

THE

RADIO CONSTRUCTOR

Vol. 25 No. 7

FEBRUARY 1972

20p



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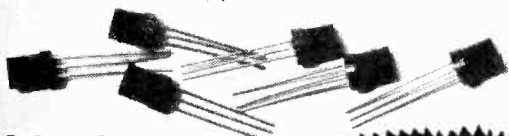
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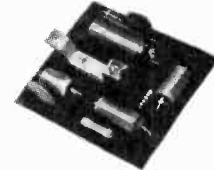
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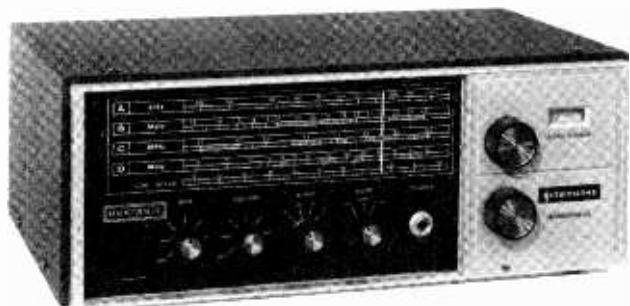
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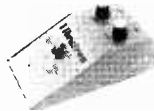


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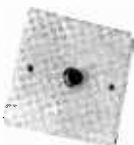
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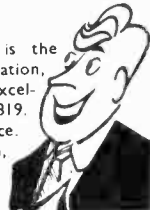
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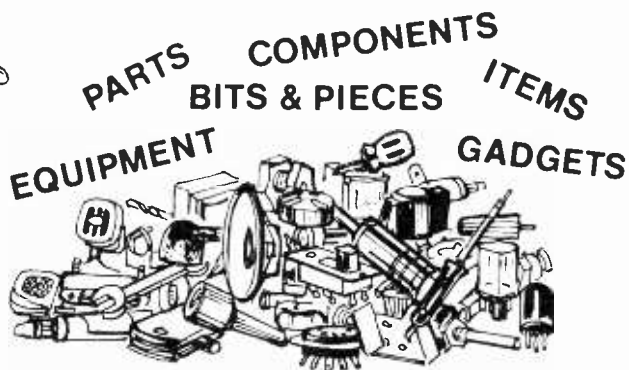
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Incorporating THE RADIO AMATEUR

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PUBLISHED ON MARCH 1st**

PRE-SELECTOR AMPLIFIER

By

F. G. RAYER, Assoc. I.E.R.E., G30GR

Operating over the medium wave band and two short wave ranges, this pre-selector can improve sensitivity and reduce second channel interference when used with a superhet receiver. Although intended primarily for the author's 'Coil-Pack Communications Receiver', it may be employed with any other similar superhet.

THIS R.F. PRE-SELECTOR IS PRIMARILY INTENDED FOR use with the 'Coil-Pack Communications Receiver' which was recently described by the author* but it may be employed with any other similar superhet receiver. A unit of this kind increases sensitivity to weak signals, thereby extending the range of reception. It also provides extra selectivity ahead of the receiver mixer, and this is very helpful in reducing second channel whistles and interference.

CIRCUIT OPERATION

Fig. 1 gives the circuit, and it will be seen that a single r.f. pentode, V1, is employed. If the unit is to be used with the 'Coil-Pack Communications Receiver', heater and h.t. current are obtained by inserting an octal plug into an added power outlet at the back of the latter. The manner in which this outlet is added is described later.

The 2-pole switch S1(a) (b) has four positions. By selecting L1, L2 or L3, three tuned bands are available,

with nominal coverage as follows:

- (1) 18.5 to 6MHz,
- (2) 6 to 1.8MHz,
- (3) 1,500 to 550kHz.

These correspond to the two short wave ranges and the medium wave range of the 'Coil-Pack' receiver. In position 4 S1(a) takes the aerial directly, by way of C1, to the aerial socket of the receiver, while S1(b) earths the grid of V1. This puts the pre-selector out of circuit, and provides a convenient operating method for general medium wave and short wave reception, since no adjustment of the pre-selector is then necessary whilst the receiver is being tuned. For amateur band reception or on any other occasion when the pre-selector is required, its switch is turned to the wanted range.

Tuning is carried out by VC1, which is fitted with a ball drive. No trimming is needed because this circuit is individually tuned, and so will always be peaked for best results with any aerial.

VR1 is the r.f. gain control. This has to be turned back somewhat with strong signals to avoid overloading. Amplified signals pass via C3 and a short length of coaxial cable to the aerial and earth sockets of the receiver.

The unit is built in a neat cabinet measuring 8 by 6 by 6in. which matches with the 'Coil-Pack' receiver. It will be found to give a useful degree of extra amplification and reduction in second channel interference.

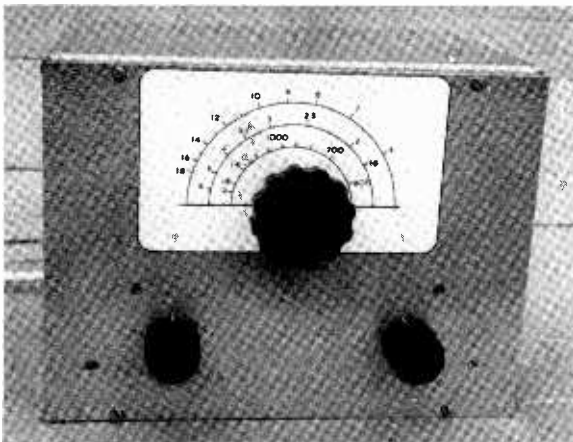
CHASSIS AND PANEL

The 7 by 5½ by 2 in. chassis is marked out as in Fig. 2. Drill ¼in. holes for the coils and cut out a ⅝in. hole for the valvholder. Drill the valvholder mounting holes such that it will, when mounted later, take up the orientation shown in Fig. 3. Also, make holes for the Aerial-Earth socket strip, position this as in Fig. 3, and taking care that the Aerial socket will be well clear of the metal.

Position VC1 so that the ball drive body will rest behind the panel. The ball drive is on the vertical

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* F. G. Rayer, 'Coil-Pack Communications Receiver', *The Radio Constructor*, October and November, 1971.



Front panel layout of the pre-selector

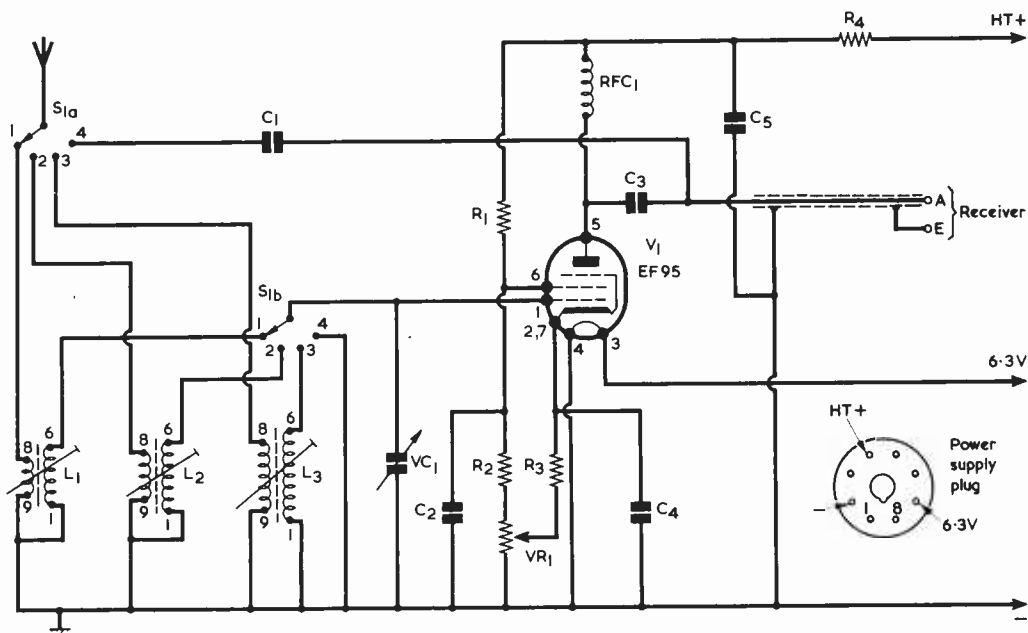


Fig. 1. Circuit diagram of the pre-selector

COMPONENTS

Resistors

(All fixed values $\frac{1}{2}$ watt 10%)

- R1 33k Ω
- R2 47k Ω
- R3 180 Ω
- R4 2.2k Ω
- VR1 10k Ω potentiometer, linear

Capacitors

- C1 22pF silver-mica or ceramic
- C2 0.01 μ F disc ceramic, 350V. Wkg.
- C3 22pF silver-mica or ceramic
- C4 0.01 μ F disc ceramic, 250V. Wkg.
- C5 0.1 μ F paper or plastic foil, 350V. Wkg.
- VC1 500pF (nominal) variable, Jackson Bros type E1 (Cat. No. VC5, Home Radio)

Inductors

- L1 Miniature Dual-Purpose Coil, valve type, Blue, Range 4 (Denco)
- L2 Miniature Dual-Purpose Coil, valve type, Blue, Range 3 (Denco)
- L3 Miniature Dual-Purpose Coil, valve type, Blue, Range 2 (Denco)

- L3 Miniature Dual-Purpose Coil, valve type, Blue, Range 2 (Denco)
- RFC1 19mH r.f. choke type RFC7A (Denco)

Valve

- V1 EF95 (or 6BA6 – see text)

Switch

- S1(a) (b) 2-pole 4-way rotary (see text)

Plugs, Sockets

- 1 B7G skirted valveholder with screening can
- 1 octal plug
- 1 octal valveholder
- 1 Aerial-Earth socket strip

Miscellaneous

- Ball drive type 4511/F (Jackson Bros.)
- Chassis type I, L 5 $\frac{1}{2}$ in., W 7in., D 2in. (H. L. Smith & Co.)
- Case type W, 8in. \times 6in. \times 6in. (H. L. Smith & Co.)
- 2 pointer knobs
- 5-way tagstrip, centre tag earthed

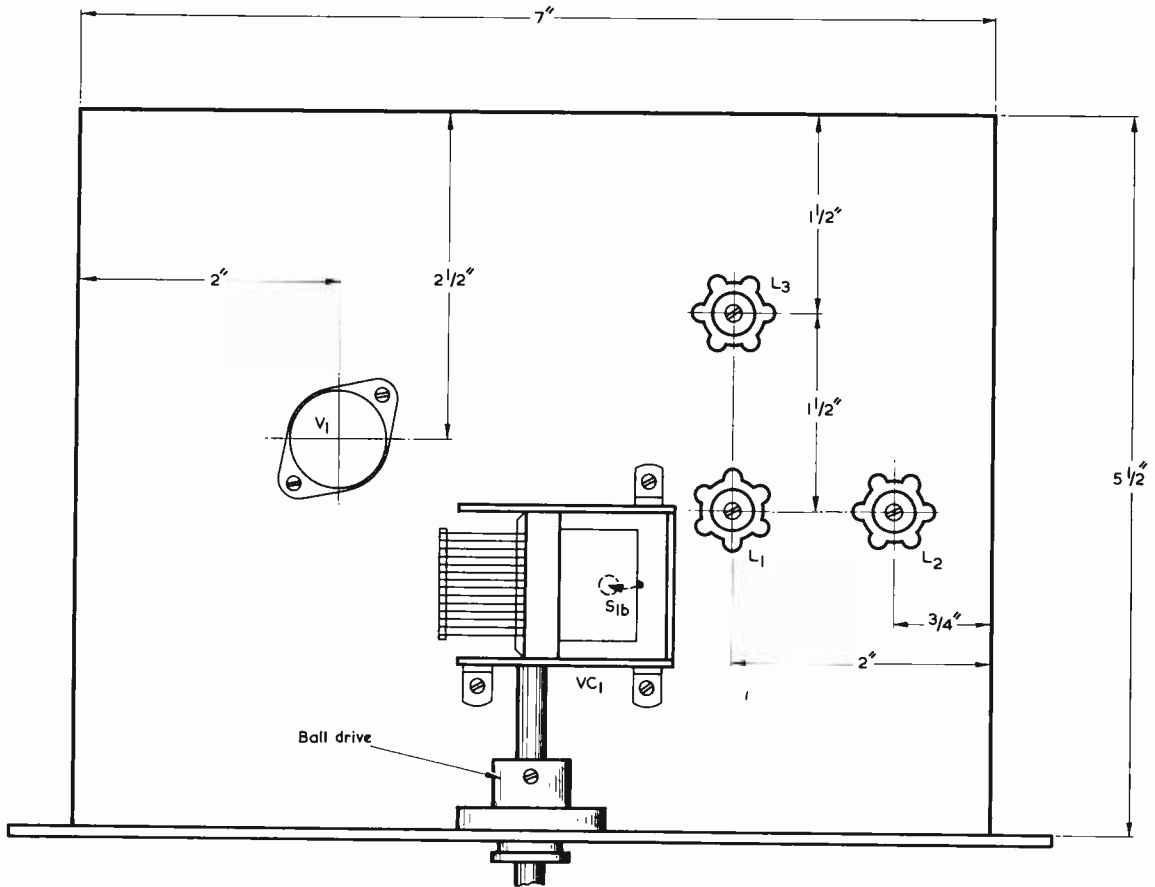


Fig. 2. Component layout above the chassis. The three coils are secured by their plastic nuts, which should not be tightened excessively

centre line of the panel, at a height which enables it to engage correctly with the spindle of VC1. Solder an insulated lead to the lower fixed vanes tag and pass this through a hole in the chassis near the tag before bolting VC1 in place. The connection to VC1 moving vanes is automatically made by way of the mounting feet of this capacitor.

The chassis has small flanges which are bolted to the panel, as in Fig. 3. The bottom edge of the panel is $\frac{1}{2}$ in. below the lower edge of the chassis in order that the assembly can be fitted in the case. A hole is cut or punched to clear the ball drive, and its lug is secured with a countersunk bolt and nut. Its flange is forward of the panel.

UNDER THE CHASSIS

Fig. 3 shows wiring and components under the chassis. The switch employed with the prototype is a wafer type with the wafer spaced away from the panel so as to be reasonably close to the coils. If difficulty is experienced in obtaining a suitable switch it may be made up from a 'Maka-Switch Kit', available from Home Radio, Henry's Radio and other suppliers. The wafer employed can be the 3-pole 4-way 'break-before-make' type, the extra pole and its contacts being unused.

When soldering L1, L2 and L3, clean each pin carefully, form a small loop on the wire, and solder it quickly to the pin. Avoid lengthy heating, which will soften the plastic material. All wiring should be reasonably short and direct. Keep the grid lead to S2, and other grid connections, away from C1 and its leads.

The power supply cable consists of three lengths of flex, red for h.t. positive, brown for the 6.3 volt heater supply, and black for the negative chassis connection. When the pre-selector is used with the 'Coil-Pack' receiver, these leads are about 12 in. long, and are taken to the pins of an octal plug, as in Fig. 1. This matches up with an octal socket on the back runner of the 'Coil-Pack' receiver. When other receivers are used, the wire length may be modified accordingly and a different type of plug and socket, or other form of connection, employed as desired.

For the output lead, and assuming once again that the unit is being used with the 'Coil-Pack' receiver, take a piece of coaxial cable about 8 in. long, and bare each end about $\frac{1}{2}$ in. Unravel the outer braiding, twist this into a pigtail and connect it at one end to the 'MC' (chassis) tag indicated in Fig. 3. The inner conductor at this end connects to C1 and C3. At the receiver end of the cable, fit an aerial plug to the inner conductor. Solder about $1\frac{1}{2}$ in. of flex to the outer

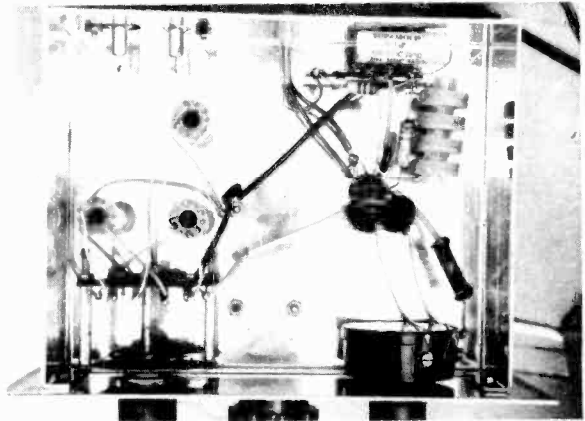
braiding and fit an earth plug. The pre-selector stands to the right of the receiver. With other receivers, the length of the coaxial cable and the type of plug or plugs employed are varied as required. The coaxial cable should still, however, be kept short.

The tagstrip at the rear supports the r.f. choke a little clear of the chassis, and also anchors some other items.

CABINET AND DIAL

It is necessary to cut holes, or a rectangular aperture, in the back of the cabinet for the output and power leads, and for access to the aerial and earth sockets.

It will be found that the pre-selector can readily be tuned with only a numbered dial, but it is somewhat more convenient to have calibrated scales. These can best be drawn on thin card or stout paper, which may be covered with thin Perspex or other transparent material, and fixed with adhesive or small countersunk screws. The ball drive flange has two small tapped holes which will take short 8BA bolts to secure a cursor or wire pointer. A suitable cursor can be cut from thin Perspex, its centre line being scored on the underside and filled with indian ink.



Components and wiring under the chassis

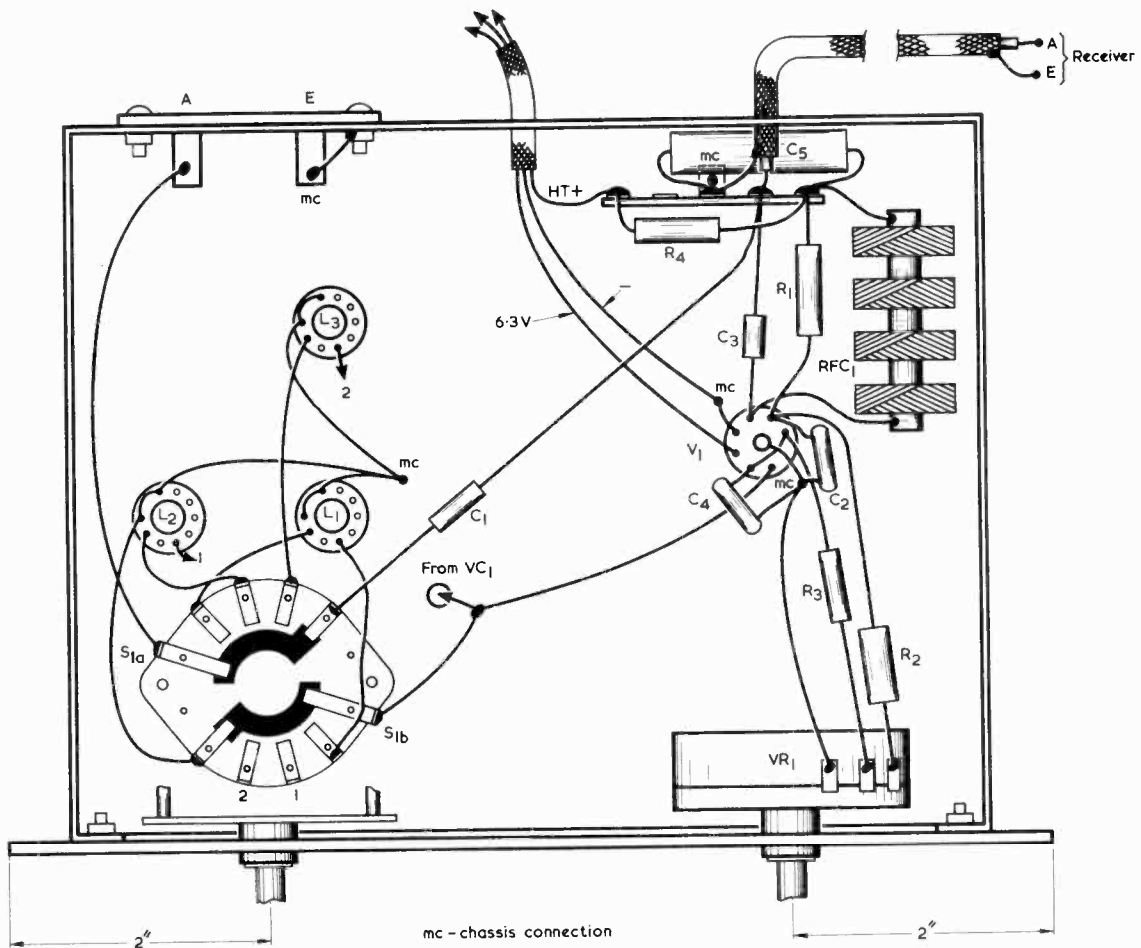
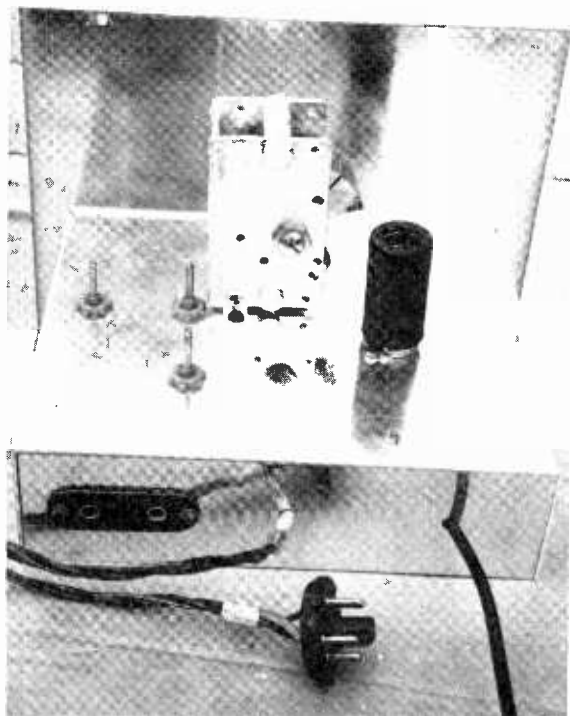


Fig. 3. Wiring below the chassis



Rear view, showing also the octal power plug

Tuning ranges do not exactly match those of the 'Coil-Pack' receiver, but tend to extend a little at both ends of each range. If necessary, coverage can be altered considerably at the low frequency end of each range by adjusting the appropriate coil core.

If no signal generator is available, tune in a transmission on the receiver with S1(a) (b) in the position which puts the pre-selector out of use. Then switch the pre-selector to the appropriate band, and adjust VC1 to peak up the S-meter reading. There should be a considerable increase in signal strength, and VR1 should act as a gain control in the usual way. Mark the frequency to which the receiver is tuned on the pre-selector dial. Tune in other signals, as required, and each time adjust VC1 for best signal strength and mark the dial. In this way the pre-selector ranges can be rapidly calibrated.

If a signal generator is available, proceed in the same way but use 'round number' frequencies obtained from the signal generator.

It will be found that the pre-selector bands overlap. For example, the medium wave range tunes into the 160 metre band when VC1 is nearly fully open. This is quite in order.

When tuning to the higher frequencies, and especially above 12MHz, take care that the pre-selector is not tuned to the second channel. This is nearly 1MHz higher than the correct frequency (actually, it is higher by twice the intermediate frequency of the receiver) and comes progressively nearer the proper tuning position as frequency increases. Accidentally tuning to the second channel is extremely unlikely on lower frequencies. When it does arise, the pre-selector and receiver signal

frequency circuits are resonant at different frequencies, and reception will be poor.

'COIL-PACK' RECEIVER

The modifications to the 'Coil-Pack' receiver which enable the pre-selector to be employed with it are very simple, and consist primarily of the fitting of an octal valveholder to the rear chassis runner. The valveholder is positioned between the mains lead grommet and the Aerial-Earth socket strip.

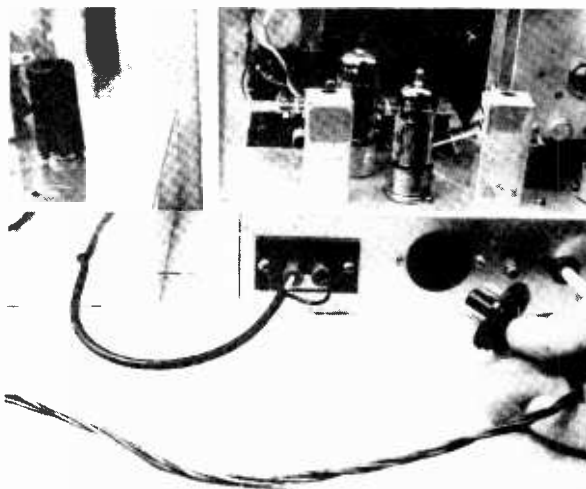
After it has been fitted, the valveholder is wired in the following manner. Pin 2 connects to chassis, at a solder tag under one of the valveholder securing nuts. Pin 4 of the octal valveholder connects to pin 1 of i.f. transformer IFT2. This is the transformer pin which is connected to 'standby' switch S3. Thus, when S3 is opened the h.t. supply is broken to the pre-selector as well as to the frequency-changer and i.f. amplifier valve in the receiver. Finally, pin 7 of the valveholder connects to pin 5 of the ECH81, thereby picking up a 6.3 volt supply.

The 'Coil-Pack' receiver has no r.f. amplifier, and the tuning meter will run off-scale with strong transmissions when the pre-selector is switched in. To avoid this, add a 330Ω $\frac{1}{2}$ watt resistor in series with the meter; that is, between the meter and the zero-adjust potentiometer.

WITH OTHER RECEIVERS

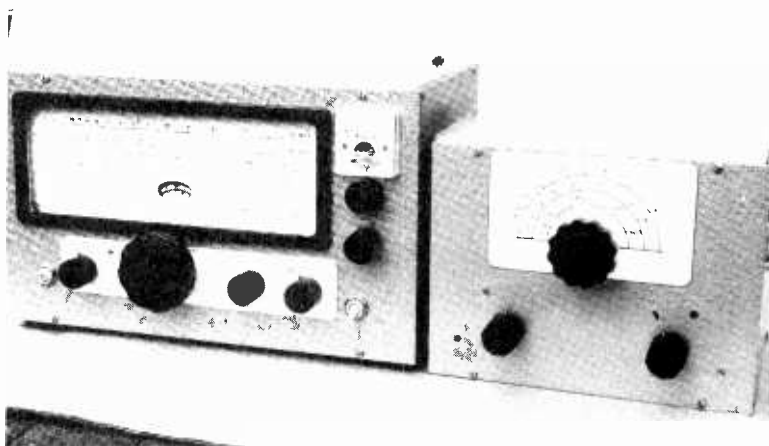
As already stated, the pre-selector can be used with receivers similar to the 'Coil-Pack' model.

The EF95 in the pre-selector requires 6.3 volts at 0.175 amp for its heater, and this should be available from all but the smallest receivers. With this valve, however, the anode potential should not be greater than 180 volts. If the receiver offers an h.t. potential greater than this, it would be preferable to use a 6BA6 instead of the EF95. The wiring shown in Fig. 3 enables a 6BA6 to be plugged in without any changes to the valveholder connections. It requires 0.3 amp heater current at 6.3 volts.



Connecting the pre-selector to the 'Coil-Pack' receiver

The pre-selector and the Coil-Pack Communications Receiver form an impressive receiving installation.



It is not wise to extend the coaxial output lead too much, as this will reduce efficiency, especially on the higher frequencies. If the pre-selector is to be put in permanent use with the 'Coil-Pack' receiver, the aerial coils and trimmers of the latter can be touched up for best possible results with the pre-selector in circuit.

With the pre-selector and receiver described, many distant stations should be within range with an indoor

aerial. For 160 metre and other signals around this frequency, a quite long outdoor aerial will greatly improve reception. For medium wave purposes a long outdoor aerial is not required, and it may prove better to place a small series capacitor in the aerial lead to the pre-selector. A 50pF pre-set variable capacitor may be tried, it being adjusted for optimum results. ■

RECENT PUBLICATIONS



QUESTIONS AND ANSWERS ON RADIO AND TELEVISION, 3rd Edition. By H. W. Hellyer.

127 pages, 4½ x 6½in. Published by The Butterworth Group. Price 60p.

This handy little book is one of a series of 'Questions and Answers' manuals published by The Butterworth Group. It is intended to take the reader from elementary aspects of electricity up to relatively advanced concepts in radio and television, this being achieved by an eminently readable text layout which is broken up into question and answer form. Every chapter of the book contains some twenty to forty single-sentence questions, each of these being followed by one or more paragraphs of text which provides the answer and, in many cases, leads up to the next question. The reader is thus able to absorb the information given by the book in single discrete 'bites' and automatically tends to prevent himself from proceeding to a further question until he has assimilated and understood what has been given in the preceding answer.

The book commences with basic electricity, then carries on to sound and radio waves, valves and transistors, and basic radio circuits. Next dealt with are the operation of radio receivers and the principles of television, these being followed by a description of television receivers. The book concludes with an appendix giving common abbreviations and an index.

Despite the fact that the subjects dealt with can obviously not be treated in great depth, 'Questions and Answers on Radio and Television' guides its reader towards quite complex details of radio and television. It offers an excellent introduction to the subject for the newcomer.

1972 HI-FI YEAR BOOK. Edited by Colin Sproston.

440 pages, 5½ x 8½in. Published by IPC Electrical-Electronic Year Books Limited. Price £1.25.

The main purpose of this book is to give details of specifications and prices of audio products available in the U.K., and in its 1972 edition it deals with more than 2,000 items marketed under some 300 different brand names. In addition, there are short articles which deal with the Dolby system, high fidelity reproduction from f.m. tuners, outstanding discs of 1971, pickup parameters, and microphones. The material on microphones consists of an extensive glossary of terms with explanatory notes.

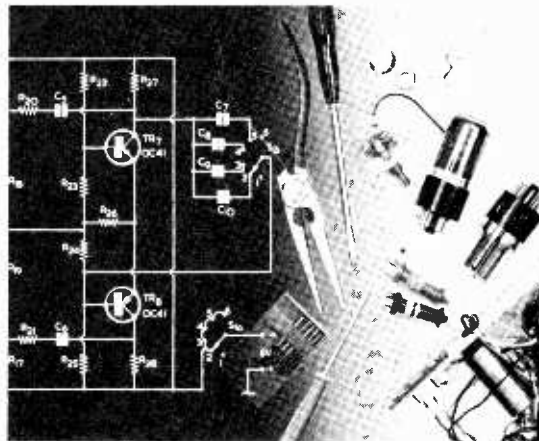
The high fidelity equipment directory in the book is conveniently grouped into twenty-two product sections covering: pickups and arms, pickup accessories, motor units, radio tuners, tuner-amplifiers, amplifiers and control units, tape recorders, tape units, tape amplifiers, mixer units, tape accessories, magnetic tapes, test tapes and discs, constructional kits, microphones, speaker drive units, speaker accessories, speaker systems, high fidelity equipment cabinets, complete audio systems, v.h.f. f.m. aerials, and headphones. More than 750 of the items listed are illustrated.

Also given is a comprehensive alphabetical index of audio manufacturers, distributors and brand names. There is, further, an up-to-date directory arranged in geographical order of retailers who stock an adequate range of high fidelity equipment and who offer full demonstration facilities.

The book includes a Stop Press section taking up changes in Purchase Tax which came into force in September 1971. These consist, firstly, of the application of P.T. to certain loudspeaker systems which had hitherto been free of tax and, secondly, the general reduction of P.T. from 36¾% to 30%.

VERSATILE SUCCESSIVE SWITCH

by G. A. FRENCH



WHAT COULD POSSIBLY BE DESCRIBED as the basic 'current amplifier' which preceded both the valve and the transistor is the relay. A relay can function as a 'current amplifier' because it allows a small current flowing in its coil to control a much larger current switched by its contacts. The relay has, of course, other attributes in addition to that of switching large currents, one of the more important of these being that the circuits controlled by its contacts can be completely separate from that which connects to its coil.

Since nearly all of the facilities offered by the relay can nowadays be carried out by semiconductor devices, it might be thought that the relay should be more than ready to retire into obsolescence. Such is by no means the case, though, and not only do we find that existing relay types continue to be used in large numbers, in both the professional and the amateur fields, but also that new relay designs are continually being released by relay manufacturers. It is evident that the relay will continue to be extensively employed in electrical and electronic work for quite some time to come.

The circuit to be discussed in this month's article in the 'Suggested Circuit' series employs relays in conjunction with transistors and semiconductor diodes to provide a successive switch in which a relay energises to provide each switching step. This switch may be employed to control any number of lamps in such a manner that they become illuminated one after the other until all lamps are lit, after which all lamps extinguish and the cycle commences once again. Lamps

controlled in this manner can form an attention-catching display for a shop window or for a stand at an exhibition; and in either instance they may be used to illuminate successive letters or phrases in a sales slogan. They may also be employed in educational work to illustrate successive phases in, say, an industrial process, and the like. The circuit may be readily modified such that the cycle can be stopped at any lamp, the order of lamp illumination can be varied, and all lamps can be extinguished before the end of the cycle is reached.

The writer would be the first to agree that the uses offered by the successive switch, as so far discussed, could also be provided by an all-semiconductor design which dispensed with relays. However, an all-semiconductor design would not necessarily have, to start with, the same simplicity as has the one to be described here, whose functioning is extremely easy to visualise and to understand. Also, the present circuit has greater versatility since it does not necessarily have to switch on a series of lamps. The relay contacts which close at each step in the switching cycle can turn on *any* electrical device whose voltage and current demands are within the relay contact ratings. If each relay is fitted with normally-closed contacts, it can alternatively switch *off* external circuits. Similarly, changeover contact sets can cause external circuits to be changed over and, again, if one or more of the relays is fitted with extra contact sets, at least two quite separate external circuits can be controlled at one or more of the switching steps. As may be gathered, there are many permutations and combinations in the

applications to which the successive switch may be put. Their availability is entirely due to the use of relays.

CIRCUIT OPERATION

The circuit of the successive switch, shown in a form in which it controls four lights in succession, is given in Fig. 1. In this diagram the relays are depicted with what is known as 'detached' presentation. Each relay coil is drawn as a rectangle, alongside which is the relay identification over a figure which shows the number of contact sets with which the relay is fitted. Thus, the rectangle shown in

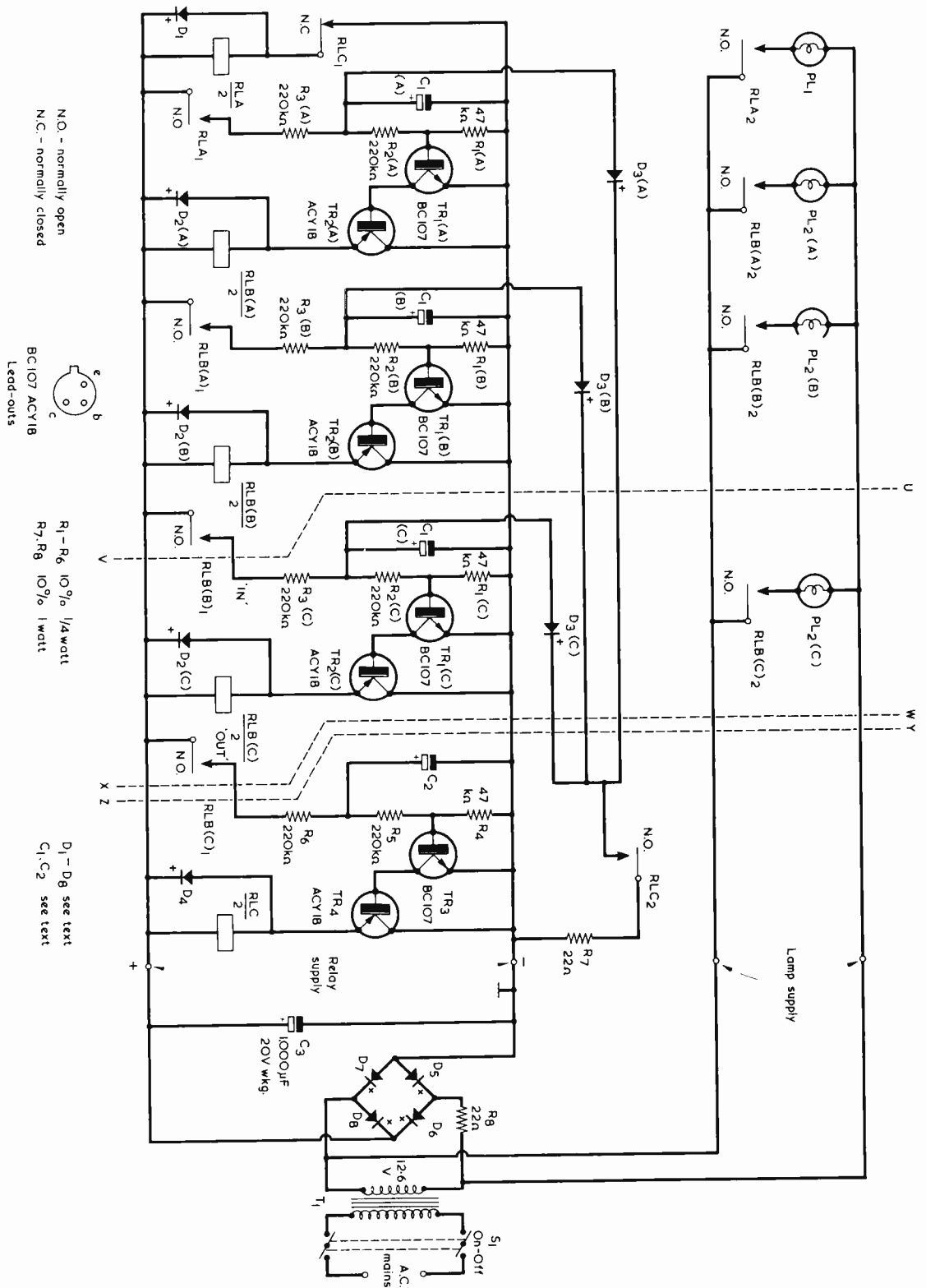
Fig. 1 as $\frac{RLA}{2}$ represents the coil of

relay RLA, whilst the figure 2 in its designation indicates that it has two contact sets. These contact sets are RLA1 and RLA2, and they may be positioned anywhere in the diagram. Unless otherwise stated, the contact sets are always shown in the position they take up when the relay is de-energised. In the diagram the terms 'normally-open' and 'normally-closed' have been added to assist in explanation. A normally-open set of contacts is open when the associated relay is de-energised, and the opposite applies to a set of normally-closed contacts.

Let us next examine the circuit of Fig. 1 when the mains on-off switch is open and no power is applied. All relays are de-energised and all contact sets, apart from contact set RLC1, are open. Contact set RLC1 is, incidentally, the only normally-closed contact set in the design.

THE RADIO CONSTRUCTOR

Fig. 1. Circuit of the prototype successive switch. The dashed lines UV and WX are not screens, but are intended to indicate one of the circuit modules. Considerably more modules than those shown may be employed



Turning on switch S1 causes a d.c. supply voltage to be applied to the relay section of the circuit via transformer T1, bridge rectifier D5-D8 and reservoir capacitor C3. Relay RLA energises by way of normally-closed contacts RLC1 and its contact set RLA2 closes, illuminating lamp PL1, which now receives an a.c. supply direct from the secondary of the mains transformer. Contact set RLA1 also closes, connecting R3(A) to the positive supply rail. Electrolytic capacitor C1(A) now commences to charge, the voltage across its plates being applied to the potentiometer given by R2(A) and R1(A). The junction of R2(A) and R1(A) is connected to the base of TR1(A), which commences to go positive with respect to its emitter.

TR1(A) and TR2(A) are connected in tandem in a configuration which produces a total current gain, from TR1(A) base to TR2(A) emitter, that is approximately equal to the product of the individual gains of the transistors. When the positive voltage on the base of TR1(A) is of the order of 0.5 volt with respect to the emitter, both TR1(A) and TR2(A) start to conduct. There is a rapidly rising current in the coil of relay RLB(A) and this relay energises, causing contacts RLB(A)2 to close and illuminate lamp PL2(A). At the same time, contacts RLB(A)1 close, connecting R3(B) to the positive supply rail.

The components and circuit around TR1(B) and TR2(B) are identical with those around TR1(A) and TR2(A), and exactly the same process is repeated. Capacitor C1(B) commences to charge and, after a period, transistors TR1(B) and TR2(B) start to conduct, causing relay RLB(B) to energise. The two contact sets of RLB(B) illuminate lamp PL2(B) and cause R3(C) to be connected to the positive rail. The circuitry around TR1(C) and TR2(C) is, again, identical with that around the previous pairs of transistors and, once more, the same circuit process takes place. After a time, relay RLB(C) energises, causing lamp PL2(C) to light up. All four lamps are now illuminated.

When relay RLB(C) energises, its contact set RLB(C)1 connects R6 to the positive supply rail. Capacitor C2 commences to charge and, when the voltage across its plates is sufficiently high, transistors TR3 and TR4 become conductive and cause relay RLC to energise. Contact set RLC1 (at the left in the diagram) now opens, whereupon relay RLA de-energises and lamp PL1 extinguishes. Also, contact set RLA1 opens, breaking the connection between R3(A) and the positive rail. Returning to relay RLC, when this energises its contact set RLC2 closes also. This causes the three capacitors C1(A), C1(B) and C1(C) to discharge via the current surge limiting resistor R7 and diodes D3(A), D3(B) and D3(C). All transistors from TR1(A) to TR2(C) now become non-conductive

and relays RLB(A), RLB(B) and RLB(C) de-energise, whereupon lamps PL2(A), PL2(B) and PL2(C) also become extinguished. Apart from the fact that relay RLC is now energised, the relay circuit is in the same condition as it was before the mains supply was switched on.

When, after relay RLC became energised, relay RLB(C) became de-energised, its contacts RLB(C)1 opened, thereby breaking the connection between R6 and the positive supply rail. Capacitor C2 now commences to discharge via R5, R4 and the base-emitter junction of TR3. When it has discharged sufficiently the positive potential on the base of TR3 is insufficient to maintain TR3 and TR4 conductive, with the consequence that relay RLC de-energises. Its contacts RLC2 open, taking the effective short-circuit off capacitors C1(A), C1(B) and C1(C), which by now have discharged to a low voltage equal to the forward voltage drop in D3(A), D3(B) and D3(C). At the same time, contacts RLC1 close, relay RLA energises and another switching cycle commences.

MODULAR CONCEPT

It will be apparent from this description of circuit operation that, between contact set RLA1 at the left in Fig 1 and resistor R6 at the right, there are three discrete and identical circuit modules. These modules are identified by the fact that all the components in each are identified by the same suffix number, followed by the letters 'A', 'B' or 'C', as applicable. One of these modules appears between the two dashed lines UV and WX. As may be seen, it has an 'In' connection and an 'Out' connection, the former being the point where the preceding module applies the positive starting potential from the positive supply rail, and the latter being the point where the module, in its turn, passes on a positive starting voltage to the succeeding circuit. If more circuit modules, and consequently more controlled lights (or other external circuits) are to be used, these modules will have the same circuitry as those shown, and can be inserted between dashed lines WX and YZ. Each circuit module will connect to the negative and positive rails in the same manner as those shown, and will take an 'In' connection from the preceding 'Out' connection, and will pass an 'Out' connection to the following 'In' connection (or to R6 of the final transistor pair, TR3 and TR4). The diode D3 of each module (connecting to the positive plate of its charging capacitor) will couple to the contact set RLC2 in the same manner as do the existing diodes D3 shown in Fig. 1. The number of successive modules which may be connected up in this manner is limited only by the ability of the relay power supply to deliver the current required

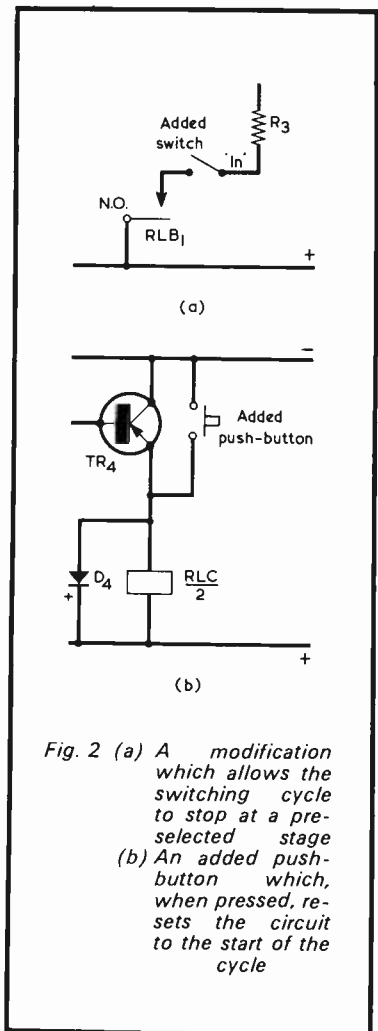


Fig. 2 (a) A modification which allows the switching cycle to stop at a pre-selected stage
(b) An added push-button which, when pressed, resets the circuit to the start of the cycle

when all relays are energised. An idea of what is possible here is given by the fact that, assuming 500 Ω relay coils and a nominal 12 volt supply, some 40 modules can be accommodated before the power supply current approaches 1 amp!

A number of simple modifications are also feasible. If, for instance, an on-off switch is inserted in series with the 'In' connection for any circuit module, as in Fig. 2(a), the cycle will stop at the preceding module when the added switch is open. Similarly, a push-button across TR4, as illustrated in Fig. 2(b), will cause all lamps to be extinguished when it is pressed, and will allow the cycle to be recommenced when it is released.

An interesting possibility is given by using a number of modules and bringing all their 'In' and 'Out' connections to a socket board, as shown (for five modules) in Fig. 3. The external circuits can then be switched on in any order by coupling together input and output sockets, as desired, by flexible jumper cords

THE RADIO CONSTRUCTOR

fitted with plugs at each end. The only proviso here is that the switching series selected must start with an 'In' connection from contact set RLA1 of Fig. 1, and must terminate with an 'Out' connection to R6 of Fig. 1. The appropriate sockets are indicated as 'Start' and 'Finish' in Fig. 3. Also, relay RLA must be the first to energise.

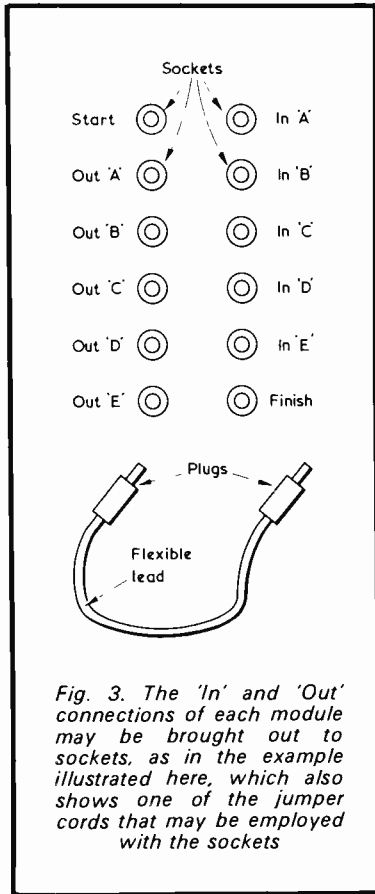


Fig. 3. The 'In' and 'Out' connections of each module may be brought out to sockets, as in the example illustrated here, which also shows one of the jumper cords that may be employed with the sockets

FURTHER DETAILS

There are a number of circuit details in Fig. 1 which have not been covered in the general description of circuit operation given earlier.

All the diodes from D1 to D4 inclusive can be small silicon rectifiers. Any type with a forward current rating of 200mA or more may be employed. Care must be taken to connect the diodes across the relay coils with correct polarity. If they are connected incorrectly excess current will flow, with the risk of damage to the diode and other components, particularly the associated transistor, which appear in the excess current path. Diodes D2(A), D2(B), D2(C) and D4 are included to prevent the formation of high back-e.m.f. voltages which could otherwise appear when the associated relay de-energises. These

high voltages could cause breakdown in the transistor supplying the relay coil. The presence of the diodes has the secondary effect of slightly delaying the release of the relays across whose coils they are connected. It is for this reason that D1 is connected across the coil of RLA, and it ensures, when relay RLC energises, that the subsequent release of relay RLA is delayed for about the same short period of time as is the release of the other relays. Diode D1 would not otherwise be required, as there is no transistor in its coil energising circuit.

Diodes D3(A), D3(B) and D3(C) are gate diodes. They permit the flow of conventional current (from positive to negative) from the positive plates of the charging capacitors to the negative supply rail when contact set RLC2 closes, but they prevent the flow of conventional current from the positive plate of any of the charging capacitors to the positive plates of the other capacitors. Silicon diodes are preferable to germanium diodes in this part of the circuit, even though the latter type, with their lower forward voltage, would cause the charging capacitors to be discharged to a lower potential. Silicon diodes possess the advantage of passing very low leakage currents when non-conductive.

It might be thought extravagant to use two transistors in each of the circuit modules when, with suitable charging capacitor values, a single transistor could be employed to energise the relay. However, a single transistor would require considerably lower base resistor values and, in consequence, much higher charging capacitor values for the same time periods. As we shall see shortly when the components are discussed the present circuit modules require quite low values in the charging capacitors. A further advantage with having two transistors per module is that when the current in the TR2 transistor starts to increase towards the relay coil energising current level the high current gain of the two transistors in tandem results in a relatively high rate of current rise. In consequence, the energising of each relay more closely approaches a 'snap-on' characteristic than could be offered by a single transistor.

The power supply arrangements shown in Fig. 1 are those employed when the prototype circuit was tested. Any reasonably well-smoothed d.c. supply of around 12 to 14 volts will be adequate for the relay circuits. The lamps in Fig. 1 are 12 volt types taking an a.c. supply from the mains transformer secondary. Any other types of lamp (or other electrical equipment) and supply may be used, provided the supply is adequate for the load when all the controlled circuits are switched on and the voltage and current capabilities of the relay contacts are not exceeded. The supply should be well regulated when lamps

are used as, otherwise, lamp brilliance will drop as more lamps are switched on.

COMPONENTS

Of the components, diodes D1 to D4 have already been dealt with. Diodes D5 to D8 were 1 amp 50 p.i.v. silicon rectifiers type 1N4001 in the prototype. The transistors are all standard types. There is a very slight possibility that if a transistor having a very high leakage current is employed in any of the TR2 positions (or in the TR4 position) it might go into thermal runaway, whereupon the associated relay would become sluggish to release or would remain energised after the associated transistor input circuit was turned off. The power dissipation in a transistor in this condition would be well below its maximum rating, but it would be necessary to replace it with one having a lower leakage current. The author ran the prototype circuit for eight hours continually and after that time found no evidence at all that any precautions to prevent this effect were needed. Nevertheless it was felt that, since the bases of the TR2 transistors do not have a bias path with respect to emitter during the turn-off periods, the point should be mentioned for the sake of completeness.

The lamps used in the prototype were 12 volt 0.18 amp m.e.s bulbs, available from Home Radio under Cat. No. PL13. The 12.6 volts a.c. was provided by two 6.3 volt heater windings on a valve receiver mains transformer connected in series. Any mains transformer offering a secondary voltage of some 11 to 13 volts at a suitable current could be used. A typical example is the Home Radio Cat. No. TH11, whose secondary is rated at 12 volts 1.5 amps.

The relays can be any robust type having a coil resistance of 400 Ω or more and the requisite contact sets, and which are capable of energising reliably at 10 volts. Those used by the writer were P.O. 3000 types with 500 Ω coils. P.O. 3000 relays with 500 Ω coils and 3 sets of changeover contacts are available from G. W. Smith & Co. (Radio) Ltd., 3 Lisle Street, London, W.C.2. Not all of the contacts on these relays would need to be employed in the present circuit. Also, P.O. 3000 relays, made up to customer's specification, can be obtained from L. Wilkinson (Croydon) Ltd., Longley House, Longley Road, Croydon, Surrey. A useful mounting aid for the P.O. 3000 relays is given, incidentally, by the Lektrokrit Relay Mounting Plate No. 1, which has holes suitable for three relays. This can be obtained from Home Radio under Cat. No. LK-1011.

The final components to deal with are the charging capacitors, shown as

C1(A), C1(B), C1(C) and C2 in Fig. 1. The values required here depend on the operation time required for each stage of the switching cycle. With the prototype it was found that values of $8\mu\text{F}$ gave an operation time for each stage of about 2 seconds, whilst $32\mu\text{F}$ gave a time of approximately 9 seconds. Due to variations in capacitance value within the tolerance of each capacitor, together with gain spread in the transistors, some departures from these figures may be expected in practice. The capacitors used should have a working voltage of 10 or more,

and it would be in order to use components having much higher working voltages if these happen to be on hand. It is important to note that the capacitors should exhibit low leakage current and it would be preferable to employ components which are reasonably new. Should any capacitor have an exceptionally high leakage current the voltage across it will not rise to a sufficiently high value to turn on the transistors it couples to. A lower leakage current may not be high enough to prevent the associated transistors from turning on but it

could still extend the time needed for turn-on to occur. Modern electrolytic capacitors in good condition should offer no problems at all in this respect. If one (or more) of the capacitors used has had a prolonged shelf life, it is advisable to run the switch through at least half a dozen cycles before assessing the performance of the capacitor. This process will enable the capacitor plates to 'form' and the capacitor to 'settle down' to its final capacitance value.

SPECIAL NEXT MONTH

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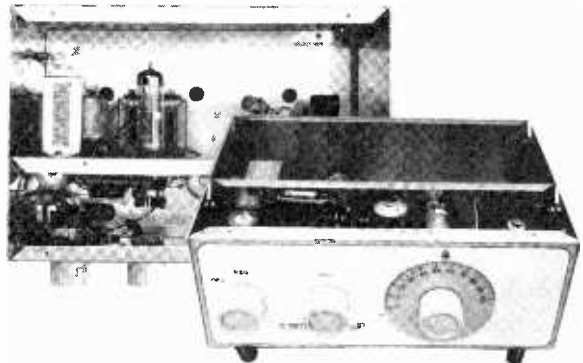
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NOTES ON SEMICONDUCTORS

Further Notes — 3

The series voltage regulator circuit offers a constant supply voltage, provides a voltage at a lower level than is elsewhere available, and gives protection against power line transients

MANY CIRCUITS HAVE HIGHER ACCURACY IF powered from a constant voltage supply; other circuits require a supply voltage different from that already available in the system of which they are to form part; yet others require protection against transients on the supply lines. All such requirements point to the need for voltage regulators and this note introduces perhaps the most basic form of series regulator.

SERIES REGULATOR

The elements needed are those already familiar from earlier notes* and the circuit is shown in the accompanying diagram. The breakdown voltage of TR1 (or the equivalent zener diode) must be slightly greater than the output voltage wanted, since there is the V_{be} of TR2 to be allowed for. The load current, divided by the current gain of TR2 gives the base current requirement of TR2, while the current in R1 must be sufficient to supply this base current and keep TR1 in the sharp breakdown region. To deduce the values required, it is probably best to take a particular example.

Assume a required load voltage of about 6V with a maximum load current of 30mA. The supply voltage is nominally 10.5V, but may vary from 9V–12V, and the transistor TR2 has a minimum current gain of 60 at the given load current.

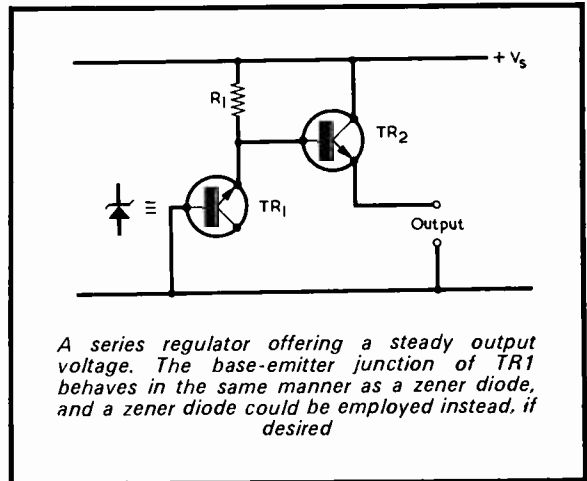
First check that the transistor ratings are not exceeded. The voltage across the transistor collector-emitter is a maximum of 6V and the maximum power dissipation is thus $6 \times 30 = 180\text{mW}$.

Both figures are well within the ratings of most modern silicon transistors provided they are not in a high ambient temperature. If in doubt use a transistor with a higher dissipation capability, or use a heat-sink. Secondly deduce the operating condition of the zener diode (or as in this case the reverse-biased transistor base-emitter junction). With maximum TR2 base current of 0.5mA ($30\text{mA}/60$) an additional 0.5mA would be a reasonable minimum current to ensure the diode remains in its breakdown condition. The minimum condition of this current is when the supply voltage is minimum simultaneously with load current maximum.

* See also 'Notes on Semiconductors' 1 to 6, published in the March to August 1971 issues.

STEADY DOES IT

by
Peter Williams



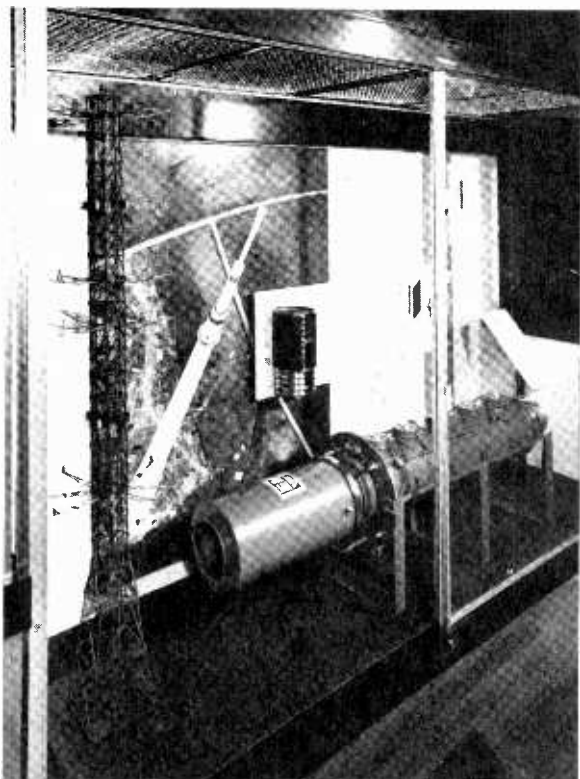
Adding 0.5V for the V_{be} of TR2 gives a required diode voltage of 6.5V and a minimum p.d. across R1 of 2.5V (9V–6.5V). At this p.d. a current flow of 1mA should be maintained (0.5mA each for the diode and the base of TR2). This gives $R1 = 2.5\text{k}\Omega$ or, choosing a near preferred value, $2.7\text{k}\Omega$ with a slightly lowered bias current for the diode. The maximum current in the diode occurs for the simultaneous conditions of maximum supply voltage and minimum load current. These conditions leave 5.5V across R1 (12V–6.5V) with all the current of 2mA ($5.5/2.7\text{k}\Omega$) flowing in the diode.

Thus the change in diode current is fourfold and limits the stability of the circuit against load changes. Other problems arise when fault conditions are imposed but these must be left till the next in this series. (As we shall then be referring to the same circuit conditions and components, this copy should be retained for reference.)

THERMISTOR TYPE R54

The thermistor type R54, specified for use in 'Wide Range Low Frequency Signal Generator', published in the October 1971 issue, is not now available from the retail source quoted in that article. This is a thermistor in everyday use and should however, be obtainable from many local component retailers. Readers experiencing difficulties may use the thermistor type R53 as an alternative, this being available from Henry's Radio, Ltd., 303 Edgware Rd., London, W.2.

SCIENCE MUSEUM DISPLAYS PROTOTYPE TV KLYSTRON



EMI-Varian Ltd. has presented a prototype UHF television klystron to the Science Museum, London, for its telecommunications gallery.

The photograph shows the EMI-Varian VA953 klystron installed in the Science Museum as part of display representing television transmission. The 5 ft. 10 in. long tube, weighs 220 lb.

EMI-Varian Ltd. has presented a prototype UHF television klystron to the Science Museum, London, for its telecommunications gallery.

This 55 kW klystron was the forerunner of the complete range of integral, high gain amplifier tubes which was used by the Independent Television Authority when it commenced UHF television broadcasting from unattended transmitter stations in 1969.

Displays in the gallery represent stages in the development of the various highly sophisticated systems which man uses today to communicate on a world-wide basis. The gallery, nearly 10,000 sq. ft. in area, provides about twice the space formerly available for displaying this collection.

The EMI-Varian VA953 klystron forms part of a display representing television transmission.

Background Information

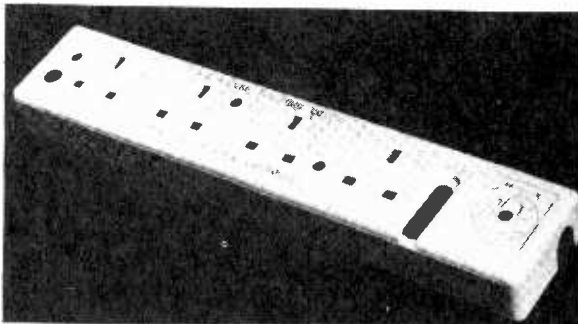
By 1967 Varian had almost completed development of its existing five-cavity klystrons to meet the exacting requirements of the ITA and the authority was able to confidently plan its future UHF network which would be based on unmanned transmitting stations. The ability to allow transmitters to operate unattended for long periods stemmed from the introduction of this new generation of klystrons and associated solid-state equipment. These klystrons have greater stability and reliability than previous external cavity tubes. They are simple to install and, at the end of their useful life, the tubes can be reconditioned and returned for further duty.

These new developments in transmitter equipment provided the ITA with significant advantages. Unmanned stations meant much lower operating costs in terms of manpower and its associated accommodation requirements, and the reliability of the new equipment enabled maintenance to be considerably reduced.

ITA's first integral 5-cavity klystrons were installed at its main London UHF transmitting station at Crystal Palace which began unattended operations on November 15th, 1969. This 1 MW station is designed to provide 625-line colour/monochrome transmissions for over ten million people.

BRITICENT "FOURLINE"

The British Central Electrical Co. Ltd., of Briticent House, 16-26 Banner Street, London, E.C.1., announce that a new 13amp 4-way "in line" fused socket designed as both an extension lead socket and as a surface mounting, wall or bench unit. It has a rubber interior with a tough P.V.C. "wipe clean" outer cover. It has many safety features including a neon indicator, plated contacts throughout, a shuttered fuse which is easily replaceable without removing the socket cover, and a patented ribbed cable lock. Available in black or white with recommended list prices of £2.00 and £2.40 respectively.



COMMENT

"SPACE-BAND" FOR AMATEURS

The International Telecommunications Union held a Conference in Geneva last summer, to consider the progress made in space telecommunications, since their similar conference in 1963.

One of the matters on the agenda was consideration of the "Amateur radio service" in relation to space telecommunication. A new definition of this aspect of amateur radio was agreed upon, which defined the "Amateur-Satellite Service" as, "a radio communication service using space stations on earth satellites for the same purpose as those of the Amateur Service".

Much discussion took place when the question of Frequency Allocations for this service came before the committee dealing with this topic, and had it not been for the presence of a strong International Amateur Radio Union observer team, a far less favourable decision would undoubtedly have been made.

Authority was ultimately gained for the Amateur Satellite Service to operate in sections of the existing 7MHz, 14 MHz, 21MHz, 28MHz and 145MHz amateur bands; and with certain provisions also in the 435MHz band. Authorisation was also granted in the 24GHz band.

These decisions thus create an Amateur Satellite Service, which is officially recognised and defined by International Radio Regulations.

IN BRIEF

● Mr. R. J. Hughes is the President of the Radio Society of Great Britain for 1972. A member of a number of the Society's committees Mr. Hughes first joined the R.S.G.B. in 1949 and obtained his amateur licence in 1950.

● The address of the Honorary Secretary of the Radio Amateur Invalid and Bedfast Club, Mrs. Frances Woolley, G3LWY, is now Woodclose, Penselwood, Wincanton, Somerset.

● "Understanding Television" our comprehensive work on TV, comprising 512 pages, is being reprinted. Owing to increased costs of production the cover price will be £2.10. There are still a few copies available, until the end of February, at the old price of £1.87, plus 20p for postage.

● Mr. Aubrey Buxton, an executive director of Anglia Television, is now a Vice-President of the Royal Television Society, and will serve for 2 years.

Lord Bowden, the President, and Mr. David Attenborough and Lord Thorneycroft existing Vice-Presidents are all serving for a further year.

● The ITA Annual Report and Accounts for 1970-71 may be obtained from Her Majesty's Stationery Office, price 85p.

FEBRUARY 1972

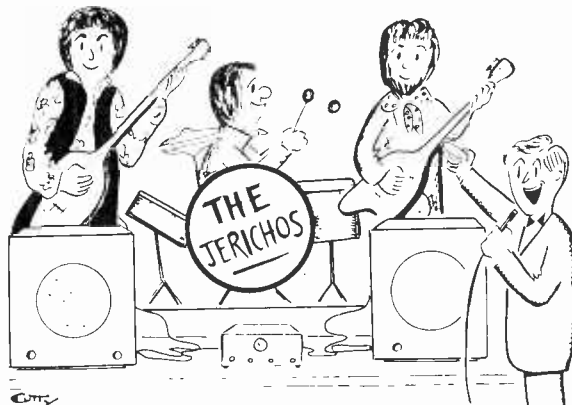
AUDIO FAIR DRAW ATTRACTED 35,000 ENTRIES



B. H. Morris & Co. (Radio) Ltd., the wellknown distributors of the TRIO range of equipment, organised a most successful free draw at their stand at the Audio Fair. There were no less than 35,000 entries, all of which were made directly on the stand. The draw was made by that respected figure in the world of Audio and Hi-Fi, the Festival Director, Mr. Cyril Rex-Hassam.

The prizes were, first: KA2000A Amplifier and KT1000A Tuner, total value £87.00; second: KA2000A Amplifier, total value, £34.50; third: KA2000A Amplifier, total value £34.50, and ten prizes of HS.2. Headphones value £6.50 each.

This success reflects very much the upward trend of enthusiasm in Hi-Fidelity when an exhibitor can positively claim to have had at least 35,000 visitors to his stand.



"I promise you boys and girls, when these boys turn the electronics on they'll bring the house down!"

AUTOMATIC THYRISTOR DIMMER

By
G. D. HOWAT

An interesting circuit which allows mains lamps to be remotely raised or lowered in brightness to any predetermined level. Resistive loads of up to 500 watts can be controlled

THE DEVICE TO BE DESCRIBED HERE IS BASICALLY A thyristor power controller of the type which is now becoming quite popular. However this version has an automatic facility which allows a slow, automatic change from one power level to another. The initial and final power levels are pre-set and may be anything from 0 to 100%, and the time taken for the change is also variable. When used as a lighting dimmer, the purpose for which the unit was originally intended, this means that the lights can be made to dim slowly from full brightness to any desired level or brought slowly back to full brightness (or any other lighting level) by simply pressing a switch.

BASIC METHOD OF OPERATION

There are two main electronic 'blocks' in the automatic dimmer, these being a triggered sawtooth oscillator and a Schmitt trigger. Fig. 1 shows the basic layout. The input mains supply is rectified by a full-wave bridge rectifier to give a series of positive-going half-cycles and the sawtooth oscillator is synchronised to these in the relationship shown in Fig. 2. This

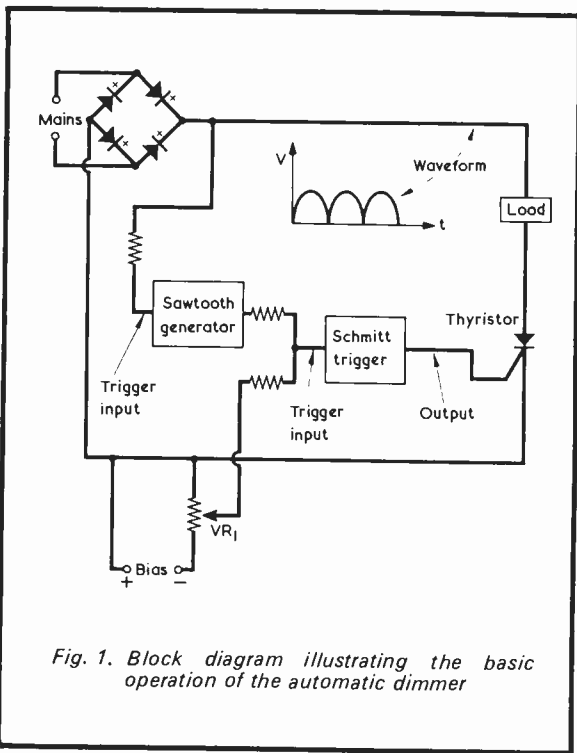


Fig. 1. Block diagram illustrating the basic operation of the automatic dimmer

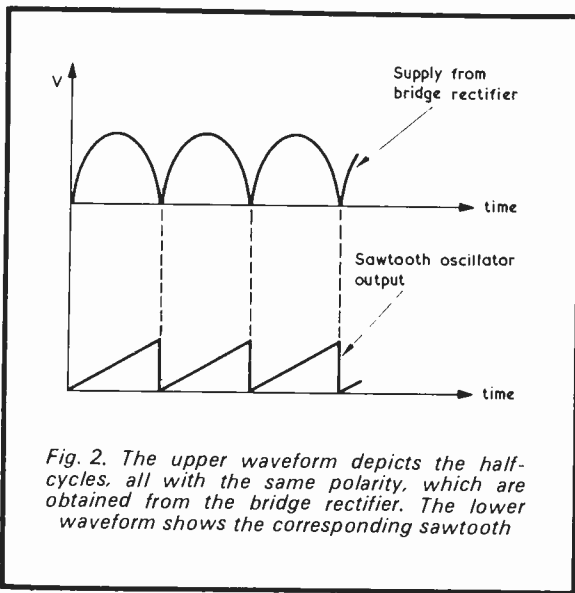
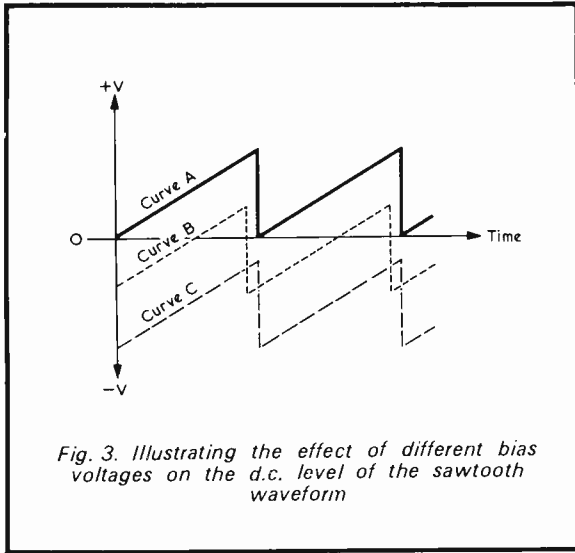


Fig. 2. The upper waveform depicts the half-cycles, all with the same polarity, which are obtained from the bridge rectifier. The lower waveform shows the corresponding sawtooth

sawtooth wave is algebraically added to a d.c. voltage and the resulting voltage/time relationships are shown graphically in Fig. 3. With VR1 of Fig. 1 set to give minimum bias curve A of Fig 3 is produced, as the bias is increased curve B and finally curve C results.

A Schmitt trigger is essentially a two-state switching circuit and it changes from one state to the other when the input voltage rises above a certain threshold value. Assume, for the moment, that this threshold happens to be 0 volts. Reference to Figs. 2 and 3 will show that as



the bias is increased this threshold value is reached at a progressively later point in each half-cycle, and if the bias is increased sufficiently the threshold will never be reached at all.

Reference back to Fig. 1 will thus show that as the bias is increased, the Schmitt trigger turns on the thyristor at progressively later stages of each half-cycle and therefore gives a linear control over the power supplied to the load.

A completely variable system thus results; varying the bias from zero volts to the critical maximum causes the Schmitt trigger to switch on later and later and thus varies the load power from almost 100% to zero.

PRACTICAL CONSIDERATIONS AND TIME DELAY

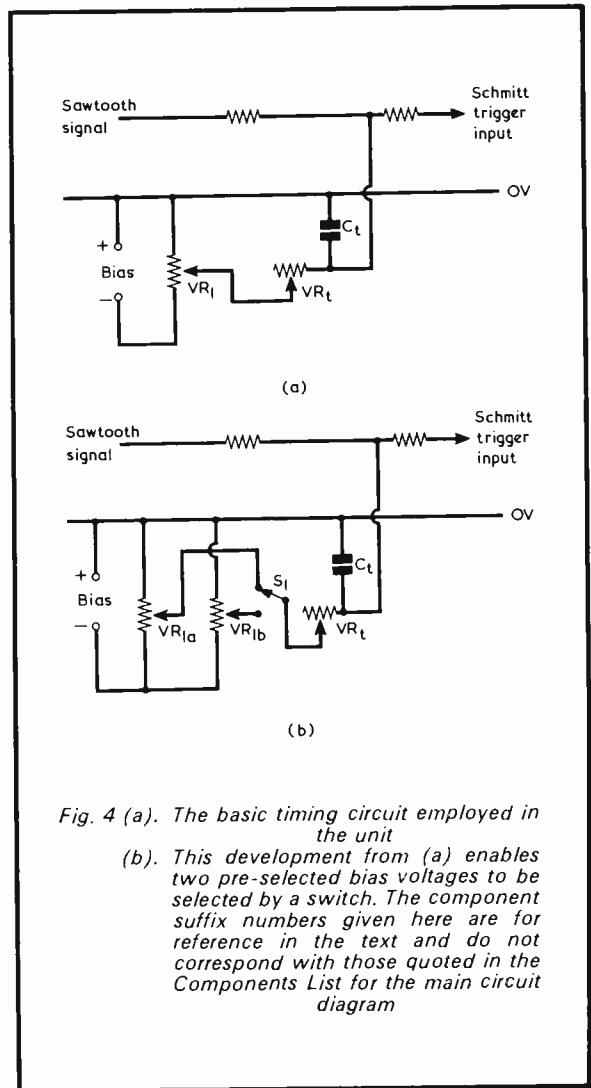
The practical version is very similar to the basic design. The Schmitt trigger threshold value is not zero volts but about 3 volts. This does not affect the circuit operation though, since the sawtooth wave produced by the oscillator does not drop to zero volts at the flyback, but 'flies back' to about 2 volts. This is an inevitable result of the oscillator design but in practice it turns out to be quite useful.

The time delay effect is produced by introducing a timing element in the bias supply, the basic idea being shown in Fig. 4(a). VR_t and C_t have a large time-constant so that a sudden change in the setting of VR_1 results in a much slower voltage change at the junction of VR_t and C_t , since C_t has to charge or discharge through VR_t . By using two potentiometers across the bias supply, and by switching from one to the other, it becomes possible to achieve a controlled change in power level by the action of operating a switch. This is the final modification needed to meet the required specification of the device and it is shown in Fig. 4(b). It can be seen that at any given time one or other of $VR_1(a)$ and $VR_1(b)$ will be controlling the output power level of the device. When S_1 is changed over the power level will change to the level specified by the other potentiometer. S_1 may be remote from the main electronics and connected to it by a 3-core cable. This allows the effect to be initiated from anywhere in the area concerned.

FEBRUARY 1972

OSCILLATOR

The requirement here is for a triggered sawtooth oscillator, synchronised to the rectified mains supply as in Fig. 2. Various types of oscillator were tried but they suffered from excessive complexity or unreliable synchronisation. Finally the circuit shown in Fig. 5 was developed and this was found to work well. The operation of the circuit is as follows. C_1 and R_5 provide a 'floating earth' for TR_1 and TR_2 so that these transistors have their emitters about a volt positive of the zero line. At time $t=0$, when the rectified mains voltage is instantaneously zero, TR_1 base will be slightly negative of the floating earth, so TR_1 will be cut off and TR_2 conducting. As soon as the next half-cycle gets under way TR_1 base will become positive with respect to its emitter, TR_1 will conduct and TR_2 will cut off. This condition will remain during the whole half-cycle. During this time C_2 will charge through R_6 . At the extreme end of the half-cycle TR_1 will cut off again, TR_2 will conduct and so will short-circuit most of the charge stored by C_2 .



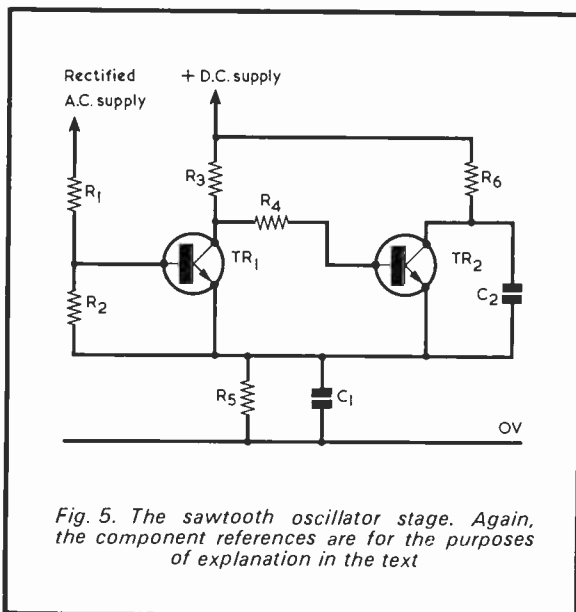
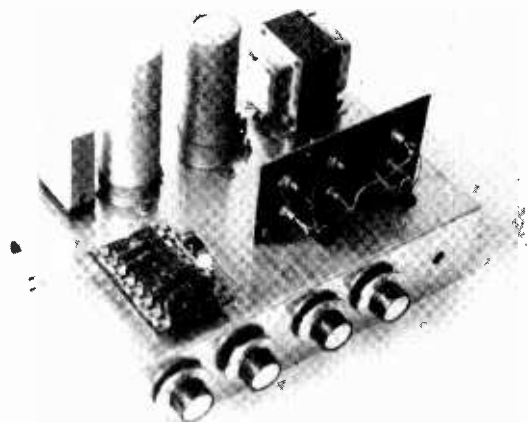


Fig. 5. The sawtooth oscillator stage. Again, the component references are for the purposes of explanation in the text

This process will be repeated during every half-cycle and the result is a sawtooth wave at TR2 collector. This is a triggered oscillator in every sense of the word since it will not oscillate in the absence of any trigger pulses.

The critical components in the oscillator are R6 and C2. In order to keep the sawtooth waveform reasonably linear, C2 should not be allowed to charge up beyond about 60% of the supply voltage. For this degree of charging, values of C2 and R6 may be calculated from the standard equation $T = CR$ (where T is time constant in seconds, C is capacitance in μF and R is resistance $M\Omega$). T in this case is 10^{-2} sec. (neglecting flyback) so possible values for these two components are: $1\mu F$ and $10k\Omega$; $0.47\mu F$ and $22k\Omega$; $0.2\mu F$ and $47k\Omega$; $0.1\mu F$ and $100k\Omega$; etc. The factors affecting the actual choice are: (a) the higher the value of R6 the more serious is the effect of the leakage current in TR2, for example using $R6 = 1M\Omega$ a leakage of $10\mu A$ in TR2 will cause almost the entire supply voltage to be lost across R6, so C2 will charge to only a very limited extent; (b) the higher the capacitance of C2, the

greater the charge that must be passed by TR2 when it begins to conduct. Unless TR2 is a power transistor any value of C2 greater than about $0.5\mu F$ can cause a damagingly high discharge current. The charge stored in a capacitor may be calculated: $Q = CV$ (where Q is in coulombs, C is in farads and V is in volts) and the average discharge current is $I_{av} = \frac{Q}{t}$ (where I is in amps, Q is in coulombs and t is in seconds). The time of discharge is the time during which TR2 is conducting, which is about 3×10^{-4} sec. The accompanying Table gives values for Q and the average discharge current for various values of C2. The instantaneous discharge current which will flow when TR2 first switches on will be much greater than the average value, and a factor of four must be allowed. This estimated maximum current is also shown in the Table, which indicates that, when using an ordinary low power transistor, a safe value for C2 is $0.2\mu F$. Such a value is used in the actual circuit.



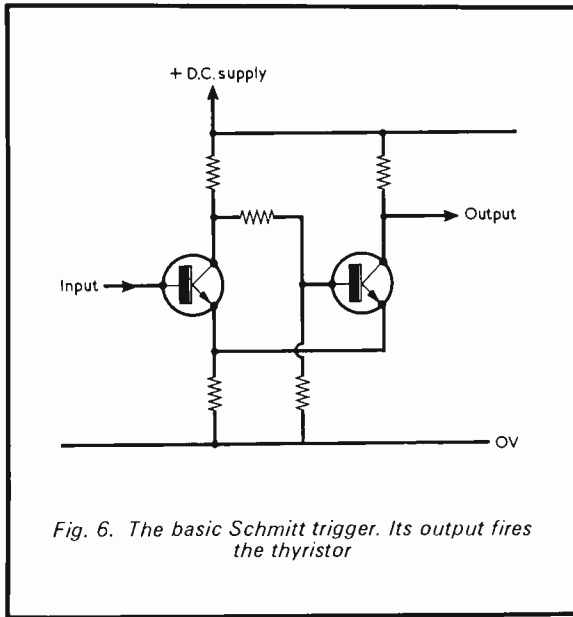
The top of the prototype unit. From left to right the controls are 'Set Level 1', 'Set Level 2', 'Fine Time Control' and 'Coarse Time Control'. On the chassis is the tagboard for the dropper resistors, and the vertical board on which are mounted all five diodes and the thyristor. At the rear of the chassis are the relay (which in the prototype took the place of S2), two timing capacitors and the heater transformer

TABLE

RC combination	$1\mu F$ and $10k\Omega$	$0.47\mu F$ and $22k\Omega$	$0.2\mu F$ and $47k\Omega$	$0.1\mu F$ and $100k\Omega$
Time to charge to approx. 60% of supply (seconds)	1.00×10^{-2}	1.3×10^{-2}	0.94×10^{-2}	1.00×10^{-2}
Charge stored (Q) assuming charging to 5 volts (coulombs)	5×10^{-6}	2.4×10^{-6}	1.0×10^{-6}	0.5×10^{-6}
Average discharge current (mA)	17	8	3.3	1.7
Estimated peak discharge current (mA)	70	32	13	7

SCHMITT TRIGGER AND TIMING CIRCUITS

The Schmitt trigger is essentially a two-stage amplifier with positive feedback effected by a common emitter load, the basic version being shown in Fig. 6. The two



stable states correspond to: (1) the input transistor cut off and the output transistor conducting, hence giving a low output voltage, (2) the converse state with the output transistor cut off and the output at the positive line level.

When used on a 7-volt supply the circuit changes from the first stable state to the second when the input rises above 3.5 volts. The change back occurs when the input falls below 2 volts. There is thus some asymmetry about the system but this does not affect the circuit operation.

As already mentioned, Fig. 4(b) shows the basic timing circuit. At any give time the output power level is set by one or other of VR1(a) and VR1(b). When S1 is changed over the power level output alters to that corresponding to the setting of the other control. Sensible values for the components of Fig. 4(b) are: VR1(a) and (b) 5k Ω , VRt 10k Ω . Ct is determined by the range of timing required, 250 μ F gives a range from approximately 0 to 10 seconds, 1,000 μ F from approximately 5 to 40 seconds, 5,000 μ F from approximately 20 seconds to 3½ minutes.

The bias supply is conveniently derived from a 6.3 volt transformer and rectifier. In the prototype S1 was replaced by a relay with a set of changeover contacts. The power for the relay came from the bias supply.

PRACTICAL CIRCUIT AND LAYOUT

Fig. 7 shows the complete circuit. (In this diagram a number of the components suffix numbers are different from those used in the previous explanatory diagrams.) The power supplies for the oscillator and Schmitt trigger are obtained by smoothing some of the rectified

mains supply, clearly no additional rectifiers are needed. An emitter follower, TR3, is used on the output of the oscillator and C6 is added as a 'speed-up' capacitor across R16. Apart from these points the overall circuit is that of Figs. 4(b), 5 and 6 joined together, and the method of operation should be quite clear. The measured direct voltages across C1 and C4 are about 9 and 16 volts respectively.

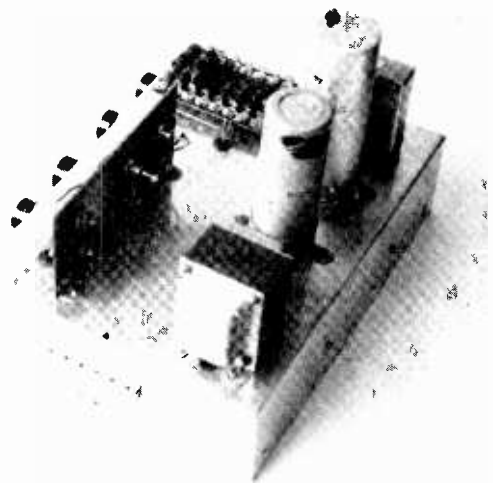
If desired, S1 could be 2-way, selecting two timing periods only, whereupon C10 is not required. It may be noted that R7 has a value of 56k Ω instead of the 47k Ω mentioned when the oscillator section was discussed. This slightly increased value gives satisfactory results in practice.

This circuit will fade tungsten-filament lamps from full brightness to complete extinction. The maximum controllable power is 500 watts. At full brightness not less than 99% of the input mains supply is applied to the load. Negligible power is consumed by the control circuits, this being a mere 250mW, although the dropper resistors needed to provide the power supplies dissipate about 3 watts. These droppers could, if required, be omitted, and the power supplies obtained from another transformer and rectifier, as with the bias.

Fig. 8 gives a suitable Veroboard layout for most of the components. The two sets of droppers needed to provide the d.c. supplies should be mounted apart from the main electronics. The various rectifiers, the thyristor, transformer, timing capacitors, and controls were also, of necessity, separate. The original prototype was built on an aluminium chassis with the five rectifiers and thyristor mounted on an insulated panel on the top. The power input and output leads were taken through a block connector at one end and the trigger connections through a similar connector at the other.

SAFETY AND INTERFERENCE ASPECTS

This device shares one disadvantage with most other thyristor power controllers: since the mains supply is directly applied to the control circuits there is a risk of electric shock. It is impossible to earth the circuit since



Another view above the chassis. Note the terminal strip, on the chassis edge, for external connections

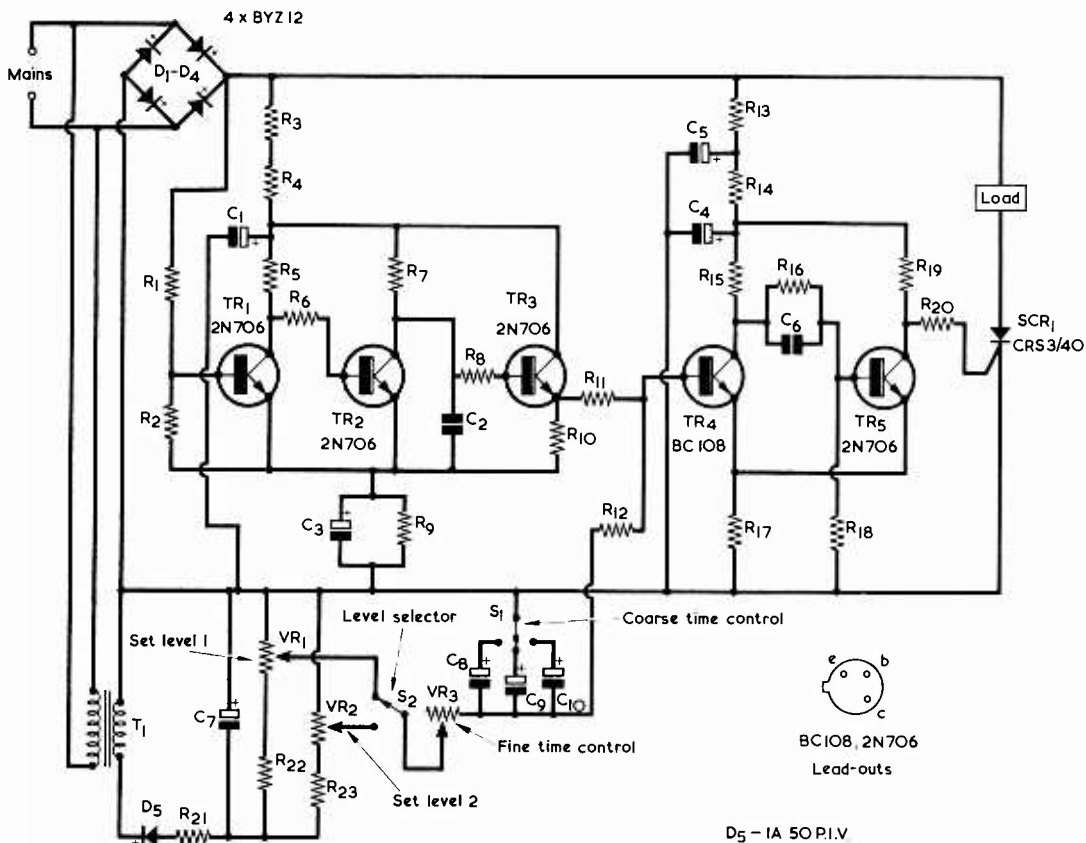


Fig. 7. The complete circuit of the automatic dimming unit

COMPONENTS

Resistors

(All fixed values 10% unless otherwise stated)

R1	120k Ω	1 watt
R2	4.7k Ω	$\frac{1}{4}$ watt
R3	82k Ω	$\frac{1}{2}$ watt 5%
R4	82k Ω	$\frac{1}{2}$ watt 5%
R5	6.8k Ω	$\frac{1}{4}$ watt
R6	2.7k Ω	$\frac{1}{4}$ watt
R7	56k Ω	$\frac{1}{4}$ watt
R8	100k Ω	$\frac{1}{4}$ watt
R9	1k Ω	$\frac{1}{4}$ watt 5%
R10	10k Ω	$\frac{1}{4}$ watt
R11	22k Ω	$\frac{1}{4}$ watt
R12	22k Ω	$\frac{1}{4}$ watt
R13	22k Ω	5 watt 5%
R14	4.7k Ω	1 watt 5%
R15	1k Ω	$\frac{1}{2}$ watt
R16	6.8k Ω	$\frac{1}{2}$ watt
R17	100 Ω	$\frac{1}{4}$ watt 5%
R18	10k Ω	$\frac{1}{4}$ watt
R19	1k Ω	$\frac{1}{2}$ watt
R20	680 Ω	$\frac{1}{2}$ watt
R21	33 Ω	$\frac{1}{2}$ watt
R22	2.7k Ω	$\frac{1}{2}$ watt
R23	2.7k Ω	$\frac{1}{2}$ watt

VR1	5k Ω potentiometer, linear, carbon
VR2	5k Ω potentiometer, linear, carbon
VR3	10k Ω potentiometer, linear, carbon

Capacitors

C1	100 μ F electrolytic, 15 V. Wkg.
C2	0.2 or 0.22 μ F paper or plastic foil
C3	25 μ F electrolytic, 15 V. Wkg.
C4	25 μ F electrolytic, 25 V. Wkg.
C5	25 μ F electrolytic, 25 V. Wkg.
C6	0.002 or 0.0022 μ F paper or plastic foil
C7	50 μ F electrolytic, 15 V. Wkg.
C8	} To suit timing periods required (see text)
C9	
C10	

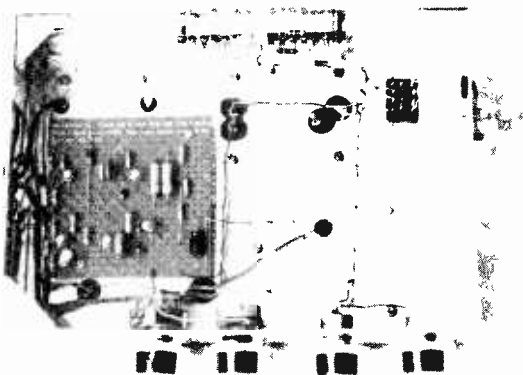
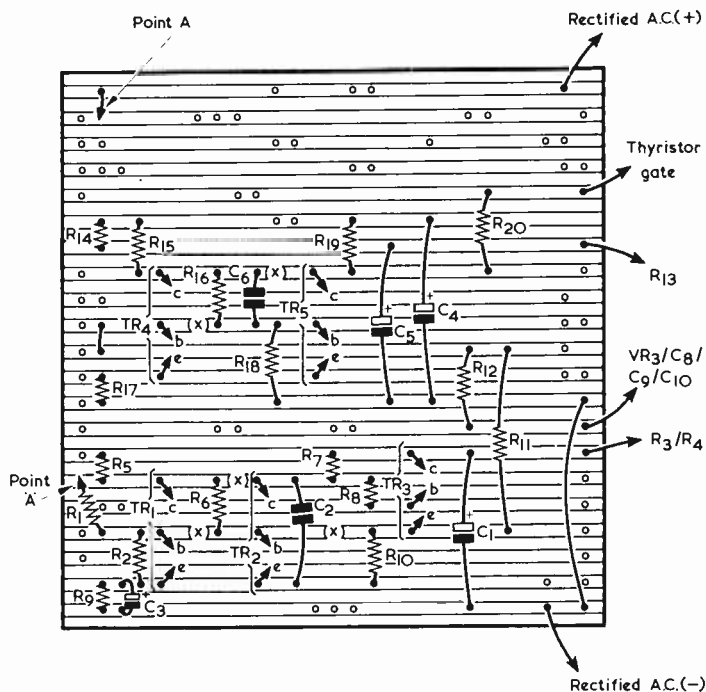
Transformer

T1 Heater transformer, secondary 6.3V 1A

Semiconductors

TR1	2N706	S1	1-pole 3-way, rotary (see text)
TR2	2N706	S2	1-pole 2-way, rotary or toggle
TR3	2N706		
TR4	BC108		
TR5	2N706		
D1-D4	BYZ12		
D5	Silicon rectifier, 50 p.i.v., 1A		
SCR1	CRS3/40		

Fig. 8. Many of the components in the prototype were mounted in a well spread-out layout on a piece of Veroboard having 26 holes per strip, as shown in this view from the component side. As there is relatively wide spacing between components, individual holes are not shown, it being merely necessary to connect to the correct strips



Underneath the chassis. The tagstrip at the rear is used for the components associated with the bias supply

this would short-circuit the bridge rectifier. Although the prototype was constructed on a metal chassis, no connection was made to this chassis. All components were isolated from it, and the whole unit was enclosed in an insulating case. It would be advisable, though not strictly necessary, to include an isolating transformer in the mains input circuit.

Some radiation is inevitable from a device of this kind and this can cause interference with nearby radio receivers. The use of an isolated chassis, as described above, will reduce this interference, and a further reduction can be made by connecting a capacitor between anode and cathode of the thyristor. Values between $0.1\mu\text{F}$ and $0.5\mu\text{F}$ may be tried in this position. These methods should be sufficient to reduce interference to an imperceptible level without affecting the performance of the unit at all. ■

BACK NUMBERS

For the benefit of new readers we would draw attention to our back number service. We retain past issues for a period of two years and we can, occasionally, supply copies more than two years old. The cost is the cover price stated on the issue, plus 4p postage. Before undertaking any constructional project described in a back issue, it must be borne in mind that components readily available at the time of publication may no longer be so. We regret that we are unable to supply photo copies of articles where an issue is not available. Libraries and members of local radio clubs can often be very helpful where an issue is not available for sale.

OVERLOAD TRIP CIRCUIT

By

G. A. MILLER and M. N. POINTING

A neat trip circuit for the protection of simple power supplies.

THE POWER SUPPLY UNIT DESCRIBED IN THIS ARTICLE employs a half-wave rectifier and incorporates a thyristor overload trip to protect the mains transformer from occasional short-circuits.

THE CIRCUIT

The circuit of the power supply appears in the accompanying diagram. In this, the mains transformer secondary may have any desired voltage rating up to a maximum of 14 volts. Its current rating should be adequate for the maximum current it is intended that the supply will provide, and this should be between 75 and 200mA.

The secondary voltage is rectified by D1, and the resultant direct voltage appears across reservoir capacitor C1. R1 and C2 provide smoothing in the usual manner. The positive potential is then applied direct to the positive output terminal. The negative potential is, on the other hand, fed to the negative output terminal by way of VR1 and transistor TR1. TR1 is kept conductive due to the base current which flows through R3, R4 and silicon diode D2.

If an excessive current is caused to flow in the output circuit the voltage dropped across VR1 rises to a sufficiently high level to trigger the thyristor TH1, the triggering current flowing to TH1 gate via R2. As soon as TH1 triggers its anode takes up a potential that is a fraction of a volt more positive than its cathode. The junction of R3 and R4 also take up this potential, with the result that no further base current flows in TR1. This transistor cuts off and the load current ceases, whereupon the overload protection trip has taken place. The presence of D2 ensures that base current in TR1 is fully cut off since the positive potential on the anode of TH1 is insufficient to pass the initial forward voltage required for the diode to conduct. At the same time, the only current drawn from the rectifier, D1, is the relatively low value which flows through R1, R3 and the conducting thyristor.

To return the circuit to its previous condition the mains input has to be switched off for a few seconds (to allow C1 and C2 to discharge) and is then switched on again. If the short-circuit is still present the trip action will take place once more.

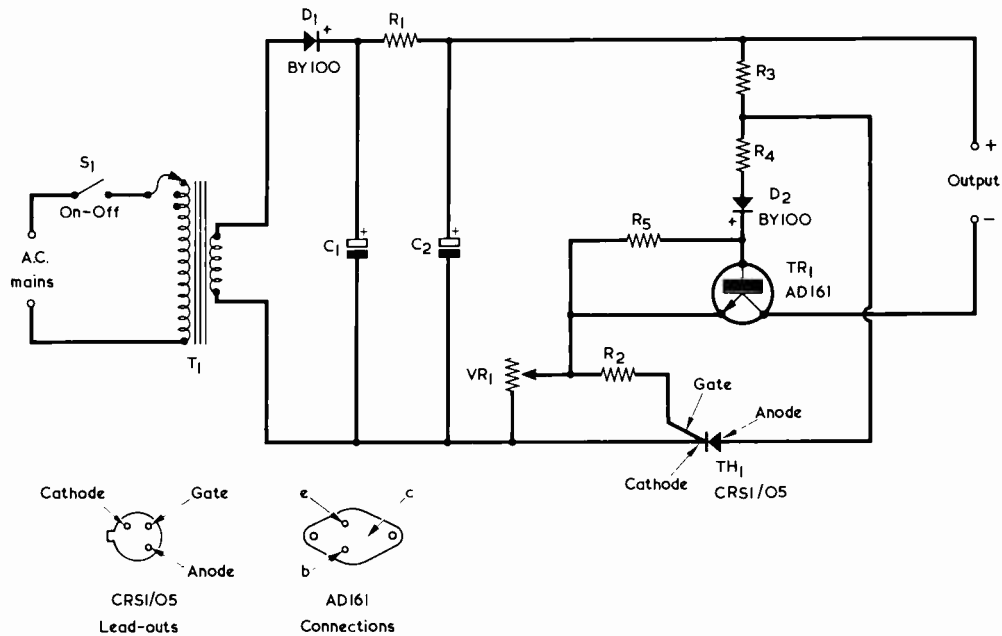
COMPONENTS

The components employed are all standard types. D1 and D2 were BY100's in the authors' version, since these were to hand, but any other small silicon rectifier rated at 1 amp could be employed instead. An AD161 was chosen for TR1 because it is capable of passing a current of 3 amps. It does not need to be mounted on a heat sink because, apart from the instant of trip, it is either fully conductive or fully cut off and consequently dissipates very little heat. It has a maximum V_{CEO} of 20 volts, which could be exceeded in the tripped condition if the mains transformer secondary voltage was greater than 14 volts. Power transistors with higher V_{CEO} figures would enable higher transformer secondary voltages to be used.

As stated, the mains transformer secondary may have whatever voltage is required up to the 14 volt figure. The direct output voltage of the power supply under no-load conditions will be a little less than 1.4 times the secondary voltage.

VR1 is set up so that the thyristor triggers at the intended overload current. It can be calibrated in terms of trip current in the following manner. Set VR1 to insert minimum resistance and connect a variable reading meter across the output terminals of the power supply. Obviously, the variable resistor load should insert maximum resistance at this stage. Switch on and adjust the variable load resistance so that an output current of 75mA flows. Slowly advance VR1 until the circuit trips. Mark the setting of VR1, noting that this corresponds to a trip current of 75mA. Repeat the process in 10mA steps up to the maximum current (which should not exceed 200mA) that it is intended that the supply should provide.

As a guide to what is required for the variable load resistor, this would need to be a 150Ω 5 watt component if the power supply offered a nominal output voltage of 9 volts. If a suitable component is not already to hand, its purchase could be considered expensive since it is employed for a calibration that is carried out once only. Suitable alternatives would be given by series parallel combinations of fixed resistors or, better, a mains valve receiver heater dropper resistor having an adjustable sliding contact.



The circuit of the power supply. The overload trip is carried out by TH1, TR1 and the associated components

COMPONENTS

Resistors

(All fixed values 10%)

R1	10 Ω	1 watt
R2	30 Ω	$\frac{1}{2}$ watt
R3	1k Ω	$\frac{1}{2}$ watt
R4	1k Ω	$\frac{1}{2}$ watt
R5	470 Ω	$\frac{1}{4}$ watt
VR1	25 Ω potentiometer, wire-wound,	1 watt

Capacitors

(Working voltages to suit transformer secondary)

C1	500 μ F electrolytic
C2	1,000 μ F electrolytic

Semiconductors

TR1	AD161
TH1	CRS1/05
D1, D2	BY100 (see text)

Transformer

T1	As required (see text)
----	------------------------

Switch

S1	s.p.s.t., toggle
----	------------------

Miscellaneous

Output terminals
Pointer knob

NEW VENNER TIME CONTROLS BROCHURE

Venner - A Division of AMF International Limited, have just issued a new colour brochure on their Time Control equipment. This brochure gives a brief summary of the features of their more popular range of timers for heating, lighting and process control for industrial and domestic applications.

Units included are the well established central heating controllers, time switches with solar dials which automatically compensate for the change in daylight hours throughout the year, a push-button process timer with automatic re-set and a miniature time switch for fitting into a lamp holder to operate the lamp ON and OFF at preset times.

This brochure, together with the recently issued Paragon Time Controls brochure, highlights the extensive range of time controls now available from Venner.

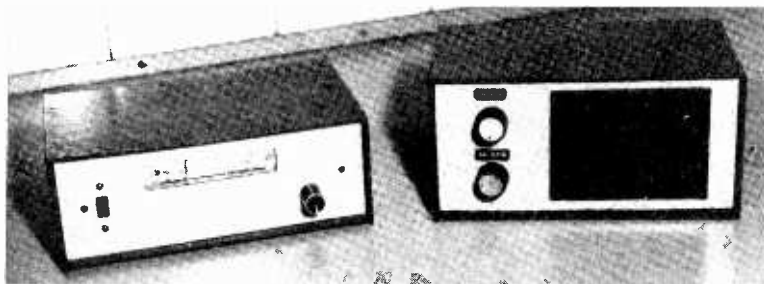
For further information write to General Sales Manager, Venner - A Division of AMF International Limited, Kingston By-Pass, NEW MALDEN, Surrey.



Cover Feature

A.F. Amplifier for beginner

E
J. HO



This a.f. amplifier offers the novice a useful feature by combining it with a ready-made f.m. tuner, but delay for reproduction

FOR THE NEWCOMER, JUST ENTERING THE FIELD OF radio construction, the choice of a suitable initial project can present some problems. Construction of a simple one or two transistor radio receiver is often suggested as a suitable starting-off point, but it has been the author's experience, during a period of introducing a number of schoolchildren to the radio hobby, that this choice can prove a little too ambitious for the complete novice. Sets of the type mentioned are often rather tricky to set up due to the use of regeneration, while good results are normally only obtainable in areas of relatively high signal strength. Frustration sets in, and the would-be constructor rapidly loses interest.

A.F. AMPLIFIER

An alternative solution with much to recommend it is that of, so to speak, 'starting at the back page,' and undertaking the construction of an a.f. amplifier of either transistor or valve design. The amateur is thus introduced to the relatively simple principles of audio amplification before the greater complexities associated with r.f. circuitry are tackled. Unfortunately, he tends at this stage to be left in possession of a fully satisfactory amplifier which must either be used with existing commercial receiving equipment, for which it may not be ideally suited, or shelved until the skill necessary to construct a matching tuner has been acquired.

In the project presented here, the beginner is presented with a design for a complete v.h.f. receiver which can be used both for quality reception of existing B.B.C. stations or for the local radio broadcasts which have commenced in many parts of the country. The design consists of a three transistor amplifier of simplified construction, which is fed from the output of a pre-built v.h.f. tuner. All wiring and constructional work on the amplifier are well within the capabilities of the handyman (or boy) who can handle a soldering iron, a vice, and a few simple hand tools. In spite of its simplicity,

however, the quality of reproduction is good, this being due in part to the use of power transistors in the output stage. A useful feature is the provision of separate cabinets for tuner and amplifier, both of which are sufficiently presentable in appearance to be used together as a complete unit, or individually in conjunction with other equipment which may be constructed or acquired at a later stage.

TUNER

The f.m. tuner is the type A.1005, available from Henry's Radio, Ltd., and it is purchased as a complete chassis assembly. A few minor additions are carried out for the present application in order to facilitate the subsequent housing of the unit. Initially, a small sub-chassis should be constructed from aluminium sheet, using Fig. 1(a) as a guide. This sub-chassis fulfils three functions. First, it provides a base for the tuner itself. Second, it holds the decorative Formica front panel in position (see Fig. 1(b).) Third, it provides small flanges at the rear for mounting the input and output sockets. The components which are additional to the tuner itself should be wired into circuit as indicated in Fig. 1(c).

It should be noted that the 3in. height dimension shown in Fig. 1(b) is nominal and may require slight alteration to suit the particular tuner and sub-chassis assembly. Before cutting out the Formica, check that the tuning scale cut-out corresponds with the actual scale of the tuner and, if necessary, redimension.

In the interests of versatility, provision is made for both coaxial and twin feeder aerial inputs to the tuner. Audio output is taken via a standard phono-type socket. The battery recommended is an Ever Ready PP3 and this can be positioned alongside the tuner chassis on the same side as the on-off switch. It is a good plan to provide a battery holding clip, which can be mounted on the sub-chassis.

Amplifier Inners

ACK

ul introduction to electronics since,
er chassis, he is able to use it without
radio transmissions

The method of assembly should be clear from the photographs illustrating the tuner. The Formica front panel of Fig. 1(b) is bolted to the front flanges of the sub-chassis by two 6BA bolts, and the slide switch, in its turn, is mounted to the panel.

After completing the simple items of wiring required, it is advisable to check that the tuner is functioning correctly. This can be easily carried out by connecting an aerial (a short length of wire will suffice at this stage), a battery and headphones. It is worth noting that in most areas a faint but perfectly audible signal can be received with the 35Ω speaker specified for the amplifier connected directly to the tuner output; thus, if headphones are not readily available this is quite a useful method of verifying correct tuner operation.

AMPLIFIER

The amplifier circuit itself, which is shown in Fig. 2, was purposely kept as straightforward as possible. This, together with the 'breadboard' layout adopted, makes it eminently suitable for the beginner. A word about the circuit used may be of some interest. In general, output transistors of the power type, as used here, require a phase inversion network based on two driver transistors of opposite polarity, p.n.p. and n.p.n., whilst an alternative circuit employs transformer coupling throughout.

The former circuit, employing two drivers, can be rather difficult to adjust for optimum balance combined with absence of crossover distortion, while the latter, although simple, requires a rather bulky output transformer. In the present instance a compromise was effected by using a driver transformer with two secondary windings to effect phase inversion. This transformer can be quite small since little audio power is present at this point, while the split secondary enables direct capacitive coupling to be taken from the output transistors to the speaker, thus saving the bulk

FEBRUARY 1972

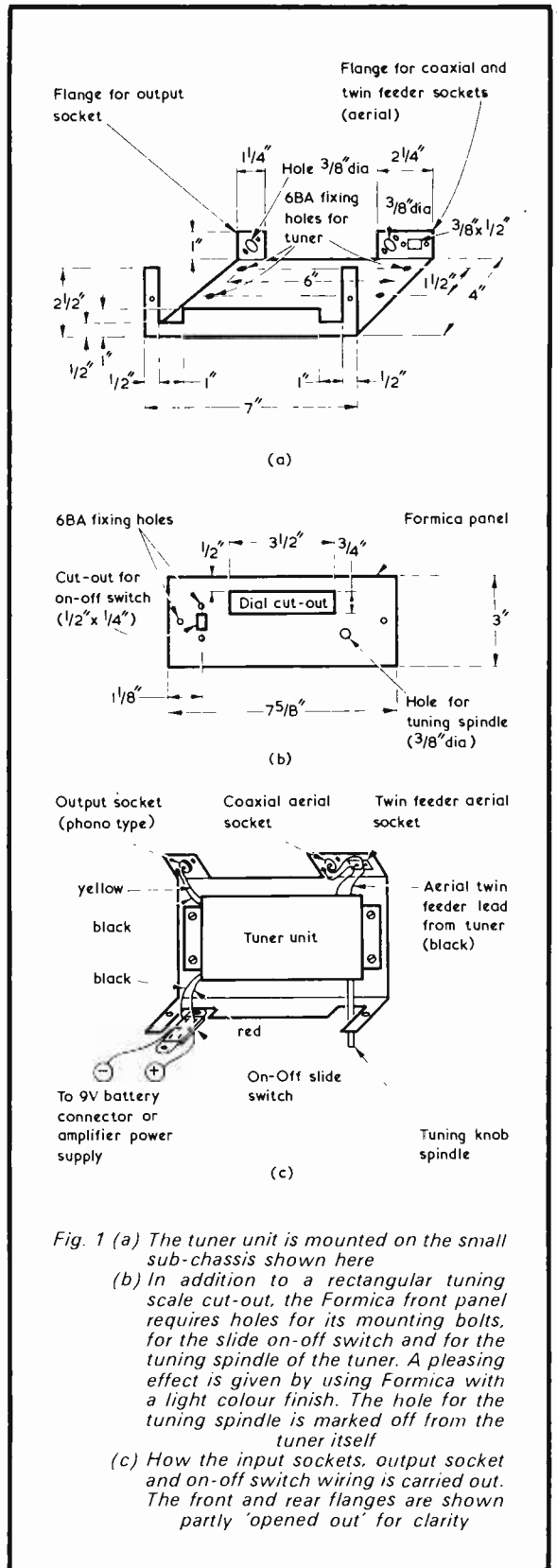


Fig. 1 (a) The tuner unit is mounted on the small sub-chassis shown here

(b) In addition to a rectangular tuning scale cut-out, the Formica front panel requires holes for its mounting bolts, for the slide on-off switch and for the tuning spindle of the tuner. A pleasing effect is given by using Formica with a light colour finish. The hole for the tuning spindle is marked off from the tuner itself

(c) How the input sockets, output socket and on-off switch wiring is carried out. The front and rear flanges are shown partly 'opened out' for clarity

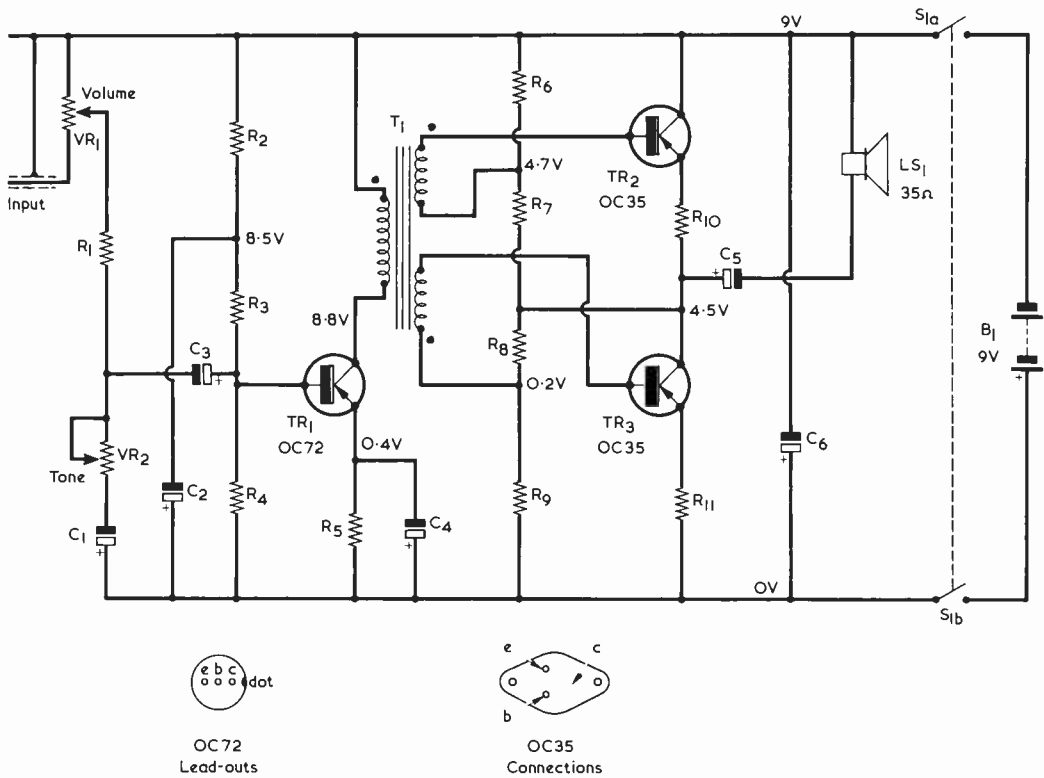


Fig. 2. The circuit of the a.f. amplifier. Approximate voltages with respect to the positive supply line are shown in appropriate points of the circuit

COMPONENTS A.F. AMPLIFIER

Resistors

(All fixed values $\frac{1}{4}$ watt 10°)

R1	470 Ω
R2	1k Ω
R3	47k Ω
R4	10k Ω
R5	560 Ω
R6	5k Ω
R7	100 Ω
R8	5k Ω
R9	100 Ω
R10	1.5 Ω
R11	1.5 Ω
VR1	5k Ω potentiometer, log, with switch S1(a)(b)
VR2	25k Ω potentiometer, line

Capacitors

(All capacitors electrolytic)

C1	1 μ F, 10 V. Wkg.
C2	50 μ F, 10 V. Wkg.
C3	10 μ F, 10 V. Wkg.
C4	50 μ F, 6 V. Wkg.
C5	100 μ F, 10 V. Wkg.
C6	100 μ F, 10 V. Wkg.

Transformer

T1	Driver transformer type T/T5 (Henry's Radio, Ltd. or Home Radio, Ltd.)
----	--

Transistors

TR1	OC72
TR2	OC35
TR3	OC35*

* With mica washer and insulated mounting bushes.

Loudspeaker

LS1 35 Ω loudspeaker, 3in., 2 $\frac{1}{2}$ watts (see text)

Switch

S1(a)(b) d.p.s.t. switch, part of VR1

Battery

B1 9-volt battery type PP9

Miscellaneous

2 knobs
2 tagboards (see text)
1 5-way tagstrip, centre tag earthed
Formica for front panel
Plywood for baseboard
Material for heat sink
Speaker fabric
Phono plug
Battery connectors
Flexible screened lead
Hardboard for case

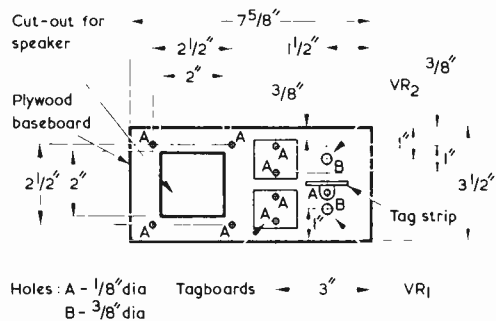
COMPONENTS F.M. TUNER

V.H.F. f.m. transistor tuner type A.1005 (Henry's Radio, Ltd.)
 Coaxial aerial socket
 Coaxial phono socket
 Twin feeder aerial socket
 D.P.D.T. slide switch
 PP3 9-volt battery
 Formica for front panel
 Material for sub-chassis
 Hardboard for case
 Battery connectors

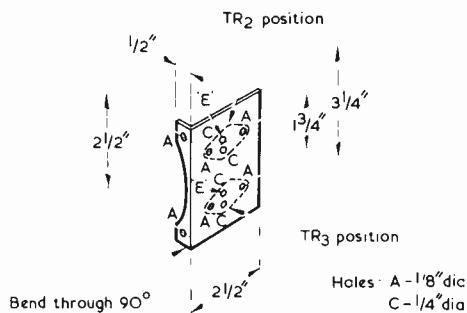
(and the cost) of a large output component.

The amplifier is constructed in two sections. A $\frac{3}{16}$ in. plywood baseboard, dimensioned as in Fig. 3(a), carries the speaker, panel controls, and all components associated with driver transistor TR1; while the output transistors are mounted on a heat sink constructed from sheet aluminium, as shown in Fig. 3(b). This sink is bolted, over the speaker frame, at the two speaker mounting holes nearest the tagboards, its circular cut-out accommodating the circular section of the speaker. The bodies of the output transistors, when these are fitted, will appear on the speaker side of the sink, and holes are drilled for them as indicated in Fig. 1(b), where the letter 'E' identifies the hole which will correspond to the emitter lead-out.

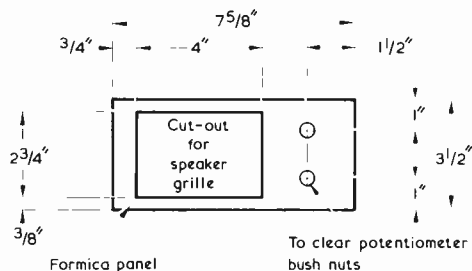
Before proceeding further it should be mentioned that the heat sink dimensions in Fig. 3(b) correspond to the particular 3 in. speaker employed by the writer, which is a Richard Allan type 395, the front part of whose frame metal frame is flat with a square outline. If the Richard Allan speaker cannot be obtained, any other 3 in. speaker of the same impedance, and preferably with a flat outer frame section, can be used instead, but it might be necessary to slightly alter the positions of the 'A' speaker holes in Figs. 3(a) and (b). A 3 in. speaker having a different construction could also be employed, the design of the heat sink mounting arrangements being modified accordingly. Whatever speaker is used should have a power capability of $2\frac{1}{2}$ watts, as has the Richard Allan component.



(a)

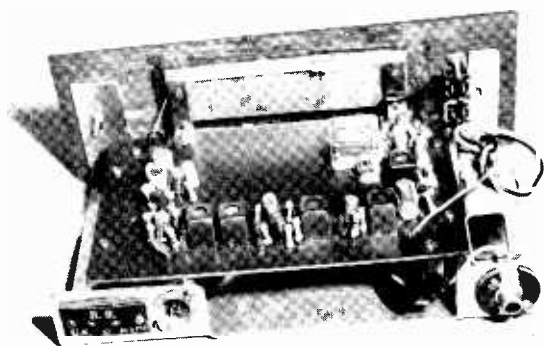


(b)

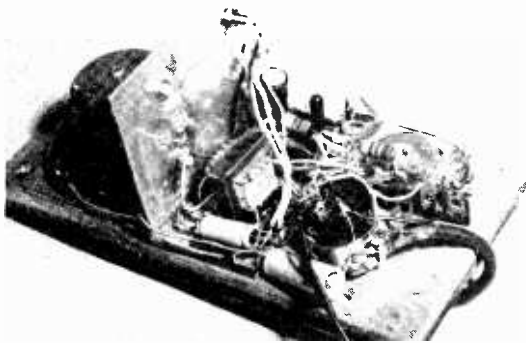


(c)

Fig. 3 (a). Component positioning on the amplifier baseboard. The bodies of the two potentiometers are on the same side as the tagboards and the speaker, and their spindles project on the opposite side of the board, away from the reader
 (b). Details of the heat sink for the output transistors
 (c). Cutting out the Formica for the amplifier front panel



The pre-built f.m. tuner is fitted to its sub-chassis in the manner illustrated here. Note also the rear of the Formica panel and the slide on-off switch



The amplifier board, with components mounted. The heat sink, secured under two of the speaker mounting nuts, appears near the centre

Construction is commenced by drilling the board in accordance with Fig. 3(a) and mounting the two panel controls, the loudspeaker, the tag strip and the two tagboards in the positions shown. The tagboards are 2 x 6-way each and their outside dimensions should not exceed 1½ by 1½ in. Suitable boards can be obtained by cutting down two miniature 2 x 10-way tagboards as retailed by Henry's Radio Ltd. The 5-way tag strip is a standard type with the centre tag also providing a mounting lug. The tagboards are orientated as indicated in the wiring diagram of Fig. 4.

Countersunk head bolts should be used for securing items to the board, as these enable a piece of decorative

Formica (see Fig. 3(c)) to be glued flush with the board after construction has been completed. Thin fabric is fitted behind the speaker aperture. The Formica should be chosen to match that on the front of the tuner assembly.

Bend and drill the aluminium heat sink as required, and bolt the two OC35's into position. Note that TR3 must be insulated carefully from the metal of the sink by means of a mica washer and insulated mounting bushes. A solder tag is fitted under one of the securing nuts for each transistor to provide a connection to the collector. The heat sink is common to the negative supply rail, and so there is no need to use an insulated mounting for TR2, which can be bolted direct to the sink.

The wiring of the amplifier, which is quite straightforward, follows Fig. 4. Since ample space is available above the board it is possible to leave the lead-out wires of TR1 fairly long, so as to avoid any chance of heat damage to this transistor whilst soldering it into position. All capacitors must be wired with the correct polarity.

POWER SUPPLIES

In the interests of making the complete receiver as versatile as possible, separate batteries were used in the prototype for both tuner and amplifier. It is not a difficult matter, however, to wire the tuner to function from the amplifier battery if desired. Both amplifier and tuner operate with a negative chassis line; therefore, since the coaxial interconnecting lead feeding the tuner output to the amplifier already carries an earth return, only a positive tuner connection to the amplifier battery

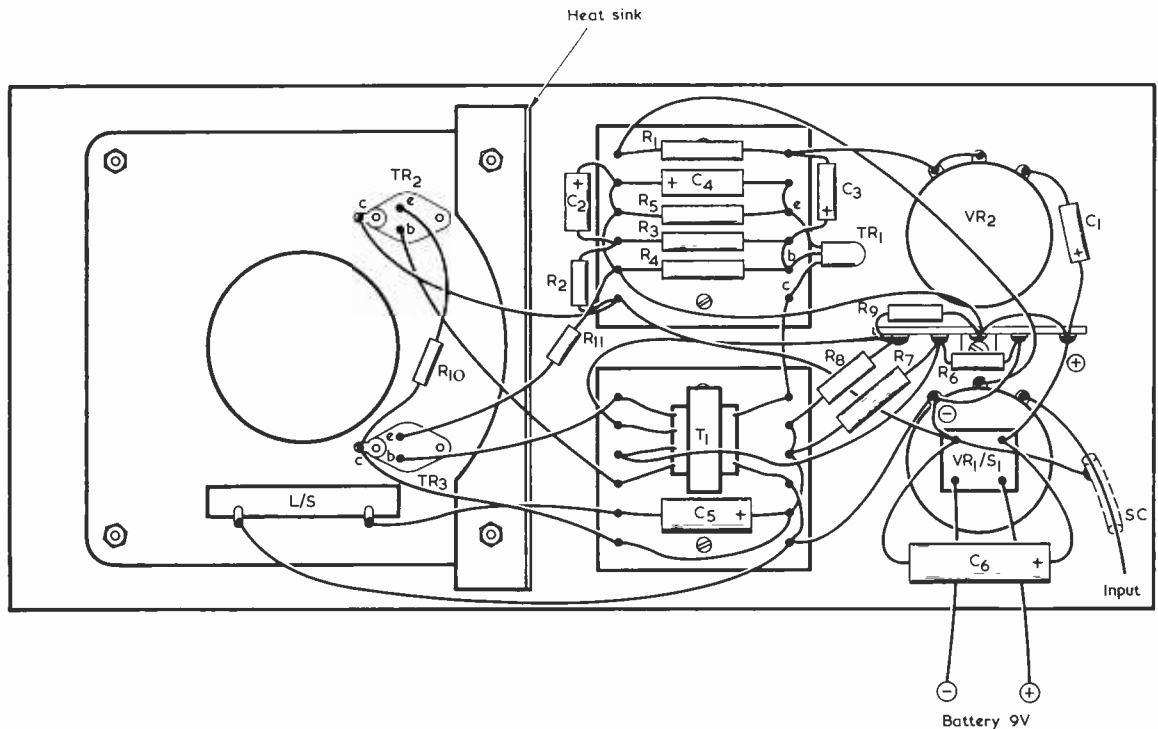


Fig. 4. Wiring up the amplifier. All components and the heat sink assembly appear on the single ply wood baseboard. The cable shown as 'SC' is a screened cable terminating in a phono plug. Check the contacts of the on-off switch with a continuity tester to ascertain the correct tags before wiring to this component

is necessary. Although the tuner current is only about 10mA, a fairly heavy-duty battery, such as a PP9, is recommended for the amplifier, especially if it is doing double duty for the tuner as indicated above. If a mains power unit is preferred, one capable of delivering 9 volts at about 100mA is recommended.

TESTING THE COMPLETED AMPLIFIER

As the beginner is unlikely to have access to an a.f. generator, the considerable advantage of using a pre-built tuner is highlighted, in that an audio signal is readily available from the outset for testing the amplifier. The presence of this signal should be verified, as already described. It is advisable to use separate batteries for the two units during the testing stages. Having ensured that a signal is available at the tuner output, fit the short length of screened cable marked 'SC' in Fig. 4 with a standard phono-type plug and insert this in the a.f. output socket which has already been fitted on the tuner chassis. Leave the tuner switched off at this stage. Connect a battery to the amplifier, turn VR1 to its maximum clockwise position, and listen for an audible hiss in the speaker. If this is present, all is probably well, and the tuner may now be switched on and

adjusted, in conjunction with VR1 and VR2, for maximum quality. It is worth noting that considerable distortion can be introduced in the v.h.f. band with an unsuitable aerial or feeder system; therefore, if quality is not up to standard, this point should receive attention first of all.

If, on first checking the amplifier, no hiss is audible, it is essential to switch off immediately and recheck the amplifier wiring. If a testmeter is available, or can be borrowed, a check of the amplifier current should be carried out by inserting the meter, switched initially to its highest current range, between the positive battery lead from the amplifier and the positive terminal on the battery itself. A standing current lower than 10mA or much higher than about 20mA should be viewed with suspicion, and would suggest that a careful check-over of the amplifier wiring is desirable. Further information can be obtained by measuring the amplifier voltages at the test points indicated in Fig. 2.

HOUSING THE UNITS

Construction of the two cabinets is extremely simple, and can be undertaken in a relative short time, even by the novice woodworker. Both boxes are identical in length and depth, but the amplifier cabinet is higher than that for the tuner, giving a pleasing appearance both with the units side by side or mounted on top of each other, as shown in the photographs.

Essentially, the cabinets consist of 'shells' of hardboard $\frac{1}{8}$ in. thick which are held together with panel pins. Four pieces of hardboard 8in. by 4 $\frac{1}{2}$ in. and two each of 4 $\frac{1}{2}$ in. by 3 $\frac{1}{2}$ in. and 4 $\frac{1}{2}$ in. by the height of the tuner front panel (which, as mentioned earlier, may differ from the nominal 3in. shown in Fig. 1(b)) are required. These form the tops, bottoms and sides respectively for each cabinet, and should be glued or nailed together with the smooth sides facing outwards. The author found it convenient to nail inserts of $\frac{1}{2}$ in. plywood to each side, about $\frac{3}{4}$ in. shorter than the cabinet depth. These served to strengthen the construction, and also provided additional supports to hold the units in a slightly recessed position, with the front panels a little behind the cabinet 'shell' fronts. This gave a fully professional finish to the completed outfit.

Before finally mounting the units in position, both cabinets should be rubbed down lightly with fine sandpaper and given a coat of matching paint having a colour which offers a pleasing contrast with the Formica front panels. ■



The tuner and amplifier make an attractive pair when used together

EMI'S LOW LIGHT TV TUBE PRESENTED AT PARIS AEROSPACE CONFERENCE

At a recent international conference held in Paris to discuss the applications of television camera tubes in outer space, EMI Electronics presented a paper on its low light level camera tube – the Ebitron.

In his paper, 'The Ebitron Low Light Level Camera Tube', Alan Dawe, sales manager for special products in EMI's Electron Tube Division, described the miniature low light level vidicon which has been developed by his division over the last three years. This remarkable tube has a sensitivity of over 300 times that of a 1" vidicon and can be built into the same camera body. It can give television pictures from daylight to 'half moonlight' conditions.

For astronomical applications, the storage properties of the bombardment induced conductivity target of the Ebitron tube may be employed in satellites to record long exposure images of the stars. The tube may be scanned slowly to tele-meter the information back to earth over a narrow bandwidth.

At Paris it was revealed that the Ebitron vidicon has already been incorporated in one of the ESRO satellites in which the tube's sensitivity is used to view a spark chamber in the TDI satellite to be launched early in 1972. In this experiment, codenamed S133, the output from the vidicon is fed into a computer on board the satellite which analyses the intensity and direction of the cosmic particles entering the spark chamber.

The EMI tube is suitable for use in a wide range of closed-circuit television applications which may operate on a 24-hourly basis.

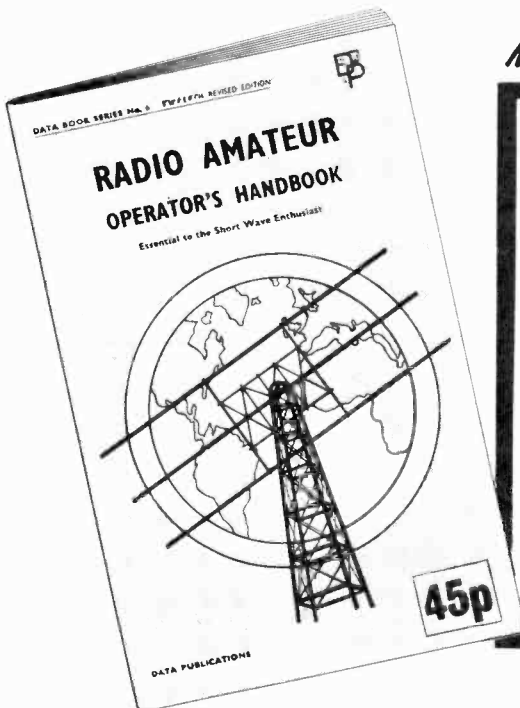
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BLOCK LETTERS PLEASE

SHORT WAVE NEWS

FOR DX LISTENERS



By Frank A. Baldwin

Times - GMT

Frequencies kHz

At the time of writing, news has just broken of two new 'out of band' stations which will almost certainly interest many readers. Radio Santiago, Dominican Republic, is reported by BADX (British Association of Dx'ers) on **3406**, being heard in the U.K. from 2343 through to 0200. ZPA1 Radio Nacional, Paraguay, according to BADX is operating on **5273** and has been logged from 0009 to 0045 with news in Spanish, commercials and station identifications here in the U.K.

NOW HEAR THESE

● SINGAPORE

Radio Singapore can be heard on **5052** (59.38m) 10kW with a programme in English at 1600, logged recently with a record session with English announcements. According to BADX, the station identifies as 'Inila Radio Singapura' for vernacular services (Hindi, Sinhala and Malay) but during English transmissions it identifies as 'Radio Singapore'. The same source informs us that 'pura' means town; hence Singapura means town of the kings. Hence, in India, Jaipur, Jodhpur, Kanpur and Jaypore.

Radio Singapore also operates on **5010** (59.88m) 10kW where it has been logged at 1535 with news in English (time 'pips' at 1530) by BADX. This is the old transmitter of BFBS (British Forces Broadcasting Service) now used by R. Singapore for the English Service.

● INDONESIA

One of the best signals from this country at this time of the year is undoubtedly YDP Medan on 5084 (59.01m) 20kW, where it has been logged by us at 1550 through to 1610 when the signal was lost in the general noise and interference. The programme consisted of Arabic-type songs and music interspersed with announcements in Indonesian.

Another consistent signal from Indonesia, despite the lower power, is that of YDK6 Djambi operating on **4927** (60.89m) 7.5kW. We logged it at 1549 through to close-down at 1601.

Indonesia can also be logged from around 1320 on **6045** (49.63m) 100kW, this being RRI at Djakarta with programme about Indonesia in English.

FOR THE BEGINNER

Turning aside from Broadcast band Dx for the moment, we provide now some information which we hope will be of assistance to those readers who are new, or nearly so, to the hobby. Listen for the stations listed at -

1830 on **7065** (42.46m) 50/240kW, Radio Tirana, Albania, with the English programme about life and events in Albania.

1830 on **7125** (42.11m) 40kW, Warsaw, Poland, pro-

gramme in English of life in a Polish factory.

2000 on **6100** (49.18m) 100kW, Belgrade, Yugoslavia, newscast in English.

2045 on **7215** (41.58m) 100kW, Delhi, India, identification and news in English.

2100 on **9525** (31.50m) 100kW, Delhi, India, identification and news about India in English.

2115 on **9605** (31.23m) 250kW, Radio Canada International, English programme beamed to Europe.

CURRENT SCHEDULES

● HUNGARY

Current until March 1st, Radio Budapest radiates the English language schedule to Europe as follows - from 1930 to 2000 on **6110** (49.10m), **7100** (42.25m), **9833** (30.51m), **11910** (25.19m), **17890** (16.77m) and **21655** (13.85m) all 100kW, except **21655** which is 3kW.

To North America, in English, from **0100** to **0130**, on **6165** (48.66m), **7220** (41.55m), **9833** (30.51m), **11910** (25.19m), **15165** (19.78m), **17840** (16.82m) and on **21685** (13.83m) all 100kW except **21685** which is 3/15kW. From 0.300 to 0.330 on **6165**, **9833**, **11910** and **15165**. From 0400 to 0430 on **6175** (48.58m), **7220**, **9833**, **11910** and on **15165**.

● CANADA

The English language schedule, to Europe, of Radio Canada International is as follows - daily from 0715 to 0745 on **5975** (50.21m) and **9625** (31.17m). From 1217 to 1313 on **15325** (19.58m). Daily news service from 1515 to 1522 on **15325**, **17820** (16.84m) and on **21595** (13.89m). Evening schedule, to Europe, from 2115 to 2152 Mondays to Fridays inclusive, on **9605** (31.23m), **11720** (25.60m) and on **15325**. Saturdays and Sundays from 2100 to 2152 on **9605**, **11720** and on **15325**. The **9605**, **9625**, **11720** and **15325** are BBC relays, 250kW.

● NIGERIA

The Voice of Nigeria, Lagos, English schedule to Europe is from 0530 to 0730 on **15185** (19.76m) 100kW and from 1800 to 1930 on **11770** (25.48m) 100kW. To West Africa on **7275** (41.24m), 100kW and to Central and South Africa on **15200** (19.74m) 100kW.

● SWEDEN

Radio Sweden radiates a half hour English programme commencing at the times shown: 1100 on **9630** (31.15m) and **21690** (13.83m); at 1230 on **6065** (49.46m) and on **9630**; at 1400 on **15240** (19.69m) and **21505** (13.94m); 1600 on **6065** and **11930** (25.15m); at 1830 on **11950** (25.10) and **15240**; at 2045 on **6065** and **9745** (30.78m); at 0030 on **6175** (48.58m); at 0200 on **6175**; at 0330 on **11705** (25.63m) and at 0515 on **9585** (31.30m) and **17840** (16.82m). All 100kW.

● CUBA

Radio Havana beams an English service to Europe from 2010 on **15155** (19.80m) 50kW.

● BELGIUM

The English transmissions from Brussels may be heard from 1800 to 1830, to Europe, on **9550** (31.41m), **11755** (25.52m) and on **15185** (19.76m), all 100kW.

● FINLAND

English transmissions from Radio Finland, to Europe, are from 1800 to 1830 on **9550** (31.41m) 15kW, **11755** (25.52m) 10kW and on **15185** (19.76m) 100kW. To North America from 0200 to 0230 on **9585** (31.30m) 100kW.

● JAPAN

Radio Japan has a European service from 0645 to 0845 on **21570** (13.91m) and from 1930 to 2100 on **9735** (30.82m).

● KOREA

The English schedule of Radio Pyongyang is from 0200 to 0300 on **6540** (45.87m) 120/240kW and **15150** (19.80m) 120/240kW, also from 1900 to 2000 on the same channels.

● U.S.A.

English programmes to Europe from the Voice of America may be heard as follows – 0300 to 0400 on **9705** (30.91m); 0300 to 0730 on **3980** (75.38m), **5965** (50.29m), **5995** (50.04m), **6160** (48.70m), **7200** (41.67m), **7270** (41.27m), **9770** (30.71m) and **11915** (25.18m). From 0400 to 0730 on **9670** (31.02m); from 0500 to 0730 on **6040** (49.67m); from 1600 to 1700 on **21455** (13.98m); from 1600 to 1730 on **21560** (13.91m); from 1600 to 1800 on **15225** (19.71m) and **17855** (16.80m). From 1600 to 1930 on **17785**; from 1600 to 2315 on **11760** (25.51m) and **15205** (19.73m). From 1600 to 2400 on **3980**, **6040** (49.67m) and **9760** (30.74m). From 1800 to 2400 on **6160** and **7170** (41.84m).

AROUND THE DIAL

The PLA (People's Liberation Army) transmitter at Fukien, China, is being currently heard in the U.K. on **2430** (123.5m), an unlisted frequency, **2600** (115.4m) in parallel with **3200** (93.75m), **3900** (76.92m) around 2100, according to BADX.

Radio Nepal on 4600 (65.22m) 5kW has been logged, according to BADX, at 1600 through to 1650 sign-off with Indian film music and Nepali announcements.

Whilst tuning around the above channel, try 4662 for the Voice of the Pathet Lao, but at 1450 or so, when it has been heard here in the U.K. (BADX).

All India Radio, Hyderabad, can be heard (by insomniacs) at 0030 when they sign-on with clock chimes for 6 a.m. Indian time. (BADX).

Radio Gazeta, Sao Paulo, Brazil, has been logged on the regular 9685 (30.98m) 7.5kW channel. When heard by us, ZYR227 was featuring a discussion in Portuguese following identification at 2130.

Nearby on the dial is ZYT29 Radio Diaro da Manha, Brazil, on 9675 (31.01m) 10kW logged by us at 2145 but suddenly off the air at 2157!

Another Brazilian in this area of the dial is ZYR56 Radio Excelsior on 9585 (31.30m) 50kW, logged with a talk in Portuguese at 2208.

Going down to the lower frequency bands, try 4907 (61.14m) for Radio Cambodia at Phnom-Penh 15kW, which we logged at 1543 with Asian-style music interspersed with the sounding of gongs.

Tuning to 3925 (76.43m) around 2015 or so can often produce signals from JOZ Tokyo (50kW). A musical

programme was heard till 2044, with announcements in Japanese but the signal was lost at 2025 in the general noise and interference. According to BADX, time 'pips' can be heard at 2100. Also to be heard on this channel, if you are lucky, is ABC Port Moresby, Papua, it has been done by a U.K. listener – Alan B. Thompson of Neath – an able operator if ever there was one! Just to confuse matters however, this channel is also used by AIR Delhi but reception of India would be earlier (in the U.K.) around 1545 or so.

LATE NEWS

● TURKS & CAICOS ISLANDS

Turks Island Radio, according to BADX, is now thought to be on the air with tests. VS18 has been logged by several U.S.A. Dx'ers and by ABT of Neath on a measured **4788**. The U.S.A. Listener heard the station from 2250 with BBC news relay to 2300 at which time music, announcements and request for reports were radiated. In the U.K., it was heard from 2330 to 2348 sign-off.

The writer recently met a Cable & Wireless Ltd., engineer who had worked on VS18 home on leave. It appears that the station is part of a hurricane early warning system used by the local government. The power 1.5kW and regular programmes (apart from tests) are radiated for half an hour from 1800, consisting of music, educational tapes, local news and, at times, the reading of received telegrams. It is understood that a more powerful transmitter, complete with aerial system, will soon be in use.

● CHINA

Latest news from BADX is that PLA Fukien uses the following frequencies at various times – **2600**, **2800**, **3200**, **3400**, **3900**, **4380**, **4840**, **5170**, **5240**, **5900**, **6400**, **6765**, **7025**, **7280** and **8195**.

● CLANDESTINE

'Bizim Radio', according to BADX, has replaced the **9500** channel with that of **9600** in parallel with **9730** for its Turkish pro-communist programmes.

● TURKEY

The 'Voice of Meteorology', Ankara, is reported by BADX to operate daily from 0500 to 0700, from 0800 to 1000, from 1200 to 1600 and from 1800 to 1930 on **6890** using a 2.5kW transmitter.

● MALAWI

The MBC International Service is announced on 3380 (88.76m) 20/100kW from 1600 to 1800, opening with news in English. (BADX).

● LEBANON

Radio Beirut is reported to be carrying its External Service for Europe and Africa from 1830 to 2030 on **15380** (19.50m). For South America from 2300 to 0100 on **17890** (16.77m) and for North and Central America from 0130 to 0400 on **9545** (31.43m). (BADX).

● PAKISTAN

Radio Pakistan, Karachi, can be heard with a programme in English commencing at 2000 on **6235** (48.10m), **7290** (41.15m) and on **9460** (31.76m).

● MALAYSIA

Radio Malaysia, Penang, may be heard, if conditions are right, on **4790** (62.63m) 10kW around 1600 to 1630 or so.

Acknowledgements: BADX, Our Listening Post.

Trade News . . .

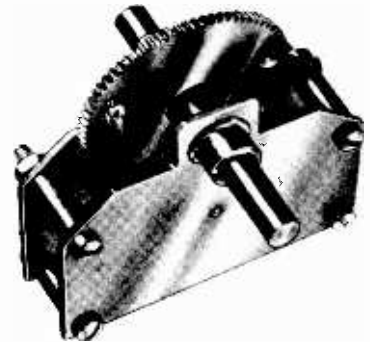
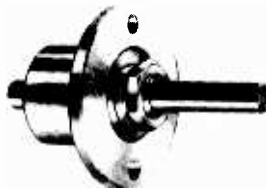
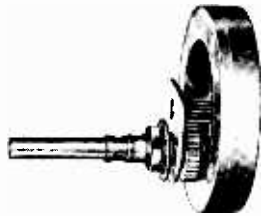
SMALL MECHANICAL DRIVES MADE BY JACKSON BROTHERS

Four new miniature drives, suitable for fine manual tuning of equipment ranging from domestic radio receivers to professional telecommunications equipment and scientific instruments, have been added to the range of small mechanical drives made by Jackson Brothers (London) Ltd., Croydon CR9 4DG.

The Accelerator Spinwheel Drive (shown at top left in the photograph) - Cat. No. 5810 - is a cord drive unit intended for modern radio receivers with extra-long scales. It incorporates a 2½-inch diameter (57 mm.) zinc-alloy flywheel driven through nylon-to-brass step-up gears at more than twice the speed of the drive-shaft. The complete unit weight is only 6 oz. (170 g.) but it provides an inertial effect equivalent to a much larger flywheel, permitting rapid traverse of the scale.

The Nylon-Bearing Spinwheel Shaft - Cat. No. 4589/Nylon - is another new cord drive, to which various flywheels can be attached. To provide an ultra-smooth 'Quality' feel suitable for expensive stereograms and radios, it incorporates - in place of the usual brass-to-brass bearing - two molybdenised nylon rings placed between a stainless-steel shaft and a brass bushing.

The 10:1 Epicyclic Ball Drive (bottom left in the photograph) - Cat. No. 5857 - is a powerful but compact drive suitable for transceivers, capacitance bridges, signal generators, etc. It provides a 10:1 reduction ratio between coaxial input and output shafts, with a limiting output torque (beyond which internal slipping occurs without damage) greater than 30 oz-in. (2.2 kg-cm). It measures 2½ inches (54 mm) overall length by 1⅞



The four mechanical drives introduced by Jackson Brothers

inches (36.5 mm) diameter of mounting flange.

The Twin-Speed Epicyclic Ball Drive (top right) - Cat. No. 5845 - is intended for driving a single potentiometer or variable capacitor, e.g. in small radio receivers. Two coaxial inputs provide direct drive for coarse adjustment and a 5:1 reduction for fine adjustment. Limiting output torque is 8 oz-in (0.6 kg-cm).

The earlier G.80 Drive (bottom right) - Cat. No. 5590 - built to British Post Office specification and intended

for professional telecommunications receivers, is now available with either 180° or 360° movement of the output shaft. It provides an 80:1 reduction ratio, without backlash, between coaxial input and output shafts, and consists of a 10:1 friction drive and an 8:1 gear drive in series. Limiting output torque is 24 oz-in. (1.7 kg-cm.).

On all drives, features such as shaft lengths, thread types, and mounting arrangements for control knobs and pointers can be varied to individual requirements.



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MARK II MODIFICATIONS FOR THE "SPONTAFLEX" F.M. RECEIVER

By

Sir DOUGLAS HALL, K.C.M.G., M.A. (Oxon)

This article discusses modifications which can further improve the performance of a popular receiver. Also described is an optional a.f. amplifier which may be employed with the 'Spontaflex' tuner or any similar unit.

THE AUTHOR'S 'SPONTAFLEX' F.M. receiver has been built in large numbers, and several readers have been good enough to suggest modifications which result in improvement. In addition, many hours of experimental work have been undertaken since the article was published. This article describes alterations which have been made to the prototype, and the result will be referred to, in future, as the Mark II version.

Although none of the changes in the tuner section is spectacular in itself, the total adds up to a useful improvement in performance. Many readers have built the tuner section only, using this with an external amplifier and speaker of their own choice. The individual modifications to be described are confined to the tuner. But although the simple amplifier which was included for the complete portable gives good quality at an output which, while modest, is sufficient for the normal sitting room, a new amplifier is now described which gives greater output up to about the maximum which can be provided before the self-contained speaker causes microphony troubles. A switch and socket are included amongst the modifications to enable the complete portable to be used with an outside amplifier without difficulty.

AMENDED TUNER CIRCUIT

Fig. 1 shows the amended tuner circuit with the components numbered as in the earlier article.

It has been found an advantage to increase the number of turns on L2 and L3 to 8 and 6 respectively. The same $\frac{1}{4}$ in. Perspex former is used and the same 24 and 32 s.w.g. enamelled wire. As the original former is employed the turns will come a little closer together. It should be noted that

the two half turns formed by the leads passing through the former are ignored when counting the turns.

The original coil was designed so that Band II would be received with the vanes of VC2 almost fully enmeshed, this being aimed at reducing hand capacitance. However, the effect was rather overdone, and some constructors found that C8 had to be replaced by a direct connection in order to allow Radio 2 to be received. With the revised coil it will almost certainly be possible for C8 to be 30 or 33pF as originally suggested; this makes tuning easier than when C8 is large or is replaced by a direct connection, and also reduces the risk of microphonic instability when the full portable is built.

Many readers will have noticed that there are two accurate tuning points for each station, with a small area of weak and distorted reception between them. This is normal for a synchronous demodulator.

Most constructors will also have found that VC1 needs to be nearly fully open for best results. The BF167 which, with its shield unconnected, may be used as an alternative to the BF225 for both TR1 and TR2 seems slightly more tolerant in this respect. But if VC1 has too much capacitance, background hiss tends to increase, and hand capacitance may prove troublesome. A 10pF trimmer may be used for VC1 instead of the 20pF originally specified, though this is not vital provided the capacitance setting is low – even at minimum in the case of some components and transistors.

R4 is increased in value to 47k Ω with a consequent increase in amplification. The larger value also makes the control of regeneration smoother. C5 is reduced in capacitance to 220pF. This improves response at the higher audio frequencies without affecting

performance at v.h.f. For the same reason, both C7 and C9 are reduced to 2,000pF.

There is a slight advantage in changing the value of C3 from 100 μ F to 10 μ F. The value specified in the first instance can cause distortion with transients due to the time taken by C3 discharging through VR3.

BATTERY CHANGES

It is a considerable advantage for the battery to be placed so that the lead from its negative terminal to the negative tag on the tuner tagboard is very short – about 1in. only. This means inserting the on-off switch in the positive lead and using separate batteries for tuner and amplifier even when the receiver is built as a complete portable. In this event the unused switch pole on VR3 can be used to control the second battery. The tuner battery can be reasonably small as only about 1mA flows from it. A PP6 would be suitable, and it should be replaced as soon as frequency drift indicates that the voltage is falling in use.

Now that the tuner uses its own battery, R5 and C6 are no longer required as decoupling components. But C6, in the form now of a 0.01 μ F component, is still needed to shunt the battery at v.h.f. R5, reduced in value to 100 Ω , is now placed in the earthy output lead of the tuner to prevent a tendency for v.h.f. signals to pass by that path into the amplifier.

A tendency for v.h.f. signals to find their way into VR3 had the annoying effect of making this component live, with the result that its adjustment could upset tuning. This is overcome by adding a direct lead from the earthy end of VR3 to the tuner tagboard. There is now a complete closed loop at negative line potential. The new lead

THE RADIO CONSTRUCTOR

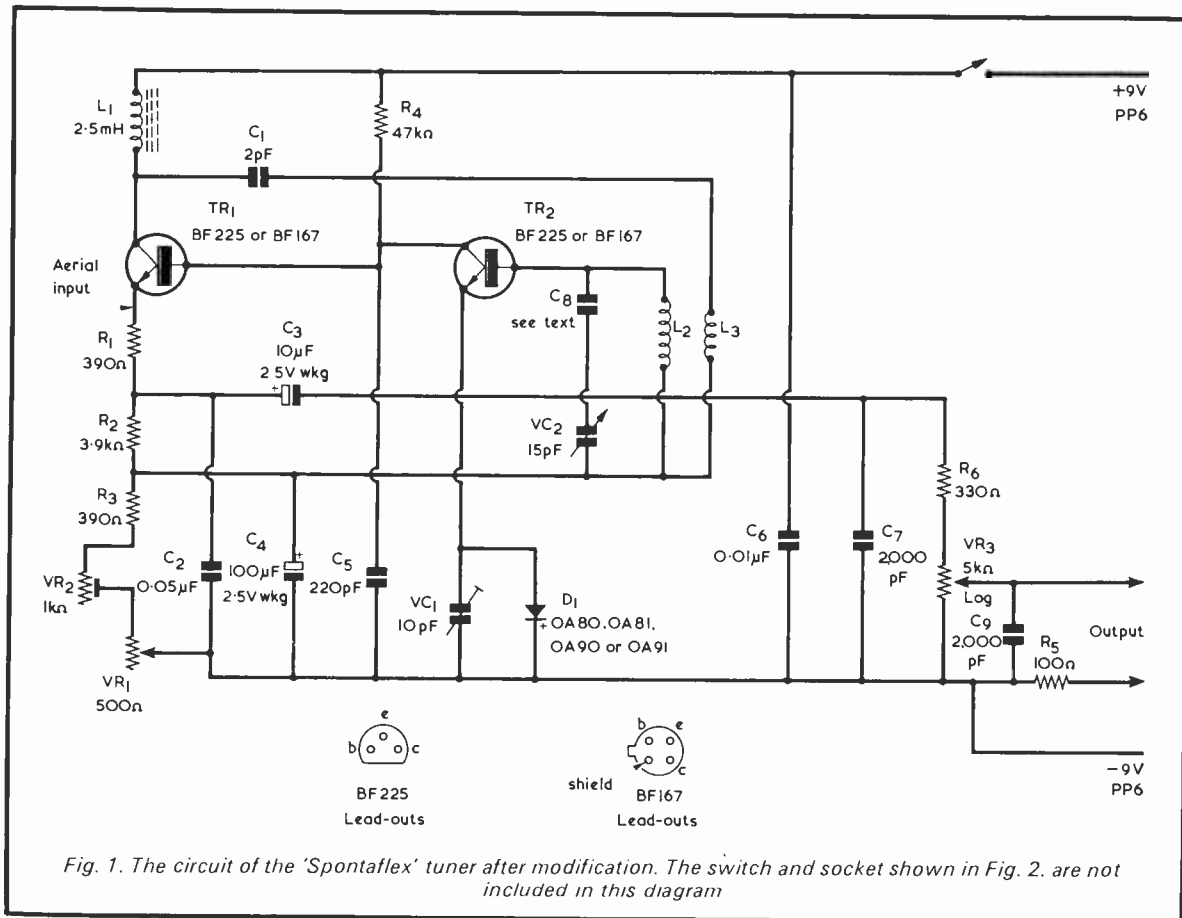


Fig. 1. The circuit of the 'Spontaflex' tuner after modification. The switch and socket shown in Fig. 2. are not included in this diagram

is shown in the layout diagram given in Fig. 2.

C13, which appears in the amplifier section in Fig. 1 of the original article, and is a large capacitance electrolytic capacitor across the amplifier battery, will need to have its negative lead taken direct to the negative tag of the amplifier tagstrip, and not to VR3 as was shown in Fig. 4 of that article. The alteration is brought about by the incorporation of R5 between the negative lines of the tune and amplifier sections. This modification only applies to receivers built as full portables with the original amplifier.

Fig. 2 shows all the modifications suggested in practical form, together with a switch and socket for easy connection to an external amplifier. When the modifications have been carried out the receiver should be free from hand capacitance effects. If they still cause trouble they are probably due to one of the following defects. VC1 may be set with too much capacitance, as already suggested. The aerial may be adjusted to an unsuitable length. Try moving in the whole or part of one or more sections. The lead from the aerial to the emitter of TR1 may pass too close to the coil unit. It should cross the coil at right angles,

and be spaced at least 1in. away. Finally, the incoming signal may be too weak for the local oscillator to lock satisfactorily with it. Sometimes careful orientation of the aerial or moving the receiver to a different part of the room will work wonders.

Microphonic instability will not be a problem when a separate speaker is used, provided this is not directed

at the tuner, and it is unlikely to be troublesome with the self-contained portable provided the Jackson C804 tuning capacitor is used, and either the original or the alternative amplifier. It is more likely to occur when the receiver has to be pushed to its limits to deal with a weak signal.

It is important for the ease and the speaker frame to be rigid, and it can

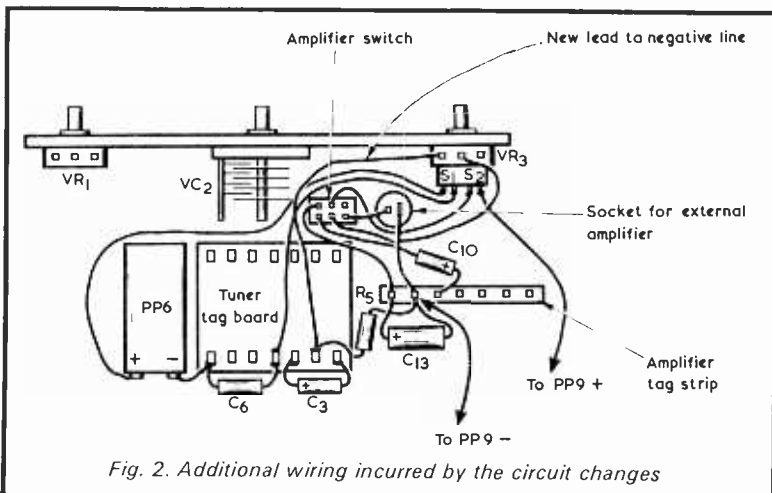


Fig. 2. Additional wiring incurred by the circuit changes

help if rubber grommets are placed between the speaker and the baffle, together with further small grommets in the holes in the speaker frame so that the holding bolts are fully insulated from the speaker frame. Microphonic instability can easily be mistaken for audio frequency oscillation. In extreme cases a howl will be heard. In milder form there is colouration of the output. It can usually be recognised by tapping the top panel, which will aggravate the effect.

The author has not considered modifications which would take away from the essential simplicity of the design, such as the addition of a second tuned circuit.

ALTERNATIVE AMPLIFIER

The original amplifier may still be used with the modified tuner. Indeed this arrangement appears in Fig 2. The alternative amplifier now to be described gives good quality with the economy characteristics of a Class B design, though it actually works in Class A. It may well be found useful for other purposes as a separate unit. The circuit is shown in Fig. 3 and it will be seen to be a modification of the author's 'Sliding Challenger', which was later repeated as part of the 'Spontaflex' S.A.5 design.^{1,2}

The original 'Sliding Challenger' used a 35Ω speaker while the one now to be described feeds a 3Ω speaker through a transformer. While the use of a high impedance speaker is attractive from some points of view, it is inefficient at high volume levels, and the use of a transformer virtually halves the power taken from the battery at maximum output. The original version gives about 250mW for a peak current of 120mA from a 9 Volt battery. The revised version gives 300mW for a peak current of 110mA from a 6 volt battery. Average current is much lower, but a large battery should be used to deal with peaks. Quiescent current is about 8mA.

The input arrangements have been modified to give more bass. The earlier circuit lost bass at the input but employed a variable treble-cut control which made it suitable for all tuners including those which lose treble due to sideband cutting. The present amplifier is designed for a tuner with a very good treble frequency response so that full bass may be accepted by the amplifier.

The signal is applied through C14. This is a non-electrolytic component which makes the amplifier suitable for connection to any fairly low impedance tuner, regardless of whether this has the negative or the positive line earthed.

Bias for TR5 is settled by the network formed by R12, R13 and R14.

¹ Sir Douglas Hall, 'The "Sliding Challenger" 200-250mW Economy Amplifier', *The Radio Constructor*, August 1970.

² Sir Douglas Hall, 'The "Spontaflex" S.A.5 Medium and Long Wave Portable', *The Radio Constructor*, June 1971.

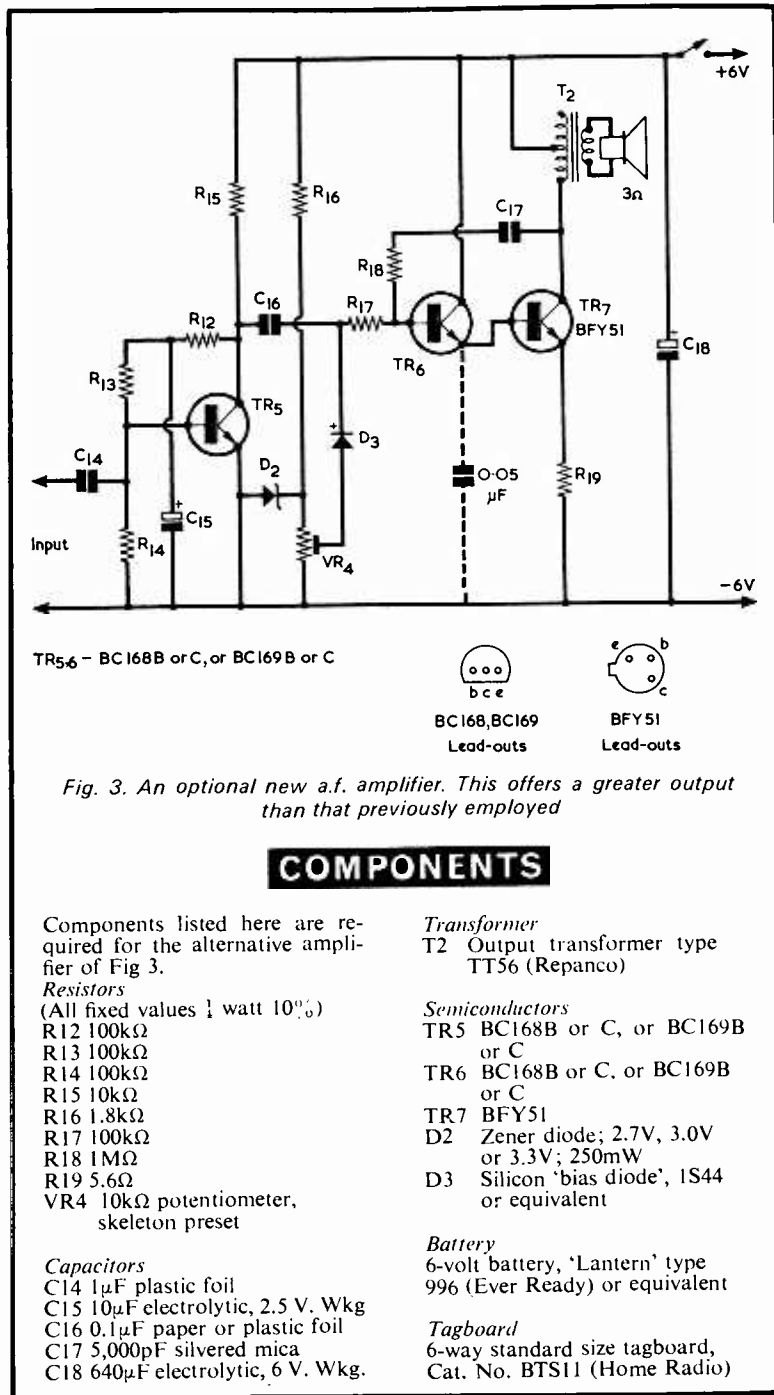


Fig. 3. An optional new a.f. amplifier. This offers a greater output than that previously employed

COMPONENTS

Components listed here are required for the alternative amplifier of Fig 3.

Resistors

(All fixed values $\frac{1}{2}$ watt 10%)

- R12 100kΩ
- R13 100kΩ
- R14 100kΩ
- R15 10kΩ
- R16 1.8kΩ
- R17 100kΩ
- R18 1MΩ
- R19 5.6Ω
- VR4 10kΩ potentiometer, skeleton preset

Capacitors

- C14 1μF plastic foil
- C15 10μF electrolytic, 2.5 V. Wkg
- C16 0.1μF paper or plastic foil
- C17 5,000pF silvered mica
- C18 640μF electrolytic, 6 V. Wkg.

Transformer

- T2 Output transformer type TT56 (Repanco)

Semiconductors

- TR5 BC168B or C, or BC169B or C
- TR6 BC168B or C, or BC169B or C
- TR7 BFY51
- D2 Zener diode; 2.7V, 3.0V or 3.3V; 250mW
- D3 Silicon 'bias diode', 1S44 or equivalent

Battery

- 6-volt battery, 'Lantern' type 996 (Ever Ready) or equivalent

Tagboard

- 6-way standard size tagboard, Cat. No. BTS11 (Home Radio)

Because R12 is connected to the collector of TR5 the bias current is stabilised. Also, since the resistance formed by R12 and R13 is split, with capacitor C15 connecting to the negative line, negative feedback of the signal is avoided.

The output of TR5 is coupled to the input of TR6 through C16 and R17. Base bias for TR6 is adjusted by VR4 so that, with no signal arriving, current

through TR6 is almost cut off. D2, a zener diode, helps to keep this bias current steady as the voltage of the battery falls. With the arrival of a signal D3 causes the base of TR6 to go more positive so that TR6 can accommodate the signal. TR6 is directly coupled to the output transistor TR7, with the result that when TR6 is nearly cut off TR7 only passes a small current. But as the current through

TR6 increases, so also does the base bias of TR7 and consequently its collector current. R19 limits the current that can pass through TR7. With a large incoming signal, this could be very high if R19 were omitted.

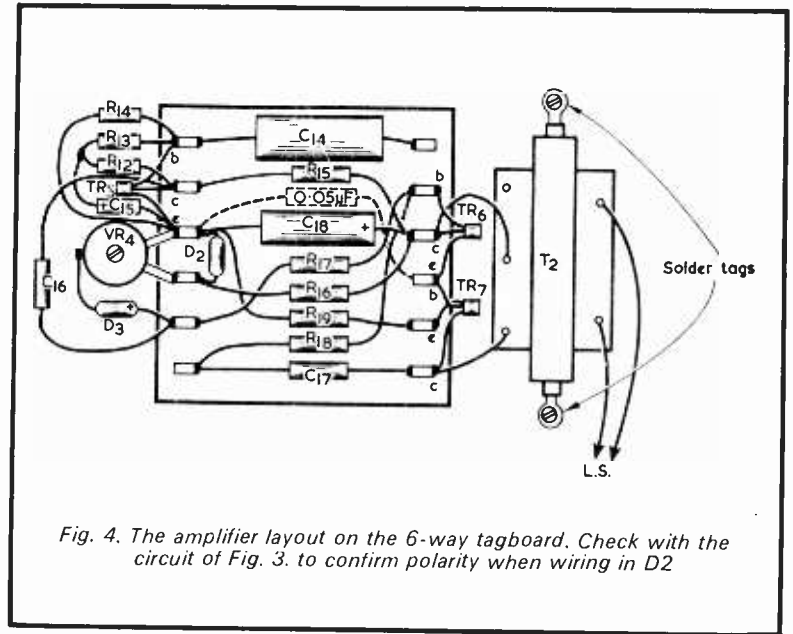
R18 and C17 provide a small degree of audio frequency negative feedback, so that the d.c. bias at the bases of TR6 and TR7 is always slightly greater than the audio signal that these transistors are called upon to handle.

The accompanying Components list gives details of the parts required for the new amplifier. To avoid confusion, component suffix numbers follow from the numbers employed in the original article. Thus, the first resistor to be listed is R12, and so on.

FITTING THE AMPLIFIER

If the new amplifier is to be incorporated in the 'Spontaflex' receiver, the original amplifier tagstrip should be removed together with the 2-way tagstrip used to anchor the secondary leads of the original output transformer T1. Also to be removed are T1 itself and the negative feedback components, if these were fitted. The original speaker may still be used. The new amplifier components are mounted on a 6-way standard size Radiospares tagboard, as shown in Fig. 4, and this board and T2 are mounted on the 12in. square baffle board as shown in Fig. 5.

In Fig. 4, the components at the tagboard side remote from T2 are shown laid out flat for ease of pre-



sentation. In practice, they should be positioned above the tags. Transformer T2 is mounted by means of tags soldered to its lugs. The positive battery connection from S2 (shown in Fig. 2 as 'To PP9+') is now made to the positive terminal of the new 6-volt battery.

To set up the amplifier a meter should be connected into one of the leads to the 6-volt battery, VR4 set with its slider to the negative line (fully clockwise in Fig 4), the receiver

switched on and then VR4 adjusted so that a reading of 8mA is given when no signal is being received. The useful life of the battery can be increased a little if this adjustment is made again after the amplifier has been used for about 20 hours and the battery voltage has settled down. If it should prove impossible to obtain a reading as low as 8mA the insulation of C17 should be suspected. This must be a first quality mica dielectric component.

In certain circumstances it is just possible that the amplifier will be found to break into spurious oscillation, either immediately on switching on, or after about one second. This is unlikely, but can happen with very high amplification transistors. This oscillation will not be in the form of a howl, but there will be severe distortion and the meter in the battery lead will show a current of 100mA or more to be flowing, a condition which cannot be corrected by adjustment to VR4. The remedy in these circumstances is to fit a 0.05μF capacitor between the junction of the emitter of TR6 and the base of TR4, and the negative line. This component is shown in dotted lines in Figs. 3 and 4. It is not likely to be needed, but its effect on quality is only marginal and there would be no harm in fitting it as a precaution in any event.

The sensitivity of this amplifier is a little higher than that of the original one. It is fully loaded by roughly the same voltage as fully loads the earlier amplifier but, of course, its output is higher when it is fully loaded. It is worth fitting, therefore, provided that signal strength in the area where the portable is used is such as to take the old amplifier to near overload point when the volume is fully turned on.

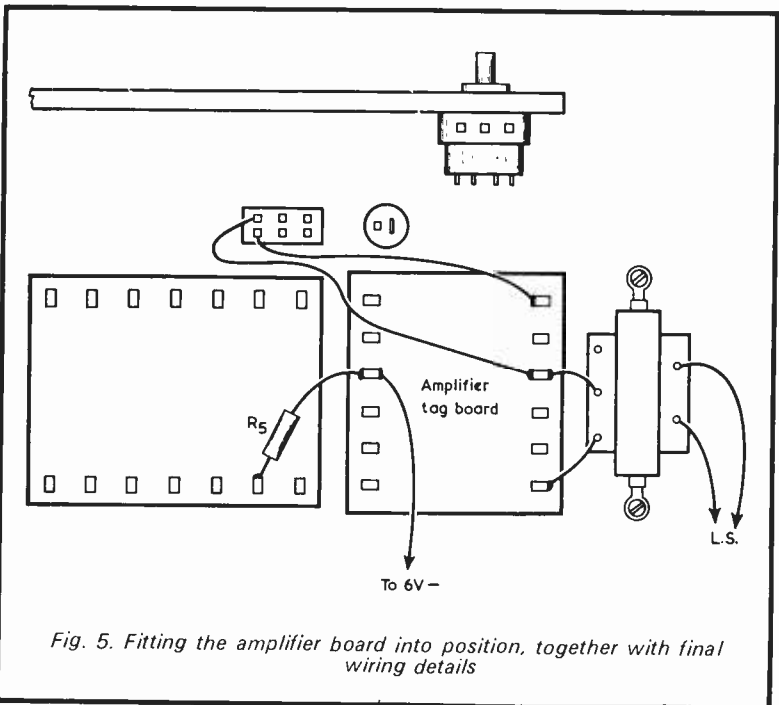
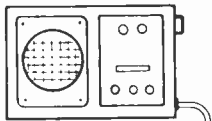


Fig. 5. Fitting the amplifier board into position, together with final wiring details

In your work-shop



This month Smithy the Serviceman attempts to obtain a little peace during the latter part of his lunch-break. But this is not easy to achieve when his assistant, Dick, is around, and Smithy eventually finds himself forced to hold forth on the mysteries of f.m. front-ends

"IT'S FUNNY, YOU KNOW."

Smithy, his disreputable tin mug poised half-way towards his lips, turned to his assistant.

"What's funny?"

"The fact that we nowadays hardly ever get any trouble with the f.m. front-end circuits in the transistor a.m.-f.m. portables we service."

Thoughtfully, Smithy drank from his mug.

"You've got a point there," he conceded. "The main reason for their reliability, I suppose, is that the design of transistor f.m. front-ends has become highly stabilized over the years. Manufacturers aren't going in for trick circuitry, and they are using well-proven designs which have become firmly established with time."

After which pronouncement, Smithy absently flicked off his trousers a crumb from the lunch he had just consumed, and resumed his peaceful contemplation of the opposite wall of the Workshop.

F.M. FRONT-ENDS

Dick threw an irritated glance at the Serviceman.

"With these f.m. front-ends," he continued, "all we ever seem to have to do is to very occasionally replace components which have become obviously faulty. And even then it's only things like resistors which have gone open-circuit or something like that. And even then it's only once in a blue moon."

There was silence.

"And even then," persisted Dick, raising his voice, "it's only once in a blue moon."

Smithy sighed and brought himself out of his reverie.

"What on earth," he asked irately, "are you raving about now? *What's* only once in a blue moon?"

"When we replace parts in f.m. front-ends."

Smithy sat up straight and bestowed a glowering glance on his assistant.

"Now, look here," he announced. "I'll have you know that this is my lunch-break and that I intend to spend what's left of it digesting the food I've just eaten. I can't digest it properly if you're going to keep rabbiting on at me all the time about f.m. front-ends."

"I'm only trying to make conversation," returned Dick plaintively. "I always remember what happened when, years ago, I started work here. You told me *then* that if I displayed a really lively interest in electronics you would be more than satisfied with me."

"Of all the acts in my life which I deeply regret," stated Smithy bitterly, "my utterance of that statement is the one which causes me the greatest grief."

"You said just now," went on Dick inexorably, "that the design of f.m. front-ends has become stabilized over the years. What sort of circuits do these f.m. front-ends use?"

Directing an expression of resignation towards the ceiling, Smithy accepted the inevitable.

"Knowing you," he said shortly, "I'm quite sure I'll get no rest until I've fully satisfied your curiosity. So, come on over here. I'll get my notepad out and I'll show you how a present-day f.m. front-end works."

Delighted, Dick shot eagerly towards Smithy's side, bringing his stool with him. He perched himself comfortably on this and looked expectantly at the Serviceman's notepad, on which the first of Smithy's sketches, a block diagram, was already taking shape. (Fig. 1).

"Here we are," said Smithy, several moments later, as he put down his pen. "However, let us first of all define what it is we're going to talk about. What we're now about to discuss are the f.m. front-end sections of transistor a.m.-f.m. portable receivers. These receivers cover the f.m. band of, nominally, 87.5 to 100 MHz, and they have an intermediate frequency for f.m. of 10.7MHz. They will also have a separate a.m. front-end which covers the usual medium and long wave bands. Occasionally, you'll encounter a set which also operates on one or two short wave bands as well. All these are for a.m. reception and the a.m. intermediate frequency is normally between 450 and 475kHz according to the particular receiver model you're considering."

"I know all that bit," remarked Dick a little impatiently. "Both the f.m. and a.m. intermediate frequencies pass into a common i.f. amplifier which deals with a 10.7MHz i.f. when the receiver is switched to f.m., and which deals with the a.m. i.f. when the set is switched to a.m. At the end of the i.f. amplifier there are two detectors. One is a ratio discriminator for f.m. reception and the other is a standard a.m. detector for a.m. reception. Their

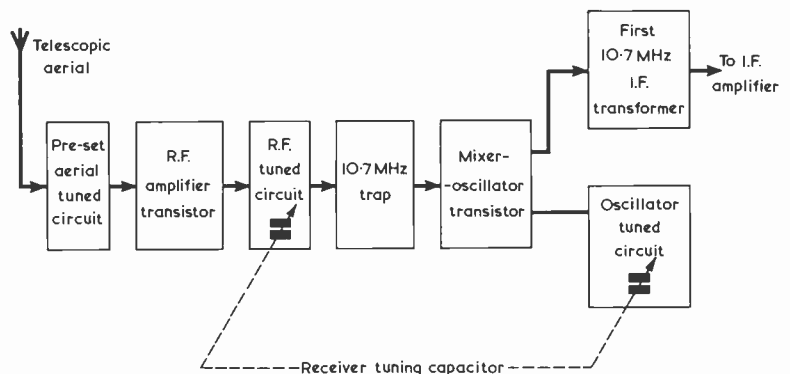


Fig. 1. Block diagram illustrating the successive sections of an f.m. front-end in an a.m.-f.m. receiver

outputs are switched by a section of the a.m.-f.m. receiver switch so that the correct one goes to the following a.f. amplifier stages."

Smithy took a further draught from his tin mug.

"Very good," he remarked. "After having got the overall picture settled, let's next get down to the f.m. front-end section. This picks up the f.m. signal, usually by means of a telescopic aerial on the receiver, amplifies it and then converts it to the f.m. i.f. of 10.7MHz. In the standardised design I mentioned just now, and which you'll encounter in almost all a.m.-f.m. portables regardless of make, the aerial input is applied to a pre-set aerial tuned circuit which is broadly tuned to the centre of the f.m. band. You can see this tuned circuit in the block diagram I've just drawn. It is pre-set for a number of reasons, one of these being that a tuned circuit in this position tends to tune broadly in any case, and there would be little advantage in adding a further section to the receiver ganged tuning capacitor in order to tune it. Another reason is that the transistor into which the tuned circuit feeds is in the grounded base configuration and thereby offers a low input impedance, whereupon it is desirable to inject a fairly high signal *current* from the aerial to the transistor input. Yet again, the aerial employed, being a telescopic type, is likely to vary considerably in the impedance it offers to the first tuned circuit, these variations resulting from its positioning and the amount by which it is pulled out of the receiver case by the user. All these factors make it desirable, in domestic a.m.-f.m. portable receivers, to have the aerial input tuned circuit broadly tuned to the centre of the f.m. band."

"Why," asked Dick, "is the transistor into which the aerial tuned circuit feeds connected in the grounded base mode?"

"Because," replied Smithy, "a transistor in the grounded base configuration is able to amplify at much higher frequencies than it can do in the grounded emitter configuration. If you remember your transistor basics, you'll recall that a transistor can be connected in either the grounded emitter configuration, the grounded base configuration or the grounded collector configuration. These are alternatively referred to as the common emitter, common base and common collector configurations respectively, the word 'common' being used because the transistor electrode which is grounded is common to both the input and output circuits. And, of course, the word 'grounded' is the American version of our own word 'earthed', and it just happens to have become accepted terminology so far as transistor operating modes are concerned. I should add that the 'ground' connection can, in practice, be given via a high value capacitor having very low reactance at the signal

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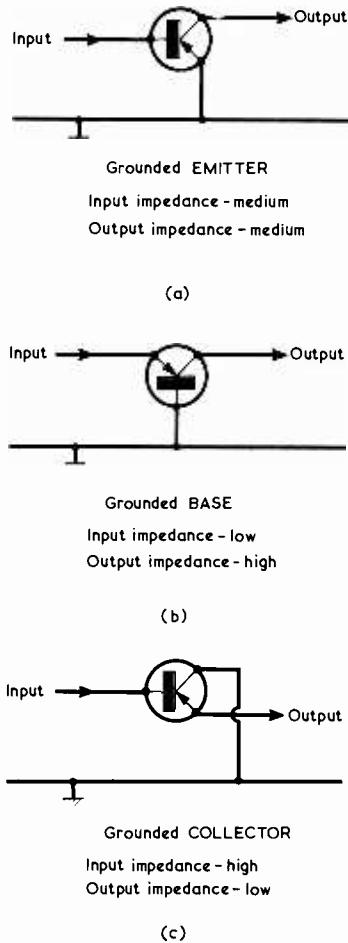


Fig. 2. The three basic transistor configurations with, roughly, their comparative input and output impedances

frequency which is being handled by the transistor."

Smithy sketched out the three circuit configurations. (Figs. 2 (a), (b) and (c)).

"The grounded collector configuration you've just drawn," remarked Dick, "is also known as the emitter follower, of course."

INPUT AND OUTPUT IMPEDANCES

"Of course," responded Smithy. "Well now, whilst we're dealing with these configurations it will be worth our while to take a quick look at the main features given by these three methods of connecting a transistor. First of all, and as I've already mentioned, the grounded base configuration is capable, with a particular transistor, of offering amplification at a much higher frequency than occurs

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with the same transistor in the grounded emitter mode. Other important attributes have to do with input and output impedances. The grounded emitter circuit gives, roughly, a medium input impedance and a medium output impedance. The grounded base mode gives low input impedance and high output impedance, and the grounded collector mode gives high input impedance and low output impedance."

"Fair enough," said Dick. "I must say that, although we're continually playing around with transistors in practice, it still doesn't do any harm to occasionally brush up on basic things such as those input and output impedances."

"That's very true," agreed Smyth. "Anyway, let's now get back to the f.m. front-end. Up to now we've passed our f.m. signal through the broadly tuned aerial tuned circuit and we next feed it into the emitter of the first transistor. This transistor is a straightforward r.f. amplifier without complications, and the amplified signal at its collector is passed to a tuned circuit which is resonant at signal frequency. This tuned circuit resonates quite sharply and its frequency is varied by one section of the receiver ganged tuning capacitor. The signal is then passed to the emitter of the second transistor which is a mixer-oscillator. Also, a 10.7MHz acceptor trap is connected between the emitter of this second transistor and chassis."

"What's the trap for?"

Smyth picked up his mug and drank deeply, then replaced it on his bench.

"Ah," he grunted in a tone of complete satisfaction, "that's just the job. I don't really know what I would do if I couldn't get the odd spot of tea every now and again."

"What," asked Dick patiently, "is the 10.7MHz trap for?"

"That 10.7MHz trap?" repeated Smyth. "Well now, that trap does several things. To start off with, it prevents any strong signals at 10.7MHz breaking through to the second transistor and from this into the 10.7MHz f.m. i.f. amplifier stages. The trap also prevents any of the 10.7MHz i.f. signal at the collector of the second transistor going back to the aerial."

"Blimey," said Dick, surprised, "does it matter if the 10.7MHz signal does get back?"

"It could do," replied Smyth. "It could be radiated and picked up by other receivers. Don't forget that the simple v.h.f. tuned circuits that are used in the front-end are not capable of offering a high level of attenuation to 10.7MHz in either direction. However, what is probably the most important reason for having the 10.7MHz trap is that it isolates the aerial circuit from the i.f. amplifier of the receiver. If the trap were omitted the situation could arise where there is effectively an overall 10.7MHz amplifier extending all the way from

the aerial, through the two transistors in the front-end, and then through the i.f. amplifier itself right up to the f.m. ratio discriminator. With a set-up like that, the whole lot could take off at 10.7MHz."

"You mean it could go unstable and start oscillating?"

"I do."

"But I don't get it," stated Dick, obviously puzzled. "Even if the front-end doesn't suppress the 10.7MHz signal, what coupling is there between the i.f. amplifier and the aerial?"

"There can," said Smyth in reply, "be all sorts of stray couplings. This is especially true in a small portable receiver with a telescopic aerial, which presents a relatively large mass of metal that is quite close to the final circuits of the i.f. amplifier. Another factor is that, with a telescopic aerial, the receiver metalwork acts as a counterpoise. The situation is rather like a quarter wave aerial over a reflecting surface. Like this."

Smyth scribbled out a further sketch on his note-pad (Fig. 3 (a).)

"With a receiver and a telescopic aerial," he resumed, "the reflecting surface is replaced by the receiver metalwork."

The Serviceman applied himself to his note-pad and produced a further sketch. (Fig. 3 (b).)

"In both these instances," he went on, "signals picked up by the aerial cause currents to circulate in both the aerial and the reflecting surface, which in my second sketch is the receiver metalwork. Conversely, any currents circulating in the receiver metalwork can enter the aerial input circuit of the receiver. With a small f.m. receiver in which most of the earthing is given by areas of thin copper foil on the printed circuit board there are liable to be quite widely circulating currents at 10.7MHz, this being particularly the case around the detector section which uses relatively low impedance circuits to handle signals having amplitudes of at least a few volts."

"Ah," said Dick, suddenly enlightened. "I can see it all now. What you're saying is that the output of the 10.7MHz i.f. amplifier can enter the aerial circuit both by stray couplings and, where the receiver employs a telescopic aerial, by way of stray 10.7MHz currents flowing in the receiver metalwork as well."

"That's exactly the situation," confirmed Smyth. "Both of these factors could cause i.f. instability or, if not that, at least sufficient regeneration to modify the shape of the 10.7MHz i.f. response curve. Fortunately, the whole problem can be cleared up very easily by the simple inclusion of the 10.7MHz trap in the f.m. front-end. This is an extremely inexpensive solution, too, as all that is required is a coil with a few turns on it, together with a small fixed capacitor. I'll be drawing up an actual front-end circuit soon, and you'll then be able to see just how simple that 10.7MHz trap is."

THE RADIO CONSTRUCTOR

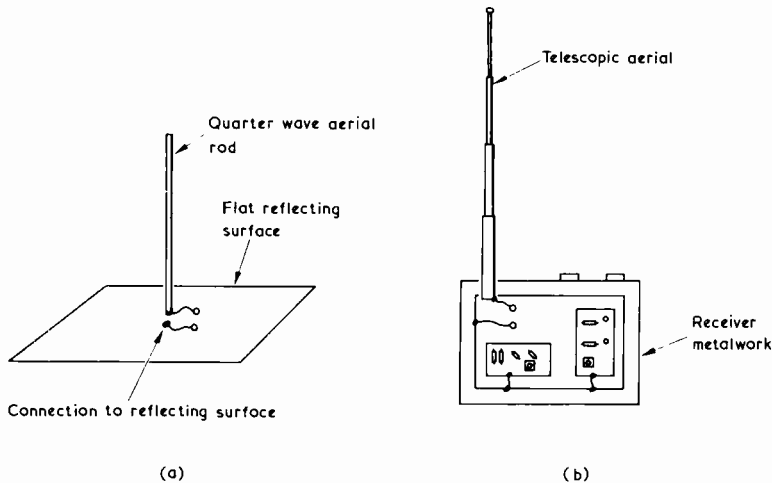


Fig. 3 (a). A quarter-wave aerial consisting of a quarter-wave rod above a flat reflecting surface. Connections are made to the bottom of the rod and to the reflecting surface beneath it
 (b). In an f.m. receiver with a telescopic aerial, the receiver metalwork partially replaces the reflecting surface of (a)

MIXER-OSCILLATOR

Smithy picked up his tin mug once more and, with one prodigious draught, completely drained it. Taking up an attitude reminiscent of a protagonist for Woman's Lib, displaying unwanted impedimenta before consignment to the flames, he held the mug up high at arm's length. Wordlessly, Dick took it from him and, walking over to the heterogeneous array of battered utensils which constituted the culinary effects of the Workshop, refilled it. He returned and placed the charged mug silently at Smithy's side. The filling of Smithy's mug was a custom of long standing.

The Serviceman picked up the mug and imbibed noisily.

"Just a few minutes ago," remarked Dick, as he watched Smithy with an air of fascinated revulsion, "you said you wanted to be quiet so that you could digest your lunch. With the vast quantities of tea you're now pouring down, that lunch must be washing around in your gut like jetsam at sea!"

"Nonsense, boy," retorted Smithy. "As it happens, I have a tea-oriented metabolism, and the occasional odd spot of the liquid just keeps my system nicely balanced. Anyway, let's return to our f.m. front-end. We've already amplified the f.m. aerial signal and passed it, through a signal frequency tuned circuit and the 10.7MHz trap, to the emitter of the second transistor. This transistor is the mixer-oscillator, and it is also connected in

the grounded base mode. It couples to the oscillator tuned circuit, which runs at a frequency removed from the signal frequency by 10.7MHz and which is tuned by a second section of the receiver ganged tuning capacitor. The first 10.7MHz i.f. transformer appears in the collector circuit of the mixer-oscillator transistor, and this feeds into the i.f. amplifier of the receiver."

"Well, that seems simple enough," remarked Dick. "Did you say just now that you were going to show me an actual circuit of the front-end?"

"I did," confirmed Smithy, "and that is just what I'm going to do next."

Fortified by his last intake of tea, the Serviceman tore off the top sheet of his note-pad and proceeded to draw a circuit diagram. (Fig. 4).

"Here we are," he announced proudly after some moments. "Now this is a typical circuit of the type you'll find used in practical receivers. Since the design of these f.m. front-ends has become so highly standardised over the years, it is possible to draw out a circuit diagram which is representative of nearly all the actual circuits you'll encounter. Incidentally, the fact that the two transistors in the front-end are in grounded base can sometimes be a help if you're looking for that front-end in a complicated a.m.-f.m. receiver circuit diagram. The transistors are nearly always shown with the base lines drawn horizontally, whereupon they stick out a mile from all the other transistors."

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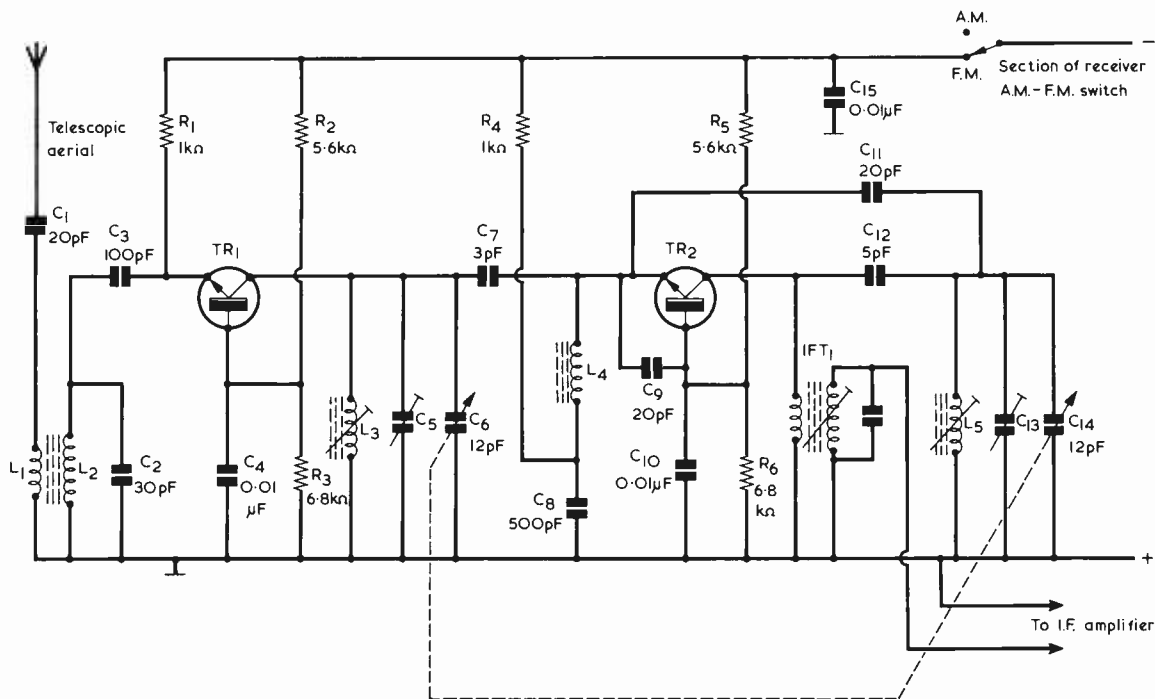


Fig. 4. Basic f.m. front-end circuit for an a.m.-f.m. receiver. Component values shown are intended to be representative only and do not apply to any particular manufacturer's design. In some instances the collector of TR1 may be coupled to a tap in L3, and/or a low value resistor may be inserted in series. Transistor types are, typically, BF222 for both TR1 and TR2.

"This circuit," commented Dick, peering closely at Smyth's diagram, "doesn't look too complicated to me."

"It isn't," agreed Smyth. "And the knowledge we have gained by considering the front-end in block diagram form will make it easier still to understand. We'll start off once more at the aerial input. This couples via an isolating capacitor, C1, to the input transformer given by primary L1 and secondary L2. L2 is tuned by capacitor C2 and, as we've already noted, is broadly resonant at the centre of the f.m. band. TR1 is the first transistor and its base is grounded to chassis via the 0.01μF capacitor, C4. It is usual nowadays to employ v.h.f. silicon n.p.n. transistors in these f.m. front-ends and both the transistors in my diagram are of this type. Also, I've shown the lower supply line, which connects to chassis, as the positive one, and the upper supply line as the negative one. The emitter of TR1 couples to the negative supply line via R1 and the base is coupled to the centre of the fixed potentiometer given by R2 and R3. The collector couples to the positive line via coil L3. So far as d.c. supplies are concerned, TR1 is connected in the same manner as are many conventional grounded emitter transistors, since there is a resistor in its emitter circuit and its base is

coupled into a fixed potentiometer connected across the supply lines. However, in a grounded emitter circuit the signal input would be applied to the base and the emitter would be bypassed to chassis via a high value capacitor."

"And here," chimed in Dick, "we have the base bypassed to chassis by the high value capacitor and the signal applied to the emitter, thereby altering the mode to grounded base. That's right, isn't it?"

The Serviceman gravely nodded in assent.

"Good," said Dick. "Is the collector coil, L3, the r.f. tuned coil?"

"It is," confirmed Smyth. "And it's tuned by C6, which is one section of the ganged tuning capacitor for the receiver. The coil also has a trimmer, C5, connected across it and it has an adjustable iron-dust core. Since the output impedance of TR1 in the grounded base mode is high, the coil is in many cases connected directly to the collector in the manner I've shown, and it doesn't suffer serious damping thereby."

"The signal across L3," remarked Dick, tracing the line along Smyth's circuit with his finger, "goes next to the emitter of TR2 via C7, doesn't it?"

"Correct," assented Smyth, "and, in that emitter circuit, L4 and C8 form

the 10.7MHz trap I was chuntering on about earlier on. These two components form a series tuned circuit, or acceptor circuit, which offers minimum impedance at its resonant frequency of 10.7MHz."

"Isn't C8 rather high, at 500pF?"

"Oh no," said Smyth. "The usual values you find for this capacitor range from about 200pF up to 1,000pF, even. This means that L4 does not have many turns, although it still offers enough inductance to give a satisfactorily high reactance at f.m. signal frequencies. You'll note that L4 provides a convenient means of feeding the d.c. supply to the emitter of TR2, the end remote from the emitter coupling to the negative supply rail via R4."

"Ah yes, I see that," remarked Dick. "Neat, isn't it?"

"It is, rather," agreed Smyth. "The base of TR2 is effectively grounded by being coupled to chassis via the 0.01μF capacitor, C10. It also connects to the junction of the two resistors, R5 and R6, which connect across the supply lines. There is therefore a d.c. supply arrangement for the base which is similar to that for the base of TR1. As a further point, the collector couples to the positive supply line at the bottom via the primary of the first 10.7MHz i.f. transformer, I.F.T.1. The second-

ary of that transformer feeds into the following i.f. amplifier. Thus, TR2 receives power supply and signal connections in much the same way as does TR1."

COLLECTOR-EMITTER FEEDBACK

"What," asked Dick, "makes TR2 oscillate?"

"There's feedback," replied Smithy, "from its collector to its emitter. Remember that, with both transistors, the base does not enter any r.f. circuitry; and also that the collector and emitter of a transistor in grounded base are in phase. This phase relationship is pretty easy to envisage if you work on from what you already know about the more familiar grounded emitter circuit. In the latter the base and collector are out of phase; that is to say, when the base goes negative with respect to the emitter the collector goes positive, and vice versa. If, instead, we refer to voltage changes with respect to the base, however, we can see that if the emitter goes positive with respect to base this is the same as the base going negative with respect to emitter. The result is that if the emitter in grounded base goes positive with respect to the base so also does the collector. Similarly, if the emitter goes negative with respect to the base so also does the collector. Because of this the oscillator feedback circuit is delightfully simple. The collector couples via C12 to the oscillator tuned circuit given by L5 and C14, and this couples in turn via C11 to the emitter.

The whole outfit then oscillates, the oscillation frequency being at the resonant frequency of L5 and C14. To obtain the correct phase relationship between the collector and the emitter of TR2 it helps to have the emitter offer a capacitive impedance, and this is provided by C9, which connects between the emitter and the base. It might appear that, since C9 has a higher value than C7, there is some attenuation of the signal input fed to TR1, but the circuit functions adequately in practice and is employed in virtually all the f.m. front-ends you'll encounter."

"I see," cut in Dick, "that C14 is a section of the receiver ganged tuning capacitor."

"That's right," confirmed Smithy. "There is also a parallel trimmer, C13, and the coil has an adjustable iron-dust core. In some versions of the circuit the collector doesn't couple to the outer end of the coil but into a tap instead. You may also bump into f.m. front-end oscillator circuits in which the emitter couples into the same tap, too."

Smithy scribbled out the circuits (Figs. 5 (a) and (b)), then added a third circuit (Fig. 5 (c)).

"Another variation you may find," he added, "has a resistor inserted between the collector of the oscillator transistor and the oscillator coil. This

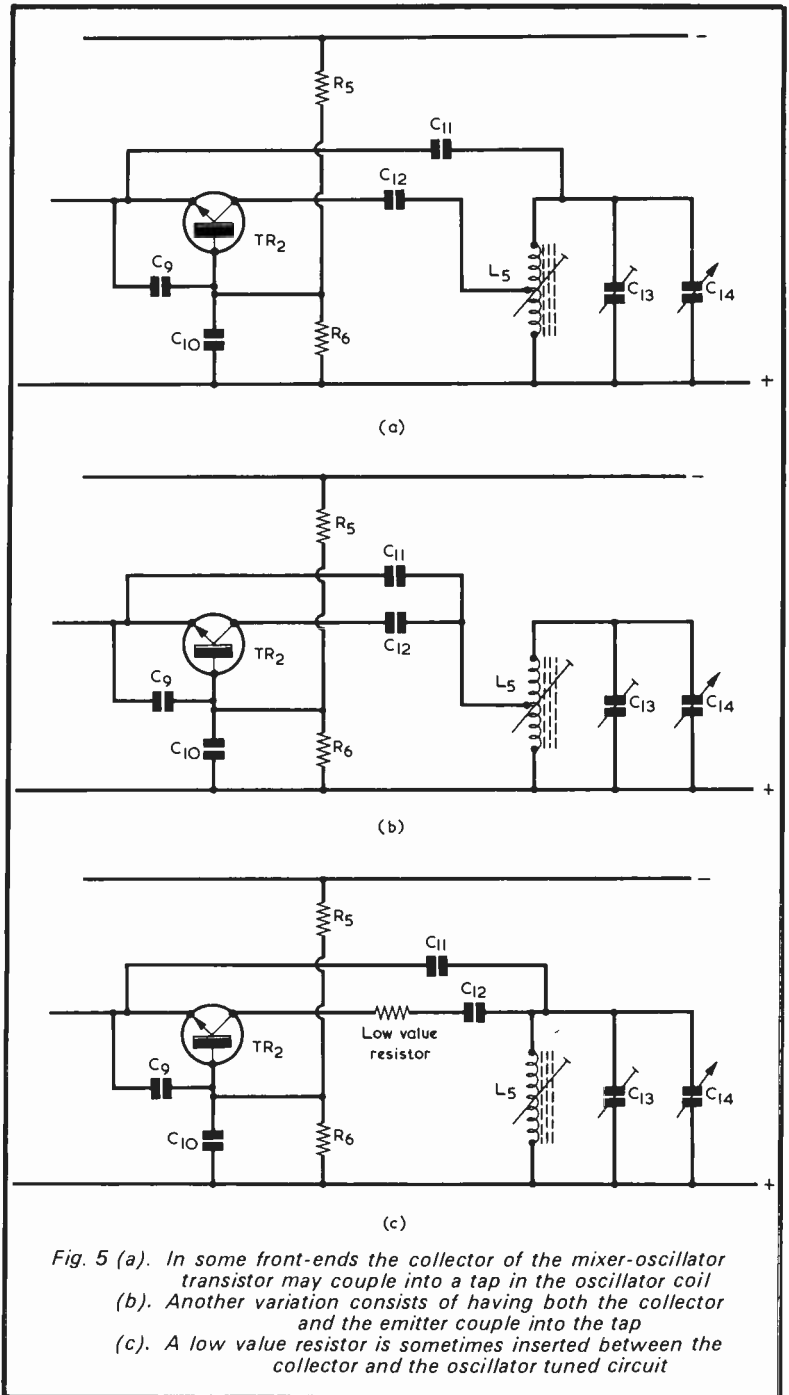


Fig. 5 (a). In some front-ends the collector of the mixer-oscillator transistor may couple into a tap in the oscillator coil (b). Another variation consists of having both the collector and the emitter couple into the tap (c). A low value resistor is sometimes inserted between the collector and the oscillator tuned circuit

resistor normally has a value lower than 100Ω or so and its main function is to prevent the transistor from oscillating too fiercely, whereupon it helps towards giving a constant oscillation amplitude over the whole tuning range."

"It looks to me," commented Dick, "that all these oscillator circuits have one basic factor in common. There is the first capacitor which couples the

collector to the tuned circuit and there is then the second capacitor which couples the tuned circuit back to the emitter."

"That's the basic form of the circuit," agreed Smithy. "It's a nice simple arrangement without any frills."

The Serviceman picked up his mug again and drank deeply.

"There are a few things I haven't mentioned yet," he continued. "For

instance, there's the a.m.-f.m. switching circuits in the receiver. The usual approach towards switching the f.m. front-end on or off consists of turning its supply on or off by means of a section of the receiver a.m.-f.m. switch. The first 10.7MHz first i.f. transformer usually stays in circuit both on a.m. and on f.m. and is not switched. In some sets, too, you'll find a slightly different first 10.7MHz i.f. transformer circuit. The usual alternative version consists of two separate coils both tuned to 10.7MHz and coupled to each other via a capacitor. The first coil will still carry the d.c. supply to the collector of the mixer-oscillator transistor."

"Some of the more recent sets," volunteered Dick, "have an automatic frequency control which you can switch in or out."

"They do indeed," agreed Smithy. "These a.f.c. circuits are quite inexpensive and they function by taking advantage of the properties of a varicap diode."

"A what diode?"

"A varicap diode," repeated Smithy. "The term is short for 'variable capacitance diode'. Diodes of this nature are also referred to as 'varactors'. These are silicon junction diodes which, when reverse-biased, offer a capacitance between their terminals which varies according to the magnitude of the reverse voltage. A typical capacitance change is from 50pF at a reverse voltage of 1 volt to 20pF at a reverse voltage of 10 volts."

"How do they work?"

"Well," said Smithy thoughtfully, "they really exhibit a property which is evident in all semiconductor junction diodes. Briefly, if a junction diode is reverse-biased the depletion layer between the p and n sections becomes wider as the voltage of the reverse bias increases. The depletion layer consists of material where holes and electrons have cancelled out and it contains very few mobile charges. The result is that it resembles an insulator and can be looked upon as the dielectric of a capacitor, the two 'plates' being the p section on one side and the n section on the other."

"Oh, I see," remarked Dick brightly. "Then these varicap diodes are designed to purposely exhibit this latent property of semiconductor diodes in its most effective form."

"You've got the idea," said Smithy. "In a.f.c. circuits in a.m.-f.m. sets the varicap diode is coupled to the f.m. oscillator tuned circuit via a capacitor of the order to 5 to 20pF, according to receiver design, like this."

Smithy drew a further circuit on his note-pad. (Fig. 6).

"One terminal of the varicap diode," he resumed, "couples via a resistor of around 100kΩ to a fixed reference voltage, this being usually the terminal which couples to the oscillator tuned circuit. The other terminal of the diode is connected via a second resistor, which is also of the order of 100kΩ,

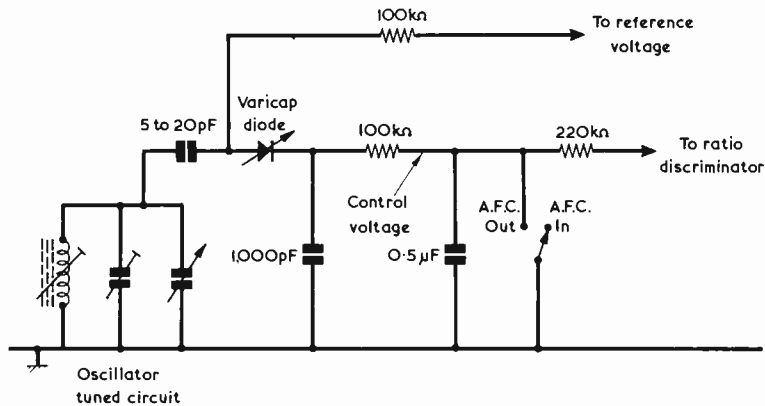


Fig. 6. Typical automatic frequency control circuit, with representative component values. The control voltage is derived from the audio take-off point of the ratio discriminator

to a control voltage which is derived from the f.m. ratio discriminator detector of the receiver. This terminal of the diode is bypassed to chassis via a high value capacitor which is normally around 1,000pF. In some sets you'll find that the control voltage is applied to the end of the varicap diode which is coupled to the tuned circuit, whilst the other terminal of the diode connects to the reference voltage. In either case the diode changes the oscillator tuning as the reverse voltage across it varies."

"You've shown," remarked Dick, "a 220kΩ series resistor and a 0.5μF capacitor to chassis in the control voltage line from the ratio discriminator. What are they for?"

"To remove a.f. from the control voltage," explained Smithy. "The voltage is taken from the a.f. take-off point of the ratio discriminator and the resistor and capacitor ensure that only the average direct voltage from the discriminator appears across the capacitor. When the receiver is tuned in correctly this average direct voltage is at chassis potential. If the receiver tuning is adjusted away from its central setting, the average direct voltage goes increasingly positive or

negative of chassis according to which side of the central setting the tuning has been adjusted. In some receivers the a.f.c. control voltage is limited by two silicon diodes connected back-to-back. Like this."

Smithy sketched out a further circuit. (Fig. 7).

"I suppose," remarked Dick, "that those diodes are to restrict the range over which the a.f.c. circuit operates."

"That's right," said Smithy. "Too wide a control range can sometimes be more of a nuisance than a help. The usual way of using the a.f.c. circuit is to initially tune in a station with the a.f.c. switched out, this being effected by short-circuiting the a.f.c. control voltage to chassis. The a.f.c. circuit is then switched on by removing the short-circuit between the control voltage and chassis. If the initial tuning was correct the control voltage from the ratio discriminator will be at chassis potential and the oscillator frequency of the receiver remains unaltered. Should the initial tuning have been incorrect the control voltage from the ratio discriminator will be positive or negative of chassis. This control voltage changes the reverse voltage across the varicap diode, and

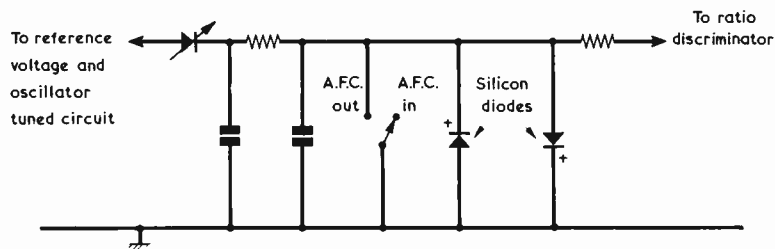


Fig. 7. In some receivers two silicon diodes are added to limit the range of a.f.c. control. Resistor and capacitor values here are of the same order as those in Fig. 6

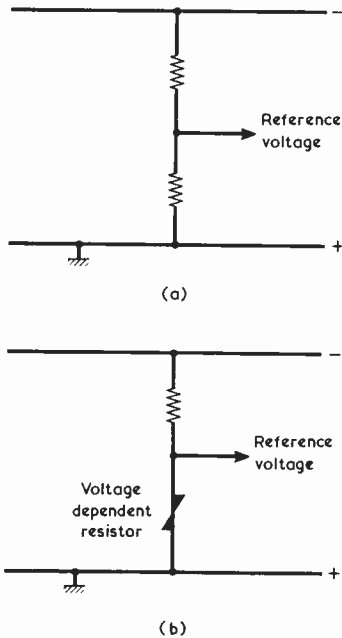


Fig. 8 (a). The reference voltage for the a.f.c. varicap diode may be obtained from a fixed potentiometer connected across the supply lines
 (b). The reference voltage may also be obtained from a voltage dependent resistor, as shown here

the consequent variation in the capacitance of the diode largely compensates for the initial mis-tuning."

REFERENCE VOLTAGE

"Well, that seems fair enough," remarked Dick. "Where does the varicap diode get its reference voltage from?"

"There are several ways of providing that voltage," said Smithy. "The simplest consists of obtaining it from a fixed potentiometer connected across the supply lines. Another method uses a voltage dependent resistor connected across the supply rails in series with a resistor. The voltage dependent resistor provides a measure of stabilization of the reference voltage."

Smithy sketched out the two methods of obtaining the reference voltage. (Figs. 8 (a) and (b).) He then picked up his tin mug and, with one gargantuan swallow, once again drained it of its contents.

"More?" asked Dick, rising.
 "Yes, please," said Smithy. "All this nattering has made me thirsty."
 "I wonder," called out Dick from the Workshop sink, where he was busy replenishing Smithy's mug, "whether we could next have a natter about the i.f. and detector stages in these a.m.-f.m. sets."

But Smithy had now resumed his earlier attitude and, with hands comfortably clasped across his stomach, was surveying the opposite wall with an expression which clearly indicated that technical discussions were now over for the day.

"We could have such a natter," he remarked firmly, "but not today. I'll leave that particular subject for our next little gen-session together."

And no further pleadings from his assistant could cause Smithy to depart from his resolute course of silence, accompanied by the leisurely but belated digestion of his lunch. ■

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- Thursday, March 2 THE TECHNICAL FUTURE OF TELEVISION. J. S. Sansom (Thames Television Ltd.)
- Thursday, March 16 TV AND CHIPS - Integrated Circuits in TV Receivers. S. N. Doherty (Rank Bush Murphy), M. C. Gander (Mullard Ltd.), R. Saxby (Rank Bush Murphy) and a representative from Motorola.
- Thursday, April 6 ANNUAL GENERAL MEETING
- Thursday, April 13 FLEMING MEMORIAL LECTURE - A Television Service Fit for Artists. A discourse on engineering - the engineer out of television. Dr. G. B. Townsend (ITA). At the Royal Institution, Albemarle St., London, W.1. at 7.00 p.m. (Tickets are required only for non-members).
- Thursday, May 4 CAMERA TUBE TESTING - luxury or necessity? John Tanner (Link Electronics Ltd.)
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All meetings, unless otherwise stated, are held in the Conference Suite, I.T.A. 70 Brompton Road, London S.W.3. and commence at 7.00 p.m. Non-members of the Society are admitted to meetings on presentation of a signed ticket obtainable from any member or from the office of the Society at 166 Shaftesbury Avenue, London WC2H 8JH.

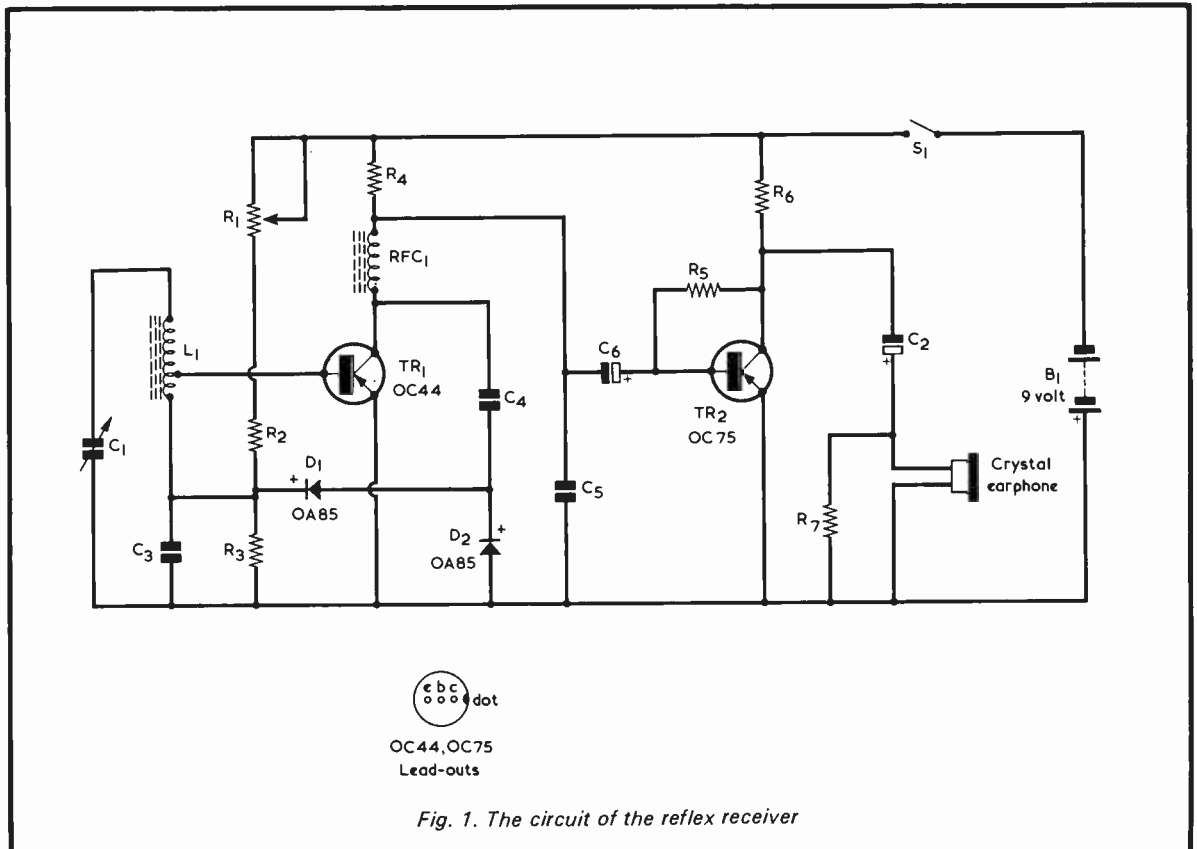
TR - 2 REFLEX RECEIVER

By
A. SAPCIYAN

A simple 2-transistor receiver intended for personal earphone medium wave reception

BUILDING RADIO RECEIVERS MIGHT SEEM, TO SOME people, to be a very complicated hobby. However, the beginner often starts by tackling simple receivers and then graduates to more complicated ones. This enables him to recognise radio components and to learn the best way of handling them. Many commence with simple diode plus a.f. amplifier circuits. But, after a time, these seem to be unsatisfactory since they often require a long aerial and a good earth, and sensitivity and selectivity may still not be really adequate.

To satisfy beginners at this stage, a reflex circuit becomes attractive, provided that a miraculous performance is not expected. A reflex circuit will usually be able to hold its own in most areas without an external aerial and earth and, in addition to this, should bring in foreign stations after dark. The receiver to be described can be built easily from readily available components and it will play almost anywhere. Its sensitivity control also enables regeneration to take place, with a consequent increase in selectivity.



THE CIRCUIT

The circuit is given in Fig. 1. As with all reflex receivers of this nature the first stage amplifies at two different frequencies, with the result that the receiver offers greater gain than would be given by two transistors in a conventional circuit. The ferrite rod aerial coil, L1, is tuned by C1, and the selected signals are then passed to the base of TR1. This transistor functions first as an r.f. amplifier, the amplified signals at its collector being passed to the diodes D1 and D2 for detection. These signals cannot pass to the subsequent section of the receiver since their passage is blocked by the r.f. choke RFC1. The detected signals are now returned to the base of TR1 as an audio frequency, and this transistor once more provides amplification, this time at a.f. The amplified a.f. signals pass through the r.f. choke and appear across R4. The base bias for TR1 is controlled by R1, R2 and R3. R1 is the sensitivity control and is adjusted for best reception conditions.

The second stage is a straightforward a.f. amplifier using feedback resistor R5 for stabilisation. The a.f. output at the collector of TR2 is coupled to the crystal earphone via electrolytic capacitor C2. R7 is included to ensure that C2 has a polarising voltage and to prevent the appearance of a direct voltage across the earphone.

COMPONENTS

Resistors

(All fixed values $\frac{1}{2}$ watt 10%)

R1	100k Ω potentiometer, linear, with switch S1
R2	100k Ω
R3	10k Ω
R4	3.9k Ω
R5	390k Ω
R6	5.6k Ω
R7	100k Ω

Capacitors

C1	300pF variable, solid dielectric
C2	4 μ F electrolytic, 10 V. wkg.
C3	0.01 μ F paper or plastic foil
C4	200pF silvered mica.
C5	0.01 μ F paper or plastic foil
C6	4 μ F electrolytic, 10 V. wkg.

Inductors

L1	See text
RFC1	See text

Semiconductors

TR1	OC44
TR2	OC75
D1	OA85
D2	OA85

Switch

S1	s.p.s.t., part of R1
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Battery

B1	9-volt battery type PP3 (Ever Ready)
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Miscellaneous

Crystal earphone with jack plug
Jack socket (to suit earphone plug)
2 knobs
Battery connectors
Material for chassis and panel

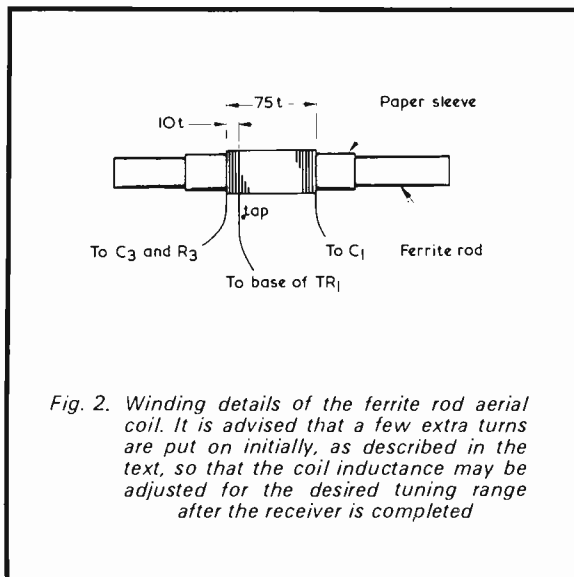


Fig. 2. Winding details of the ferrite rod aerial coil. It is advised that a few extra turns are put on initially, as described in the text, so that the coil inductance may be adjusted for the desired tuning range after the receiver is completed

The total current consumption of the receiver is about 2.5mA.

COMPONENTS

The two transistors are inexpensive and easily obtainable types. It may be necessary to make slight changes to component values if either of the transistors is at an extreme of its gain spread. With TR1 it may be necessary to slightly increase or decrease the value of R2. Whether this is necessary will be indicated by the performance offered as VR1 is adjusted. If TR2 is a low gain specimen the value of R5 may need to be slightly reduced.

The ferrite aerial coil consists of a total of 75 turns of 30 s.w.g. enamelled wire close-wound on a ferrite rod 4in. long with a diameter of $\frac{3}{8}$ in. The tap is made at the 10th turn, as shown in Fig. 2, and the coil is wound on a paper sleeve which is free to slide along the rod. It is possible that different grades of ferrite rod may give slightly varying values of inductance to the coil and the constructor is advised to commence with 85 turns overall (the tap still being made at the 10th turn). After the set has been completed turns are then, if necessary, taken off at the end remote from C3 until the desired medium wave range is covered.

The r.f. choke is a home-made component and is wound on a polystyrene coil former of $\frac{1}{2}$ in. diameter fitted with a dust core. Cat. Nos. CR4 and CR5 respectively, from Home Radio, would be suitable. The winding consists of 200 turns pile-wound of 38 s.w.g. enamelled wire. The inductance of the choke is not critical and a few turns more or less will not make any difference.

ADJUSTMENT AND OPERATION

The receiver may be built up on a small piece of perforated insulated board fitted with a front panel for C1 and R1. If metal, this panel should be connected to the positive supply line. Alternatively, the components may be mounted on tagstrips or on a tagboard fitted to a small metal chassis and panel, which should similarly be connected to the positive supply line. L1

should be kept well away from either the metal panel or the metal chassis, if these are used, as it will otherwise lose efficiency. Layout is not critical provided wiring is kept reasonably short and the collector circuit of TR2 is spaced away from the base circuit of TR1. An earphone jack socket may be positioned on the front panel at the end remote from C1. R1 should be wired up such that the resistance it inserts into circuit reduces as its spindle is rotated clockwise. The leads to the battery should not be longer than about 6in. RFC1 should not be fitted permanently in position during wiring, as it may be necessary to rotate it when setting up. It should be spaced away from the ferrite rod by about 1 to 2in.

Set L1 winding near the centre of the ferrite rod, switch on and turn R1 fully anticlockwise. If all is well the receiver should then pick up signals, it being at its most sensitive if R1 spindle is turned clockwise to the setting just below that at which oscillation commences. A different setting of R1 is required for each station, although a single setting will suffice for two stations which are close together in frequency. If oscillation is excessive and cannot be controlled by R1 slide L1 coil towards the end of the ferrite rod. The position of RFC1 relative to the rod may have an effect on oscillation and this component should be oriented, if necessary, to see if this reduces or otherwise alters the degree of feedback. In extreme cases, particularly where the

transistor used in TR1 position has a high gain, R2 may need to be increased in value, as was mentioned earlier. Suitable alternative values are 120k Ω and 150k Ω . It should be noted that the regeneration effect reduces as the battery ages so that, if R2 is increased to an unnecessarily high value with a new battery, the battery may have to be discarded at an earlier time as its voltage reduces.

The frequency range can be checked by identifying received signals, whereupon the final number of turns required on L1 can be ascertained. The process of finding the frequency range can be made easier if a standard medium wave transistor radio is available since, if VRI is advanced beyond oscillation point, the reflex receiver acts as a small transmitter whose signal can be picked up by the standard receiver. However, do not allow the reflex receiver to remain in the oscillating condition for more than short periods as it could interfere with other radios. Also, avoid tuning the standard receiver incorrectly to harmonics: the best plan is to set both receivers to an easily identifiable transmission, such as Radio 1 on 247 metres, advance VRI beyond oscillation point, and then adjust the tuning capacitors of both receivers across the medium wave band, keeping them in step with each other. The range covered by the reflex receiver will then be shown on the tuning scale of the standard receiver. ■

Radio Topics

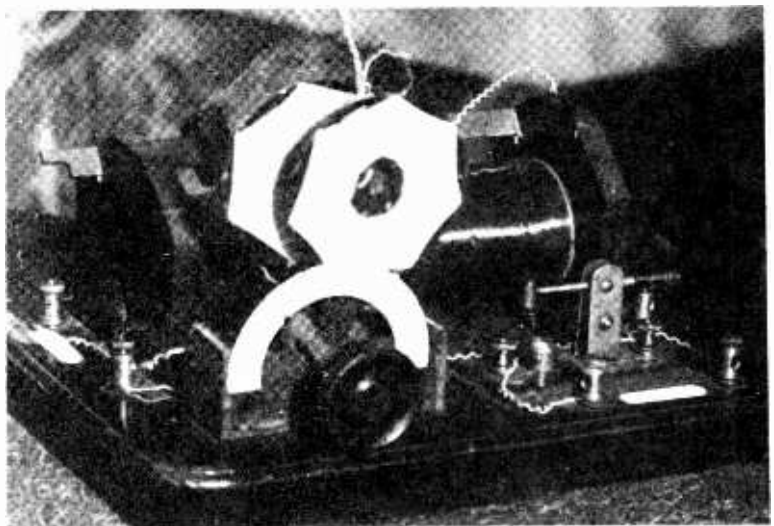
By Recorder

DOWN MEMORY LANE

The two accompanying photographs show a receiver which certainly didn't require the adjustments that are necessary with a present-day superhet! I am indebted to reader P. J. Barsby for sending us these reminders of the earlier days of radio.

The receiver in the photographs is a crystal set which Mr. Barsby built in 1924 when he was 18 years of age. The base was an electrical wiring block and the main coil was wound with 7/22 s.w.g. copper wire, being tapped at intervals by means of a brass rod and plunger taken from discarded electrical equipment. The basket coils were wound on pieces of shellacked cardboard. The crystal employed was a 'Tungstalite' type, but good results were also obtained from a piece of galena picked up in Derbyshire.

The set cost exactly 4s. 6d. to make, plus 11s. 6d. for the headset, and with a high outside aerial it had a range of 30 miles. The young man seen listening to the receiver is Mr. Barsby's younger brother, Ernest.



A home-constructed crystal receiver of the early 1920's. The crystal detector, with the cat's whisker touching it from above, is on the right. Interconnecting wires are in spiral form, a common practice in those days.

TOO CAREFUL?

Are we being *too* careful in our attitude towards the soldering of transistors? Another reader, Peter Hopkinson, thinks we are, and I can do no better than reproduce his letter here.

"Although most firms in this country seem to set a high standard of soldering," writes Mr. Hopkinson, "many readers like myself must, at times, be confronted with small electronic apparatus made by 'cottage industries', members of the Empire and by youngsters with their first D.I.Y. kit. These items do not work and one of the most prevalent faults is the soldering of the transistors.

"How often are we told to use a heat shunt on transistor leads, to keep the leads at least an inch long and to apply the iron very briefly. All these rules are fine within themselves but must make the would-be solderer very nervous.

"Accordingly, I wondered how much soldering it needs to destroy a transistor. I took two transistors, one silicon and the other germanium, and cut their leads to $\frac{1}{2}$ in. I then measured their gains and the leakage current of the germanium transistor. The silicon transistor didn't register any leakage current. I soldered them onto a printed circuit board, leaving the iron on the joints for five seconds each time.

"One at a time they were removed, their gains measured and re-soldered to the board. This cycle was repeated 20 times. Throughout the test the silicon transistor was unaffected but the germanium one tended to lose amplification when very hot. However, on cooling it reverted to its original performance.

"For confirmation I repeated the test in its entirety with different transistors and obtained similar results. I can only recall one instance in several hundred where soldering has destroyed a transistor but I have known of dozens where temerity has resulted in a dry joint that is difficult to find.

"May I then appeal to the novices in this transistor game to be bolder with their solder? If the normal heat of soldering is going to destroy a transistor, then that transistor ought to be destroyed and during assembly where it is soon found and easily replaced."

Well, that's one man's point of view. Personally, I think it's better to be safe than sorry, and I shall still take reasonable care when soldering transistors into circuit. It might be worth-while passing on one item of advice to the novice who is embarking on his first soldered joints, and that is to get some practice in by soldering components other than transistors first. There is a knack to soldering which, although easily acquired, does need a little experience. That experience is best gained with components which are definitely less liable to suffer damage due to heat.

FEBRUARY 1972



A far cry from the modern transistorised portable, the set required a high outside aerial to achieve satisfactory reception. But it offered a far greater thrill to its young listener than any present-day receiver could.

EDDYSTONE RECEIVERS

I see that the Post Office has selected Eddystone high stability receivers Type EC958/1 for ship-to-shore s.s.b. and other services. Incidentally, Eddystone Radio is now a member of Marconi Communication Systems within G.E.C.-Marconi Electronics. The Eddystone receivers are to be installed in Britain's eleven medium-range coastal radio stations, and some of them have already been delivered and are in service.

The EC958/1 receiver is a version of the highly successful EC958 equipment, of which over 700 have already been sold, mainly for export. First introduced two years ago, they have achieved widespread approval from Post and Telegraph authorities for maritime and other applications throughout the world. Hundreds of them are now in daily operation in military, naval and security applications.

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COASTAL RADIO AT THE BOAT SHOW

Coastal Radio Limited, a subsidiary of the Marconi International Marine Co., Ltd., a GEC-Marconi Electronics Company, featured a wide range of radiotelephone equipment and echo-sounders, together with radar, television, crew-call equipment and an electronic chronometer on its stand (UK.36) at the International Boat Show at Earls Court.

Highlights of the communications equipment displayed were a powerful 'Transarctic 400' 400 watt MF/HF single-sideband radiotelephone and its lower powered brother, the 150 watt 'Falcon II'. On the VHF radiotelephone side Coastal Radio showed a 33-channel 'Argonaut S', a 16-channel 'Corvette 20S', a 10-channel 'Westminster 15MN' and the new portable 'Pocketfone 70' frequency modulated transceiver.

A range of four echo-sounders was on view, the G.1000, G.500, 'Inshore Graphic' G.180, and the 'Rotascopic' R.300, and also a 'Minical' talk-back system with associated speaker units, and an 'EB.37' cabin broadcast receiver.

Also shown was an 8-inch display 'Raymarc 8' low-cost transistorised radar, a 'Survivor' survival craft radio transceiver, and radar reflector. ■



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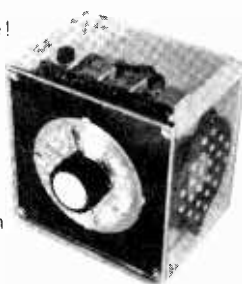
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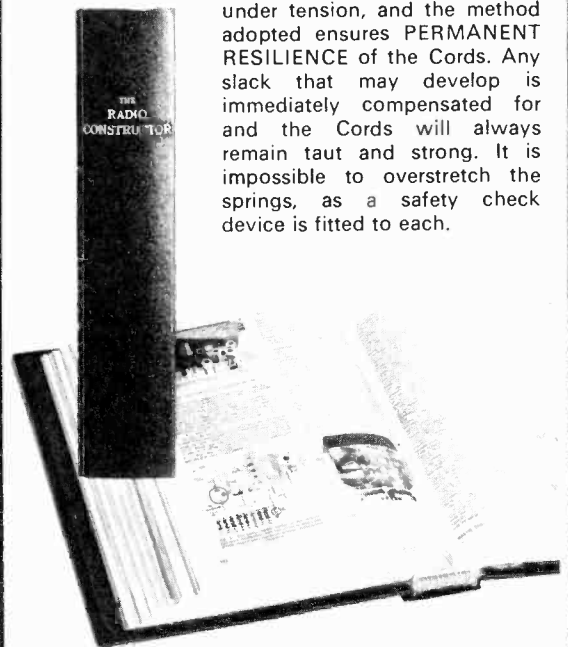
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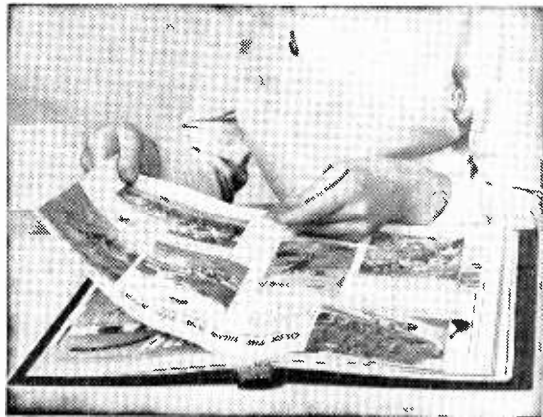
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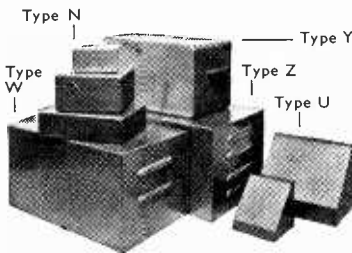
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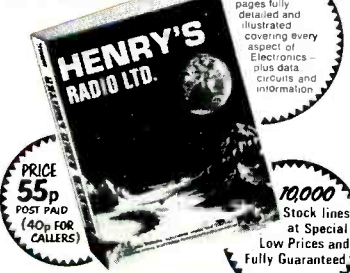
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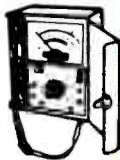
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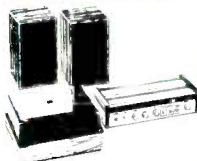
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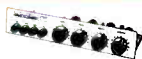
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