_1 and TR_2 is the same as for Fig. 1, with the exception that the variable resistor R_5 is replaced by an ORP12. Since a continual tone, even of changing frequency, is not particularly striking in a device of this nature, a second multivibrator given by TR_3 and TR_4 has been added. This second multivibrator switches the first multivibrator on and off at about 3 times a second, giving an impressive "bleep-bleep" effect.

The multivibrator provided by TR_3 and TR_4 has a nominal frequency of about 4 c/s. Due to tolerances on value, however, the two electrolytic capacitors C_4 and C_5 will probably exhibit a working capacitance which is higher than the value marked on their cases, whereupon the actual running frequency of the multivibrator may, in practice, be of the order of 3 c/s or even less. Alternative capacitances, to change the running frequency, can of course be used, if desired. The collector load of TR_4 is the 2kΩ resistor R_8, whilst the collector load of TR_3 is the multivibrator circuit given by TR_1 and TR_2. When TR_3 is on, the positive supply is applied to the emitters of TR_1 and TR_2, and to the ORP12. Note that the chassis connection is now transferred to the negative supply line, and the on-off switch to the positive supply line. The output is taken from the collector of TR_2 and the negative supply line, and the input impedance of any following amplifying device should, preferably, be at least 15kΩ. Lower impedances may upset the switching action. With high impedances, as would be given by a valve amplifier, C_3 can be reduced to 0.1μF.

Again, transistors type ACY18 are shown for TR_3 and TR_4. However, almost any a.f. type should cope satisfactorily in the circuit. The current drawn from the 9 volt supply by the circuit of Fig. 2 is approximately the same as with Fig. 1 (i.e. 4.5 to 6.5mA) because transistor TR_4 has, like TR_2, a collector load of 2kΩ and the collector load of TR_3 is of the order of 2kΩ.

When amplified and reproduced at reasonable volume over a large speaker, the output of the Fig. 2 circuit has a distinctive quality which should particularly impress the layman, this being partly due to a slight change in frequency at the start of each of the rapid "bleeps". A considerable change of frequency is available by varying the incident light falling on the ORP12, the frequency increasing with light intensity. If the ORP12 is mounted in a tube with a small convex lens at the open end, as in Fig. 3, it will become markedly directional, causing changes in frequency as it is directed around a room. It can, for instance, detect the difference between white and coloured paper due to the different amounts of light reflected from the paper. The lens can be any inexpensive "magnifying glass", positioned slightly less than its focal length from the light-sensitive surface of the cell. This positioning enables maximum illumination of the light-sensitive area to be achieved. The focal length of the lens may be found by causing it to reproduce the image of an electric light bulb on a piece of paper. The distance between the paper and the lens is then the focal length.

If the circuit is to be used to indicate the interruption of a light beam, it may be helpful to remember that very nearly minimum resistance in an ORP12 mounted in an assembly such as that of Fig. 3 can be achieved with a 6 volt 0.3 amp cycle dynamo bulb mounted about 2ft away from the lens. If the 6 volt bulb is fitted with an efficient reflector, the distance may be 6ft or more.

We wish all our readers a very Happy Christmas and a Prosperous New Year—Editor

Low-Cost Capacitance Meter

by G. A. STANTON

Details of an inexpensive instrument which provides accurate measurements of very low values of capacitance

FROM TIME TO TIME IN THE COURSE OF CONSTRUCTING experimental equipment it is often desirable, and sometimes essential, to be able to measure small values of capacitance. To find —for example—the swing of a particular variable capacitor, or the capacitance of a specific length of coaxial cable, or even the "strays" presented by a certain layout. For such purposes the normal Wheatstone bridge type of instrument is frequently inadequate, being difficult to manipulate for values below 100pF. The instrument described here has, in consequence, been constructed to meet this need.

Basic Circuit

The basic circuit of the instrument is shown in Fig. 1, and from this the principle of operation can be readily studied. TR_1 is a straightforward Pierce type crystal oscillator, the output of which is fed to TR_2. This acts as a buffer amplifier and in turn feeds the parallel tuned circuit given by L and VC. The tuned circuit is so arranged that when VC is set at its maximum capacitance the circuit resonates at the frequency generated by the crystal oscillator. TR_3 is a simple resonance indicator, the point of resonance being shown by maximum reading in the indicating meter.

Operation of the instrument is simple. If a small unknown capacitance is connected across the Test terminals, VC will have to be reduced in value in order to bring the circuit back to resonance. The amount by which the value of VC needs to be reduced will then indicate the unknown capacitance. If VC is adjusted by way of a suitable scale then the instrument can be made direct reading, and accuracy will depend entirely upon the accuracy of calibration and the ease with which the scale can be read. The range will be determined by the maximum capacitance of VC. Thus, if this is made 100pF then the instrument will read from zero to very nearly this figure.

Practical Version

The simple circuit just described would be of limited use in practice, and Fig. 2 gives a practical arrangement developed from it which has proved to be a very versatile piece of test gear. The prototype was designed to use components that were at

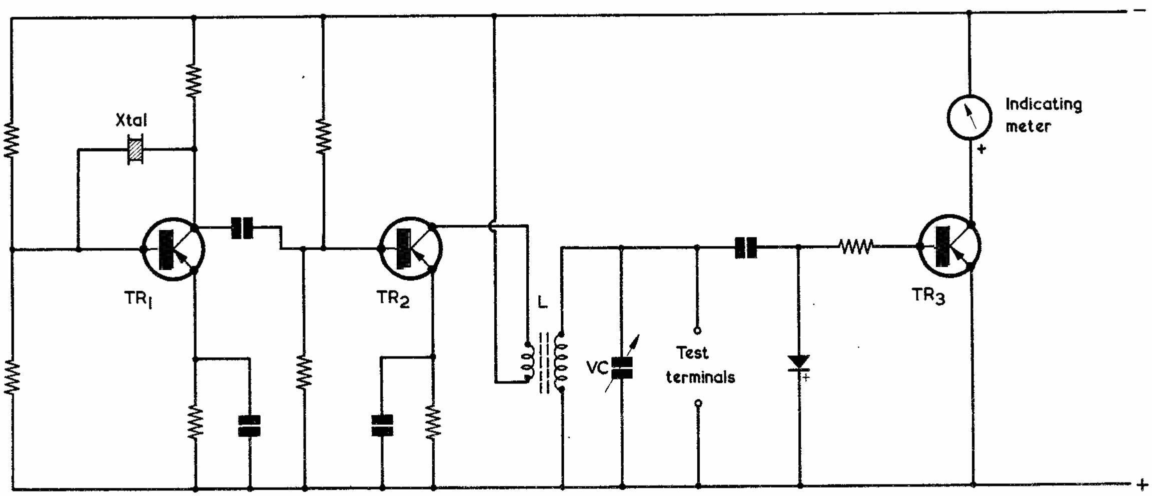


Fig. 1. The basic circuit. This demonstrates the method of operation of the capacitance meter

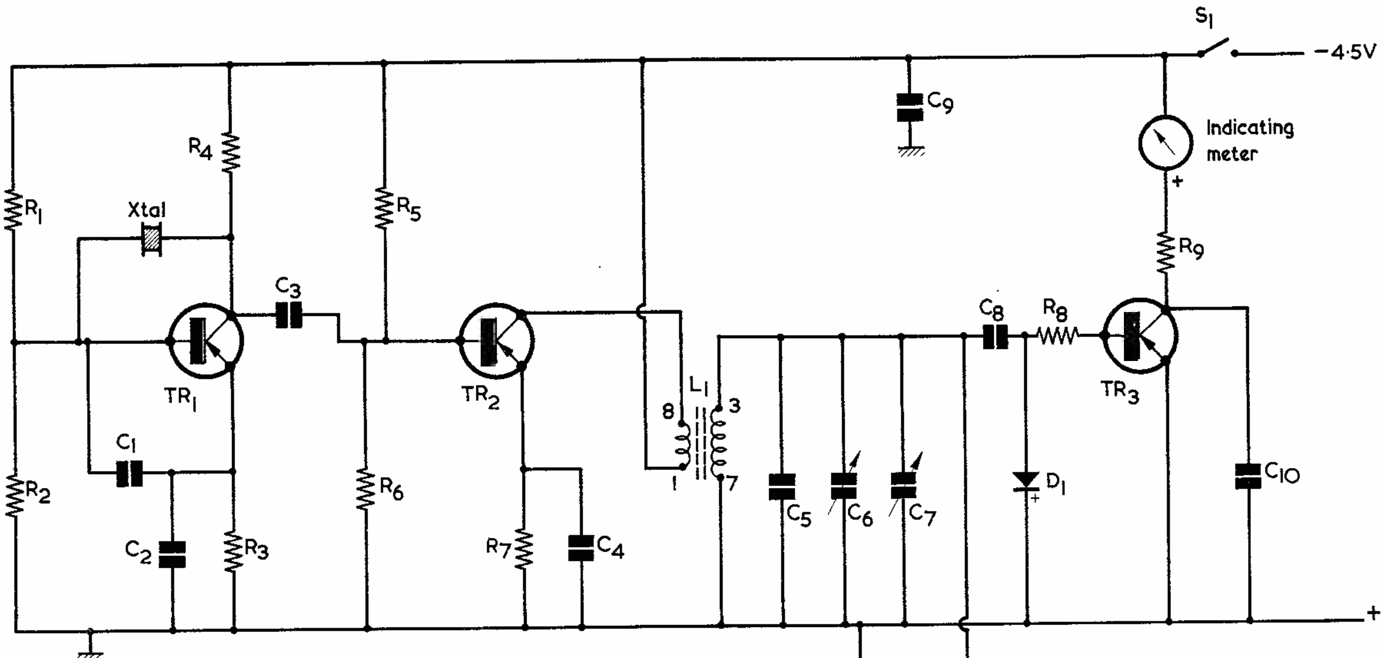


Fig. 2. The practical circuit developed from Fig. 1. This is capable of measuring capacitances below 100pF with high accuracy

COMPONENTS

Resistors
(All resistors ¼ watt 10%)

R_1	15kΩ
R_2	3.3kΩ
R_3	1kΩ
R_4	4.7kΩ
R_5	22kΩ
R_6	4.7kΩ
R_7	1kΩ
R_8	33kΩ
R_9	4.7kΩ

Capacitors

C_1	500pF silver-mica or ceramic
C_2	0.002μF paper
C_3	10pF silver-mica or ceramic
C_4	0.002μF paper
C_5	100pF silver-mica
C_6	25pF variable
C_7	100pF variable
C_8	10pF silver-mica
C_9	0.1μF paper
C_{10}	0.01μF paper

Semiconductors

TR_1	OC44
TR_2	OC44
TR_3	OC45
D_1	OA91

Coil
L_1 Maxi-Q coil, Red, Range 3 (Denco)

Crystal
Xtal (see text)

Meter
0-1mA moving-coil meter

Switch
S_1 s.p.s.t. switch

Battery
4.5 volt battery

hand and was built entirely out of the spares box. For this reason TR_1 and TR_2 are both OC44's and TR_3 is an OC45. Other types having similar performances could easily be substituted providing the circuit values were adjusted to suit. Again, the diode D_1 in the original is an OA91, but any small germanium diode can be used. The meter suggested as an indicator can be any moving coil type with a full scale reading of 1mA. It could of course be a meter external to the unit, or even a multimeter switched to the appropriate range.

The only critical components are in fact the crystal and those composing the tuned circuit itself, and these are only critical in the sense that they must work correctly with each other in terms of the frequency. In the author's case the crystal (a surplus type) has a frequency near 2.5 Mc/s, whilst L_1 is a Denco Range 3 Red coil which is tuned by C_5, C_6 and C_7 in parallel.[1] Of these C_7 is the main "tuning" capacitor (i.e. VC in the preceding explanation). C_6 is a small trimmer which enables the instrument to be zeroed in use. C_5 is important not only to "pad" the circuit but also to prevent it tuning to an unwanted harmonic.

The stability of the calibration will depend upon the tuned circuit and here good quality components must be used. C_6 and C_7 should be air-spaced types with ceramic insulation, whilst C_5 should be silver-mica.

With the circuit as it stands any crystal with a frequency between 2.1 Mc/s and 2.6 Mc/s can be used, the exact frequency being quite unimportant. Odd frequency types can often be purchased very cheaply from surplus stores and one of these would serve equally as well as any other. By experimenting with different values of C_5, crystals slightly outside the 2.1 to 2.6 Mc/s range could also be utilised. For instance, an increase in C_5 would enable crystals in the amateur 1.8 to 2.0 Mc/s band to be used. By experimenting with different values of inductance for L_1 a crystal quite outside the above range could again be used.[2]

It may be necessary to adjust the value of R_8 if the transistor in the TR_3 position exhibits a widely differing gain from that occurring in the prototype. A transistor with higher gain will require a higher value in R_8.

Construction

Construction will depend upon the components available and especially upon the tuning capacitor and meter employed. The original was built upon a Paxolin panel with a small sub-chassis holding the crystal, transistors and tuning coil. Power is supplied by a "flat" 4.5 volt torch battery, the total consumption being under 5mA. The whole unit fits into a small plywood box.

Calibration

Before calibrating the unit the tuned circuit must be adjusted for resonance. To do this C_7 is set at its maximum capacitance and C_6 is set at half capacitance. The core of L_1 is then adjusted for maximum reading on the indicating meter. The maximum point should be quite definite, but final adjustment can be made by a slight movement of C_6, ensuring that this is capable of passing through the peak. The instrument is now ready for calibration and this can be carried out by connecting known values of capacitance across the Test terminals. As each value is connected the meter will drop in reading and C_7 will need to be adjusted to bring it back to its maximum. The point indicated on the dial for C_7 will represent the value of the capacitance connected. If sufficient known capacitances are available these can be used to complete the calibration; if insufficient are available a graph can be drawn and the required calibration points interpolated from this. It need hardly be stressed that the calibration will only be as good as the "standards" employed in this way, and in the care taken in the calibration process.

The Instrument In Use

Before any measurements are taken, C_7 should always be set at its maximum capacitance (i.e. zero on the calibration) and C_6 adjusted if necessary for maximum meter indication. Most capacitors to be checked can be connected directly across the Test terminals. For some purposes, however, it will be necessary to use external leads in order to connect the instrument to the component to be measured. In these cases the leads should be connected to the instrument only at first, C_6 then being used to balance out their self-capacitance. After this has been done the component can be connected and its capacitance alone will be measured.

Apart from indicating the value of a capacitor the unit will also give a rough indication of the Q or goodness of the component under test. This is due to the fact that a component with a low Q will introduce losses into the tuned circuit and therefore result in a lower maximum reading on the indicating meter.

All in all the unit will prove to be a most useful addition to any test bench.

[1] The coil employed by the writer is the Maxi-Q type which fits in an octal valveholder. Its normal function is that of superhet oscillator coil (i.f.=465 kc/s) for a signal frequency range of 1.67 to 5.3 Mc/s. Pins 3 and 7 connect to the tuned winding.—EDITOR.

[2] A range of crystals between 2.1 and 2.6 Mc/s is available from Henry's Radio Ltd.—EDITOR.

NEW BRIMAR VALVE BOOKLET

The Brimar Data List No. 33 has been completely redesigned specially for dealers' maintenance technicians. The abridged data, given in a modernised easy-to-read form, covers 542 BRIMAR valve and Teletube types. Virtually every valve type ever sold by BRIMAR is given in one continuous alpha-numerical sequence. This makes it unnecessary to know in advance whether the valve is a Special Quality, Industrial or Commercial type or whether it is Current or Obsolete. Each valve is given a "Sales Classification" (Current, Maintenance, Obsolescent or Obsolete) so that the technician has an indication of availability.

Among the useful ancillary matter are some notes on the use of the new 625-line Test Card and a table detailing Special Quality valves which may be used as plug-in replacements for certain commercial valves. The expanded Equivalents List now covers 1220 valves and Teletubes including CV types.

Copies of the BRIMAR Data List No. 33 are now available from BRIMAR valve Representatives, some BRIMAR wholesalers or direct from—

BRIMAR Publicity Department,
Thorn-AEI Radio Valves & Tubes Ltd.,
7, Soho Square,
London W.1.

NEWS . . . AND .

STC Enters Radio and Electronics Hobbies Market

One of Britain's largest electronic companies, Standard Telephones and Cables Limited, has entered the radio and electronics hobbies market, both at home and abroad.

It has acquired the business patents and other assets of Electroniques (Felixstowe) Limited, a company well known for its high quality products for amateur communications, and has incorporated this enterprise into a new fully comprehensive electronic component/equipment supply service specially tailored to meet the requirements of the radio and electronics enthusiast.

Operating under the name Electroniques (proprietors STC Ltd.), this new service is part of Electronic Services Division—STC, the "same-day despatch" organisation formed in January 1965 which supplies industry and professional organisations with components by return of post.

A logical development of this highly successful industrial venture, Electroniques offers to hobbyists a similar rapid-supply service covering a vast selection of equipments, test sets, modules, components, tools and accessories—over 1,000 items in all—constituting the largest range of electronic hobby products available from a single source. Over 80 British and overseas manufacturers are represented.

Complementing this service will be a 600-page "Hobbies Manual" designed to assist all builders of equipment, whether keen beginners or experienced experimenters, in their construction projects. Due to be published on December 1st (price 10/6d., post free) it will contain salient details—including prices—of all items offered, plus a large number of useful circuits and construction tips.

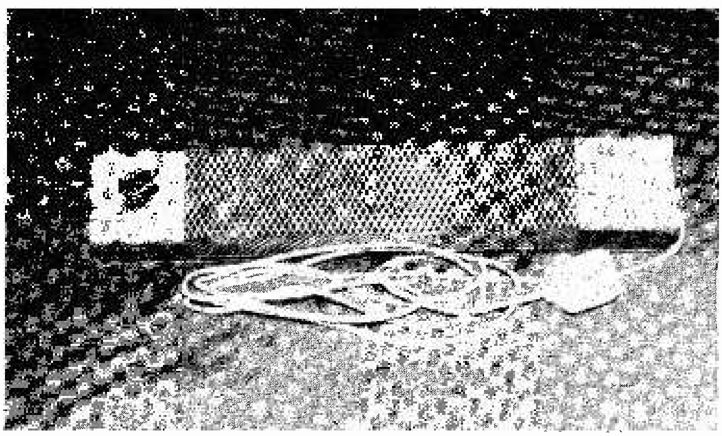
Overseas enthusiasts can also obtain the manual and enjoy the benefits of the service, either direct by post, or through agents being appointed in countries throughout the world.

STC are pleased to announce that the founder of Electroniques (Felixstowe) Limited, Mr. Ronald A. Wilson, has agreed to join the new STC organisation.

Mr. Wilson is now technical manager at Felixstowe where the development and pilot production of "Electroniques" coil products and modules is being continued. Quantity production will be carried out by STC Modular Electronics Division at Rhyl, North Wales.

The address for enquiries regarding the Electroniques hobbies supply service is:

Electroniques (proprietors STC Ltd.),
Edinburgh Way, Harlow, Essex.
Tel: HARLOW 26777



The portability and ease of installation of the Vigilante Audible Fire Alarm can be clearly seen from the above illustration

The R.S.G.B. International Radio Communications Exhibition

The above exhibition is reported on another page in this journal, but there is a quotation from the speech of welcome given by the President of the society to H.R.H. Prince Philip, Duke of Edinburgh, which is worth quoting. The President said ". . . . . In view of your recent return from South America, I feel that it is opportune to bring to your notice the action of the President of Peru who is a Radio Amateur and who has made it an offence, punishable by imprisonment, to reduce the size of the bands available for our use. It is probably too much to ask for a similar enactment in this country . . . . ."

There was not enough space in our report on the exhibition to mention two of the awards given to amateurs. They were:

The Horace Freeman Trophy to M. H. Emmerson, G3OQD, for a transistorised s.s.b./a.m./c.w. transceiver covering 160–10 metres.

The Thorogood Plaque to S. F. Weber, G8ACC, for a 7 W Transistorised Transmitter for 432 Mc/s.

Vigilante Audible Fire Alarm

These notes are being written just prior to 5th November, therefore one's mind naturally runs to the terrible damage and loss of life which accidental fires can cause.

Insurance companies are greatly concerned at the losses caused by fire, and figures recently issued showed annual losses in this country exceeding £80,000,000, that is more than £220,000 for every day of the week! Therefore it is good to hear of a fire alarm which is inexpensive (less than £10), easy to install and which can be moved from place to place as easily as an electric heater.

The fire alarm is known as the "Vigilante". It is an electronic smoke detector with a built-in loud alarm buzzer which will sound off immediately it detects the presence of a minimum amount of smoke.

There are no installation costs at all. All that is necessary is to hang the Vigilante in a suitable position and plug into the electric current. Because the consumption is so low any light or power point will do.

. . . COMMENT

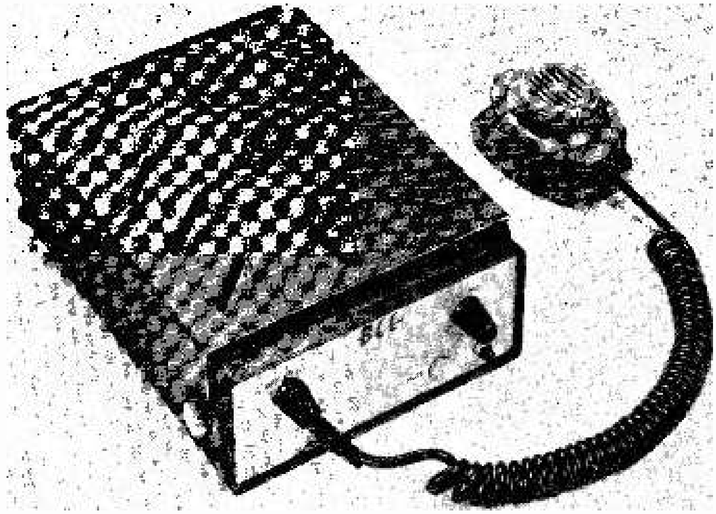
Vinyl-clad Radiotelephones for Civil Airports

A £30,000 contract to supply vinyl-clad radiotelephones to the Ministry of Aviation, Civil Branch, has been secured by British Communications Corporation Ltd. The mobile transceivers, which will soon be in general use in perimeter vehicles at Civil Airports throughout the U.K., were displayed at the Farnborough International Air Show.

At London Airport an aircraft takes-off or lands every two minutes throughout the day and this requires ground and air control of the highest calibre. Patrol cars, ambulances, and fire tenders equipped with radiotelephones stand by on continuous "listening watch" ready to move quickly into action to deal with any emergency.

The case and mounting of the BCC 81 radiotelephone are carefully designed in Bondene pvc-clad aluminium to give the advantages of light weight, toughness, and durable colour finish in keeping with modern vehicle design.

The BCC 81 is a compact 5 watt a.m. v.h.f. set with up to date circuit design, fully transistorised receiver, and crystal filter selectivity to ensure excellent performance for medium range communication. Single and six channel versions are available and a public address facility is included as an optional item.



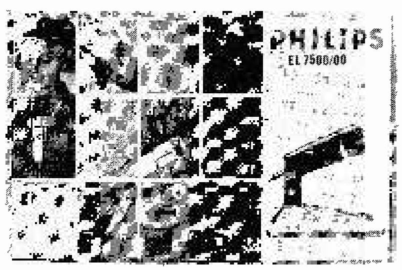
Medium range mobile radiotelephone produced by British Communications Corporation Ltd.

Radio amateurs and tape recording enthusiasts who are looking for a sensitive versatile microphone will welcome the first kit-mike by Philips, available from Peto Scott of Weybridge, shown below.

It takes approximately 3 hours to assemble and costs only 7 guineas.

The kit contains everything needed to assemble and use the microphone, including a stand for table or desk use, and a cord and clip for wearing around the neck. The microphone can also be hand held, hung from an overhead bracket or fitted onto a professional stand. The mic, has an unobtrusive on-off switch on one side.

Direction for assembly are illustrated, step by step, in a well-designed booklet.



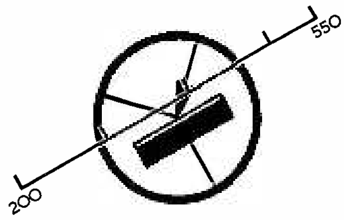
The Royal Television Society

It was announced recently that Her Majesty, The Queen has been graciously pleased to command that The Television Society shall now be known as

"The Royal Television Society".

This is a great honour for the Society and it follows work which the Council and Secretariat have been undertaking during the last two years. The Society is especially pleased that this honour has been bestowed at the beginning of its 40th Anniversary year and it highlights the contributions which members of the Society have made to the development of British television.

This also means that, for the first time, the art of television has been officially and separately recognised in this way.



Medium Wave Transistor Preamplifier

by R. L. A. BORROW, B.Sc.

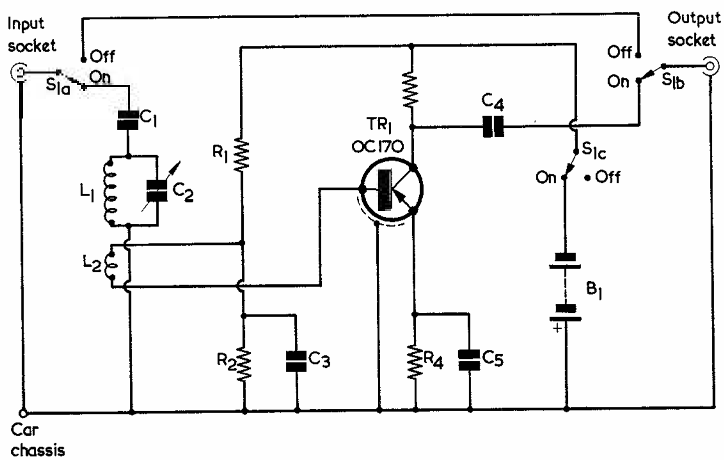
A single transistor preamplifier which, by virtue of having a high input impedance and a relatively low output impedance, can offer a significant improvement in car radio reception

When designing a radio receiver for use in a car one is faced with a large number of conflicting requirements. The ideal receiver would pick up the weakest signals, give high fidelity reproduction and be quite immune from any traces of interference. These requirements are difficult enough to meet when designing for a fixed location but in a car they become almost impossible, since sources of interference are many and varied and the design of an aerial system is subject to severe limitations.

Consideration of these factors usually leads to a receiver incorporating one stage of radio frequency amplification preceding a mixer/oscillator. These are followed by several stages of intermediate frequency amplification, a diode detector and a low frequency amplifier of moderate gain and power output. This type of receiver provides a satisfactory service in most locations but does not give sufficient sensitivity to enable all programmes to be received in all parts of the country. An extra stage of high frequency amplification improves reception enormously but to incorporate this in the receiver is difficult, expensive and almost impossible without considerable increase in size.

Aerial Preamplifier

One solution to this problem can be found in the design of an aerial preamplifier. An untuned single transistor amplifier will produce some gain in sensitivity. Also if fitted close to the aerial it can be designed to provide matching to the aerial feed cable. However, such an amplifier, being unselective,



The circuit of the preamplifier. A screened wire connects the aerial to the input socket, and a second screened wire connects the output socket to the radio

COMPONENTS

Resistors
(All resistors $\frac{1}{4}$ watt 10%)
- R_1 15kΩ
- R_2 2.2kΩ
- R_3 10kΩ
- R_4 1kΩ

Capacitors
- C_1 10pF ceramic or silver-mica
- C_2 500pF variable
- C_3 0.1μF paper
- C_4 0.01μF paper
- C_5 0.1μF paper

Inductor
- $L_{1,2}$ Medium wave coil with coupling winding (see text)

Transistor
- TR_1 OC170

Switch
- $S_{1(a), (b), (c)}$ 3-pole 2-way, rotary

Battery
- B_1 3-volt battery

Sockets
- Input and output coaxial sockets

increases noise level and may cause trouble to be experienced with interference between stations close together in frequency.

A much more satisfactory solution is found in a tuned amplifying stage placed between the aerial and the receiver. This increases the strength of the wanted signal and can improve the selectivity of the system as a whole. The disadvantage of such an amplifier is that it has to be tuned separately from the receiver. However, if the switching is such that the preamplifier can be cut out of circuit, then the weak signal can be tuned in on the receiver first, after which the amplifier is switched in and its tuning adjusted.

The amplifier about to be described was arrived at after much experimental work with different types of circuit. No spectacular results should be expected but the gain is such that many programmes can be received at entertainment level which would otherwise be only just audible. The main use has been found when on camping trips in the North of Scotland. Some campers expect to be able to listen to the usual Pop stations even when camping in the remotest Scottish glen. The amplifier has been found to open up a number of these remote situations to the demands of this section of our community.

The Circuit

Several types of transistor were tried and an OC170 was found to be the most suitable among those readily available at small cost. The circuit is shown in the accompanying diagram. The aerial is coupled via a small capacitor to the top end of the tuned circuit. A 3-7 turn coupling coil fitted at the earthy end of the tuned coil feeds into the base of the transistor, which has a 10kΩ load in its collector circuit. The output is fed to the receiver via a 0.01μF capacitor.

The tuning coil used in the amplifier was designed to have a high Q in order to achieve a high value of selectivity. The author's version consists of 40 turns of litz wire close-wound on a former ⅜in diameter and 1in in length. The core consists of a short piece of ferrite rod fitting into the former. However, any medium wave coil of suitable inductance may be used, but it should be remembered that the higher the Q the better the selectivity. The coil is tuned by a 500pF variable capacitor.

The unit is powered by a 3 volt dry battery housed inside the case. For optimum results the supply voltage applied to the amplifier needs to lie within certain limits. In this case it was found that the gain increased as the voltage was raised but that the amplifier became unstable at 4.5 volts. At 3 volts the stability was good and the gain adequate. The current requirement as specified is only about 0.3mA at 3 volts.

A three-pole two-way switch has been incorporated in the preamplifier so that in the "Off" position the aerial is fed direct to the receiver and the power supply to the amplifier is cut off.*

All the components are mounted on a plastic panel measuring 6½ins by 3ins and the whole is housed in a wooden box 6½ × 3 × 2ins. This arrangement has been found satisfactory since the amplifier is normally only used when the car is stationary. If the unit is to be used when all the car electrics are functioning it would be worth using a metal box and metal panel and ensuring that all the screening of input and output circuits was complete.

* Instability with the circuit, as shown in the diagram, may be due to capacitive feedback between switch sections in S_1(a) and S_1(b). Thus, a small stray capacitance exists between C_4 and the linking wire back to S_1(a), and a further stray capacitance between this linking wire and C_1. A fourth switch pole, which connected the linking wire to the positive supply line when the preamplifier is switched on, would eradicate this source of feedback.—EDITOR.

CAN ANYONE HELP?

Requests for information are inserted in this feature free of charge, subject to space being available. Users of this service undertake to acknowledge all letters, etc., received and to reimburse all reasonable expenses incurred by correspondents. Circuits, manuals, service sheets, etc., lent by readers must be returned in good condition within a reasonable period of time

"I should like to place on record my appreciation of the "Can Anyone Help?" service in your publication *The Radio Constructor*, August issue. Not only did I get the Manual I was seeking but the sender gave me some good advice and information."

"I cannot speak too highly of *The Radio Constructor* which succeeded where others had failed."—Reader's letter, one of many that we have received over the years that this feature has been running.

Beam-Echo AM/FM Tuner BM611.—Cpl. B. W. Parker, 4 Squadron, 30 Signal Regt., Blandford, Dorset,—borrow or purchase service sheet or circuit.

R103 Receiver Mk 1.—R. E. Boxell, 33 Northfield Road, Enfield, Middx.,—circuit diagram or any information.

Spencer West TV S181.—J. Chatterton, 230 Brownley Road, Wythenshawe, Manchester 22,—service sheet or manual.

Receiver Type 78.—R. A. Krakeel, 28 Mount Ephraim Road, London. SW 16,— circuit or any information.

Jason Everest Portable Receiver.—R. J. Goodman, 26 Killarney Road, London. SW 18,—alignment data for this transistor portable.

IN LAST MONTH'S ISSUE WE INTRODUCED THE THREE-stage receiver which forms the second of the constructional projects in the "Understanding Radio" series. The circuit design was discussed and details were given of chassis assembly. We shall now proceed to construction and wiring.

Construction

Fig. 1 shows the layout of the components above the chassis. The first component to be fitted is the tuning capacitor, C_1. As was explained last month this may be either a single-gang or two-gang component, the two-gang capacitor being used if the reader intends to add the r.f. amplifier stage which will be described at a later date. The instructions which follow apply to either type of capacitor. It should be added that, during assembly of the receiver, the moving vanes of the capacitor should always be kept closed to prevent their being accidentally bent out of position. This point applies, incidentally, to any constructional work involving air-spaced variable capacitors.

First, obtain the tuning dial and drive assembly specified in the Components List. This is fitted with a drive mounting bracket whose horizontal section will very probably project forward. Remove the two drive mounting screws and re-fit the drive mounting bracket so that its horizontal section projects to the rear, as in Fig. 2. Secure the drive mounting bracket with 6BA ¼in. screws and nuts to two holes in the front row of ⅛in. holes in the Chassis Plate No. 1 so that it is positioned centrally on the plate, as illustrated in Fig. 1.

Slightly slacken the two drive mounting screws so that the drive and scale assembly can be adjusted for height. Unscrew the spindle securing screw (see Fig. 2), or screws if more than one are fitted, so that a ¼in. shaft is free to move in and out of the bush.

Take up the tuning capacitor and solder a 3in. length of wire to the lower fixed vane tag (of the front section, if the two-gang capacitor is used). It is desirable to use a thick wire here, since it enters the tuned circuit, and 14 s.w.g. bare tinned copper or similar will be satisfactory. This wire is connected at this stage since the tuning capacitor tag is a little difficult to reach when the capacitor is fitted, and the wire should project sideways in the direction indicated in Fig. 1.

Insert the tuning capacitor shaft into the bush of the drive assembly. Pass a 1¼in. 6BA screw with a washer under its head through the rear bracket of the capacitor and through two ⅜in. Lektrokit spacers. It will be found possible to locate three ⅛in. holes in the Chassis Plate No. 1 which will accommodate this screw, as well as similar screws through the two front brackets, whilst allowing the capacitor to sit vertically with good engagement of its shaft in the bush of the drive assembly. Under the Chassis Plate, loosely tighten a nut on to the 6BA bolt at the back bracket and similarly fit 1¼in. 6BA screws, washers, spacers and nuts to the two front brackets of the capacitor. When the constructor has satisfied himself that the correct holes in the Chassis Plate have been selected the three 6BA screws can be finally tightened up. The method of assembly is shown in Fig. 2. Next, tighten the drive mounting screws (Fig. 2) on the drive assembly, ensuring that the scale is horizontal. Fit the large knob type K403 to the tuning drive spindle and rotate it so that the pointer indicates 100. Then tighten the spindle securing screw and ensure that the tuning capacitor may be reliably adjusted over its full range with minimum capacitance corresponding to zero on the scale and maximum capacitance to 100 on the scale. Leave the capacitor with its vanes fully enmeshed before proceeding further.

The remaining assembly work simply consists of bolting components direct to the Chassis Plates, and proceeds in the following manner.

Turn the chassis over and secure the four 5-way tagstrips in the manner illustrated in Fig. 3. 6BA ¼in. screws are used with their heads above the chassis. The tags are numbered in Fig. 3 and subsequent under-chassis diagrams for ease of reference when wiring is carried out. The dimensions given in Fig. 3 are approximate and intended for guidance only as the positions of the tagstrips are not excessive-

UNDERSTANDING RADIO

Constructing the 3-Stage Receiver

$$f=\frac{1}{2\pi\sqrt{LC}}$$

by W. G. Morley

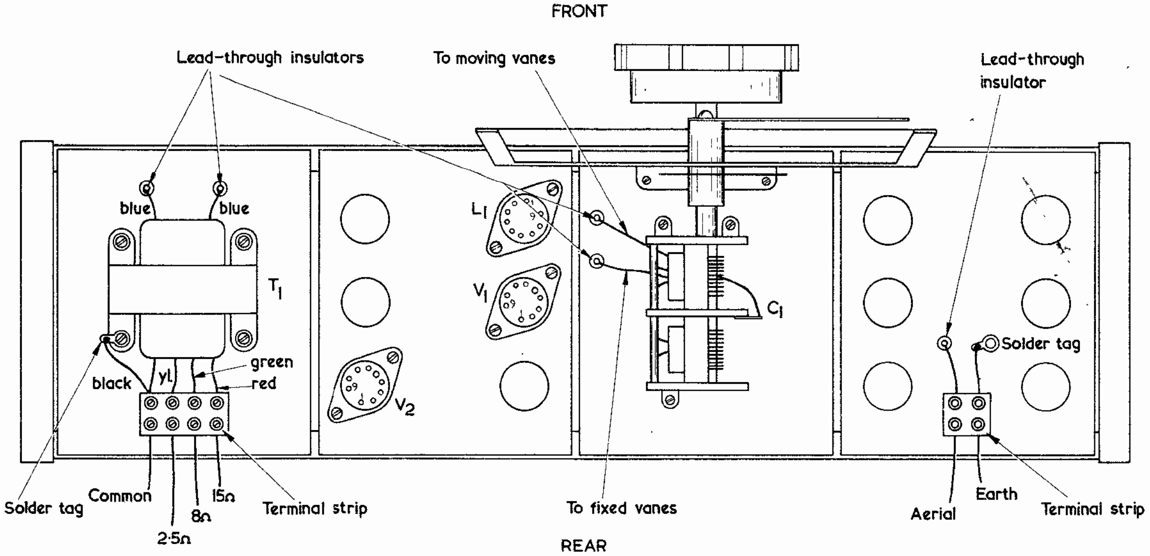


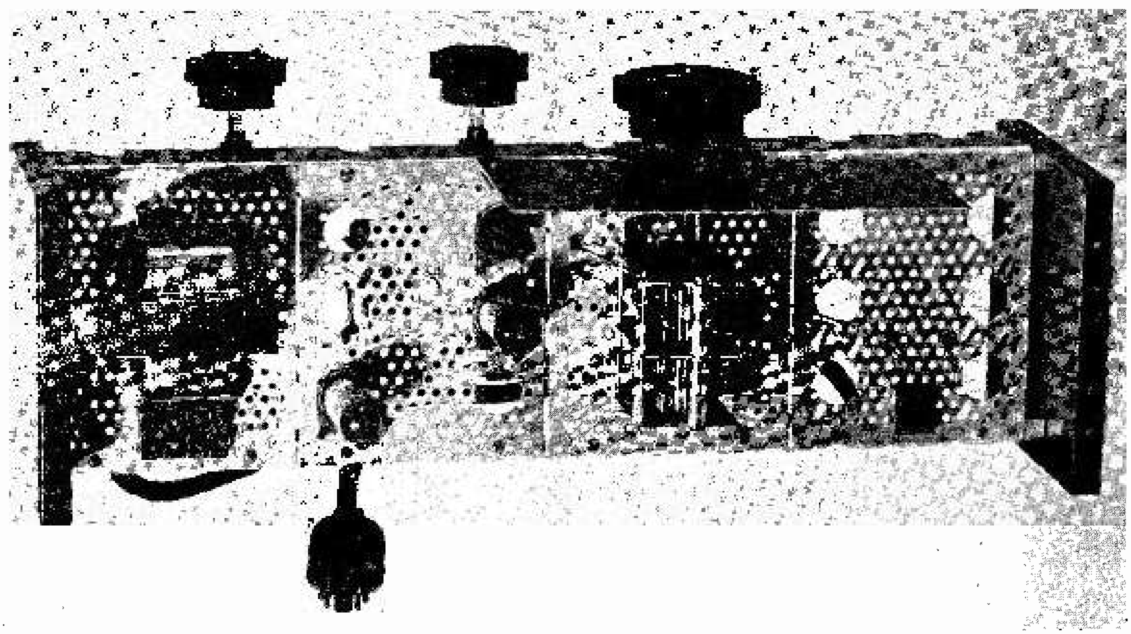
Fig. 1. The layout of components above the chassis. Also shown is the above-chassis wiring

ly critical.

Turn the chassis over again, and fit T_1 in the position shown in Fig. 1. This is secured with four 6BA ¼in. screws, three of which have washers under their heads to accommodate the wide mounting slots of the transformer, whilst the fourth has a solder tag under its head which also performs service as a washer. Ensure that the transformer is mounted with its blue leads at the front.

Cut a 4-way section from the barrier terminal strip and clean up as necessary. Fit this in the position shown in Fig. 1 with two 6BA ¾in. screws. It should be found that the two outside mounting holes in the terminal strip coincide with holes in the Lektrokit Chassis Plate.

Fit two lead-through insulators to the front of the transformer, as in Fig. 1. These may be conveniently inserted in the second row of ⅛in. holes from the



A top view of the receiver, showing the positions of the major components

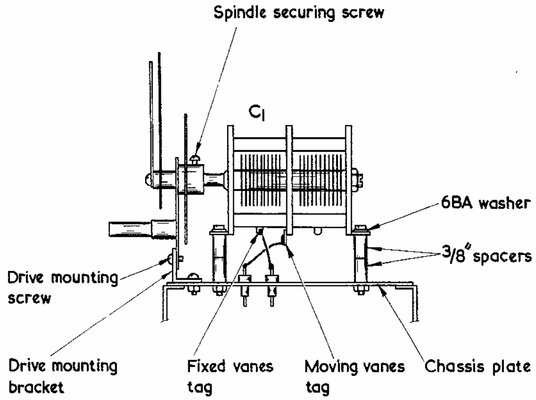


Fig. 2. How the tuning capacitor is mounted. Again, wiring details are given

front in the Chassis Plate.

Fit the valveholders for V_1, V_2 and L_1 in the positions indicated in Fig. 1 and with the orientation shown. Note that a solder tag is secured, below the chassis, under one of the mounting nuts for V_1 valveholder, and that another is similarly mounted at L_1 valveholder. The positions of these tags are shown in Fig. 4.

Returning to Fig. 1, fit two lead-through insulators between the tuning capacitor and L_1 valveholder, as shown. These may be inserted at the extreme right (tuning drive knob towards the reader) of the Chassis Plate No. 1 on which the tuning capacitor is mounted.

Cut a 2-way section from the barrier terminal strip, clean up as necessary, and secure with a single 6BA ¾in. bolt in the position shown in Fig. 1. This provides the aerial and earth terminals, and should line up with the 4-way terminal strip behind T_1.

Secure a solder tag to the Chassis Plate No. 2 in front of the 2-way terminal strip, as shown in Fig. 1, using a 6BA ¼in. screw and nut. Also as in Fig. 1, fit a lead-through insulator in front of the 2-way terminal strip.

Finally take the ½in. grommet and fit it to the end U-slot of the rear Chassis Rail as shown in Fig. 4. Secure it in position by a wire passed through the Chassis Rail holes on either side (as was shown, for the similar grommet in the power supply unit, in Fig. 6 (*c*) in the October issue.)

Component assembly is now complete.

Above-Chassis Wiring

In the wiring instructions which follow, all connections are made with insulated wire unless otherwise stated. In some cases sleeving is fitted over component lead-out wires to obviate the risk of short-circuits to adjacent tags and wires. It is understood that the lead-out wires of resistors and capacitors are shortened as necessary to achieve a neat layout. Joints should only be soldered when stated.

Wiring above the chassis comes first, and this follows the wiring details given in Fig. 1.

1. Connect the earth terminal (at the right of the diagram) to the adjacent chassis solder tag. Solder at the tag.
2. Connect the aerial terminal to the adjacent lead-through insulator, soldering at the insulator.
3. Connect the 3in. length of wire, which was soldered to the fixed vanes of the tuning capacitor before the capacitor was mounted, to the adjacent lead-through insulator, shortening as necessary, (see Fig. 1). This wire should be kept as short as possible. Solder at the insulator.
4. The moving vane tag of the tuning capacitor is next connected into circuit and, since this connection also enters the tuned circuit, a thick wire of the same type as was used in Step 3 is required. Using this wire, connect the moving vane tag to the remaining lead-through insulator, keeping the wire as short as possible, (see Fig. 1). Solder at the tag and at the insulator.
5. Connect the blue leads from transformer T_1 to the adjacent lead-through insulators, shortening as necessary. It is immaterial which lead goes to which

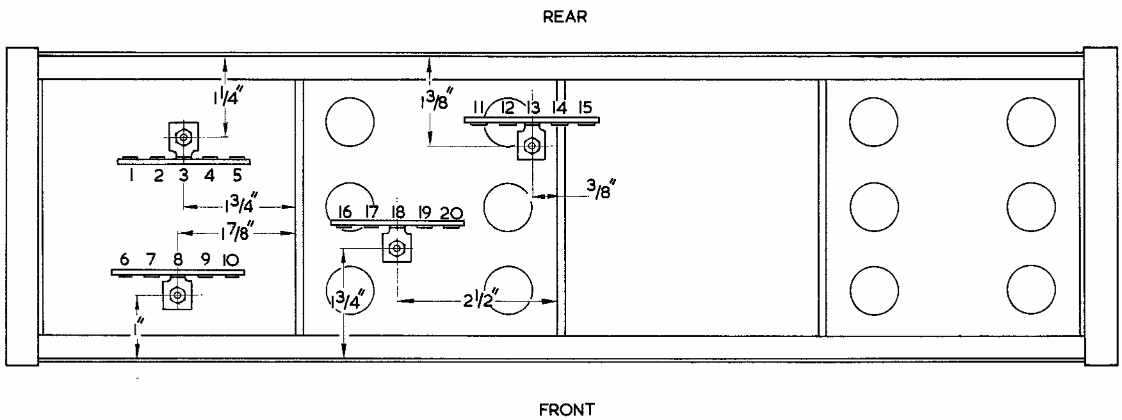


Fig. 3. Fitting the 5-way tagstrips below the chassis. The dimensions shown here are approximate and intended for guidance only

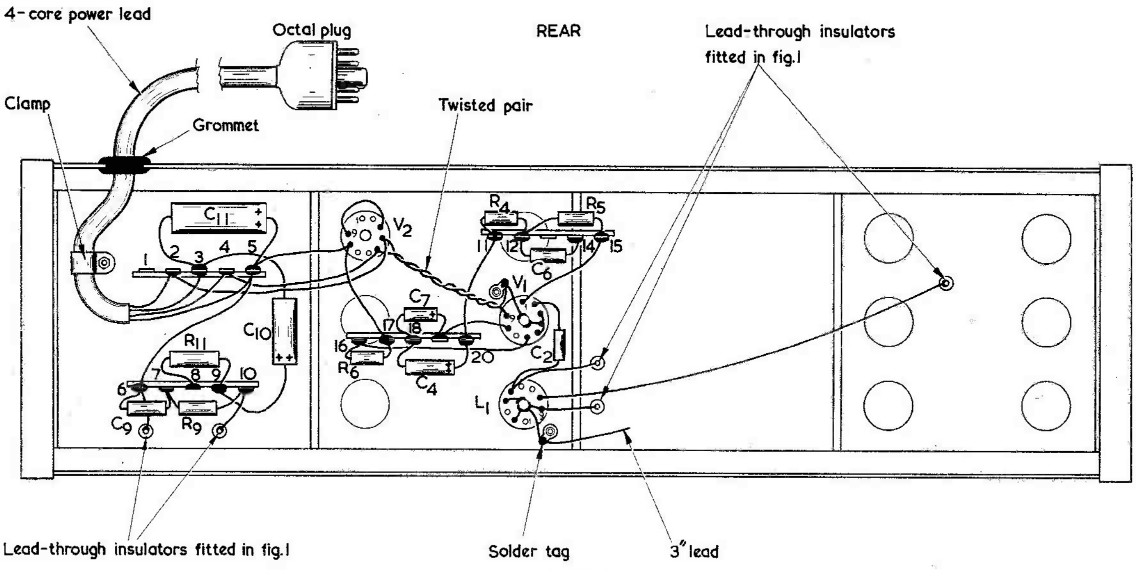
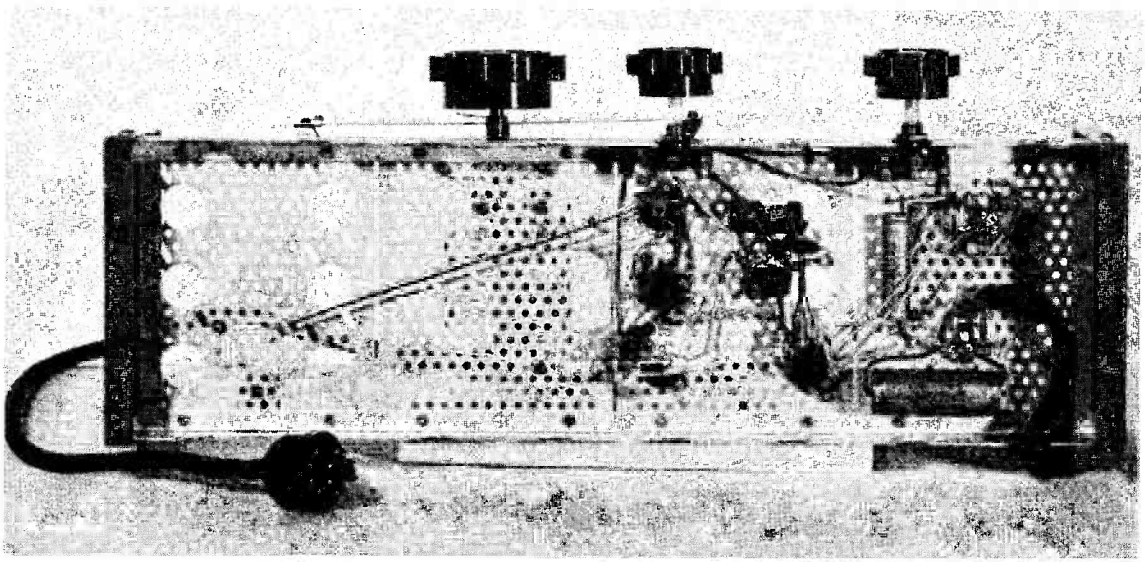


Fig. 4. First steps in under-chassis wiring

tag. Solder at the insulators.

6. Connect, and solder, a short lead to the chassis solder tag under the securing screw for T_1. The lead should have correct length for fitting to the common terminal of the adjacent 4-way terminal strip.

7. Clean the insulation from the secondary lead-outs of T_1 so that they may be fitted to the 4-way strip. Some of these lead-outs consist of enamelled wire and the enamel must be scraped off before connections are made. It is a good plan to tin the wire after the enamel has been removed to ensure that a reliable connection is likely to be made, and then to bend the tinned section back on itself so that a double thickness of wire is inserted into the connector of the terminal strip. Solder the free end of the wire fitted in Step 6 to the black transformer lead then insert the two wires, soldered together, into the appropriate (common) connector of the terminal strip. Fit the yellow, green and red leads to the



Under-chassis wiring. The use of Lektrokit chassis components enables a clean wiring layout to be obtained without cramping of parts terminal strip. All these leads follow the layout given in Fig. 1.

Under-Chassis Wiring

The under-chassis wiring follows, the first steps being shown in Fig. 4. The tags on the four tag-strips will be referred to by the numbers given to them in this diagram and in Fig. 3.

8. Connect tag 2 to pin 5 of V_2 and tag 4 to pin 4 of V_2. The two wires run alongside each other and close to the underside of the chassis. Although these are in the heater circuit, the wires need not be twisted together.

9. Connect one end of a 5in. length of wire to pin 4 of V_2 and one end of a second 5in. length of wire to pin 5 of V_2. Solder at pins 4 and 5.

10. Twist the two wires just fitted tightly together and, shortening as necessary, connect one wire to pin 9 of V_1 and the other to the chassis solder tag adjacent to that pin. It is immaterial which way round the wires connect. The twisted pair should run close to the underside of the chassis. Solder at pin 9.

11. Connect the solder tag of Step 10 to the centre spigot of V_1.

12. Using bare wire, connect the centre spigot of V_1 to pin 4 of V_1. Similarly using bare wire connect pin 4 of V_1 to pins 3 and 5 on either side. Solder all connections which have been made to the centre spigot, and at pins 3, 4 and 5.

13. Following the layout of Fig. 4 connect tag 6 to the adjacent lead-through insulator. Similarly connect tag 10 to the remaining lead-through insulator. Solder at both insulators.

14. Fitting sleeving over its lead-out wires, connect R_{11} between tags 8 and 9. Solder at tag 8.

15. Following the layout of Fig. 4, and fitting sleeving over its lead-out wires, connect C_{10} between tag 3 and tag 9, with the positive lead-out to tag 9.

16. Connect R_9 between tags 7 and 10.

17. Connect C_9 between tags 6 and 7. Solder at tag 7.

18. Connect tag 6 to tag 5. Solder at tag 6.

19. Prepare both ends of the 4-core power lead. This may be conveniently about a yard in length before fitting. Connect the leads at one end to pins 1, 4, 5 and 8 of the octal plug. The connections at the pins are made by passing the stripped wire of the appropriate lead down the pin and soldering at the pin tip, after which the excess wire is cut off. The pins are numbered in the plug moulding.

20. Pass the other end of the power cable through the ½in. grommet on the rear Chassis Rail and clamp it as indicated in Fig. 4 using a 6BA ¼in. screw and the Lektrokit Plastic Clip No. 3 or a suitable alternative clamp. If a metal clamp is employed, fit sleeving or several layers of p.v.c. insulating tape around the cord at the point of clamping to prevent direct contact with the power lead insulation.

21. Connect the power lead wires as follows: the wire from pin 1 of the octal plug to tag 2, the wire from pin 8 of the octal plug to tag 4, the wire from pin 4 of the octal plug to tag 5, and the wire from pin 5 of the octal plug to tag 3. *Take care not to accidentally transpose the wires from pins 4 and 5: pin 4 is h.t. positive and pin 5 is chassis.* It is assumed that the constructor will be able to trace the wires through the power lead, either by a colour code in the wires themselves or by the use of a continuity meter (which could consist, it its simplest form, of a torch battery in series with a bulb). Solder at tags 2 and 4.

22. Fitting sleeving over its lead-out wires, connect C_{11} to tags 3 and 5 with positive to tag 5. Solder at tag 3.

23. Connect tag 5 to pin 8 of V_2. Solder at tag 5.

24. Connect pin 8 of V_2 to tag 17. Solder at pin 8.

25. Connect pin 3 of V_2 to pin 9 of V_2. Solder at pin 3.

26. Connect pin 6 of V_1 to tag 16. Solder at pin 6.

27. Connect R_6 between tags 16 and 17.

28. Fitting sleeving over its lead-out wires, connect C_7 between tags 18 and 19, with positive to tag 19. Keep this component fairly close to the chassis underside, as R_7 is fitted above it later.

29. Fitting sleeving over its lead-out wires, connect C_4 between tags 18 and 20, with positive to tag 20.

30. Connect tag 20 to tag 11.

31. Connect R_4 between tag 11 and tag 12. Solder at tag 11.

32. Connect R_5 between tag 12 and tag 15.

33. Connect tag 15 to pin 1 of V_1. Solder at tag 15.

34. Connect C_6 between tags 12 and 14. Keep this component fairly close to the chassis underside as C_5 is fitted above it later.

35. Connect C_2 between pin 2 of V_1 and pin 5 of the valveholder for coil L_1. Keep C_2 lead-out wires reasonably short, whilst following the layout in Fig. 4.

36. Connect pin 8 of V_1 to tag 19. Solder at pin 8.

37. Connect the centre spigot of L_1 valveholder to the adjacent chassis tag.

38. Using three pieces of bare wire, connect the centre spigot of L_1 to pins 2, 4 and 9 of L_1. Solder at pins 2, 4 and 9.

39. Using the same thick wire as was employed in Steps 3 and 4, and following the layout shown in Fig. 4, connect the front lead-through insulator on the tuning capacitor Chassis Plate to the centre spigot of L_1 valveholder. Keep this wire as short as possible, but route it so that it passes over pin 9 (whereupon there is no risk of a short-circuit to pin 8). Solder all the connections which have been made to the centre spigot of L_1. Solder also at the lead-through insulator. (Fig. 4 may give the impression that the wire just fitted is connected to pin 9 of L_1, but the actual connection is at the spigot.)

40. Using the same thick wire as in the last Step, connect the remaining lead-through insulator on the tuning capacitor Chassis Plate to pin 5 of L_1 valveholder. Keep the wire as short as possible. Solder at the lead-through insulator and at pin 5.

41. Connect one end of a 3in. length of wire to the chassis tag adjacent to L_1 valveholder. Solder at the tag. The free end of this wire will later be connected to the reaction potentiometer, R_1.

(Continued on page 302)

The "Handyamp"

by Wilfred Smith

A neat low-cost amplifier which requires a 3-volt supply only

THE LITTLE POWER AMPLIFIER which is described here has given a good account of itself during tests. It uses only two transistors and, working from a 3 volt supply, provides an output greater than that given by the smaller transistor radios. It uses a minimum of components and these are readily available to the constructor. Although an OC81M was used in the TR_1 position in the prototype, an equally suitable alternative would be an OC81, or, even, an OC81D.

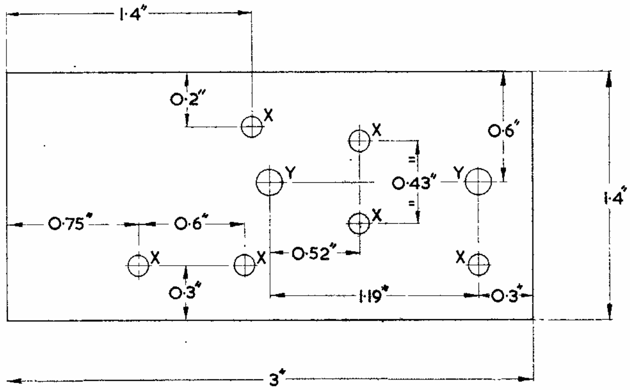


Fig. 2. How the Paxolin board is drilled. Holes "X" are ⅛in. and holes "Y" are 4BA clearance

The Circuit

The amplifier is a 2 stage unit with direct coupling between the two transistors. As is shown in the circuit diagram of Fig. 1, TR_1 operates in the common-collector mode, offering a relatively high input impedance, whilst TR_2 functions as a common-emitter amplifier. TR_2 feeds directly into a 10Ω loudspeaker, thus eliminating the output transformer. Any size loudspeaker of 10Ω impedance should be suitable, but some of those fitted to the smaller transistor portable radios may not be able to handle the audio applied to them.

Negative feedback is applied, to widen the frequency response, by means of R_3, this resistor being

Resistors
(All ¼ watt 10%)
R_1 5.6kΩ
R_2 270Ω
R_3 15kΩ

Capacitors
C_1 8μF electrolytic 6V wkg.
C_2 100μF electrolytic 6V wkg.

Transistors
TR_1 OC81M or OC81
TR_2 XC141

Loudspeaker
10Ω impedance

Switch
S_1 s.p.s.t. on-off switch

Battery
3-volt battery

Miscellaneous
Paxolin, 3 x 1.4in
4 6BA solder tags
1 4BA solder tag
2 4BA nuts and bolts
4 6BA nuts and bolts

COMPONENTS

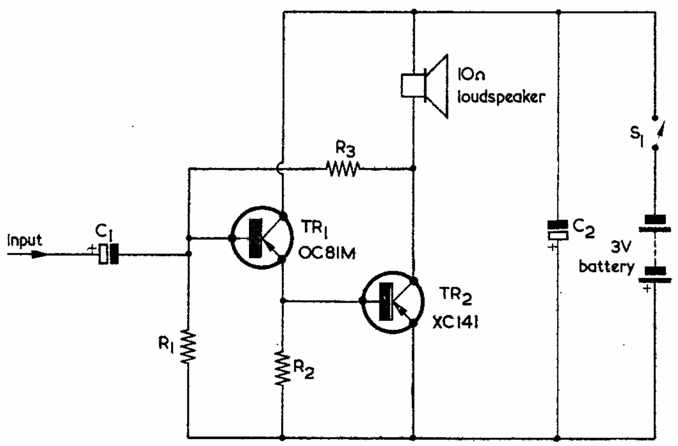


Fig. 1. The circuit of the "Handyamp"

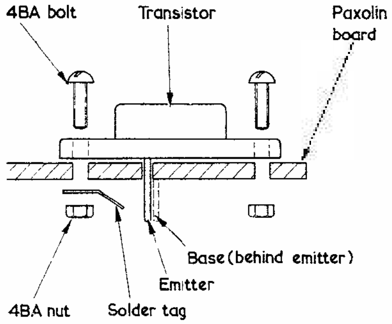


Fig. 3. Fitting TR_2 to the board

solder tags fitted, TR_2 is mounted with its body on the underside of the board, and with its emitter and base lead-outs passing through. A solder tag is secured under the inside securing nut and this provides the connection to the collector. Fig. 3 shows the method of mounting TR_2.

Wiring then proceeds as illustrated in Fig. 4. Care should be taken to prevent excessive heat when soldering to transistor lead-outs, and a heat shunt (as is given by holding the appropriate lead with taper-nosed pliers) should be applied between the point of application of the soldering iron and the body of the

connected between the collector of TR_2 and the base of TR_1. No heat sink is necessary for TR_2, because it is only handling small currents as compared to its maximum ratings. Even after several hours of continuous use no rise in the case temperature of TR_2 was observed with the prototype.

The current consumption with no signal applied was found to be about 125mA at 3 volts. A convenient method of obtaining the 3 volt supply is given by joining two U2 batteries in series, and these will have a moderately long life. The prototype is now, however, operated from a mains supply unit.

C_2 is connected across the battery to provide a low supply impedance.

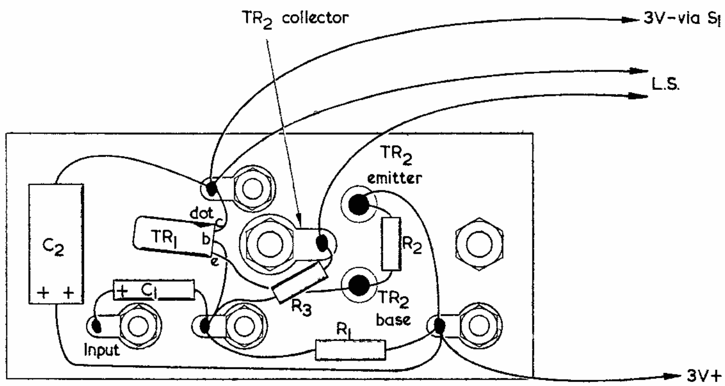


Fig. 4. Wiring the components on the board. The body of TR_2 is on the underside

Construction

The amplifier is assembled on a piece of Paxolin measuring 3 x 1.4in, which is drilled to the dimensions shown in Fig. 2. In this diagram, holes Y are 4BA clearance and take the mounting bolts for TR_2. The base and emitter lead-outs for TR_2 then pass through the two ⅛in X holes between the Y holes. TR_2 is mounted with its body on the underside of the Paxolin board whilst the remaining components are fitted above. There are four further X holes on the board, and these provide anchoring points for the components. A convenient means of anchoring is provided by using solder tags secured by 6BA nuts and bolts at these points. The on-off switch, S_1, is not mounted on the board.

After the Paxolin board has been drilled and the four 6BA transistor. This injunction applies to all lead-outs of TR_1 and the base and emitter lead-outs of TR_2.

When wiring is complete, a loudspeaker, the battery and a switch may be connected up. Input signals are applied between the positive terminal of C_1 and the positive supply line. A good output should be given with input signals of the order of 100mV.

EMI Demonstrate Educational TV

EMI Electronics recently provided a complete studio to demonstrate the use of educational TV to members of the Hillingdon Borough Council Education Committee. The Committee meeting had been called to finalise aspects of the Borough's pilot plan to link eight schools within the area with Brunel University which will be the transmitting centre.

On three monitors screens in the main committee chamber, the audience of about 50 Committee members and teachers saw a 20 minute programme presented by a local Headmaster. The programme was relayed from the studio which EMI Electronics had completely equipped in another part of the building. The whole production was carried out by EMI Technical staff.

Emitter Amplifier

Using N.P.N. Silic

by R. M

7 PRACTI

Direct-Coupled Amplifier

Sine/Square Wave Converte

* * *

Silicon planar transistors have been appearing on the home-constructor market recently, and they offer a number of advantages when compared with germanium types. In this article our contributor describes 7 high-performance circuits which have been specifically designed around two newcomers to this field—the Sinclair n.p.n. transistors type ST140 and ST141

WITHIN THE PAST YEAR OR SO A NUMBER OF manufacturers and distributors have introduced ranges of low cost v.h.f. silicon planar n.p.n. transistors suitable for amateur use. These semiconductors offer a number of advantages over the normal germanium types, the most important of these being as follows:

(*a*) Very low leakage currents, which are not greatly affected by temperature variations.

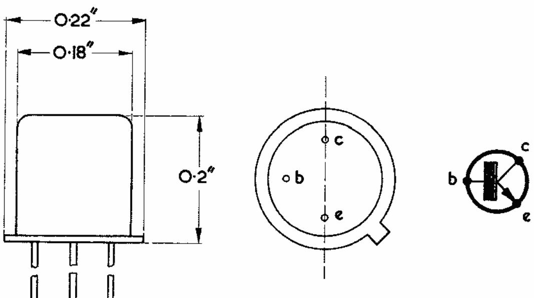


Fig. 1. Dimensions and lead-out layout of the ST140 and ST141 transistors. The collector is in contact with the metal case

This characteristic makes it possible to simplify the design of base bias networks with consequent reductions in the number of components used, thus reducing building costs. It also makes it possible to use very large values of collector load resistance, with consequent high power gains.

(*b*) Very low noise, making the transistors suitable for use in the early stages of pre-amplifiers, etc.

(*c*) Very high cut-off frequencies, generally in the order of 100 Mc/s or greater, making them suitable for use in all types of equipment ranging from direct coupled a.f. amplifiers to radio control transmitters and v.h.f. receivers.

(*d*) Low cost, generally in the range 5s. to 10s. each. This is, of course, lower than the cost of most germanium types, which have, by comparison, an inferior performance.

(*e*) Silicon transistors can be operated at high temperatures, and are able to withstand considerable abuse without breaking down.

Having considered the general advantages of this type of transistor, we can select just one or two specific types for experimental work and then go on to apply them to a number of practical circuits. The recently announced Sinclair types ST140 and ST141 will be used for this purpose.

Sinclair ST140 and ST141 Transistors

These recently announced transistors have a performance that is claimed to be far superior to any alternative types that are now available. The general characteristics are listed in the accompanying Table.

Comparing these characteristics with those of alternative types it may be stated that the Sinclair types have a cut-off frequency several times greater than others, that they are able to handle collector currents up to 25 times greater than some alternatives, and that they are lower in price than other types. It will be noted that they have high power

n Planar Transistors

Marston

IL DESIGNS

Two High Impedance Amplifiers

Crystal Oscillator

Low Impedance Amplifier

handling capabilities; two transistors of this type may be fitted with heat sinks and used as the push-pull output stages of an audio power amplifier, where they are capable of delivering an output of 2 watts! This is an impressive fact when the very small physical sizes of the ST140 and ST141 are taken into account. Details of physical dimensions are shown in Fig. 1.

The high power handling capabilities of these transistors are made possible by the internal construction that is employed; the collector is in contact with the transistor case, forming an ohmic link and thus making a very large effective collector area available for cooling purposes. Another unusual feature offered by these low-cost transistors is that the connecting leads are gold plated for ease of soldering and corrosion resistance. The whole assembly is very robust, making it possible to use and re-use the transistors many times over without fear of damage. This is, of course, ideal for experimental work.

TABLE

General Characteristics of Transistors Type ST140

Type No.	ST140	ST141
I_c (max.)	500mA.	500mA.
V_{cbo}.	20 volts.	20 volts.
I_{cbo} (max @ 10V).	1μA.	1μA.
F_t (@ 1mA, 5V).	400 Mc/s.	400 Mc/s.
F_t (@ 10mA, 10V).	700 Mc/s.	700 Mc/s.
h_{fe} (@ 100μA).	15–40.	30–150.
h_{fe} (@ 1mA).	20–60.	40–200.
h_{fe} (@ 10mA).	20–60.	40–200.
h_{fe} (@ 100mA).	15–40.	30–150.
C_{ob} (@ 1V).	2.5pF.	2.5pF.
P_{tot} (free air).	360mW.	360mW.
P_{tot} (case @ 100°C).	680mW.	680mW.
Price.	4/–.	6/–.

Note: Max. operating junction temperature = 200°C.

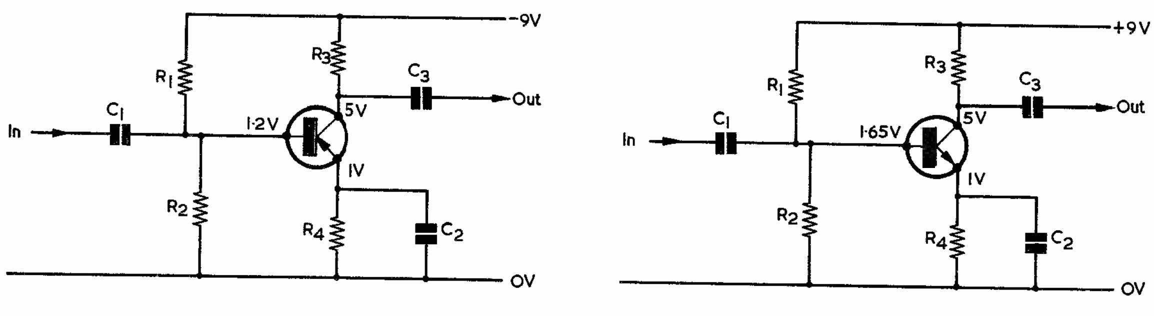


Fig. 2. Two similar common emitter circuits, one using a p.n.p. germanium transistor and the other using an n.p.n. silicon planar transistor. Note the differences in supply polarity and emitter-base junction potentials

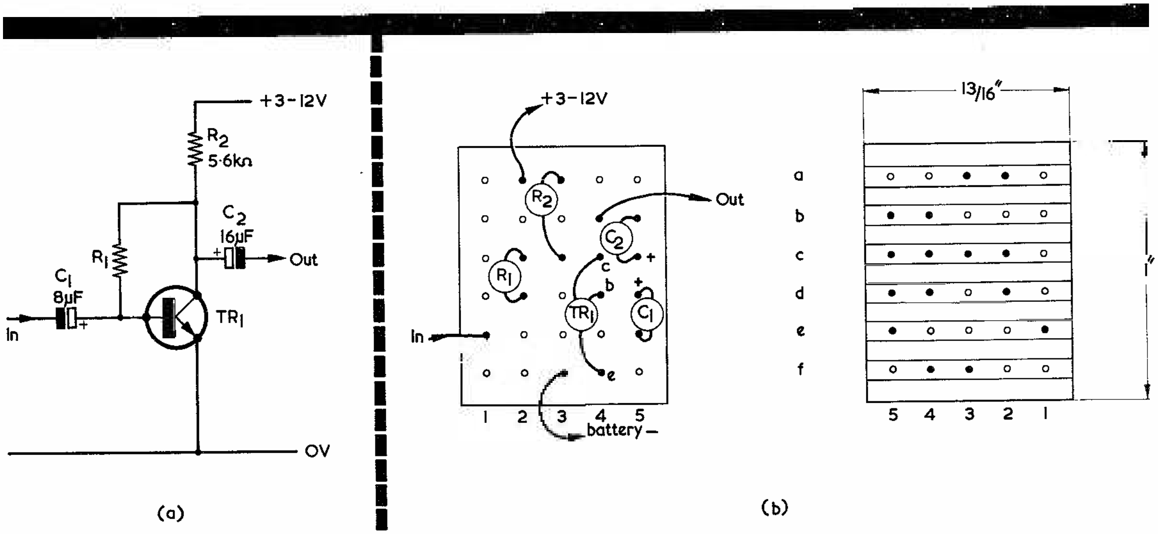


Fig. 3 (a). A practical common emitter amplifier using an ST140 or ST141 transistor. R_1 is 270kΩ with the ST140, and 470kΩ with the ST141

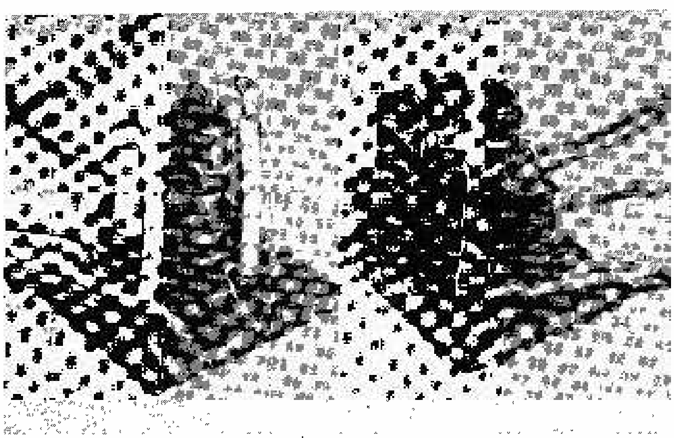
(b). The circuit of (a) assembled on a small piece of Veroboard. In this and succeeding layout diagrams it is intended that, unless otherwise shown, all resistors and capacitors should be mounted vertically. Also, the outside dimensions given apply to Veroboard of 0.15 in matrix

Using the ST140 and ST141

The first difficulty that some readers, who are more used to ordinary p.n.p. transistors, may run into is how to visualise a normal circuit, such as a common emitter a.f. amplifier, designed around n.p.n. transistor types. This is, of course, quite a simple problem to solve, and Fig. 2 shows the two types next to one another for comparison; it will be noticed that the only difference between the two circuits lies in the fact that the two supply rails have their polarities transposed, the p.n.p. circuit having negative collector potentials while the n.p.n. circuit has positive collector potentials, and in the fact that different symbols are used for the two transistor types. As far as the symbols are concerned, it should be noted that in both cases the arrow denotes the transistor's emitter, and that in both cases the direction of the arrow indicates the direction of current flow, using the "conventional" positive-to-negative current flow theory.

Although no component values are shown in the circuits of Fig. 2, typical potentials at emitter, base, and collector are included, and the important point to notice here is that the emitter-base potential of the silicon transistor is considerably greater than that of the p.n.p. germanium type, being approximately 0.65 volt in the former case and 0.2 volt in the latter. This difference between the base-emitter junction potentials of germanium and silicon types is probably the most significant difference to bear in mind when designing amplifiers that are otherwise similar. In the case of Fig. 2, the germanium p.n.p. circuit can be modified to operate with a silicon n.p.n. transistor by simply transposing the supply connections and altering the value of R_1 to give the required base potential, leaving R_2, R_3, and R_4 unaltered. Design work thus presents very few problems.

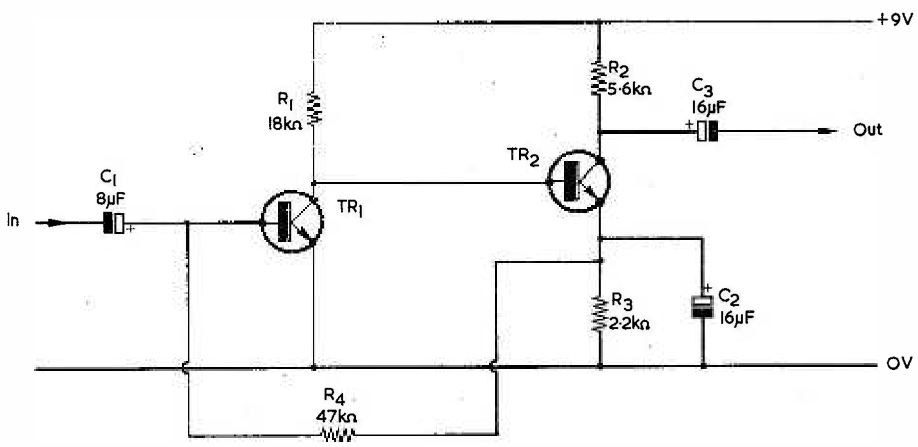
Although conventional p.n.p. germanium transistor circuits can be easily arranged to work with n.p.n. silicon types, such an approach is rather pointless since it does not take full advantage of the benefits offered by the silicon transistor. With this point in mind, a few practical circuits will now be considered.



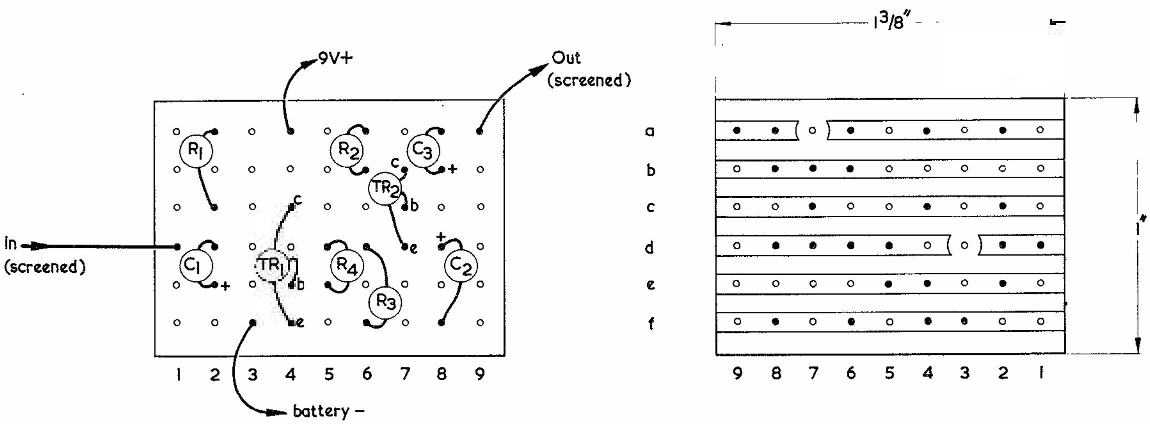
The amplifier of Fig. 5 appears at the left, and that of Fig. 3 at the right

As shown in Fig. 2, germanium transistors require a fairly complex base-bias network if they are to give satisfactory operation over a reasonable temperature range; three resistors, R_1, R_2, and R_4, and a capacitor, C_2, are required for this purpose. This complexity is needed partially to allow for differences in the current gains of transistors of a similar type, but mainly to compensate for the large leakage currents that are inherent with germanium transistors. Silicon transistors, on the other hand, have very low leakage currents, and the base-bias networks can thus be considerably simplified, with no deterioration in performance. Fig. 3 (*a*) shows a complete common emitter amplifier stage, using n.p.n. silicon planar transistors.

Here, only one base-bias resistor, R_1, is used, and it is connected directly between base and collector. This connection provides a reasonable degree of negative feedback, and so compensates for large variations between the current gains of

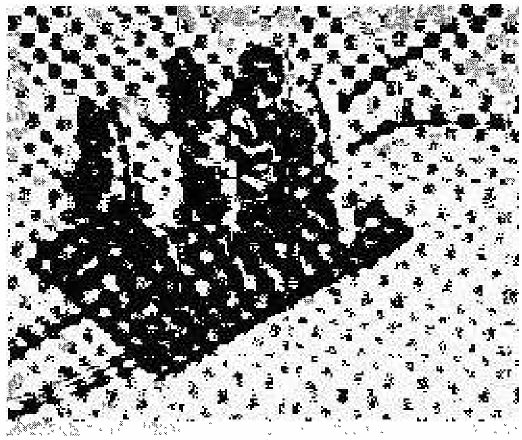


(a)

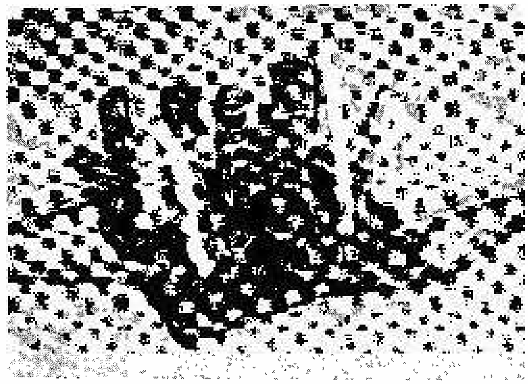


(b)

Fig. 4 (a) A 2-stage direct coupled amplifier giving very high gain, and with component values suitable for either ST140 or ST141 transistors. Input and output leads must be screened.
(b) Constructional details for the 2-stage amplifier



The high-gain amplifier of Fig. 4



The very high impedance amplifier whose circuit is that of Fig. 6

individual transistors. A total of only 5 components is used in the circuit, including the input and output coupling capacitors, compared to the 8 components used in the more conventional version of the amplifier; building costs are thus very low.

As shown in the diagram, this circuit is sufficiently well stabilised to operate from any voltage in the range 3--12 volts, without component changes. The design, using the ST141 transistor, will give power gains up to 20,000 times.

Fig. 3 (*b*) shows how this simple circuit can be wired up on a small piece of Veroboard for test and experimental purposes.

A 2-Stage Direct Coupled Amplifier

Because of the high leakage currents that are inherent with germanium transistors, it is usually necessary to use a.c. coupling between the individual stages of a multi-stage amplifier; typically, a conventional 2-stage amplifier will use a total of 15 components. Occasionally, using germanium transistors, it is possible to employ direct coupling between two stages and so save on components, but such designs require some care in setting up, and may need individual component selection to suit individual transistors.

Silicon transistors, on the other hand, can be direct coupled with ease, and suffer from none of the above difficulties. Fig. 4 (*a*) shows a typical 2-stage direct coupled circuit designed around ST140 and ST141 transistors.

Since the specified transistors have very low leakage currents and retain their high current gains at low values of emitter current, it is possible to provide them with high values of collector load, even in direct coupled circuits. This is done in Fig. 4 (*a*), where TR_1 has an 18kΩ collector load resistance, R_1. TR_1, which is connected as a

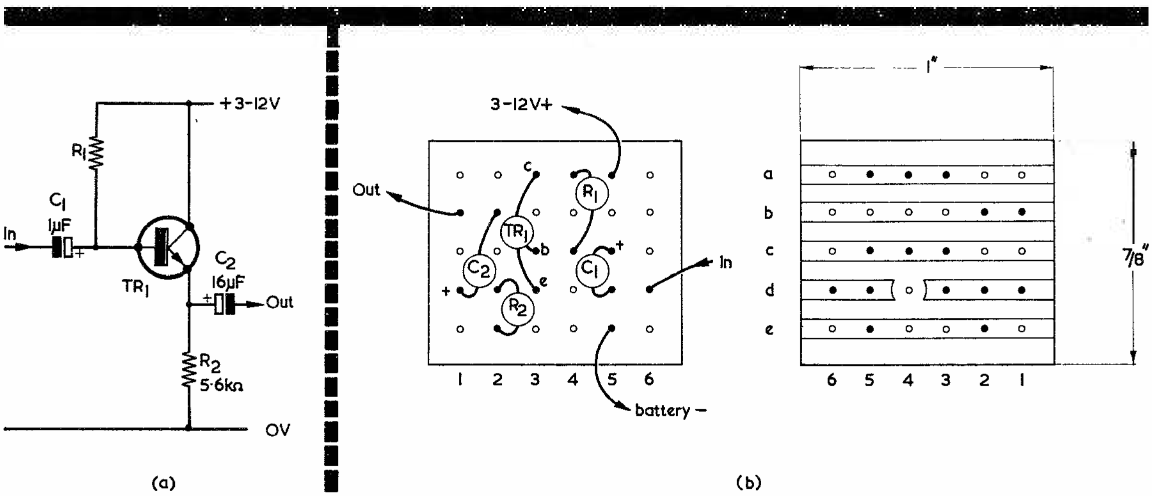
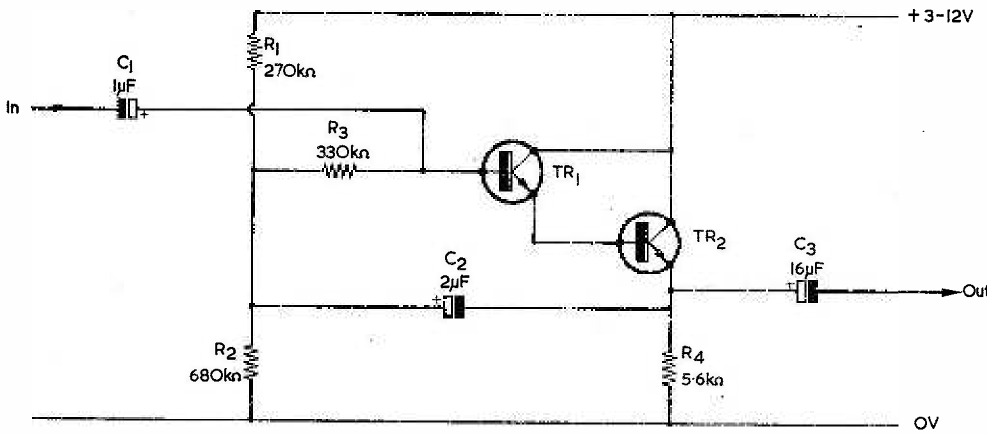


Fig. 5 (a) A high impedance amplifier. With the ST140, R_1 should be 220kΩ, giving a Z_{in} of 120kΩ. With the ST141, R_1 should be 330kΩ, giving a Z_{in} of 230kΩ
(b) The circuit of (a) built up on Veroboard

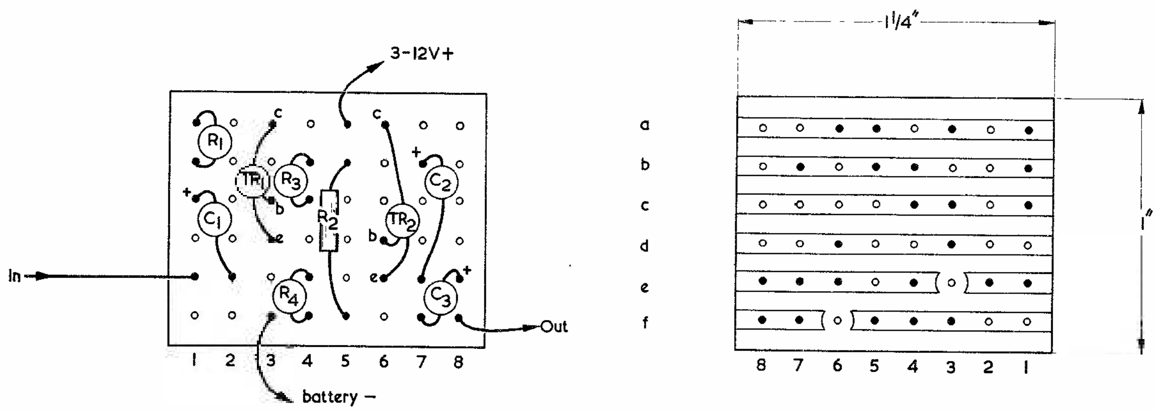
common emitter amplifier, thus gives a high power gain. The collector of TR_1 is direct coupled to the base of TR_2, which is also connected as a common emitter amplifier, with collector load R_2. The emitter of TR_2 is biased by R_3 and decoupled by C_2, the low impedance d.c. at TR_2 emitter being used to provide, via R_4, the base-bias for TR_1. A d.c. negative feedback loop is thus formed, and the operating levels of the circuit are automatically adjusted to suit individual transistors; signal feedback is, of course, prevented by C_2.

Because of the high value of TR_1 collector load, the elimination of signal feedback, and the minimisation of bias loading networks, the circuit has a very high order of efficiency; power gains of up to 50,000,000 times can be obtained using ST141 transistors. The available gain is so high, in fact, that it is necessary to use screened input and output leads with the circuit, and in practice it will usually be found that the gain is far higher than is needed for most applications. In such cases, the gain can be reduced to more manageable proportions by either introducing signal negative feedback by removing C_2 from the circuit, or by using ST140 transistors.

It will be noticed that the circuit of Fig. 4 (*a*)

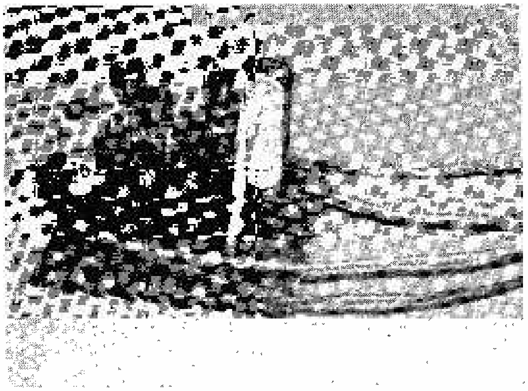


(a)



(b)

Fig. 6 (a). An amplifier having a very high input impedance of the order of 3.3MΩ. Either ST140 or ST141 transistors may be used, but the latter will give a lower output impedance
(b). Constructing the very high impedance amplifier



The 2-stage low impedance amplifier of Fig. 7

uses a total of only 9 components, compared to the 15 components of a conventional 2-stage amplifier. The building costs are thus kept at a low level.

Fig. 4 (*b*) shows how to build the circuit on a small piece of Veroboard for test and experimental purposes.

High Impedance Amplifiers

In many applications in electronics it is necessary to feed the output of a circuit under test into a high impedance load or amplifier; in such cases, the emitter follower circuit may be used to give the required high input impedance.

When germanium transistors are used in emitter follower circuits, fairly complex bias and leakage compensation networks are required, and these are, of necessity, connected in parallel with the input circuits of the transistors, thereby lowering the maximum input impedance that is available. In addition, germanium transistors have fairly low leakage impedances, and these also reduce the available input impedances.

Silicon transistors, on the other hand, have high values of leakage impedance, and can be designed to use very simple biasing networks, thus making possible input impedances several times greater than are available with germanium transistors whilst using fewer components.

Fig. 5 (*a*) shows the circuit of a typical single-stage emitter follower, using either ST140 or ST141 transistors. The circuit may be used with any supply in the range of 3 to 12 volts, without component changes. Using the ST140 transistor, input impedances of the order of 120kΩ are available, or, using the ST141, impedances of around 230kΩ may be obtained.

Constructional details of the circuit are shown in Fig. 5 (*b*). These circuits give a low output impedance, and, because of the small overall dimensions of the completed units, they may be built into the cases of high impedance microphones, etc., and used as impedance converters where very long connecting leads have to be used.

If very high input impedances greater than several hundred thousand ohms are required, more complex circuitry may be used, as shown in Fig. 6 (*a*). Here, TR_1 and TR_2 are Darlington connected in the emitter follower configuration, with base-bias provided by the voltage divider network R_1–R_2, which is isolated and bootstrapped via R_3 and C_2. The input is applied via C_1, and the output is taken via C_3. The circuit will operate from any supply in the range 3 to 12 volts, without component modifications.

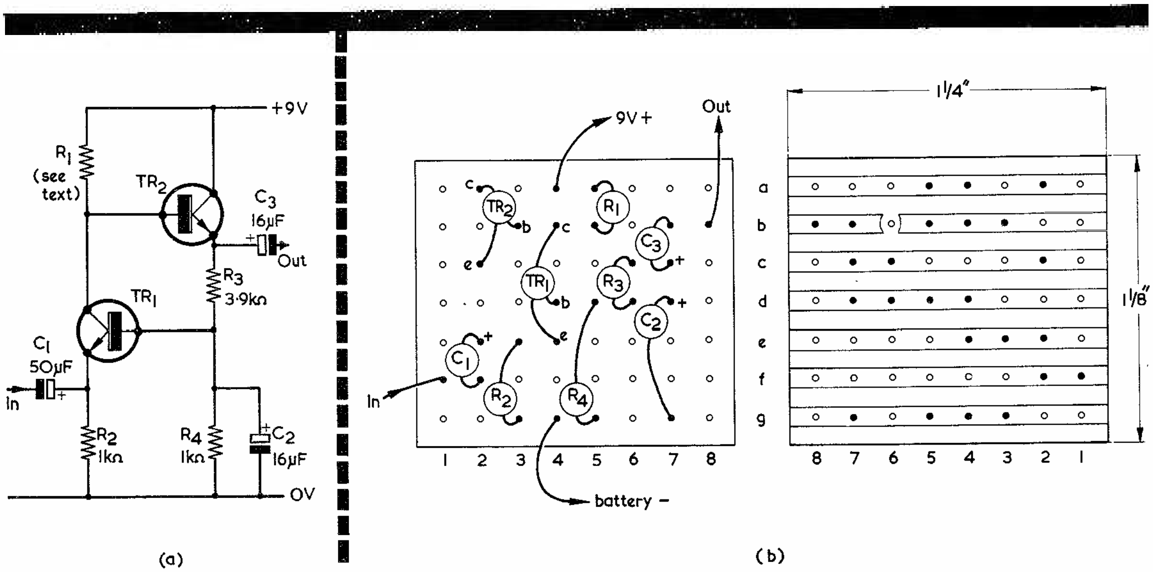


Fig. 7 (a). A 2-stage self-compensating low impedance amplifier. Either ST140 or ST141 transistors may be employed.
(b) Assembling the amplifier of (a)

Either ST140 or ST141 transistors may be used in this circuit, which gives an input impedance of about 3.3MΩ, but a lower output impedance will be made available if ST141 transistors are used.

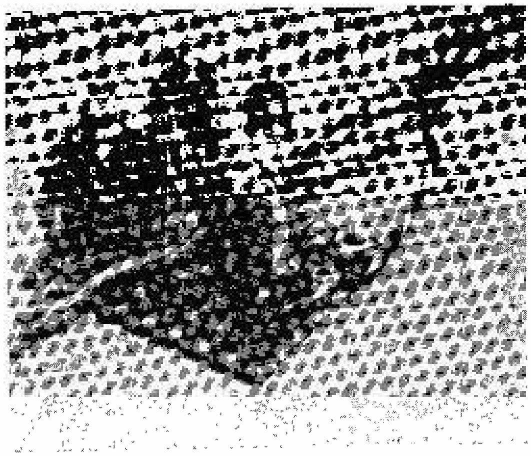
Full constructional details of this unit are shown in Fig. 6 (*b*); a screened input lead should, of course, be used. Note that, as in the case of the basic emitter follower circuit, this unit is sufficiently small to fit in a microphone case, for use as an impedance converter, if required.

A Low Impedance Amplifier

Circuits with a very low input impedance are sometimes required in electronics, to match with magnetic pick-up heads, etc. When germanium transistors are used in such applications, it is usually necessary to design each individual circuit to suit the equipment with which it is used; because of the problems of biasing and leakage compensation, however, such design work is fairly complex.

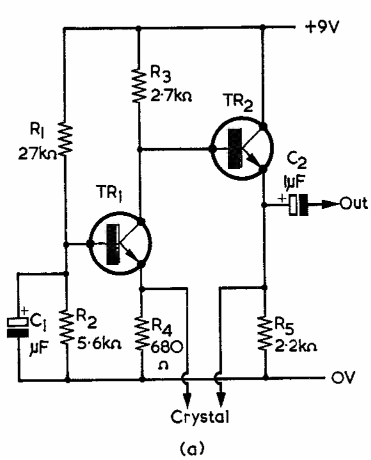
When silicon transistors are used, on the other hand, design work can be considerably simplified, and Fig. 7 (*a*) shows the circuit of a 2-stage self-compensating low impedance amplifier, which can have its input impedance varied between about 24Ω and 120Ω by simply altering the value of one resistor, R_1.

Here, TR_1 is wired as a common base amplifier, with collector load R_1, and the input signal is applied to the emitter via C_1. The collector of TR_1 is direct coupled to the base of TR_2 which is, connected as an emitter follower with its emitter load split into two parts, R_3 and R_4. The junction of these last two components is decoupled to a.c. by C_2, and is used to provide the base-bias of TR_1. A heavy d.c. negative feedback loop is thus formed, and the operating levels of the amplifier are automatically self-compensating against large variations in the values of R_1 and in the characteristics of the transistors.



The crystal oscillator of Fig. 8

The input to the amplifier is, effectively, applied across the emitter-base junction of TR_1, and the input impedance tends to become equal to the forward impedance of this junction, or 'diode'. This impedance is proportional to the emitter current of TR_1, and is equal to approximately 25Ω at 1mA; if the current is doubled, the impedance is halved, and vice versa. Because of the self compensating action of this circuit, the emitter current, and thus the input impedance, is almost directly proportional to the value of R_1, so that the input impedance can be increased or decreased by either raising or lowering the value of R_1. The value of R_1 can be varied between approximately 2.7kΩ and 22kΩ, without adversely affecting the operation of the circuit.



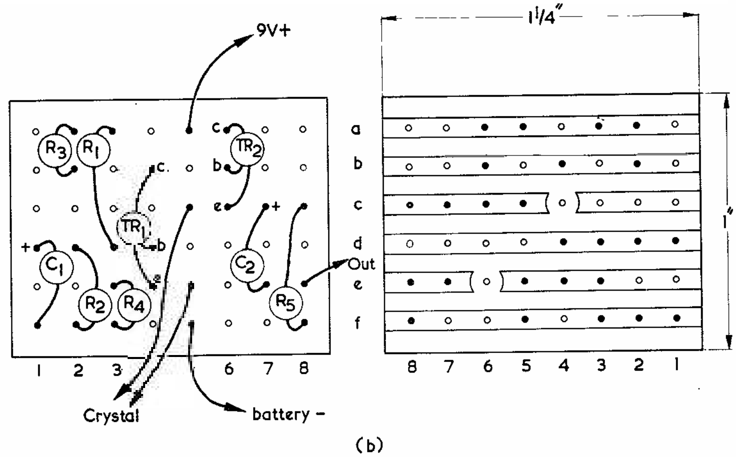


Fig. 8 (a). A crystal oscillator with rich harmonic content. Either the ST140 or ST141 may be used
(b). The crystal oscillator assembled on Veroboard. For reasons given in the text, it must be stressed that this is an experimental layout

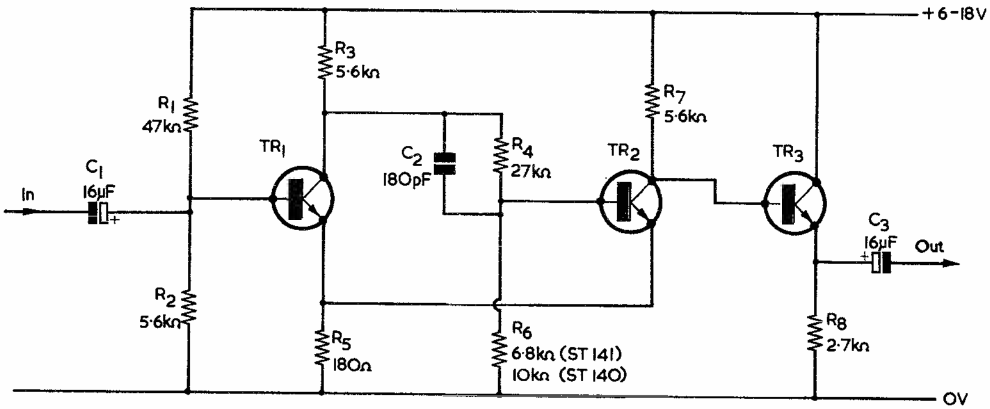
The input impedance of the circuit is approximately equal to $10\Omega + \left(\frac{R_1 \text{ (in ohms)}}{200}\right)$ so that the impedance can be varied between about 24Ω and 120Ω.

The voltage gain is virtually constant at about 200 times, irrespective of the value of R_1 and the types of transistor used. Power gain, however, is subject to considerable variation, depending on the value of R_1 and the types of transistor used for TR_1 and TR_2. Using the maximum value of R_1 and ST141 transistors, power gains of about 5,000,000 times can be obtained.

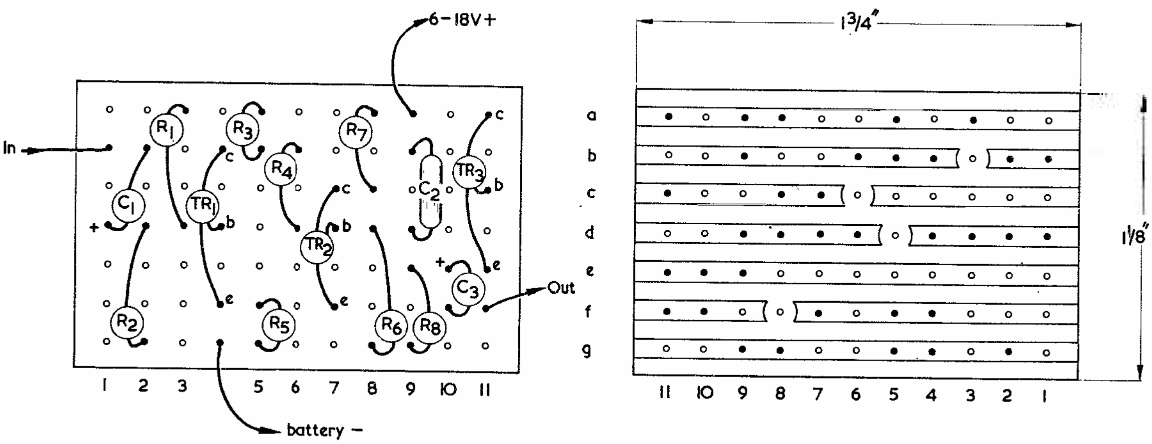
Constructional details of the unit are shown in Fig 7 (*b*). Note that the unit is designed for operation from a 9 volt supply.

A Versatile Crystal Oscillator

Although it is possible to design crystal oscillators to operate with a single transistor, such circuits suffer from the disadvantage that they must be individually designed to suit the particular crystal frequency and harmonics in use.



(a)



(b)

Fig. 9 (a). A sine/square wave converter having an exceptionally fast rise time. Again, either ST140 or ST141 transistors may be employed

(b). Constructional details for the sine/square wave converter

This disadvantage can be overcome by using a circuit similar to that shown in Fig. 8 (*a*). Here, a 2-transistor circuit is used, and is wired as an emitter coupled multivibrator, using a series crystal as the tuning element, no other tuned circuits being required. Thus, the circuit automatically operates at the frequency of the crystal that is in use, and no special design work is required.

In effect, TR_1 is wired as a common base amplifier, with the input applied to its emitter; the input and output of this transistor are in phase, but voltage amplification takes place. TR_2 is wired as an emitter follower, with its base connected to TR_1 collector; the input and output of this transistor are also in phase. Thus, the signal at TR_2 emitter is an amplified version of that at TR_1 emitter, and both signals are in phase, so that when the two emitters are coupled together via a blocking capacitor, etc., a positive feedback loop is formed and the circuit oscillates. When the crystal is inserted in this feedback loop, the feedback is greatest at the resonant frequency of the crystal, and the circuit oscillates at that frequency.

An additional advantage of this circuit is that the output waveform is very rich in harmonics. Also, the output is available at a low impedance from TR_2 emitter.

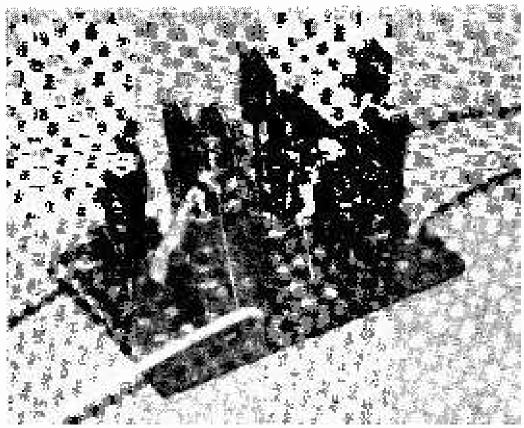
Although this circuit is suitable for use with almost any types of transistor, including germanium, it is particularly suited to the ST140 and ST141 types, since their very high cut-off frequencies enable it to operate at fundamental frequencies up to many tens of megacycles, and to produce harmonics at frequencies of several hundreds of megacylces.

Wiring up details of a unit suitable for test or experimental purposes are shown in Fig 8(*b*). It should be emphasised that this layout is suitable for experimental purposes only. In a practical circuit, the crystal should be secured in a holder and wired rigidly in position, keeping all wires as short as possible. At very high operating frequencies, it may be necessary to screen the unit.

At very high operating frequencies, or if alternative transistors are used, it will be necessary to wire a small trimmer capacitor in series with the crystal, to compensate for phase shifts occurring in other parts of the circuit.

Sine/Square Converter with Ultra-short Rise Time

The final circuit to be described in this article will be a very high performance sine square wave converter. The full circuit diagram of this circuit is shown in Fig 9 (*a*). As can be seen, a total of three transistors are used, TR_1 and TR_2 being wired as a conventional Schmitt trigger, and TR_3 being wired as an emitter follower with its base direct coupled to TR_2 collector, thus giving a low impedance output that is virtually unaffected by external loading conditions. A sine wave input may be connected to TR_1 base via C_1 and, providing the sine wave has an amplitude greater than several hundred millivolts, a large amplitude square wave will be made available at the output terminals via C_3.



The sine/square wave converter of Fig. 9

The circuit is sufficiently versatile to operate from any supply within the range 6 to 18 volts without component modifications, and the amplitude of the square wave output signal is almost equal to the supply rail potential.

Although this type of circuit is suitable for operation with almost any transistor types, it is frequently found that, when other transistors are used the resulting square wave is rather inferior in form. Typically, for example, good square waves with very sharp corners may be available at frequencies of a few kilocycles, but at frequencies in the order of 100kc/s or so the corners become so badly rounded that the 'square' wave looks almost like a sine wave; i.e., the waveforms have a rather long rise time. In such cases, the circuits may give rise times in the order of a few microseconds, and may cease to operate completely at frequencies greater than about 150kc/s.

If, however, the ST140 and ST141 transistor types are used, their very high cut-off frequencies enable near-perfect square waves to be obtained even at operating frequencies greater than 1 Mc/s. This is because rise times are extremely short. The rise times are so short, in fact, that at the time of writing it is not possible to quote precise values for rise times since they have proved to be beyond the range of the available measuring equipment. They are, however, in the range of a few nanoseconds (a nanosecond is one thousandth part of a microsecond).

As well as giving a very short rise time, the circuit has the advantage of being able to operate at frequencies in excess of 3 Mc/s. Either the ST140 or ST141 transistor types may be used in the circuit, but the latter type will give greater sensitivity and will operate up to higher maximum frequencies than will the ST140. Both types give similar rise times.

Full constructional details of the unit are shown in Fig. 9 (*b*), and the layout given is suitable for use in a practical sine/square converter.

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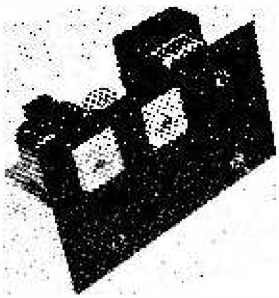


Cover Feature

Quality Power Pack for the Beginner

by James S. Kent *Part 1*

The power pack design presented here contains all those features that are desirous in a unit of this nature—fully metered h.t. output, stabilised h.t. output, visual indications of both heater and h.t. voltage and a double-smoothing circuit. The author has paid particular attention to safety with beginners in mind, a fully-shrouded mains transformer and a fused a.c. input being features of the design. For the benefit of beginners, the construction of this power unit is fully described. A point-to-point wiring diagram, together with the illustrations, provides all details for an interesting practical project which is ideal for those about to commence the hobby of radio construction

ALL BEGINNERS MUST START SOMEWHERE IN whatever hobby they decide to participate and, in the field of radio construction and operation, the very first necessity is a receiver and power supply. Many receiver designs are presented with integral power supplies but the writer tends to favour having the power pack as a separate entity. This confers several advantages—(*a*) the source of a.c. mains (50 c/s) hum is removed from receiver circuits, (*b*) the power supply is capable of being used with other units under construction or test and (*c*) it is portable within the workshop, i.e. it can be moved from one bench to another or to any location having access to the mains supply.

A power pack is probably one of the most expensive items of equipment that the beginner will undertake to build and the design discussed here is not by any means cheap. It is intended as a quality unit with a fully metered output and visual indications for both heater and h.t. supplies are fitted on the front panel. Once the initial cash outlay has been made and the unit constructed, however, this design will give many years of service and repay the operator many times over. As a workbench power supply it is ideal for supplying power to those experimental projects we all undertake from time to time—both the output voltage of the power unit and the current consumption of the project being visually indicated at all times.

For those beginners who wish to construct a cheaper unit, the following items could be dispensed with—voltmeter, both the visual indicators, the 150C2 stabiliser tube and its resistor and even, if paring to the bone, one section of the double-smoothing circuit. However, the writer does not recommend any of these economies for, sooner or later, such features will become desirous and will almost inevitably become added to the circuit at a later date.

The design features of power packs are many and varied, but that discussed here has been drawn up specifically with the beginner in mind. As such it has been made as safe as it can possibly become. A double-wound mains transformer provides complete isolation from the a.c. mains supply, this being fully shrouded to avoid the touching of bare high voltage connections; also employed are adequately rated components, a fused a.c. input and a double-pole on/off switch. All the components are of quality manufacture and currently obtainable on the retail market.

This article has, at the Editor's request, been specially prepared and presented for the beginner and as such it includes a point-to-point wiring diagram which, together with the illustrations, makes the construction of the project a comparatively trouble-free venture.

Circuit

The circuit is shown in Fig. 1. The mains transformer primary winding has three separate a.c. voltage input taps, the one shown connected here being 240V. The intending constructor should ascertain the local mains voltage and use the appropriate tap. The double-pole, single-throw switch is inserted in the a.c. mains input leads,

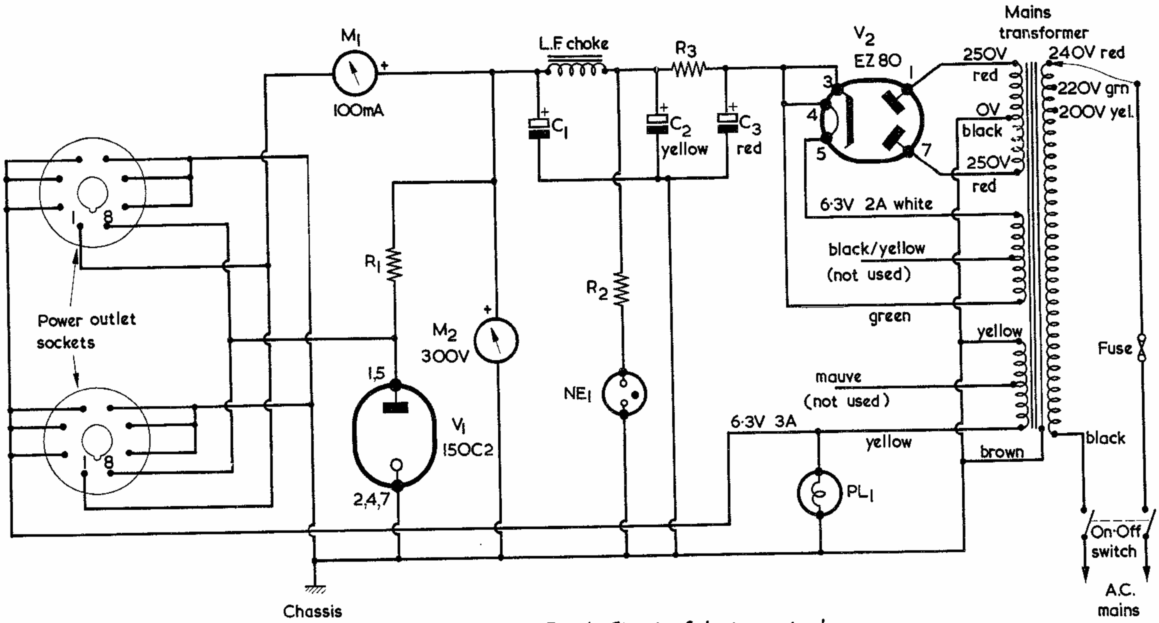


Fig. 1 Circuit of the power pack

COMPONENTS

Resistors
- R_1 4.7kΩ 5 watts
- R_2 Integral with Neon
- R_3 1kΩ 7 watts

Valves
- V_1 150C2 (Mullard)
- V_2 EZ80 (Mullard)

Meters
- 0–300V d.c. Type MR38P, S.E.W. (Henry's Radio Ltd.)
- 0–100mA d.c. Type MR38P, S.E.W. (Henry's Radio Ltd.)

Panel Lamp (PL_1)
L.E.S. (H. L. Smith & Co, Ltd) 6.5V 0.15A.

On/Off Switch
d.p.s.t. (Pear Dolly) Bulgin type S300

Chassis
$5\frac{1}{2} \times 8\frac{1}{2} \times 2$in (H. L. Smith & Co, Ltd)

Panel
10×6in (H. L. Smith & Co, Ltd)

Capacitors
- †C_1 32μF electrolytic, 450V wkg
- *C_2 16μF electrolytic, 450V wkg
- *C_3 32μF electrolytic, 450V wkg

†16 + 16μF in parallel, wire-ended
*Contained in single can

Fuseholder
Panel-mounting type with 2A fuse (cartridge)

Mains Transformer
Pri: 200-220-240V. Secs: 250-0-250V, 75mA; 6.3V, 5V, 2A; 6.3V 3A (centre-tapped). Type 3104A. (H. L. Smith & Co, Ltd)

L.F. Choke
20H, 75mA, 350Ω. Type 101C. (H. L. Smith & Co, Ltd)

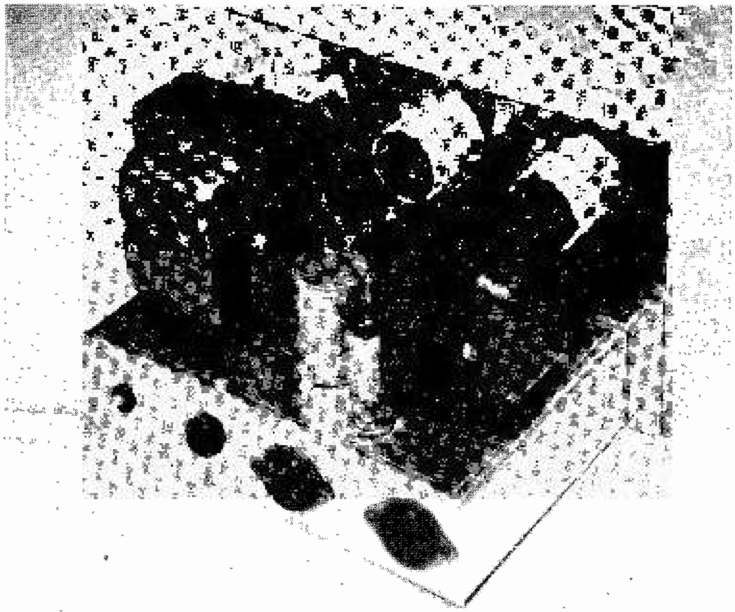
Neon (NE_1)
Panel-mounting type (H. L. Smith & Co, Ltd)

Miscellaneous
5-way tagstrip (2 outside tags earthed); 1-way insulated tag; chassis tags; capacitor mounting clip; 2BA and 4BA nuts and bolts; mains connecting cable; 4 off grommets ($\frac{3}{8}$in); 3 off grommets ($\frac{1}{4}$in); 2 off Octal plugs, Bulgin P.112; solder, wire, etc.

Valveholders
- 2 off International Octal
- 1 off B7G
- 1 off B9A

thus ensuring that both sides of the mains are disconnected when the switch is in the off position. A 2 amp cartridge fuse is inserted in one mains lead, this fuse being fully enclosed in a panel-mounting holder on the rear chassis apron of the unit.

The three secondary windings are connected as shown, the colours of the individual wires from the mains transformer being indicated alongside the



Showing the layout of components on the chassis deck. Note the orientation of the mains transformer and the l.f. choke, as illustrated here and in Figs. 2 (a) and 3

appropriate wires. The 250-0-250V secondary winding connected to the anodes of the EZ80 rectifier valve has a centre-tap which is connected to chassis, whilst the taps in the remaining two secondary windings are not used in the present design. One side of the 6.3V 3A heater winding is connected to chassis, and a panel-mounted lamp assembly (PL_1) to give visual indication of the presence of heater voltage is connected from the other side of this winding to chassis.

The rectified h.t. (high tension) voltage is taken from the EZ80 rectifier via pin 3 and is fed to the first smoothing section, given by C_2, R_3, C_3. Double-smoothing of the h.t. supply to receivers is favoured by the writer. For the small cost of the two extra components involved, R_3 and C_1 (in a more "conventional" circuit the l.f. choke would be inserted between C_2 and C_3—these two capacitors being contained within a single can) the advantage which accrues is well worthwhile. There is a complete absence of 50 c/s ripple (hum) in the receiver, particularly when headphones are used.

After C_2, the h.t. potential is applied to the second smoothing section given by the l.f. choke and C_1. This latter is a wire-ended component, and consists of two 16μF capacitors contained within a single can and connected into circuit in parallel (i.e., both the positive wire connections are twisted together, soldered and connected up as a single wire). The resultant capacitor therefore has a value of 32μF.

At this point, the neon visual indicator (NE_1) and resistor R_2 have next to be noted. The neon gives indication of the presence of h.t. potential, and resistor R_2 being an integral part of the panel-mounted neon lamp assembly.

Voltmeter M_2 is connected from the fully smoothed h.t. positive line to chassis and provides an accurate indication of the voltage of this output at all times. At the same time, meter M_1 provides an indication of the external current being consumed from this output by any unit connected to the power pack.

The voltage regulator (150C2), which provides a stabilised voltage of 150V to the power outlet sockets at pins 8, is fed from the h.t. line via the dropper resistor R_1, this component regulating the h.t. current passing to the stabiliser tube. The current drawn by the 150C2, under no external load conditions at pins 8 is 23mA.

The unstabilised h.t. output is taken to pins 1 of both the respective power outlet sockets, these being international octal valveholders mounted on the rear apron of the chassis. As has already been mentioned, the stabilised output is taken to pins 8. The earth (chassis) connection is taken to pins 5, 6 and 7, and the 6.3V 3A supply to pins 2, 3 and 4.

The h.t. output available at C_1 is 250V at 75mA. When the 150C2 is plugged in, the 23mA drawn by the regulator circuit limits the current available at pins 1 of the output sockets to 52mA, which should be more than adequate for any normal receiver and similar designs likely to be constructed. Since the h.t. output at pins 1 is not regulated, this may rise above the nominal figure of 250V for low load currents. If at any time high load currents, up to the full 75mA available from the mains transformer, are required from pins 1, the 150C2 may be temporarily removed from its socket, whereupon the regulated supply facility is not, of course, then provided. With the 150C2 in circuit, the stabilised voltage at pins 8 is a nominal 150V at currents up to 18mA.

The heater supply is 6.3V a.c. at 3A. Three pins have been provided for each side of the 6.3V output since the usual type of octal plug is rated at 1A per pin. If a unit connected to the power supply has a heater consumption, at 6.3V, of 1A or less, one connection may be made to either pin 2, 3 or 4, and the other to either pin 5, 6 or 7. Should the consumption be between 1 and 2A, two of the plug pins (say 2 and 3) should be wired in parallel for one connection, and two of the plug pins (say 6 and 7) should be wired in parallel for the other connection. For currents from 2 to 3A three plug pins should be wired in parallel for both connections. In all cases,

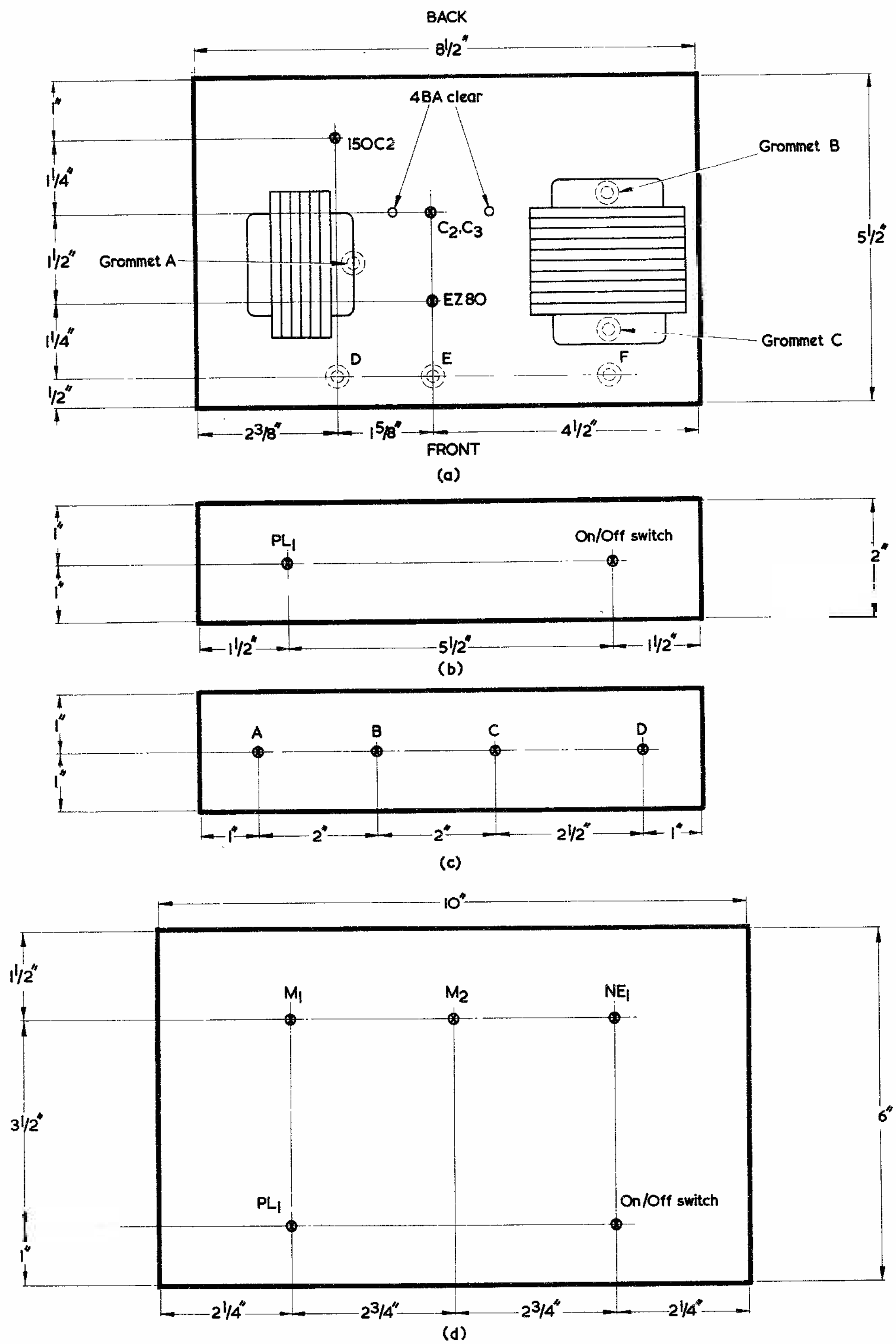


Fig. 2 (a) Drilling measurements of the chassis deck, inductors not to scale, (b) chassis front apron, (c) chassis rear apron and (d) the front panel pins 5, 6 and 7 also carry the chassis connection from the power supply.

Construction

The first task is to drill the chassis, and the required measurements for this are shown in Fig. 2 (*a*). First, mark out the central drilling points for the 150C2, the EZ80 and the capacitors C_2C_3, to the measurements as shown. The hole for the 150C2 should have a diameter of $\frac{5}{8}$in. and that for the EZ80 should have a diameter of $\frac{3}{4}$in. A convenient method of cutting these out is by the use of Q Max chassis cutters with an Allen key.

The capacitor hole is best cut by a $1\frac{3}{8}$in. Q Max cutter with Allen key. These chassis cutters are a worthwhile investment for they have an indefinite life and will save much future time and trouble when preparing holes of these sizes. Two 4BA clear holes on either side of the $1\frac{3}{8}$in hole are needed, also, for the capacitor clip.

The next job is to temporarily place the mains transformer and the l.f. choke on the chassis in the positions they will finally occupy—see diagram and illustration. It should be noted that sufficient room must be allowed between the front panel (when mounted to the chassis) and the mains transformer and l.f. choke to provide clearance for the two meters and the mains neon mounted to the panel. Sufficient clearance will be obtained, with the specified components, if $1\frac{1}{4}$in spacing is allowed between the panel and the two aforementioned components. Using the mains transformer and the l.f. choke as templates, mark and drill (2 or 4BA clearance as applicable) the holes for the respective fixing screws. Do not secure these components as yet. Mark and drill ($\frac{5}{8}$in) the holes for the grommets A, B and C. Following this, mark and drill ($\frac{3}{8}$in) the holes for the three small rubber grommets, D, E and F.

Refer now to Fig. 2 (*b*). This is the front apron of the chassis and the holes for PL_1 ($\frac{7}{16}$in) and the on/off switch ($\frac{1}{2}$in) should now be marked and drilled. These holes may be made using a brace and drill should the existing drill chuck be incapable of taking the size required. Failing this, they will have to be drilled as large as possible with the existing drill and the holes enlarged with a file—an Abrafile being ideal for this purpose.

Fig. 2 (*c*) shows the drilling measurements for the rear apron of the chassis. Hole A is that for the mains input grommet and this should be drilled $\frac{3}{8}$in; hole B is for the fuseholder ($\frac{5}{8}$in); C and D for the two power outlet sockets ($1\frac{1}{8}$in). The latter holes can be cut with the Q Max chassis cutter already referred to.

Fig. 2 (*d*) provides the front panel drilling measurements, the pilot light assembly (PL_1) hole should be $\frac{7}{16}$in; on/off switch $\frac{1}{2}$in; mains neon (NE_1) $\frac{7}{16}$in and the two meters $1\frac{1}{2}$in. The two meter holes may first be cut with an octal sized ($1\frac{1}{8}$in) chassis cutter and then enlarged to the required size by means of a half-round file. Similarly, the hole for NE_1 will also have to be slightly enlarged.

Using the valveholders and output sockets as templates, drill mounting holes for these to enable them to have the orientation shown in Fig. 3. As is also shown in Fig. 3, the rear earthed tag of the tagstrip is secured under one of the mounting holes for C_2, C_3. Drill a mounting hole for the forward earthed tag of the tagstrip. Also drill a hole for the single insulated tag adjacent to V_1 (see Fig. 3). This should be well clear of the outlet socket tags.

Next, mount the mains transformer and its two grommets, ensuring (from Fig. 3) that this component is mounted correctly, i.e. such that the correct coloured wires emerge through the chassis grommets. Carefully feed each lead through separately, dealing with one grommet and the associated wires at the same time. Once the transformer is firmly on the chassis, ensure that neither of the rubber grommets has become displaced.

After fitting the transformer, mount the remaining grommets, the l.f. choke (leads through grommet A), C_2, C_3 (see Fig. 3 for orientation), the 5-way tagstrip, the valveholders and output sockets (ensure correct orientation is maintained), PL_1, the on/off switch, the single insulated tag and the fuseholder. Note the chassis tags fitted at the two output sockets. As yet, do not securely tighten the on/off switch or PL_1. This will be done when the front panel is fitted.

Before proceeding with the wiring-up of the chassis-mounted components, it will be an advantage to paint (or cellulose) the front panel, to the constructor's choice of colour, having first ensured that all the panel-mounted components fit into their respective holes and that the panel is clean and free from grease. An easy way of cleaning the panel is to use lighter fuel and a clean piece of rag. The panel can then be left to dry whilst the wiring-up of the chassis is completed. After this, the panel is mounted to the chassis and the remainder of the wiring to the panel components is finally carried out.

(To be concluded)

UNDERSTANDING RADIO (*Continued from page 285*)

42. Identify the lead-through insulator which connects to the aerial terminal (see Fig. 1). Following the layout of Fig. 4, connect this lead-through insulator to pin 8 of L_1 valveholder. Solder at the insulator and at pin 8 of L_1 valveholder.

(To be continued)

International Radio Communication Exhibition

An award of 3 gns. and a Certificate of Merit to each of the following:—

D. R. Bowman, G3LUB, for a Transistorised Receiver built to the G2DAF Design.

M. J. Griffin, G3IIN, for an Electronic Multimeter designed to be used by blind persons and incorporating Braille markings.

E. St. B. Sydenham, G3LOK, for a transistorised voltmeter and r.f. probe.

A. L. Mynett, G3HBW, for an FET Converter for 432 Mc/s.

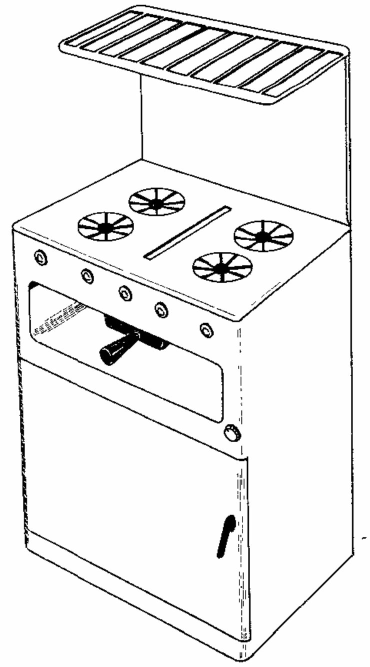
H. C. Hopkins, G3NRI, for a 144 Mc/s Transverter.

A Special Award has been made to W. L. Kinchen, G2DZT, for his design work on the "Noviset".

★

Simple Gas Lighter

by D. P. NEWTON



A novel approach towards lighting household gas appliances

OLD RADIO AND TELEVISION SETS OF THE PRE-transistor era have many components which are virtually useless because of their size alone. Outsize valves, capacitors and resistors slowly pile up in the spares box with little chance of ever finding employment. However, the author recently found a use for the frequently occurring large speaker transformer, in the circuit of a gas lighter. The circuit diagram is very simple, as may be seen from Fig. 1.

It is, of course, necessary to know which of the two windings is to be used as the primary and which as the secondary. In the absence of an ohmmeter, this can be found with the use of headphones and the 6 volt battery connected in series. The winding which gives the fainter click is to be used as the secondary in the gas lighter circuit. It may seem obvious from visual inspection which windings are which, but with old transformers this can be deceptive.

When testing the circuit itself, a spark gap of about 1mm should be used. The gap will pass a spark on the breaking of the primary circuit rather than on its making, and this spark is sufficient to ignite household gas.

It is convenient to house the spark gap in an old fountain pen barrel, as shown in Fig. 2. The pair of wires inside the barrel are about 22 s.w.g. and are insulated. At one end they are bared and curved to form the spark gap as shown, taking care that the bared wires are nowhere closer together than at the spark gap. The switch in Fig. 1 can be made up as depicted in Fig. 3. A springy metal strip is employed.

Usually a 6 volt dry battery is sufficient to give a useful spark. If no spark can be obtained then try reversing the windings, i.e. interchanging the supposed primary and secondary. If a spark can still not be obtained then suspect the transformer.

The switch should be closed for short periods only, because of the heavy current drain from the battery.

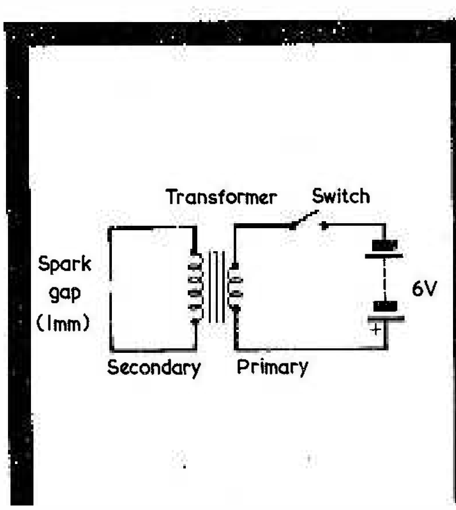


Fig.1.

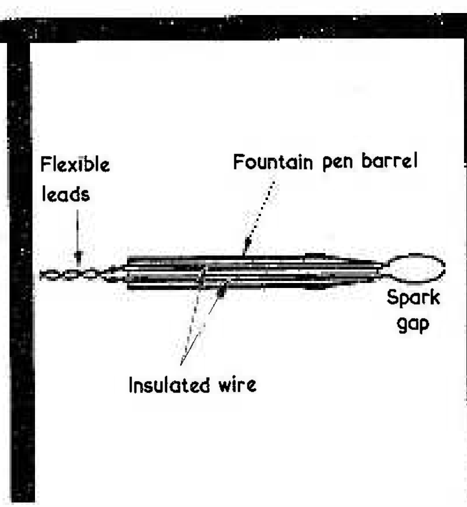


Fig.2.

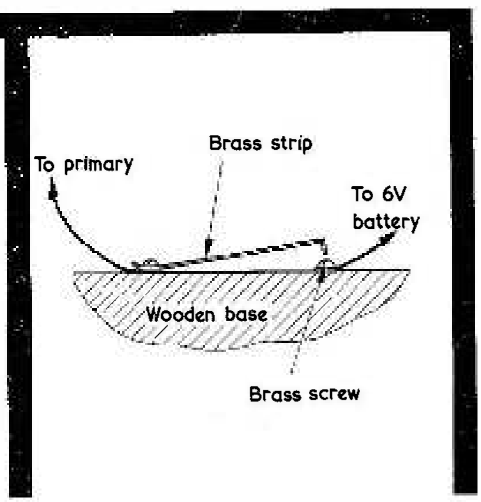


Fig.3.

In Your Workshop

The workshop door swung open, to admit a swirling flurry of snow and a heavily-laden Smithy. The Serviceman kicked the door shut behind him and staggered to his bench, on which he carefully placed his burden.

It was the early morning of Christmas Eve. A weak light broke through the windows, infusing the familiar Workshop surroundings with a grey and sepulchral atmosphere. Smithy returned to the door and switched on the lights. The shadows fled and all was bright and cheerful.

Smithy's eyes wandered briefly over the "For Repair" racks. As always happened on Christmas Eve, these were groaning under the weight of sets which had mysteriously developed faults over the last few days, and which had to be fixed before the great Day itself. Then he gazed lovingly at the object which he had deposited on his bench.

To the uninitiated, this would have appeared to be nothing other than a somewhat old-fashioned 21 inch TV receiver in a cabinet whose dimensions indicated a 90 degree tube. But this was no ordinary receiver. This was Smithy's Personal Television Set which, by artifices known only to himself, had been modified to produce a picture of unsurpassed excellence. On Smithy's receiver the Test Card frequency gratings stood out like stripes on a humbug; the black level was held as rigidly as a rock; the vertical and horizontal linearity was of so outstanding a character that the roundness of the Test Card circle was equalled only by the squareness of the Test Card squares; the extreme praiseworthiness of the contrast range was exhibited by an exact graduation from black through the greys to peak white; and the fineness of focus, free from any blemish of astigmatism, was evident at every point on the entire surface of the screen.

Overburdened, perhaps, with the responsibility of reproducing so superior a picture over the years, the c.r.t. of this admirable receiver had, on the previous evening, broken down and burnt out. Whereupon Smithy had decided that his last job in the Workshop for Christmas Eve would be the fitting of a new tube. Tenderly, Smithy picked up the receiver and placed it gently on the floor at the side of the spares cupboard.

Christmas Rush

Almost immediately afterwards, the Workshop door burst open for the second time that morning, to admit a snow-bespattered Dick. At once, everything was noise and bustle and the working day commenced. The number of sets in for repair gradually decreased as Smithy and his assistant worked feverishly to clear their many faults. There was a steady movement to and from the spares cupboard as the pair replaced faulty components in the receivers on their benches.

"Hey, Smithy," suddenly called out Dick. "Have you got a spare EF183 over there?"

"What's wrong," returned Smithy irritably, "with getting one out of the spares cupboard?"

"I've looked in there," said Dick. "We're right out."

"Have another look, then," snorted Smithy over his shoulder, "there's bound to be one knocking around somewhere."

Dick shrugged his shoulders, and did as he was bid.

But there seemed to be a running shortage of spare components and it was not long before Dick once more raised his voice.

"Hey, Smithy!"

Despite the inevitable rush and bustle of Christmas Eve, Smithy the Serviceman still finds time to explain the functioning of a modern flywheel sync circuit to his able assistant, Dick. It is a pity that Dick does not impart quite the same sort of favour to the Serviceman!

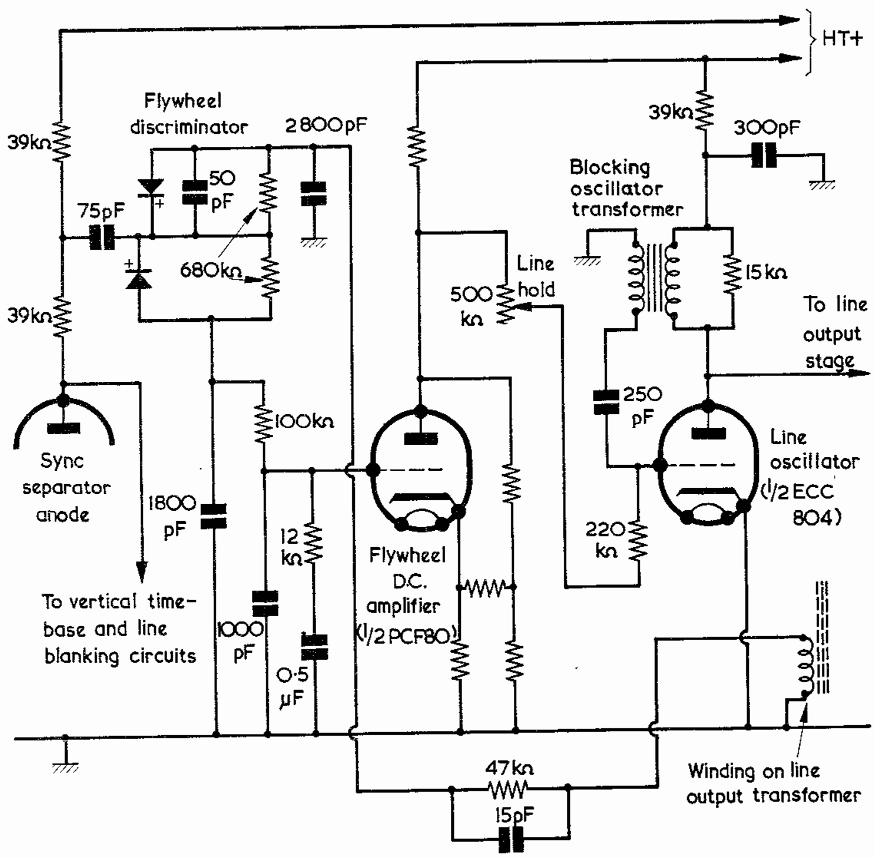


Fig. 1. A typical flywheel sync circuit employing discriminator diodes connected back to back. This particular version is that used in the Thorn 850 series chassis. For simplicity the d.c. amplifier is shown in basic form and 405/625 switching (which changes the gain and operating point of the d.c. amplifier) has been omitted. The 300pF shaping capacitor shown in the line oscillator anode circuit represents the capacitance switched in on 405 lines; on 625 lines this capacitance is 180pF

"Hullo!"

"You wouldn't by any chance have a gash 25k skeleton pot on your bench, would you?"

"No I wouldn't," replied Smithy abruptly "For goodness' sake stop pestering me for odds and ends. Have a look around and see what you can find."

Again, Dick shrugged his shoulders and carried out Smithy's injunction. It was evident that the Serviceman was far too preoccupied with getting the work finished for the day to bother with his requests for spare components. When, later in the morning and, after an attenuated lunch-break, during the afternoon, Dick found that the spares cupboard held no stocks of further parts that he needed, he forebore to trouble the Serviceman and looked around elsewhere. Work proceeded uninterrupted and the stock of sets on the "For Repair" racks continued to diminish. It was half-way through the afternoon when the Serviceman suddenly realised that the racks were completely empty.

Flywheel Sync

"That's it," he called out joyfully, his previous testiness vanishing completely. "Dick, my boy, we've cleared out all the sets!"

"No we haven't," came a morose voice from Dick's bench. "I've got the last one here. What's more, it's got a flywheel sync snag on it."

"Has it now?" said Smithy breezily, as he walked over to Dick's side. "Well, that shouldn't cause too much trouble."

"It does with me," replied Dick moodily. "Flywheel sync and me never seem to get on, somehow. With this set I can alter the line hold control so that the timebase runs at line frequency but it just won't lock."

To demonstrate this point, Dick adjusted the line hold control of the receiver, which was switched on and adjusted for a local 405 line transmitter. The control was obviously varying the line timebase frequency and, at a central setting, a nearly stationary picture could be resolved.

"Well," commented Smithy, as he looked at the picture. "There must, at any rate, be sync pulses at the sync separator anode."

"How do you make that out?"

"Because," said Smithy, "the vertical timebase is locked. The vertical timebase sync circuit picks up its pulses from the sync separator anode, and so it is obvious that there must be sync pulses present at that anode. Another point is that, since you can take the line timebase through line frequency, it seems pretty safe to assume that there isn't much wrong with the timebase either. Let's have a shufti at the circuit."

It was an indication of Dick's extreme state of perplexity that he had actually brought out the service manual for the receiver. It was open at the circuit diagram, and Smithy examined the flywheel sync section. (Fig. 1).

"Ah, yes," he said confidently. "This uses one of those sync discrimators in which the two diodes are connected back to back. Piece of cake, these are."

"I'm glad *somebody* thinks so," grumbled Dick. "Anyway, what I've done up to date is to check the two diodes with an ohmmeter and they seem to be O.K. There are 680kΩ resistors across them so it's possible to at least check that they've got a high reverse resistance and a low forward resistance without taking them out of circuit."

"Did you," asked Smithy, "check the 100kΩ resistor between the lower diode and the grid of the flywheel d.c. amplifier valve?"

"I did," replied Dick. "And that was O.K. too. I then switched the set back on again and checked the anode voltage of that d.c. amplifier. This was pretty close to the figure given in the service manual, so I didn't get any clues there either."

"You haven't done too badly." commented Smithy. "You've already unearthed quite a few little bits of useful information. The fact that you're getting what seems to be a respectable voltage on the d.c. amplifier anode, combined with the fact that you can take the line hold control through line frequency, would seem to indicate that there's nothing glaringly wrong with the circuit from the amplifier anode to the line timebase oscillator. That anode voltage would also make it fairly safe to assume that the valve is passing a reasonably correct anode current, which means, in turn, that there's probably nothing wildly wrong with the components immediately associated with it. Did you check the resistance between the d.c. amplifier grid and chassis?"

"As a matter of fact, I did," said Dick. "Not, I must admit, with any particular end in view, but merely as a routine test. The resistance to deck was well over a meg, which is what you'd expect from the various resistors in the circuit."

"Excellent," said Smithy, rubbing his hands together. "It looks, then, as though there's nothing obviously wrong with the circuit from the diode discriminator to the grid of the amplifier. We know that the discriminator diodes seem to be O.K. so we can make a fairly safe assumption that either the discriminator is not receiving a sawtooth from the line output transformer or it's not getting pulses from the sync separator anode."

"That," complained Dick bitterly, "is just typical. With a flywheel sync snag it can't be something nice and simple like a burnt-out resistor or a shorted capacitor. Oh, no. It has to be something with a sawtooth and pulses in it!"

"Don't worry," chuckled Smithy. "There's still another ohmmeter test you can do. Switch the set off and measure the resistance across the 2,800pF capacitor which is connected between the top diode and chassis."

Dick carried out Smithy's instructions.

"There's about 45kΩ there," he announced after a moment.

"Fair enough," said Smithy. "That means that the capacitor isn't, at least, a dead short. In addition, it very probably means that we're reading the resistance offered by the 47kΩ resistor in series with the line output transformer winding it connects to, the winding offering continuity to chassis. Seeing as it's Christmas, I'll have a half-crown bet with you that the 75pF capacitor from the sync separator anode load to the centre of the discriminator diodes has gone open-circuit!"

"Blimey," said Dick, impressed. "You're taking a bit of a risk, aren't you?"

"I am rather," agreed Smithy. "Because I'm working on some pretty general assumptions which are based on ohmmeter tests only. Still, I'll chance it."

Dick walked over to the spares cupboard and, after a little rummaging, returned with two small capacitors. He connected these in parallel and temporarily soldered them into circuit. He snipped one of the leads of the suspect 75pF capacitor, which the new capacitors now replaced, after which he switched on the receiver and waited for it to warm up. As soon as a picture appeared he adjusted the line hold control. It functioned perfectly.

Flywheel Discriminator Operation

"Half a crown, please," said Smithy, promptly.

"Hang on a jiffy," protested Dick. "I'll agree that the 75pF capacitor must have been faulty, but I don't think it's fair for me to fork out my hard-earned cash without understanding *why* it should have caused the trouble."

"If," explained Smithy, patiently, "the capacitor was open-circuit, the sync pulses couldn't have got into the diode discriminator circuit."

"I *know* that," replied Dick impatiently. "What I don't understand is how the discriminator *works*. All you've got are a couple of diodes together with a few odd resistors and capacitors, and yet it gives a complete flywheel sync control system."

Smithy looked at his watch.

"Well," he remarked, "we've finished earlier than I'd expected, particularly for Christmas Eve, so I suppose it won't hurt if I spend half an hour or so explaining that circuit to you. Actually, it's quite easy to understand, but I'll have to start off from basic theory if I'm going to put it over to you."

He seized Dick's notepad, sat down and took a pen from his pocket.

"Let's start off," he remarked, "with a simple leaky-grid circuit. You can't have anything easier than that. We'll apply a train of positive-going pulses to it, like this."

Smithy sketched out the circuit and pulses on the pad. (Fig. 2 (*a*)).

"Now what," he asked, "happens here?"

"That's dead easy," said Dick promptly. "The grid and cathode of the valve act as a diode with the grid as anode, and it conducts on positive pulse tips. The average voltage on the top end of the grid resistor then goes negative to a value which is very nearly equal to pulse amplitude"

"Very good," said Smithy approvingly, as he scribbled a second sketch. (Fig. 2 (*b*)). "Now, let's change all the polarities in the circuit! This time I've got a train of negative-going pulses and they're going to a diode which is connected the other way round. I've drawn a crystal diode in the circuit, but I've added a valve diode of the same polarity alongside it so that you can compare it with the previous circuit. What happens now?"

"The same as before," said Dick. "Only this time you get an average *positive* voltage which is nearly equal to pulse amplitude. The positive voltage appears at the upper end of the resistor which, in the previous circuit, was the grid leak."

"Do you know, Dick," commented Smithy approvingly, "you're really quite clever."

"You're no slouch yourself," replied Dick.

The pair beamed at each other.

"We now", continued Smithy, as he returned to the notepad, "arrive

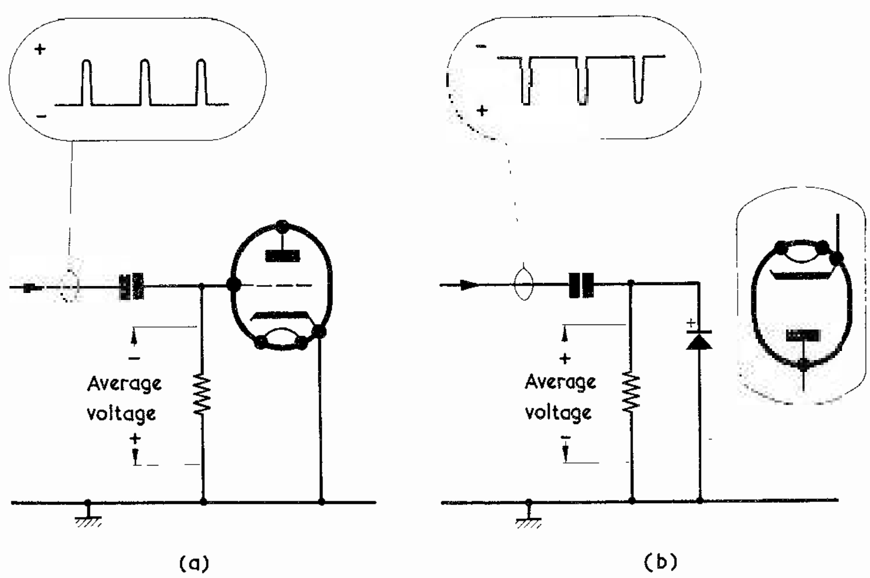


Fig. 2(a). If positive-going pulses are applied to a leaky-grid-circuit the grid acts as the anode of a diode, causing an average voltage with the polarity shown to appear across the grid resistor
(b). Applying negative-going pulses to a diode connected the other way round results in the average voltage across the resistor having opposite polarity. The top end of the resistor is positive

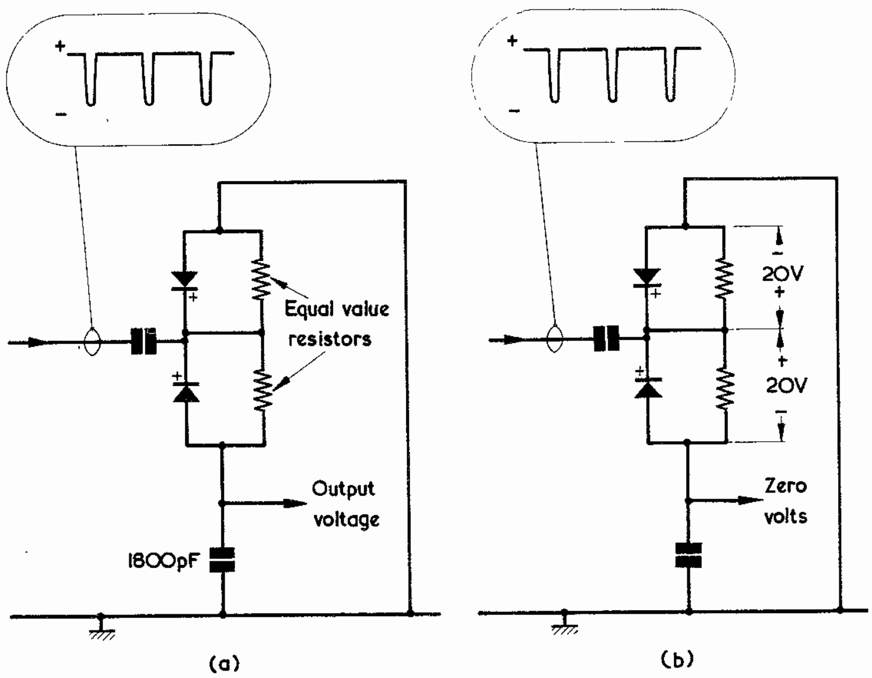


Fig. 3(a). Feeding negative-going pulses to two diodes and parallel resistors (b). Equal voltages (assumed here as 20 volts) appear across the diodes, resulting in an output voltage of zero

at the second stage of the explanation. I'm next going to draw a circuit in which there are two diodes and two resistors."

One again, Smithy's pen rattled swiftly over Dick's notepad. (Fig. 3 (*a*)).

"In this circuit," said Smithy, "you'll notice a similarity with the flywheel sync discriminator because we now have two diodes connected back to back with equal value resistors across them. But don't let that distract you. The upper end of the top diode connects to chassis, and we have negative-going pulses going, via a capacitor, to the junction of the diodes at the middle. The bottom end of the lower diode goes to a fairly large-value capacitor, say 1,800pF, and the voltage on the upper plate of this capacitor is labelled 'output voltage'. O.K. so far?"

"I'm with you all the way," replied Dick confidently.

"Under normal conditions," continued Smithy, "the output voltage given by this circuit will be zero, with the result that the output voltage capacitor has no charge and the bottom end of the lower diode is at chassis potential. What happens in the circuit?"

"Well," replied Dick. "The two diode circuits are exactly the same as the single diode circuit you drew previously. So, I suppose that you'll get the same sort of average voltages appearing across the resistors which connect across the diodes."

"That's the idea," confirmed Smithy. "To take some easy figures, let's assume that the amplitude of the negative-going pulses is a little higher than 20 volts, and that it causes 20 volts average to appear across each of the diode resistors. You then get voltages distributed like this."

Smithy added the voltages to his diagram. (Fig. 3 (*b*)).

"The lower diode," he said, "is exactly the same as our previous single diode and so we get 20 volts across its resistor with the top end positive. The upper diode is also the same as the previous diode except that it's drawn upside-down. So the positive end of *its* resistor is the lower end. As you can see, we now have two sets of 20 volts in series but, due to their opposing polarities, the total voltage they produce is zero."

"I see what you mean," commented Dick thoughtfully. "Due to the symmetry of the circuit, the voltages across the diode resistors cancel out, and so the output voltage remains at zero. As it would, now I come to think of it, if you didn't have the negative-going pulses in the first place."

"You are," pronounced Smithy, "an extremely bright young man. I feel that I am indeed fortunate in being able to work with someone who is as perceptive as you."

"No more lucky," responded Dick, "than myself in having a geyser who gives with the gen as well as you do."

"It is very kind of you to say so."

"My pleasure."

Unbalancing The Discriminator

"Dear me," remarked Smithy, "what a very pleasant Christmassy spirit we've got here today. Anyway, let's get back to that diode circuit. I'm now going to unbalance the discriminator by suddenly introducing a 10 volt battery between the upper diode and chassis. The upper terminal of the battery is positive."

Smithy sketched out the new circuit. (Fig. 4 (*a*)).

"What happens now," he said, "is that the upper end of the top diode goes positive of chassis by 10 volts. The upper diode rectifies in just the same way as it did before, and so 20 volts appears across the resistor across it. But the lower diode is now cut-off because, since the output voltage capacitor has no charge, the lower terminal of the diode is at chassis potential and its upper terminal is at 30 volts positive. Obviously, this state of affairs cannot continue and the 30 volts positive at the junction of the resistors causes the output voltage capacitor to charge up via the lower resistor. This charging process continues until the top plate of the output voltage capacitor reaches 10 volts positive. The lower diode then starts to rectify on negative pulse tips and the circuit settles down once more to a state of equilibrium. In practice, the values in the circuit are such that it will reach this new state almost immediately."

Smithy marked in the new voltages in the circuit. (Fig. 4 (*b*)).

"That's interesting," remarked Dick. "You put in 10 volts positive at the top of the diodes and 10 volts positive comes out at the bottom."

"That's right," agreed Smithy. "Now let's see what happens when we suddenly put in a 10 volt battery with its *negative* terminal at the top."

Again, Smithy's pen raced over the surface of Dick's notepad. (Fig. 5 (*a*)).

"We start off," went on Smithy, "with the circuit in the state where the output voltage is at zero. This time it's the upper diode which is cut-off, because 30 volts becomes applied across it. This is given by the 20 volts across the lower diode resistor and the negative 10 volts from the battery. You can't have 30 volts across one series resistor and 20 volts across a second resistor of the same value. So, current flows in the opposite direction to the previous instance until 20 volts appears across both resistors. The result is that the output voltage now becomes 10 volts negative, and both diodes are rectifying on pulse tips once more." (Fig. 5 (*b*)).

Line Output Sawtooth

"I see what you mean," said Dick. "Well, we've now found out that, when you put a voltage at the top of the diodes, an equal voltage of the same polarity appears at the output point of the circuit. What happens next?"

"We next," replied Smithy, "make the assumption that the negative-going pulses applied to the diodes are sync pulses, derived from the sync separator anode. O.K.?"

"Sure."

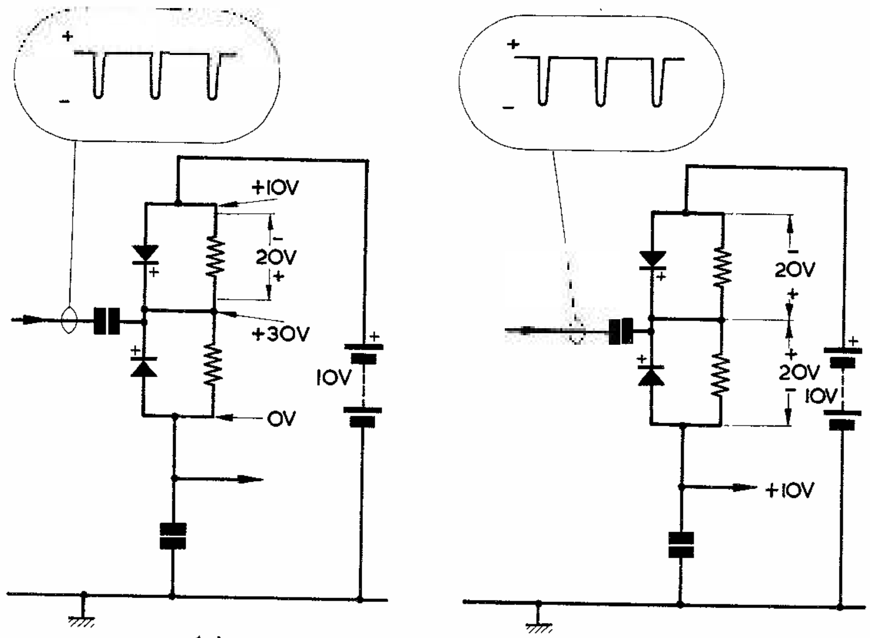
"We then replace the batteries we have been putting into the circuit by a sawtooth derived from the line output tranny. Like this. (Fig. 6). As you'll see, we're now using the component values which appeared in the service manual circuit. The sawtooth is shaped by the 47kΩ resistor and 15pF capacitor in series with the line output tranny winding, together with the 2,800pF capacitor sitting at the top end of the diode circuit. The diodes still conduct on sync pulse tips as before. If a sync pulse tip appears at an instant when the sawtooth waveform is negative of chassis, then the discriminator output voltage will similarly go negative. Don't forget that conduction in the diodes only occurs on negative-going sync pulse tips so that if, at the instant of conduction, the voltage applied to the top of the diodes is negative then the circuit behaves in just the same way as if the negative voltage had been applied by means of a battery. Similarly, if sync pulse tips coincide with a positive part of the sawtooth then you get a positive output voltage from the diode circuit."

"Gosh," breathed Dick. "This *is* something."

"Right," said Smithy, briskly picking up his pen once more. "We're on the home stretch now! When the line timebase is running at too low a frequency the sawtooth cycle will be too long and the sync pulse tips will hit it at a point where it is negative. (Fig. 7 (*a*)). And, when the line timebase is running at too high a frequency, the sawtooth cycle will be too short and sync pulse tips will hit it at a point where it is positive. (Fig. 7 (*b*)). So, too slow a timebase frequency gives you a negative control voltage and too high a timebase frequency gives you a positive control voltage. You apply this control voltage, by way of the usual time delay filter to get the flywheel effect, to the grid of the flywheel d.c. amplifier. This both amplifies the control voltage and reverses its phase, and the anode voltage of the d.c. amplifier is then fed to the grid leak of the line oscillator, as in the original service manual circuit."

Smithy paused for a moment.

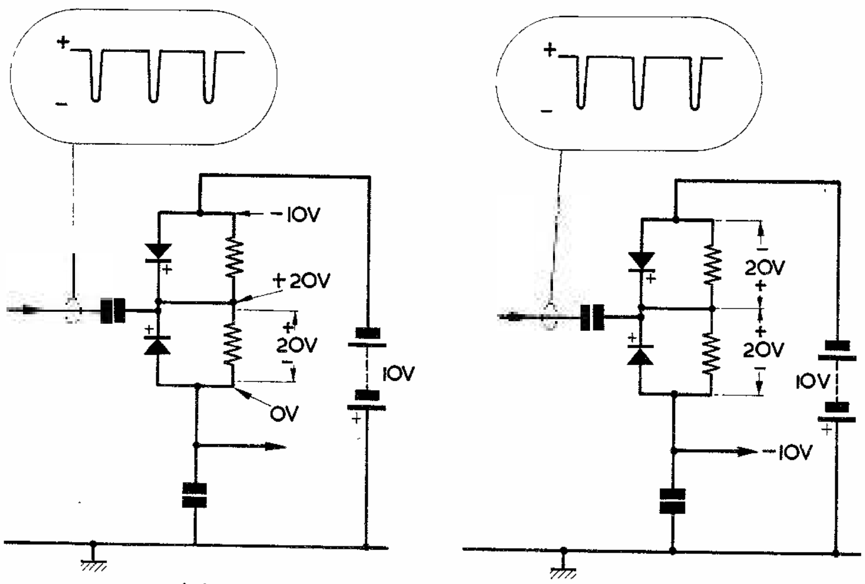
"We can now," he said, "examine the whole overall effect. If the timebase oscillator runs at too low a frequency the output control voltage from the diode discriminator circuit goes negative and the voltage on the anode of the d.c. amplifier goes positive. Which is just what you need to speed the oscillator up again. And if the timebase oscillator runs



(a) (b)

Fig. 4(a). When a 10 volt battery is suddenly introduced, the voltages appearing in the circuit are as shown here

(b). The unbalanced voltages of (a) cause the output voltage capacitor to charge, resulting in an output of 10 volts positive



(a) (b)

Fig. 5(a). The voltages which result when a 10 volt battery of opposite polarity is introduced

(b). Again, the diode circuit reverts to the balanced condition, giving an output of 10 volts negative

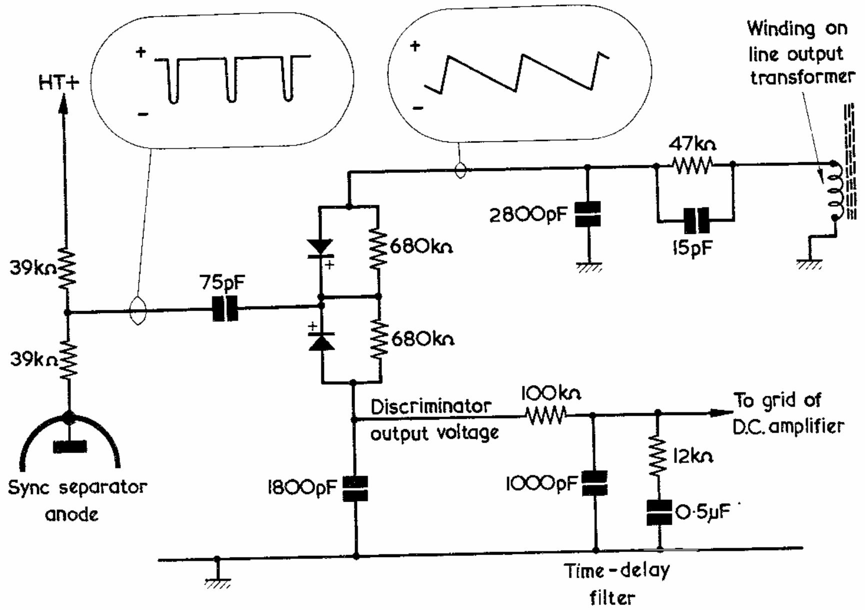


Fig. 6. In this diagram the negative-going pulses are obtained from the sync separator anode, and the battery is replaced by a sawtooth derived from the line output transformer. Component values and circuitry are the same as for Fig. 1

at too high a frequency the control voltage from the diode discriminator goes positive, the anode voltage of the amplifier goes negative, whereupon the timebase oscillator slows down again. You adjust the actual degree of control by means of the line hold control, whereupon the line timebase oscillator runs at correct frequency and phase with the flywheel sync circuit preventing it from straying in either direction."

"In the original circuit," offered Dick, "there's a 50pF capacitor across the upper diode."

"True enough," agreed Smithy. "Its function is to balance the diode discriminator. In practice, this won't work in quite as linear a fashion as in our explanation and there will also be some non-linearity in the section of the sawtooth on which it operates. The 50pF capacitor helps to trim out these discrepancies."

"Also," continued Dick, "you're discriminating on the short section of the sawtooth instead of the long section."

"Agreed," said Smithy. "And it's essential to do this because the short section of the sawtooth is the part which starts with the commencement of the line output stage flyback. The commencement of line flyback offers a reference point, in time, for the sawtooth. If, incidentally, the sync pulse tips *should* hit the sawtooth during its long period the control voltage which results is in the wrong sense, and the circuit hops back to control in the correct sense, as is given when the sync pulse tips coincide with the short section of the sawtooth. To complete the picture, I can now add that what was taking place in the particular receiver on your bench was that, due to the 75pF capacitor being open-circuit, no sync pulses were getting through to the diodes. These couldn't rectify so that all that was happening was that the average voltage of the sawtooth was finding its way through to the grid of the d.c. amplifier by way of the resistors in the discriminator circuit."

Job Complete

"And that," said Smithy, "is that. You'd better put a new 75pF capacitor in that receiver. And not two in parallel as you've used temporarily."

"We haven't *got* any 75pF capacitors," replied Dick aggrievedly. "I've looked all through the spares cupboard and the best I can find are a 50 and 25 to connect in parallel."

"Dear, oh dear me," sighed Smithy. "Well, have another look. There *must* be a 75pF capacitor somewhere."

For the third time that morning, Dick shrugged his shoulders. He picked up his side-cutters and wandered over in the direction of the spares cupboard. A short time later there were two ominous snips, after which Dick returned with a small capacitor in his hand.

Smithy gazed at him open-mouthed.

"Where," he spluttered, "did you get that capacitor from?"

"I nipped it," replied Dick carelessly, "out of an old set that someone's dumped at the side of the cupboard."

With a cry of anguish Smithy shot from his stool and rushed to the spares cupboard. He went down on his knees and gazed unbelievingly at the inside of the TV receiver he had brought in that morning.

"Ye gods," he moaned, "what in blazes have you been *doing*? You've ripped half the guts out of this receiver."

"I had to get spare parts from somewhere," replied Dick defensively. "And so I whipped them out of that old set. I've been doing it all through the day."

"You call *this* an old set?" wailed the outraged Smithy. "Jumping alligators, this is my own special TV!"

"Your what?" gasped Dick incredulously. "*That* clapped-out old wreck?"

"It's my special TV," moaned Smithy. "You've been cannibalising my special TV!"

"Well, it certainly *looked* a wreck," commented Dick flatly. "Dash it all, Smithy, it's gots bits hanging off the chassis all over the

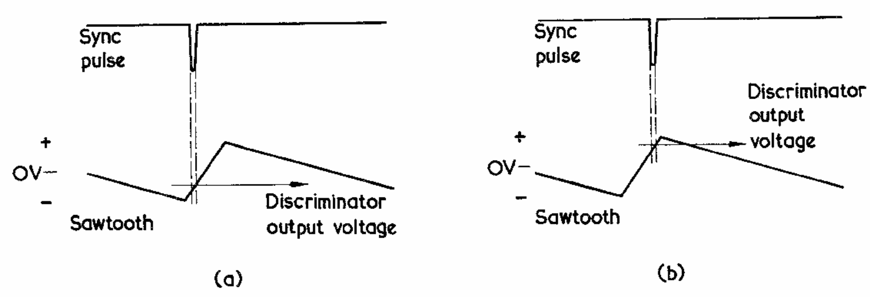


Fig. 7(a). If the line timebase runs at too low a frequency the sync pulse tips coincide with a negative part of the sawtooth waveform. The discriminator output control voltage is similarly negative

(b). Too high a line timebase frequency results in the sync pulse tips coinciding with a positive section of the sawtooth waveform. A positive control voltage results

place. It hasn't even got a printed circuit."

"Those bits hanging around the chassis are the mods I've put in it," commented the stricken Serviceman. "And it's a pre-printed circuit set because they're easier to modify."

The Serviceman was, at last beginning to grasp the full enormity of his loss. He pointed a trembling finger at his assistant.

"I've put years of work into this set," he accused furiously. "And you, with those darned side-cutters of yours, bring it all to naught in just one day. And to think," added Smithy inconsequentially, "that this is Christmas Eve. What a Christmas present!"

"Don't take on so," said Dick soothingly. "Anyway, seeing that it's Christmas, you shouldn't be blasting off at me. You should be burying the hatchet, mate."

"Burying the hatchet?" roared Smithy. "The only place where I'd bury the hatchet right now is in your flaming head!"

Over the years, Dick had learned that the only soothing influence, at times of crisis, was to set about boiling up the Workshop kettle. But it was obvious that the present emergency called for a far stronger remedy than tea. He rushed to his bench drawer and produced a small bottle, together with two glasses.

"I felt," he suggested hastily, "that it was my turn to provide the drop of Christmas cheer this year. So how about having a spot of something with me, Smithy?"

The Serviceman gazed uncertainly at the glass which Dick proffered him. Gradually, his fury abated and he eventually broke into a rueful chuckle.

"I suppose," he said grudgingly, "it wasn't entirely your fault."

"And here," added Dick quickly, "is that half-dollar I owe you."

The Serviceman's eyebrows shot up.

"Blimey," he remarked incredulously, as he pocketed the coin. "This really *must* be Christmas. You'd better tell me afterwards what you took from the set, so that I'll know where to start making replacements."

He sipped appreciatively at his glass. Dick waited quietly for a little while, to allow mellowness and its attendant benevolence to return.

"This seems," he remarked eventually, "to be an opportune moment for festive greetings. So let me wish you a very Merry Christmas, Smithy."

"And the same to you, my boy," responded Smithy warmly. "A very Merry Christmas, indeed."

The pair rose.

"We mustn't forget," continued Smithy, "to also wish a very Merry Christmas to the readers who've put up with our exploits over the last twelve months. A truly Happy and Merry Christmas to you all!"

"And let us end," added Dick, "as we have done on all our previous Christmasses, by saying 'God Bless Us, Every One'!"

RADIO TOPICS . . . .

by Recorder

HERE WE ARE ONCE AGAIN IN December, with Christmas in the offing and New Year to follow shortly after. And all those horrible bills after that again!

As a jobbing journalist I am taxed under Schedule D, whereupon the gentlemen of the Inland Revenue employ a particularly fiendish device for the collection of my hard-earned lolly. Under Schedule D there are two Income Tax payments in the year—one on July 1st and the other on January 1st. And I can assure you that the January 1st one does nothing whatsoever to dispel the dyspeptic gloom which arises after a hectic New Year's Eve.

Still, at the time being it's best to dismiss the aftermath from mind and to concentrate on the festivities immediately ahead. There are sure to be several parties to organise and bright ideas are needed to make these go with a swing.

Fun with The Tape Recorder

Quite a lot of fun can be had at a party with a tape recorder, provided that it isn't overdone and you set about things in the right way. In many households the tape recorder tends to gather dust in the cupboard after its initial novelty has worn off, but it can still enable one's guests to have quite a bit of enjoyment. People are pretty blasé these days about hearing their own voices by way of a recorder, and so it is best to avoid making up a recording which merely consists of a succession of self-conscious "party pieces". This sort of programme was amusing in the early days of tape recording but nowadays something quite different is required.

A good scheme, and one which, in my own case, has resulted in several hilarious evenings in the past, consists of recording a short performance in which every guest takes a part. An eay approach is given by making up a skit on a well-known B.B.C. sound radio programme. Particularly suitable here are "Down Your Way", "Have A Go!" and "Saturday Club".

With the "Down Your Way" format, one of the guests can take the part of the interviewer (who, in the real programme is of course Franklin Engelmann). He interviews the others in turn, each taking the part of a "local character" of extreme eccentricity. A send-up of "Have A Go!" allows a similar degree of eccentricity in the characters interviewed, with the added attraction that those who claim the greatest age get the most applause. And the "prizes" at the end of this particular show provide a useful exercise in imagination on the part of the organiser. For those who haven't heard it, "Saturday Club" intersperses pop records and music with short interviews with the artistes concerned. There is great scope here for a succession of interviewees who outvie each other in gormlessness (you should hear the original programme) together with a really glad-hand interviewer.

Probably the best idea is to make up a skeleton framework for the skit before the guests arrive. An anchor-man to play the part of the interviewer is then chosen, after which each guest makes up his own character and gags. Give about half an hour for everyone to finalise their ideas, then start the recording. As a general guide a playing time of about 15 to 20 minutes will cope very nicely with an average party.

It's best not to aim for technical perfection as far as production is concerned. Normally, once the programme has started it will run under its own steam. Somebody needs to be stationed at the gain control of the recorder, but recording level should be fairly consistent if each performer keeps some three feet or so away from the microphone. This will also enable background comments from other guests to be recorded at good level on the tape.

Be firm about ending the skit or it may tend to drag on. Don't forget that 50% of the fun is given by playing back the tape, and that this will take just as long as did the recording.

Given the right spirit, an exercise of this nature can really help to make a party go, and it has the advantage that children can join in as well. Quite a lot of what goes onto the tape will possibly be pretty corny; but there is a great deal to be said for corny humour, especially amongst friends.

And the final advantage of the idea is that, after the party is over and has slipped into the past, you'll still have a pleasant memento which you can play back at any time.

Traffic Detector

If you happened to call in at the Imperial College exhibition at the end of September, you will have noticed a new and fascinating device which has been developed by the Marconi Company, and which may well become a standard feature on the roads of this country. The device is a traffic sensor which works on an ultrasonic "radar" principle.

The conventional traffic signal system at road intersections detects the passage of vehicles by means of rubber pressure pad switches fitted into the road surface. These pressure pads detectors are subject to considerable wear and tear, especially by heavy vehicles, and require periodic maintenance. Also, excavation of the roadway is necessary when they are initially installed.

The new Marconi device is installed *above* the road on any convenient structure such as a lamp standard or bridge. It directs a train of ultrasonic pulses downwards at a repetition rate of 20 to 25 per second onto the roadway underneath. When a vehicle passes under the sensor the echo returns after a shorter time than when the reflecting surface is the road itself. The resulting difference in echo time is detected and causes a relay to energise, allowing the information to be passed to the traffic control equipment.

If desired, the sensor can be adjusted so that vehicles above a certain height operate a different relay, with the result that it becomes possible to monitor cars and lorries separately.

A very approximate measurement of vehicle speed may be obtained by working to an average vehicle length and timing the period over which the reflection from any vehicle occurs. A more accurate measurement of vehicle speed is given by positioning two sensors a set distance apart. The vehicle speed is then a function of the time taken to pass between the two.

The sensor is intended to be mounted some 5 to 10 metres above the road surface. It is fully transistorised and is housed in a weatherproof box. The price is roughly the same as the rubber pressure pad detector it replaces, with the advantage that it does not require maintenance. It may be employed with simple traffic light systems or complex computer controlled schemes such as the experimental traffic automation installation proposed for the centre of Glasgow.

In the Imperial College exhibition a sensor was mounted outside the College and coupled to a chart recorder on the Marconi stand. This instrument then recorded the passage of vehicles under the sensor.

End of a Year

With which note on the new Marconi traffic sensor I must now wind up for 1966. We have had a very busy time at the *Radio Constructor* offices over the last twelve months, and it has all been very well worth while.

I've also had a look at some of the features lined up for next year, and I can assure you that plenty of really exciting constructional projects are being prepared for your delight and delectation.

So let me send you all my best wishes for a truly Happy and Merry Christmas. And I'll be seeing you again in 1967!

Nickel Cadmium Rechargeable Cells

It will interest many of our readers to know that these rechargeable cells and constant current chargers are available from Elmbridge Instruments Ltd, Elmbridge Works, Island Farm Avenue, West Molesey Trading Estate, East Molesey, Surrey.

The cells are hermetically sealed and require no maintenance, details of the units available are as follows:—

Maintenance:

None	*Capacity*	*Voltage*	*Charging Current*
Equivalents:			
PP3 (Tr 7/8)	75 m AH.	9 volts.	7 mA. (I 10)
U2 (BD 2.5)	2 AH.	1.25 volts.	200 mA. (I 10)
U7 (4.51 D)	450 m AH.	1.25 volts.	45 mA. (I 10)
U11 (RS 1.5)	1.5 AH.	1.25 volts.	150 mA. (I 10)

Charging:

It is recommended that constant current charging is employed; the cell can be completely recharged from "flat" in 14 hours. (Voltage per cell is adjustable between 1.35—1.50V: except P33 which is between 10.8—12V).

NOTES:

Overcharging—Permissable occasional over-charge rates for a discharged cell are: Up to 24 hours with I 10.
Up to 100 hours with $\frac{1}{3}$ I 10.

Mounting:—Cells can be mounted in any position.

Storage—Recharge the cells every 4–5 months if they have not been used.

PRICES: PP3 Equivalent: 37/– (p & p 2/–)
U2 Equivalent: 32/6 (p & p 2/–)
U7 Equivalent: 12/– (p & p 1/6)
U11 Equivalent: 26/– (p & p 1/6)

CHARGERS.

Special constant current chargers are available for the U7 & PP3 Equivalent types:—

PRICES: U7 Charger (Encapsulated): 22/– (p & p 1/6)
PP3 Charger (Special Moulding with recess for battery): 76/– C.W.O. (p & p 2/–)

1966 INTERNATIONAL RADIO COMMUNICATIONS EXHIBITION

THE EXHIBITION WAS OPENED ON WEDNESDAY, 26TH OCTOBER, BY HIS ROYAL Highness The Prince Philip, The Duke of Edinburgh, K.G., Patron of the Radio Society of Great Britain, after an introductory speech by the President of the Society, R. F. Stevens, G2BVN. Prince Philip's speech was broadcast to the world, on amateur band frequencies, through the Society's transmitting station GB3RS.

In his speech, Prince Philip commenced by saying, "In a world which seems to demand more professionals, more specialists and more expert qualifications, activities by amateurs are inclined to get pushed into the background," and went on to add:—

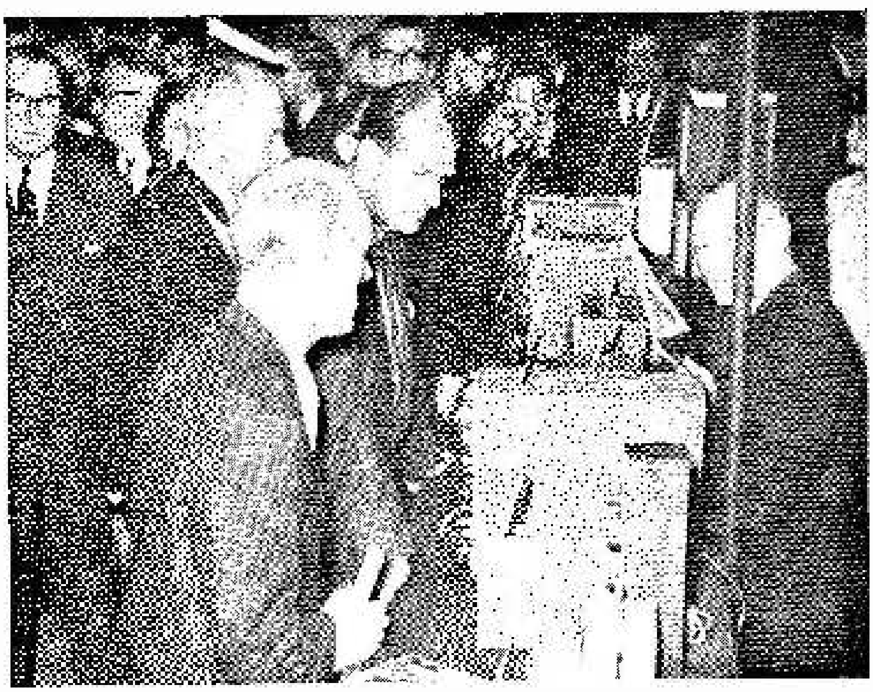
"This is a great pity because the things which people choose to do as amateurs in their spare time are those things which give them the greatest amount of personal pleasure and satisfaction. No matter how fascinating working for a living may be, it is never quite the same as the freedom and relaxation of a hobby.

Amateur Radio is almost unique among hobbies in that it is very much a part of one of the major modern technologies and in the early days it played a significant part in the development of radio communications. However, I suspect that while there is a great attraction in messing about with the equipment, the real enjoyment comes from making contact with other enthusiasts all over the world.

Not least among the enjoyments must be this chance to browse about among the tantalising displays in this Exhibition. The only trouble is that on the way home you're either kicking yourself for not having bought something or you get that terrible sinking feeling when you know you've been rather extravagant and you wonder how you're going to explain it away.

Far be it for me to interrupt your enjoyment for longer than necessary. So now it gives me great pleasure to declare the International Radio Communications Exhibition open."

The equipment display of most interest to the writer is that of the home-built variety to be seen every year on the Radio Society of Great Britain stand. This year, as in the past, the exhibits covered a wide range of equipment from test gear to receivers and transmitters of all types and sizes. Some of the workmanship to be seen in these units closely approached the best professional standards, the compact construction and wiring showing a high degree of efficiency and a great deal of advance planning, thought and design work. Among the home-constructed equipment, only a few of which are mentioned here, the following were noted—80 and 160 metre bands receiver together with a transmitter covering the same bands by W. L. Kinchen G2DZT; 80 and 160 metre bands aerial tuning unit by G3VQN (16 years of age); a grip dip oscillator by A. L. Mynett, G3HBW; a 432 Mc/s cascode converter by S. F. Weber, G8AAC and, last but not least, an 80 and 160 metre bands receiver by R. C. Marshall, G3SBA.



Prince Philip looking at equipment on show at the Heathkit (Daystrom Ltd.) stand accompanied by Mr. R. F. Stevens G2BVN, President of the RSGB and Mr. P. Thorogood G4KD, Exhibition Organiser (foreground)

The whole display represented a very creditable effort by all concerned and it was obvious that many hours of construction must have been spent in bringing such designs as were to be seen to final fruition. We hope such equipment will always be available for inspection at future exhibitions.

Among the many interesting stands in the hall, the writer feels that two call for special mention by reason of their many and varied exhibits.

The Heathkit (Daystrom Ltd.) range of equipment was outstanding and was evidenced by the many visitors obviously interested in individual items.

S.T.C. Limited one of the largest electronic companies in the country, have now entered the radio and electronic hobbies market–see News and Comment.

The exhibition as a whole was one of the most interesting that the writer has yet attended.

TRADE NEWS . . .

New Transistor Encapsulation for Printed Circuits

Mullard has developed a new type of "lock-fit" transistor which represents a major breakaway from traditional encapsulation and mounting techniques, and offers equipment manufacturers reduced assembly times and lower production costs. The first two devices to be introduced in the new encapsulation are r.f. silicon planar types for all radio applications at frequencies up to 100Mc/s (brief details are given below). Further types will be announced in the near future.

The bodies of the "lock-fit" transistors are in high-quality epoxy resin and have a non-symmetrical but regular outline to simplify both handling by operatives and automatic insertion by machines into printed circuit boards.

The transistors have flat, shaped-to-grip connecting pins in place of the normal wire leads. These pins provide a "lock fit" insertion into printed circuit boards and at the same time guarantee good solderability. The excellent soldering properties are ensured by the secure and intimate contact with the printed circuit given by the spring set imparted to the pins during manufacture.

The "lock fit" mounting also eliminates the lead-cropping and pre-shaping operations that are unavoidable with wire-ended transistors.

The spacing of the pins conforms to the lead spacing of the standard TO-5 encapsulation and is suitable for circuit boards with 0.1in. grids. The pin outline is stepped to provide a "lock-fit" in either of the standard apertures encountered on printed boards.

The epoxy encapsulation provides good environmental protection and has a junction-to-ambient thermal conductivity superior to that given by most metal encapsulations. Furthermore, the good insulation of the epoxy encapsulation, together with its near-rectangular shape, enables high component packing densities to be achieved on the printed board.

Approximate body dimensions of the "lock-fit" transistors are $7.5 \times 4.5 \times 5$mm. The pins are approximately 5.5mm long.

Brief Details of the new types BF194 and BF195

BF194 This transistor is recommended for use in the i.f. stages of mains and battery-operated a.m./f.m. receivers and car radios, its high current gain and high f_T being particularly suitable for such applications. It can also be used in the sound i.f. stages of television receivers.

BF195 The BF195 is recommended for the first stages of car radios and f.m. receivers, where its low noise figure at frequencies up to 100Mc/s ensures optimum noise performance over a wide range of source impedances. The BF195 is also recommended for use in all stages of a.m. portable receivers, where its narrow current spread is especially advantageous.

New Marconi Range of Packaged Crystal Oscillators

The Marconi Company has announced the introduction of a new range of packaged transistorised oscillators offering design engineers a low priced, medium stability frequency source, housed in a single plug-in unit. Prototypes of these devices were on display at the I.E.A. Exhibition in May and they are now in full production.

A 6 volts, low current supply is all that is required to provide an efficient ready-to-use crystal oscillator with applications in many branches of electronics. Mounted on International Octal or B7G valve bases, they can be provided at frequencies in the range of 1 kc/s to 100 Mc/s. The more compact B7G unit, type F3171, which covers the range 115 kc/s to 100 Mc/s, has the added feature that it can be placed in a standard Marconi F3006 Crystal Oven to provide increased temperature stability.

The larger Octal based unit, type F3170, covering the range 1 to 115 kc/s, is contained entirely in a single anodized aluminium tubular case, 1.125 in. in diameter. Depending on frequency, the seated height varies from 3.125 to 5 in. whereas the higher frequency oscillators, with a B7G base, have a standard seated height of 3.125 in. These units are also contained in a cylindrical aluminium can, but of $\frac{7}{8}$ in. diameter.

Stabilities better than 1 part in 10^4 are obtainable with a temperature variation of -20 to $+70$°C which represents the operating temperature range. If desired, the frequency of the units can be trimmed by means of an external variable capacitor connected between one of the base pins and earth.

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