RADIO & ELECTRONICS CONSTRUCTOR

MAY 1974 22p

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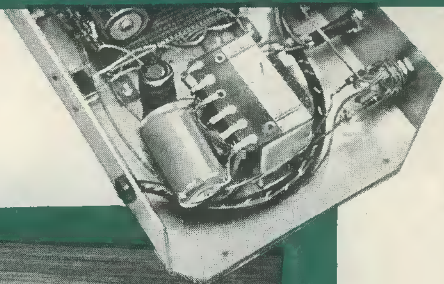

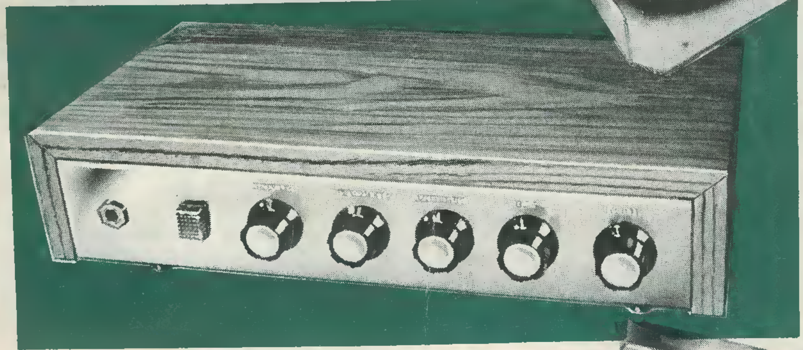

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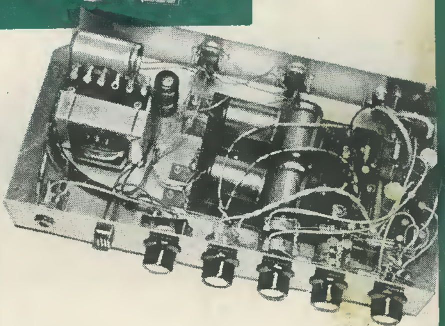

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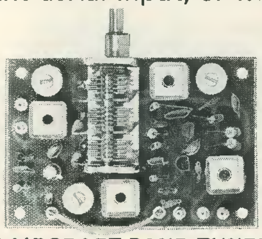

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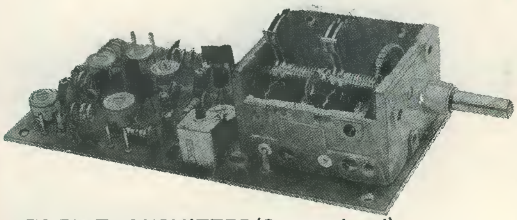

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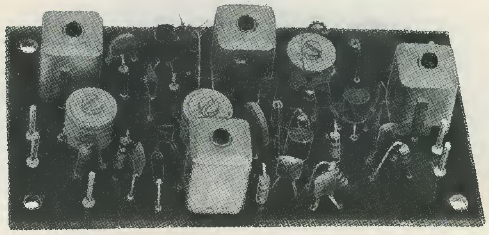

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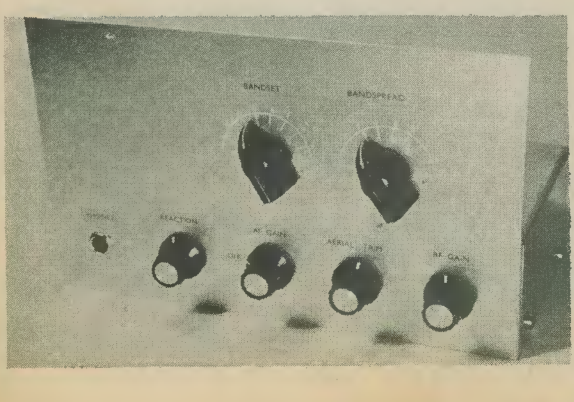
SHORT WAVE REGENERATIVE RECEIVER

By R. A. Penfold

This is a 3-transistor short wave receiver covering 17 to 4.8MHz for reception of the most popular broadcast bands. If desired, two additional coils may be employed, whereupon the recevier range includes the 80 and 160 metre amateur bands.



ONE OF THE MANY FASCINATIONS OF SHORT WAVE listening is that stations thousands of miles away can be received quite well using only a fairly simple receiver. Thus although the receiver described here has only modest gain by modern standards, when properly used with a good aerial world-wide reception is possible.

The set has been designed mainly for use on the short wave broadcast bands, and the frequency coverage with the specified Denco Range 4T plug-in coils extends from about 17 to 4.8MHz. This takes in five of the most popular bands at 19, 25, 31, 39 and 49 metres, and also includes the 20 and 40 metre amateur bands. Results on the amateur bands are not likely to be as good as they are on the broadcast bands due to the lower power of amateur transmissions. Many European stations can be received, however, and occasionally stations from further afield. If desired, the constructor can fit Denco Range 3T coils in addition to the Range 4T coils, whereupon the receiver will operate quite efficiently on the 80 and 160 metre amateur bands.

Power is obtained from an internal 9 volt battery, and the battery life is very good as the consumption is only 4mA. The receiver is intended for high impedance headphones, and the output may also be coupled to an a.f. amplifier.

RECEIVER CIRCUIT

The circuit diagram of the receiver is shown in Fig. 1. As can be seen from this, only three transistors are employed. The first, TR1, is used as an r.f. amplifier, whilst TR2 functions as a regenerative detector and TR3 as an a.f. amplifier. The aerial is coupled to the primary of L1 via the potentiometer VR1, which acts as an r.f. gain control. VC1 is the main tuning capacitor for L1, with VC3 operating as an aerial trimmer. The third winding on L1 couples to the base of TR1. This is a conventional r.f. amplifier using a standard germanium transistor biasing circuit.

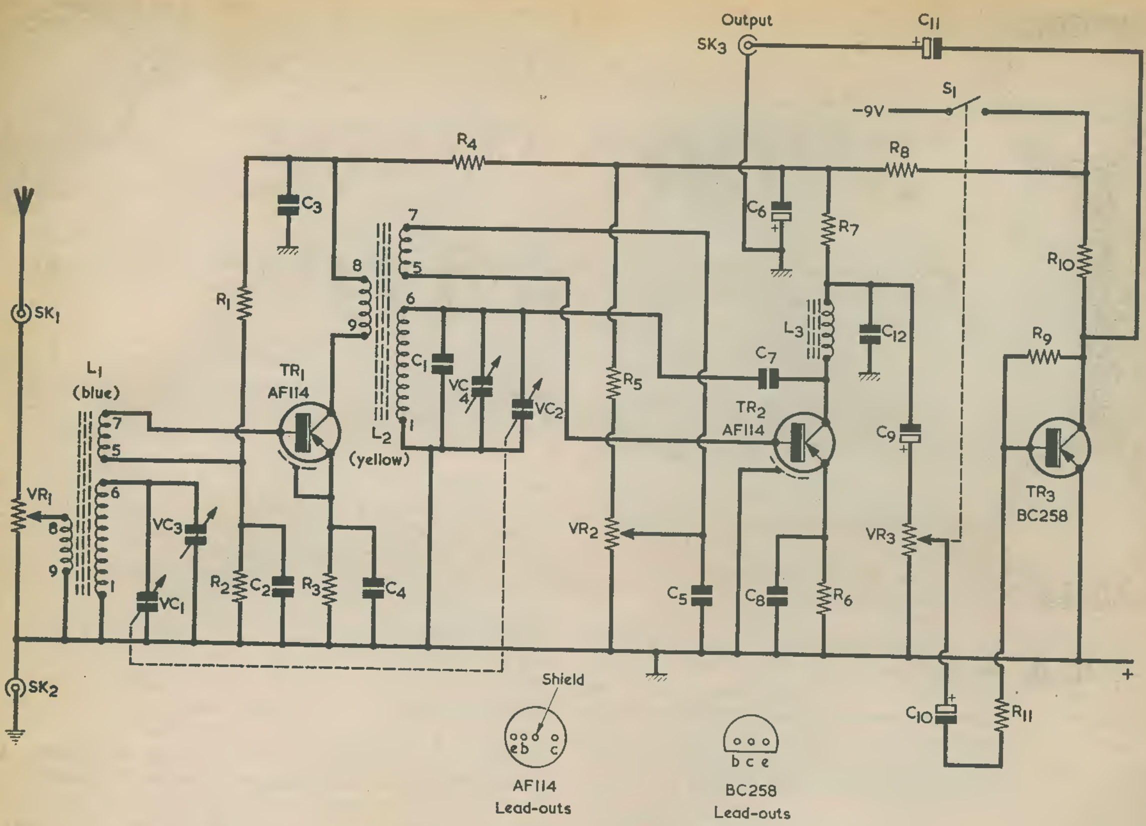


Fig. 1. The circuit of the regenerative short wave receiver.

The primary of L2 provides the collector load for TR1. VC2 and VC4 are connected across the tuned winding of L2. VC2 is the main tuning control and is ganged with VC1 in the aerial input stage. The 2-gang capacitor functions as a bandset control, and VC4 operates as a bandspread capacitor. The third winding on L2 couples into the base of TR2 and is connected such that the signal at the collector of TR2 is in phase with that at the upper end (pin 6) of the tuned winding. In consequence, regeneration is introduced via C7. Potentiometer VR2 controls the biasing current for TR2 and hence its gain. For the reception of a.m. signals this control is set just below the point at which the gain of the circuit is sufficient to cause oscillation. To receive c.w. and s.s.b. signals VR2 is set just above this point so that the detector is gently oscillating. Results on c.w. and s.s.b. are very good with regard to quality.

Apart from giving a very useful increase in gain, the r.f. amplifier also serves to prevent oscillations in the TR2 stage from reaching the earial, where they could cause interference in neighbouring receivers.

L3 is the r.f. load for TR2 collector, and R7 is the a.f. load, with C12 providing r.f. decoupling. VR3 is the a.f. volume control and it feeds the a.f. stage by way of C10 and R11. The last component offers final r.f. filtering. The a.f. stage, incorporating TR3, is quite conventional and has sufficient output to feed a pair of high impedance headphones. S1 is the on-off switch and is ganged with VR3. R4, R8, C6 and C3 are supply decoupling components.

The BC258 specified for TR3 is available from Electrovalue Ltd., 28 St. Judes Road, Englefield Green, Egham, Surrey. Many of the components are fitted to three tagstrips with horizontal tags, one of these being 6-way and the other two 8-way. The 6-way tagstrip is approximately 2.9in. long and the 8-way tagstrips approximately 3.7in. long. These were obtained by the writer from a local retailer, and identical types are not available from the usual mail order houses. However it will be in order to employ other tagstrips which are of around the same size or somewhat smaller, such as the Bulgin tagstrips available from Home Radio under Cat. No. BTS62 (6-way) and Cat. No. BTS64 (8-way).

CHASSIS AND PANEL

The chassis measures 8 by 4 by 2in. and can be home-made from 18 s.w.g. aluminium or purchased already made. The author obtained his chassis from H. L.

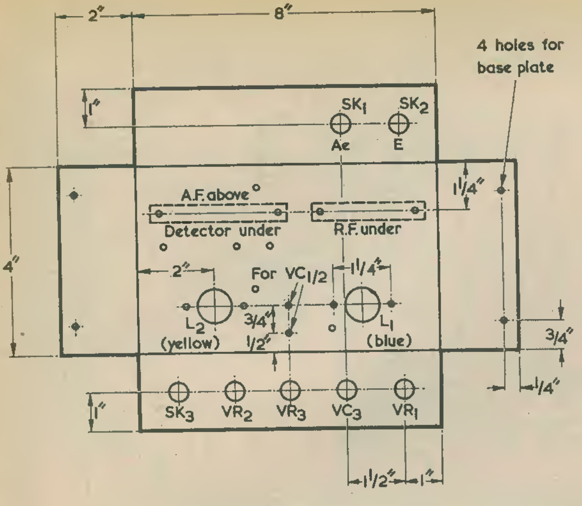
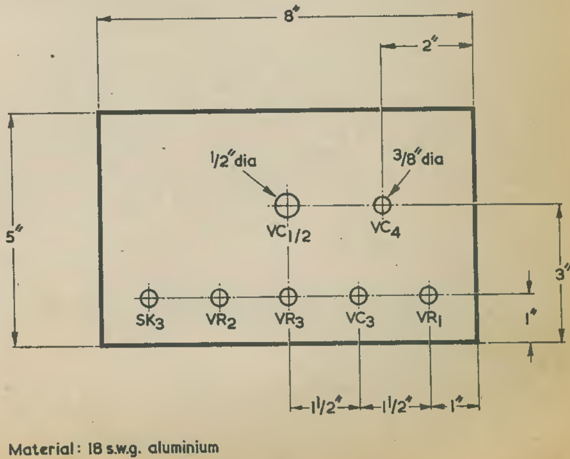


Fig. 2. Drilling details for the receiver chassis. Dimensions not shown are discussed in the text.

Smith & Co. Ltd., 287/9 Edgware Road, London, W.2. In Fig. 2, the chassis is viewed from the top with the four flanges opened out. When home-constructed, the flanges will be bent down, away from the reader. Coils L1 and L2 are plugged into standard B9A valveholders, which require a ¾in. diameter cut-out. The valveholder tags should have the orientation with respect to chassis which is shown in the under-chassis wiring diagrams of Figs. 4 and 5 and, with some valveholders, this may mean that the two 6BA clear mounting hole positions for each holder may be displaced slightly from those shown in Fig. 2. The ¾in. holes should be made first, the valveholders held in these to give the required tag orientation and the mounting holes then marked out using the valveholders as templates. A solder tag is secured, below the chassis, under each of the 6BA mounting nuts.

The mounting holes for VR1, VR2, VR3 and VC3 are ⅜in. diameter. The diameters of the holes for SK1, SK2 and SK3 depend upon the particular components employed. Fig. 2 also shows the positioning of the 6-way r.f. amplifier tagstrip, and the 8-way detector and a.f. amplifier tagstrips. The first two are below the chassis whilst the last is above. The two 8-way tagstrips share the same pair of mounting holes. All the tagstrip holes are marked out with the aid of the tagstrips themselves and are drilled 6BA clear or 8BA clear to suit the actual tagstrips to be used. Two mounting holes are shown for the 2-gang capacitor and these should be 4BA clear. The 2-gang capacitor is mounted by two ¼in. 4BA screws passing through these holes, and its final positioning should be such that its spindle protrudes by about ¾in. through the centre of the panel hole which is shown in Fig. 3. The capacitor should not

Fig. 3. The front panel of the receiver.

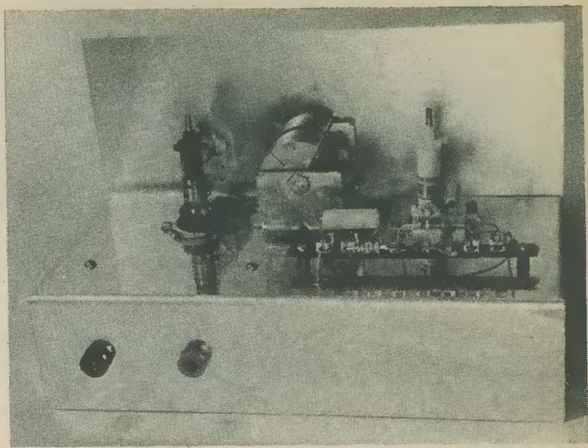


be mounted until the front panel has been fitted.

There are five further holes shown in Fig. 2 on the chassis deck. These are intended for the passage of wires and are drilled ¼in. diameter in the approximate places indicated. They are then fitted with grommets to protect the wires.

A base plate is fitted to the chassis. This can be obtained with the chassis, if this is commercially made, but the author chose to make one from an 18 s.w.g. aluminium sheet measuring 8⅞ by 3⅞in. This has a ½in. flange bent up at 90° at each end, giving a 7⅞ by 3⅞in. plate which pushes into place under the chassis. The four holes in the side flanges of the chassis are drilled clearance size for small self-tapping screws. The base plate is then temporarily placed in position and the required four holes in its flanges marked out with a pencil. These are then drilled out tapping size for the self-tapping screws. The base plate may be fitted with four small rubber feet near its corners.

The front panel, which as already been referred to, is shown in Fig. 3. This is cut from a sheet of 18 s.w.g. aluminium and measures 8 by 5in. The lower row of holes is identical to the corresponding holes in the front flange of the chassis and the front panel is, in fact, secured to the chassis under the bush mounting nuts of SK3, VR2, VR3, VC3 and VR1. Also required are the ½in. hole for the spindle of VC1, VC2 and a ⅜in. hole for VC4.



Rear view of the chassis. The two coils plug into B9A valveholders.

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1	12kΩ
R2	2.2kΩ
R3	1kΩ
R4	820Ω
R5	56kΩ
R6	1kΩ
R7	2.2kΩ
R8	220Ω
R9	820kΩ
R10	4.7kΩ
R11	2.2kΩ
VR1	25kΩ poteniometer, linear
VR2	10kΩ potentiometer, linear
VR3	5kΩ potentiometer, log, with switch S1

Capacitors

C1	18pF silvered mica
C2	0.022μF polyester
C3	0.022μF polyester
C4	0.01μF disc ceramic
C5	0.022μF polyester
C6	100μF electrolytic, 10 V.Wkg.
C7	1.8pF ceramic or silvered mica
C8	0.01μF disc ceramic
C9	10μF electrolytic, 10 V.Wkg.
C10	1μF electrolytic, 10 V.Wkg.
C11	10μF electrolytic, 10 V.Wkg.
C12	0.01μF polyester
VC1, VC2	365+365pF 2-gang variable, type 'O' (Jackson Bros.)
VC3	50pF variable, type C804 (Jackson Bros.)
VC4	15pF variable, type C804 (Jackson Bros.)

Inductors

L1	Miniature dual-purpose, transistor usage, Blue coil Range 4T and 3T (optional) (Denco)
L2	Miniature dual-purpose, transistor usage, Yellow coil Range 4T and 3T (optional) (Denco)
L3	R.F. choke, 1.5mH

Transistors

TR1	AF114
TR2	AF114
TR3	BC258

Switch

S1	S.P.S.T. toggle, part of VR3

Sockets

SK1	Wander plug socket
SK2	Wander plug socket
SK3	3.5mm jack socket

Miscellaneous

9-volt battery type PP3 (Ever Ready)
4 round knobs
2 pointer knobs
2 B9A valveholders
Battery connector
1 6-way tagstrip (see text)
2 8-way tagstrips (see text)
1 aluminium chassis 8 x 4 x 2 in. with base plate (see text)
1 aluminium panel, 18 s.w.g., 8 x 5 in.
4 rubber feet.

COMPONENT ASSEMBLIES

Most of the components are mounted on the tagstrips already discussed, and details of the wiring involved are given in Figs. 4, 5 and 6. Fig. 4 illustrates the r.f. stage wiring, Fig. 5 the wiring for the detector and Fig. 6 that for the a.f. stage. These diagrams show nearly all the other wiring for the receiver.

Start the electrical side of construction by mounting the various components on their tagstrips. In the diagrams the components are shown well spaced out for clarity. In practice, however, component leads are all kept fairly short, as can be seen in the photographs. It is advisable to cut the component leads to length, and to tin these with solder prior to attempting to mount the components.

When the strips have all their components fitted to them they may be mounted on the chassis. The r.f. stage is mounted on its own on the underside of the chassis, being spaced away from the chassis by about ½ to 1in. The detector and a.f. tagstrips are mounted by the same bolts or lengths of studding, and are also spaced away from the chassis by about ½ to 1in.

As can be seen from the diagrams, quite a lot of interconnecting wiring is required. This is carried out with thin p.v.c. insulated wire, and it must be kept reasonably short. C1, C5 and C7 are not mounted on the tagstrips, but in the manner shown in Fig. 5. It will be necessary to solder an extension lead to the base lead-out of TR1 in order to reach tag 7 of L1 coil holder. See Fig. 4. This lead should be covered with thin p.v.c. sleeving. Since TR1 and TR2 are germanium types, their lead-outs should be at least ½in. long, and the use of a heat shunt during soldering is advised.

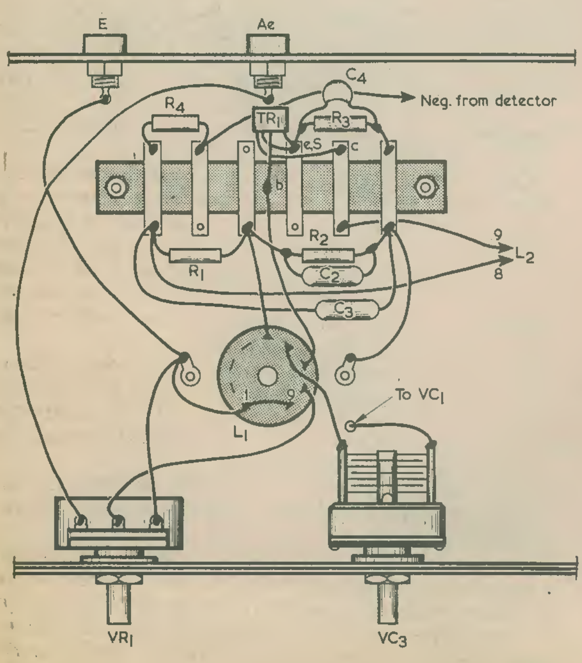


Fig. 4. The wiring around the aerial stage.

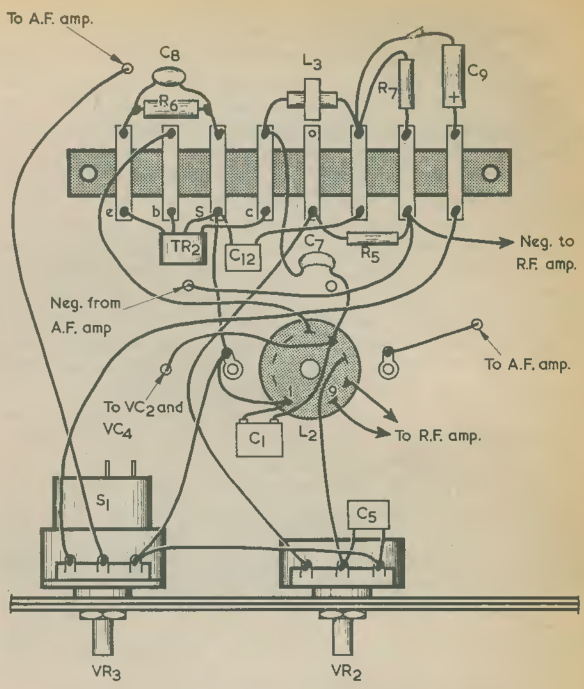


Fig. 5. The components and wiring at the detector tagstrip.

The fixed vanes of VC4 are connected above the chassis to the fixed vanes of VC2. Connection to the moving vanes of VC1, VC2, VC3 and VC4 is automatically made by way of their mounting on the chassis or front panel.

Only one lead is shown, in Fig. 6, passing to SK3.

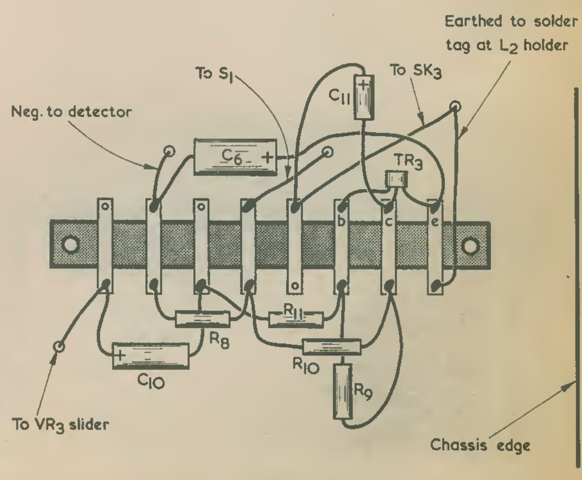


Fig. 6. The layout of the a.f. amplifier stage.

The tag on this socket which corresponds to the sleeve of the jack plug should automatically provide a chassis point by way of its mounting bush, and this tag takes the positive battery lead. If SK3 is of the type which is insulated from chassis, the tag in question is connected to the nearer solder tag under L2 coil holder mounting nut. A lead from the a.f. amplifier tagstrip passes through the chassis to one tag of S1. The negative battery lead connects to the remaining tag of S1. There are a number of convenient spaces under the chassis where the battery can be mounted vertically. It is held firmly in place when the base plate is screwed in position, a piece of foam rubber or plastic being glued to the plate to hold the battery firmly in place. A blue aerial coil plugs into the holder for L1 and a yellow r.f. coil into the holder for L2.

ALIGNMENT

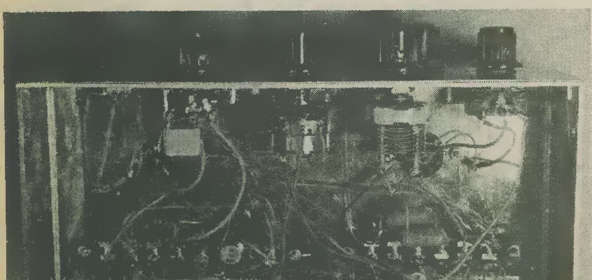
Due to the presence of a panel operated aerial trimmer there is no necessity for precise alignment, as this trimmer can be adjusted to peak the aerial tuned circuit at the various settings of the main tuning control. The only setting-up required consists of initially adjusting the core of the yellow r.f. coil so that about ⅜in. of the threaded brass stem protrudes from the top. The aerial trimmer, bandspread and main tuning capacitors are then set to their central positions and the core of L1 adjusted for maximum sensitivity.

If Range 3T coils are also to be used these are set up in the same way. The cores can be held in position by passing a 6BA nut over each of the threaded stems and locking this gently against the top of the plastic former.

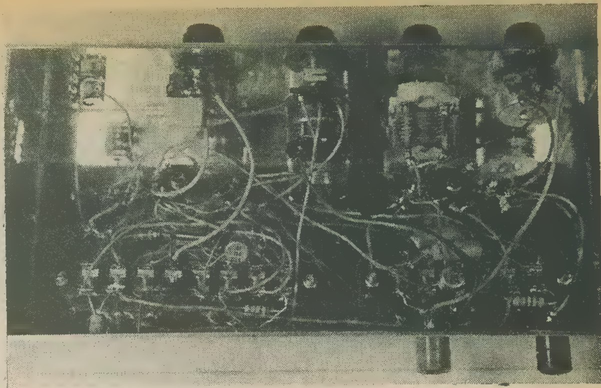
AERIAL AND EARTH

A normal long wire aerial should be used, and this should preferably be a proper outdoor type, some 50ft. in length and set as high as possible. A short indoor aerial will give some results and a surprisingly large number of stations can be received with such an earial. It will not, however, give results which are comparable with those resulting from the use of a good outdoor aerial.

A proper earth connection, consisting of a metal rod or plate with wire attached, and buried in damp earth, will probably slightly improve results. A mains earth connection is not usually of much help, and may even introduce interference.



The underside of the chassis. Most of the small components in the r.f. amplifier and detector stages are mounted on two tagstrips.



Another view of the parts fitted below the chassis.

OPERATING NOTES

The bandset control, VC1, VC2, is employed to search the dial for the required band. When this has been located and VC1, VC2 set to the band centre, the bandspread capacitor, VC4, is employed to tune across the band. VC4 has a much smaller value than the bandset control and so only covers a very restricted range of frequencies. This gives the same effect as tuning the bandset control by way of a high ratio reduction drive. VR3 and S1 function as a normal combined a.f. volume control and on-off switch. VR2 is the reaction control and, as stated earlier, is adjusted so that the detector is just below the point at which oscillation occurs when receiving a.m. signals. It is at this point that the receiver is most sensitive and exhibits its greatesr selectivity. VR2 is set just above the threshold of oscillation for the reception of c.w. and s.s.b. signals. It is obvious when the detector is oscillating since there is a sudden increase in the noise level, and a loud whistle is heard as the set is tuned across an a.m. transmission.

It should be mentioned that the yellow Denco r.f. coil is basically intended for r.f. coupling without the provision of regeneration and there is a very slight possibility that its base coupling coil may be incorrectly phased. If no oscillation can be obtained, this point may be ascertained by temporarily transposing the connections to tags 5 and 7 of the holder for L2.

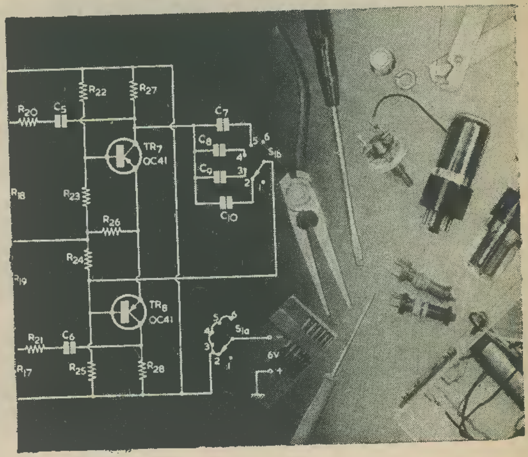
VR1 is the r.f. gain control and is normally set to maximum. It may be turned back somewhat with very strong signals, which can otherwise overload the detector and make it impossible to obtain oscillation. In extreme cases the overloading will be heard as a loud hissing noise in the headphones. Very strong s.s.b. signals will tend to sound a little distorted and their quality can be improved by reducing the r.f. gain.

The aerial trimmer VC3, is used to peak received signals and it is important to see that this is always correctly adjusted. Both VR2 and VC3 will probably need some slight adjustment each time the tuning controls are significantly altered.

Best results are given with 4,000Ω headphones. Also, crystal headphones or even a crystal earpiece can be used.

Logging scales can be marked around the knobs of the bandset and bandspread controls. On the prototype a simple 0–10 scale is provided around each, but more comprehensive scales can be used if desired. The 0–10 scales were taken from 'Panel Signs' Set No. 5. Legends were also provided above each control to indicate function, and these were provided by 'Panel Signs' Set No. 4. 'Panel Signs' are available from the publishers of this journal. ■

MAINS – HUM TOUCH BUTTON



by G. A. FRENCH

Operation of electrical and electronic circuits by touch-button is by no means a new feature of technology, and buttons of this nature have been employed for the control of lifts and similar purposes in America for quite a few years. A touch-button sets a circuit in operation when it is touched by a human finger, and no pressure is required as occurs with a conventional push-button. One of the advantages conferred is that there is no mechanical wear on the button, but there is the accompanying disadvantage that the circuit required around the button is more complex than is given by the simple closure of two contacts in a push-button.

Touch-buttons are appearing more and more frequently in domestic entertainment equipment, a typical example being given in the Ferguson 4000 series of colour television receivers. Here, the touch-buttons are referred to as 'touch pads' and are used for channel selection. Each touch pad has two exposed contacts which are bridged by the finger tip when touched. This causes a small current to be passed to one of the inputs of an MOS integrated circuit. The i.c. latches on at the latest pad to be touched and provides a corresponding output which switches in one of a number of pre-set varicap tuning circuits.

HOME CONSTRUCTOR CIRCUIT

The device to be described in this article operates on quite a different principle and employs pick-up of mains hum to actuate a relay by way of an a.f. amplifier and rectifier. All constructors will be familiar with the mains hum which is reproduced by the speaker of an audio amplifier when an input point is touched with a finger. Advantage is taken of this effect here; the touch-button is coupled to an a.f. amplifier input and a mains hum voltage is injected when the button is touched. The circuit has to be classed as experimental because it depends upon the mains fields which exist in the area where the button is located. In the writer's house, which has unscreened mains wiring, the circuit was sufficiently sensitive to be actuated by holding a finger very close to the button without actually touching it. In consequence it was possible to actuate the device even whilst wearing gloves. In houses which have screened mains wiring, the mains fields will be smaller in intensity, and sensitivity may be lower. It is possible that a field may be artificially introduced by running an unscreened mains wire near the touch-button and this point is dealt with later.

The circuit of the device appears in Fig. 1, in which the touch button couples via screened wire to capacitor C1 and then to the base of TR1. TR1 and TR2 appear in a high gain a.f. amplifier circuit. The collector of TR1 connects directly to the base of TR2, and the final amplified signal appears across R3. R1, the base bias resistor for TR1, is taken to the emitter of TR2, which is bypassed for a.f. by C4. Under d.c. conditions TR2 acts as an emitter follower: its base, and hence the collector of TR1, takes up a potential which allows the corresponding bias current to flow into the base of TR1. The circuit thus stabilizes at this emitter potential in TR2, and the overall result is a high gain a.f. amplifier which requires few components.

The base of TR1 would normally be fed by a low impedance input circuit, but in the present application there is negligible loading on the base at all. Because of this it is necessary to screen the base wiring of TR1 to prevent capacitive coupling to the following components in the amplifier as, otherwise, r.f. instability can result. The circuit is quite stable provided that the screening is carried out efficiently. Capacitor C2 is included to reduce the gain at radio frequencies. The input impedance looking into TR1 base is low, but this base proves in practice to offer an adequate mains hum pick-up point.

When the touch-button is touched, the amplified hum signal at TR2 collector is fed, via C3, to the rectifier D1. The junction of C3 and D1 then takes up a rectified potential which is proportional to the signal amplitude from TR2 and which is negative with respect to the positive upper supply rail. This rectified signal has a very high alternating content at mains frequency and its harmonics, and needs to be 'smoothed' before it can be applied to the relay actuating section of the circuit. The 'smoothing' is carried out by R5 and C5, whereupon a negative-going signal is fed to silicon transistor TR3. This functions as an

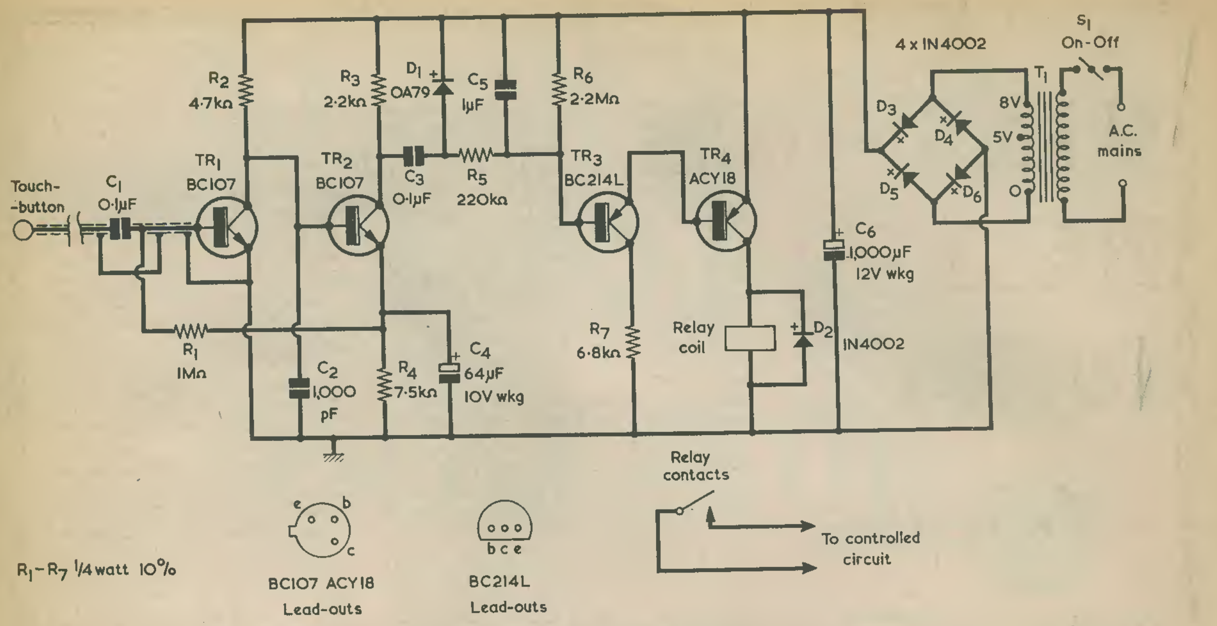


Fig. 1. Complete circuit of the touch-button unit.

emitter follower and passes an amplified current to the base of TR4. TR4 is a small robust germanium transistor and its collector current then energises the relay.

Overall circuit operation may be summed up in the following manner. When the touch-button is not touched, any signal present at TR2 collector is mainly amplified noise with possibly a low hum content. Should this signal voltage be sufficiently high to be rectified by D1, it will still be too low to take the base-emitter junction of TR3 up to the 0.6 volt level it requires for the transistor to become conductive. Thus TR3, and in consequence TR4, remains cut off. When the touch-button is touched, a rectified hum signal in excess of 1 volt appears at the junction of C3 and D1, and this is sufficient to make TR3 conductive and thereby turn TR4 fully on. The relay energises and its contacts switch on any external circuit which it is desired to have the touch-button control.

The power for the circuit is obtained from the a.c. mains supply by way of transformer T1 and the bridge rectifier given by D3 to D6. The only other power supply component is reservoir capacitor C6, which also carries out the secondary function of providing a signal frequency bypass across the supply rails.

PRACTICAL POINTS

The components employed in the circuit are all standard widely available parts. Like TR3, TR1 and TR2 are silicon transistors. Diode D1 is a germanium component, whilst D2 to D6 are silicon rectifiers. The function of D2 is to prevent the appearance of a high reverse voltage across the relay coil when its energising current is turned off. It is important to connect D2 into circuit with correct polarity, or excess current can flow in TR4 and cause this transistor to be damaged.

Capacitors C1, C3 and C5 are polyester or polycarbonate components. A 1µF electrolytic capacitor having a working voltage of 4 volts or more could, alternatively, be fitted in the C5 position. Its positive lead-out should connect to the positive supply rail. Mains transformer T1 is a small bell transformer of the type which is available at the electrical counter of Woolworth's Stores. It has an 8 volt secondary with a 5 volt tap which is not used here. The relay can be any component having a coil resistance of 250Ω or more, and which is capable of energising at 8 volts or less. In the prototype circuit, the author used a P.O. 3000 relay with a 500Ω coil.

With the exception of the input wiring to TR1 base, layout is not at all critical. It is essential, however, to prevent interaction between the base of TR1 and the remainder of the a.f. amplifier section. C1 *and* R1 should be mounted several inches from the other components, and the connection between TR1 base and the junction of C1 and R1 should be carried out with screened wire, the braiding of which extends very nearly to the base lead-out of the transistor. The base lead-out should not be anchored to a tag on a tagstrip or, say, to a strip of copper foil on a piece of Veroboard, as either of these would provide an excessive area of metal in contact with the base of the transistor which could couple by stray capacitances to the other components. The connection between the screened cable and the transistor base lead-out should take the form of a 'mid-air joint', as illustrated in Fig. 2. The braiding of the screened cable may be earthed at the emitter connection point of the transistor. The author used thin flexible screened wire having closely meshed braiding. This was also used for coupling C1 to the touch-button. Any flexible screened wire suitable for connecting a pick-up or a microphone to an a.f. amplifier would be suitable

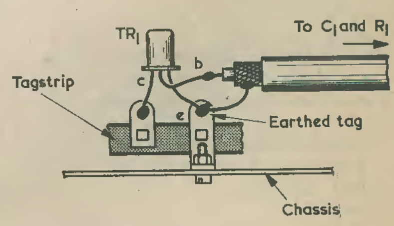


Fig. 2. The screened wire to the base of TR1 must connect to it in the manner shown here. It is assumed that the transistor is mounted on a tagstrip, but any other suitable means of anchoring the emitter and collector lead-outs can be used.

here. Television aerial coaxial cable might not be suitable and is best avoided.

It should be repeated that the precautions against instability just described apply only to the base of TR1. The circuitry around TR1 and TR2 may be looked upon as a simple a.f. amplifier involving no unwanted feedback problems, with the proviso that there is just one point, at the base of TR1, which is 'hot'.

The touch-button can be a small round metal disc having a diameter of about ¼ in. which is suitably mounted on an insulating material, as in Fig. 3. The screened wire between C1 and this disc can be any length up to 6 ft. or so. The mounting for the button must be a reliable insulator, and the disc should not be fixed direct to a wooden surface.

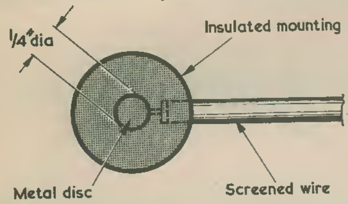


Fig. 3. The centre lead of the screened wire connects to the touch-button, which consists of a metal disc fitted on an insulated mounting.

Working from the writer's experience, the area of the button should be kept low or it will, itself, pick up an excessive hum signal. With the prototype it was possible to energise the relay when a flat piece of metal 2 in. square was rested, on its own, on the touch button. To give a further idea of sensitivity, the relay also operated when the author held one lead-out of a 4.7MΩ resistor between his fingers and applied the other lead-out of the resistor to the button. This high sensitivity means that the button could not be sited out of doors due to the problems of electrical leakage during and after rain. As was mentioned earlier, the results obtained depend on the strength of the mains fields in the vicinity of the button. If these are weak a single unscreened insulated wire connected to the live side of the mains could be positioned vertically on a wall about 2 yards away from the button. The wire could be about 5 ft. long and should provide a sufficiently high field for the touch-button, although this point would have to be determined experimentally and has not been checked out by the writer.

The operation of the a.f. amplifier section can be monitored by connecting a pair of high resistance headphones across diode D1. These should reproduce a low background hiss which rises to a loud hum when the button is touched. A loud hiss accompanied by erratic operation of the relay indicates that the amplifier is oscillating, and attention should then be paid to the screening of the lead to the base of TR1. Connecting the headphones will prevent the relay from operating because of the relatively low resistance then applied across the diode. Alternatively, the input of an external a.f. amplifier could be coupled to the diode, the earthy input terminal connecting to the negative supply rail and the non-earthy input lead to the junction of D1 and C3 via a 0.01μF capacitor. The external amplifier gain will need to be kept fairly low due to the high amplitude of the signal across D1.

As a final point, it will in many cases be found preferable not to have the chassis of the touch-button unit connected to earth. This will enable the chassis to carry a small mains voltage itself by way of the internal stray capacitances in transformer T1. In houses with screened mains wiring this will enable a hum voltage to be developed across the base and emitter of TR1 due to the capacitance to earth of the body of the operator touching the button, rather than through the pick-up of external mains hum fields. ■

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 for 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.

Radio Constructor, November and December 1968 – K. Stephenson, "Red Screes", Mayo Street. Cockermouth, Cumberland, CA13 0BY – To Purchase.

BC 221 AL Signal Corps Frequency Meter – P. Berwick, 10 Selbourne Road, Hockley, Essex – Manual required, or any relevant information, to purchase or borrow.

Power Supply – R. G. Coombe, 45 Saxon Road, Exeter, Devon, EX1 2TD – Circuit of power supply to run Car Radio/Cassette Recorder from 240 volt a.c. mains, required.

Radio Constructor bound volumes, Nos. 20/21/22 (August 1966–July 1969) – Trevor F. C. Davis, 1064A London Road, Thornton Heath, Surrey, CR4 7ND – To purchase in unmarked condition suitable for private library.

Ferranti 194 Mains Receiver – J. Carver, 112 Merthyr Mawr Road, Bridgend, Glamorgan, CF31 3NY – circuit diagram required.

Mecablitz 500 Electronic Harp – W. Swann, 127 St. Wilfrids Road, West Hallam, Derbyshire, DE7 6HG – circuit diagram or information as to where obtainable.

R-C Bridge – T. R. Smith, 7 Purbeck Court, Park Barn, Guildford, Surrey – circuit diagram, preferably for transistorised R-C Bridge.

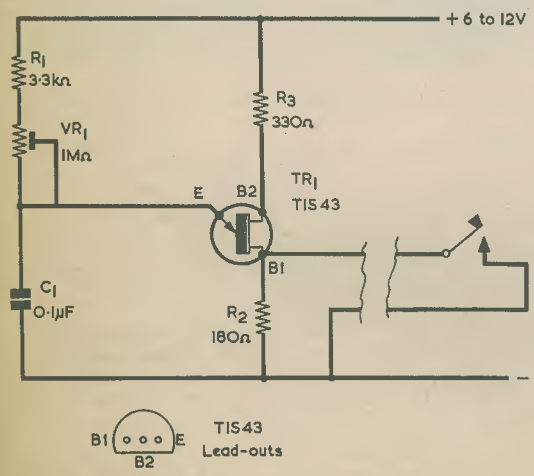
World Tapes for Education – A. J. Woodhams, 18 Normanhurst Road, Borough Green, Sevenoaks, Kent – Information of this or any other known international organisation for the exchange of recorded correspondence tapes.

Phillips Communication Receiver and Power Unit – Type P.C.R. – V. R. Robb, 33 Stranmillis Gardens, Belfast, BT9 5AS, Northern Ireland – Circuit diagram and/or any other data.

R.F. COUPLED MORSE OSCILLATOR

By M. H. George

An unusual and inexpensive design which allows a Morse practice oscillator to be inductively coupled to an a.m. transistor radio.



Circuit of the r.f. coupled Morse practice oscillator. The three fixed resistors are ¼ watt 10% and VR1 may be a skeleton potentiometer.

THIS UNIT EMPLOYS A STANDARD UNIJUNCTION A.F. oscillator, and it has the unusual feature that it can be coupled to any medium or medium and long wave transistor radio without making any direct connections.

CIRCUIT OPERATION

The circuit of the unit appears in the accompanying diagram. The tone is produced by the unijunction transistor TR1, the frequency of oscillation being controlled by the pre-set potentiometer VR1. When the key is open, the unijunction pulses given by C1 discharging into R2 have a relatively long fall time. However, when the key is closed C1 is discharging more or less into a short-circuit, apart from the emitter – base 1 junction of TR1, and the pulses have correspondingly a very short fall time and a high current amplitude. These pulses can be picked up by the ferrite rod aerial of an a.m. transistor radio positioned about a foot from the leads to the key. The signal consists of r.f. harmonics of the unijunction tone modulated at the basic tone frequency. Thus, a loud tone is given by the speaker of the radio each time the key is pressed.

In the prototype the leads between the oscillator unit and the key are about 3 feet long and consist of two separate untwisted wires. Performance may vary according to the particular radio employed, but a little experiment will soon indicate the best mutual positioning required for this and the key leads.

The frequency of oscillation is set up by adjusting VR1. The range of oscillation is wide and VR1 needs to be adjusted fairly carefully for the desired frequency. The unit can operate from any d.c. supply between 6 and 12 volts. At 6 volts current consumption is 1.5mA, and at 12 volts it is 2.6mA. The current drawn from the supply alters only slightly when the key is pressed. ■

NEWS . . . AND .

SIMPSON MULTIMETER

Electroplan Limited of Orchard Road, Royston, Herts., have signed an agreement to distribute the well-known Simpson Multimeter. This high performance, low cost American-made unit is an ideal alternative to centre pole multimeters currently available in the UK. It has twenty-nine ranges covering AC/DC, volts, current, ohms and decibels. Full scale voltage measurements are from 250mV to 1000V and current (DC only) from 50μA to 10A. DC accuracy is 2% over full operating temperature range. The Simpson has a high sensitivity of 20K ohms/volt DC and 5k ohms/volt AC with excellent overload protection using an extremely fast transistorised cut-out, with a reset button, diode protection of the meter movement and externally accessible fuse.

The multimeter is supplied complete with batteries and test leads. A wide range of accessories are available including an Amp-Clamp for AC current measurements up to 300A, a 30Kv high voltage probe and leather carrying case.

The Simpson Multimeter is available ex-stock from Electroplan at £39.50 (VAT extra).

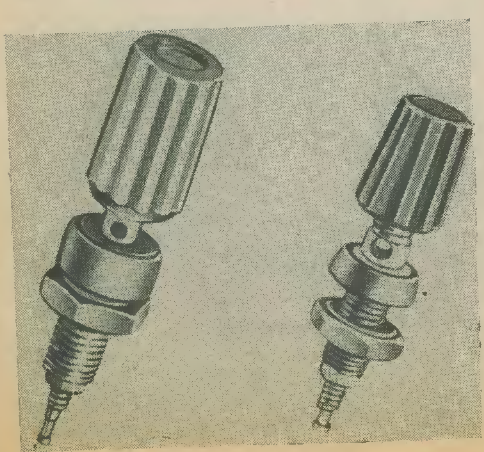
AUDIO ENGINEERING SOCIETY MEMBERS VISIT EMI TAPE LTD.

Following a lecture presented to the Audio Engineering Society by Ray Gilson technical consultant to EMI Tape Ltd. members of the Society visited the Emitape manufacturing plant at Hayes in Middlesex recently.

The photograph below shows a group of A.E.S. members quizzing manager Tom Anderson on tape slitting techniques, during their comprehensive tour of one of the largest and most up to date tape making plants in Europe.

Particular interest was also shown in the test equipment used by the quality assurance laboratories of EMI Tape Ltd. Strict checks are carried out by the laboratories on both raw materials and finished product to ensure that high manufacturing standards are maintained.

E. F. JOHNSON RANGE OF BINDING POSTS



As part of the E. F. JOHNSON range of components, Vero Electronics Limited of Chandler's Ford, Eastleigh, Hants., are now able to offer deliveries from stock of their Terminals or Binding Posts. Two sizes of binding post are available to accept either .080 in. tip plugs, miniature banana plugs, or standard banana plugs. They offer excellent current capacity up to 15 amps and a high peak voltage up to 8000 volts. They are pre-assembled with a moulded body and silver plated shank. The fluted thumb is self-captivated and they are designed for use with a solder stud or lug for thumb screw retention, or a plug connection to the top end.

. . . COMMENT

BEATING THE DUST PROBLEM

Do you have problems with dust, attracted by static electricity, on your favourite longplaying records? BBC World Service outlined a new device for dealing with the problem.

The Industrial Development Unit at the University College of North Wales in Bangor has invented an anti-static gun. The device looks like a water pistol but, instead of shooting out a stream of water, this pistol fires a stream of electrically charged air particles.

It contains a piezo-electric crystal. When the trigger on the pistol is squeezed the crystal is compressed and it generates a high voltage, about 12,000 volts, which is fed to a fine metal point in the nose of the pistol.

The fine point is in fact a sewing needle. Air particles become positively charged and as they strike the surface of the record, they neutralize all the negatively charged particles on that surface. Conversely when the trigger is released negative charge is emitted and this neutralizes any positive charge on the record.

The uncharged particles no longer stick to the record and can be shaken or blown off.

The pistol has a range of about two feet and has several advantages over existing methods of removing dust. While conventional record cleaning techniques may remove the dust effectively, the surface is often left sticky which in turn leads to a build-up of dust.

Cleaning cloths have a tendency to dry out and rubbing with them may just increase 'static'. The pistol's crystal is very rugged and will continue to function even after thousands of squeezes.

The device has wider applications, in industry where static is often a problem, for example, in manufacturing textiles or polythene bags. The hand-operated gun is at present being tried out in some firms to see whether an automated version would be appropriate. The device is expected to cost under £5.

LEARN ELECTRONICS WITH THE LADIES

An evening class in electronics at the Ernest Bevin School, Tooting, London, includes among the 40 students the two attractive young ladies pictured above – all the other students are male.

They are Jennifer Raggett and Shirley Hooper, employees of Home Radio Components Ltd of Mitcham. Mr. Alan Sproxton, Managing Director of Home Radio, suggested they joined the evening class and the idea is proving a great success.

1974 B.A.R.T.G. CONVENTION

The 1974 British Amateur Radio Teleprinter Group Convention will be held this year at the village hall, Meopham, Kent, on Saturday, 18th May, from 11.00 to 18.00 hours. The village hall is located on the east side of the A227 road, to the south of Meopham village centre. Transport will meet trains from London at Meopham station until 1 p.m.

Attractions will include – Trade Stands: A live station operating RTTY on the 14 MHz band, under the BARTG call, G4ATG; Lectures on 'Getting Started on RTTY' and 'Advanced Terminal Unit Design'; Bring and Buy Stand; Technical Advice Corner.

Food and refreshments will be available, and there is ample car parking space.

Further details may be obtained from the Hon, Secretary of BARTG, D. F. Beattie, G30ZF, 'Mayerin', Churchway, Aylesbury, Bucks.

"I gather that our friend from the 'Whizzbang TV Flying Doctor Service' does not regard this as a stock fault!"

TRANSISTOR GAIN BRIDGE

by R. J. Caborn

A test circuit that is easy to build, calibrate and operate.

THE UNIT DESCRIBED HERE ENABLES THE CURRENT gain of small-signal transistors to be quickly measured. It is based on the circuit simplifications which are given when an emitter follower has an emitter potential equal to half the supply voltage.

HALF VOLTAGE OPERATION

To appreciate basic circuit operation, it will be helpful to look first at Fig. 1, which shows a transistor connected as an emitter follower with RE as its emitter load and RB as its base bias resistor. We will assume for the moment that there is zero voltage drop across the base-emitter junction of the transistor.

The values of the resistors are such that the voltage across RE, shown as VE, is equal to the voltage, VB, across RB. Now, the emitter follower has a current gain of h_{FE} + 1, so the current flowing in RE is h_{FE} +1 times the current flowing in RB. Since the voltage across each resistor is equal it follows that the resistor values are in inverse ratio to the currents. So, the value of RB is h_{FE} + 1 times the value of RE.

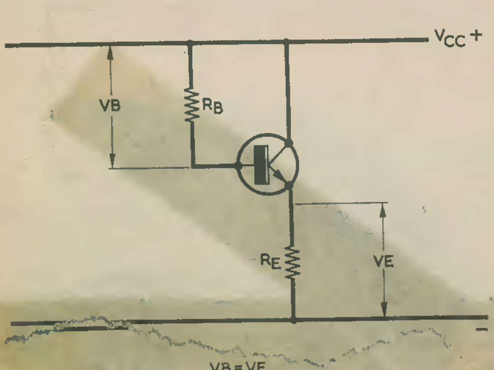


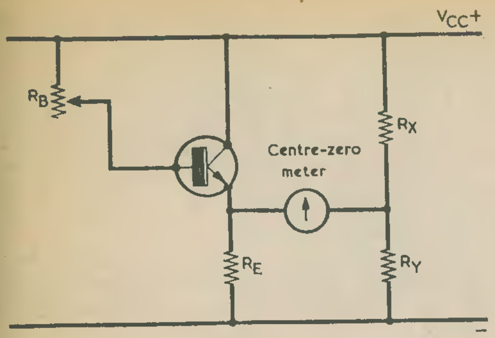
Fig. 1. The resistors nere have values which cause emitter voltage to be half supply voltage.

We can use this state of affairs to make up a transistor gain bridge, as illustrated in simplified form in Fig. 2(a). The transistor shown here is the device whose current gain we wish to find, and RB is now a variable resistor. The two resistors to the right, RX and RY, have equal values, with the result that the voltage at their junction is equal to half the supply voltage. The meter is a centre-zero type and the similarity with a standard Wheatstone bridge can be seen straightway.

We next adjust RB until the meter reads zero, which means that the transistor emitter is at half the supply voltage. The gain of the transistor, in terms of h_{FE} + 1, is then equal to the value given by RB divided by the value of RE. In a working version of the circuit we would know the value of RE and we would have previously fitted RB with a pointer knob and scale calibrated directly in terms of transistor gain.

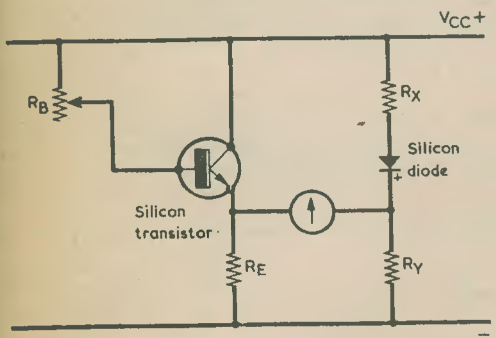
We have to consider a few further points before we can bring the basic circuit of Fig. 2(a) up to a fully practical state. First of all, the transistor gain figure provided by the bridge is h_{FE} + 1. But unless the gain figure is very low we would introduce little error if we quite simply forgot the '+ 1' term and said that we are obtaining a measure of h_{FE}. We have also assumed that there is zero voltage drop across the base-emitter junction of the transistor being checked. If this is a germanium type the actual voltage drop in the base-emitter junction will be about 0.15 volt, and this will introduce a small error in the readings given by the bridge. Provided that the supply voltage is reasonably high, say 9 volts, this error should not be large enough to be significant.

If, on the other hand, the transistor being measured is a silicon type then there will be a voltage drop of approximately 0.6 volt across the base-emitter junction. This higher voltage can cause an error in bridge readings which is large enough to merit action, and it is necessary to modify the bridge by inserting a silicon diode between RX and RY, as shown in Fig. 2(b). This diode similarly drops 0.6 volt, with the result that the voltages across RX and RY are both equal to half supply voltage minus 0.3 volt. When RB is adjusted for zero



RX = RY

(a)



(b)

Fig. 2. (a) The basic transistor gain bridge. (b) A silicon diode is added when balancing the bridge with silicon transistors.

reading in the meter the voltages across RB and RE are also equal to half supply voltage minus 0.3 volt. In consequence, the voltages across RB and RE are equal and the transistor gain is given accurately by RB divided by RE.

COMPLETE CIRCUIT

A complete working circuit for a practical transistor gain bridge is shown in Fig. 3. In the previous diagrams the transistor under test was an n.p.n. type but we will also want to check p.n.p. types as well. Switch S3 selects the supply polarity required. There is no need to fit a polarity reversing switch to the meter, M1, because this is a centre-zero type and it does not matter which way its needle travels on either side of zero.

RX and RY of Figs. 2(a) and (b) now appear as the equal value resistors R7 and R8. The silicon diode of Fig. 2(b) is now replaced by D3 and D4. When, whilst checking p.n.p. transistors, the upper supply rail is negative, D3 conducts and drops the requisite 0.6 volt. When, with n.p.n. transistors, the upper rail is positive, it is D4 which conducts and drops the necessary 0.6 volt. D3 and D4 are short-circuited by switch S2 when measuring germanium transistors, whereupon the circuit behaves in the same manner as that of Fig. 2(a).

There are two back-to-back diodes, D1 and D2, across the meter and R6 as well, and their purpose is to prevent excessive current flow in the meter when the bridge is off balance. The internal resistance of the meter and the value of R6 should add up to approximately 6kΩ, so that 0.6 volt is dropped across the pair at a current of 100μA. Thus, if the internal resistance of the meter is 1kΩ, R6 could be 5.1kΩ. R6 may be a 5% component. It might be thought that germanium diodes instead of silicon diodes could be used for D1 and D2, since these would enable the value of R6 to be reduced and thereby allow the bridge to have higher resolution. However, the resolution given with the

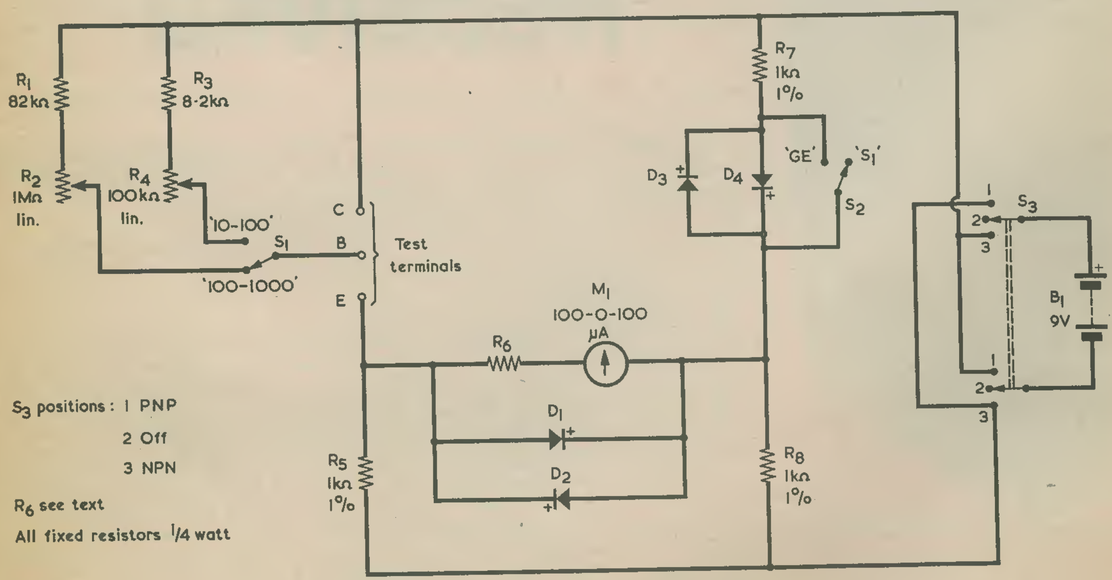


Fig. 3. Complete working circuit for the gain bridge. S1 selects the desired range, S2 sets up the circuit for germanium or silicon transistors and S3 prov,des the required supply polarity.

circuit as it stands is quite adequate, and the silicon diodes have the advantage of low slope resistance and abrupt turn-on.

The four silicon diodes can be any small silicon rectifier such as the 1N4002.

Resistor RE of the preceding diagrams now appears as R5, and it is a close tolerance component with a value of 1kΩ. This value means that an emitter current of the order of 4 to 4.5mA flows when the bridge is balanced, and this should be high enough to ensure that no errors result due to leakage current in the transistor being checked.

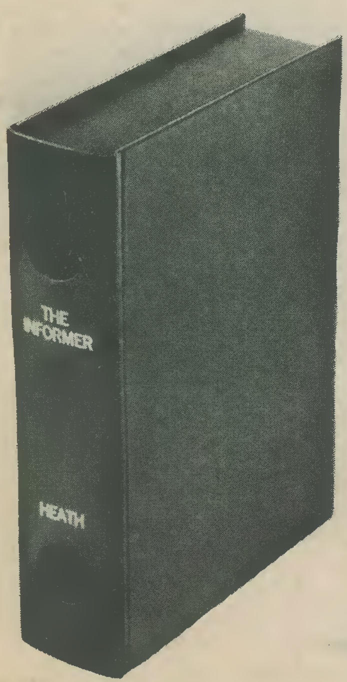
The base resistance is given by R1 and R2 in series, or by R3 and R4 in series, according to the position of S1. The first of these pairs of resistors allows gain measurements from 100 to 1,000, and the second allows gain measurements from 10 to 100. The two potentiometers are fitted with scales which are calibrated with the aid of an ohmmeter. The ohmmeter is connected across R1 and R2 for calibrating the 100 to 1,000 range, and across R3 and R4 for calibrating the 10 to 100 range. The gain figure is the same as the number of kilohms in the resistors. When R2 is adjusted so that R1 plus R2 gives 100kΩ, the corresponding h_{FE} figure is 100, and so on.

The test terminals for the transistor whose gain is being determined may consist of three terminals fitted with miniature insulated crocodile clips.

In use, the transistor to be checked is connected to the test terminals, S2 is set to 'Ge' or 'Si' as applicable, and S3 set to give the required polarity. The bridge is then balanced by R2 or R4, according to which of these allows a zero reading to be given in the meter, after which the h_{FE} of the transistor is read from the appropriate potentiometer scale.

The maximum base current which can flow in the test transistor is limited by R1 and R3. If the transistor is turned hard on during a measurement, the maximum emitter current that flows is limited by R5 with R8 (coupled to it by D1 or D2 according to circuit polarity) effectively in parallel. This maximum current is approximately 18mA. If it is felt undesirable to allow even this low current to flow through the transistor, initially set R2 and R4 to the highest gain figures and S1 to the '100 to 1,000' range. Then switch on and take R2 down from 1,000 to 100 until the zero reading is observed. If no zero reading is given, switch S1 to '10 to 100' and repeat with R4. This procedure means that base current increases from an initial low value up to the level at which the bridge balances. ■

CATALOGUE RECEIVED



A new addition to the Heathkit range, the 'Informer' ultrasonic Intrusion Alarm is designed to have the appearance of a book.

Currently available is the latest Heathkit catalogue from Heath (Gloucester) Ltd., Bristol Road, Gloucester, GL2 6EE. This company also has a showroom at 233 Tottenham Court Road, London, W.1.

The catalogue lists an exceptionally wide choice of electronic kits. To be found amongst these are high fidelity receivers, tuners, amplifiers and speakers, amateur receivers, transceivers and transmitters, and a solid state monochrome television receiver. Further items are electronic calculators, a metal detector and an electronic digital clock. The section devoted to test equipment gives details of signal generators, oscilloscopes, multimeters and digital frequency counters. Amongst the more unusual items are an ultrasonic cleaner, an electronic thermometer and a complete weather station.

The catalogue also includes a particularly interesting addition to the Heathkit range, this being the 'Informer' Intrusion Alarm type GD-39. As can be seen from the accompanying photograph, this unit is designed to give the appearance of an unobtrusive book, and it may be left on a table or bookshelf in any premises it is desired to protect. Behind the two decorative circles on the spine are an ultrasonic transmitter and receiver. When the device is switched on, the room in which it is placed is filled with a frequency of 41kHz, this being reflected by walls and furniture, etc., back to the receiver. Any movement within the surveillance field is at once detected by the receiver, which triggers an alarm after 30 seconds.

The catalogue is available free from Heath (Gloucester) Ltd., at their Gloucester address, as also is a Technical Consultation service both before and after purchases.

MAKING PRINTED CIRCUIT BOARDS

How to make up printed circuit boards for your own or for published designs

by Arthur C. Gee, G2UK

IT IS BECOMING COMMONPLACE NOWADAYS FOR DESIGNers of home-constructor radio and electronic equipment to produce their designs based on a printed circuit board layout. A typical example which comes to the writer's mind is of fairly recent origin, and it appeared in the December 1972 issue of this journal in the "Transistorised Oscilloscope" by R. A. Penfold. In Part 1 of that article, the circuit of the X Amplifier is shown in Fig. 8 and a full size reproduction of the prepared printed circuit board is shown in Fig. 9. These two figures are reproduced herewith as Figs. 1 and 2, so that readers can see just what we are talking about. The photograph shows a completed printed circuit board made to this design according to the procedure outlined in this article. Similar theoretical circuits and the corresponding printed circuit board layouts were given in Part 2 of the earlier article, these being for the timebase, the Y amplifier and the sync amplifier.

BOARD PREPARATION

Generally speaking, it is necessary for the constructor of such designs to make the printed circuit boards up himself. Occasionally, if they think the demand is going to be great enough, some commercial firms will make and market printed circuit boards for a published design, and they usually announce the fact by means of an advertisement or note in the journal concerned. Very occasionally you may find a firm who will undertake to make up "1-off" printed circuit boards on request. But this is likely to be pricey, and most constructors will prefer to make up the boards themselves. How then, do we go about it?

The printed circuit board, or "laminate", consists of a sheet of insulating material on one side of which is affixed a thin layer of copper foil. A piece of the board is cut to the shape and size required by the design and

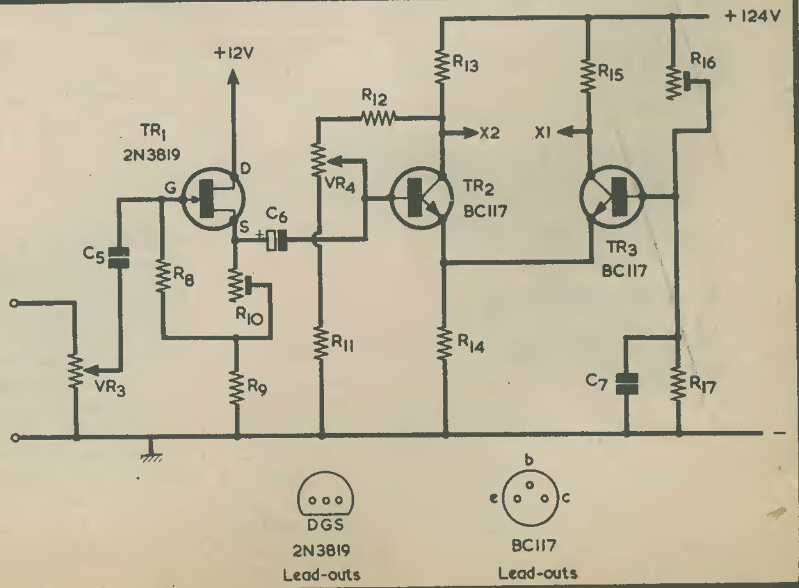


Fig. 1. A circuit which lends itself readily to printed circuit board assembly. This is the X amplifier of the "Transistorised Oscilloscope" article by R. A. Penfold, which appeared in the December 1972 and January 1973 issues of this journal

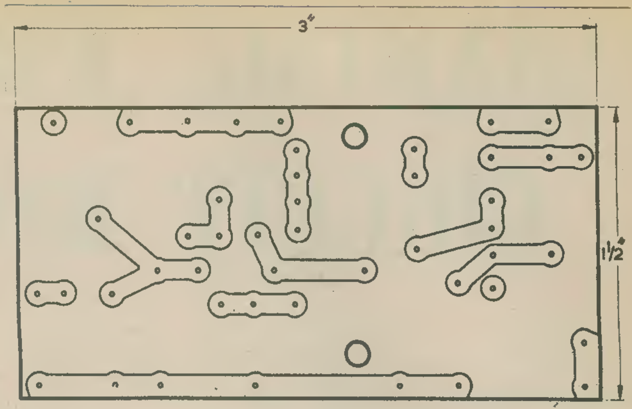


Fig. 2. The copper side of the board employed for making up the X amplifier. This is also reproduced from the earlier article. It is shown full-size and the copper pattern may be traced directly

the required copper pattern is drawn on it, using an ink or paint material which is impervious to the etching fluid. The copper which is not required is etched away by immersing the board in the etching fluid. As an example, Fig. 2 shows the copper pattern illustrated in Fig. 9 of the previous article. If it is simple enough, the pattern can be drawn on the copper free-hand, alternatively it can be traced using duplicating paper. Very complicated circuit designs can be reproduced on the copper by photographic means, but such a method is outside the scope of the present article.

Special etch-proof fluid is available for marking the copper foil, but more of this later.

The insulating material forming, so to speak, the "backing" of printed circuit boards can be one of a variety of materials. Cheap boards employ a brown phenolic material which is referred to in engineering circles as "s.r.b.p.", the letters standing for "synthetic resin bonded paper". Amongst home-constructors, this material is perhaps better known as "Paxolin". Better quality boards use glass fibre, and for special purposes, such as v.h.f. or u.h.f. projects, laminate of epoxy resin can be obtained at greater expense. These special laminates are often hard to cut and drill. Cutting the laminate to shape is best done with a fine toothed, metal saw. Don't try to use an ordinary hack saw as this is too coarse and will bind badly. You will also need one or two fine twist drills to make the holes in the board through which the printed circuit boards component leads pass.

Laminate for making up printed circuit boards can be bought in various sizes from most component suppliers. Generally speaking it is sold in stock sizes and from these you will have to cut out the shape and size you need for the project.

ETCH-PROOF MATERIALS

Now to return to the etch-proof materials we use for marking out the copper we do not want to be etched away.

Special "resist" paint or varnish, specifically made up for this purpose, can be purchased. This can be painted on with an artist's fine brush. There are also "marking pens", and the makers of one such item describe their product as a "slim nylon-tipped marker, charged with a free flowing etch resistant ink offering complete immunity to attack from ferric chloride and other usual etchant solutions". The particular one used by the writer, which works very well, is that made by Decon Laboratories Ltd., Ellen Street, Portslade, Brighton; and is called the Decon Dalo 33 P.C. Marker. Another useful resist material is automobile touch-in paint, the small brush included in the pack being fine enough for making quite neat printed circuit boards.

ETCHING SOLUTION

So to re-cap. We have obtained our piece of laminate, cut off the shape and size we want, traced on the copper foil the copper pattern we require and have painted over this pattern with the resist fluid. We now leave the resist fluid to dry until it is quite hard, and we must next give some thought to the etching fluid.

The function of the etching fluid is to dissolve away all the copper foil we don't need, so that we are left with the copper circuitry only. First of all, we need a small dish to take the printed circuit board for etching, just large enough to hold the board so that it can be just covered with the etching fluid. The ideal utensil for this purpose is a photographic plate developing dish – if you can still find one. Failing this, large glass Petri dishes as used in bacteriological laboratories or a deep saucer can be used. Receptacles of glass, china or plastic are suitable; but not metal or enamel ones as these will also be etched away! Again, various fluids are available for etching. Commercially produced etching fluids can be purchased but the most convenient one to use is a solution of ferric chloride, which one can make up

The copper side of a practical printed circuit board made up to the pattern in Fig. 2 oneself, from crystals, as required. It is easier, more convenient and safer to store away ferric chloride in crystalline or powdered form, than as bottles of etching fluid. Ferric chloride can be purchased from some radio component stores or from a pharmaceutical store, and a suitable etching fluid can be made up by dissolving 3oz. of the crystals in a quarter of a tumbler of tap water.

Make up the solution in an old jam jar which will not be required again, and throw the jar away after use. Add the ferric chloride slowly to the water, as a good deal of heat is produced as it dissolves. If, alternatively, you pour the water on the crystals they may "spit" and fly around, and this can be dangerous because ferric chloride is very corrosive. You certainly don't want it on the table top or around the sink; still more, you don't want it on your skin or, worse still, in your eyes. So be careful and treat both the crystals and the solution with respect! If you do get it where it should not be, wash it off instantly with copious quantities of warm water.

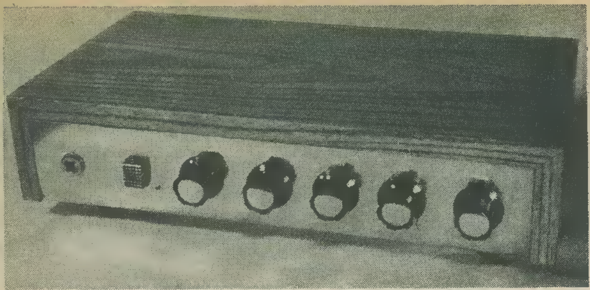
Having made up the solution, place the printed circuit board in the dish, copper side up, and cover with the ferric chloride solution. Again remember that the solution is corrosive, so keep your fingers out of it! Agitate the solution slowly by rocking the dish. The unwanted copper should be etched away in 20 minutes or so. When etching is complete, remove the board with a pair of tweezers, wash it thoroughly in tap water and leave it to dry.

SOLVENT

Next, remove the resist with a suitable solvent such as paint remover, nail varnish remover, acetone or, if a proprietary resist fluid has been used, whatever remover its manufacturer recommends. You'll then see the circuitry in the copper foil on the printed circuit board. Clean up with abrasive powder, such as is used for domestic purposes, and the printed circuit board is almost complete. Not quite, however, for we still have to drill the holes for the component leads. These will be indicated on the original design and usually present no problems.

Finally, give the board another good clean-up and, if necessary, straighten up the edges and corners of the copper foil sections with a scalpel or sharp fine-pointed knife. If desired, a coat of flux varnish can then be painted over the whole surface on the copper side to protect the copper, and to act as a soldering flux when the board is wired up.

It is possible to buy kits of the materials required for making printed circuit boards. The writer recently acquired one which contained a tube of resist paste, a small spatula for spreading it on to the copper foil, a bottle of resist remover, a bottle of etching fluid, a tube of polishing powder to clean up the copper after etching, two pieces of phenolic copper clad laminate for practising on, two sheets of tracing paper, and a stencil knife and a hole pricker to assist in transferring the tracing design onto the copper. These were all nicely packed in a plastic container, the lid of which could be used as the receptacle for the etching if you wished. Good, well illustrated, instructions were included. It was made in Japan and called the Hayato PK3 Printed Circuit Handicraft Kit. You may find one in your radio components store. It is a convenient way of getting all the bits and pieces you need for making printed circuit boards at one go, though it would probably be cheaper to shop around and buy the items separately. ■



Front view of the completed amplifier.

6 + STER AMPL

SOME OF THE POPULAR INEXPENSIVE RECORD DECKS fitted with a ceramic or crystal stereo cartridge are capable of a surprisingly high quality of reproduction. The amplifier described in this and next month's issue was primarily designed for use with such a unit. It feeds two 8Ω loudspeakers, whereupon a complete stereo record player system is made available.

It was also a design requirement that the amplifier should have an input suitable for use with a radio tuner. As it happens, the input for the pick-up is at a sensitivity and impedance – 200mV and 1.5MΩ – which are suitable for most tuners and therefore only one input socket is provided. The input impedance is really somewhat higher than is required for a radio tuner but, since it is on the high rather than the low side, this point is of no real consequence.

A maximum continuous power output of just slightly less than 6 watts r.m.s. per channel (both channels operating) is available into 8Ω loads. Speakers of 15Ω impedance can also be used, and the amplifier will give a lower distortion figure with these as it is working into lighter loads, but the maximum r.m.s. output will only be about 3 watts per channel. The peak power per channel into 8Ω loads is approximately 10 watts.

The amplifier is very compact, measuring 12 by 6 by 2½ ins., excluding the control knobs and feet. There are five rotary controls, these being for on-off switching, balance, volume, bass lift and cut, and treble lift and cut. An output for a pair of stereo headphones is provided on the front panel. Excluding the power supply section the circuit uses 21 semiconductor devices, including 2 f.e.t.'s and 16 silicon transistors.

PRE-AMPLIFIER

A circuit diagram of one channel of the amplifier is shown in Fig. 1. In order to obtain the correct frequency response from a crystal or ceramic cartridge it must be matched into an impedance of 1 to 2MΩ. The amplitude of the signal from a cartridge of this type is quite high, and can be several hundred mV peak-to-peak on loud passages. The requirements of the pre-amplifier are, therefore, high input impedance, the capability to handle large signals with low distortion and, of course, low noise.

Either a Darlington pair in the emitter follower mode

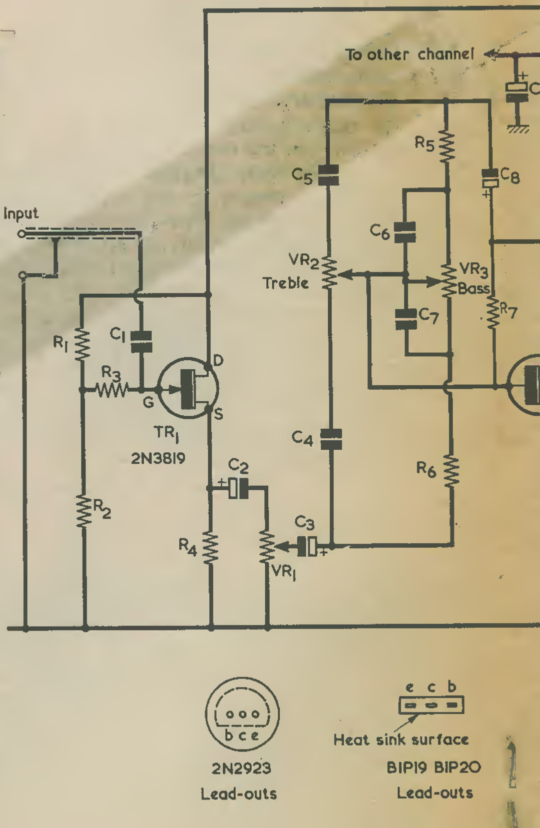


Fig. 1. Complete circuit dia… all com…

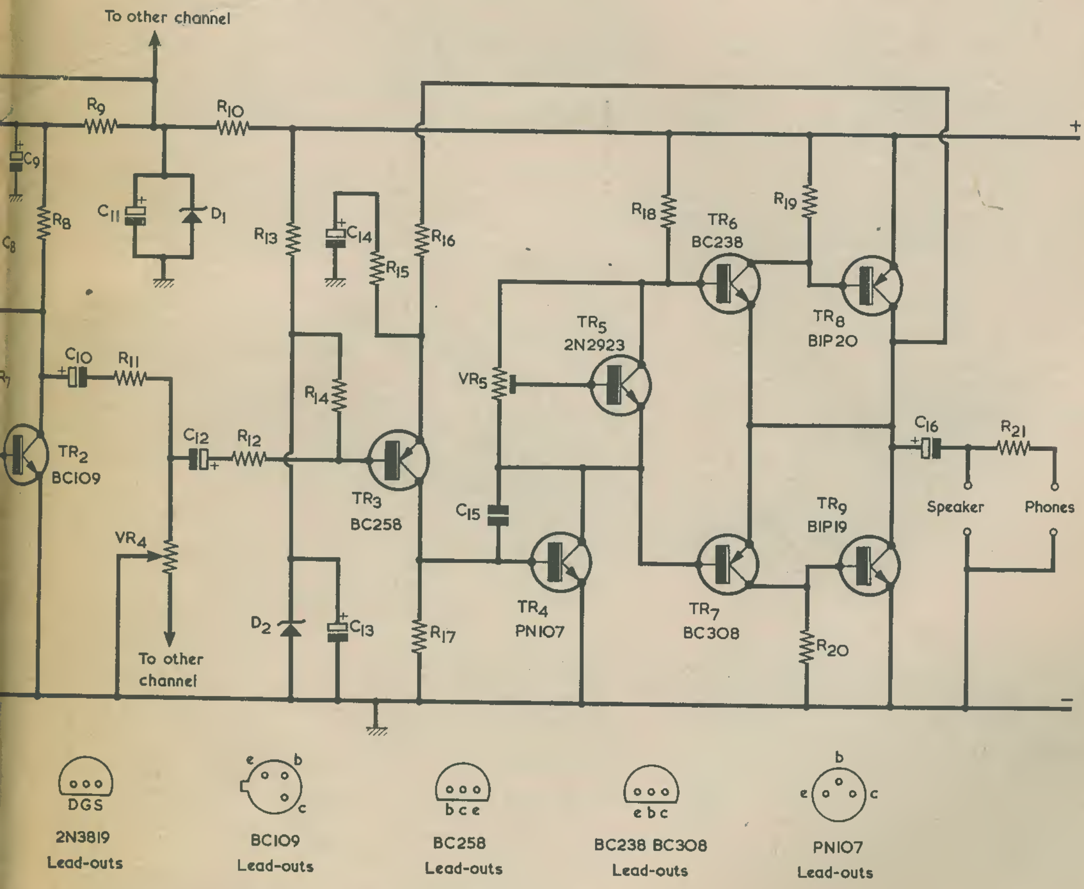
+ 6

REO

LIFIER

This is the first of a 2-part series describing the construction of a fully solid-state stereo amplifier having continuously variable treble and bass boost and cut controls. The concluding article, to appear next month, will describe the procedures of construction and setting up.

By A. P. Roberts



agram for one channel of the amplifier. Apart from R9, R10, VR4, C9, C11 and D1, mponents ate duplicated in the amplifier for the other channel.

6 + 6 STEREO AMPLIFIER

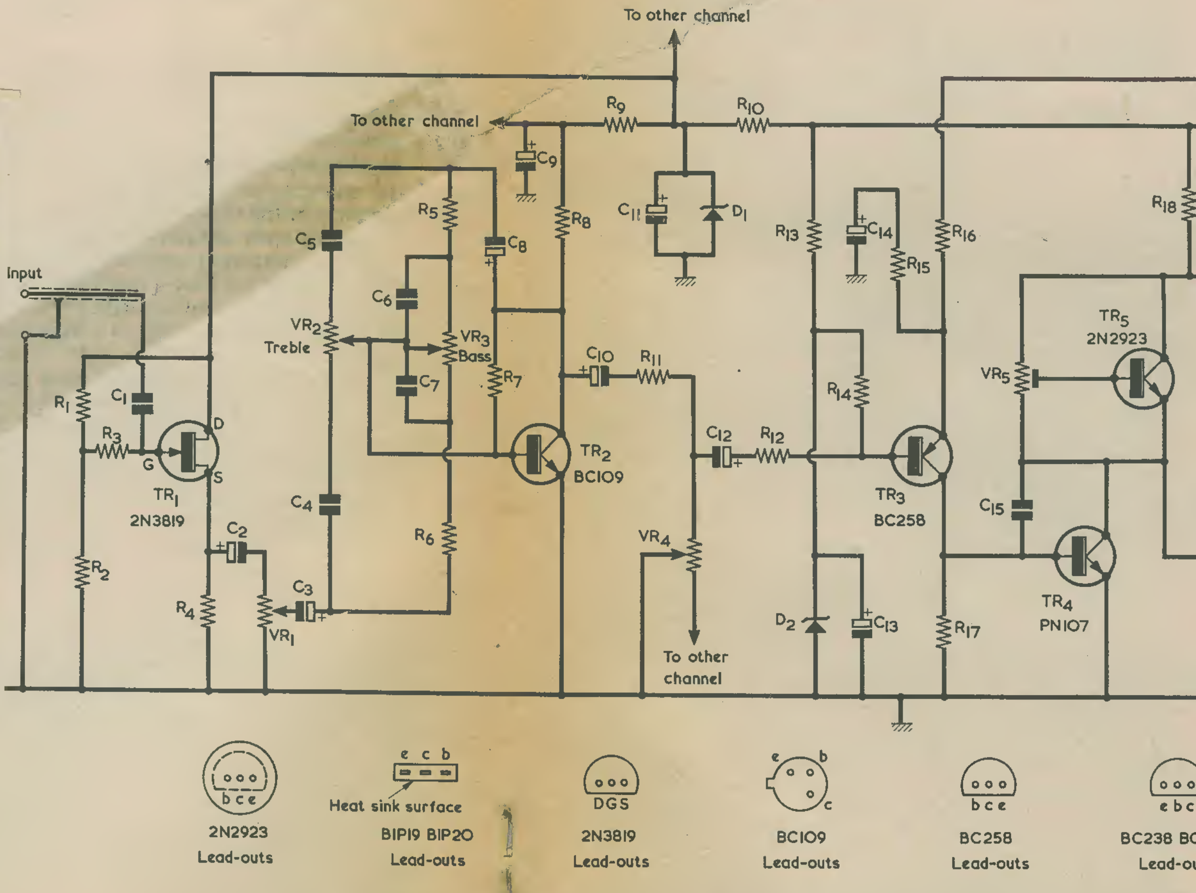


Fig. 1. Complete circuit diagram for one channel of the amplifier. Apart from R9, R10, VR4, C9, all components ate duplicated in the amplifier for the other channel.

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1, R101	270kΩ
R2, R102	150kΩ
R3, R103	1.5MΩ
R4, R104	10kΩ
R5, R105	10kΩ
R6, R106	10kΩ
R7, R107	2.7MΩ
R8, R108	10kΩ
R9	4.7kΩ
R10	1.5kΩ
R11, R111	4.7kΩ
R12, R112	2.2kΩ
R13, R113	33kΩ
R14, R114	100kΩ
R15, R115	22Ω
R16, R116	1kΩ
R17, R117	1.2kΩ
R18, R118	2.2kΩ
R19, R119	820Ω
R20, R120	820Ω
R21, R121	100Ω
VR1, VR101	5kΩ dual-gang potentiometer, log
VR2, VR102	50kΩ dual-gang potentiometer, linear
VR3, VR103	50kΩ dual-gang potentiometer, linear
VR4	50kΩ potentiometer, linear
VR5, VR105	5kΩ pre-set, sub-miniature skeleton, horizontal mounting

Capacitors

C1, C101	0.047μF, polyester, side wires
C2, C102	15μF electrolytic, 16 V.Wkg. (see text)
C3, C103	12.5μF electrolytic, 16 V.Wkg.
C4, C104	0.0068μF polyester
C5, C105	0.0068μF polyester
C6, C106	0.047μF polyester (see text)
C7, C107	0.047μF polyester (see text)
C8, C108	10μF electrolytic, 10 V.Wkg.
C9	220μF electrolytic, 16 V.Wkg.
C10, C110	10μF electrolytic, 10 V.Wkg.
C11	220μF electrolytic, 16 V.Wkg.
C12, C112	12.5μF electrolytic, 16 V.Wkg.
C13, C113	12.5μF electrolytic, 16 V.Wkg.
C14, C114	150μF electrolytic, 25 V.Wkg.
C15, C115	0.005μF ceramic
C16, C116	1,500μF electrolytic, 30 V.Wkg.
C17	5,000μF electrolytic, 30 V.Wkg. (2 x 2,500μF wire-ended in parallel, see text)
C18	3,000μF electrolytic, 30 V.Wkg. (2 x 1,500μF wire-ended in parallel, see text)

Inductors

T1	Mains transformer, secondary 9–0–9 volts at 1 amp, Osmabet type MT9V.
L1	Smoothing choke (see text)

Semiconductors
(TR8, TR9 and TR108, TR109 are matched pairs)

TR1, TR101	2N3819
TR2, TR102	BC109
TR3, TR103	BC258
TR4, TR104	PN107
TR5, TR105	2N2923
TR6, TR106	BC238
TR7, TR107	BC308
TR8, TR108	BIP20
TR9, TR109	BIP19
D1	13 volt zener diode type BZY88C13V
D2, D102	10 volt zener diode type BZY88C10V
D3–D6	Silicon bridge rectifier, 2 amp 100 p.i.v.

Switch

S1	D.P.S.T. toggle, rotary

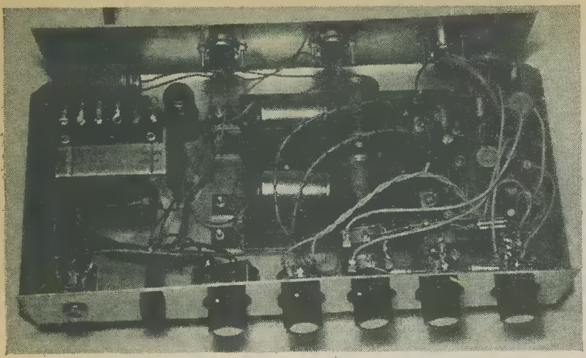
Neon

NE1	240 volt panel-mounting neon assembly with integral resistor

Miscellaneous
5 control knobs
Veroboard panels 0.1 in. matrix (see text)
2 loudspeaker sockets (3-way DIN)
1 input socket (3-way DIN)
1 stereo jack socket, ¼ in.
2 TO3 mica insulating washers (see text)
Ferrite rod, 1¾ by ¼ in. dia. (see text)
10 yards of 24 s.w.g. enamelled copper wire (see text)
18 s.w.g. aluminium sheet
4 rubber feet
½ in chipboard
Plastic veneer (see text)
Screened cable, grommets, etc.

or an f.e.t. in the source follower mode could be employed. An f.e.t. source follower has been chosen for the present design as this gives a lower noise level than would be the case if bipolar transistors were used.

The input circuit employs an offset gate biasing method, the appropriate components being R1, R2 and R3. C1 is the input coupling capacitor and R4 is the source load resistor. TR1 has a voltage gain of slightly less than unity, but the amplitude of the signal from the cartridge is sufficiently high to drive the following power amplifier without any intermediate voltage amplification. TR1 mainly functions as a buffer stage to give an adequate input impedance. The output from TR1 is fed to the volume control, VR1, via C2. The slider of the volume control then couples into the tone control circuit by way of C3.



The amplifier with its cover removed. The components are mounted on one large Veroboard panel for the power amplifiers, and on two smaller Veroboard panels for the pre-amplifier and tone control sections respectively.

TONE CONTROLS

An active tone control system is used, and this has separate bass and treble controls. The stage is built around TR2, which is a common emitter amplifier. Normally one would expect this to have a very high voltage gain, but such is not the case here as a high degree of negative feedback is introduced via the tone control networks.

VR2 is the treble control. This works independently of the bass control. With VR2 slider at the bottom of its track, treble signals are considerably boosted. This is because treble signals are at higher frequencies than the middle and bass signals, and will therefore find a much easier path through C4 to the base of TR2. When VR2 slider is at the top of its track, treble signals are attenuated. The treble signals still have to pass through C4 to reach the base of TR2, but they now have to pass through the whole track of VR1, at the top end of which there is negative feedback, from TR2 collector, of the treble signals via C5. Thus there is maximum treble boost when the slider of VR1 is at the bottom end of its track and maximum treble cut when VR1 slider is at the top of its track. Intermediate settings of VR1 slider give intermediate levels of boost or cut.

VR3 is the bass control. When its slider is at the bottom end of its track C7 is virtually short-circuited and there is negative feedback of the middle and treble frequencies by way of R5 and C6. This results in bass boost. When VR3 slider is at the top of its track, C6 becomes virtually short-circuited. Negative feedback is still provided via R5 but this is not frequency selective. The signal from C3 now has to pass through R6, VR3 track and C7 to reach the base of TR2. C7 will offer a lower impedance for the middle and treble frequencies than it will for the bass signals, and so the circuit then gives bass cut. As with VR2, intermediate settings of VR3 will give intermediate levels of boost and cut. In both cases, the extreme instances have been described as these best demonstrate how the controls work.

Capacitor C8 has no effect on the tone control circuits as its capacitance is much higher than the frequency selective capacitors C4 to C7. It is merely a d.c. blocking component which prevents the flow of direct current through the tone control network.

POWER AMPLIFIER

The power amplifier employs a basic circuit configuration which is now used in many hi-fi amplifiers. The output stage is Class B push-pull.

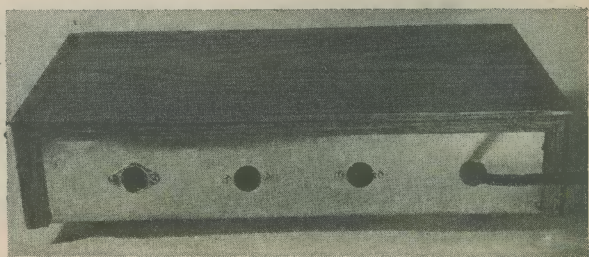
There are two pairs of common emitter amplifiers in the output stage, one pair being TR6 and TR8 and the other pair being TR7 and TR9. Since in each case the emitter of the first transistor is connected to the collector of the second transistor there is 100% negative feedback in both pairs of transistors. They therefore produce a voltage gain of almost exactly unity, but have an extremely high current gain. The output impedance of this arrangement is sufficiently low to enable an 8Ω speaker to be driven directly via C16.

The output stage is fed by a common emitter amplifier TR4, the collector load for which is R18. TR5 and VR5 are employed to set, and when set to stabilize, the small biasing current required by the output stage. This current reduces crossover distortion to an unnoticeable level.

TR5 helps to stabilize against thermal shifts in the output transistors in the following manner. As the output transistors warm up they tend to draw a higher quiescent current. The heating of the output transistors causes the air inside the amplifier case to warm up also. This affects TR5 and it conducts more heavily, thereby reducing the voltage between the bases of TR6 and TR7 and, in consequence, the output stage quiescent current.

The input transistor for the power amplifier, TR3, is in another common emitter stage. This is a p.n.p. transistor with its emitter taken, via the bias stabilizing resistor R16, to the collectors of the output transistors. This gives the overall power amplifier circuit 100% d.c. negative feedback. C14 provides an a.c. bypass but R15 limits its effect, allowing the power amplifier to have a relatively low a.f. gain. The considerable amount of a.c. feedback which is still present produces noise and distortion levels which are both very low.

An unstabilized supply is used, and the various amplifier circuits have their own built-in stabilization networks. R10, C11 and zener diode D1 form a circuit which provides a stabilized supply voltage for the pre-amplifiers and tone control networks. As already stated, the power amplifier has unity d.c. voltage gain. The base of TR3 is stablized by being returned via R14 to the zener diode D2, whereupon the collectors of TR8 and TR9 become d.c. stabilized in consequence. C13, across D2, removes any noise which might be introduced here and which could otherwise find its way into the amplifier.



The rear of the amplifier has a neat uncluttered appearance.

With circuits of this type, which use large amounts of negative feedback, in the interests of stability it is normal to roll off the upper frequency response, which otherwise extends well into the r.f. spectrum. This is the purpose of C15.

An output suitable for a pair of headphones is provided, R21 giving the necessary attenuation.

Fig. 1 shows the circuit for one amplifier channel. This is duplicated in the other channel except that the latter does not have D1, C11, R9, R10 and C9. Similarly the balance control, VR4, is shared between the two channels. VR1, VR2 and VR3 are each one section of a 2-gang potentiometer, the remaining section being incorporated in the same circuit position in the other channel. Component numbering in the other channel commences at 101, whereupon R101 occupies the same circuit position as R1, and so on. It is not very important whether the amplifier shown in Fig. 1 is in the left channel or the right channel. In the author's amplifier it is in the right-hand channel.

POWER SUPPLY

The circuit of the power supply is given in Fig. 2. The 9–0–9 volt secondary of transformer T1 gives 18 volts a.c. overall, and this is rectified by D3 to D6. The smoothing components are C17, L1 and C18. Both C17 and C18 consist of two equal-value capacitors in parallel. So far as C17 is concerned this aids construction, although a single 5,000µF component could be used if it has wire lead-outs at the ends and fits physically into the layout.

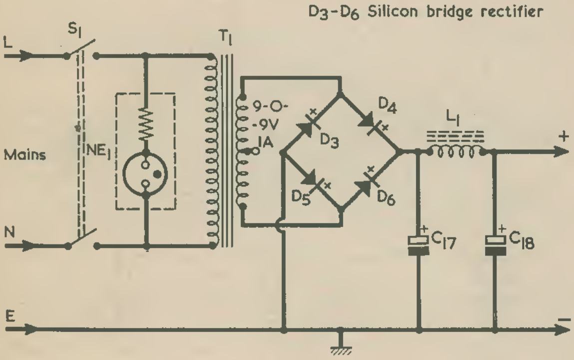
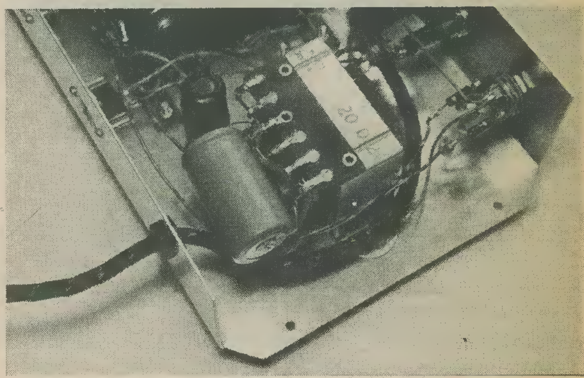


Fig. 2. The circuit of the power supply section.

The two capacitors which make up C18 are fitted separately on the amplifier board, one being close to the power amplifier on one channel and the other being close to the power amplifier on the other channel. In the type of amplifier employed here, where high currents are involved, instability can easily arise and it is advisable to have a large supply bypass capacitor mounted close to each amplifier. Thus, the two capacitors which form C18 carry out this function as well as providing smoothing.

A low value resistor was originally used in the position now occupied by L1. The ripple voltage was rather high, however, and a very marked improvement can be given by employing a choke here. A suitable commercially made choke seemed difficult to obtain, and a home-made component was employed instead. This was wound on a small piece of ferrite rod and, whilst it is admittedly not very efficient, it is simple and inexpensive and works quite well in practice with this particular amplifier. It is probable that the ferrite rod saturates at the higher supply currents but, since these correspond with heavier output levels, any consequent reduced efficiency in the choke does not make any practical difference.



A view of the power supply section. The ferrite rod choke, vertical to the chassis deck, can be seen alongside the mains transformer. Note the two resistors soldered to the output jack tags.

COMPONENTS

The components are all standard types. The mains transformer, T1, is an Osmabet component type MT9V, and is listed by Home Radio under Cat. No. 4/TM55. The transistors type BC258 and PN107 are available from Electrovalue Ltd., 28 St. Judes Road, Englefield Green, Egham, Surrey. The BC238 and BC308 may be obtained from Henry's Radio Ltd., and the 2N2923 from Bi-Pak. Bi-Pak can also provide the B1P19 and B1P20 as a matched pair.

In the prototype, C2 and C102 were tantalum capacitors. Tantalum types were employed because these two capacitors connect to adjacent holes on a 0.1 in. Veroboard panel and the small physical size of tantalum capacitors enables them to be wired in more easily. Miniature aluminium electrolytic capacitors may be employed instead, of course, although the wiring may then be a little more difficult to carry out. Similarly for reasons of small size, C6, C7, C106 and C107 were disc ceramic capacitors. It is in order to use such capacitors in these positions provided that their capacitances are known to be close to their nominal values. Usually, high value disc ceramic capacitors are intended for r.f. bypass functions and have a very wide tolerance on value.

The full Components List accompanies this article. Quite a number of the items listed here will be discussed in the concluding article, to be published next month, with the consequence that any outstanding queries on the components will be satisfied when the next issue appears.

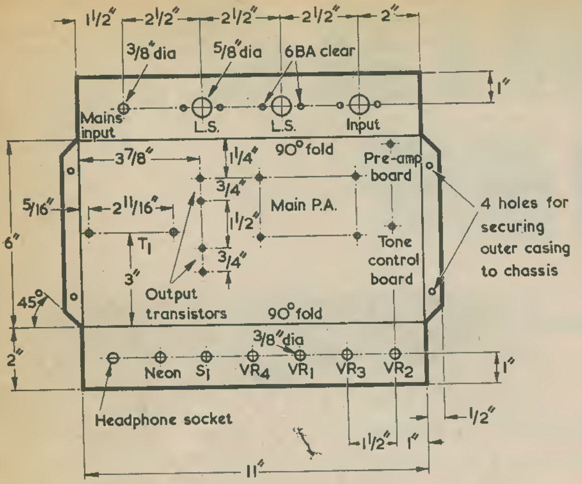


Fig. 3. Drilling details and dimensions of the chassis.

CHASSIS

The chassis is constructed from 18 s.w.g. aluminium sheet. A piece of this material measuring 12 by 10 ins. is cut to the shape shown in Fig. 3, after which the various holes for the controls and sockets, etc., are drilled. The mounting holes for the mains transformer are 4BA clear. There are four 6BA clear holes for the main amplifier board and one 6BA clear hole each for the pre-amplifier board and the tone control board. These boards take up the positions shown in the photograph of the amplifier interior, and the chassis holes are marked out through the mounting holes in the boards themselves. The boards will be described in next month's concluding article. Also required are four 6BA clear holes for the output transistors, and four holes for rubber feet. The latter may be drilled near the corners of the chassis deck.

After all the holes have been drilled, the front and rear panels are bent up, towards the reader. The two ½ in. segments at the sides are left flat.

(to be concluded)

R.F. 'NOSE'

By James Kerrick

A useful addition to the shack test-gear.

THIS SIMPLE DEVICE WILL TRACE THE PRESENCE OF R.F. oscillations when the conventional methods of an oscilloscope or short-circuiting oscillator coils, etc., do not work or are inappropriate. It operates by detecting the r.f. currents induced into a search coil by means of a diode and microammeter, and is capable of a very wide frequency range. It is mainly intended for checking amateur transmitters rather than the oscillator circuits of receivers.

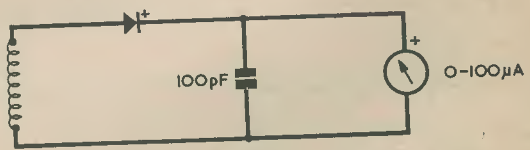


Fig. 2. The simple circuit employed in the 'nose'.

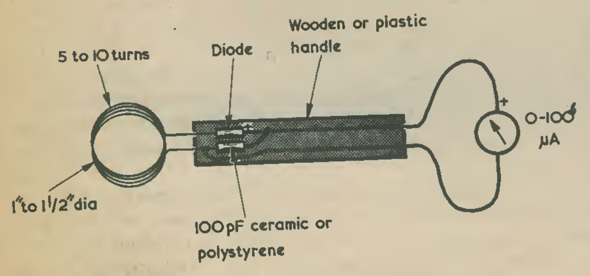


Fig. 1. Construction of the r.f. 'nose'.

Construction is simple, the coil being wound with single core wire and cemented, together with the other components, to the handle, which may be of wood or plastic as available. Alternatively, as in the author's case, the handle was a plastic tube with the two components inside; the top of the tube was melted over to hold the coil firm.

Leads then run to the microammeter, which shows a deflection in the presence of r.f. fields. Loading on the circuit under test may be minimised by keeping the search coil at the maximum distance away consistent with a reasonable meter deflection. A suitable diode is the OA90, although most germanium types would be satisfactory, with preference for those specifically designed for r.f. detection. ■

I.C.-TRIAC TIMER

By P. Manners

Coupling an integrated circuit timer directly to an a.c. mains triac.

A RECENT NEWCOMER TO THE INTEGRATED CIRCUIT scene is the '555' 8-pin dual-in-line timer. This has appeared as the NE555V, the LM555CN and, most recently, as the R.S. Components '555 Type' timer. The last version of the i.c. can be obtained from any retail supplier of R.S. Components products.

BASIC CIRCUIT

The '555' devices just mentioned all have identical pinning, and can be used in similar timing circuits. The devices may also be employed as continuously running multivibrators, but this aspect of '555' operation will not be considered in the present article.

There are several basic circuits in which a '555' i.c. may be employed as a timer, and a typical example of one of the simplest is shown in Fig. 1. In this diagram the timer is triggered by momentarily closing the push-button. The negative pulse thus applied to pin 2 causes an internal flip-flop to change states and to turn off an internal transistor which previously short-circuited the timing capacitor, CT. Capacitor CT now commences to charge via RT. Also, as soon as the flip-flop changes over, the output at pin 3 goes positive. When the voltage across CT reaches approximately two-thirds of the supply potential the internal circuitry in the i.c. turns the flip-flop back to its initial state, causing the output to go low again and once more turning on the internal short-circuiting transistor which discharges CT. The circuit is then ready for another timing run.

As is to be expected, the internal circuitry in the i.c. is more complex than this simple explanation of its operation would appear to indicate. In addition to several diodes and resistors, the i.c. incorporates about two dozen transistors.

The output at terminal 3 is capable of providing currents of up to 200mA, and the total dissipation rating for the i.c. is 600mW. The R.S. Components recommended range of supply voltage is 4.5 to 15 volts. Other manufacturers specify an absolute maximum of 18 volts. Operating temperature range is 0°C to +70°C.

The load in Fig. 1 is not specified, and this may be resistive or inductive. A resistive load could be given by a subsequent transistor or t.t.l. circuit. An inductive load would consist, typically, of a relay coil. When a coil is used as a load it is essential to add the diode which is shown connected into circuit via broken lines in Fig. 1. This diode prevents the formation of high reverse voltages when the supply to the relay coil is turned off, and such reverse voltages could damage the integrated circuit.

The inset in Fig. 1 shows the pinning for the device. This is a top view, with the pins pointing away from the reader. Pin 1 is 'ground', or negative supply input, whilst pin 8 is Vcc and takes the positive supply. Pin 2 is the trigger input and, as already mentioned, a negative pulse here changes over the state of the internal flip-flop. Pin 3 is the output, and is derived from two internal transistors in a totem-pole configuration. Pin 4 is a 'reset' input; if a negative pulse is applied to this terminal during a timing run the transistor which short-circuits the timing capacitor is turned on, the output falls to its low level and the timing run recommences at the end of the pulse. For simple timing

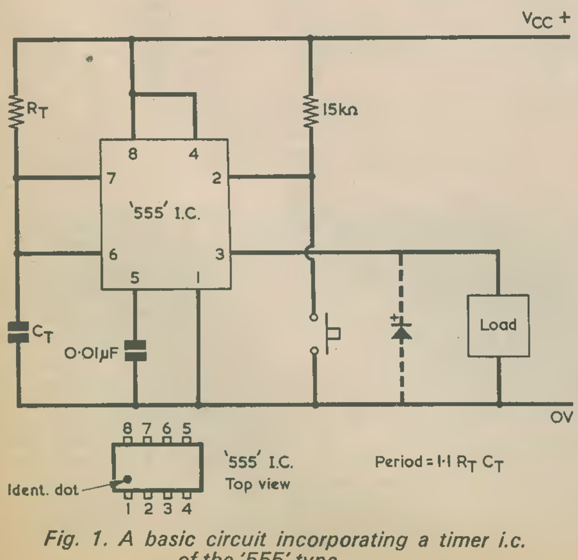


Fig. 1. A basic circuit incorporating a timer i.c. of the '555' type.

applications the reset facility is not required, and pin 4 is returned to the positive supply rail, as in Fig. 1. Pin 5 couples to the internal control reference voltage which determines the end of the timing period. In Fig. 1 this terminal is merely bypassed to the negative rail via a 0.01μF capacitor. Pin 6 is the 'threshold' input, and this causes the timing period to come to an end when the voltage applied to it from the timing capacitor is at the requisite level. Pin 7 couples to the internal transistor which, before and after the timing period, short-circuits the timing capacitor.

The length of a timing period is equal, in seconds, to 1.1 times the product of RT and CT in ohms and farads (or in megohms and microfarads). Timing periods can range from microseconds up to an hour or more. Since the threshold level at which the device causes the timing period to cease is a fraction of the supply voltage there is no need for a stabilized supply, although the supply potential should remain steady during a timing period.

Apart from its alternative use as a multivibrator, the timer i.c. can appear in more complex timing circuits than that shown in Fig. 1. The latter has, however, the advantage of considerable simplicity, since virtually the only external components are the timing resistor and capacitor, another resistor and capacitor, a push-button and the load.

OPERATION WITH A TRIAC

Home-constructor timer projects frequently incorporate relays, this being the case even when the controlled item is a mains-driven filament lamp. The use of relays tends to raise difficulties, particularly with respect to contact rating, and the author felt it would be of interest to check the operation of a '555' timer i.c. in conjunction with a triac. The triac chosen was the R.C.A. 40430, which has proved to be popular in recent home-constructor designs.

The full circuit of the timer incorporating the '555' i.c. and the 40430 appears in Fig. 2. In this diagram the i.c. couples directly to the gate of the triac, and there are no intermediate active devices.

The circuitry coupling to pins 1, 2, 3, 4, 5 and 8 of the i.c. is the same as in Fig. 1 and requires no further explanation. Pins 6 and 7 are the same also, and these

COMPONENTS

Resistors
(All fixed values ½ watt 5%)

R1	15kΩ
R2	15kΩ
R3	100Ω
R4	1kΩ
R5	560Ω
R6	100Ω
VR1	500kΩ potentiometer, linear

Capacitors

C1	32μF electrolytic, 10 V. Wkg.
C2	0.01μF plastic foil
C	1,000μF electrolytic, 10 V. Wkg.

Transformer
T1 Heater transformer, secondary 6.3 volts at 0.5 amp or more

Integrated Circuit
NE555V, LM555CN, or '555 Type'

Triac
40430

Diodes
D1 – D4 1N4002
LED1 TIL209

Lamp
LP1 240 volts, 100 watts maximum

Switches

S1	Push-button, push to make
S2	S.P.S.T., toggle
S3	D.P.S.T., toggle

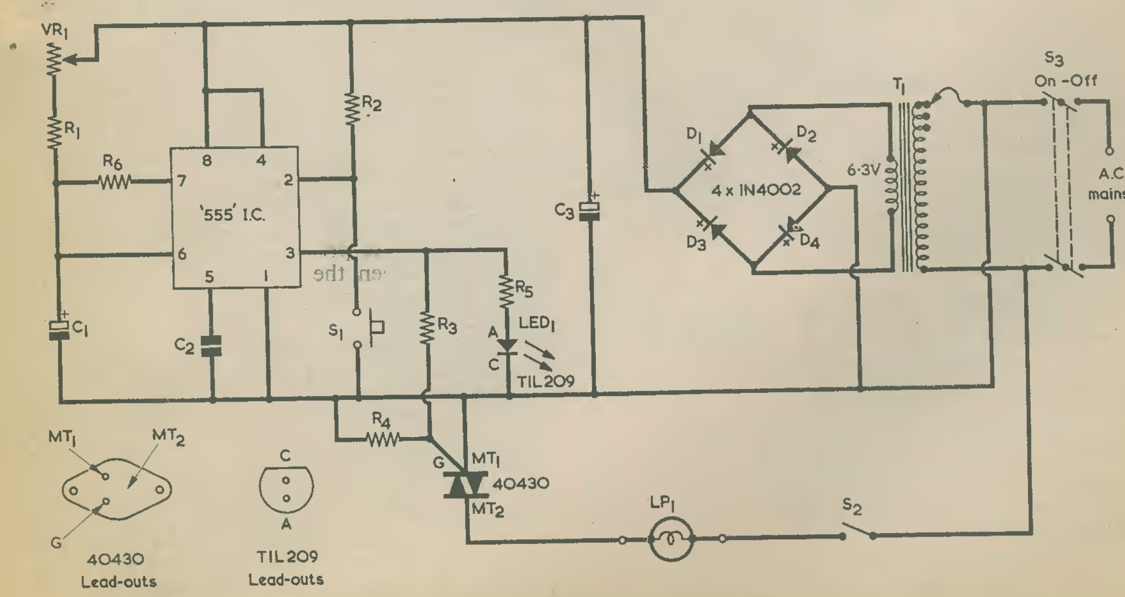


Fig. 2. A practical circuit incorporating the timer i.c. in conjunction with a triac.

couple to the timing resistor, given by R1 and VR1 in series, and to the timing capacitor, which now appears as the electrolytic component, C1. R6 is added here to limit the discharge current from C1. Capacitor C1 has a nominal value of 32μF, whilst R1 is 15kΩ and VR1 is 500kΩ. Assuming that all three components have their nominal values, the longest timing period, which is given when VR1 inserts full resistance, calculates out as 1.1 times the product of 0.515MΩ (500kΩ plus 15kΩ) and 32μF, or 18 seconds. The shortest timing period, given when VR1 inserts minimum resistance, is 1.1 times the product of 0.015MΩ and 32μF, and this works out as 0.5 second. A range of timing periods from 0.5 to 18 seconds is suitable for a photographic timer, or for any similar application. In practice, tolerances on value in the timing resistors and capacitor will cause the timing periods to differ from the calculated figures, but it is still nevertheless a relatively simple matter to calibrate VR1 in terms of the periods actually obtained. The value of 500kΩ for VR1 is around the highest realistic figure for a timing circuit in which the timing capacitor is an aluminium electrolytic type having the usual leakage current associated with such a component.

When S1 is pressed at the start of a timing run, the output at pin 3 of the i.c. goes positive, causing a current to flow, via R3, through the gate and Main Terminal 1 of the triac. The triac turns on and the a.c. mains is applied via its Main Terminal 1 and Main Terminal 2 to the lamp, LP1. The fact that the timer output has gone positive is also indicated by the lighting of LED1. When the timing run comes to an end, the output at pin 3 drops towards the level of the negative supply rail, whereupon the triac becomes open-circuit and LP1 extinguishes. So also does LED1.

Resistor R4, between the gate and Main Terminal 1 of the triac, is probably unnecessary, but it was nevertheless added as a safety precaution to protect the integrated circuit. The current and voltage levels controlled by the triac are well in excess of those associated with a small i.c. output circuit, whereupon R4 damps down any high impedance voltage spikes which might, just conceivably, appear at the gate.

The power supply is quite standard. T1 can be any small heater transformer offering 6.3 volts at a current of 0.5 amp or more, and its 6.3 volt secondary connects to the bridge rectifier consisting of D1 to D4 inclusive. C3 is the reservoir and smoothing capacitor. The rather high value of 1,000μF employed here ensures satisfactory supply voltage regulation.

Switch S3 controls the mains input supply to both the timer circuit and the controlled lamp. Switch S2 is also in series with the lamp and this switch is included, in company with LED1, to guard against an occasional effect which occurs at switch-on. It was found with the prototype circuit that the i.c. would cometimes commence a single timing run immediately after S3 was closed, despite the fact that S1 had not been pushed. The reason for this effect is not known and is presumably due to the circuit settling down to its operating condition with C1 and C2 in their proper charge conditions. Because of this, effect the following sequence is employed in bringing the timer into use. S3 is initially closed, with S2 open. If the circuit should then start a timing run, this fact will be indicated by the illumination of LED1. The timing run will have a length which depends upon the setting of VR1 and, when it has come to an end, LED1 will extinguish. S2 may then be closed, whereupon the circuit is ready for normal use.

There was no evidence of further untriggered timing runs in the prototype circuit after the occasional initial run immediately after switching on, and the circuit performed satisfactorily after these runs had taken place. If it is felt that the occasional untriggered run at switch-on would not cause any difficulties in use, the l.e.d. circuit, consisting of R5 and LED1, and S2 can both be omitted.

It should be noted that S1 need only be closed momentarily to start a timing period. If this push-button is held closed, the output at pin 3 will remain high even after the end of the period. The period commences when S1 is closed and it is only then required that S1 be opened again at any time before the end of the period. This point necessitates fairly quick operation of S1 when the period selected is of the order of 0.5 second, but the required quick pressure and release of the button is not at all difficult to accomplish. When LP1 is the bulb in a photographic enlarger, it may be desirable to have it turned on for a continual period for purposes of focusing. Pressing S1 and keeping it closed will provide the necessary continual illumination in LP1.

CONSTRUCTION

By far the most important thing to bear in mind, so far as construction is concerned, is that all points in the circuit of Fig. 2 are at, or near, mains potential. The parts should preferably be assembled in an insulated case. If a metal case is employed, this must be reliably earthed. Lamp LP1 will be external to the main unit and may be coupled to it by way of a suitable plug and socket. The push-button, S1, should have insulation suitable for mains voltages. The l.e.d. may be fitted so that it is central in a small grommet on the front panel of the unit. The l.e.d. type specified is available, incidentally, from Henry's Radio, Ltd.

In the prototype, the triac was mounted on a small heat sink about 1½ in. square. It ran quite cool on this sink. The circuit was checked with domestic 240 volt bulbs up to 100 watts in rating. Bulbs of higher power than 100 watts should not be used. It was found that the triac was fully turned on by the circuit; short-circuiting its Main Terminals 1 and 2 when it was conductive caused no noticeable increase in the voltage across the bulb.

VR1 is a standard panel-mounting carbon potentiometer. A 'moulded track' type of potentiometer would represent a good choice and would offer a high degree of repeatability. It needs to be fitted with a pointer and scale which can be calibrated later in terms of seconds.

As with all d.i.l. integrated circuits, the terminal pins of the timer i.c. are fragile. Connections to these pins should be made by way of *thin* wire. It is a good plan to wire to an i.c. holder rather than directly to the i.c. itself, since any damage due to the wiring process can then only result in the loss of the less costly holder.

The layout of components in the timer unit is not important, provided that C2 is positioned close to the i.c. and R4 is positioned close to the triac.

The measured supply voltage across C3 in the prototype was 7.4 volts before and after timing runs, and 7.0 volts during a timing run. The voltage at terminal 3 of the i.c. during the run was 5.4 volts, which infers that 1.6 volts is dropped inside the i.c. when the output is positive. Assuming, for convenience of calculation, a forward voltage drop of zero across the gate and Main

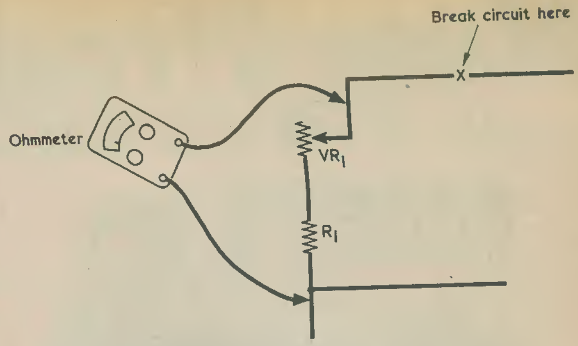


Fig. 3. A simple means, described in the text, of calibrating VR1 in terms of seconds.

Terminal 1 of the triac, the output current flowing through R3 is 54mA. The current in R5, assuming zero forward voltage drop in the l.e.d., is of the order of 10mA. Thus, the total output current is 64mA, which is well within the maximum of 200mA specified for the '555' device. The output current of 64mA, in combination with the 1.6 volts dropped inside the i.c. represents a dissipation inside the i.c. of 102mW. The i.c. circuits not directly associated with the output can be assumed to dissipate some 30mW, whereupon the total dissipation in the i.c. is well within the 600mW maximum rating.

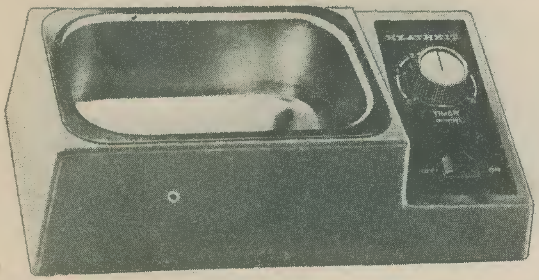
The prototype circuit gave a maximum time period of 23 seconds, which is to be expected since the actual capacitance of electrolytic capacitors is usually in excess of their nominal values. When the unit has been completed, it should be run for a number of periods to check operation and to allow C1 to 'form', after which VR1 may be calibrated. One method of carrying out the calibration consists of timing a number of runs with VR1 in various positions and then making up a scale from the results obtained.

A less tedious approach is possible if an accurate ohmmeter is to hand, and it relies on the fact that the length of the timing period is proportional to the resistance of VR1 plus R1. The timer is initially run with VR1 inserting maximum resistance and the length of the period is measured and noted. The timer is then disconnected from the mains and the circuit to VR1 slider broken, as in Fig. 3. The ohmmeter is connected between the slider of VR1 and the lower end of R1, whereupon it initially indicates the resistance given by VR1 plus R1 when VR1 inserts maximum resistance. Resistance values in VR1 plus R1 for round-number periods of time can then be calculated, and VR1 calibrated by simply setting it up for these resistance values.

To give an example of this technique, it was found in the prototype circuit that the longest timing period of 23 seconds corresponded to a measured resistance in VR1 plus R1 of 520kΩ. Since, in this instance, 520kΩ corresponds to 23 seconds then it follows that 520kΩ divided by 23 corresponds to 1 second. The result of this division is 22.6kΩ. VR1 is adjusted to give this resistance in VR1 plus R1 and its scale is calibrated for 1 second. The 5 second point is then at 113kΩ, the 10 second point at 226kΩ, the 20 second point at 452kΩ, and so on. After calibration in this manner the ohmmeter is removed. The circuit connection to VR1 slider is then re-made and the timer is ready for use. ■

New Products

HEATHKIT ULTRASONIC CLEANER



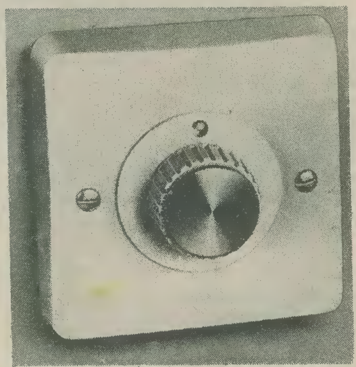
Art and decorating brushes, jewellery, watches, glasses, dentures etc. Simply fill the stainless steel tank with solvent, place the item to be cleaned into the tank, set timer and await results.

You'll be amazed how quickly and easily your possessions become clean. Agitating cleansing power feeds into the smallest crevice of the most intricate object. This ultrasonic cleaner works by a 41 kHz signal driving a transducer to produce mechanical motion that creates pressure variations in the cleaning solvent which result in microscopic bubbles being formed. These tiny bubbles are the secret behind the fantastic effectiveness of ultrasonic cleaning. The comprehensive kit building manual makes assembly a snip, even for the beginner. This is a must for home or laboratory.

For 110–130 V AC mains operation (250 V AC Transformer available as extra). Mail Order Basic Price Kit K/GD-1150 £27.50. Carr. 44p.

For a FREE catalogue and further information, write to HEATH (Gloucester) LTD., Bristol Road, Gloucester, GL2 6EE.

LIGHT SWITCH AND DIMMER



The SECUREYE flush or surface mounted switch performs three functions: 1. Manual on/off switch; 2. Dimmer; 3. Automatic on/off switch – operated by ambient light level.

Designed as an immediate replacement for an existing modern light switch, the SECUREYE embodies a light sensitive element which facilitates many security applications. As light falling upon the cell is reduced, power is allowed to flow through the switch progressively until approximately half brilliance is achieved. When ambient light level is increased the control automatically operates as a dimmer until power is cut off completely.

In addition the SECUREYE operates in the same way as a conventional dimmer switch to provide sophisticated lighting control manually.

Recommended Retail Price for the SECUREYE combined Auto-Switch and Dimmer is £5.60 plus VAT.

Manufactured in Britain by Rendar Instruments Limited, Victoria Road, Burgess Hill, Sussex.

I.C. AUDIO AMPLIFIER

New from R.S. Components Limited is a 5W silicon monolithic integrated circuit audio amplifier, incorporating both pre and power amplifier stages.

Priced at £2.22 the device is suitable for the amplification of speech or music when fitted with a type 173 heat sink, also available from R.S. at 14 pence. The output is protected against short-term load faults, and input sensitivity suits most popular crystal and ceramic pick-ups. Full information is included with each device and covers the construction of a mono or stereo amplifier circuit with tone controls.

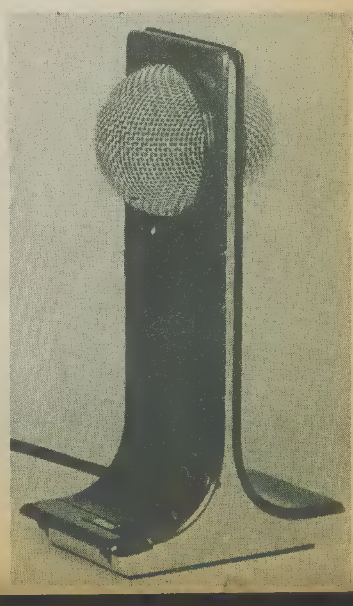
Further details are available from R.S. Components Limited, 13-17 Epworth Street, London E.C.2.

TWO-WAY RADIO BASE STATION MICROPHONE

Reslosound Limited, of Spring Gardens, London Road, Romford, Essex, RM7 9LJ today released a new base station, or paging, microphone, the Reslo Dispatcher which is available in both dynamic and capacitor electret versions.

A "press-to-talk" switch is incorporated in the base of the unit for operator use whilst sitting down, and if it is picked up by a standing operator an alternative press bar falls naturally under the operator's thumb.

The Reslo Dispatcher microphone is available in standard two-tone Post Office telephone colours, or to customer's requirements if ordered in substantial quantities.



SHORT WAVE NEWS
FOR DX LISTENERS

By Frank A. Baldwin

Times = GMT   *Frequencies* = kHz

The opening gambit in the April issue dealt with three clandestine transmitters "Voice of the Middle East Peoples", "Voice of Palestine, Voice of the Palestine Revolution" and "Radio Korush". For news of more clandestine stations we present –

"Voice of the Arabian Peninsular People", an anti-Saudi transmitter operating from 1200 to 1300 on **7193, 9562** and **11850** in Arabic. This one has also recently been reported on an additional frequency of **8360.** Also from 1800 to 1900 on **7193, 9560** and **9573.**

"Voice of the Free Yemeni South" radiates from 1130 to 1445 on **5345.**

"Voice of Peaceful Laos" is reported with daily programmes in Laotian from 2300 to 0200 and from 0500 to 1430 on **7385.** Also in Vietnamese from 1430 to 1500 on the same channel.

With all the clandestine stations brought to readers' attention in this and previous issues of this magazine, one could well spend a fruitful series of operating periods trying to log them. Needless to say, some of them, such as the "Voice of Peaceful Laos", would prove rather difficult. Although many attempts have been made by the writer to bring this one to book, the log sheet shows no such entry. However we persist and, who knows, one day success might be our reward. Perhaps Dxers should appoint themselves a patron saint!

CURRENT SCHEDULES

Current schedules are of assistance to short wave listeners in that they may plan to some extent their listening periods. This is especially useful when the QSL card of a particular station is required in that most of the information presented under this heading deals with broadcasts in English directed to Europe and/or the U.K. In this manner both the times and frequencies are known to the operator and the language, English, understood.

● INDIA

The External Service of "All India Radio" Delhi directs a programme in English to East Africa, West Europe and the U.K., in the General Overseas Service, from 1745 to 1945 on **7215, 9525, 9575** and on **15080** with a newscast from 1800 to 1810.

From 1945 to 2045 to North & West Africa, Australasia and the U.K. on **7215, 9525, 9755, 9912, 11620** and on **11880,** newscast from 2000 to 2010.

From 2045 to 2230 to West Europe, Australasia and the U.K. on **7215, 7260, 9525, 9912, 11620** and on **11740,** newscast from 2200 to 2010.

● LIBERIA

"E.L.W.A. Eternal Love Winning Africa", Monrovia, the radio voice of the Sudan Interior Mission, has an External Service in English and vernaculars as follows – from 0615 to 0700 (Saturdays to 0815, Sundays to 0800) to West and Central Africa on **11950.**

From 1345 to 1615 (Sundays only) to West and Central Africa on **11950.**

From 1615 to 1700 (Sundays only) to West and Central Africa on **11940.**

From 1800 to 2100 to West and Central Africa on **11940.** The vernaculars are Fulani, Hausa, Ibo, Igala, Kanuri, Nupe and Yoruba.

E.L.B.C. Liberian Broadcasting Corporation, Monrovia, operates a Home Service in English and Liberian from 0528 to 1000 and from 1200 to 2400 Monday to Friday, from 0528 to 2400 on Saturday and from 1558 to 2400 on Sunday as follows – **3255** (1915 to 2400), **6090** (0528 to 1000; 1200 to 1915; Sundays 0600 to 1915).

● ISRAEL

Still searching for clear channels, the Israel Broadcasting Authority currently (at the time of writing) has an English transmission for North America, Europe and Africa from 2000 to 2045 on **7335, 7395, 9009, 9495, 10250, 11700** and **15100.**

● PAKISTAN

Radio Pakistan has a broadcast of news in English, at slow speed, to the Middle East from 1530 to 1545 on **11672** and **15520.** To East Europe from 1745 to 1800 on **9690** and **11672.**

● BANGLADESH

Radio Bangladesh is currently operating an External Service in English from 0615 to 0645 on **15520** and **17690;** from 1230 to 1300 on **17690;** from 1815 to 1915 on **7260** and **9495** with slow speed news from 1900 to 1915.

● **PHILIPPINES**
The "Voice of the Philippines", Manila, has an External Service in English, Japanese, Standard Chinese, Tagalog, Vietnamese and Indonesian from 0700 to 1900 on **9580.**

● **ALGERIA**
The "Radio of the Democratic People's Republic of Algeria", Algiers, presents an External Service in English directed to East and West Africa and the Mediterranean area from 1900 to 1925 on **11910** with a newscast from 1900 to 1915.

The Home Service (Arabic Network) has an English lesson for schools (not Friday or Sunday) from 1015 to 1045 on **9610, 11715** and on **11965.** This programme is also radiated on the French Network at the same time on **11835, 17825** and on **21715.**

Broadcasts for the Palestine Liberation Organisation "Voice of Palestine, Voice of the Palestine Revolution", in Arabic, is radiated from 1830 to 1930 on **6145, 7195, 7245, 9610, 9665, 11715, 11810, 11965** and on **15160.**

AROUND THE DIAL

Some of the stations recently logged on the HF bands which may interest some readers have been –

● **ZAIRE**
Radio Lubumbashi at 2020 on **11865** with African drums, chants, colourful African music by a local orchestra and announcements in French. This one is well worth logging by those equipped with a tape recorder and interested in African music.

● **ROMANIA**
Radio Bucharest at 1500 on **11940** with a newscast in English and station identification at 1508.

● **CHINA**
Radio Peking at 1515 on **11650** with the news in English read by YL announcer, identification at 1523 then into Chinese music.

Radio Peking at 1520 on **7350** with OM in Standard Chinese to South East Asia and South East Africa, Chinese music at 1522.

● **VATICAN CITY**
Vatican Radio at 1500 on **7250** with station identification and news of the Catholic church in English.

● **PAKISTAN**
Radio Pakistan at 2107 radiating on a measured **7082.5** with OM in vernacular, identification by YL in English at 2110 then into local music.

● **SWITZERLAND**
Berne at 2115 on **11720** with a programme in English about Swiss retailing methods and trade in general.

QSX

For the Dxer, mostly interested in the frequencies below 6MHz, recent loggings of possible interest may be –

● **MALAYSIA**
Penang at 2323 on **4985** with short musical items rendered on a piano with OM giving a short talk on each example.

● **COSTA RICA**
TIHB Radio Capital, San Jose, at 0042 on **4832** with discussion group talking about Guatemala in Spanish.

● **PERU**
OAX7Q Radio Quillabamba at 0020 on **5025** with LA music, announcements by OM. Identification and newscast in Spanish, after a few bars of classical music as an introduction at 0030 then into light classical music European-style.

● **CHINA**
Radio Peking at 2253 on **4800,** YL in Chinese dialect; **4815** at 2300 with interval signal on chimes, identification by OM then orchestral rendering of "East is Red"; **4850** at 2304 YL in Chinese dialect; Wuhan at 2249 on **3940** OM in Chinese vernacular; PLA Fukien at 2148 on **4840** with YL talking and Kunming at 2340 on **4759.5** with OM in Chinese.

● **BRAZIL**
ZYS8 Radio Difusora do Amazonas, Manaus, at 0030 on **4806.5** (listed **4805**) with identification then harangue by OM in Portuguese till 0040 tune-off.

● **VENEZUELA**
YVMG Radio Popular, Maracaibo, at 2325 on **4810** Latin American music, OM with identification at 2330.

● **SOUTH AFRICA**
SABC Johannesburg at 2100 on **4875** identification and a newscast in Afrikaans after 6 pips. Also on **3250** at 2258 with announcements in English.

● **INDIA**
AIR Delhi at 2350 on **3905** with local music, songs by YL.

● **GHANA**
Ejura at 2306 on **4980** signing off with "This is the Voice of the Revolution, Good Night" and National Anthem.

● **NIGERIA**
Lagos at 2236 on **4990** with OM in talk in English about Nigerian sports and facilities provided for them.

● **ANGOLA**
Radio Texeira da Sousa at 2117 on **4886.5** with OM in Portuguese, an endless talk, or so it seemed!

The above logging is only tentative, conditions were not good enough to enable a positive identification but the writer hopes to establish this in the immediate future.

At the moment, there is some confusion in the Dx world about this transmitter, a few Dxers maintain that the Texeira identification can be heard up to 2300 whilst another Dxer holds that it closes at 2100, the station then heard on this channel being Teresina (Radio Pioneira de Teresina) on 4887. Yet another Dxer states that "Programa A Voz do Zaire" has been heard at 2230. Is it Texeira or Voz do Zaire up to 2100 or 2300 and then Teresina? (Acknowledgement "Bandspread" 65/5).

● **NEPAL**
Radio Nepal at 0016 on new 3425 sign-on with piano music, 6 chimes at 0020, announcements by YL then Indian-style music.

THE 'BIFLEXETTE' PORTABLE RECEIVER

By Sir Douglas Hall, K.C.M.G., M.A. (Oxon)

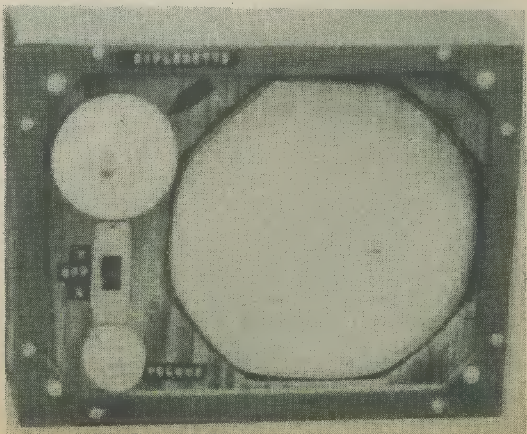
A 2-transistor reflex receiver which offers loudspeaker reception of local stations on the medium and long wave bands.

THE RECEIVER TO BE DESCRIBED EMPLOYS A NEW circuit which requires only two transistors, an N-channel f.e.t. and a p.n.p. transistor, and a few other components. For signal pick up it employs a 6in. ferrite rod aerial only, and it is easy to build and set up. Yet it offers no less than four amplifying stages plus a detector stage and will give good loudspeaker results from local stations. In most parts of the country it will provide loudspeaker reception of two or three Continental transmitters as well. At a more modest output level, suitable for bedside listening, it will pick up many more. It covers the whole of the medium and long wave bands.

Right from the start the author must emphasise the importance of using the specified components. This is especially necessary with a very simple receiver such as the present design, which is designed to give the maximum possible performance with the minimum of parts.

SEMICONDUCTORS

The constructor must ensure that the semiconductors are genuine first grade components. If different transistors are used the receiver may not work at all, or only inefficiently. Both the diodes are R.S. Components parts, and may be obtained from an R.S. Components retailer such as Elekon Enterprises, 224A, St. Paul's Road, Highbury Corner, London, N.1. It is particularly important that D1 be the correct type; a different silicon diode here would almost certainly require a modification to the value of C2 at least. The volume control is a moulded track R.S. Components type, also available from R.S. Components retailers, and this type of control is essential for the circuit as others are liable to become noisy. Above all, use a sensitive speaker. At the risk of boring readers the author will emphasise once again that it is audible output and not electrical output which reaches the ear. The difference between a good high flux speaker and a normal rather cheaper one is quite surprising. If a speaker having a 7,000 gauss magnet is compared with one having a 10,000 gauss magnet, using a switch to change them over when coupled to a low level signal, the difference will prove to be very marked. The author employed an Elac 3Ω 5in. speaker with a 10,000 gauss magnet in the prototype. This can be identified by the maker's name and the large 2¼in. diameter magnet. The Elac speaker is excellent in the present design, but may not be very easy to find. Constructors are advised to shop around for it or a similar high gauss unit. Many 8Ω high gauss speakers will match quite well with the LT700 transformer. The author obtained his own speaker from Radioparts, Market Way, Plymouth, and it is worthwhile contacting this firm, who should be able to supply the Elac speaker or a suitable equivalent. Also, high flux 5in. speakers are listed by Henry's Radio Ltd.,



Front view of the 'Biflexette' receiver in its case.

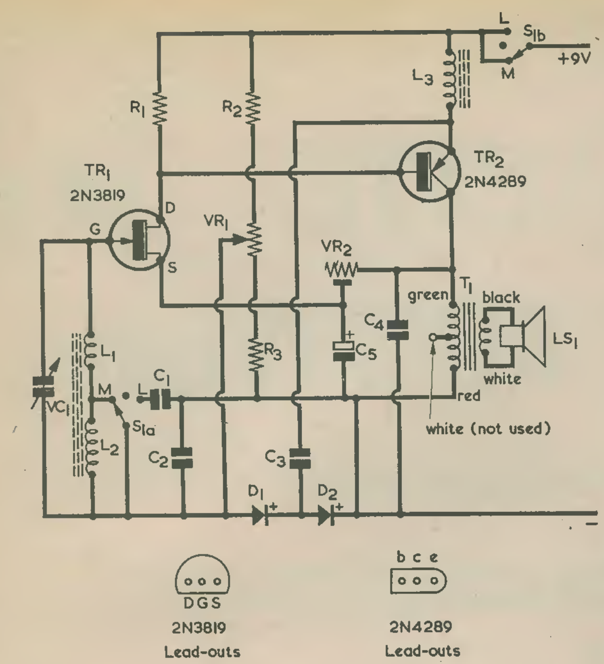


Fig. 1. The circuit of the 'Biflexette' receiver.

CIRCUIT

The theoretical circuit of the 'Biflexette' receiver is given in Fig. 1. When S1 (a) is in the position shown, signals are picked up by the medium wave winding, L1, on the 6in. ferrite rod, this being tuned by the 150pF air-spaced variable capacitor, VC1. The non-earthy junction of L1 and VC1 is applied to the gate of TR1, a field-effect transistor which functions as a grounded source radio frequency amplifier. The amplified r.f. signal appears across R1 and is applied to TR2 which, at radio frequencies, acts as a common collector current amplifier, or emitter follower. Its output appears across the r.f. choke L3 and is applied to the two diodes, D1 and D2. Note that D1 is a silicon diode and that D2 is a germanium type.

If there is a very low voltage only across D1 it will act as a very high resistance for current in both directions, and not as a diode. When the voltage across it approaches about 0.6 volt rectification will start, the impedance in the forward direction becoming less as the voltage increases. D1 and D2 then form a voltage doubler circuit. C2 has a value which allows an effective capacitive tap to be made into the tuned circuit such that oscillation can take place in the Colpitts mode, always provided that the voltage across D1 is sufficient to prevent it from offering too high an impedance in the feedback circuit. The level of regeneration is controlled by VR1, which first takes D1 into the conducting state as its slider moves upwards and then varies the current flowing in this diode. R3 is included because, if the lower end of VR1 track were connected direct to the negative supply point, the first 90 degrees of its travel would be wasted. With R3 in circuit the whole of the first half of the movement of VR1 slider is useful.

It can be seen that VR1 functions as a reaction control. When it is turned well back, i.e. with its slider at the negative end of its track, and when in consequence D1 offers a very high forward impedance, a potentiometer is formed in which D1 is the upper arm and R3 the lower arm. The potentiometer given by D1 and R3 acts as a volume control across D2 which, being a germanium device, will still give some rectification even with a very low voltage across it. To sum up, the process of taking VR1 slider up from the negative end of its track initially allows detection to occur in D2, with D1 and R3 providing a control of volume. As the slider moves further up the track D1 is brought more and more into use as a detector in its own right and eventually a point is reached where the overall efficiency of the diode circuit allows oscillation to take place.

It is possible for a very powerful signal to overload the receiver detector circuit, whereupon a distorted output will be given even then the volume control is turned well back. Should this occur, advantage is taken of the directional properties of the ferrite rod aerial and

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1	3.3kΩ
R2	2.2MΩ
R3	68kΩ
VR1	1MΩ potentiometer, log, moulded track (R.S. Components)
VR2	22kΩ or 25kΩ, pre-set potentiometer, miniature skeleton

Capacitors

C1	2,200pF silvered mica
C2	82pF silvered mica
C3	2,200pF silvered mica
C4	2,200pF silvered mica
C5	100μF electrolytic, 6.4 V.Wkg.
VC1	150pF variable, air-spaced, type C804 (Jackson Bros.)

Inductors

L1, L2	see text
L3	1.5mH r.f. choke, ferrite cored, type CH5 (Repanco or equivalent)
T1	Output transformer type LT700 (Eagle)

Semiconductors

TR1	2N3819
TR2	2N4289
D1	Silicon diode type 1SJ50 (R.S. Components)
D2	Germanium diode type 1GP5 (R.S. Components)

Switch

S1(a)(b)	D.P.D.T. slide switch with centre off position (see text)

Speaker

LS1	3Ω 5in. speaker, high flux (see text)

Battery
9 volt battery type PP6 (Ever Ready)

Miscellaneous
Battery connectors
2 knobs
18-way 'Miniature' group panel (R.S. Components – see text)
6 × ⅜in. ferrite rod (see text)
Fablon or Contact
Speaker fabric
¼in. plywood, Paxolin, etc.

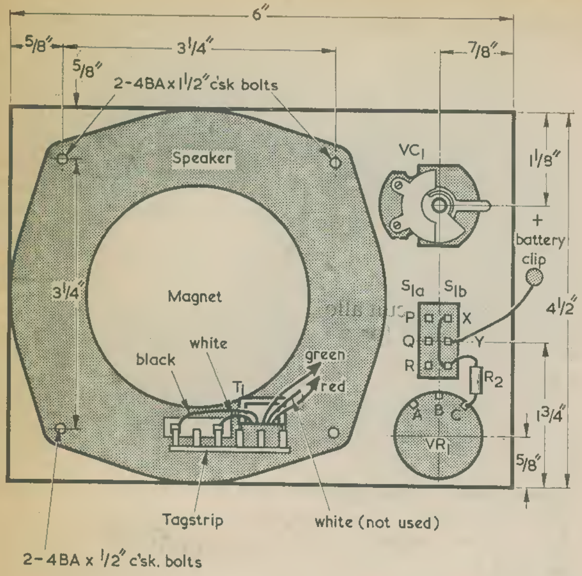


Fig. 2. Components and wiring on the front panel.

the receiver is turned so that signal pick up is reduced to a level where the overload distortion disappears.

The detected signal at the junction of D1 and VR1 slider is passed to the gate of TR1 via L1 (and via L2 when S1 (a) is set to long waves). TR1 next functions as a grounded source voltage amplifier at audio frequency with its drain coupling direct to the base of TR2. TR2 now acts as a high gain voltage amplifying output transistor. The presence of L3 in its emitter circuit causes negligible negative feedback of audio frequencies.

For TR2 to function correctly, about 0.65 volt needs to be dropped across R1. This means that TR1 must pass a current of about 200μA. The source bias of TR1 is adjusted by VR2 to produce this current. As there is heavy negative feedback at d.c. between the two transistors the setting of VR2 is not unduly critical and the circuit is very stable.

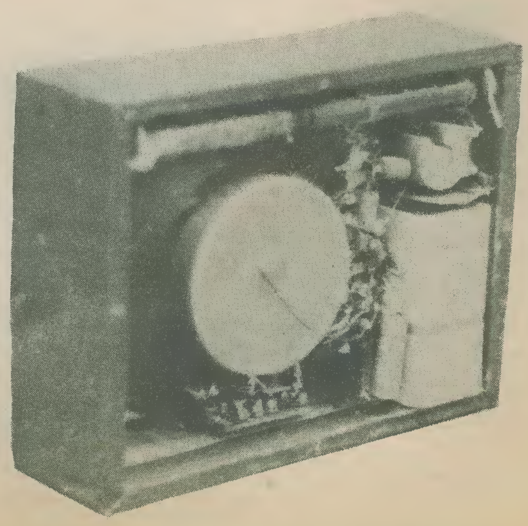
When S1 (a) is switched to long waves L2 comes into circuit. Also, capacitor C1 is switched across C2 to provide a suitable capacitive tap at the lower frequencies involved. In the prototype, a 2-pole slide switch was used for S1 (a) (b), this having a centre off position. If a switch of this type cannot be obtained, two separate small toggle switches mounted side by side can be employed instead. One switch can offer a single-pole double-throw action and it then replaces S1 (a). The other may give a single-pole single-throw action and replace S1 (b). The first switch is then the wavechange switch and the second the on-off switch.

CONSTRUCTION

Construction commences by cutting a piece of $\frac{1}{4}$in. plywood to measure 6 by $4\frac{1}{2}$in., as illustrated in Fig. 2. The positions for VC1, S1 (a) (b) and VR1 are shown in this diagram and the requisite mounting holes should be cut out. If a slide switch with a central off position has been obtained for S1 (a) (b), a rectangular cut-out is made to take its body, which passes through the plywood. The front plate of the switch is on the front of the plywood panel (the surface away from the reader in Fig. 2) and the switch is secured at the front with two small wood screws. If separate toggle switches are to be used, these may be mounted side by side with their centres $1\frac{3}{8}$in. from the bottom of the plywood panel. The position of the speaker is also shown in Fig. 2 and a suitable cut-out should be made for it before it is mounted, over a piece of gauze. The $3\frac{1}{4}$in. dimensions between speaker mounting holes apply to the Elac speaker used in the prototype. These dimensions may differ slightly with other speakers. The speaker is secured with 4BA countersunk bolts, these being $\frac{1}{2}$in. long at the two lower holes in Fig. 2 and $1\frac{1}{2}$in. long at the two upper holes. As will be seen shortly, the longer bolts will also hold a Paxolin panel, and the $1\frac{1}{2}$in. length is based on the construction of the Elac speaker. Longer bolts may be required if an alternative speaker with a different chassis shape is employed.

Two tagstrips are required in the receiver and these are cut from a single 18-way R.S. Components 'Miniature' tag panel. The tag panel can be obtained from R.S. Components retailers, or from Home Radio under Cat. No. BTS12. A 6-way tagstrip cut from the tag panel can be seen in Fig. 2, and it is used to mount the output transformer T1. The feet of the transformer clamp are bent in slightly and are then soldered to two of the tags on the tagstrip. Two of the remaining tags are soldered to the speaker tags as shown, as also are the black and white secondary leads of the transformer. Tag spacing on the tagstrip is correct for the Elac speaker. It might be necessary to use different tags, thereby necessitating a longer strip, with other speakers.

VC1, VR1 and S1 (a) (b), or the two separate switches which are employed instead, are all now mounted. The ends of the fixed vane lugs of VC1 may need to be clipped off or they may foul the back of the case when this is fitted on completion of the receiver. If, however, the constructor uses components different to those employed in the prototype it is possible that the case will have to be deeper in any event, and so the question of clipping the fixed vane lugs is left until later. During construction and testing, the connections to the fixed vane lugs may be made at their existing ends.



The receiver with the back of its cabinet removed.

Next to be cut out is a piece of Paxolin to the shape shown in Fig. 3. This has a large hole for the speaker magnet and two 4BA clear holes to pass over the longer 4BA bolts which secure the speaker. The dimensioning of the large hole and the two 4BA clear holes which is given in Fig. 3 applies to the Elac speaker. A 12-way tagstrip is cut out from the 18-way group panel and is secured to the Paxolin by two 10BA bolts passing through the holes in the end tags.

Next wind L1. The author employed blue grade ferrite rod for the aerial and this has a lower permeability than most of the ferrite rods currently available. The latter can be employed just as readily in the receiver but they will require somewhat fewer turns for coverage of the medium and long wave band. If the constructor has obtained blue grade rod (which is marked by a blue colour code at one end) the winding instructions which are given next will offer the correct frequency coverage. If another grade of rod is used the windings should be made up as described. After the receiver has been checked out it may then be found necessary to remove a few turns from the windings to obtain correct range. In most cases it will probably be necessary to take turns only from the medium wave coil, L1.

Take a piece of Fablon or Contact 2in. wide and 3in. long and remove a $\frac{1}{2}$in. strip of the backing paper along one of the 2in. edges. Wind the piece onto the ferrite rod with the exposed adhesive at the outer end, so that the piece is secured in place by being stuck on itself. The tube should be loose enough to slide on the rod. Then close-wind 100 turns of 28 s.w.g. enamelled wire in a single layer on the outside of the piece of Fablon or Contact.

L2 is wound on an exactly similar tube, and consists of 6 pies of 38 s.w.g. enamelled wire. Each pie has 70 turns scramble-wound and is about $\frac{3}{16}$in. wide. Separation between pies is approximately $\frac{1}{16}$in. The exact form of the overall winding is not critical as long as there are 6 separate pies. Slide the two coils onto the rod and fit rubber or p.v.c. grommets at the ends. The two inside wires of the coils are joined together, during wiring later, and they should be mutually aiding in terms of inductance when both are in circuit. The ferrite rod is held in place by means of nylon thread passed through 4 small holes in the Paxolin, at each end of the rod, the thread being knotted in the grommet grooves. Do not use bare wire to secure the ferrite rod as this will constitute shorted turns at the rod ends.

Thread a 4BA nut onto each of the longer 4BA bolts which secure the speaker, and pass the Paxolin piece over these bolts. Adjust the nuts so that the Paxolin settles as low down on the speaker as the construction of the latter permits. Then pass two more nuts over the bolt ends and tighten these up to hold the assembly secure.

Next fit small components to the 12-way tagstrip, and wire this up as illustrated in Fig. 3. In this diagram some of the components and wiring are shown spread out for reasons of clarity. In practice, all leads should be as short as is conveniently possible. This point does not apply to choke L3, however, and this component should have lead lengths which are sufficiently long to enable it to be oriented during setting-up of the receiver. It is necessary for the speaker magnet to be earthed to the negative supply point as, otherwise, it is possible for low frequency instability to occur due to unwanted coupling between T1 and the ferrite rod assembly. No attempt should be made to solder to the magnet. A suitable connection can be made by splaying out the cores at the end of a length of fine flexible wire and holding these down with Sellotape; and this serves quite satisfactorily in practice. If there is still evidence of low frequency distortion or instability when the set is tried out, the red and green leads from T1 primary may be transposed at the tagstrip, but it is unlikely that this will prove necessary.

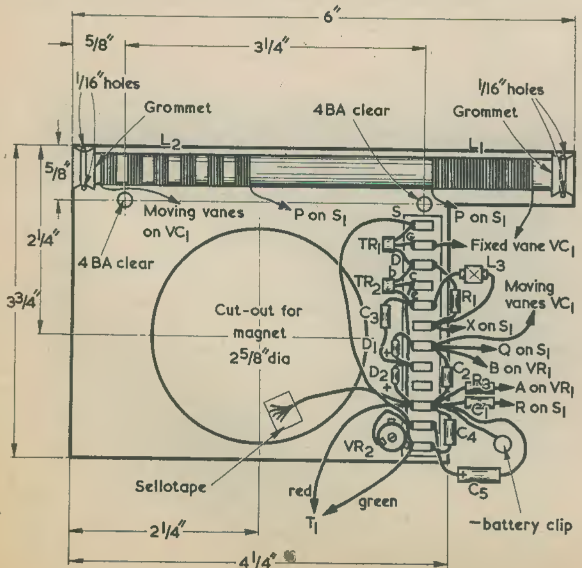
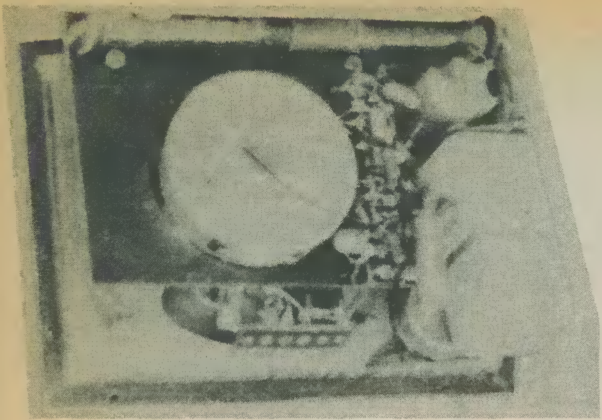


Fig. 3. The majority of components are fitted to a Paxolin panel, as shown here.

SETTING UP

When the wiring is complete and has been checked, put the PP6 battery in position behind the body of VR1. If the slide switch type employed by the author has been used, the battery should be well clear of the tags of this switch. If separate toggle switches have been fitted it may be necessary to provide a means of insulation to prevent the metal body of the battery from touching their tags. Ensure that VR2 is adjusted to insert full resistance into circuit. This is the fully clockwise setting in Fig. 3. Connect up the battery with a current reading meter in one lead. Set VR1 fully anti-clockwise, switch on and slowly reduce the resistance inserted by VR2 until a reading of 7mA is given. There should be a small reading initially which will increase as VR2 is adjusted; if there is not, something is wrong. Do not adjust VR2 to insert zero resistance in an attempt to obtain the correct reading. Such a setting will not be necessary if all is well, and it could cause damage to the transistors.

Select medium waves and adjust VC1 until a local station is heard. It should be possible to make the receiver oscillate throughout the full range of settings of VC1, oscillation being denoted by a whistle if a station is tuned in or by a hiss if no signal is present. Should this not happen, adjust the orientation of L3 with respect to the ferrite rod. This adjustment will assist oscillation for settings in VC1 between half and full capacitance. Find an angle for L3 which gives good oscillation throughout the full range of VC1, without oscillation commencing too early in the advancement



The internal construction of the prototype.

of VR1 at any setting of VC1. When all is well, oscillation should take place over the full range of VC1 with VR1 not too far from its central position.

Switch to long waves. Provided that L3 was correctly set for medium waves, oscillation will be satisfactorily available throughout the range of VC1, although it may be necessary to take VR1 a little further clockwise to obtain oscillation than was needed on medium waves.

If the ferrite aerial employed a ferrite rod other than the blue grade, it may now be necessary to remove a few turns from L1 to obtain the desired medium wave coverage. If necessary, turns may also be taken from L2, but it is doubtful whether this modification will be necessary in practice.

CABINET

A suitable case may be made up, with ¼in. plywood, as shown in Fig. 4. The dimensions given here are for

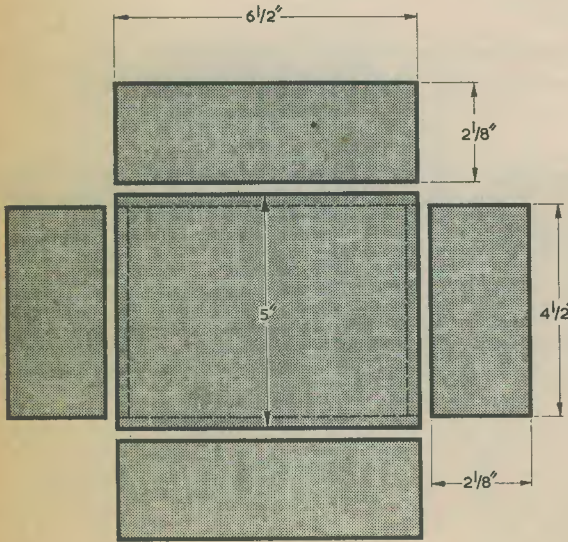


Fig. 4. Making a case for the receiver. The dimensions given are for guidance and may need slight alteration in practice.

guidance only and assume that the plywood panel illustrated in Fig. 2 is made exactly to size and that the plywood of the panel and the case is exactly ¼in. thick. The internal width and height of the case should be such as to fit comfortably over the plywood panel of Fig. 2. The 2⅛in. depth of the case corresponds to the instance where, as in the prototype, the Elac 5in. speaker and the slide switch S1 (a) (b) is employed. Other speakers, or other switches, may require the 2⅛in. dimension to be increased, whereupon it should be modified accordingly. If the depth of the cabinet is equal to that indicated in Fig. 4, or is only slightly greater, the outside ends of the fixed vane lugs of VC1 will need to be cut off, as mentioned earlier. The connections to these lugs should be unsoldered, the lugs cut short, and the connections re-made. When the case of Fig. 4 has been completed, it can be covered with Fablon or Contact.

Next, cut out a frame of Paxolin or Formica, as illustrated in Fig. 5, again checking exact dimensions.

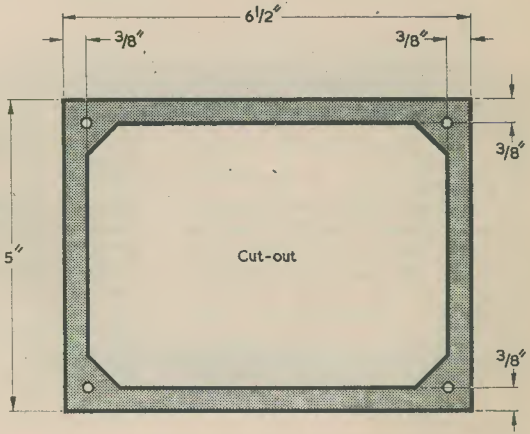
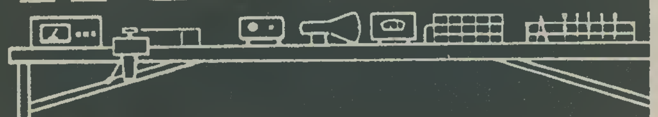


Fig. 5. A frame for the front of the receiver.

This frame covers the front edges of the case and the heads of the screws which secure the speaker, and its outside dimensions should be the same as those of the case. It is secured to the front of the plywood panel of Fig. 2 by small wood screws passing through the four holes shown. The receiver assembly, with the frame screwed to it, is then fitted into the case, being secured by wood screws passing through holes in the edge of the frame into the front edges of the case. The holes for these screws are not shown in Fig. 5.

Suitable knobs may be fitted to VR1 and VC1 and a tuning scale and labels for the controls added. The receiver is then complete. ■

In your workshop



This month we find Dick and Smithy engaged in a little recreational interlude. Also, Dick takes advantage of the situation to tap the Serviceman's brains on the basic aspects of a.m. diode detectors.

Seated at his bench, Smithy studied the sheet of paper in front of him. He scratched his head irresolutely, then steeled himself towards making a decision.

"D6," he called out.

On the other side of the workshop, Dick gazed down at another sheet of paper. He picked up a pencil and made a mark at the point indicated by Smithy.

"Nothing," he called out cheerfully.

"Are you sure?"

"Absolutely positive," replied Dick. "It's my go now and I'll have a bash at F6."

"Did you say F6?"

"I did."

"Then darn it all," snorted Smithy irritably. "You've scored your second hit on my battleship. Blow me, I've lost two subs, one destroyer *and* a cruiser, and now you've had two hits at my battleship. And you still say that I haven't hit *anything* of yours yet."

"That's right," replied Dick promptly. "You've been missing me all along up to now. Mind you, you've got very close at times."

"Well, I'll have another go," stated Smithy. "I'll try E7. There *must* be something there."

Dick examined his paper.

"Nope," he remarked happily. "You've missed again."

DETECTOR DIODES

Smithy threw his pencil down on his bench in disgust.

"I just," he remarked, "don't seem able to locate any of your ships."

Dick chuckled.

"You're as useful in detecting my ships," he grinned, "as a silicon diode would be at detecting a.m. signals!"

Smithy considered this remark judicially.

"I don't think that's a very good comparison."

"Why not?" replied Dick. "You're no good at detecting ships and a silicon diode is no good at detecting a.m. signals."

"You *could* use a silicon diode as an a.m. detector," commented Smithy, thoughtfully, "provided it had a sufficiently fast response and low self-capacitance."

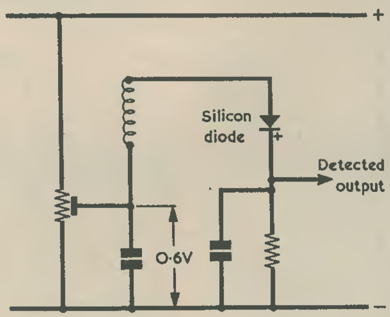


Fig. 1. Although not an attractive choice, it would be possible to use a silicon diode of sufficiently fast response and low self-capacitance as a detector by biasing it in the manner shown here. The r.f. signal appears across the coil, and both capacitors have a low reactance at radio frequency

"Oh, come off it, Smithy," said Dick scornfully. "For a start, a silicon diode doesn't start to conduct until there's a forward voltage of around 0.6 volt across it. It wouldn't even notice the small signals and it would distort all the big ones!"

"It could work as a detector if you biased it so that it was just on the point where it started to conduct," replied Smithy. "It certainly wouldn't be a very attractive circuit, but the idea should be quite feasible, nevertheless." (Fig. 1.)

"What would be the point of providing a bias supply?" objected Dick. "You can use a point-contact germanium diode as a straightforward detector without any bias at all."

"You haven't been looking at your transistor radio circuits very closely," commented Smithy. "In nearly all transistor a.m. superhets the germanium diode detector has forward bias applied to it."

"You must be joking, Smithy," protested Dick. "Why, all you have in a transistor a.m. detector circuit is the secondary of the last i.f. transformer coupling into the diode and diode load in series, plus the usual i.f. filter resistor and capacitors, of course. There's no bias there." (Fig. 2.)

"I'll agree," conceded Smithy in reply, "that circuits like that are used occasionally in transistor radios. But you won't find them very often, and the vast majority of sets have the a.m. diode forward biased. Don't forget that even a germanium diode doesn't pass forward current until the voltage across it is around 0.1 to 0.2 volt. Giving it a small level of bias brings it on to a more linear part of its characteristic."

"Where does the bias come from,

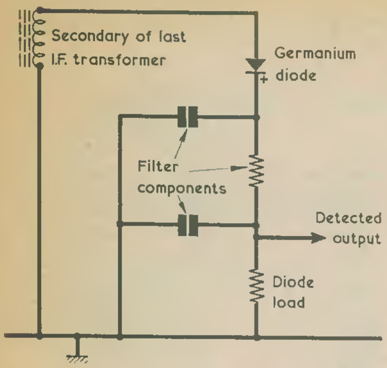


Fig. 2. A practicable diode detector circuit employing a germanium point-contact diode

then?"

"From the a.g.c. circuit," replied Smithy promptly. "The normal form of a.m. detector consists of the secondary of the last i.f. transformer feeding via the diode into the diode load, together with the i.f. filter components, just as you said. But also connected to the upper end of the diode load or the filter resistor is a resistor which takes an automatic gain control voltage back to one or more of the i.f. transistors. If the set uses p.n.p. i.f. transistors the diode will be connected so that the voltage at the non-earthy end of the diode load goes more positive as signal strength increases. This positive voltage is passed to the base or bases of the controlled transistor or transistors, and reduces the i.f. gain accordingly." (Fig. 3.)

"Well?"

"If the circuit is examined closely," went on Smithy, "it can be seen that, in the absence of signal, there is a small forward current flowing from the positive supply rail, through the secondary of the last i.f. transformer, through the diode and then through the a.g.c. circuit to the negative supply rail. This circuit automatically ensures that, in the absence of signal, the diode detector is always forward biased up to the point at which it starts to conduct. If the set has n.p.n. i.f. transistors then the detector diode is turned the other way round and an increasing negative voltage is coupled back to the i.f. transistor base, or bases, as signal strength increases. The diode is still forward biased in the absence of signal because the supply polarity is also reversed." (Fig. 4.)

REVERSE BIAS

Dick absorbed this information for some moments.

"Humph," he remarked musingly. "I can see what you're getting at now. At any rate, when a signal is present the diode should be well and truly forward biased."

"No, it won't," replied Smithy. "In the presence of signal the diode becomes reverse biased!"

"It becomes what?"

"It becomes reverse biased," confirmed Smithy. "Well now, I don't want to spend the rest of this lunch-break talking about diodes, so let's get back to our game of Battleships. Whose go is it?"

"Mine," said Dick absently. "F5."

"F5?" repeated Smithy furiously. "Stap me, you've hit my battleship *again*. And you don't even seem to be trying."

And, indeed, judging from Dick's expression, it was obvious that his thoughts were far removed from naval engagements.

"How the deuce," he pursued doggedly, "can a detector be reverse biased in the presence of signal?"

"Oh, to heck with the diode," said Smithy impatiently. "It's my turn now and I'll try B4."

Dick looked down carelessly and made a mark on his paper with a pencil.

"You've hit a sub," he remarked indifferently. "Now, what about this diode?"

"I've hit a sub?" repeated Smithy

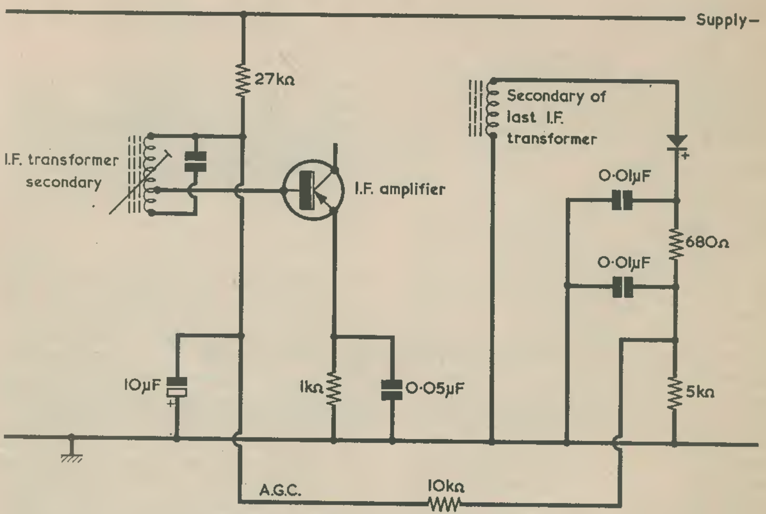


Fig. 3. A typical detector and a.g.c. circuit in a receiver having a negative supply rail and p.n.p. i.f. transistors. Frequently, the a.g.c. voltage is applied to two i.f. transistors instead of only one

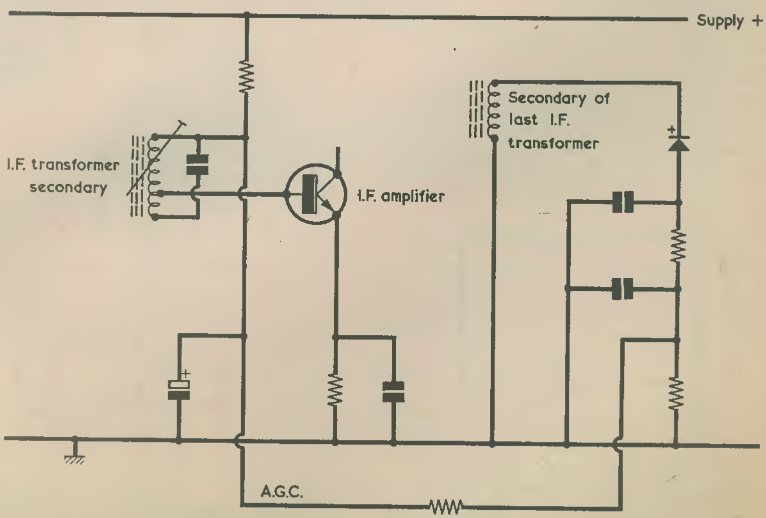


Fig. 4. If the receiver has n.p.n. i.f. transistors, the upper supply rail is positive and the diode detector polarity is reversed

Fig. 5. When an unmodulated i.f. signal is applied to a detector diode, such as that of Fig. 3, the voltage across the first bypass capacitor resembles that shown here in heavy line

jubilantly. "Hooray, blood at last! What's this about a diode?"

"Why," persevered Dick, "is the detector diode reverse biased in the presence of signal?"

"Because of the charge in the capacitor across the diode load and filter resistor," explained Smithy. "That is to say, the filter bypass capacitor which immediately follows the diode. This capacitor charges up like the reservoir capacitor in a half-wave power supply circuit, with the exception that it discharges further between half-cycle tips than a reservoir capacitor of normal value would. Assume for the moment that an unmodulated r.f. carrier is picked up by the receiver. This will be applied as a steady unmodulated i.f. signal to the diode, which will then conduct on half-cycle peaks. If the diode is connected up with the polarity needed for a set having p.n.p. i.f. transistors, it will conduct on the positive half-cycle tips, with the bypass capacitor discharging slightly into the resistance across it between the tips." (Fig. 5.)

"I can visualise that," said Dick, furrowing his brow. "What happens next?"

"Well," said Smithy, "the capacitor becomes charged such that the terminal which connects to the diode cathode is positive, with its other terminal negative. During the periods, between half-cycle tips, when the diode is not conducting, the diode is then reverse biased due to the voltage across the capacitor." (Fig. 6.)

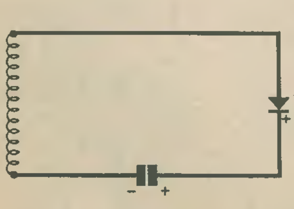


Fig. 6. The first bypass capacitor following an a.m. detector diode charges up with the polarity shown here, whereupon the diode is reverse biased between half-cycle tips

"Blow me," commented Dick. "It's obvious when you think about it. What happens when the signal is modulated, Smithy?"

"The reverse bias across the diode still corresponds to the voltage across the capacitor," explained Smithy, "but that voltage is now changing in sympathy with the modulation amplitude. The effect you get is that the capacitor discharges between half-cycle peaks and that the average voltage across it is proportional to the modulating voltage. In other words, the modulating a.f. voltage appears across the capacitor together with a certain level of intermediate frequency signal, which has to be filtered off before the modulation signal can be fed to the following a.f. amplifier."

"I suppose," remarked Dick, "that the bigger you make the first bypass capacitor the lower the intermediate frequency level across the diode load becomes."

"That's true enough," agreed Smithy. "Also, the larger the first bypass capacitor, the greater the amplitude of the detected a.f. signal. This is to be expected, of course, because of the similarity between the capacitor and the reservoir capacitor in a half-wave power supply. When the capacitor has a larger value it discharges less between half-cycle peaks and so the average modulation voltage across it is higher. At the same time, though, you can't make the capacitor too large or you introduce a.f. distortion."

"Do you?" queried Dick. "What sort of distortion would that be; treble cut or something like that?"

"Oh no," replied Smithy. "What happens is that there is distortion of the actual modulation waveform, and it is liable to occur when the modulation amplitude falls very quickly from a high level to a low level. If the bypass capacitor has too high a value it won't discharge down to successive half-cycle peak levels during the fall in modulation amplitude, and it will merely discharge into the load resistance until the voltage across it is sufficiently low for it to start charging on half-cycle tips again." (Fig. 7.)

"I see," said Dick brightly. "Instead of following the modulation waveform, the voltage across the capacitor follows an epicyclic curve."

"A *what* curve?"

"An epicyclic curve," repeated Dick innocently. "Isn't that what you get when a capacitor discharges into a resistor?"

"You raving binner," snorted Smithy. "What you mean is an *exponential* curve. The word 'epicyclic' applies to tuning drives, for heaven's sake."

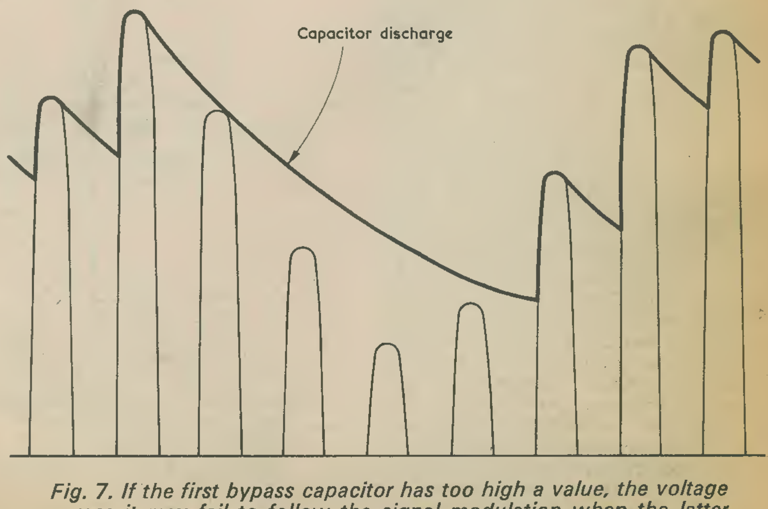


Fig. 7. If the first bypass capacitor has too high a value, the voltage across it may fail to follow the signal modulation when the latter changes quickly from a high to a low level

"Hey," said Dick defensively, "don't get so uptight about it. It's only a word."

"Oh, all right then," grumbled Smithy. "But you always put me right off my stroke when you come out with statements like that. And I don't like that other word you used either: 'uptight'. Nasty horrible modern word with all sorts of sinister connotations."

Wisely, Dick remained silent.

"Well now," grunted Smithy after some moments, "where were we? Oh yes, we'd just got to the point where we'd seen that too high a value of bypass capacitor can cause distortion when the modulation level drops very quickly from a high to a low level. This distortion can only happen when the modulation level falls and not when it rises. If the modulation level rises quickly, the successive half-cycles charge the first capacitor after the diode in the usual manner and the voltage across this capacitor then follows the level of the half-cycle peaks."

TIME CONSTANT

"Would that distortion occur during a quick transient sound?"

"It could," confirmed Smithy. "It could also happen on successive cycles of high frequency sound. If you think about it you'll realise that the distortion is dependent both on the frequency and the amplitude of the modulating signal. It could, for instance, occur with a low amplitude signal having an extremely high frequency, or with a high amplitude signal having a lower frequency. Fortunately, high frequency signals in speech and music normally appear at quite low amplitudes. Also, the higher frequencies are usually reduced in strength at the detector of an average a.m. superhet receiver because the i.f. amplifier cuts down the outer sidebands of the signal. Because of these two factors, the practical problem of preventing the type of distortion we are talking about is not very difficult. As a rule of thumb, it is pretty reasonable to say that we shouldn't have too much trouble if the time constant given by the first bypass capacitor and the diode load and filter resistance is less than the length of a half-cycle of the top audio frequency we expect the receiver to reproduce. Time constant is the time needed for a capacitor to discharge to 37 per cent of the initial voltage across its terminals, and a high frequency signal would have to have a very high amplitude to require the capacitor to discharge as much as all that on downward-going modulation."

"This sounds interesting," said Dick. "Let's try a few actual figures."

"All right," replied Smithy obligingly. "Let's say that the top frequency we expect the receiver to reproduce is 5kHz. Now, the length of a cycle at 5kHz is 0.2 millisecond, or 200 microseconds. So the length of a half-cycle is 100 microseconds. Let's say that the value of the detector diode load plus the filter resistor is 5kΩ, which is representative of what is given in many a.m. transistor sets. Now, what capacitance across 5kΩ will give a time constant of 100 microseconds?"

Smithy busied himself with his pencil as he worked out the time constant.

"Ah yes," he remarked, "here we are. The value of capacitance is 0.02 μF. Which is pretty well the sort of thing you get in practical transistor a.m. detector circuits."

"What about," asked Dick, "the second bypass capacitor? If the filter resistor has a low value this second capacitor will almost be in parallel with the capacitor which comes immediately after the diode."

"True enough," agreed Smithy. "If the filter resistor has a relatively low value the two capacitors can be looked upon as being in parallel so far as the distortion we are talking about is concerned. Their total value should not then be greater than the calculated value for the single capacitor. If, on the other hand, the filter resistor has a high value then the second bypass capacitor will be less liable to contribute to the distortion and could be largely ignored. But we are speaking in general terms here anyway, and you'll find quite a few transistor a.m. radios whose detector load time constants are longer than the 100 microsecond figure we arrived at in our own example."

"Are there any further types of distortion in an a.m. detector circuit?"

"There's another one, and this is given by what is usually called 'a.c. shunting' or 'a.c. loading'," replied Smithy carelessly. "However, let's get back to our game. Whose go is it next?"

"A.C. shunting, eh?" commented Dick reflectively. "That's something I've never heard of before."

Smithy ignored him.

"Who's got the next turn in this game of Battleships?" he queried sharply.

"Come on, Smithy," wheedled Dick. "It won't take you long to give me the gen on this a.c. shunting business."

"Who," thundered Smithy, "has the next go?"

Reluctantly, Dick allowed his curiosity to diminish for the moment.

"Well, it's my turn," he replied, concentrating on the paper in front of him. "I'll have a stab at F4."

Stricken, Smithy reeled back from his sheet of paper.

"Ye gods," he breathed incredulously. "You've sunk my battleship. You've gone and sunk it, just like that."

He stared unbelievingly at his paper.

"All right, then," he stated, a note of iron entering his voice. "I'll try A7."

"No hit."

"There *must* be a hit."

"I tell you, no hit."

Smithy glared at his assistant suspiciously.

"You aren't using any right-angled cruisers or things like that, are you?"

"All my vessels are of regulation size and shape," retorted Dick icily. "You wouldn't find better in Jayne's *Fighting Ships*. Anyway, it's my turn again and I'll try D3."

"D3?"

"D3," repeated Dick firmly.

"This is terrible," moaned the shattered Serviceman. "You've just knocked a great chunk out of my second cruiser. Have you got radar over there or something?"

"Of course I haven't," replied Dick airily. "I just use logical deduction, that's all. I'd much rather hear about a.c. shunting than play Battleships, though."

"I'm not," said Smithy, "going to utter another word about electronics until I've had the satisfaction of scoring at least one further hit."

A glint appeared in Dick's eye.

"Aren't you?"

"I am not," averred Smithy. "So let me have another bash at your fleet. I'm going to try B7."

"Did you," asked Dick carelessly, as he marked up his sheet of paper, "say B7?"

"I did," said Smithy. "Now don't keep me in suspense."

"You have," remarked Dick slowly, "hit a destroyer."

"Thank goodness for that! All right, you have a go now."

"E3."

"E3? Blow me, you've hit my cruiser again. Let's have another bash at that destroyer of yours. How about C7?"

Once more, Dick marked up his sheet.

"You have," he announced unemotionally, "sunk my destroyer."

"Oh good," said Smithy happily. "Success at last."

"Well then," commented Dick, "how about this a.c. shunting effort then."

A.C. SHUNTING

"All right," replied Smithy obligingly. "I'll break off the game for a bit so that I can give you the gen on that. Now, a.c. shunting comes into the picture when you couple a further resistor via a capacitor across the diode load resistor. In practical sound radio circuits you have to do this anyway in order to prevent the mean d.c. level of the detected signal getting through to the following a.f. stage. The mean d.c. level is just the job for providing automatic gain control but, if the diode load were coupled direct to the following a.f. stage, it would upset the biasing for that stage. So the d.c. level has to be blocked off by a capacitor which has a low impedance at audio frequencies. A typical instance is given by having the capacitor couple to a second resistor which is also a volume control." (Fig. 8(a).)

"I can picture a set-up like that,"

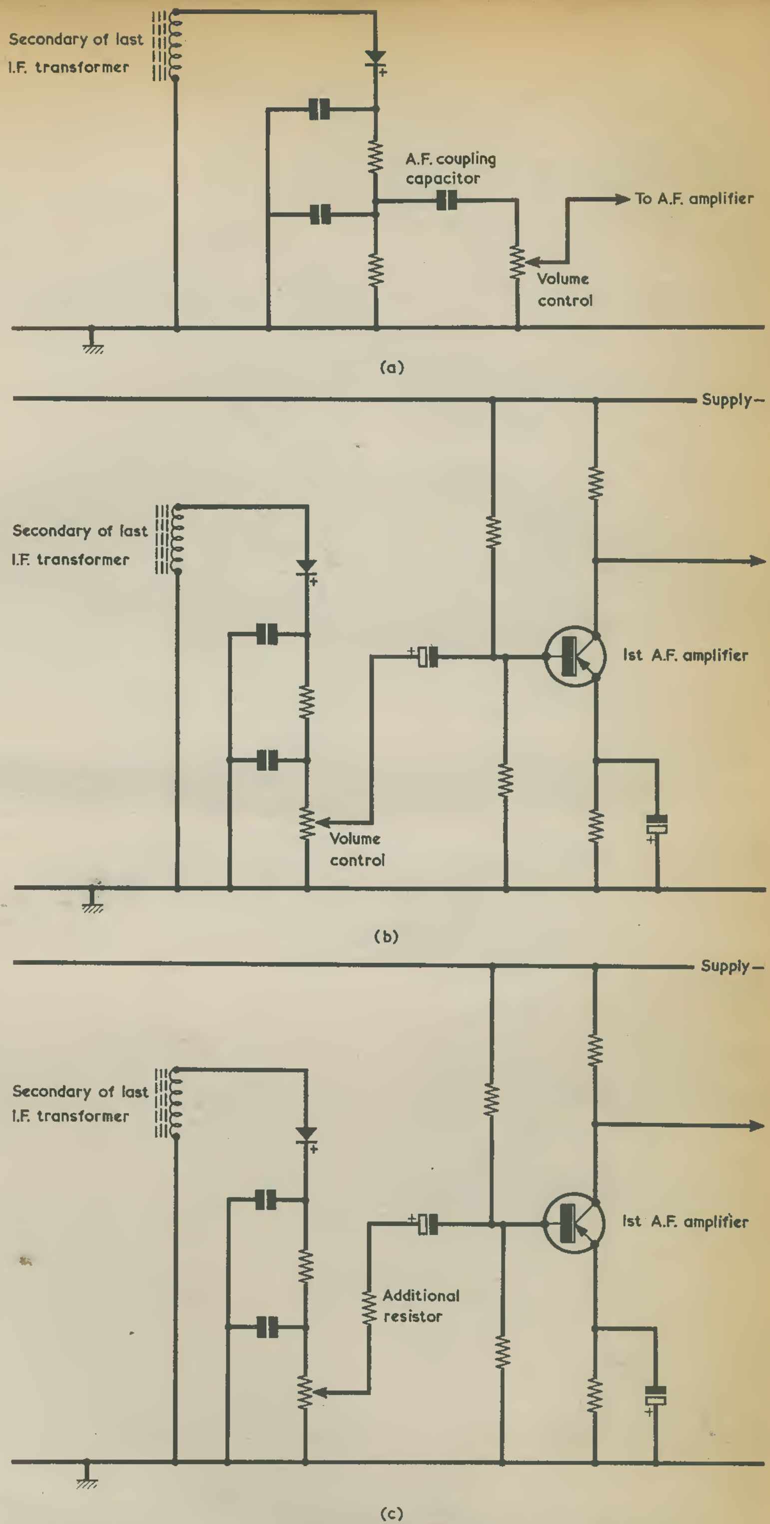


Fig. 8 (a). Adding an a.f. coupling capacitor and a volume control. This circuit helps to demonstrate a.c. shunting and it should be assumed that the slider of the volume control couples to a device having a high input impedance such as a valve or an f.e.t.

(b). In a practical transistor a.m. detector circuit the diode load is frequently the volume control for the receiver, and its slider couples direct to the base of the first a.f. amplifier

(c). An additional resistor may be inserted in the base circuit of the first a.f. transistor to reduce a.c. shunting

remarked Dick. "It used to be particularly common in the old valve receivers."

"Quite so," concurred Smithy, "and I've chosen it here because it affords a good starting-off point to explain a.c. shunting. With this latest circuit the diode now has two effective loads. One is the d.c. load and, assuming that the filter resistor has a relatively low value, can be considered as being the diode load resistor on its own. And the other is the a.c. load. Since the a.f. coupling capacitor has negligible impedance at modulation frequencies the a.c. load consists of the d.c. load and the volume control track in parallel. Obviously the a.c. load must always have a lower value than the d.c. load. Okay?"

"Yep," said Dick. "Things seem pretty reasonable up to now."

"That's good," responded Smithy. "Because we're now getting to a rather tricky bit. If an unmodulated signal is applied to the diode circuit a direct voltage is built up across the diode load in the usual manner. Also, the current flowing in the diode to keep the first capacitor which appears after it charged up on i.f. half-cycle tips will be the same regardless of whether or not the a.f. coupling capacitor and the volume control are in circuit or not. If, however, we modulate the signal, the diode will pass more current at modulation frequency into the a.c. load than it would into the d.c. load on its own when the modulation goes up; and it will pass less current at modulation frequency into the a.c. load than it would into the d.c. load on its own when the modulation goes down. If the modulation level is high, and the a.c. load is quite a lot smaller than the d.c. load, the diode can actually cut off on the lowermost tips of the modulation waveform; that is, on the parts of the modulation waveform which produce minimum carrier amplitude."

"Blimey," remarked Dick, impressed. "That should cause quite noticeable distortion."

"It will," said Smithy. "The distortion sets in when, approximately, the degree of modulation depth in the signal is greater than the value of the a.c. load divided by the value of the d.c. load. In the old valve sets, a detector of the type we're talking about would be satisfactory in practice if the volume control track had a resistance four times greater than that of the diode load. These values would result in the a.c. load being four-fifths of the d.c. load, and the circuit could cope with modulation depths of up to 80%, which is higher than that transmitted by most a.m. broadcast stations. With transistor receivers, though, it's usual to make the diode load the volume control and couple it via an a.f. coupling capacitor to the base of the first a.f. transistor." (Fig. 8(b).)

"Ah yes," commented Dick. "I know that circuit pretty well off by heart now."

"It seems to work all right in practice," said Smithy. "In theory, the d.c. load for the diode is the volume control track on its own, plus the small filter resistor which immediately follows the diode. When the volume control is set to maximum the a.c. load then consists of the volume control track with the input impedance of the following transistor in parallel, and this will be considerably lower than the d.c. load. Normally, however, the volume control is only partly advanced from the minimum volume end, whereupon the a.c. shunting given by the following a.f. circuit is only applied across the lower part of the volume control track, and the overall a.c. load is not in consequence much lower than the d.c. load. Distortion on high modulation signals is then only possible when the volume control is at a high setting near the non-earthy end of its track. There are other approaches used in transistor a.m. radios towards seeing that the a.c. load is not too much smaller than the d.c. load. For example, the bypass resistor between the diode and the volume control can be given a higher value, of the order of that of the volume control itself. This ensures that the a.c. shunting is not too great even when the volume control is set to a high level. Again, a high value resistor can be inserted between the volume control slider and the base of the first a.f. transistor. This resistor can have a value which is about the same as that of the volume control." (Fig. 8(c).)

"Couldn't the input impedance of the first a.f. stage be increased?"

"It could," confirmed Smithy. "The input impedance can be increased by negative feedback."

VISION DETECTOR

"Well," said Dick, visibly pleased with the knowledge he had acquired. "I must keep my eyes open for these d.c. and a.c. diode loads in the future. Hang on a minute, I've just had a thought!"

"Oh dear," remarked Smithy unhappily. "I hope you aren't going to open up a whole new discussion."

"I don't think I shall be," said Dick quickly. "What's happened is that it's just occurred to me that the vision i.f. signal in a TV set is also amplitude modulated. Do you have trouble with a.c. and d.c. loads at the vision detector?"

Smithy grinned.

"You don't get any trouble in present-day transistor TV circuits," he chuckled, "because the a.c. and d.c. diode loads are virtually the same! The usual practice is to couple the d.c. diode load direct to the base of the vision emitter follower with no coupling capacitors at all. You then have a delightfully simple arrangement in which there are no problems with the different loads whatsoever." (Fig. 9.)

"That seems to tidy up *that* ques-

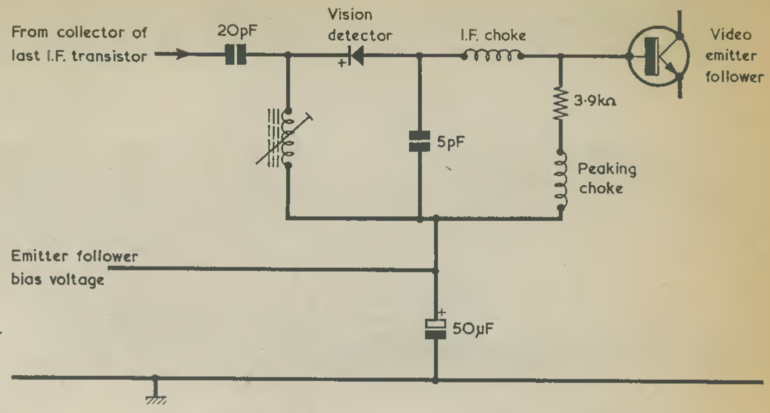


Fig. 9. A basic 625 line vision detector circuit with representative component values. The direct coupling to the emitter follower eliminates a.c. shunting problems

tion," commented Dick. ' And it also seems to have cleared up all the queries I had about a.m. diode circuits."

"Thank goodness for that," remarked Smithy, glancing at his watch. "Well, we've still got five minutes left to finish off this game of ours, so let's get back to it. Your go!"

"Is it? Okay then, I'll have a bash at C3."

"Well, stap me," said Smithy delightedly. "For the first time in this game you haven't hit anything. I'll try D4."

"Nothing there."

"Are you sure?"

"Positive."

"I don't believe it," said Smithy, rising from his stool.

He walked quickly over to his assistant's bench and, before the latter could stop him, snatched up Dick's paper.

"Why, you rotten cheat," he expostulated. "You didn't fill in any of your ships at the start at all. You're filling them in now, *after* I've called out my numbers!"

"And why not?" replied Dick defensively. "Any silly twirp can fill in the ships before the game starts. But it takes a man of skill to enter them after it gets going, because you've then got to bear in mind how many squares are available for the ships as each square gets cancelled off. I've still got room for all my ships in spite of the number of goes you've already had."

"But," protested Smithy, "if we both did that, we'd both call out a lot of meaningless numbers until we got to the inevitable bit at the end where practically every number would result in a hit. There's no point in playing if you don't stick to the rules."

"Mine," replied Dick, "is the 1974 version of the game. Nobody sticks to the rules."

"And you know," stated Smithy grimly, "what the outcome of that is, don't you?"

"No, what is the outcome?"

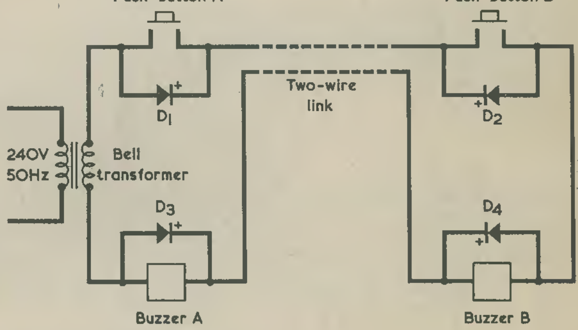
"Nobody wins." ■

"It was a snip at £75 — one careful owner and its own distinctive TV programme!"

TWO – WIRE TWO – WAY BUZZERS

Directional signalling over two wires.

By Barrie Gilbert



A two-way signalling system which requires only two inter-connecting wires.

IT IS OFTEN NECESSARY TO SIGNAL FOR ATTENTION AT either one of two points separated by appreciable distance. For example, a telephone extension in a home can be a nuisance if a call is taken on the wrong receiver – no way is usually available to alert the person for whom the call was intended. Of course, a simple buzzer circuit can be employed, but since signalling is required in both directions a three-wire circuit is sometimes used.

TWO-WIRE SYSTEM

There is a very simple way this requirement can be met with just two wires. The diagram shows how. Diodes across each of the push-buttons allow the circuit to be completed even if only one button is pressed. If, for instance, button A is pressed the diode across button B allows negative half-cycles to pass to the two buzzers. Buzzer B sounds but buzzer A is silent because it is effectively short-circuited by diode D3.

Similarly, if button B is pressed, D1 allows positive half-cycles to pass to the buzzers. In this case buzzer B is effectively short-circuited by diode D4 and does not sound.

The diodes can be any silicon rectifiers having a forward current rating of 1 amp and a peak inverse voltage rating of 100 volts or more. A high p.i.v. is desirable because some buzzers can produce a high back e.m.f. on operation or on the cessation of current. A suitable type would be the 1N4002. It would also, of course, be possible to employ bells instead of buzzers. ■

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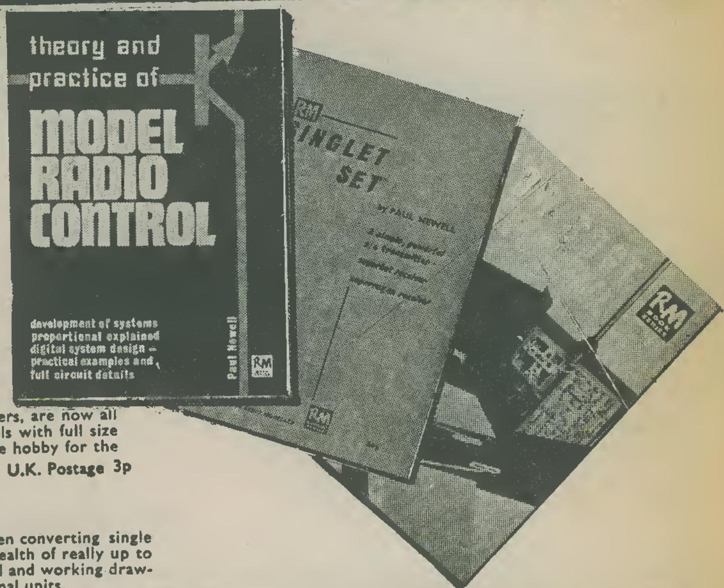

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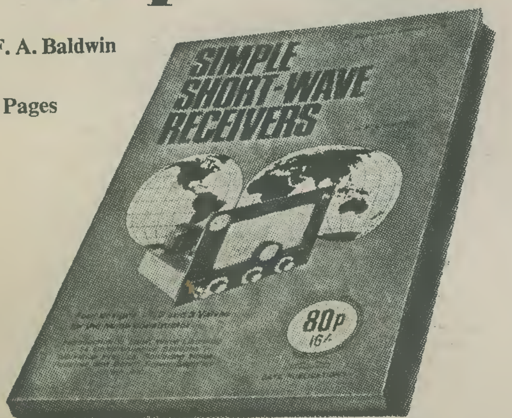

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TELEVISION TRANSMISSION FREQUENCIES I

The Table lists vision and sound carrier frequencies for television transmissions in Bands I and III (v.h.f. and 405 lines) and Band IV (u.h.f. and 625 lines). Band I consists of Channels 1 to 5 and Band III of channels 6 to 13. The next Data Sheet will give transmission frequencies in Band V.

Bands I and III			Band IV		
Channel	Vision Carrier (MHz)	Sound Carrier (MHz)	Channel	Vision Carrier (MHz)	Sound Carrier (MHz)
1	45.0	41.5	21	471.25	477.25
2	51.75	48.25	22	479.25	485.25
3	56.75	53.25	23	487.25	493.25
4	61.75	58.25	24	495.25	501.25
5	66.75	63.25	25	503.25	509.25
6	179.75	176.25	26	511.25	517.25
7	184.75	181.25	27	519.25	525.25
8	189.75	186.25	28	527.25	533.25
9	194.75	191.25	29	535.25	541.25
10	199.75	196.25	30	543.25	549.25
11	204.75	201.25	31	551.25	557.25
12	209.75	206.25	32	559.25	565.25
13	214.75	211.25	33	567.25	573.25
			34	575.25	581.25