THE

RADIO CONSTRUCTOR

Vol. 23 No. 8 MARCH 1970 THREE SHILLINGS

The Discovery

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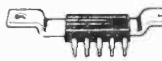

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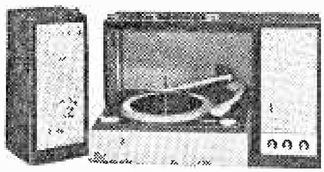

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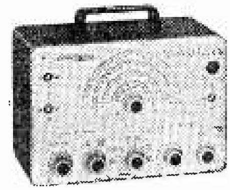

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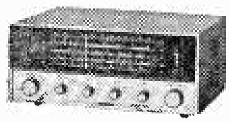

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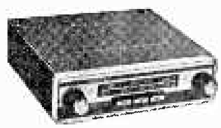

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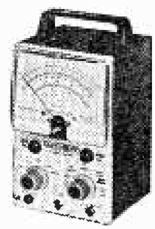

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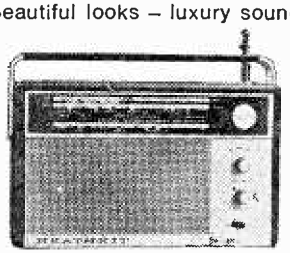

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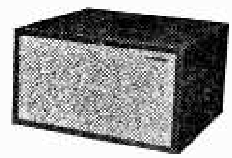

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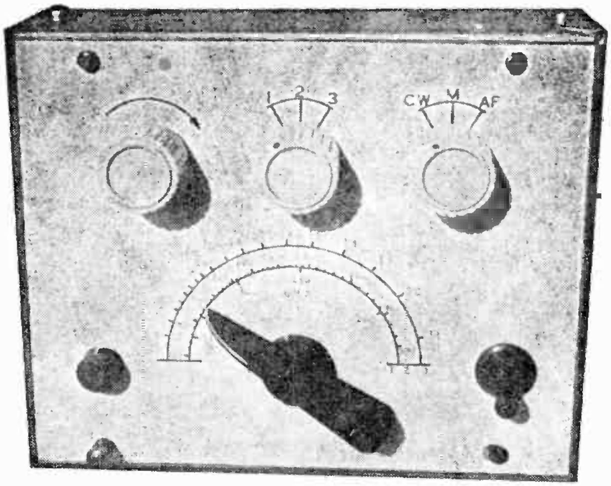

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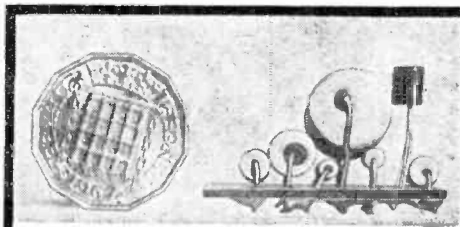

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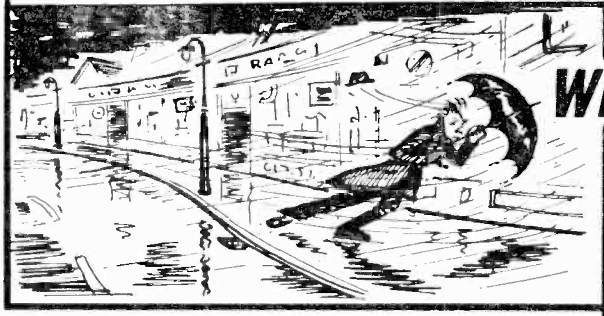

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RADIO CONSTRUCTOR'S DATA SHEET No. 36 (Phase Shift Oscillator C-R Values) iii

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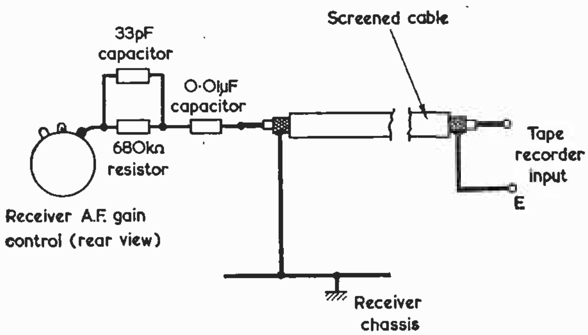
FOR THE SWL . . . Getting started with a Tape Recorder

Sooner or later, if serious work is to be engaged upon on the various short wave amateur and broadcast bands, the s.w.l. will consider equipping himself with a tape recorder. These days, more and more top flight short wave listener operators regard the acquisition and operation of a tape recorder, and place almost as much importance on it, as they do their communications receiver.

The uses of a recorder in the hobby of short wave listening are numerous and the instrument soon becomes a most important part of the operating equipment. Facilities offered by the recorder include the taping of both amateur and broadcast transmissions either for semi-permanent or permanent purposes; the recording of broadcast station interval signals and identifications as proof of reception in lieu of QSL cards – the same use also applying to amateur stations; the sending of a short tape to a station in addition to a written report; and the taping of one or more of the Dx programmes radiated by broadcast stations.

WHAT TYPE OF RECORDER?

This will depend to some extent on the amount of cash available. Basically, a mono tape recorder of the two-track type is perfectly adequate for the uses outlined above. Where it can be afforded, however, a 4-track machine should be obtained. An additional feature with the more expensive machines is the provision of several recording speeds – usually 1$\frac{7}{8}$in., 3$\frac{3}{4}$in. and 7$\frac{1}{2}$in. per second. Other tape speeds available are $\frac{15}{16}$in., 15in. and 30 i.p.s. respectively – the latter two speeds being used mostly in the professional world. The faster recording speeds produce the best quality of reproduction, recordings for ordinary home use being mostly made at 3$\frac{3}{4}$in. per second. With the faster recorders more tape is required for a given recording time and they are therefore more costly in operation. The recording tape speed of 3$\frac{3}{4}$ i.p.s. represents a compromise with regard to recording quality and running expenses.



Coupling a tape recorder to the a.f. gain control of a superhet communications receiver. Keep the connections between the centre conductor of the screened cable and the potentiometer tag short, and use components that are small in physical size

The purchaser should ensure that the recorder obtained is fitted with a recording level indicator, a programme numerical indicator with provision for zero setting, and interrupt and super-impose controls.

Most modern tape recorders are transistorised and are operated from the a.c. mains supply. The more expensive types may additionally be operated from an internal battery, thereby making the instrument truly portable for outside usage. Where a further interest is likely to be that of taping such outside sounds as wildlife calls and birdsong etc., the latter type of machine should be purchased.

TAPES

The subject of recording tape is extensive and cannot, due to space considerations, be gone into here in any great detail.

Tapes can be obtained in a variety of lengths and types. The lengths commonly available are 300, 600, 900, 1,200, 1,800, 2,400 and 3,600 feet respectively.

Further tape classifications are given by the base material – tape bases being either p.v.c., polyester or cellulose acetate. The first two types have a great degree of suppleness and are mostly used in amateur recordings, whilst the last type is mainly found in the broadcasting studios, although it is available on the market for those who require it. Tape suppleness is important in that contact between the sensitive (dull) face of the tape and the recording head must be as close as possible if the high frequencies are to be reproduced at a comparable level with the middle and lower frequencies. Furthermore, uneven contact due to a less supple tape can cause distortion and unwanted accompanying sounds. Also, it is important that the tape base material be strong enough to withstand the pull produced by the recorder mechanism; it must not stretch or curl and must remain unbroken when the braking mechanism is operated thereby abruptly bringing the tape to a stop.

Apart from the tape base material, tapes also appear in the categories: standard, long play, double play and triple play. The distinction here is largely one of tape thickness, it being possible to store more of one type than another on a given spool size. The average thickness, in microns, of the tape types are: standard 52; long play 35; double play 26; and triple play 18.

TAPE SPOOLS

Tape spools are commonly supplied in the following diameters: 3, 5, 5$\frac{3}{4}$ and 7 inches respectively, other sizes being available if required. Generally speaking, the shortwave listener will find that a selection of

3, 5¾ and 7in. spools fitted with long or triple play tape will suffice for the recording side of his hobby.

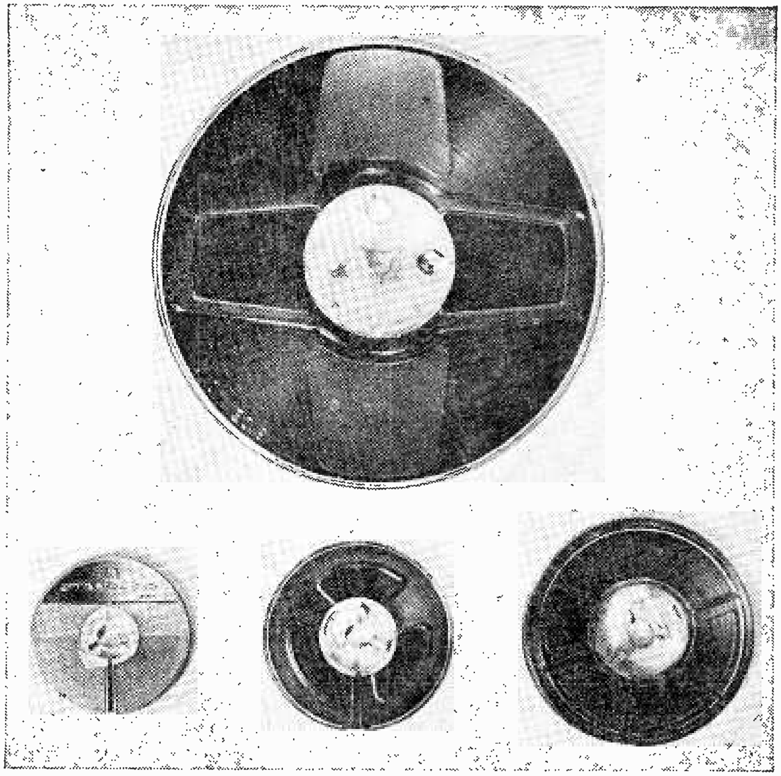
As an example of the recording time available, a 1,200ft. polyester tape on a 5¾in. spool running at 3¾ i.p.s. will allow approximately one hour each track – two hours for a 2-track machine and four hours for a 4-track machine.

The method by which the tape has either 2- or 4-track recordings made, by transposing and inverting the spools, will be described in the manufacturer's instruction book for the recorder.

CONNECTING THE RECORDER

Once the short wave listener has become accustomed to the use of the various controls on his tape recorder, the next task will be that of coupling the machine to the communications receiver.

It is not recommended that a recording be made by simply placing the recorder microphone in front of the receiver loudspeaker. The acoustic matching between the loudspeaker and the microphone will be poor and the signal passed by the microphone to the recorder will have all the distortion introduced by the receiver loudspeaker and output stage as well as any hum or noise introduced in the receiver a.f. stages. The latter may not be particularly evident during normal usage of the receiver but may reappear at a surprisingly high level after having been picked up by the microphone and passed through the recording system.



Some of the tapes and spools used by the author for recording short wave transmissions. At lower left, a 2in. spool – useful when sending a tape to a station for QSL purposes; centre, a 2½in. spool – sometimes used for the same purpose; right, a 3in. spool – used for recording amateur transmissions and top, a 5¾in. spool – used for taping music, programmes, etc

An electrical connection between recorder and receiver is very much better. It must be emphasised that such a connection may only be made if the receiver is isolated from the mains supply by a double-wound mains transformer or if it is battery operated. *Never couple a tape recorder to the circuits of a receiver whose chassis is common to one side of the mains supply.*

The simplest, but by no means the best, method of connecting the recorder to the receiver consists of coupling it via screened cable to the receiver output, either at a speaker or headphone socket or by connecting directly across the receiver speaker itself. It is necessary here that the receiver output chosen has one terminal common to the receiver chassis. The outside braiding of the screened cable connects to the receiver chassis at one end and to the recorder chassis at the other.

Whilst this method of connection is an improvement over the coupling given by placing the microphone in front of the receiver loudspeaker, there is still the disadvantage that any hum or distortion introduced by the receiver a.f. stages will once more accompany the signal passed to the recorder.

All these difficulties can be overcome by coupling the recorder to the receiver at a point immediately following its detector. If the receiver is a superhet (as will almost inevitably be the case with a communications receiver) a very convenient point for taking off the signal for the recorder is then given at the a.f. gain control. Apart from the fact that the tags of this control will normally be readily accessible for soldering purposes, the control itself can be quickly identified without circuit tracing.

Check the wiring at the receiver a.f. gain control, and couple to it by means of the circuit given in the accompanying diagram. The braiding of the screened cable connects to the receiver chassis at any convenient adjacent point whilst the centre conductor couples to the potentiometer tag at the non-earthy end of the track (corresponding to the slider at the maximum volume position) via a 680kΩ resistor paralleled by a 33pF capacitor, these being in series with a 0.01μF capacitor. The function of the 680kΩ resistor is to avoid upsetting detector performance, and the 33pF capacitor counteracts high frequency attenuation due to self-capacitance in the screened lead and at the tape recorder input. The 0.01μF capacitor blocks any direct voltage (either due to bias circuits or detected signal voltages) appearing on the gain control. If it can be ascertained that no direct voltage exists, the 0.01μF capacitor may be omitted, whereupon the centre conductor of the screened cable connects direct to the 680kΩ resistor and 33pF capacitor. Where any doubt exists, however, it is best to be on the safe side and retain the 0.01μF capacitor.

The screened lead from the receiver may be coupled into a high or medium impedance input at the recorder. Many recorders have a 'radio input' socket expressly intended for this application. The receiver output to the recorder is not affected by adjustments of the receiver a.f. gain control.

This method of connection also enables the tape recorder to be played back over the a.f. stages and loudspeaker of the receiver. The tape recorder output is fed into the screened cable for this function, the receiver r.f. gain and tuning being adjusted to prevent interference by received signals.

Once the short wave listener has become accustomed to using his tape recorder it will prove to be an indispensable part of the shack equipment. Armed with a suitable collection of tapes and spools, it will soon become apparent that a system of written records will have to be kept in conjunction with the various tapes, tracks and parts of tracks – but this is another subject! ■

ELECTRO-CHEMICAL ELAPSED TIME INDICATOR

by

J. B. DANCE, M.Sc.

ELECTRO-CHEMICAL CELLS ARE GRADUALLY FINDING more applications in the electronics field where long times are to be determined. One of these applications has already been discussed in this journal*. Indicators employing an electro-chemical effect are now available for showing the number of hours for which a piece of equipment has been operating. This information is important if the equipment must be serviced at regular intervals.

These miniature elapsed time indicators are 1¼in. long by ¼in. diameter and fit into any standard fuse holder designed for this size of fuse. They have metal end-caps, a glass body and look like a fuse, except that the outer glass envelope bears graduation marks and a liquid is present in an inner glass tube. The time for which a potential has been applied can be read from the scale.

During operation a potential of 4 to 12 volts from the timed equipment is applied to the unit via a series resistor, the current taken being 2.2 to 110μA, depending on the time range. Standard units have ranges of 100 to 5,000 hours. However, the time scale is inversely proportional to the current passing and it can therefore be varied by a suitable adjustment of the value of the series resistor. The accuracy is better than ±5% if a stabilised supply is used.

These relatively inexpensive units have the advantages of a wide operational temperature range (−40°C to +100°C) and ruggedness. The electrolyte is non-corrosive and is therefore not likely to cause trouble if the glass envelope is fractured. The manufacturers are Messrs. S. Davall and Sons Ltd., Wadsworth Road, Greenford, Middlesex.

* J. B. Dance, M.Sc., "Electronic Oil Change Indicator", *The Radio Constructor*, March, 1969.

■

CURRENT SCENE

SEASON'S END

It is in this month that we approach the end of the winter radio season and await the onset of the spring and summer sessions. If all those constructional projects we promised ourselves and looked forward to with some excitement – or maybe some trepidation – have been by now completed then we can count ourselves fortunate indeed! After much chassis-bashing, wiring and soldering, sweat, puzzling of the mind and who knows – even some constructional success – we can look to our workbenches and see our latest creation, pristine with its gleaming new paint, spun-aluminium knobs and full-vision dials, with much satisfaction. For most of us our workshop, or shack, by virtue of the winter season's efforts will be a more complete entity than hitherto.

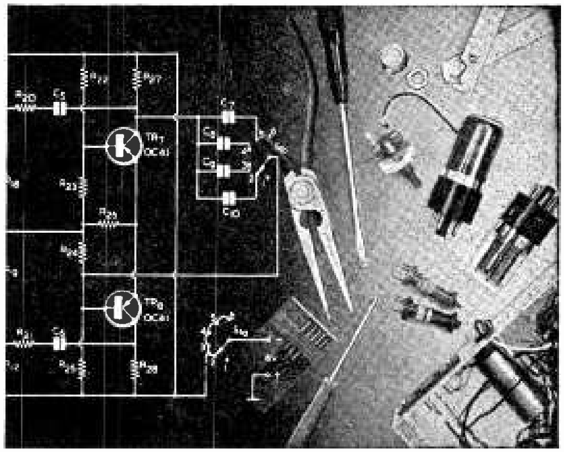
This is not, however, the whole story. Many of us will have that uncompleted venture, often placed to one side, whilst other more engaging or easy projects are embarked upon and completed. Some of us are great "putters-off"! Now is probably the best time to salvage that half-completed item of equipment gathering dust beneath the workbench – the usual repository for lost ventures – and to get cracking on completing it.

With the main constructional project complete, many constructors will be entering the stage of testing and/or aligning the newly-built "super-whatever-it-is". Past experience of testing and aligning home-constructed equipment has shown that this is also the season for that best known of all radio constructional sport – "chasing the gremlins"! Gremlin-chasing is more often than not a time consuming task but it can also be rewarding in the knowledge gained from mistakes inadvertently made and later corrected. Even where errors are not made, many circuits stubbornly refuse to function properly and efficiently as they should. This is all part of the fun and games, however disconcerting and disappointing the end product results may be. Most of us manage to win through in the end, picking up know-how and knowledge on the way – the glow of satisfaction we experience at the eventual successful outcome of our winter time constructional projects – this feeling imparting a sense of well-being and some private preening of one's ego – makes the whole thing worthwhile in the end. After all, we are all human!

To the Broadcast band enthusiast, this time of year means the fading out of the Far Eastern stations and the beginning of the signal strength build-up and receivability of transmissions from the South American continent. Thus, the Broadcast band listener is faced with a re-orientation of interest in addition to direction. The timing of primary listening sessions will differ from those engaged upon during the winter season. To the Amateur band operator, it means the onset of thoughts about mobile working and the coming field days, mobile rallies, etc., with the consequent de-cobwebbing of special equipment. To the tape recording hobbyist it will mean the taping of wildlife and outdoor sounds.

To all of us, in one way or another, the coming of the spring/summer season invarlably envisages a change of direction within the hobby. C.W. ■

SIMPLE H.T. DELAY SWITCH



by G. A. FRENCH

IN HIGH POWER AMATEUR TRANSmitters it is usually desirable, when switching on from cold, to apply the a.c. supply to the anodes of the rectifier or rectifiers providing high voltage h.t. (for the power amplifier and associated stages) a short time after the heater and lower voltage h.t. supplies have been turned on. This practice ensures that all valves operating from the high voltage h.t. line are fully warmed up when their h.t. voltage appears, and thereby prevents the appearance of the unnecessarily high h.t. voltages which could otherwise be formed under no-load conditions. In many instances, the time delay also protects the rectifier or rectifiers providing the high voltage h.t. supply. If, for instance, the 5R4GY full-wave high voltage rectifier is employed under certain circuit conditions, it is a manufacturer's requirement that the a.c. supply to its anodes be applied at least 10 seconds later than its filament supply. A longer delay is required with mercury vapour rectifiers. The filaments of mercury vapour rectifiers must be allowed to warm up for some 30 to 60 seconds (according to rectifier type) before the anode voltage is applied as, otherwise, internal arcing can occur with consequent damage to the rectifier filaments.

Normally, an automatic switching circuit of some kind is incorporated in the transmitter to delay the application of a.c. to the high voltage rectifier anodes when the transmitter is first switched on, the most common technique consisting of using a bimetal strip thermal unit to provide the necessary delay. The circuit described in this article employs an alternative approach and it has the advantage that the component which produces the time delay is an inexpensive TV booster diode of a type which has been very extensively used in the past. Many constructors will, indeed, probably be able to obtain the diode at zero cost from an old discarded television receiver.

In the circuit description which follows it is assumed that the reader is familiar with standard power supply design for high power transmitters.

THE CIRCUIT

The circuit of the h.t. delay switch appears in Fig. 1, where it will be seen that the booster diode is a PY81. Potentials of some 3 to 4kV appear between the cathode and heater of this diode when it is used in a standard television circuit, with the result that an essential part of its design is the provision of considerable spacing between these two electrodes inside the valve. This high spacing results in a slow warm-up of the cathode – an advantage for the present application.

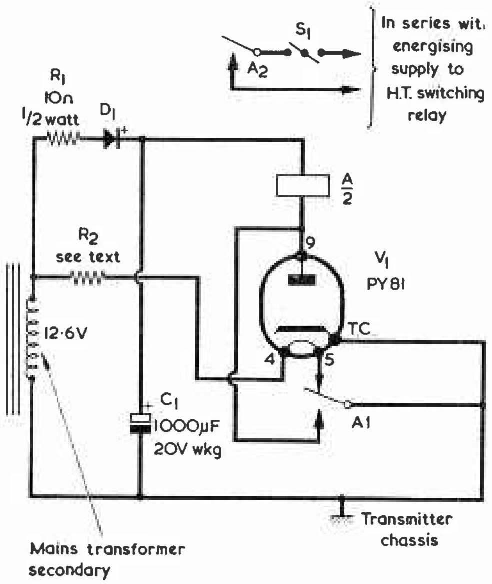


Fig. 1. The circuit of the h.t. time delay switch. Component functions not immediately apparent from the diagram are discussed in the text

The specified heater voltage for a PY81 is 17 volts but in the circuit to be discussed the heater is slightly under-run, thereby increasing further the time delay between application of heater voltage and the commencement of cathode emission. Incidentally, the fact that high voltages appear between the heater and cathode of a PY81 when it is used for its normal function explains why its cathode connection is brought out at its top cap.

A relay is employed in the circuit of Fig. 1, this being shown with the 'detached' method of presentation. Here, the relay coil is represented by the rectangle designated A/2, this term indicating that the coil is that for relay A, and that the relay has two contact sets. These contact sets are A1 and A2 and, with 'detached' presentation, can be drawn anywhere in the diagram. The contact sets are shown in the state which corresponds to the relay being de-energised. As may be seen from Fig. 1, A1 is a changeover contact set, whilst A2 is a 'make' (on energising) contact set.

The delay switch circuit is powered by a 12.6 volt mains transformer secondary. With some transmitter power supplies this secondary voltage may be available directly from the mains transformer or transformers already fitted whilst, with others, it may be obtained by connecting a separate 6.3 volt heater winding in series with an existing 6.3 volt winding. Relay contacts A2 and switch S1 are shown as being in series with the energising supply to the h.t. switching relay for the transmitter. This latter relay will be a heavy-duty component whose contacts, when energised, apply the mains supply to the primary of the transformer feeding the high voltage rectifier anodes. Switch S1 is the main H.T. On-Off switch for the transmitter.

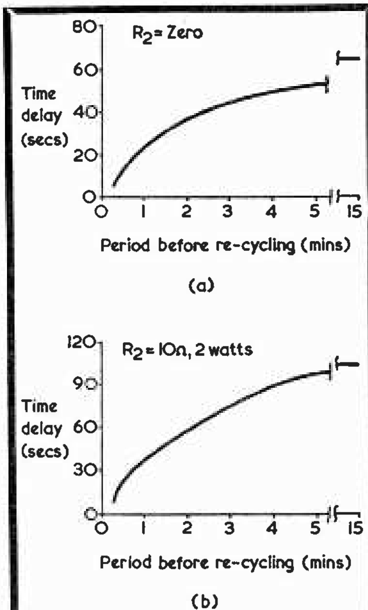


Fig. 2. Since the cathode of the PY81 does not cool immediately after the circuit has functioned, subsequent operations shortly afterwards result in reduced time delays. The curves show the delays given when R2 equals (a) zero resistance and (b) 10Ω

When the transmitter is switched on from cold, the low voltage h.t. supply and all heater supplies, including those to the high voltage rectifier filament or filaments, are turned on. A voltage from the 12.6 volt secondary in Fig. 1 becomes available and this is applied, via R2 and de-energised contact set A1, to the heater of the PY81. This 12.6 volt supply is also fed, via limiter resistor R1, to diode D1, which rectifies and causes a positive potential of some 17 volts to appear on the upper plate of C1. Under present conditions contact set A2 is open, and it is impossible for the high voltage h.t. switching relay in the transmitter to be energised.

The cathode of the PY81 slowly increases in temperature until, after a period, it emits and causes an anode current to be drawn through relay coil A/2. The relay energises and its contact set A1 changes over, breaking the heater circuit to the PY81 and connecting the lower terminal of the relay coil to chassis. The relay thus remains continually energised, and does not now have to obtain energising current via the PY81. Also, contacts A2 close, whereupon it becomes possible to energise the h.t. switching relay and apply high voltage to the rectifier anodes. No harm would have resulted if S1 had been closed immediately after switching on the transmitter from cold, because of the time delay provided by the circuit around the PY81.

After relay A has energised, the cathode of the PY81 cools, becoming ready for the next switching-on cycle. When the transmitter is later switched off relay A returns to the de-energised state, and is also ready for the next switching-on cycle.

COMPONENTS AND SETTING-UP

The component employed in the prototype circuit for relay A was a standard P.O. 3000 type with a coil resistance of 500Ω. This, with the contact sets shown, is capable of energising at around 9 volts. Relays with roughly the same characteristics should offer a similar performance. (P.O. 3000 relays, made up to customer's specification, are available from L. Wilkinson

(Croydon) Ltd., Longley House, Longley Road, West Croydon, Surrey.)

Diode D1 may be any small silicon rectifier having a p.i.v. rating greater than 40 volts. The author used a Lucas DD000 in the prototype circuit.

The value of R2 depends upon the time delay required, and this, in turn, depends upon the energising current and coil resistance of the particular relay used. It is advisable to initially check out the circuit with zero resistance in the R2 position to ensure that the relay employed is capable of energising reliably when the PY81 cathode achieves emitting temperature. The circuit should not, of course, be coupled to the transmitter h.t. switching relay when carrying out this test or when, later, finding the value required in R2. Various values of resistance, up to some 20Ω, may then be tried experimentally in the R2 position until the desired time delay (to be discussed in more detail shortly) has been achieved. It may be found that for some purposes the time delay provided is adequate with zero resistance in the R2 position. Zero resistance, with the prototype, resulted in a delay of 65 seconds when switching on from cold, whilst a resistance of 10Ω resulted in a delay of 105 seconds when switching on from cold.

A point which must now be mentioned is that for some minutes after the delay has operated the delay provided on re-cycling the circuit is less than that given after switching on from cold. This means that if the transmitter is switched on, switched off after the delay circuit has operated, then switched on again shortly after, the time delay on the second occasion will be shorter than on the first. This effect is due to the fact that the cathode of the PY81 takes some time to become completely cool, and it appears to be acceptable for amateur transmitting requirements. For instance, the high voltage power supply circuit given in the 'Power Supplies' chapter of both the third and fourth editions of the R.S.G.B. *Radio Communication Handbook* incorporates a bimetal thermal switch which, after having energised the high voltage h.t. switching relay, is similarly left to cool (although its cooling may be quicker than occurs with the PY81 cathode).

Fig. 2(a) shows the time delays offered by the prototype circuit when, with zero resistance in the R2 position, it was re-cycled shortly after initial operation. If the circuit is re-cycled quarter of a minute after initial operation the time delay it offers is only of the order of 5 seconds. After 2 minutes it is just short of 40 seconds and after 5 minutes it is a little above

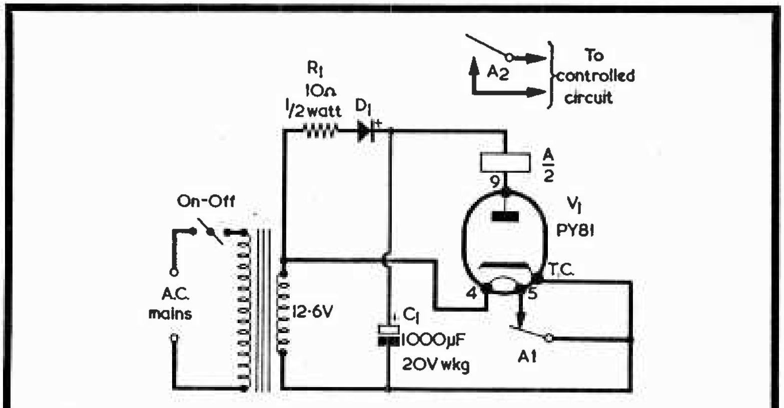


Fig. 3. A simple modification to the circuit enables it to function as a long-cycle periodic switch

50 seconds. When the cathode is completely cool, which can be expected about 10 to 15 minutes after operation, the delay offered is 65 seconds.

The curve in Fig. 2(b) shows the results given when a 10Ω resistor is inserted in the R2 position. If re-cycling takes place quarter of a minute after initial operation, the resultant delay is 8 seconds, whilst re-cycling after 2 and 5 minutes produces delays of 60 seconds and 95 seconds respectively. When the cathode is completely cool the delay is 105 seconds.

It is interesting to note that the delay on re-cycling approaches the final 'cool' value much more quickly in Fig. 2(b) than in Fig. 2(a) and this is probably due to the fact that, with the 10Ω resistor in circuit, the rise in heater temperature as the circuit is switched on is slower and that, in consequence, the heater temperature is less higher than cathode temperature when the latter commences to emit. As a result, less heat has to be dissipated via the cathode surface when the heater circuit is opened.

To find the value required in R2 for a specific time delay, the value of the resistor should be adjusted until the delay offered is a little greater than the minimum figure required when the circuit is re-cycled after 1½ minutes. The delay figure for switching on from cold should then, working from the curves of Fig. 2, be some 2½ to 3 times the minimum figure, which gives an ample safety margin in hand. If, for some reason, the transmitter is switched on, then off and on again, to result in a re-cycling time of less than 1½ minutes, switch S1 should be left open.

The writer checked the operation of several PY81's in the circuit, both with R2 at zero resistance and at 10Ω. There was no significant difference in performance with any of the diodes.

PERIODIC SWITCH

If the circuit of Fig. 1 is slightly altered, the combination of PY81 and relay produces a simple periodic long-cycle switch. This application may be of sufficient interest to some readers to merit a brief description here, and the appropriate circuit is shown in Fig. 3. In this diagram the 12.6 volt supply is obtained from a small heater transformer, and contact set A2 of the relay continually switches a controlled circuit on and off again.

The circuit of Fig. 3 functions in the following manner. When the on-off switch is closed the 12.6 volt supply is applied to rectifier D1, and to the heater of the PY81 via contact set A1. The heater warms up and, when the cathode reaches emitting temperature, the relay energises. Contact A1 opens, and the cathode commences to cool. Because of thermal inertia in the cathode and because the de-energising current of a relay is lower than its energising current, some time elapses before the relay de-energises. When it does, contact set A1 closes and the cycle starts again.

With the prototype, using the relay referred to earlier, the arrangement of Fig. 3 produced a cycle in which contacts A2 were closed for approximately 20 seconds and were open for approximately 15 seconds. ■

"EXPERIMENTAL RECORD PLAYER AMPLIFIER"

In "Experimental Record Player Amplifier", published in the January 1970 issue, the output transformer was referred to as an Eagle LT44. The correct transformer to employ in the amplifier is the Eagle LT700, and we regret the error.

The Discovery

A 2-VALVE, 4-STAGE SHORT WAVE RECEIVER

by

FRANK A. BALDWIN

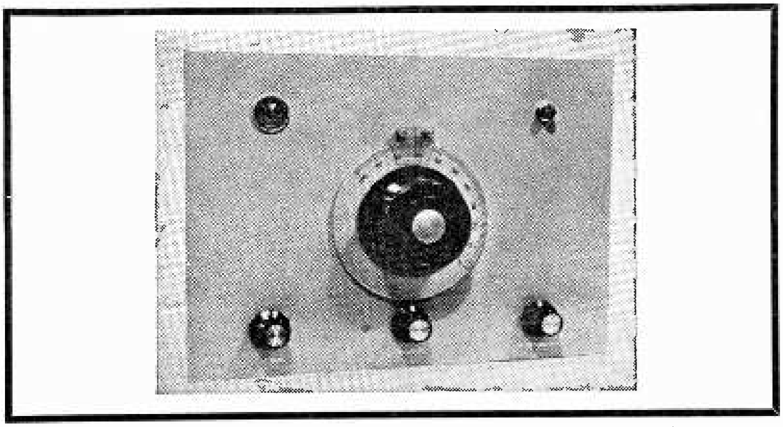
This receiver has been specifically designed for the budding short wave enthusiast, and it is not intended to be a constructional project for the absolute beginner. Each valve has two separate functions and the whole design represents, in effect, a 4-valve receiver, much development work having gone into its circuit. When used with an efficient aerial and earth system this receiver will undoubtedly outperform any comparable design the author has produced over many years in this type of work. The Discovery can be thoroughly recommended to the short wave enthusiast who requires an efficient and comparatively inexpensive receiver

THIS RECEIVER HAS BEEN specially produced for the near-beginner who has already acquired some experience in the constructional field with, say, simple 1-valve circuits, and who wishes to produce an efficient receiver for the short wave frequencies. The *Discovery* has been specifically designed to operate over the short wave spectrum with the maximum efficiency possible. It will also perform well on the medium wave band if a Denco Green Range 2 coil (not included in the Components List) is plugged in.

The 2-valve, 4-stage design has been thoroughly air-tested with an efficient aerial and earth system and has performed extremely well over both the Amateur and Broadcast bands.

A notable feature of this design is the smooth operation of the reaction circuit at any point within the frequency limits over which the set operates. This state of affairs has been made possible by using a well-known v.h.f. technique – a grounded-grit input stage. In the more orthodox "straight" receiver designs the tuned circuit to which reaction is applied is almost invariably damped by the inductance and capacitance to earth of the aerial, making the stage concerned comparatively unselective and, what is often a major problem with "straight" designs, causing the appearance of "dead spots" at various points in the receiver's coverage where reaction cannot be obtained at all. It is these two failings – poor selectivity and inefficient operation of the reaction circuit – that cause many "straight" receiver designs to be inadequate in performance. The normal approach to the removal of these two bugbears is to add a conventional r.f. stage, this requiring the inclusion of at least a further valve (for an untuned stage) plus an inductor and a 2-gang capacitor and associated components (when the r.f. stage is tuned).

With the *Discovery*, the approach adopted is to isolate the tuned stage from the aerial input by means of a grounded-grid stage. After much experimental work the present circuit was evolved, and it has proved to be entirely satisfactory in practice. The receiver tuned circuit, now isolated from the damping effect of the aerial-earth system, offers an acceptably high degree of selectivity. There is also complete freedom from "dead spots", whereupon it is possible to obtain maximum efficiency from the reaction circuit at all frequencies. This latter facility is, of course, a valuable asset with simple receiver designs.



CIRCUIT

The circuit of the *Discovery* receiver is shown in Fig. 1, reproduced here in the detachable section annexed. From this it will be seen that the aerial is fed to the cathode (pin 8) of the first stage (V1(a)) of the ECC83 double-triode via the variable capacitor C1. RFC1 provides a high r.f. impedance at this point, whilst R1 is a standard bias resistor. In this configuration the grid and *not* the cathode is maintained at zero r.f. potential, thereby providing a screen between the cathode and anode, which are the respective input and output electrodes.

The h.t. supply to the anode of V1(a), (pin 6) is via R2 and RFC2, decoupling to chassis being provided by C2. The output from the grounded grid stage is fed, via C3, to L1 of the coil. The windings depicted in the circuit of L1, L2 and L3 are the input, reaction and tuned windings respectively of coils in the Denco Miniature Dual-Purpose Green series. Three coils are required, these being for Range 3 (1.67 to 5.3MHz), Range 4 (5.0 to 15.0MHz) and Range 5 (10.5 to 31.5MHz). These coils plug into a B9A valveholder, and the numbers

Cut along this line

THE 'DISCOVERY' 2-VALVE RECEIVER

WORKSHOP PLANS PRESENTED FREE WITH MARCH 1970
ISSUE OF THE RADIO CONSTRUCTOR

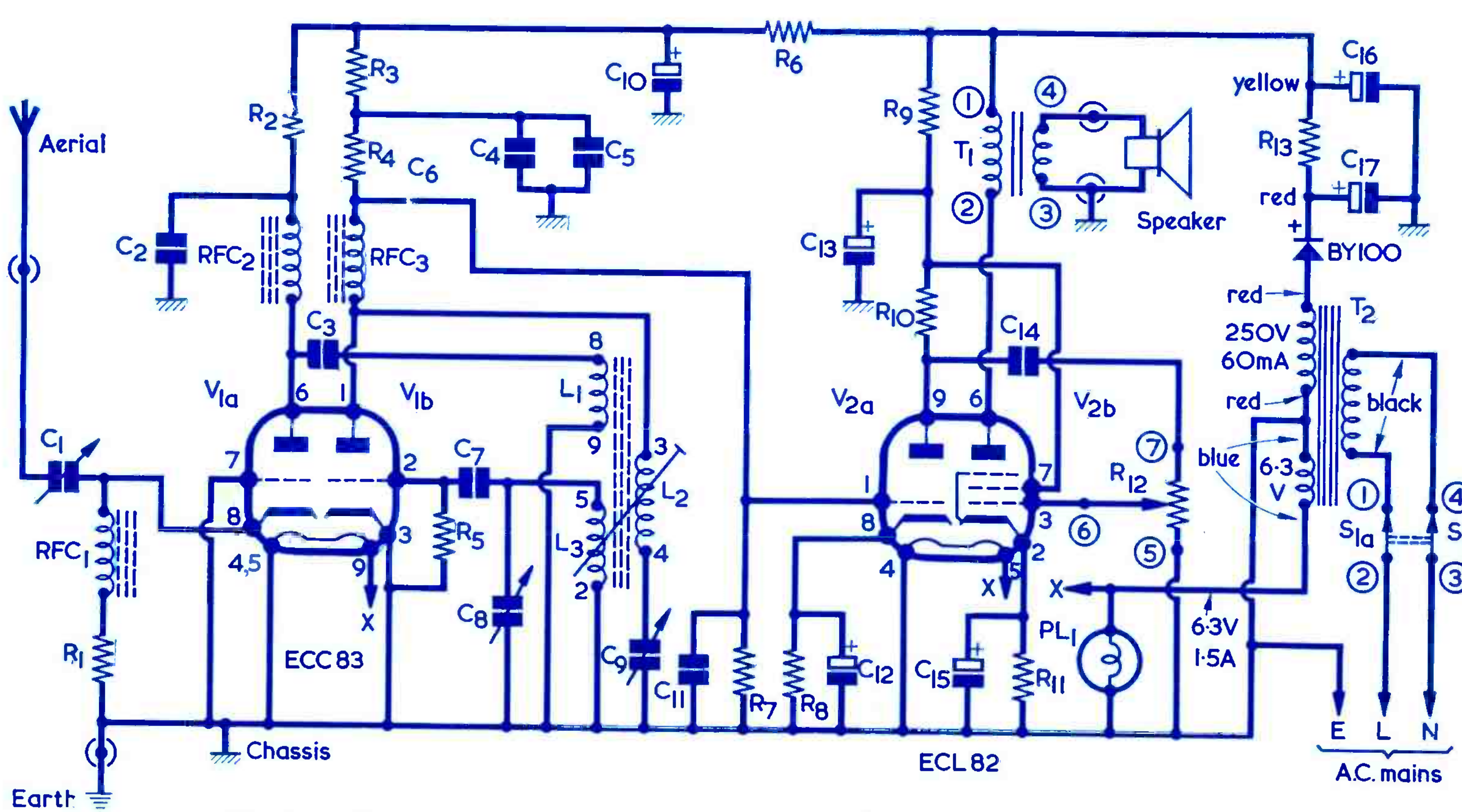


Fig. 1 THE CIRCUIT OF THE 'DISCOVERY' SHORT WAVE RECEIVER

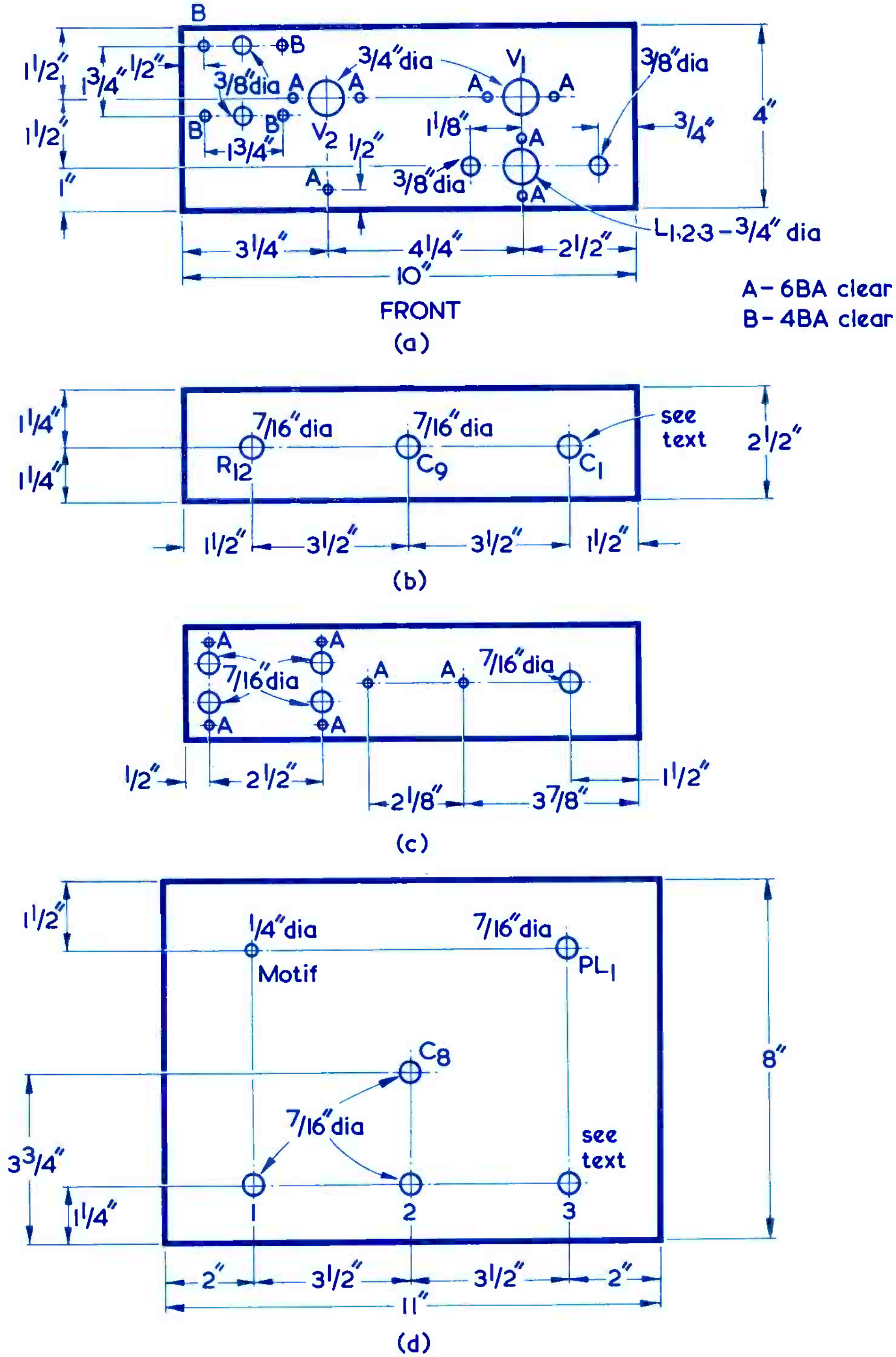


Fig. 2 Showing the drilling details for: (a) the chassis deck
(b) chassis front apron
(c) chassis rear apron and
(d) the front panel

shown around the windings in Fig. 1 indicate the coilholder pins to which the coils connect.

V1(b) operates as a leaky-grid detector, the required signal being selected by the tuned circuit L3, C8, and passed to the grid (pin 2) via capacitor C7. Reaction is provided by variable capacitor C9 in conjunction with winding L2, the values of R5 and C7 being such that smooth and stable reaction entirely free from backlash is obtained. Positive h.t. supply to the anode (pin 1) of V1(b) is via resistors R3 and R4 and r.f. choke RFC3. Efficient decoupling to chassis, a most important requirement in this stage, is provided by the parallel connected capacitors C4 and C5.

The detected audio frequency signal at the anode of V1(b) is now passed, via coupling capacitor C6, to the grid (pin 1) of V2(a).

The first audio amplifier stage and the power amplifier stage are incorporated in an ECL82 (the sections being V2(a) and (b), respectively).

The first stage (V2(a)) is a simple triode a.f. circuit in which resistor R10 is the anode load across which the output voltage is developed, R9 and C13 being h.t. decoupling components. C11, across grid resistor R7, bypasses to chassis any remanent r.f. signal present at this point. Bias is developed across the cathode components R8 and C12, the voltage across these being produced by the current flowing through R8, thus making the cathode positive with respect to the grid. The signal at V2(a) anode is a much amplified version of the original signal, and this is now taken, via capacitor C14, to the a.f. gain control R12.

With many simple receiver designs it is common to position the a.f. gain control between the detector and the first audio amplifying stage. It is often the case however that operation of the gain control then affects, to some degree or another, the reaction characteristics of the detector stage, thereby producing interaction between these two controls. In the present design this undesirable effect has been obviated by placing the volume control between the first audio amplifying stage and the power output stage, thus entirely removing any unwanted relationship between the reaction and audio gain controls.

The input for V2(b) is taken, from the slider of R12, to the signal grid (pin 3). V2(b) provides further amplification and offers an output, at speaker power level, via the output transformer T1. The speaker is not an integral part of the receiver but is contained in a separate housing, the speaker being connected to two output sockets on the chassis rear apron.

The components C16, C17 and R13 ensure that a ripple-free h.t. potential is supplied to the circuit. Note here that C16 and C17 are contained within a single can. The resistor R6, decoupled to chassis by C10, ensures that no unwanted coupling exists along the h.t. line between V1 and V2. The h.t. secondary of the mains transformer, T2, is rated at 250V, 60mA.

It will be noted that C10, C13, C16 and C17 are all rated at 450V wkg. In practice it would be in order to use 350V wkg. capacitors in these circuit positions, if the constructor so desires. The author chose the higher voltage capacitors, however, with the question of long working life and reliability in mind. It is his experience, also, that the dual-electrolytic capacitor is more readily obtainable at 450V wkg.

The colours shown in the circuit diagram around T2 are those of its lead-out wires. The encircled figures shown around the output transformer T1, the on/off switch S1(a), (b) and the potentiometer R12, correspond with the tag numbers shown in the point-to-point wiring diagram in the pull-out section.

One side of the heater supply is connected to chassis, the 6.3V winding of T2 feeding pilot lamp PL1 in addition to the valve heaters. The BY100 silicon rectifier feeds a rectified direct voltage to the smoothing circuit given by C16, C17 and R13. The a.c. mains supply is applied to the primary winding of T2 by the double-pole switch S1(a), (b), this being integral with a.f. gain control R12.

The receiver should be connected to the a.c. mains supply via a length of 3-core cable, the mains plug of which should contain a 3 amp fuse.

CONSTRUCTION

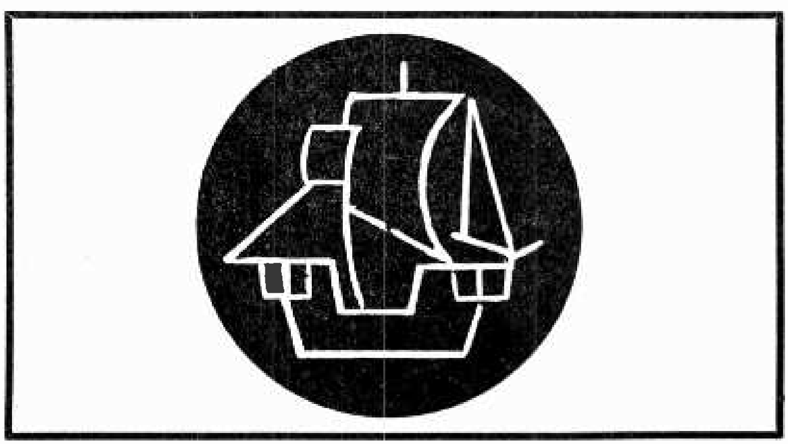
Fig. 2 of the detachable section provides information on the drilling details required for the chassis and panel of the receiver. Fig. 2(a) gives details of the chassis deck as seen from above; Fig. 2(b) drilling details of the chassis front apron; Fig. 2(c) details for the chassis rear apron and Fig. 2(d) details for the front panel.

Commence drilling operations with the front panel shown in Fig. 2(d). This makes for later ease of working when dealing with the chassis front apron. Measure and mark out with a centre punch on the front panel all hole centres with the exception of that for C8. Due to chassis tolerances, etc., the height of this hole may vary somewhat from the 3¾in. figure shown in the diagram and it is best to mark out this hole with the aid of the actual component employed for C8. The necessary procedure is carried out at a later stage. Drill holes 1 and 2 to a diameter of $\frac{7}{16}$in. The hole at position 3, that for C1, should be cut out slightly larger than $\frac{7}{16}$in. This is because C1 must not make contact with the chassis or front panel at any point, and is mounted with the aid of insulating washers. (If difficulty is experienced in obtaining suitable washers, these may be made up from oddments of Paxolin.)

Next drill a ¼in. hole for the motif. This is a button obtained from the button counter at a Woolworth's store and the ¼in. hole accepts its eye. The motif is affixed in place, after the panel has been painted, with the aid of adhesive. Finally, drill the hole for PL1.

Deal now with the drilling of the chassis front apron, as shown in Fig. 2(b). Offer the front panel to the front apron such that both lower edges are exactly in line, and the front panel projects at each end of the chassis by ½in. Clamp the chassis and panel together and centre-punch the chassis apron through the centre of the panel holes 1, 2 and the enlarged 3. Remove the panel and drill the chassis front apron to the same diameters as the corresponding panel holes.

Deal next with the chassis rear apron as shown in Fig. 2(c). Holes marked A should be drilled with a



$\frac{1}{8}$in. drill to take 6BA bolts and nuts. From left to right of Fig. 2(c) the fitments required are an aerial/earth socket strip (this requiring two 6BA clear holes and two $\frac{7}{16}$in. diameter holes as shown); the speaker output socket strip (which requires similar holes); the next two holes are 6BA clear for securing the output transformer; and at far right the $\frac{7}{16}$in. hole is for the a.c. mains input lead grommet. The best course here is to use the specified components themselves as templates when marking out their holes.

The next task is that of drilling the chassis deck, and Fig. 2(a) provides the required information here. The holes for the two valves and the coil are cut by means of a $\frac{3}{4}$in. chassis cutter for B9A valveholders. The three valveholders should be set to the orientation given in the point-to-point wiring diagram (i.e. with pins 6 and 7 of V1 and V2 valveholders nearest the rear of the chassis, and pin 9 of the coilholder nearest the front) after which two mounting holes are marked out for each and drilled 6BA clear. Remember that V1 valveholder is that fitted with a skirt for a screening can. The four mounting holes for the mains transformer are next marked out and drilled $\frac{5}{32}$in. for 4BA bolts and nuts. Also drilled are two $\frac{3}{8}$in. holes for the grommets through which the transformer leads will later pass. It is helpful here to use the transformer itself as a template when marking out these holes. Drill also the remaining two $\frac{3}{8}$in. holes shown in Fig. 2(a) together with the 6BA clear hole which is forward of V2 valveholder hole.

Place the variable tuning capacitor to be employed on the chassis deck such that the spindle protrudes as far as possible over the chassis front apron and is located in a central position exactly 5in. from either edge of the chassis. Ensuring that the two front fixing lugs are as close to the front apron edge as possible, mark and drill the three fixing holes for the capacitor, to take 4BA bolts and nuts.

If the underchassis photograph is examined, it will be noted that the dual-electrolytic capacitor C16, C17 is fitted to the side apron at the mains transformer end of the chassis. Fit the clip to the capacitor in the manner shown, position the capacitor on the side apron so that the clip securing nut and bolt are away from the chassis underside with the clip projection just inside the apron edge, and mark out the two mounting holes required. The capacitor centre should be $2\frac{1}{2}$in. from the front apron of the chassis. Drill the two holes 4BA clear.

Apart from the holes for C8 spindle and the tuning drive, the metalwork is now completed. The front panel may then be painted or sprayed to a colour of the constructor's choice.

ASSEMBLY

The next task is that of assembly and wiring and the constructor should work from the wiring and layout diagram in the detachable section. Frequent references to the photographs should also be made.

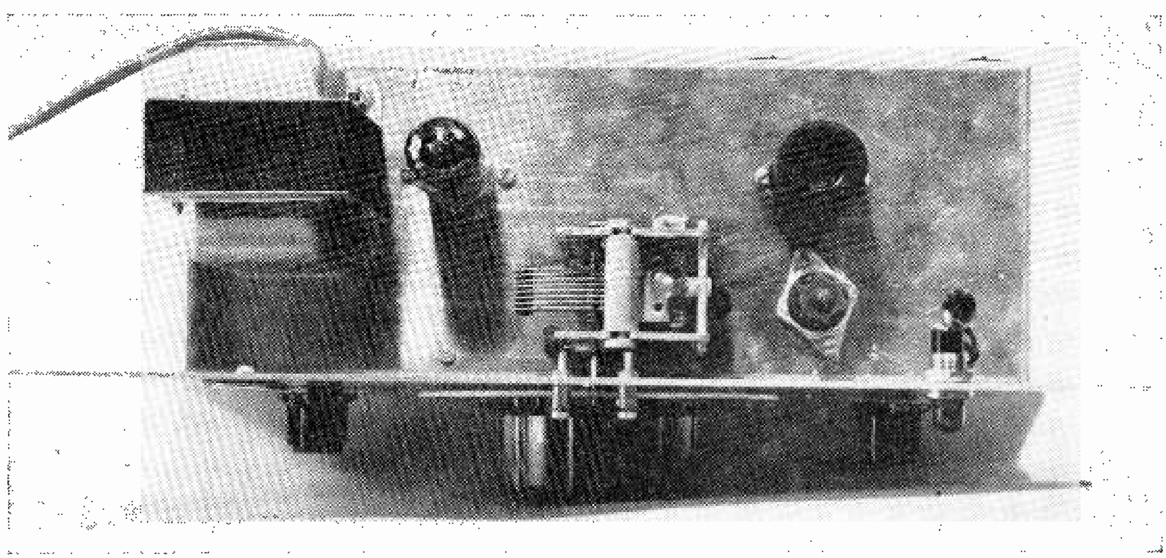
For ease of wiring, it should be noted that the front panel is not fitted to the chassis until a later stage. During the description of the wiring-up process, soldering at a particular point or tag should **only be carried out when stated,** thereby avoiding the bad practice of re-soldering a joint several times.

Commence the assembly in the following manner. 1. Mount V1 and V2 valveholders with 6BA nuts and bolts, such that pins 6 and 7 of both are nearest the rear edge of the chassis. To V2 valveholder fit a 6BA chassis tag under the nut nearer pin 9. Fit the coilholder such that pin 9 is nearest the chassis front apron using 6BA nuts and bolt. Under the nut nearer the rear of the chassis secure Tagstrip 3 – see point-to-point diagram for correct location.

2. Fit the four $\frac{3}{8}$in. grommets to the chassis deck and the $\frac{5}{8}$in. rubber grommet to the chassis rear apron.

3. Fit Tagstrip 1 using a 6BA nut and bolt. Fit the output transformer to the chassis rear apron such that the two eyeletted holes are nearest the bottom edge of the chassis, fitting also Tagstrip 2 under the left-hand (see point-to-point diagram) mounting lug of the former. Fit the aerial/earth Paxolin socket strip to the chassis rear apron by means of 6BA nuts and bolts, fitting a 6BA chassis tag under the nut nearer the bottom edge of the chassis. Next. fit the speaker output Paxolin socket strip to the chassis rear apron by means of two 6BA nuts and bolts. Ensure that none of the sockets make contact with the chassis.

4. Fit to the chassis front apron the volume control R12, the reaction capacitor C9 and the r.f. attenuator capacitor C1 – see point-to-point diagram for correct orientation of these components. C1 should have its inside insulating washer



Above-chassis view of the receiver. Components, from left to right, are V2, tuning capacitor C8 and V1

COMPONENTS

Resistors
(All $\frac{1}{2}$ watt 10% unless otherwise stated)

- R1 1kΩ
- R2 33kΩ
- R3 100kΩ
- R4 10kΩ
- R5 1.5MΩ
- R6 4.7kΩ
- R7 470kΩ
- R8 2.2kΩ
- R9 2.2kΩ
- R10 220kΩ
- R11 680Ω
- *R12 500kΩ log pot with switch S1
- R13 2.2kΩ 5 watt

*A. B. Components, miniature, (H. L. Smith & Co. Ltd.)

R. F. Chokes
3 off 2.5mH, type CH1 (H. L. Smith & Co. Ltd.)

Valves

- V1 ECC83 (Mullard)
- V2 ECL82 (Mullard)

Valveholders

- 2 off B9A with centre spigot
- 1 off B9A with centre spigot, skirt and screen

Inductors
Miniature Dual-Purpose, Green, Ranges 3, 4 and 5 (Denco Ltd.)

Dial & Drive
6 : 1 Slow Motion Drive, Part. No. 4489, Jackson Bros. Ltd.

Capacitors

- C1 150pF variable (Jackson Bros. Ltd., type C804)
- C2 5,000pF ceramic disc
- C3 100pF silver mica
- C4 0.1μF, tubular (Mullard) 400V wkg.
- C5 5,000pF ceramic disc
- C6 0.01μF tubular (Mullard) 400V wkg.
- C7 100pF silver mica
- C8 310pF variable (Jackson Bros. Ltd. Cat. No. 4507, 1-gang)
- C9 100pF variable (Jackson Bros. Ltd. type C804)
- C10 8μF electrolytic, 450V wkg. (RTC)
- C11 500pF silver mica
- C12 12μF electrolytic, 6V wkg.
- C13 8μF electrolytic, 450V wkg. (RTC)
- C14 0.01μF tubular (Mullard) 400V wkg.
- C15 25μF electrolytic, 25V wkg.
- †C16 32μF electrolytic, 450V wkg. (RTC)
- †C17 16μF electrolytic, 450V wkg. (RTC)

†Contained in single can, complete with fixing clip, upright mounting.

Mains Transformer
Secondaries: 250V, 60mA; 6.3V, 1.5A; type 6BR10 (H. L. Smith & Co. Ltd.)

Output Transformer
Wharfdale type T165 (H. L. Smith & Co. Ltd.)

Panel Lamp Assembly
PL1 Panel lamp type, LES 6.5V, 0.15A (H. L. Smith & Co. Ltd.)

Chassis
10 x 4 x $2\frac{1}{2}$in. (H. L. Smith & Co. Ltd.)

Panel
11 x 8in. (H. L. Smith & Co. Ltd.)
Socket Strips
2 off Aerial/Earth and Speaker (H. L. Smith & Co. Ltd.)

Earth Tags

- 2 off 6BA
- 1 off 4BA

Insulating Washers
2 off $\frac{3}{8}$in. fitting – see text

Rectifier
BY100

Tagstrips

- 1 off 5-way, centre tag earthed
- 1 off 4-way, tag 2 earthed
- 1 off 2-way, one tag earthed (H. L. Smith & Co. Ltd.)

Knobs
3 off Eagle type KB3 (H. L. Smith & Co. Ltd.)

Speaker
3Ω speaker

Rubber Grommets

- 4 off $\frac{3}{8}$in.
- 1 off $\frac{5}{8}$in.

Miscellaneous
P.V.C. covered wire, 4 & 6BA nuts and bolts, 3-core a.c. mains cable, mains plug fitted with 3A fuse, solder, etc.

fitted at this stage. There is no necessity to fit its outside washer, as this can be added later when the front panel is secured in position.

5. To the left-hand chassis side apron fit the smoothing capacitor assembly with two 4BA nuts and bolts, placing under the nut nearer the chassis front apron a 4BA chassis tag

7. Secure the mains transformer T2 to the chassis deck such that the two black wires are threaded through the grommet nearer the chassis front apron. Feed the two blue and two red wires through the rear grommet. Ensure that neither of the two grommets are displaced from their seatings. Secure T2 by means of four 4BA nuts and bolts.

8. Secure the variable capacitor C8 by means of three 4BA nuts and bolts.

WIRING-UP

9. Commence the wiring-up process by dealing with the power supply sections as the first task. See Fig. 3 of detachable section. To the black tag of the smoothing capacitor assembly connect one end of both a blue and a red wire from T2 (it does not matter which blue or red wire is selected) having first removed the enamel covering from the blue wire by means of scraping with a pen-knife. Also to the black tag connect a short length of p.v.c. covered wire, this terminating at the 6BA chassis tag associated with V2. **Solder** the three connections to the black tag of the smoothing capacitor assembly.

10. To the tag of C16 (yellow) connect one end of R13 (2.2kΩ 5 watt) and one end of a length of p.v.c. covered wire, the other end of the wire being connected to tag 3 of Tagstrip 1. Connect one end of a further length of p.v.c. covered wire to the C16 (yellow) tag, the other end of this wire connecting to tag 1 of the output transformer T1. **Solder** the three connections at the **yellow C16** tag, and **solder** the single connection at tag 1 of T1.

11. To the tag of C17 (red) connect the free end of R13 and the **positive** lead-out of the BY100 rectifier. Connect the other lead-out of the rectifier to tag 5 of

(Continued on page 498)

RADIO FREQUENCY PROBE

by

G. A. STANTON, G3SCV

With an input resistance of 250kΩ and a range extending beyond 100MHz, this neat r.f. probe can be employed with any standard high impedance valve or f.e.t. voltmeter

THE SOLID STATE ELECTRONIC VOLTMETER RECENTLY described in *The Radio Constructor* was designed to measure d.c. and audio frequency voltages up to 20kHz.[1] In order for such an instrument to 'read' radio frequency voltages an r.f. probe is required. The small unit now to be described has been designed for this purpose, and enables the frequency range of the electronic voltmeter to be extended to 100MHz, with useful indications well above that frequency. The probe makes it possible to check oscillators, adjust r.f. amplifiers, trace signals in receivers and carry out numerous other tests at radio frequency. Although originally designed for the electronic voltmeter just referred to, the probe can of course be used with any standard type of valve or f.e.t. voltmeter.

THE CIRCUIT

The circuit of the probe is given in Fig. 1 where it will be seen that only four components are employed. R.F. signals are passed via C1 to the semiconductor diode where they are rectified. The rectified voltage is then filtered by R1 and passed to the d.c. section of the electronic meter for measurement. The operation of the circuit is, however, not as simple as would appear but fortunately a complete analysis is not required for the purpose of this article.[2] For our present requirements it will be sufficient to note that the rectified voltage is approximately equal to the peak value of the r.f. signal. The r.m.s. value can therefore easily be obtained by multiplying the meter reading by 0.707. It should also be noted that due to the characteristics of the diode, readings lower than 1 volt will be non-linear. This however need not cause undue concern, for r.f. measurements are often comparative rather than exact. The maximum voltage that can be handled by the probe is dependent upon the maximum reverse voltage that can be applied to the diode. For this reason the type chosen is a Mullard OA91 with an average maximum reverse limit of 90 volts. A peak voltage of 45 can be safely measured. Often r.f. voltages are superimposed upon high d.c. potentials (e.g. in the anode circuits of valve amplifiers). The limiting factor here is the d.c. working voltage of the capacitor C1. In the original this is a 250 volt working type, but if the probe is to be used on, say, transmitters a higher voltage type of suitable working voltage rating should be substituted.

In order that the circuit under test be 'disturbed' as little as possible it is important for the probe to have a high input impedance. This comprises a resistance in parallel with a capacitance. The former is determined by the nature of the circuitry and in the present arrangement is equal to $\frac{R1 \times R2}{R2 + 3R1}$ i.e. 250kΩ. The capacitance is composed largely of circuit strays and is therefore mainly dependent upon the layout of the components. In the present design the measured value is less than 5pF.

CONSTRUCTION

Full constructional details are given in Figs. 2(a) to (d). The components are mounted on a piece of printed circuit board and housed in a dispenser in which Multicore 'Savbit' solder is supplied. The dispenser is a substantial aluminium unit ideal for probe construction. The printed circuit board is cut and etched as indicated in Figs. 2(a) and (b) and is firmly held in place by a 6BA brass bolt which also effectively connects the container to the earthy side of the circuit. See Figs. 2(c) and (d).

With each supply of solder is provided a length of p.v.c. tubing. This is used to insulate the probe tip from the container. The dispenser is prepared by slightly enlarging the hole at its tapered end until the p.v.c. tubing is a tight fit. A 6BA clearance hole is drilled ¼in. from the base to take the securing bolt. A solder tag at this point serves to connect the 'earthy' probe lead, which may be terminated in a crocodile clip.

The paint is easily removed from the container by wiping with a piece of rag soaked in cellulose thinners. The result is a professional bright aluminium finish.

The probe tip itself can be formed from either a length of 12 s.w.g. copper wire or of brass rod. One end is rounded to form a blunt 'point' and the oppo-

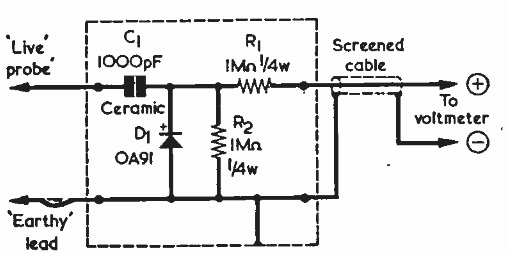


Fig. 1. The circuit of the r.f. probe

1 G. A. Stanton, 'Solid State D.C. Voltmeter and A.C. Millivoltmeter', *The Radio Constructor*, September 1969.

2 See 'Cathode Ray,' 'Watch Your Diode Measurements!', *Wireless World*, January 1969. The formula for input resistance given later is taken from the article by 'Cathode Ray'.

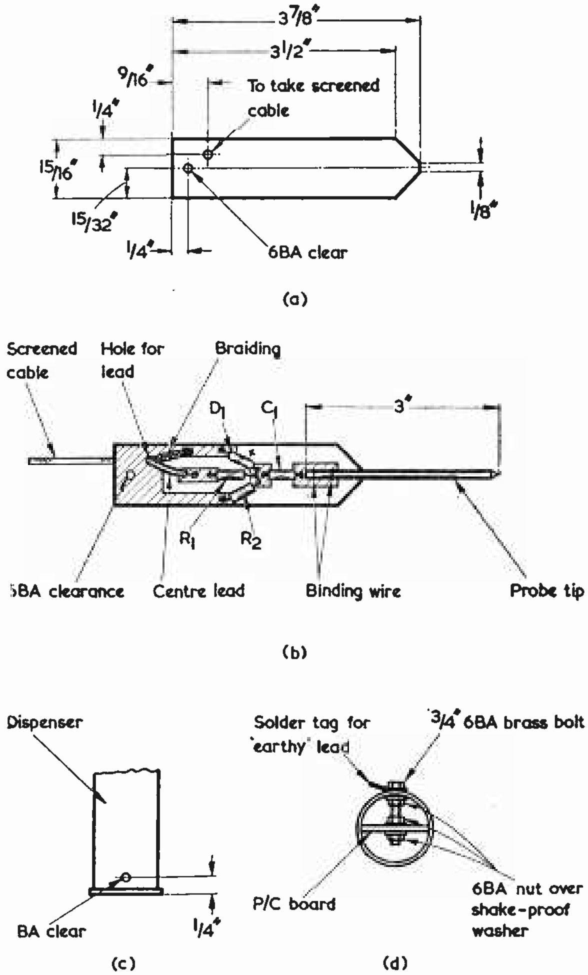


Fig. 2(a). Dimensions of the printed circuit board
(b). The printed circuit board with components mounted after etching
(c). The mounting hole drilled at the dispenser base
(d). Illustrating how the printed circuit board is secured inside the dispenser

site end slightly flattened for a distance of one inch. The whole should be cleaned and tinned with solder. The probe tip is secured to the printed board by two short lengths of 20 s.w.g. copper wire and then soldered to the copper laminate. The binding prevents undue strain on the laminate and the solder gives a reliable connection.

The probe is connected to the d.c. terminals of the electronic voltmeter by a length of thin flexible screened cable, as used for audio frequency work, the centre lead connecting to the positive terminal. The probe is effectively sealed by the plastic base supplied with the dispenser.

A simple probe of this kind greatly increases the usefulness of the original meter and is well worth the few shillings spent on its construction. ■

NOW HEAR THESE

All times GMT. Information correct at time of preparation.

● **NEPAL**
11970kHz Radio Nepal, Katmandu (5/100kW) signs on at 0120 GMT on this channel and also on **7105kHz** (5kW). Signs on at 1200 GMT on **7165kHz** (100kW) and also on **11970kHz.**

● **NEW ZEALAND**
11780kHz ZL3 Radio New Zealand, Wellington (7.5kW) may be heard on this channel at around 0700 until sign off at 0845 GMT.

● **NIGERIA**
9570kHz Radio Kaduna (10kW) can be heard on this channel around 2200 GMT.

● **COLOMBIA**
9635kHz HJCQ Radio Nacional de Colombia, Bogata (20kW) has been reported with an English language course being heard at 2245 GMT.

● **JORDAN**
9560kHz Radio Amman (100kW) has a daily English broadcast from 1400 to 1710 GMT.

● **ECUADOR**
3570kHz HCOS4 La Voz del Rio Carrizal, Calceta (0.5kW), a rare Dx catch, has been reported by a U.S.A. listener. Schedule is from 1100 to 0400 GMT.

● **BRAZIL**
5975kHz ZYT44 Radio Guaraja, Florianopolis (10kW) has been logged at 2330 GMT. Schedule is from 0900 to 0300 GMT.

● **CHINA**
15435kHz Pekin (20/240kW) logged on this channel at 0830 GMT with news in English.

● **EQUATORIAL GUINEA**
6250kHz Emisora de Radioffusion Santa Isabel, Fernando Poo (10kW) may be heard at reasonable signal strength around 1900 to 2300 GMT. Logged at 2130 with identification followed by music in Spanish style. Schedule is from 0700 to 2300 GMT. Verifies by letter.

● **NETHERLANDS ANTILLES**
11720kHz PJD Radio Bonaire (50/260kW) has been reported on this new channel with an English programme after 0100 GMT. Listed on **11775kHz.**

● **ETHIOPIA**
11910kHz ETLF Addis Ababa (100kW) logged on this frequency with a programme in English at 2000 GMT.

● **COSTA RICA**
4690kHz TIHGB Radio Reloj, San José (1kW) has moved to this channel from 6206kHz. First heard by us on the new frequency in January. Good signals from 0300 to 0500 GMT.

● **CENTRAL AFRICAN REPUBLIC**
5035kHz Bangui (30kW) logged at 0450 with cockerel crowing thrice followed by hunting horn gallop and station announcements in African dialect.

● **IVORY COAST**
11920kHz Radio Abidjan (100kW) has been heard with news in English at 1830 GMT. ■

NEWS . . . AND .

AMATEUR RADIO SATELLITE LAUNCHED

Australis Oscar-5, the amateur radio satellite, was launched as a secondary payload, along with Tiros-M from NASA's Western Test Range on Friday, 23rd January. The amateur satellite was ejected into orbit from the second stage engine compartment of the Thor- Delta launch vehicle in the same manner as previous Delta secondary payloads have been launched.

Australis Oscar-5 is a 12 x 17 x 16in., 39-pound spacecraft constructed by a group of amateur radio operators at Melbourne University in Australia – hence, the name Australis. The Oscar portion of the name is derived from Project Oscar (Orbiting Satellite Carrying Amateur Radio), a West Coast-based organisation of radio amateurs that has constructed and sucessfully secured launches for four amateur radio satellites to date. This will be the first launch for AMSAT, which was formed in March of last year to foster radio amateur participation in space research projects as described in News & Comment, November 1969 issue. AMSAT's role in the Australis-Oscar mission is one of preparing the satellite for launch, performing the necessary tests to be certain that the satellite will function properly once in orbit, conducting liaison with NASA to arrange for the launch, and assisting in the collection of the satellite data.

Australis Oscar-5 is designed to transmit low-power signals on two amateur bands, at frequencies of 29.45 MHz in the ten-metre band at 144.05 MHz in the two-metre band. These transmissions will be used by radio amateurs throughout the world for training in the art of tracking satellites and for experiments in the science of radio propagation. These beacon transmissions will carry telemetry data pertaining to the condition of the spacecraft, including battery current and voltage, internal and external temperature and the satellite's orientation with respect to the earth. This orientation information will be used to assess the effectiveness of a simple attitude control system used on Australis Oscar-5. This will be the first amateur satellite to employ such a stabilisation system.

A transmitting life of approximately two months is expected from the 20 pounds of batteries which the satellite will carry. This lifetime is based on continuous operation of the two-metre transmitter and week-end operation of the somewhat higher power ten-metre transmitter. The ten-metre transmitter can be turned on and off by appropriate commands from the ground. Several amateur stations are being set up at various locations in the world to accomplish this command function.

Construction of Australis Oscar was begun in 1966 by Project Australis. The Australis Group is an outgrowth of the Melbourne University Astronautical Society and was set up for the purpose of building satellites which can be used by amateurs for long distance communication on the VHF and higher amateur bands.

Many radio amateurs and others throughout the world are expected to take part in tracking, and receiving telemetry data from Australis Oscar-5. Their reports will be collected by three groups; one in Europe, a second in Australia and the third in the United States. The U.S. group is the Radio Amateur Satellite Corporation (AMSAT), P.O. Box 27, Washington, D.C. 20044. Special reporting forms are available from this organisation.

£450 OF ELECTRICAL EQUIPMENT TO BE WON

A top prize of £300 worth of electrical goods of your choice – plus ten prizes of £15 worth for runners-up – are offered in the "Zany Zoo" content sponsored by 3M, makers of Scotch magnetic tape.

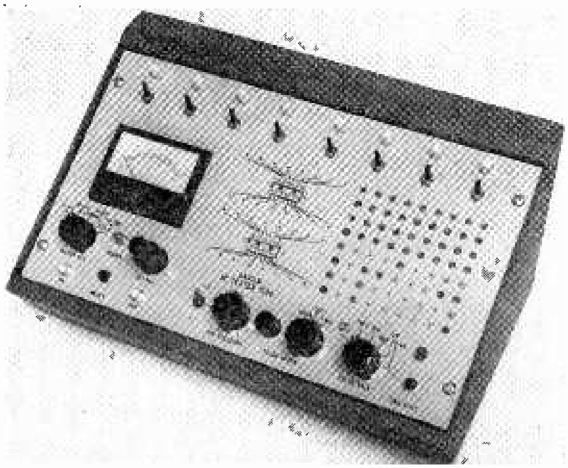
Entry forms for the contest have been in the hi-fi and electrical shops since January. Entrants are asked to link each of the eight animals pictured on the colourful illustration with a suggested quotation printed alongside – and to invent a suitable tape-orientated slogan to be credited to a wise owl.

Each entry must be accompanied by a tartan tab taken from a reel of Scotch magnetic tape, or from the wrapping of a Scotch magnetic tape cassette.

Last date for receipt of entries is March 31, 1970.

Look out for this counter unit at your local hi-fi or electrical stockist – it contains full details and entry forms for the Scotch magnetic tape

. . . COMMENT



I.C. TESTER–ANALYSER

Davian Instruments are selling a complete, low cost, integrated circuit analyser. It offers an extremely high degree of flexibility in circuit evaluation as a manually operated instrument and by fitting Davian programmed plugs is converted to an automatic "Go/No-Go" tester. As well as testing DTL, RTL and TTL integrated circuits, complete logic assemblies may be evaluated. The instrument is thus of use not only in the service, test, inspection and quality control departments, but also in the laboratory as a development aid and in education as a teaching aid.

The instrument consists of 2 dual in line 16 pin sockets, 4 power supplies, 8 logic state indicators, 8 single pole change-over switches, 4 load networks, comprehensive metering and pulse generation systems and an independent input and output, all of which are terminated at a precision 8 x 9 matrix.

The user may either adapt these facilities to his own requirements by patch-lead programming, or by using Davian programme plugs; carry out automatic testing of specific logic I.C.'s.

All power supplies are protected and the Voc and VL supplies are interlocked such that Vcc will trip if its preset (programmable) current limit is exceeded (as a result say, of the I.C. being faulty or perhaps incorrectly connected). When Vcc trips, VL is cut off and an alarm system causes all logic indicators to flash until reset.

Further details may be obtained from Davian (Instruments) Ltd., 47 Rowelfield, Luton, Beds.

48th AWARD OF FARADAY MEDAL

The Council of The Institution of Electrical Engineers has made the 48th awfrd of the Faraday Medal to Professor C. W. Oatley 'for his many contributions to the development of microwave valves and particularly for his outstanding leadership of the team of Cambridge University responsible for the development of the scanning electron microscope'.

MULLARD GOLDEN JUBILEE

The 50th anniversary of the founding of the Mullard company will be celebrated this year.

It was in 1920 that Mr. Stanley Mullard, born in 1883 and still a member of the Mullard Ltd. Board, formed The Mullard Radio Valve Company Ltd. – the first venture to bear his name. It occupied floor space rented from his former employers and its initial product was high-power transmitting valves.

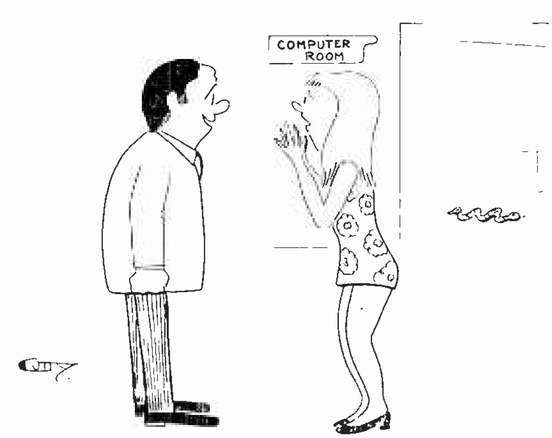
From this beginning the Mullard enterprise has developed into one of the U.K.'s biggest electronic component companies. It employs around 17,000 people, over 1,200 of whom are qualified scientists and engineers, in 14 production centres, laboratories, service depots and other ancillary establishments.

During jubilee year production capacity will be substantially expanded by the addition of three new plants at Thornaby (Teesside), Stockport (Cheshire) and Bolton (Lancs).

A number of plans to mark this 50 years of progress have been made. Among them is the creation by Sam McCredy of Portadown, Northern Ireland, of a fragrant pink hybrid tea rose called the Mullard Jubilee Rose. It will be introduced at this year's Chelsea Flower Show. Bushes will be planted at Mullard establishments and will also be made available to local authorities in those areas, and to company employees.

A Golden Jubilee Exhibition will be mounted in the Electronics Centre at Mullard House, London, and will run for about three weeks, starting early in October. Together with a sound and vision presentation of the company's past achievements and future prospects, the exhibition will visit Mullard plants during the following three months.

It is planned to film and/or record for the archives many of the other functions, now being arranged, at head office and the individual establishments.



"Yes, Miss Scatworthy, I know there's an adder in that room."

ECONOMICAL VOLTAGE REGULATOR

by

R. W. COLES

A novel circuit approach results in a low-cost voltage regulator which offers an exceptionally high performance

TRANSISTOR VOLTAGE REGULATORS MAY BE FOUND these days in a wide range of amateur projects, and a great many circuits have appeared in the popular electronic press. It sometimes seems as though efficient voltage regulation has become an end in itself, rather than a means to an end. It must be remembered, however, that these circuits are popular because, for the small outlay involved, a very worthwhile improvement in performance can be expected in the main equipment supplied.

Most of the published circuits the writer has seen up to now fit into one of two broad categories, these being either simple 1 or 2 transistor arrangements which provide regulation to within a volt or so at currents up to half an amp, or much more complex circuits which give excellent regulation at high currents, often with a variable voltage output. There are occasions when circuits in the first category do not match up to the specification required, whereas to employ a circuit from the second group would be like using a sledge-hammer to crack a nut!

The regulator to be described in this article provides, in the writer's opinion, a very useful compromise between performance and simplicity, and it achieves excellent regulation with just three transistors, one zener diode and two resistors.

OPERATING PRINCIPLES

Most simple transistor voltage regulators use a power transistor in series with the load, the transistor acting as a variable resistance. The circuit is arranged such that as output voltage increases the transistor resistance increases also, thus lowering the voltage to its intended level. To control the regulating transistor, an accurate reference voltage independent of supply variations is applied to its base. The simplest reference is given, of course, by a battery, though this is never employed in practical circuits which usually use a zener diode in series with a resistor as shown in Fig. 1.

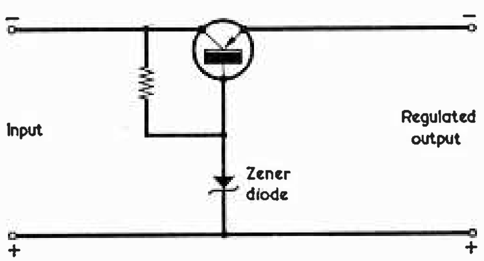


Fig. 1. Simple series regulating circuit

This simple circuit has a number of disadvantages. For instance the current it can supply is limited to the product of the d.c. current gain of the transistor and the maximum base current which can be obtained from the zener diode. Also, the zener diode is connected to the unstabilised side of the supply, which means that as the input voltage varies the zener diode current varies also. As a glance at the typical zener characteristic curve given in Fig. 2 shows, the varying current can cause small variations in the zener voltage.

These limitations may be overcome by using a d.c. amplifier to increase the base current available to the series regulating transistor, and by supplying the zener diode from a constant current source to keep it biased on a fixed part of its characteristic. A d.c. amplifier can be incorporated in the circuit quite easily (and cheaply) but a constant current source would normally involve at least another transistor and associated components, moving the circuit into the "luxury" class.

Luckily, there is a simple "dodge" which will provide a stable zener current without employing too many extra components, and this is given by simply

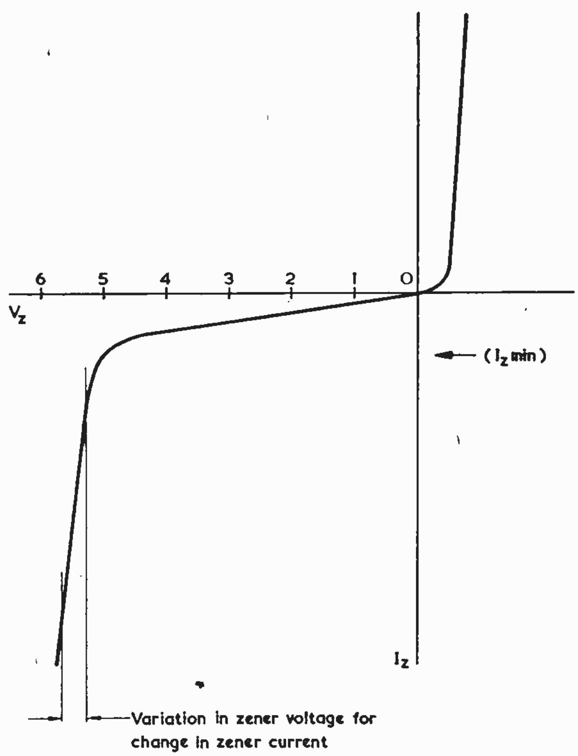


Fig. 2. Typical voltage-current characteristic for a zener diode

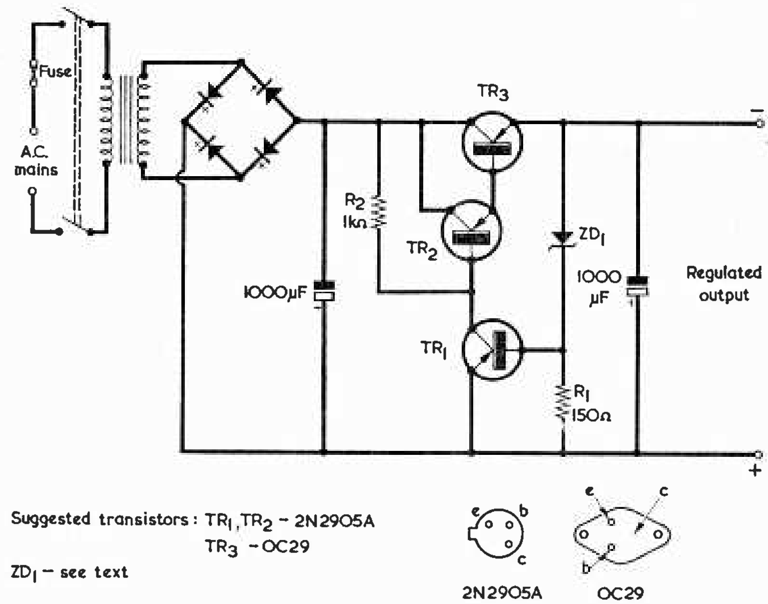


Fig. 3. Achieving regulation by inserting the zener diode after the regulating transistor

supplying the zener diode from the *stabilised* side of the supply.

The complete circuit is shown in Fig. 3, the unregulated supply being provided by the usual transformer, bridge rectifier and reservoir capacitor combination, with the series regulating element consisting of TR2 and TR3 in a compound emitter follower configuration. This configuration may be considered as a single transistor of very high current gain, and hence very low output impedance.

In Fig. 3, zener current flows through R1 and the base-emitter junction of TR1. The circuit is inherently self-balancing because the collector of TR1 assumes a potential which ensures that the corresponding current flows via the zener diode in its base-emitter junction. If, for instance, TR1 collector attempted to go more negative, the increased base current via ZD1 would force it to go positive, returning it to the original potential. A similar feedback action prevents TR1 colector going positive. Thus, the voltage between TR3 emitter and TR1 base is maintained equal to the zener voltage.

PRACTICAL POINTS

TR3 is a germanium transistor of the "power" variety, since it will be required to pass all the current demanded by the load and will also have the difference between unregulated and regulated voltages dropped between its collector and emitter. It will therefore dissipate considerable heat under full load conditions and will need to be mounted on a substantial heat sink. The transistor used in this position can be almost any germanium power type provided it is operated within its ratings for power, current and voltage, but if the constructor is not sure how to arrange this it would be better to stick to an OC29, as used by the writer, since this is an excellent transistor for the job. In the writer's version of the circuit, TR1 and TR2 are silicon planar p.n.p. transistors type 2N2905A, though germanium transistors type 2N1309 have been used in a version delivering less current.* The zener reference in the writer's supply, which was intended to offer a nominal output of 12 volts, was given not by a single diode but by two 5.6 volt 250mW zener diodes connected in series. An advantage conferred by using these diodes is the fact that zener diodes of roughly 6 volts have a zero temperature coefficient, rendering the supply less sensitive to temperature variations. The constructor's choice of zener diode will depend on the desired output voltage, of course, and in fact a wide range of types may be used, either singly or in series-connected groups. Under the voltage conditions in the writer's supply, R2 should be between 820Ω and 1.2kΩ. Resistor values between these limits worked best for a wide range of transistor types.

The mains transformer and bridge rectifier follow normal practice for a supply of this nature. The mains transformer should be rated at the maximum current required, and its secondary should provide a d.c. input after rectification and smoothing about 4 volts higher than the desired regulated output. The rectifiers in the bridge circuit can be standard silicon or germanium types having the requisite current rating, these being mounted on heat sinks if necessary.

Two high-value electrolytic capacitors are employed, one before the regulator to act as a reservoir and 100Hz ripple filter, and one after the regulator to act as a further reservoir. An added advantage

* Due to considerations of reverse V_{eb}, it would be preferable to use an OC28 or OC36 instead of the OC29 if the output voltage is to be greater than 20. The 2N2905A is available from Bi-Pre-Pak Ltd. —Editor.

of using a regulator is that mains hum suppression is far better than can be obtained with an unregulated supply using the same values of reservoir and smoothing capacitance, this being due to the high input impedance and low output impedance of the series transistor.

CURRENT LIMITER

Destruction of the regulating components will rapidly follow if the output of the supply is accidentally short-circuited. To guard against this it is recommended that the unit be protected on the output side by a fuse of suitable rating. This is in addition to the usual mains input fuse, of course.

Where a fuse would be inconvenient, or where self-recovery after occasional overloads is required, a current limiter can be incorporated. This requires only one more transistor and a resistor, as shown in Fig. 4.

The circuit action in Fig. 4 is quite simple. As the load current increases the voltage across R3 rises until the turn-on voltage of TR4 is reached. This transistor switches on rapidly, pulling the base of TR2 down to the potential of the lower rail and thus causing the output voltage to fall. The current will then be held at the limiting level (determined by the value of R3) and the output voltage will drop to about 0.5 volt until the overload is removed. A 0.5Ω resistor limits the current to 1.25 amp when using a silicon transistor type 2N2905A for TR4, but if a germanium type is used R3 will need to be of much lower value. This simple limiting circuit still allows the power transistor to dissipate considerable heat

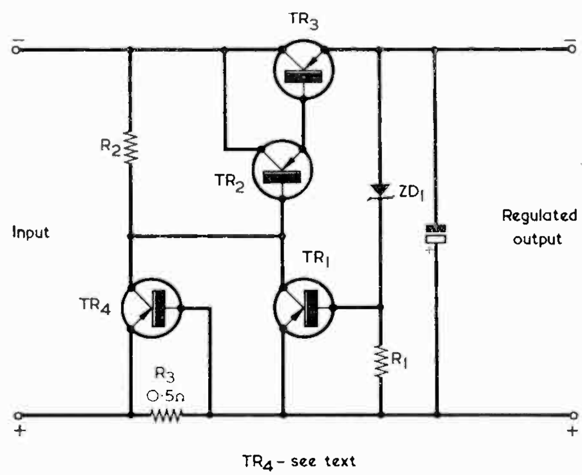


Fig. 4. Adding an overload protection circuit

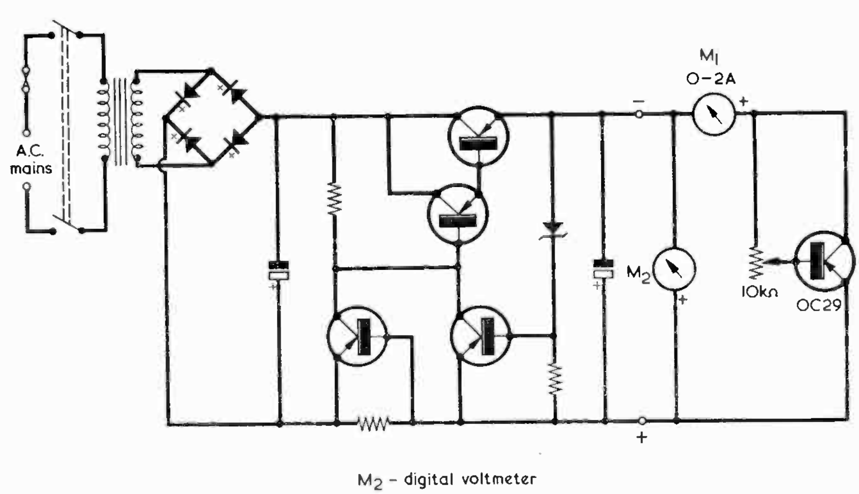


Fig. 5. Test set-up for evaluating the performance of the supply. (For the readings in the tables, a variable voltage input to the regulator was employed instead of the mains transformer and bridge rectifier shown here)

under short-circuit conditions (power dissipation equals the limiting current multiplied by the *unregulated* voltage) so when using this circuit it is necessary to employ a generous heat sink.

RESULTS

To test the efficiency of the regulation provided by this circuit, it was connected to a variable voltage d.c. supply, a variable load being provided by an OC29 connected as shown in Fig. 5. The output current was monitored by a 0-2 amp meter and the output voltage was checked by a digital voltmeter. Results are shown in the accompanying Tables.

In Table I the load current is 0.5 amp. Table II demonstrates the operation of the overload protection circuit. As will be seen, this comes fully into operation at 1.3 amp.

TABLE I

Regulated output voltage at 0.5 amp load current for input voltages from 15 to 30. Zener voltage is 2 x 5.6V.

Input Volts	Output Volts
15	11.816
16	11.838
18	11.858
20	11.858
25	11.858
30	11.858

TABLE II

Output voltage at varying load currents with overload protection circuit in operation. Unregulated input is approximately 15 volts.

Load Current (amps)	Output Volts
0	11.835
0.1	11.838
0.2	11.834
0.5	11.818
1.0	11.778
1.3	0.5

Output variations due to temperature outweigh those due to other causes, but output voltage always remains accurate to within 100mV.

The performance of the circuit compares favourably with complex arrangements which would cost far more to build, and the regulator circuit can be incorporated to advantage in many amateur projects which would normally use unregulated power supplies.

FIRST ATTEMPT

Do you remember your first attempt at a constructional radio project? It is unlikely that you have ever forgotten – most of us remember with nostalgia our first attempt, the mistakes made and rectified, the mis-reading and misunderstanding of the simple circuit diagram, the head-scratching and that often final symptom – complete bewilderment when the dratted thing stubbornly refused to function! However, most of us managed to win through at the end.

One's first attempt remains indelibly impressed on the mind and, long after the project has been consigned to the dust of the past, one recalls the pride of successful achievement and the many hours of pleasure later derived from use of the albeit modest but nevertheless prized equipment. It is true to say that one never again enjoys the same feelings with any subsequently constructed equipment however large and complex it may be.

It is probably the case that most beginners commence interest in the hobby with the construction of a simple receiver – and why not? The end product can be endless hours of fun, with the success of the venture easily judged by the aural results obtained.

Most of us have trodden this well-worn path and the writer vividly recalls that first attempt of many years ago. A battery-operated short wave 2-valve receiver, completed in the first instance as a 1-valve design with headphone output, laboriously and carefully constructed on a breadboard base – made from a wooden packing case – with all of the large components fixed into position by wood screws! The coil was of enormous proportions, being made of brown Bakelite, around the ribs of which were the various windings coloured in a bright shade of green. Both the valveholders were anti-microphonically spring loaded, the detector valve being a HL2 triode to which was added, at a later date, a simple amplifying stage. The circuit connections were made by simply tightening a nut. The various wires exhibited a most tidy appearance, being arranged in parallel to each other and having correct 90° bends where necessary. It all looked very neat and scientific like!

Impressed on the memory is that never-to-be-lived-again-moment when, with the headphones on, one heard the faint rustling sound of the reaction and the heterodyne of the first ever station to be received on the 1-valve receiver made by one's own hands.

One recalls the careful hoarding of schoolboy pocket money – miserly by present-day standards – the time and energy expended in running errands and doing odd jobs to increase one's purchasing power and the excitement of the long-planned visit to the local radio shop, all agog to part with those precious few shillings in exchange for the even more valued radio parts. Such visits also resulted in words of sought after advice from that fount of all wisdom – the 'wireless' expert behind the counter! Other oracular advice was obtained during frequent visits to the accumulator charging shed from one who, to the writer's boyish mind, was the human repository of all radio knowledge. It was all many, many years ago and recalled here with both affection for the characters mentioned and much nostalgia.

C.W.

QSX

by

FRANK A. BALDWIN

(All Times GMT)

● AMATEUR BANDS

Reception conditions on these bands have been far from good of late. During the hours of darkness the favourite band of most amateur Dx'ers, 14MHz, has for the most part been almost useless for cropping the Dx. Occasionally, however, even when the band has been almost 'dead', some Dx has surprisingly broken through, and a recent example of this was the reception of EL8K, EL2AW and ZS5CK at the CW end of the band just at the time when everything seemed hopeless.

The two LF bands conformed to winter conditions by perking up and providing most of the Dx interest. Top band continued to be very interesting at the CW end, whilst 3.5MHz provided the SSB surprises.

1.8MHz

The Top Band Trans-Atlantic Tests held so far have not proved to be as good as they were last year. However, that held on December 28th did produce many CW signals from across the pond.

CW: EUROPEAN

DL9KRA, EI9BG, GM3BGW, GM3EZQ, GM3YOR, GW3XJC, GW3YGH, OK1AIN, OK1ALI, OK1ALM, OK1ATP, OK1BLU, OK1FAB, OK1JBF, OK1KYS, OK1MAA, OK1MIO, OK2KKD, OK2KNZ, OK2KYI, OK2RGA, OK3TOA, OK3ZMT/P, OL1AMR, OL2AIO, OL2ANK, OL5ALY, OL5AMT.

CW: USA

K2ANR (1802kHz, 0607GMT), K8DH (1802kHz, 0540), K8RNE (1802kHz, 0610), KV4FZ (1804kHz, 0500), W1BB/1 (1804kHz, 0500), W1HGT (1802kHz, 0512), W2IU (1803kHz, 0502), W4BRB (1802kHz, 0545), W8AH (1803kHz, 0520), W8ANO (1802kHz, 0517), W8GDQ (1802kHz, 0605), W9BKA/8 (1804kHz, 0543), WA4SGF (1804kHz, 0525).

The American calls listed were logged during the December Test.

3.5MHz

The mode to use on this band has undoubtedly been SSB, as the following few call signs show, all garnered at one sitting!

SSB: CO2FA, HK3WO, W1AW, W4IHK, XE1GGW, XE1KS.

14MHz

CW: CM6HT, CR6KB, EL2AW, EL2BZ, EL8K, ET3USA, FM7WG, HI3PC, HZ4MG, KP4ABD, KV4CI, LU7WH, LU8FCO, PY2DFR, PY2EAJ, PY8EL, PZ1AG, PZ1AV, VK2ARV, VK2EO, ZE2KL, ZL1ATH, ZP5MA, ZS2CV, ZS5CK, ZS5NF. Corsica, in the shape of F9VN/FC was heard being chased by the Dx pack in full cry!

SSB: CR7IC, HC2GG/1, PZ1BI, VK2WC, VK3RZ, VK5FO, VK5NJ, VP9MI, YS6BM, ZL3GJ, ZS1BK, ZS1JA, ZS2A, ZS2MI, 9Y4MM.

Little time was spent on the other bands, 7MHz produced on CW only VE3DBB, W3HQU, W3NX, W4SSU and W6RR. 21MHz after dark produced only HC2GG/1, ZE1BT and ZD9BM.

So much for the Amateur bands. What did the Broadcast bands provide? A whole host of interesting stations, which fare did brighten up the Dx Tables somewhat as the following will show.

● BROADCAST BANDS

The end of the 'season' for Far Eastern stations is now upon us and the S.American 'season' is about to commence. Beginners, however, should beware when trying to identify the latter stations on the lower frequency bands (60 and 90 metres) during early morning sessions at the commencement of the S.American season. Often, African stations can be heard on these bands with the commencement of their daily transmissions. A case in point was the recent reception of Omdurman on 4994kHz at 0430; this *could* possibly be mistaken for a S.American by an unwary beginner.

3204kHz 0555 Ibadan, Nigeria with African music and announcements in vernacular. Ibadan is the capital of the western province of Nigeria some 60 miles north of Lagos. Population 600,000.

3345kHz 1555 Kashmir, India with a programme of typical Asian music. This one has a power of 2kW. Traversed by ranges of the Himalayas, Kashmir is in N.W. India and N.E. Pakistan, divided along a cease-fire line. Summer capital Srinagar, winter capital Jammu.

3366kHz 0600 Accra, Ghana with identification and news in English.

4815kHz 1850 Ouagadougou, Upper Volta, heard with a talk in an African dialect.

4823kHz 1410 Hanci, N.Vietnam, logged with a programme of Asian music.

4855kHz 1455 YDK Palembang, Indonesia with Asian music and songs.

4875kHz 0405 HCHE4 La Voz Esmeraldas, Ecuador with Latin American music.

4932kHz 0555 Benin City, Nigeria with announcements in English. Benin City is the capital of the Mid-West region of Nigeria. A former African kingdom, it is famous for its African bronze work.

4975kHz 1525 Foochow, China with talk in Chinese dialect.

5055kHz 1540 Singapore with news in English.

5084kHz 1550 RRI Nusantara Tiga, Medan, Indonesia. Talk in vernacular till 1600, followed by identification and Asian music and songs until 1610. Closed at 1615.

7215kHz 2025 AIR Delhi, India with English programme.

9545kHz 2017 Accra, Ghana with impressive sound of African drums and chants.

9912kHz 2034 AIR Delhi, India with talk in English and identification. Frequency announced and checked. Listed on 9910kHz.

11850kHz 2040 Ejura, Ghana with drums, chants and shrill cries!

11865kHz 2030 PRA8 Radio Club Pernambuco, Recife, Brazil with Latin American music and identification. Recife is a seaport with a fine natural harbour, sometimes called the Brazilian Venice.

15240kHz 0910 Ascension Island relaying BBC news in English. Identification and close at 0915. This island is part of the British Colony of St. Helena, has an earth satellite tracking station and an airstrip known as 'miracle mile'.

● BEGINNER'S CORNER

I have been asked by several beginner listeners to list some stations that they could fairly easily receive, preferably when announcements are in English and, as one reader put it, "at reasonable times". I wonder what he meant by that! Here are a few such stations with actual logging times.

6035kHz 1745 Warsaw, Poland with English programme.

6070kHz 1730 Sofia, Bulgaria with English programme.

6234kHz 1937 Budapest, Hungary with news in English.

7285kHz 2007 Tangiers (Voice of America), with news in English.

9670kHz 2045 Damascus, Syria with news in English and identification. This one has been moving around of late and is not listed on this channel.

15060kHz 0840 Peking, China with news in English. Also on **15435kHz** at the same time.

● UNIDENTIFIED

4700kHz 1457 Chinese (?) station here, opens at 1457 with choral rendering of an Asian song, this being followed by announcement repeated several times. ■

SELF - REGULATING BATTERY CHARGER

By taking advantage of silicon controlled rectifiers (thyristors) this battery charger automatically reverts to trickle charge as soon as the battery becomes fully charged. It is intended for 12 volt batteries only

THIS SELF-REGULATING DEVICE CHARGES A 12 VOLT car battery at a rate of 3 to 4 amps when the accumulator is 'flat', but then automatically reduces the charge to a trickle rate when the battery voltage reaches its 'fully charged' value. The unit thus eliminates the danger of overcharging a battery, and eliminates the need for the owner to occasionally check the battery state when it is connected to the charger. If, in fact, a battery is permanently connected to the charger, it will automatically be maintained in a permanent state of full charge, but will never be over-charged.

CIRCUIT OPERATION

The full circuit of the charger is shown in the accompanying diagram. Transformer T1 and bridge rectifier D1 to D4 step down and rectify the mains voltage, and apply a charging current to the battery via limiter resistor R1 and silicon controlled rectifier (or thyristor) SCR1. The gate current for SCR1 is derived from the rectified a.c. line via D5 and R6. SCR2 is wired between the junction of D5 and R6 and the lower rectified supply line, and its gate current is initially derived from the battery under charge via the potential divider given by R2, R3 and R4. The voltage on the slider of R3 is applied to capacitor C1 and zener diode ZD1, and then to R5 and the gate of SCR2. R3 is adjusted so that SCR2 is triggered on only when the battery voltage reaches a 'fully charged' value. For the purpose of explanation let us assume that this value is 13 volts.

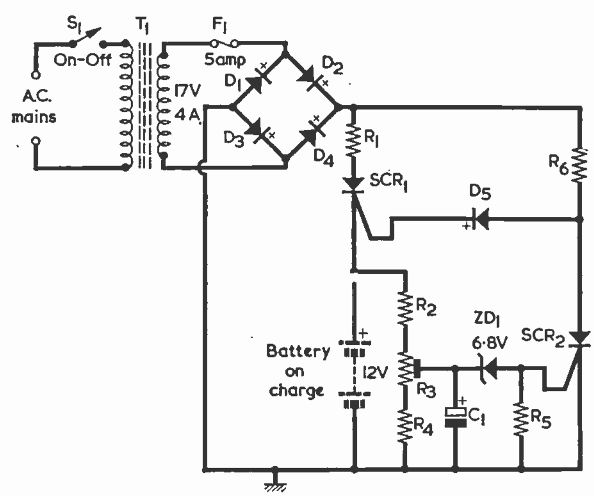
Thus, when the battery is initially placed on charge, its terminal voltage is inevitably less than 13, so zero gate current flows to SCR2, and SCR2 is thus off. SCR1 is therefore triggered on via R6 and D5 at the start of each half cycle from the bridge rectifier, and high charge currents flow to the battery via R1 and SCR1. R1 limits charge currents to safe average values of 3 to 4 amps over the approximate battery voltage range of 10 to 13 volts.

As the battery charges up its terminal voltage rises in proportion to the state of charge and eventually reaches a value of 13 volts around full charge. At this stage, sufficient voltage is developed at the slider of R3 to cause zener diode ZD1 to conduct, and SCR2 is thus triggered on. As SCR2 comes on its anode pulls the junction of R5 and C6 towards the lower rectified supply line and thus removes the gate current to SCR1. SCR1 turns off, and the battery charge current reduces to zero.

Once the battery charge current is reduced to zero, the battery terminal potential slowly decays back below 13 volts, and when it has fallen by a small amount SCR2 turns off again allowing SCR1 to become conductive once more. A re-charge current is applied to the battery and brings its terminal voltage back to 13. This 'cycling' process then repeats *ad infinitum*, so that the battery is effectively trickle charged under conditions which maintain its terminal voltage at 13. The sensitivity of the circuit is such that the battery voltage is then automatically kept within a few tens of millivolts of the value pre-set by R3.

CONSTRUCTION AND SETTING-UP

Constructional details of the unit are in no way critical, and it can be wired up directly from the circuit diagram. If individual silicon rectifiers are



The circuit of the self-regulating battery charger. This changes automatically to trickle charge when the battery is fully charged used for D1 to D4 they must be mounted on suitable heat sinks, as also must SCR1. Fuse F1 can be replaced by a re-settable 5 amp mechanical trip, if preferred. A 0-4 amp charge current meter can be wired in series with R1, if desired. Alternatively, an indication of charge current can be obtained by connecting a voltmeter across R1, which develops a potential of 0.5 volts per amp of current.

COMPONENTS

Resistors

(All fixed values 10%)

R1	0.5Ω 12 watts, wirewound (see text)
R2	100Ω ½ watt
R3	500Ω preset potentiometer, 1 watt, wirewound
R4	680Ω ½ watt
R5	1kΩ ½ watt
R6	220Ω 2 watts

Capacitor

C1	100μF electrolytic, 15V wkg.

Semiconductors

(See text for suggested devices. Current wattage and p.i.v. figures are minimum values)

D1-D4	5 amp, 50 p.i.v. silicon rectifiers, or one 5 amp 20 volt bridge rectifier
D5	100mA, 25 p.i.v. silicon diode
ZD1	6.8 volt 5%, 400mW zener diode
SCR1	5 amp, 50 p.i.v., SCR
SCR2	1 amp, 50 p.i.v., SCR

Transformer

T1	Battery charger transformer, secondary 17 volts 4 amp

Switch

S1	s.p.s.t. on-off switch

Fuse

F1	5 amp fuse (or resettable trip)

When construction is complete, turn R3 slider down towards R4, connect a fully charged battery into circuit with the polarity shown, and switch the unit on. Check that the unit passes a charge current of approximately 3 amps; if current is greatly above this, increase the value of R1 to bring it to approximately the correct value.

Now slowly adjust R3 slider up towards R2 until a point is reached where the charge current just drops to zero or to a low trickle value. Place a high current lamp or other load across the battery terminals so that the battery voltage falls by a few tens of millivolts, and ensure that (probably after a short delay) the charge current switches to 3 amps again. Remove the lamp load, and check that (probably after a further delay of several minutes) the unit again reverts to trickle charge. If satisfactory, the unit is now complete and ready for use, and can be connected up to a discharged battery.

When setting up and using the charger it may be found that, instead of the charge rate falling abruptly from full to trickle as the battery reaches full charge, the charge current in fact falls briefly from full rate to half rate, and then falls to trickle rate some time later. If it does occur, this phenomenon is due to slight unbalance in the D1-D4 bridge rectifier diodes, and is nothing to worry about.

EDITOR'S NOTE

A suitable rectifier for D1 to D4, if individual components are used, is the GEX541. An adequate heat sink area would be 3 x 3in. SCR1 may be a CR71 with a similar heat sink, and SCR2 a CR3/05. A suitable diode for D5 is a DD000 and for ZD1 an SZ68A. These types are merely suggested, since the specification allows a wide range of alternative semiconductor devices to be employed. All the devices just mentioned are available from Henry's Radio Ltd.

Charger transformers offering 17 volts at 4 amps or more are generally available. A typical example is the Cat. No. TC3 retailed by Home Radio.

R1 may, if desired, be made up from four 0.5Ω 3 watt resistors (Home Radio Cat. No. R14). Make up two parallel pairs, each giving 0.25Ω, and connect the pairs in series to give 0.5Ω total. ■

CAN ANYONE HELP?

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

Ever-Ready Sky Monarch FM/AM.—C. W. Manley, 47 Belle Cross Road, Kingsbridge, Devon – valve line-up or service sheet or conversion of this battery set to mains operation.

R1155 Receiver.—P. Saint, 321 Manchester Road, Clifton, Manchester M27 2PT — circuit of receiver and details of power unit.

Williamson Amplifier. — J. Walker, 191 King Street, Broughty Ferry, Dundee — any information on this and the Baxendall a.f. amplifiers, loan or purchase of circuits.

Metal Locator. — C. Galloway, 41 Eastfield Road, Mitcham, Surrey — requires a good reliable circuit.

C.R.O. Using ICP1. — E. Taylor, 19 Scafell Way, Clifton, Nottingham — requires the circuit published in this magazine some years ago and now out of print. ■

"DO-IT-YOURSELF" CERAMIC I.F. FILTERS

by

G. W. SHORT

New in the field of 455kHz i.f. ceramic filters are the Identical Resonators recently introduced by Brush Clevite Company, Ltd. By using these in conjunction with standard capacitors it is possible to build filters of any complexity with a continuous range of bandwidths and selectivities, these latter being varied by change of capacitance values in the filter circuit. Tables showing the capacitance values required are available from Brush Clevite Company. In this article our contributor discusses several practicable 455kHz filters suitable for home-constructor applications, using data obtained from the Brush Clevite tables

CERAMIC RESONATORS, WHICH are rather like quartz crystal resonators in many ways, have been around for some time, but they have been used mainly in professional-grade equipment. One reason is that, to make up a complex filter, careful selection and matching of resonators is needed.

The picture has now changed radically. At the cost of adding a few capacitors to the filter circuit, the design can be standardised and simplified, using nominally identical resonators. The required Identical Resonators (IR's) are currently manufactured by Brush Clevite Company, Ltd.

The type of resonator employed in these filters is the 'fundamental' resonator illustrated in Fig. 1. This has an electrical equivalent circuit which has the same form (see Fig. 1(b)) as the equivalent circuit of a quartz resonator, though the values of L, C, and Cs are quite different. The ceramic resonators are physically small and have Q values of about 500, so they are suitable for building compact filters with sharp cut-offs. Their frequency stability is also good: the performance figure for Brush Clevite Identical Resonators is given as 0.1% frequency change for a temperature change of −20 to +60°C. The resonators are made in two types, one for the narrower passbands and the other for the wider passbands. For amateur use, the narrow-band type is most suitable. It is known as type TF 04–442, and all the circuits discussed in this article use it.

FILTER DESIGN

The simplest type of filter designable with the Brush Clevite resonators is shown in Fig. 2(a). This filter uses two Identical Resonators and three capacitors, the latter being of any normal type suitable for use at 455kHz in high–Q circuits, such as silvered mica or polystyrene film.

The response of the filter has the general shape shown in Fig. 2(b). It is symmetrical, has two sharp attenuation peaks on either side of the centre frequency, and offers a certain minimum amount of attenuation, denoted by S, outside the pass band.

The particular two-resonator arrangement of Fig. 2(a) is designated 'IRI' by Brush Clevite. The characteristics can be selected by the designer. All that needs to be done is to look up the Brush Clevite table of capacitor values for C1, C2, and C3 and select the ones most suited to the requirement. In general, it is possible to have a very sharp response, with high attenuation outside the passband but rather high insertion loss (I.L.) at the centre frequency, or less sharp selectivity with less insertion loss but not such good rejection of frequencies outside the two rejection slots.

The separation of the slots, P, is 26kHz for the TF 04–442. The passband, B6, (which is the usual '6dB bandwidth' referred to in normal i.f. filter data) can be set to values from 4.65kHz to 13.2kHz by using different sets of capacitors. For B6 = 4.65kHz, the insertion loss I.L. is 4.4dB, and the minimum stop-band attenuation S is 31.4dB. Also, C1 (as shown in Fig. 2(a)) is 296pF, C2 is 1,670pF, and C3 is 304pF. These are not standard values but variations of 10% have little effect on performance, so C1 and C3 can both be made 300pF ± 5%, with plenty of tolerance in hand, while C2 can consist of two 820pF capacitors in parallel.

Three other design parameters have yet to be dealt with. Bs is the bandwidth for which the attenuation is at least equal to S. For the IRI circuit it is 19kHz. R1 (in Fig. 2(a)) is the input impedance, and for the particular case we are discussing, where B6 is 4.65kHz, this impedance is 525Ω. The output impedance, R2, is 8,800Ω.

This information throws light on the advantages and disadvantages of the IRI arrangement. The input impedance is seen to be rather low, and the stop-band attenuation is not as great as might be desired. On the other hand the selectivity around the centre frequency is good, and the presence of an atten-

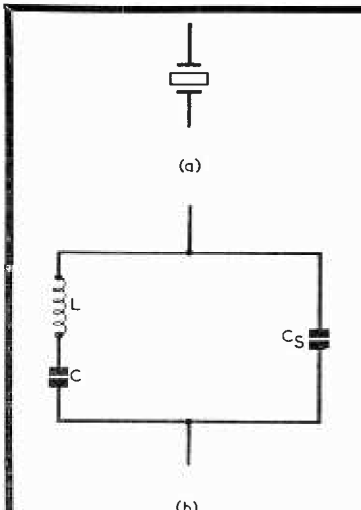


Fig. 1(a). Ceramic resonator symbol
(b). Equivalent circuit at fundamental resonant frequency

uation peak starting at 9.5kHz on either side of the centre frequency is a useful feature which is not provided by ordinary LC filters of the type used in i.f. amplifiers. There is, however, another disadvantage which is not revealed by the response curve of Fig. 2b. At frequencies far above the passband there are minor dips in the attenuation curve. These are caused by mechanical overtone resonances in the ceramic resonator, and they occur, not at harmonics of 455kHz, but at 1,200, 1,770, 2,300 and approximately 4,400kHz.

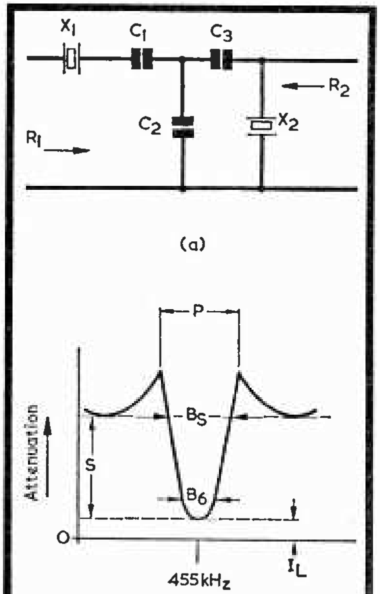


Fig. 2(a). The 'IR1' filter configuration. This employs two resonators
(b). General response curve offered by the 'IR1' filter. The terms shown are described in the text

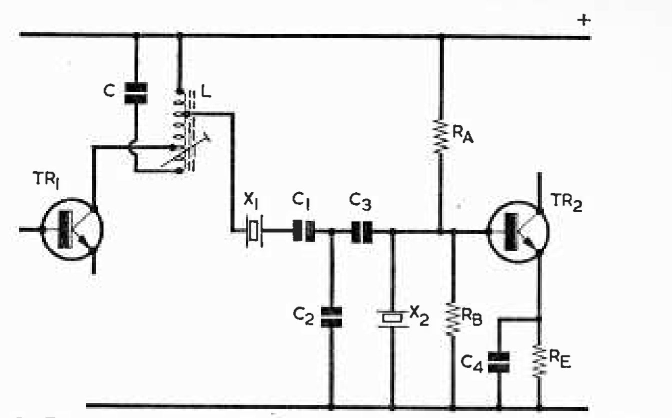


Fig. 3. The 'IRT-1' configuration employs one LC circuit to provide impedance matching and suppress spurious responses

'IRT-1' FILTER

All these snags can be overcome by the arrangement shown in Fig. 3. This is called the 'ITR—1' configuration, and it is just the IRI with one ordinary LC tuned circuit added at the front end. If the tappings on the coil are chosen correctly (they are about the same as on an an ordinary single-tuned i.f. transformer) the gain of TR1 (which could be a frequency-changer) is not optimised, the filter is matched, and the spurious resonances are suppressed.

The design tables give the following performance data for an IRT–1 filter when C1 is 307pF, C2 is 1,170pF, and C3 is 330pF: with these values, B6 is 4.7kHz, S is 50dB, I.L. is 7.2dB, R1 (the input impedance of the 'IRI' part of the filter) is 204Ω, and R2 (the output impedance) is 4,360Ω.

The designer must select the correct tapping points on the coil, since these depend on the load required by TR1, but some useful information is given in the Brush Clevite data. It is also up to the designer to ensure that the correct load is presented to the filter by TR2. This is made up of RA, RB, and the input resistance of TR2, all in parallel. Clearly, it is possible to make the only uncertain element, i.e. the input resistance of TR2, high by leaving out the usual emitter bypass capacitor (shown in Fig. 3 as C4) and thereby introducing emitter feedback from RE, which increases the input impedance. The load on the filter is then largely determined by RA and RB. In any case, the performance of the filter is not greatly affected by load variations; the load can be halved or doubled with only a 10% change in performance figures.

This article has dealt with only the simplest types of filter circuit. The Brush Clevite data covers filters with up to eight Identical Resonators. Most do not use the LC matching circuit, but one which does, the 'IRT-2', incorporates four ceramic resonators and gives a performance approaching communications-receiver standards. It will be clear that with such a filter after the frequency changer no further i.f. selectivity is needed. The i.f. amplifier can then be of the wideband untuned type, perhaps using an integrated circuit.

The TF 04-442 ceramic resonators cost about 10s. each, and are now available from Amatronix, Ltd. The design data was supplied to the writer free of charge by Brush Clevite Company, Ltd., Thornhill, Southampton, SO9 1QX.

VHF/FM RECEPTION IN BAND II

With the announcement by the Minister of Posts and Telecommunications of the next twelve Local Broadcasting Stations, it is appropriate once again to draw attention to the need for listeners to use suitable aerials and to be properly instructed in the adjustment of VHF receivers.

The BBC has recently completed an analysis of complaints of unsatisfactory VHF reception during 1968/69 and this shows that more than 50% of the complaints were due to the use of inadequate aerials or to faulty or maladjusted receivers.

ELECTRONIC EXHIBITIONS

New dates have been fixed for the Manchester Electronic Instruments Exhibition.

The Electronic Promotion Group announce that, to prevent a clash with the International Broadcasting Convention in London, the exhibition at the Hotel Piccadilly will be held from September 15th to 17th – a week later than originally planned.

The dates for the Southampton Electronic Instruments Exhibition have now been finalised. This show will be held at the Skyway Hotel from September 22nd to the 24th.

HIGH QUALITY LOUDSPEAKER

by

A. J. WHITTAKER

This high performance loudspeaker employs a readily available high fidelity speaker unit in a home-constructed bass reflex cabinet. Although the outside dimensions of the cabinet are only 14in. by 17in. by 17in., it almost completely tunes out the bass resonance of the speaker unit, offering an excellent standard of reproduction over the entire audio spectrum

HIGH QUALITY SOUND REPRODUCTION NECESSITATES a loudspeaker having features which are fundamentally better than the reproducers in domestic radio and TV sets. Cabinet design plays a major part in the quest for quality reproduction. Suitable cabinet design embraces a certain amount of science, and if one delves deep enough one enters the realm of Besel Functions, Helmholtz resonators and the rest. There are many variations of loudspeaker enclosure and in this article we shall discuss the construction of a simple unit which can be made up by the home constructor, at a reasonable cost and with the minimum of effort.

CABINET CONSTRUCTION

The loudspeaker unit itself is an important link in the chain and a Fane model 805 was selected after taking into account cost, performance and quality of workmanship. This is a heavy duty 8in. speaker with a roll rubber surround and a free field bass resonance of 28Hz. Its impedance is 15Ω.

Fig. 1 shows the construction of the cabinet, together with the dimensions. The most important factor in loudspeaker cabinet construction is rigidity. These cabinets are not sounding boards as used in pianos or violins, but are intended to control the sound waves created by the speaker unit and to couple the cone vibrations to the surrounding air with the minimum of error. If the cabinet vibrates it will absorb power and produce spurious sounds at certain frequencies which were not present in the original signal. The cabinet must therefore be of rigid construction and the enclosure airtight. The interior surfaces should be covered with absorbent material such as cotton waste or carpet underfelt (wool) at least 1in. thick. This treatment minimises internal reflections within the cabinet which would add unwanted colouration to the reproduction.

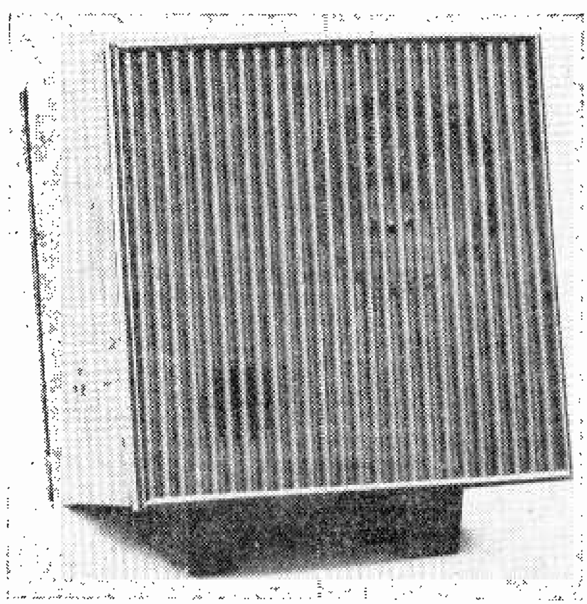
The cabinet is of a bass reflex design and is constructed of 1in. thick block board, glued and screwed together as shown in Fig. 1.

The 7 by $2\frac{1}{2}$in. plastic loading tube shown in the diagram is a piece of plastic down pipe commonly used nowadays on houses, and is readily available from any builder's merchant. Its wall thickness is about $\frac{1}{8}$in. It fits into a circular hole in the front of the cabinet, the tube front edge being flush with the cabinet front. The front end of the tube is of course open to the air.

TUNING

To derive the optimum benefit from a bass reflex cabinet it is necessary to tune it to suit the loudspeaker drive unit. This procedure was carried out with the present design, using an audio signal generator and a valve voltmeter in the test set-up illustrated in Fig. 2.

First to be determined was the free field bass resonance of the speaker unit, this being measured with the speaker on a table with its cone facing upwards. The speaker terminals were connected to the signal generator via a 100Ω 1 watt resistor. The valve voltmeter, set up to read peak a.f., was connected across the speaker terminals. Initially, a 1kHz note was injected, the audio signal generator output amplitude being adjusted until a reading of 1 volt was given in the voltmeter. The signal generator was



The completed cabinet not only performs well but also represents a very acceptable item of furniture

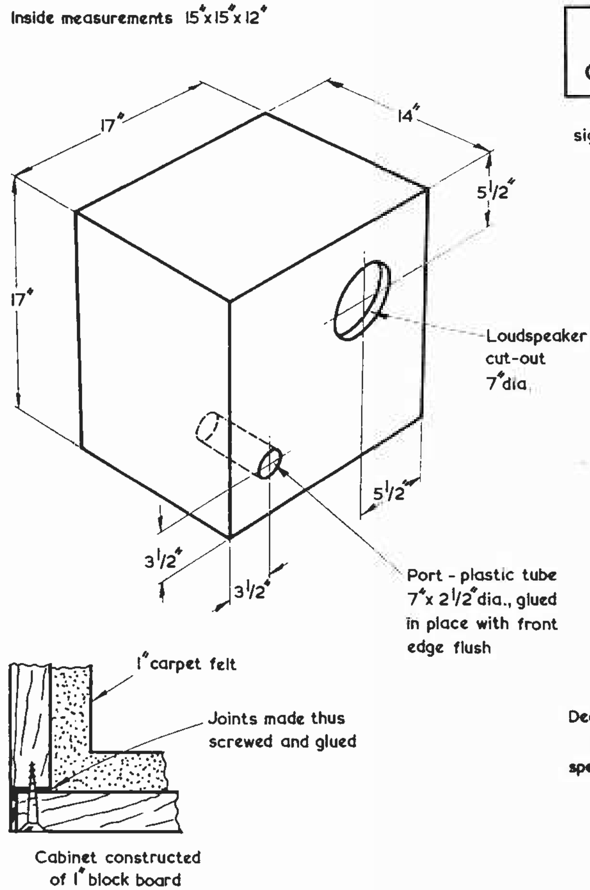


Fig. 1. The dimensions of the cabinet and tuning pipe. Apart from the port and loudspeaker apertures the cabinet is completely enclosed, and the back, covered on the inside with sound absorbent material, must be screwed in position securely

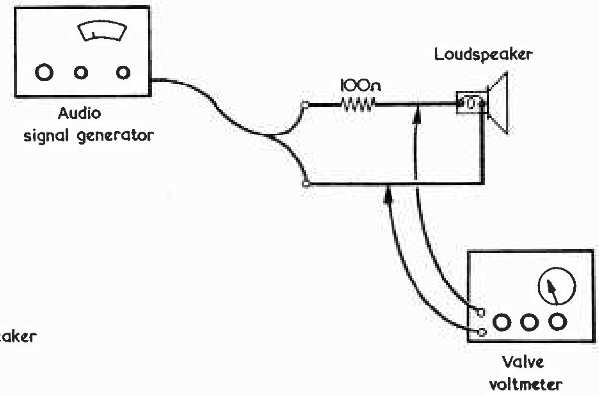


Fig. 2. Test set-up for evaluating loudspeaker resonances

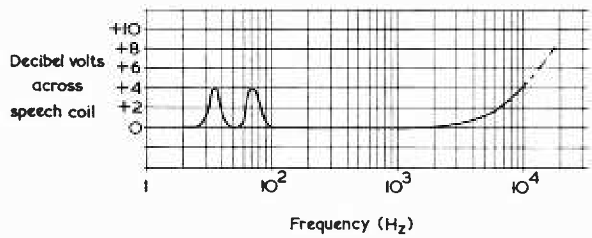


Fig. 3. The performance offered by the Fane 805 unit when fitted in the enclosure

then swung slowly down in frequency towards 20Hz, whereupon resonance showed up as a rise in voltage and increased amplitude in cone vibration. Under these conditions the Fane 805 tested by the author gave a bass resonance at 27Hz with a peak amplitude of 15dB.

The speaker unit was next mounted in the cabinet and, after suitable wires had been connected to the terminals, the back was fixed and screwed in place. The test gear was set up as before. It was observed that the large peak at 27Hz had now disappeared, two much smaller peaks being present at 35Hz and 70Hz, each with an amplitude of 4dB.

The loudspeaker assembly was next checked over the full frequency range from 20Hz to 20kHz, and the results are shown in Fig. 3. The zero dB reference level is at 1kHz.

A larger cabinet would reduce the peaks at the low frequency end of the spectrum, but since the prime object of the present exercise was to produce a high quality sound reproducer in a reasonably sized cabinet, and since listening tests confirmed the excellent reproduction provided, the design was considered justifiable.

Those who are able to repeat the setting-up procedure carried out by the author will find that it is possible to vary the amplitude of one low frequency peak against the other by closing the port or by lengthening or shortening the tuning pipe. The peaks given in Fig. 3 are those resulting from a pipe with the dimensions and method of mounting shown in Fig. 1.

EMBELLISHING THE CABINET

Without suitable ornamentation the cabinet is nothing more than a plain wooden box that would hardly fit in with room furnishings. However, with skill and patience this situation may soon be remedied.

The author covered the top and sides of the cabinet with wood veneer. The front and back were sprayed

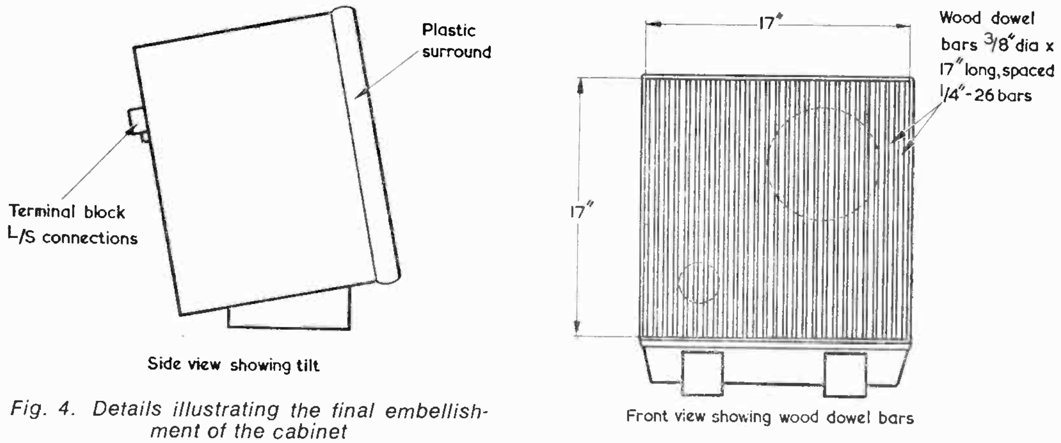


Fig. 4. Details illustrating the final embellishment of the cabinet

with dull black paint. The front panel, and loudspeaker and pipe openings, were covered by twenty-six 17in. lengths of circular cross-section wood dowel of ⅜in. diameter. These were pinned and glued vertically to the front panel and spaced about ¼in. apart. They allow free transmission of sound and at the same time have some effect as a refracting grating for the higher frequencies, giving a better dispersion angle. The whole assembly is mounted on two wedge-shaped blocks which tilt the unit upwards, with attendant advantages. See Fig. 4.

To complete the decor of the cabinet a plastic beading (bronze colour) was fixed around the front edge, overlapping the veneer and the dowel bar ends.

If this loudspeaker is made up as described, the constructor will be rewarded for his labours by excellent reproduction coupled with minimum cost. The cabinet is of minimal dimensions and two of the units can be comfortably accommodated in the average family sitting room without taking up too much space. The bass reflex form of acoustic loading produces a good clean response and, with the Fane 805, which has an additional high frequency cone, the reproduction is well balanced in the higher register also. The address of the manufacturers of the loudspeaker unit is: Fane Acoustics Ltd., Hick Lane, Batley, Yorks.

Other makes of loudspeaker unit could possibly be employed with this enclosure, provided that their performance closely matches that of the Fane 805.

TAKE A TAPE TIP – FROM 'PLAYBACK'

'Playback' is the title of a 16-page mini-magazine available free of charge from stockists of Scotch magnetic tape.

The issue now available from electrical and hi-fi shops includes features on actor David Hemmings and his use of a tape recorder both on and off the film set; tape recording in schools; and 'how-to-do-it' articles on recorder care and recording the spoken word. There is also some helpful advice on using a tape recorder to make your party go with a swing.

'Playback' is published quarterly by the 3M Company, manufacturer of Scotch magnetic tapes and cassettes.

'Playback' magazine is published quarterly by 3M, manufacturers of Scotch magnetic tape, and is available free of charge from electrical and hi-fi stores.

EXPERIMENTAL REFLEX RADIO

This simple reflex medium-wave receiver offers good sensitivity and selectivity, yet requires only a small quantity of components. It is a particularly attractive design for the constructor who wishes to experiment with a working receiver having a reliable circuit

WHENEVER THE AUTHOR WISHES TO BUILD A SIMPLE but efficient radio using transistors he always thinks in terms of the reflex principle, with which most amateurs and home constructors are familiar. The reflex receiver should never be confused with the superhet as the latter is a more efficient design. However, building a superhet can be difficult for beginners or home constructors who are not conversant with the superhet mode of operation.

The receiver described in this article gives good results so far as sensitivity and selectivity are concerned. After designing and experimenting with various forms of reflex receivers, improved detection and controlled regeneration was obtained with the circuit to be described. The output is in excess of 250mW, which is more than sufficient for normal listening.

THE CIRCUIT

The circuit of the receiver appears in the accompanying diagram. Signals are tuned in by the ferrite aerial coil and C1 and are amplified at r.f. by TR1, which then passes the signal to diodes D1 and D2 for detection. At the same time, the r.f. choke, L2, prevents the amplified r.f. signal being passed to the second stage. The detected a.f. signal is returned to the base of TR1, which then amplifies this also. In consequence TR1 functions as a reflex amplifier. It does the job of two transistors and a semiconductor is saved.

C2 is the feedback capacitor for regeneration, the main regeneration control being R2. A critical value in this stage is that of R1, which depends upon the diodes and transistor used for D1, D2 and TR1 respectively. To give an example of what is involved, R1 was 68kΩ when two Mullard OA70's were employed, but had to be increased to 150kΩ with two Philips or Valvo OA70's. Because of this, the best value for R1 has to be found by experiment.

Despite the lack of stabilising components in its emitter circuit, the first stage is quite satisfactory on its own for earphone listening. The stage can be checked by connecting a magnetic earphone having a resistance of 500Ω or more in parallel with R3. The omission of stabilising components saves a resistor and an electrolytic capacitor. Potentiometer R2 functions as a base bias potentiometer and, at its normal setting, causes the collector current of TR1 to be about 1mA.

A number of transistors were checked in the TR1 position, best results being given by an AF114. Its miniature version, the AF124, may also be used. No connection is made to the shield lead-out in either case.

The amplified a.f. signal at TR1 collector is passed, via L2 (which offers negligible impedance at audio frequencies), to the volume control R4 and, thence, to the base of TR2. TR2 is the driver transistor and provides the requisite signal for the two output transistors, TR3 and TR4. Its collector current is of the order of 2 to 3mA.

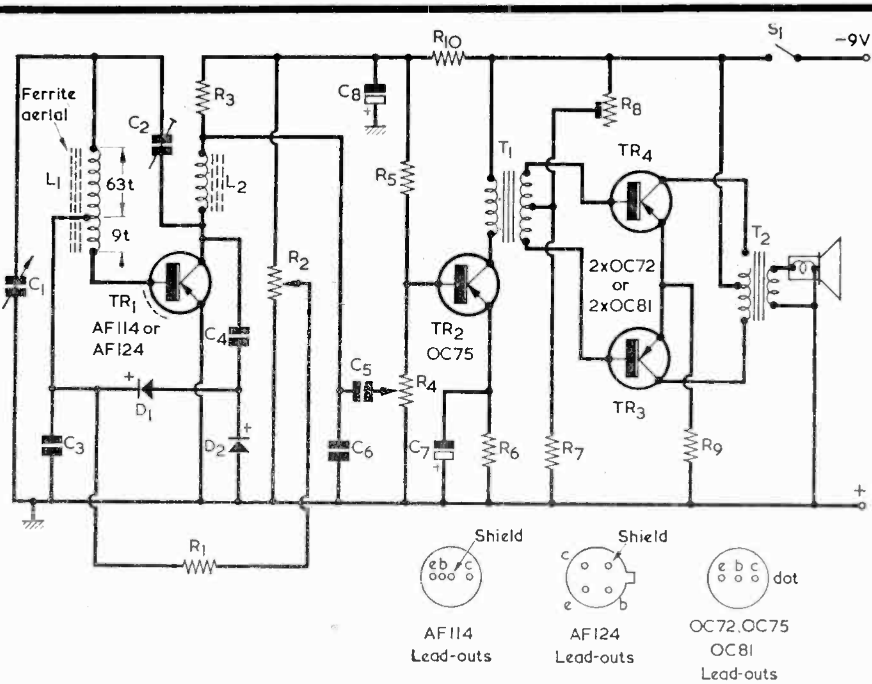
After checking a number of transistors of different type in the driver stage it was found that good results were given with an OC75, and this is specified in the Components List. The a.f. coupling capacitor, C5, may have any value between 0.25μF and 5μF, and should be paper or plastic foil, and *not* electrolytic. It was found that the use of an electrolytic capacitor affected sensitivity, although it resulted in an increase in a.f. output. (Experimenters may find it of interest to try a low-leakage tantalum electrolytic capacitor for C5.—Editor.)

The two output transistors should consist of a matched pair of the same p.n.p. germanium type, and a suitable choice is given by a pair of OC72's or a pair of OC81's. It is necessary to have a matched pair since the output stage operates in Class B, with each transistor amplifying alternate half-cycles of the applied signal.

The performance of the output stage depends upon the output of the first two stages. The latter may be checked, if desired, by temporarily connecting an earphone of around 100Ω across the primary of T1. The output in the earphone can be uncomfortably loud when tuned to a local station.

by

A. SAPCIYAN



The circuit diagram for the experimental reflex radio

COMPONENTS

Resistors
(All fixed values ¼ watt 10%)

R1	68kΩ (see text)
R2	100kΩ potentiometer, linear
R3	2.2kΩ
R4	10kΩ potentiometer, log, with switch S1
R5	47kΩ
R6	330Ω
R7	33Ω
R8	5kΩ potentiometer, linear, preset, skeleton
R9	5.6Ω
R10	470Ω

Capacitors

C1	365pF variable, air-spaced
C2	15pF trimmer, mica
C3	10,000pF ceramic
C4	470pF ceramic
C5	0.25μF (see text)
C6	10,000pF ceramic
C7	100μF electrolytic, 6V wkg.
C8	100μF electrolytic, 10V wkg.

Inductors

L1	See text
L2	R.F. choke, 2.5mH (see text)
T1	Driver transformer type T/T1 (Radiospares)*
T2	Output transformer type T/T7 (Radiospares)*

*Radiospares components may only be obtained through retailers.

Semiconductors

TR1	AF114 or AF124	
TR2	OC75	
TR3	OC72 or OC81	matched pair
TR4	OC72 or OC81	matched pair
D1	OA70	
D2	OA70	

Switch
S1 s.p.s.t., part of R4

Loudspeaker
3Ω loudspeaker

Battery
9-volt battery

Miscellaneous
3 knobs (for C1, R2 and R4)
Connecting wire, etc.

R8 varies the quiescent current (i.e. the current under no-signal conditions) for the output transistors and is adjusted for minimum quiescent current consistent with lack of distortion. The quiescent current may be measured by inserting a meter between the centre-tap of T2 primary and the 9-volt negative line. A simpler approach is possible when the current drawn by the first two stages on their own is known, and consists of inserting the meter in series with the lead to the negative terminal of the battery. The current drawn by the output transistors will then be additional to the current for the first two stages, which

CURRENT SCHEDULES

★ INDIA

17380kHz All India Radio, Delhi (10/100kW) radiates an English programme from 1000 to 1100 GMT on this channel. Other frequencies used are – **11775, 15105, 15430, 17820** and **21486kHz.**

★ ISRAEL

9009kHz Kol Israel, Tel Aviv (7.5/50kW) broadcasts an English programme from 2045 to 2130 GMT. **9625kHz** channel in parallel.

★ PAKISTAN

9465kHz Radio Pakistan, Karachi (10/50kW) directs an English programme to the U.K. from 1945 to 2030 GMT. **11672kHz** channel in parallel. Reports are required.

★ MONGOLIA

9540kHz Radio Ulan Bator (50kW) radiates an English programme from 2200 to 2230 GMT according to a recently received schedule. Also on **11860kHz** in parallel.

★ PHILIPPINES

9580kHz Voice of the Philippines, Manila (7.5kW) regular schedule is from 0300 to 0400 and from 0900 to 1400 GMT. Also in parallel on **11950kHz.** Test transmissions have been reported from 1100 to 1200 GMT, in English, on **15420kHz.**

★ SOLOMON ISLANDS

3995kHz VQO4 Honiara (5kW) is on the air from 0730 to 1130 GMT and from 1900 to 2200 GMT. Reported to be opening a new outlet on **7115kHz** with a power of 5kW.

★ PAPUA & NEW GUINEA

11880kHz VL8BM Port Moresby (10kW) schedule is as follows – Monday to Friday from 0100 to 0200 GMT and from 0430 to 0530 GMT. This is a newcomer to the short waves, commencing operations on 7th November last year. Programmes are in English and Pidgin. Verifies by letter. VLT4 Port Moresby on **4890kHz** has been logged in the U.S.A. from 1200 to 1400 GMT.

★ MALI REPUBLIC

4783kHz Radio Mali, Bamako (18kW) schedule is now – Monday to Friday from 0600 to 0800 and from 1830 to 2300 GMT. Also in parallel on **4835kHz.** Sundays 0800 to 1730 and 1830 to 2300 GMT. Mid-day frequencies are **7285kHz** (18kW) and **9635kHz** (18kW) from 1200 to 1430 (Friday till 1730). News in English at 1935 GMT on **9745kHz.** Sundays from 0800 to 1730 and 1830 to 2300 GMT on all channels.

★ CYPRUS

11910kHz Nicosia (30kW) latest schedule to hand – Monday to Saturday from 1900 to 2105 GMT. **17875kHz** on Sunday from 0900 to 1600 GMT.

★ DOMINICAN REPUBLIC

According to the Dominican Law of Telecommunications no broadcasting station can now radiate programmes on wavelengths below the 60 metre band (4750-5060kHz).

Acknowledgments to our own Listening Post, Swedish Dxer's and WDXC.

is already known. R8 must always be initially set to insert *maximum* resistance into circuit when current checks are being carried out on the output stage. The resistance it inserts into circuit should then be carefully and *slowly* reduced until the required quiescent current and distortion level is obtained. Too low a resistance in R8 can result in the output transistors passing excessive current, with consequent damage.

The current drain from the battery when the receiver is operating at full volume is around 30mA.

A final circuit note concerns C8 and R10. These decouple the first stage and the input of the second stage from the remainder of the receiver, thereby preventing motorboating which could otherwise occur when the battery ages and its internal resistance increases.

COILS AND TRANSFORMERS

L2 can either be a standard 2.5mH r.f. choke (such as the Repanco type CH1) or it can be home-wound. When home-wound, the total number of turns is 400 of 34 s.w.g. enamelled single rayon covered wire scramble-wound on a $\frac{1}{4}$in. diameter former fitted with an iron-dust core.

The aerial coil for the prototype was wound on a 5in. ferrite rod having a diameter of $\frac{1}{2}$in. The total number of turns was 72 close-wound, these being tapped at the 9th turn to give 9 and 63 turns in each section. The wire was 30 s.w.g. enamelled single rayon covered. Slight variation of the turn numbers may be necessary for precise coverage of the medium wave band, this being done by adding or taking off a few turns at the C2 end of the coil. (A suitable alternative rod—which may also necessitate a slight readjustment in the number of turns—is the 6in. by $\frac{3}{8}$in. diameter rod available from Home Radio under Cat. No. FR2.—Editor.)

The a.f. transformers T1 and T2 are standard driver and output transformers respectively. Suitable types are listed in the Components List.

LAYOUT

Layout is not critical but it is necessary for the inductive components to be well spaced out. In particular, L2 and the two transformers should be at least $2\frac{1}{2}$in. to 3in. from the ferrite rod. The circuit does not lend itself to a miniaturised layout. Provided the spacing of inductive components is catered for, the actual dimensions of the receiver may be left to the wishes of the constructor.

The prototype receiver was wired up on an eyeletted insulated board with the stages proceeding along the board in the same general order as they appear in the circuit diagram.

SETTING UP

After wiring is completed and all connections have been checked, R8 is primarily adjusted to insert maximum resistance into circuit. The receiver is then switched on and R8 is *slowly* adjusted to produce a quiescent current in the output transistors of around 1mA, as already described. Again, it must be emphasised that R8 must *not* be allowed to insert into circuit too low a resistance or the output transistors will pass excessive current. The quiescent condition can be ensured by keeping R4 to minimum whilst carrying out the adjustment to R8. Also, the slider of R2 should be at the positive end of its track.

Volume control R4 is next set to maximum and the slider of R2 advanced from the positive to the negative end of its track until oscillation commences. The setting just below oscillation point corresponds to the receiver being at its most selective and sensitive. If no oscillation occurs, increase the capacitance inserted by C2. It should now be possible to tune in signals with C1. Finally set C2 so that regeneration is possible over all the band by adjustment of R2.

If oscillation occurs continually with C2 at its lowest capacitance, and cannot be controlled by R2, it will be necessary to increase the value of R1. This is carried out experimentally until satisfactory control is achieved with a new battery. The value finally chosen for R1 should enable regeneration to be maintained as the battery ages.

If, on the other hand, oscillation cannot be obtained with C2 at full capacitance and R2 slider at the negative end of its track, the value of R1 needs to be experimentally reduced until satisfactory regeneration is obtained. As was explained earlier, the value of R1 is critical and depends upon the particular transistors and diodes employed in the first stage.

Next, check that correct medium wave coverage is obtained and, if necessary, vary the number of turns in L1. Incidentally, if this coil is wound on a thin sleeve capable of sliding along the rod, quite a useful range of adjustment is available by merely changing the coil position.

The final process consists of setting up R8 for the desired quiescent current and distortion level, bearing in mind the precautions already mentioned with respect to this component. Normally, it is adequate to advance R8 slowly until distortion at low signal levels just clears.

The prototype gave good results on the medium wave band, with adequate selectivity and sensitivity for a receiver of this class. Also, there was no evidence of overloading, even with strong local signals.

■

AUTOMATIC LIGHT CONTROL FOR TV FILMS

Marconi Broadcasting Division have introduced a new 'Auto-Light' unit for Marconi telecine cameras. The unit performs automatically the adjustments necessary when film and slides of varying density are televised. These adjustments are to maintain correct black and white levels in the transmitted signal and are particularly important when newsfilms are shown, as these may have been made under widely varying exposure conditions.

The Auto-Light unit frees the camera operator from continual manual correction of picture whites and blacks, and in the case of colour film it enables him to devote his full attention to the important task of maintaining colour balance. The Auto-Light unit has a faster response to changing film density than a human operator, and results in a more consistent picture quality for the viewer.

CATALOGUES

In recent years the practice of selling goods through the medium of catalogues has grown apace. Catalogues have been around for many years and, notably in the U.S.A., it has been a standard method of marketing merchandise to the public – the Sears Roebuck catalogue probably being the best known of these publications – for some decades.

In mo:e recent times, the issuing of catalogues has become a feature of life in this country. Many housewives use their spare time as selling agents, armed with attractive, multi-coloured catalogues offering for sale goods of every conceivable description, they sell to the public a growing volume of merchandise currently running into millions of pounds per year.

Not slow to perceive the commercial possibilities, several radio component specialist houses publish catalogues for the radio enthusiast on an annual basis. These catalogues, displaying the goods and wares of the company concerned, are attractively produced, comprehensive and represent the easiest method yet devised for shopping direct from one's own home.

Lavishly illustrated with photographs of the components offered for sale, information on the voltage and current ratings are also included for the guidance of intending purchasers. A veritable mine of information, these publications are often complete with an index, current price list, postal and hire purchase information and circuit suggestions. Possession of one or more of these catalogues provide the home-hobbyist, in addition to the most comfortable method of purchasing goods, a vast range of currently available electronic components and equipment that could not possibly be displayed in the limited space of a shop window. Moreover, no expensive and time-consuming journey to the point of sale is entailed when purchasing by this method.

Expensive to produce, most component houses are economically forced to charge a cover price for their catalogues; but this, in most cases, is more than recoverable by purchasers when taking advantage of the free vouchers or special offers that are a feature of these publications.

The present-day catalogue has become so comprehensive and informative that few workshops, shacks or dens – call them what you will – are complete without them. Even the physical measurements of many components are stated and often accompanied by full-sized illustrations, this information being especially helpful when planning a constructional project in advance of component purchases. Pictorial presentation of such small items as 2, 4, 6 and 8BA nuts, bolts and washers drawn to actual size leave nothing to the imagination.

It is a fact that few authors writing technical articles for *The Radio Constructor* would attempt to submit a manuscript without first consulting a current catalogue to ensure the availability, catalogue number, rating, etc., of the components specified if the article is to stand any chance of being accepted – knowing full well that we will make a check !

These days, every enthusiast is advised to have as many as possible of the catalogues to hand in the workshop – they are a welcome addition to the current scene.

C.W.

CATALOGUES RECEIVED . . .

★ HENRY'S RADIO LTD.

The latest edition of the Henry's Radio Ltd. catalogue will undoubtedly be of great interest to all our readers. This 330 page publication now has a companion volume – the 120 page High Fidelity and General Catalogue. Both publications will be revised and issued regularly and each will contain discount vouchers to be used when purchasing items from the catalogues.

A feature of the new High Fidelity and General Catalogue is the wide range of equipment available, covering all aspects of high fidelity and public address with particular accent on complete hi-fi systems at all price ranges – over 40 recommended systems being available to suit most requirements.

The price for the new High Fidelity and General Audio Catalogue is 5/-, p.p. 1/- and includes a 12/6d. discount voucher. The Electronic Components and Equipment Catalogue is priced at 7/6d., p.p. 2/- and includes five 2/- discount vouchers.

Also published in January were two free catalogues – one of 16 pages covering all types of test equipment for amateur and professional users and a 16 page brochure covering electronic organs, organ components and kits.

These latest catalogues may be obtained from Henry's Radio Ltd., 303 Edgware Road, London, W.2.

★ LASKY'S RADIO LTD.

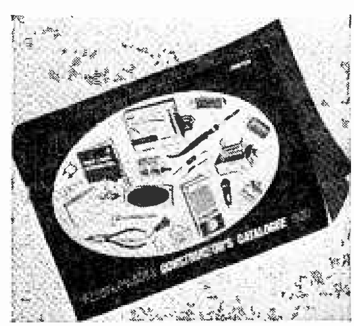
The 1970 edition of the *Audio-Tronics* catalogue was released last month to all whose names are on the circulation list. This is the third edition and it features full colour illustration for the first time. Much enlarged, the print order for this edition was 250,000 copies – ten times the original order for the first edition two years ago. Over 150,000 customers of Lasky's Radio Ltd. will have received a copy on publication – now an annual event.

As in previous years, there is no cover charge for the catalogue and copies are available from any of the West End and City branches of the company. Readers making a postal request for a copy are asked to forward 1/6d. to cover return postage and inclusion on the regular mailing list, after which further editions will be forwarded automatically as they are published.

The catalogue presents a very wide range of items covering every aspect of high fidelity, radio, TV, communications, tape recording, test equipment, and electronics. In addition, there are "Package Deal" complete stereo systems on offer and a 12 month Money Voucher Scheme worth over £25.

Attractively presented, this catalogue is well worth perusing and may be obtained, by post, from Lasky's Radio Ltd., 3/15 Cavell Street, London, E.1.

★ ELECTRONIQUES (S.T.C. LTD.)



The 1970 edition of this catalogue replaces the Hobbies Manual previously issued. Cheaper than the Manual, it is still an attractively produced and comprehensive catalogue.

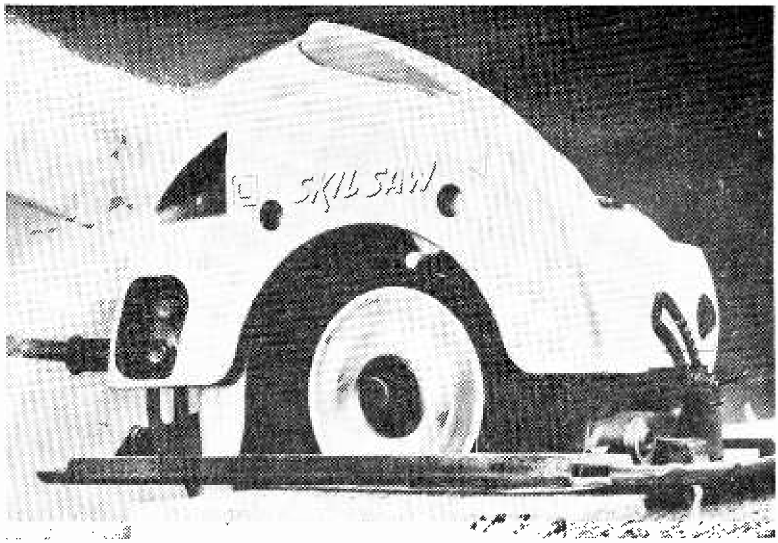
Rationalisation of the range of coils has been made enabling a better service to be given for the varieties listed in the catalogue. Rationalisation has not prevented the addition of new products in many sections.

There are six sections: –Short Wave Listening; Amateur Radio; Components and Hardware; Test Equipment and Tools; Audio and Hi-Fi; Accessories; Kits; and Books. The sections are then subdivided, for example–components and hardware commences with a sub-section on aerials, followed by batteries, battery holders, bells, boxes, brimistors, capacitors and so on alphabetically.

The 464 pages of the catalogue are well printed and illustrated with many photographs and occasional diagrams. A very clear index, order forms and general information of interest complete the publication which is attractively bound in a full-coloured card cover.

Electroniques Constructor's Catalogue 1970 edition is available direct from Electroniques (S.T.C. Ltd.), Edinburgh Way, Harlow, Essex, at 10/- per copy plus 3/- postage and packing. ■

CURRENT TRENDS



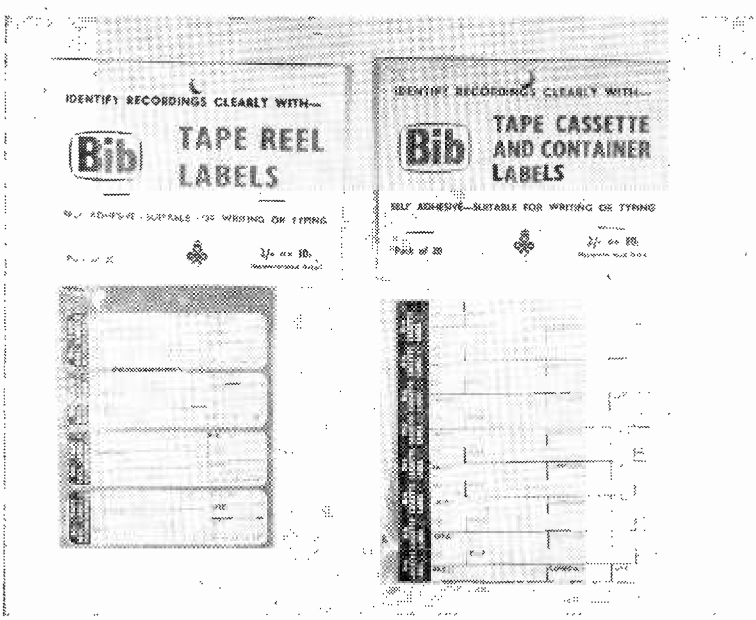
● NEW SKIL CIRCULAR SAW

The cradle of the do-it-yourself movement is in the United States. As far as tools are concerned the real "do-it-yourselfer" over there, has long since switched from an electric drill as a power unit for driving different accessories, to integral tools for sawing, cutting, grinding, sanding, etc. Slowly this tendency is also coming through in the U.K. For the manufacturers of portable electric tools this means an adapted product line, with a less accentuated border line between "do-it-yourself" and professional tools.

A typical example is the new model 416H SKIL circular saw; designed in the first place to meet the sophisticated "do-it-yourselfer's" demand, it is also highly appreciated by the professional who can do with a handy, low priced tool for numerous light duty cutting jobs. Market research has shown that many professionals in the building industry are also interested in this compact, easy-to-handle circular saw, which can easily be carried to the job and does not require large capital investment. The new model 416H is double insulated in accordance with CEE standards and has a burnout protected motor. Its dependable ball bearing construction guarantees long tool life. Some more technical data: 1,020 input watts, blade diameter $6\frac{1}{2}$in., 90° depth of cut $2\frac{1}{8}$in., 45° depth of cut $1^{13}/_{16}$in., no-load speed 5,800 r.p.m., net weight $10\frac{1}{2}$lbs.

● TAPE CASSETTE AND REEL LABELS

Adding further to their range of audio aids and accessories, the Bib Division of Multicore Solders Ltd. (winners of the Queen's Award to Industry), of Hemel Hempstead, Herts, announce the introduction of two new useful accessories for tape recorder users.



Bib Self-Adhesive Tape Reel Labels

Supplied in packs of 20, and presented printed in a form which makes them easy to complete, to indicate the title, composer, artist, reel number, date and type of tape. The labels are supplied on a backing paper in sheet form, so that the details may be written or typed.

Bib Tape Cassette and Container Labels

Specially designed to fit precisely on either side of a tape cassette, and also on the edge of the plastic cassette container. Here again the labels are pre-printed for easy completion of title, composer, artist, date, cassette number, and to denote mono or stereo recording.

These labels will be found particularly useful for applying to cassettes and containers, when the original labels have been used to identify a previous recording.

Both types of labels are packed in plastic bags, with attractive, descriptive header cards, and have a recommended retail price of 2s. or 10p. per pack of 20. ■

UNDERSTANDING RADIO

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

MOVING-COIL METER

IN LAST MONTH'S ARTICLE IN THIS series we continued our discussion on the moving-coil meter and saw how this may be employed in multi-range voltmeters and in ohmmeters.

We now turn our attention to the use of the moving-coil meter for the measurement of alternating voltages and currents.

A.C. VOLTMETERS

If an alternating voltage of sinusoidal waveform is applied direct to the terminals of a moving-coil meter, it will cause a deflecting force to be applied to the coil which acts in one direction for alternate half-cycles of one polarity, and in the opposite direction for alternate half-cycles of the other polarity. However (provided that the frequency of the alternating voltage is sufficiently high – above some 10 to 20Hz with a standard moving-coil meter) each of the two deflecting forces will be applied for too short a time to overcome the mechanical damping which is built into the meter. The pointer of the meter will in consequence remain at zero. It is interesting to note that the meter, under these conditions, is indicating the *average* value of the alternating voltage (i.e. the average of all the voltages appearing throughout a complete cycle), because the alternate deflecting forces acting on the coil are equal and opposite.

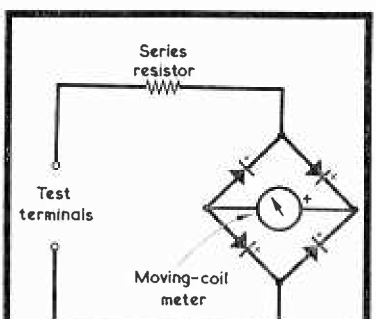


Fig. 1. The basic circuit of an a.c. voltmeter

Since a moving-coil meter cannot indicate the magnitude of an alternating voltage directly it is necessary to provide it with some form of external rectifying circuit which will convert the alternating voltage to be measured to a direct voltage. The most commonly employed moving-coil meter rectifier circuit is illustrated, in basic form, in Fig. 1. In this diagram four rectifiers are connected in a bridge arrangement, their rectified output being fed directly to the terminals of the moving-coil meter. The alternating voltage to be measured is applied to the bridge rectifier via a series resistor which carries out the same function as the series resistor in a moving-coil voltmeter intended for the measurement of direct voltage. Despite the slight inaccuracy in meanings inherent in the term, the circuit of Fig. 1 is referred to as an *a.c. voltmeter*. When it is necessary to differentiate between them, voltmeters intended for the measurement of direct voltage are then described as *d.c. voltmeters*.

If the rectifiers in the bridge circuit of Fig. 1 have 'perfect' characteristics (that is, they exhibit zero resistance throughout the half-cycles during which they conduct and infinite resistance throughout the half-cycles during which they do not conduct) the rectified voltage appearing across the meter terminals will have the waveform shown in Fig. 2. It is assumed, in Fig. 2, that the alternating voltage applied to the voltmeter is sinusoidal. All the half-cycles now have the same polarity with the result that the pointer of the meter is deflected from the zero position, the amount of deflection being proportional, as before, to the *average* value of the waveform.

In general, engineers who wish to measure alternating voltage with a moving-coil a.c. voltmeter are not interested in the average value of the voltage; they want to know, instead, its r.m.s. value. It will be recalled that the r.m.s. or 'effective' value of an alternating voltage or current is equal to the direct voltage or current which has the same heating effect in a resistive load. Now, it happens that the average value of the full-wave rectified waveform in Fig. 2 is equal to 0.9 times the r.m.s. value of the applied alternating voltage. The existence of this relationship between the two values raises no problems if all the alternating voltages we intend to measure are sinusoidal in waveform, since all we have to do is accept the fact that the meter responds to the average values of alternating voltages being measured, and to calibrate its scale in terms of the corresponding r.m.s. values.

Difficulties appear, unfortunately, when the alternating voltages being measured are not sinusoidal in character, because the average values of the full-wave rectified versions of such voltages will not be equal to 0.9 times their r.m.s. values. Thus, the moving-coil a.c. voltmeter, whose pointer deflection is proportional to average values, gives incorrect readings in terms of its r.m.s. scale calibration when measuring non-sinusoidal voltages. This point has always to be remembered when using a moving-coil a.c. voltmeter. In practice, the prob-

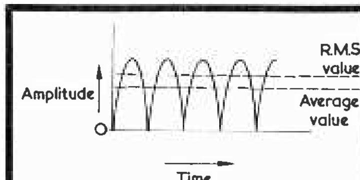


Fig. 2. Assuming 'perfect' rectifiers, the waveform of the rectified voltage applied to the meter in Fig. 1 has the appearance shown here. Also indicated are magnitudes of the r.m.s. and average values of the waveform

lems arising from this fundamental short-coming in performance of the moving-coil a.c. voltmeter are not particularly great, since the voltages it will normally be called upon to measure will nearly always be sinusoidal or near-sinusoidal. Errors due to heavily distorted sinusoidal waveforms may be too high to allow precise readings of their r.m.s. values to be made, but roughly approximate indications will still be given. Voltages having waveforms which are almost completely divorced from the sinusoidal shape (e.g. square waves) would result in considerably inaccurate readings; but voltages with waveforms of this nature are in any case normally measured by means of quite different instruments, such as oscilloscopes, which take account of the waveform shape.

Before concluding on the subject of average and r.m.s. values, as applicable to the a.c. voltmeter circuit of Fig. 1, it is necessary to introduce a term which defines their relationship and which will often be encountered in literature devoted to instruments of this type.

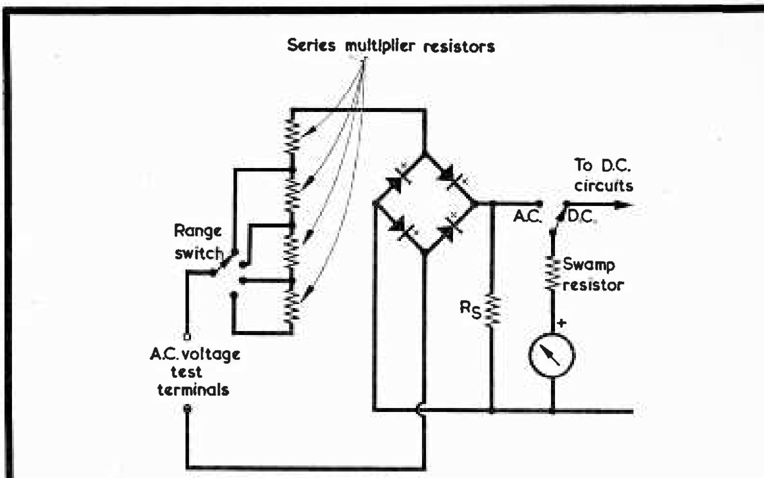


Fig. 4. Illustrating, in simplified form, the a.c. voltage switching circuits of a multi-testmeter

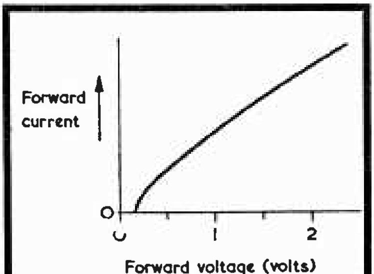


Fig. 3. Representative forward voltage/forward current curve of a meter rectifier. Forward resistance is indicated by the slope of the curve

We have stated that the average value of the full-wave rectified waveform of Fig. 2 is equal to 0.9 times its r.m.s. value. The more usual method of expressing this relationship consists of stating that the r.m.s. value is 1.11 times the average value (which is, of course, simply the reverse way of saying the same thing) whereupon the figure 1.11 is referred to as the *form factor* of the full-wave rectified waveform. The term 'form factor' may be applied to any rectified waveform, and it is equal to the r.m.s. value divided by the average value.

METER RECTIFIERS

We have assumed, up to now, that the rectifiers in the bridge circuit of Fig. 1 are 'perfect' components. In practice 'perfect' rectifiers cannot be manufactured, and much of the design work carried out with moving-coil a.c. voltmeters is based on selecting rectifier types which are best suited for the application, and of overcoming any inaccuracies in meter indication that they introduce by suitable circuit design and choice of meter operating conditions.

The most serious limitation imposed by rectifiers of any type for the present application is that the forward resistance they offer (i.e. the resistance to current flow in the conducting direction) is not constant at very low forward voltages. A representative forward voltage/forward current characteristic is shown in Fig. 3, where it may be seen that the curve is markedly non-linear at forward voltages below about 0.5 volt. Rectifiers intended for use in moving-coil a.c. voltmeters are components designed to present a curve in which linearity commences at as low a forward voltage as is possible. This requirement is usually satisfied by employing rectifiers of the copper oxide type. So far as meter operating conditions are concerned, it is helpful to employ a fairly insensitive moving-coil meter since this ensures that readings over most of its scale correspond to rectifier currents which fall on the linear part of the forward characteristic or, put another way, necessitate the application of forward voltages which are sufficiently high to cause such currents to flow. A moving-coil meter used in an a.c. voltmeter may have, typically, a full-scale deflection value of the order of 1mA.

Fig. 4 shows an a.c. voltmeter with simple range switching, as would be encountered in a typical multi-testmeter which also measured direct voltages. Such a testmeter will employ the same scales for indicating the r.m.s. values of alternating voltages as are used for the direct voltages, and it may have a sensitivity on the direct voltage ranges of, say, 10,000 ohms per volt. When the testmeter is switched to read alternating voltages the shunt, Rs, is connected across the basic meter and its series swamp resistor. Resistor Rs increases the f.s.d. current, and is given a value which causes the series multiplier resistors to have values corresponding to, say, 1,000 ohms per r.m.s. volt. The f.s.d. current for the combination of the meter, swamp resistor and Rs would not then be 1mA (as would be required in the basic meter of a 1,000 ohm per volt d.c. voltmeter) but, to take form factor into account, 0.9mA.

Because of rectifier non-linearity at very low forward voltages, the arrangement of Fig. 4 might require a separate scale for the lowest a.c. volts range. If this range were, say, 0-10 volts, its scale would then have the appearance illustrated in Fig. 5, where it is drawn alongside a standard 0-100 a.c. and d.c. volts scale. The non-linearity introduced by the rectifiers is of less importance on the higher a.c. volts ranges

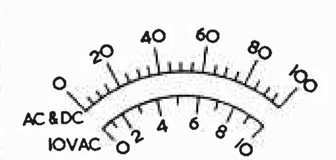


Fig. 5. Because of rectifier non-linearity, the lowest a.c. voltage range may be cramped at the low voltage end, as is shown in this typical example

and these can employ the same linear scales as are used for indicating direct voltages. An alternative approach, encountered in more sophisticated testmeter designs, obviates the necessity for a separate low a.c. volts scale. In these meters the test terminals are applied, on the lower a.c. volts ranges, to the current range autotransformer. We shall deal with the circuits involved when, later in this article, we discuss the current autotransformer.

The reverse resistance offered by the meter rectifiers (that is, the resistance they exhibit during non-conducting half-cycles) is not normally so low as to cause any difficulty in meter design. The capacitance between the two electrodes of each rectifier tends to be relatively high, with the result that the rectifiers can pass sufficient alternating current at the higher frequencies to cause errors to be introduced in meter readings. Because of this factor the a.c. voltage ranges of many multi-testmeters are accurate up to frequencies of some 2 to 3 kHz only. Meter rectifiers usually have a low peak inverse voltage rating (this rating defining the maximum reverse voltage which may be applied to the rectifier without risk of its breaking down). However, high inverse voltages cannot be applied to rectifiers in a bridge circuit because when one pair of rectifiers is non-conductive the other pair is conducting and keeps the alternating voltage applied to the bridge at a low level.

A rectifier circuit encountered in the more inexpensive type of multi-testmeter is illustrated in Fig. 6.

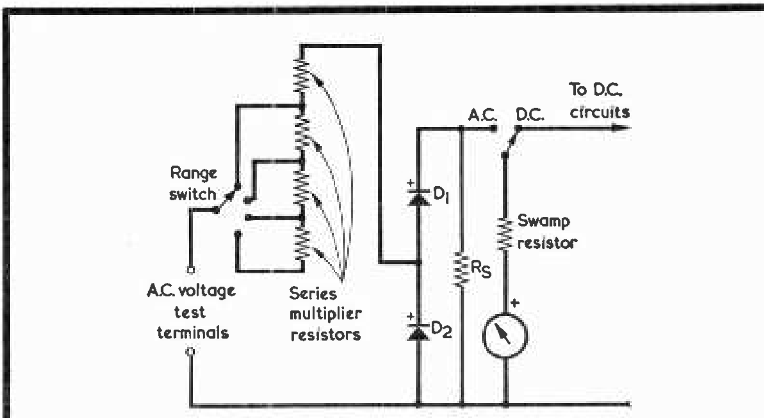


Fig. 6. A simpler meter rectifier circuit, as encountered in the more inexpensive multi-testmeters

This is simply a half-wave rectifier arrangement, the half-wave rectifier being provided by D1, which is in series with the moving-coil meter. The function of D2, which may be a similar type to D1, is to ensure that high inverse voltages are not applied to D1 during half-cycles when this rectifier is not conducting. Circuit operation is similar to that given with the bridge rectifier, a shunt, Rs, being placed across the basic meter circuit to increase its f.s.d. current rating to a value which is well along the linear section of the rectifier forward resistance characterstic. Typically, the series multiplier resistors have values corresponding to some 1,000 ohms per r.m.s. volt. The form factor for the half-wave rectified output fed to the meter is 1.57. The type of circuit shown in Fig. 6 is liable to give greater errors in meter indication when the testmeter is coupled to non-sinusoidal voltages which are asymmetric about zero voltage. The lowest a.c. voltage range is normally presented on a separate scale, as in Fig. 5.

A.C. CURRENT METERS

The bridge rectifier circuit can also be employed with a moving-coil meter to measure alternating current. Due, however, to the non-linearity present in the rectifiers it is impracticable to obtain a series of current ranges, as would be required in a multi-testmeter, by the use of resistive shunts on either the

Under this heading we shall be commencing, in our issue dated May, a short series on this most interesting aspect of electronics written by our well known contributor W. G. Morley.

Mr. Morley has been contributing material to this magazine exclusively for some twenty years and any article flowing from his pen is acknowledged as authoritative. His articles in the series *Understanding Radio* have probably become the most comprehensive treatise on the subject yet published in any magazine – it will have run to 100 issues on completion!

Understanding Tape Recording*, scheduled to run for approximately eight issues will, we feel sure, prove to be a popular feature with many of our readers – join us as we delve into *Understanding Tape Recording!

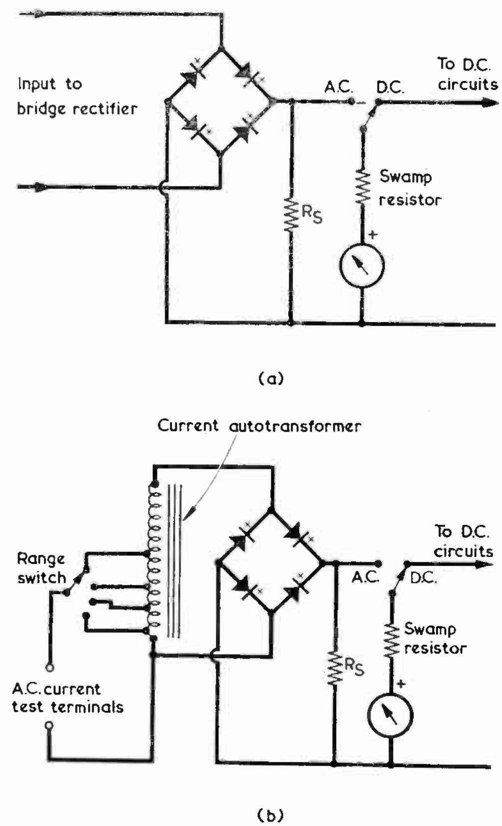


Fig. 7(a). By careful choice of components and operating conditions the basic rectifier and meter circuit shown here can give acceptably linear meter readings for all alternating currents up to that which causes f.s.d.

(b). Coupling a current range autotransformer to the basic rectifier and meter circuit

test terminal or the meter side of the bridge rectifier.

The normal approach here consists of initially employing a combination of meter sensitivity, swamp resistance and added shunt resistance (Rs of Fig. 4) whose values are such that acceptably linear meter readings are given for all alternating currents, up to that which causes f.s.d., that are applied to the bridge rectifier. The basic meter and rectifier circuit is illustrated in Fig. 7(a), in which the swamp resistor and Rs provide the same functions as in Fig. 4. The winding of an autotransformer is connected to the bridge as in Fig. 7(b), and current ranges are selected by switching the test terminals of the multi-testmeter to tappings along the autotransformer winding. The autotransformer then steps *down* the current applied to the test terminals so that it falls within the range over which the bridge rectifier and meter are intended to operate. The step-down in current depends upon the ratio between the turns through which the current being measured flows and the total number of turns in the autotransformer. Thus, if an alternating current of 100mA is applied to one-hundreth of the total winding, the current applied to the bridge rectifier is 1mA.

Readers who have not previously encountered the fact that what appears to be a step-up transformer causes current to be stepped down may be able to appreciate this fact more readily by examining the simple numerical example given in Fig. 8. In Fig. 8(a) we have an autotransformer with a tap positioned at the central point of its winding. Across the whole of the winding is connected a 10Ω load through which we want an alternating current of 1 amp to flow. The alternating voltage across the resistor will then, from Ohm's Law, be 10 volts. In Fig. 8(b) we apply an input of 5 volts across half the autotransformer winding whereupon the requisite 10 volts appears across the 10Ω resistor and a current of 1 amp flows through it. The current required in the 5 volt input to maintain the 10 volt 1 amp output is, obviously, 2 amps. In consequence, the autotransformer has stepped the 5 volt input up to 10 volts, and has stepped the 2 amp current input down to 1 amp. This example of transformer operation, employing concepts with which we are already familiar, should assist in explaining why the autotransformer in Fig. 7(b) steps down the currents applied to its tappings.

Since the combination of bridge rectifier, moving-coil meter, swamp resistance and shunt Rs in Fig. 7(a) are set up to give linear readings over alternating currents up to that which causes an f.s.d. reading in the meter, the current autotransformer may also be employed for the lower alternating voltage ranges. The test terminals for these ranges are applied, via the voltage range switch and suitably valued resistors, to taps in the current autotransformer, with the result that the currents which flow in the autotransformer are stepped down

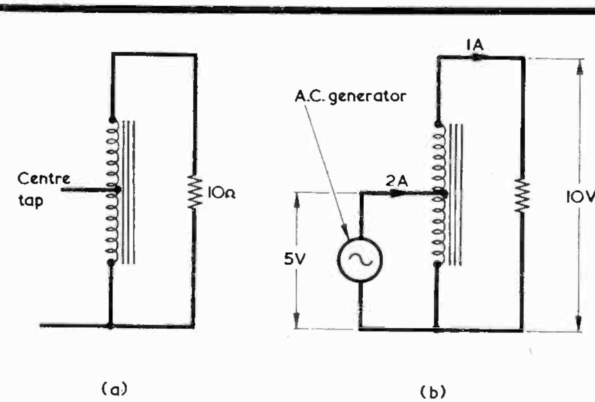


Fig. 8. Illustrating the fact that a step-up transformer causes a step-down in current

as required before being applied to the bridge rectifier. Higher voltage ranges are provided by series multiplier resistors, as in Fig. 4. The current drawn by the testmeter at f.s.d. from the source of alternating voltage being measured is greater on the ranges which are switched to the current autotransformer than on the higher voltage ranges in which the series multiplier resistors are brought into circuit.

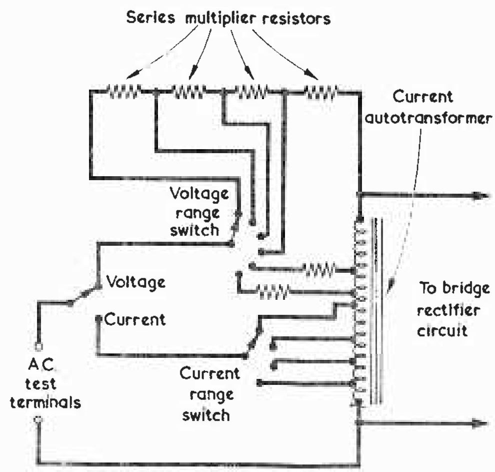


Fig. 9. To obtain linear scale readings, the current autotransformer may be brought into use on the lower a.c. voltage ranges, as shown in this simplified circuit

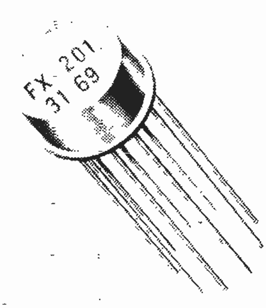
NEW SERIES

This article now brings the 'Understanding Radio' series to a close. As regular readers will know, the series has covered virtually all the basic elements encountered in radio work with the exception of semiconductor devices. It so happens that the present article is No. 100 in the series, a happy accident that enables its termination, so far as coverage of subject matter is concerned, to coincide neatly with its numbering!

The 'Understanding' articles will not, however, cease. After a break of one month (to enable the author to relieve his writer's cramp) a new series will commence in the May issue under the title of 'Understanding Tape Recording'. This will be a relatively short series, when compared with 'Understanding Radio', and will be followed by a run of further 'Understanding' series, each devoted to a particular subject in the field of electronics and radio.

The author has gained much pleasure from writing 'Understanding Radio'. He is also particularly grateful to, and has been greatly encouraged by, those readers who have written in to state that the articles have enabled them to appreciate points which had previously eluded them. He hopes that he will be able to render similar service in the series to come. These, by the time this present article appears in print, will be well past their initial planning stages and the first one will be partly in production.

NEW MICROCIRCUIT IS FREQUENCY SELECTIVE



The Consumer Microcircuits type FX-201 'Z-Trip' is a new frequency sensitive switch of unique design and exceptionally high performance. It is a low voltage MOS/MSI microcircuit device combining analogue and digital techniques in a single monolithic chip of silicon, and is believed to be the first microcircuit of its type available anywhere in the world. The FX-201 has wide application in the communication and remote control signalling fields, and is a British designed and manufactured device subject to Patent Applications in all the principle countries.

The FX-201 consists of two independent 'band accept' frequency selective switches packaged in a T0-5 style case. The device incorporates an input amplifier, analogue/digital frequency discriminating circuits and buffered bistable output switches; operates from a single d.c. supply and is rated for operation in industrial environments.

The FX-201 accepts sinewave and pulse input signals, and when an input signal frequency falls within either of the two predetermined acceptance bands the corresponding output is switched. Operating frequencies and bandwidths are determined simply by means of a few externally connected resistors and capacitors, and are adjustable over a very wide working range.

The functional specification for the FX-201 includes the following advanced features: band frequencies – adjustable 10Hz to 30kHz, bandwidths – adjustable 1% to 50%, separation between the two bands – adjustable 1% to 50%, band edge 'slope' – typically better than 0.1% (effective Q exceeds 1,000), response time – approximately 1.8 milli-seconds at 5kHz. The FX-201 operates from input signals between 20mV and 20V pk-pk, requires only 2mA of operating current from a nominal 9/12V supply (excluding switched load currents), and is immune to random signal noise and harmonics. The FX-201 is a high performance/low cost device and is available for immediate delivery.

The Discovery 2-VALVE, 4-STAGE SHORT WAVE RECEIVER

(Continued from page 469)

Tagstrip 2. **Solder** the two connections at C17 tag.

12. Connect the remaining red wire from the mains transformer T2 to tag 5 of Tagstrip 2 and **solder** the two connections at this tag.

13. Connect one end of the remaining blue wire of T2, having first removed the enamel covering, to pin 5 of V2. To pin 5 of V2 connect a length of p.v.c. covered wire, the other end of which is connected to pin 9 of V1. Solder the two connections at pin 5 of V2.

14. This step deals with the wiring to the tags of the on/off switch S1(a), (b), this being an integral part of the volume control R12. A word of warning here – not all switches have the same tag layout as that shown in the point-to-point diagram, and constructors should ascertain with a continuity tester which of the four tags correspond to the required switching circuit. The tag layout shown is correct for the potentiometer/switch specified. Connect one of the black wires from T2 (it does not matter which one is selected) and **solder** to tag 1 of switch S1(a). The remaining black wire from T2 is now **soldered** to tag 4 of switch S1(b).

15. Obtain the a.c. mains cable, allow sufficient length to reach from the chassis rear apron to the switches S1(a), (b), tie a loose knot in the cable at a point just inside the chassis, feed the cable under the smoothing capacitor assembly, bare the three wire ends, and **solder** the live lead to tag 2 of S1(a), **solder** the neutral wire to tag 3 of S1(b) and connect the earth wire to the 4BA chassis tag mounted with the smoothing capacitor assembly. To this same chassis tag, connect one end of a short length of p.v.c. covered wire, the other end of which is **soldered** to tag 5 of the a.f. gain control R12. Next, **solder** to tag 6 of R12 one end of a length of p.v.c. covered wire, the other end which is **soldered** to pin 3 of V2. To tag 7 of R12 **solder** one end of C14 (0.01μF) the other end of which connects to pin 9 of V2.

16. To tag 1 of Tagstrip 1 connect the positive lead-out of C13 (8μF, 450V wkg.) the other lead of which is connected to the 4BA chassis tag associated with the smoothing capacitor assembly. **Solder** the three connections at this chassis tag.

17. The wiring at V2 valveholder comes next. Take up a short length of bare wire and connect one end to the 6BA chassis tag associated with V2 and the other end to pin 4 of V2 such that the centre of this wire connects to the centre spigot but touches no other tags. **Solder** at pin 4 of V2, at the spigot and the two connections at the 6BA earth tag.

18. To pin 1 of V2 connect one end of C6 (0.01μF), the other end of C6 connecting to tag 8 of Tagstrip 3. Obtain C11 (500pF) and R7 (470kΩ, yellow, violet, yellow), bind the lead-outs of these two components together so as to connect them in parallel, and **solder** the joints thus formed. Remove any surplus wire and connect one end of the C11/R7 combination to pin 1 of V2. **Solder** the two connections at pin 1 of V2. Connect the other end of the C11/R7 combination to tag 2 of Tagstrip 1.

19. Obtain C15 (25μF, 25V wkg.) and similarly **solder** this component in parallel with R11 (680Ω, blue, grey, brown). Next, **solder** the positive end of the C15/R11 assembly to pin 2 of V2 and connect the other end to tag 2 of Tagstrip 1. **Solder** the two connections at tag 2 of Tagstrip 1. To pin 6 of V2 **solder** one end of a length of p.v.c. covered wire, the other end being **soldered** to tag 2 of the output transformer T1.

20. To pin 7 of V2 **solder** one end of a length of p.v.c. covered wire the other end of which connects to tag 1 of Tagstrip 1. Obtain C12 (12μF, 6V wkg.) and **solder** across this component resistor R8 (2.2kΩ, red, red, red). **Solder** the positive end of this combination to pin 8 of V2. **Solder** the other end of this assembly to tag 6 of tagstrip 2. To pin 9 of V2, connect one end of R10 (220kΩ, red, red, yellow) and **solder** the two connections at pin 9 of V2. Connect the other end of R10 to tag 1 of Tagstrip 1.

21. To tag 1 of Tagstrip 1 connect one end of R9 (2.2kΩ, red, red, red) and connect the other end of this resistor to tag 3 of Tagstrip 1. **Solder** the four connections at tag 1 of Tagstrip 1. To tag 3 of Tagstrip 1 connect one end of R6 (4.7kΩ, yellow, violet, red) and **solder** the three connections at tag 3 of Tagstrip 1. Connect the remaining end of R6 to tag 4 of Tagstrip 1. To tag 4 of Tagstrip 1, connect one end of a length of p.v.c. covered wire, the other end being connected to tag 7 of Tagstrip 3. To tag 4 of Tagstrip 1, connect the positive lead-out of C10 (8μF, 450V wkg.) the remaining wire of which connects to pin 9 of the coilholder. **Solder** the three connections at tag 4 of Tagstrip 1.

22. The next task is to wire up the connections to the coilholder. To pin 2 connect a short length of bare wire, the other end of which is connected to pin 9 of the coilholder. Connect a length of bare wire from pin 2 of the coilholder to the centre spigot of the coilholder, continuing it to tag 9 of Tagstrip 3 and ensuring that this wire touches no other tags. To pin 2 of the coilholder connect one end of C4 (0.1μF) the other end of which is connected to tag 10 of Tagstrip 3. **Solder** the three connections at pin 2 of the coilholder. Connect C5 (5,000pF disc ceramic) between the centre spigot of the coilholder and tag 10 of Tagstrip 3. **Solder** the connections at the spigot. To pin 3 of the coilholder **solder** one end of a length of p.v.c. covered wire, the other end of which connects to pin 1 of V1.

23. To pin 4 of the coilholder solder one end of a length of p.v.c. covered wire, the other end of which is **soldered** to the nearest fixed vane tag of the reaction capacitor C9. To pin 5 of the coilholder, connect one end of a length of p.v.c. covered wire, the other end of which is passed through the adjacent grommet and **soldered** to the fixed vane tag of the tuning capacitor C8. To pin 5 of the coilholder connect one end of C7 (100pF silver mica) the other end of which is connected to pin 2 of V2. **Solder** the two connections at pin 5 of the coilholder.

24. To pin 8 of the coilholder, **solder** one end of C3 (100pF silver mica) the other end of which is connected to pin 6 of V1. The remaining connection to pin 9 of the coilholder will be made at a later step.

25. Dealing with the wiring associated with V1 valveholder, commence by connecting a short length of bare wire to tag 9 of Tagstrip 3. **Solder** the two connections to this tag. The other end of this bare length of wire now connects to pins 3, 4, 5 and 7 of V1. **Solder** at pins 3 and 5 only.

26. To pin 1 of V1 connect one end of RFC3, the other end of which connects to tag 8 of Tagstrip 3. **Solder** the two connections at pin 1 of V1. To pin 2 of V1, connect one end of R5 (1.5MΩ, brown,

Cut along this line

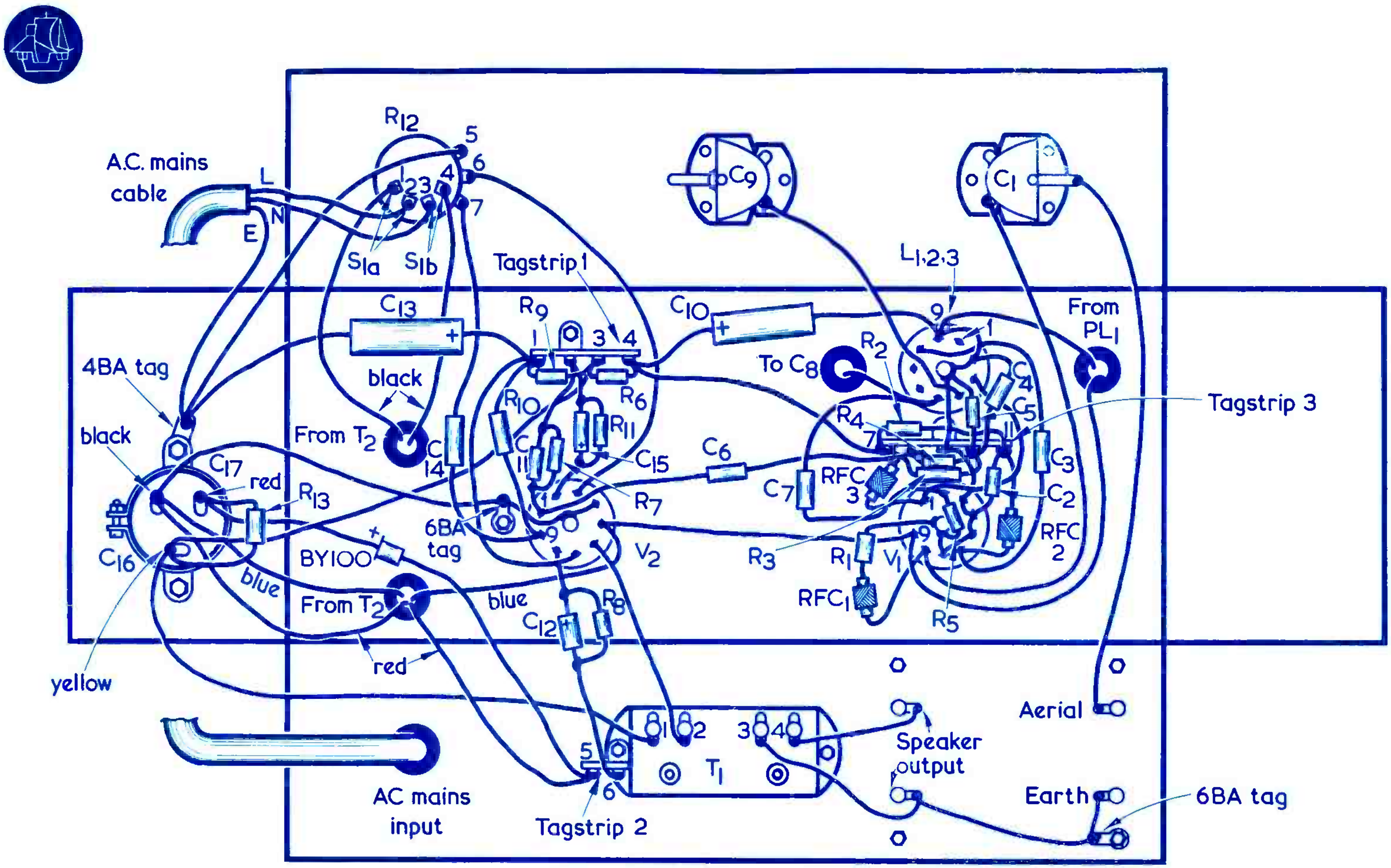
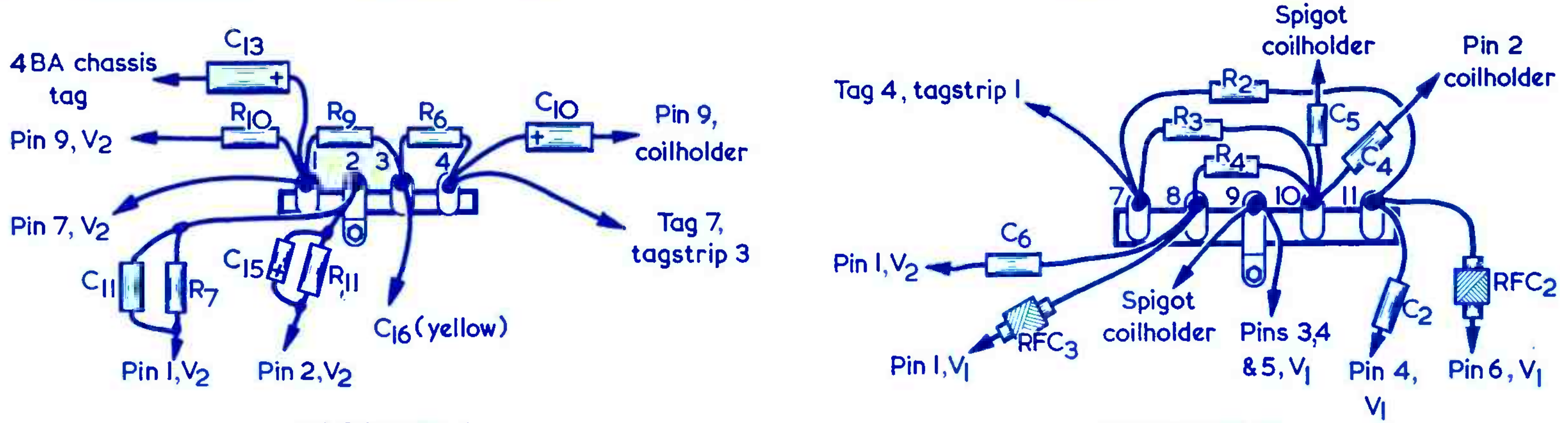


Fig.3 POINT-TO-POINT WIRING DIAGRAM OF THE 'DISCOVERY' RECEIVER

Note that all wiring is shown in exploded form for purposes of clarity.
All signal-carrying wires should be kept as short as possible



TAGSTRIP 1
(a)

TAGSTRIP 3
(b)

Fig. 4 To further assist in the correct wiring of tagstrips 1 and 3, these are reproduced here on their own for the convenience of constructors

TABLE I

Circuit position	Volts d.c.
Junction R_{13}, C_{16}	200
" R_6, C_{10}	180
" R_3, R_4	40
Pin 6 of V_1	85
" 9 of V_2	85
" 2 of V_2	15

Voltages obtained under no-signal conditions, C_9 at minimum capacitance. A.C. mains voltage-240
Total h.t. current approx. 44 mA

TABLE II

Frequency coverage

Range	Frequency
3	1·67 to 5·3 MHz (180 to 57 metres)
4	5·0 to 15·0 MHz (60 to 20 metres)
5	10·5 to 31·5 MHz (28 to 9·5 metres)

Subject to variation by adjustment of core green, green) the other end of which connects at the centre spigot of V1. **Solder** the two connections at pin 2 of V1.

27. To pin 4 of V1, **solder** one end of C2 (5,000pF disc ceramic) the other end of which connects to tag 11 of Tagstrip 3. **Solder** the two connections at pin 4 of V1.

28. To pin 6 of V1 connect one end of RFC2, the other end of which connects to tag 11 of Tagstrip 3. **Solder** the two connections at pin 6 of V1. To pin 7 of V1 connect a short length of bare wire, the other end of which connects to the centre spigot. **Solder** the two connections at pin 7.

29. To pin 8 of V1, connect one end of a length of p.v.c. covered wire, the other end of which is **soldered** to the nearest fixed van tag of C1. To pin 8 of V1 connect one end of RFC1, the other end of which is **soldered** to one end of R1 (1kΩ, brown, black, red), the remaining end of R1 being connected to the valveholder centre spigot. **Solder** the three connections at the spigot and **solder** the two connections to pin 8 of V1.

30. Dealing now with the remaining connections to Tagstrip 3, commence by connecting to tag 7 of the Tagstrip one end of R3 (100kΩ, brown, black, yellow) the other end of which connects to tag 10 of Tagstrip 3. To tag 7 of Tagstrip 3 connect one end of R2 (33kΩ, orange, orange, orange) the other end of which connects to tag 11 of Tagstrip 3. **Solder** the three connections to tag 11 of Tagstrip 3. **Solder** the three connections to tag 7 of Tagstrip 3.

31. To tag 8 of Tagstrip 3, connect one end of R4 (10kΩ, brown, black, orange) the other end of which connects to tag 10 of Tagstrip 3. **Solder** the three connections at tag 8 and the four connections at tag 10 of Tagstrip 3.

32. To the moving vane tag of C1, **solder** one end of a length of p.v.c. covered wire, and **solder** the remaining end to the aerial input tag on the chassis rear apron. Obtain a length of p.v.c. covered wire, bare at one end a 1in. length and **solder** this to both the earth input tag and the associated chassis tag on the rear apron. The other end of this wire is now connected to the speaker output socket tag nearer the bottom edge of the chassis. To this latter tag connect a further length of p.v.c. covered wire, the remaining end of which is **soldered** to tag 3 of the output transformer T1. **Solder** the two connections at the speaker output socket tag. To the remaining speaker output tag, **solder** one end of a length of p.v.c. covered wire, the other end of which is **soldered** to tag 4 of T1.

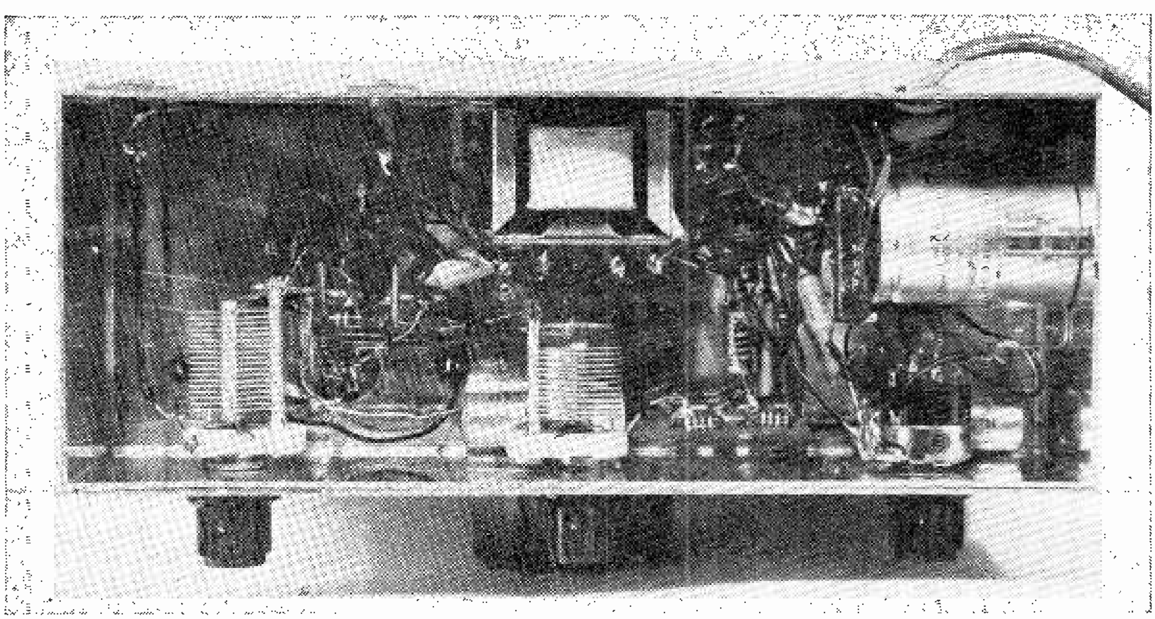
REMAINING TASKS

33. The remaining tasks are those of completing and fitting the front panel and the two soldered connections to PL1.

The front panel should now be drilled with a hole of $\frac{7}{16}$in. diameter at the precise point through which the tuning capacitor spindle will protrude. This may easily be determined by wetting the end of the spindle and offering the panel to the chassis such that the three controls R12, C9 and C1 coincide with the holes on the panel. The mark thus made on the rear of the panel is then that required for the C8 spindle hole. Having determined the correct position of the hole centre for C8 spindle, drill also the holes required for the dial drive assembly, following the manufacturer's instructions in the leaflet provided with the assembly. Remove the bush-locking nuts of R12, C9 and C1, fit the panel in place and refit the nuts, remembering to fit the outside insulating washer under the nut for C1. Check, with an ohmmeter or continuity tester, that there is no short-circuit between the spindle of C1 and chassis. If there is, adjust the position of C1 bush within the enlarged hole made for it until the short-circuit clears.

34. Secure to the panel the motif by means of a suitable contact adhesive. Also secure to the panel the panel lamp assembly PL1. Fit to the panel the ball drive assembly and cursor as described in the manufacturer's leaflet. The dial should read 100 with the moving vanes of C8 fully enmeshed.

35. Fit to the spindles of R12, C9 and C1 the knobs specified. To one of the tags of the panel lamp assembly PL1, **solder** one end of a length of p.v.c. covered wire of sufficient length to be fed through the adjacent grommet to pin 9 of V1. Do not feed through the grommet as yet. To the remaining tag of PL1 **solder** a further length of p.v.c. covered wire of sufficient length to reach pin 9 of



Below-chassis view of the "Discovery" receiver. Note from this illustration the correct positioning of the various components – the layout should be followed as closely as possible the coilholder. Twist these wires around each other and connect the free end of one length to pin 9 of V1 and solder the two connections to this tag. Connect the remaining free wire from PL1 to pin 9 of the coilholder and solder the three connections to this tag.

The assembly and wiring-up of the *Discovery* receiver is now complete and testing can commence.

TESTING THE RECEIVER

Fit V1 and V2 into their respective holders, and for the initial testing process, plug coil 3 which covers the range 1.67 to 5.3MHz into the coilholder. Connect an aerial and earth and the 3Ω speaker to their respective sockets on the rear apron of the chassis. Connect the receiver to the a.c. mains supply. Switch on, whereupon the panel lamp, followed later by the valve heaters, should light up. All being well, secure the valve can over V1. Switch off, disconnect the a.c. mains plug, turn the receiver over such that the underneath of the chassis is uppermost. Check that V2 is not fouling the bench top; it is a good plan here to rest the chassis deck on some books or similar items. Switch on once more.

Table 1 gives voltage readings obtained with the prototype receiver. (See detachable section). These are intended for guidance only and small differences from the figures given do not necessarily indicate a fault condition. When taking voltage measurements, or carrying out any other work on the receiver, always take full precautions against accidental shock.

The main winding inductance of the three inductors is subject to a variation of approximately 15%, by means of core adjustment. The nominal coverage quoted by the manufacturer is shown in Table II. (See detachable section).

OPERATION

In operation, the receiver is kept just below the oscillation point by adjustment of the reaction capacitor C9. In actual fact, only a very slight adjustment is required when operating over the short wave bands. The adjustment of C9 should be kept in step with that of the tuning capacitor C8, and the requisite operating procedure will soon become automatic with a little practice.

The degree of r.f. attenuation, which has a bearing on the selectivity of the circuit, is varied by adjustment of the attenuator control C1. With the vanes fully enmeshed, maximum transference of input signal is obtained from the aerial. When the control is set to a lower capacitance, the input decreases but selectivity is increased. Owing to the grounded-grid input stage, there are no reaction "dead spots". Operation of the a.f. gain control has no effect whatsoever on the detector circuit.

In operation, with an aerial some 33ft. in length at a height of 35ft. and an efficient earth system, the *Discovery* has been thoroughly air-tested and found to out-perform other similar simple receivers designed by the author. It should be stressed, however, that an efficient aerial and earth is necessary with this receiver if maximum efficiency is to be achieved.

It should be noted that the receiver must not be operated without a loudspeaker connected to the speaker sockets. Excessively high a.f. voltages can appear in the primary circuit of T1 if its secondary is not loaded, and these may result in damage.

Once testing has been completed, Panel Sign Transfers from Panel Sign Set No. 3 should be applied to the front panel as shown on the front cover illustration.

Those readers who desire to cover the medium waveband in addition to the three short wave ranges will require to obtain a further coil in the Green range – that for Range 2 (0.515 to 1.545MHz – 580 to 194 metres). The *Discovery* performs almost like a superhet receiver over this range. ■

MAN – COMPUTER INTERACTION CONFERENCE

The current growth of management information systems will lead to more executives, managers, operatives and supervisors communicating directly with computers. The problems of laymen and non-specialist users working in this way will be discussed at the conference on man–computer interaction to be held at the U.K. National Physical Laboratory at Teddington from the 2nd to 4th September, 1970.

Careful design of both equipment and computer information systems is not to be divorced from basic languages will be necessary if the growth of future requirements. It is expected that similar human problems will arise in other areas of man – computer interaction, such as medical diagnosis and information retrieval.

Although the conference will be mainly concerned with human and communication problems, it is hoped that contributions on engineering problems, experimental devices and theoretical topics will also be presented. The scope of the conference includes languages, human-factors aspects of terminal design, new techniques and devices, psychological studies, and the evaluation of total working systems.

Offers of contributions to the conference programme are welcomed and 250-word synopses should be submitted to the IEE Conference Department as soon as possible. Full contributions not exceeding 3,000 words will be required by the 1st May, 1970.

Further details and registration forms will be available in due course from the manager, Conference Department, IEE, Savoy Place, London, W.C.2.

MANCHESTER AND SOUTHAMPTON EXHIBITIONS

Plans for the expansion of the successful professional electronic instruments exhibitions, initiated in Manchester in 1967, are announced by the Electronic Promotion Group after a meeting of 26 firms on January 22nd.

The EPG is an alliance of major manufacturers whose aim is to promote professional grade electronic products. Exhibitors take part in the Group's shows by invitation only. The first exhibition was limited to 16 manufacturers. Last year there were 24 firms represented at Manchester while a similar show at Coventry was confined to 20 exhibitors.

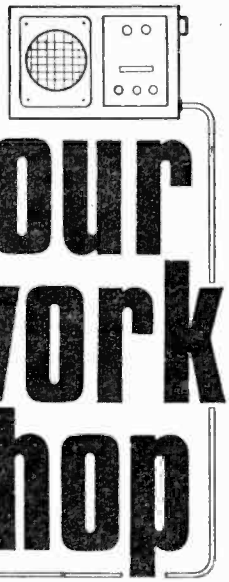
This year's Manchester Electronic Instruments Exhibition, from September 8th to September 11th, will again be held in the Peacock Suite of the Hotel Piccadilly. Additional space has been made available and there will be up to 36 companies represented.

A second show – also restricted to professional grade instruments – will be held at the Skyway Hotel, Southampton, in the Autumn, with 24 exhibitors.

Plans for 1971 envisage a much broader-based exhibition in Manchester. This will be held in the City Hall in October and will include professional grade instruments, components and industrial control equipment.

Mr. G. C. Briggs (Marconi Instruments), resigned the chairmanship of the EPG working party, a position he has held since 1966. He continues as a member. Mr. Gordon McEwan (Bell and Howell) was elected the new chairman.

In your work-shop



This month we find Smithy passing on to his able assistant Dick the details of a very simple signal tracer which is capable of operating with a wide range of signal input levels. Dick's concentration on the construction of this instrument has the subsidiary advantage of enabling Smithy to finally clear up his outstanding paper-work

"WHAT'S A 'DOG'?"

The long-suffering Serviceman once more detached his attention from the papers on his bench.

"What's a *what*?"

"What's a 'dog'?"

"Can't you ever," asked Smithy, with the manner of one who is goaded beyond endurance, "do *anything* on your own which doesn't involve disturbing everyone else in the vicinity?"

"I was only," returned Dick in injured tones, "asking you a question."

"You've done nothing else all *day*," exploded Smithy, "but ask me questions or otherwise get in my hair. If this latest one about a 'dog' is intended to be a gag, then I refuse to hold myself responsible for my actions."

"It's a dead serious question," retorted Dick. "The word 'dog' keeps popping up every now and again in an article on servicing in one of these American radio mags you gave me."

"Does it?" replied Smithy, mollified. "In that case there may be some justification in your query. As it happens, the word 'dog' is a slang American term for faults that are very difficult to locate and cure."

SIGNAL TRACES

"Oh, I see," said Dick brightly. "Thank you, Smithy. What you've just told me clears up something that had me completely baffled."

"Good," said Smithy shortly, returning to his work.

The Serviceman had had a very tiresome day. On arrival at the Workshop in the morning he had noted with pleasure that there were only a small number of sets in for servicing and he had decided that he would devote the day to clearing up all his outstanding paper-work. After delegating the servicing jobs to his assistant, he had then contentedly started to tackle his self-assigned task.

Inevitably, however, Dick got into trouble with his first two sets, and Smithy had to spend most of the morning personally supervising their repair. Even more infuriatingly, Dick cleared the remainder of the sets in hardly any time at all. After this he began to wander aimlessly around the Workshop, banging at things with his screwdriver all the time and whistling continually on a single fundamental note of such peculiar dissonance

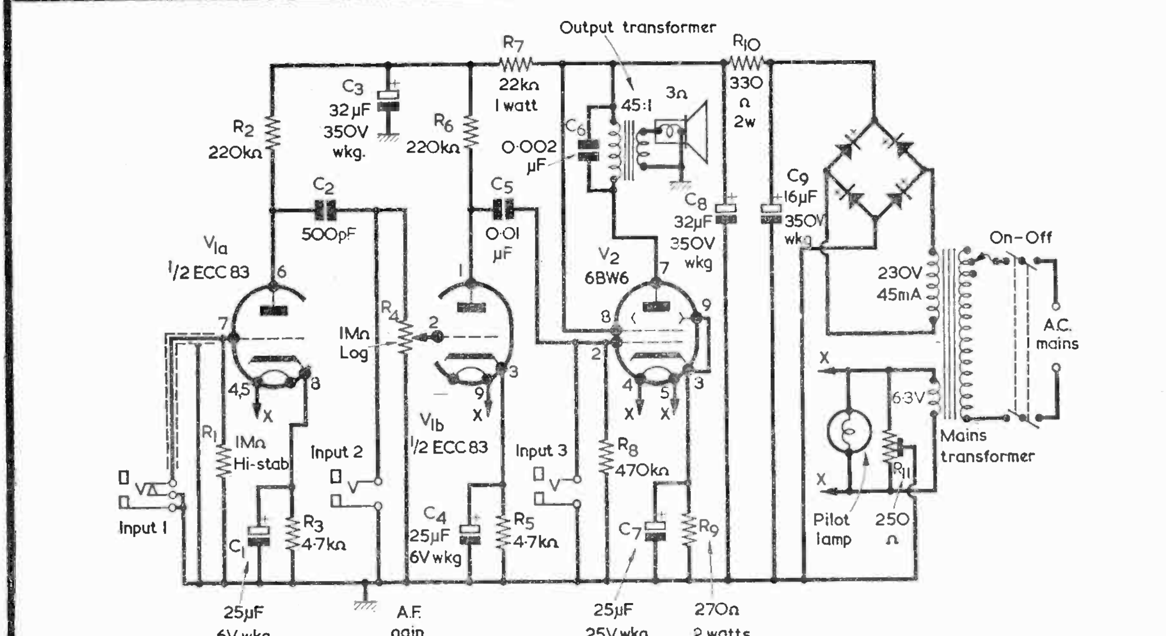


Fig. 1. Circuit diagram for the amplifier section of Smithy's signal tracer. Note that the Input 1 jack is a closed circuit component

that its family of odd harmonics would have defied analysis by Fourier himself. Smithy's nerves were becoming tautened almost to breaking-point when, fortunately, lunch-break intervened. It was during this blessed interval that Smithy suddenly remembered a collection of American radio and electronics magazines he had deposited several months before in the cupboard under his bench. He had then presented these to his assistant with the optimistic hope that they would keep him quiet for at least an hour or two.

"Smithy!"

"Oh, not *again!*"

"Do you know something?"

"What?"

"In the States," continued the unabashed Dick, "they seem to do quite a lot of their servicing with the aid of signal tracers."

"I suppose they do," replied Smithy, reluctantly drawing his thoughts away from the papers in front of him. "Servicing with a signal tracer is quite a useful technique, once you acquire experience with the performance of the particular signal tracer you're using."

"So far as I can make out," continued Dick, turning the pages of the magazine on his bench, "these American signal tracers have a probe which will take either r.f. or a.f. signals. How do you use a signal tracer, Smithy?"

"Well," replied Smithy, "the usual sort of signal tracer is basically an a.f. amplifier coupled to a speaker, and you apply an input either to the amplifier direct or via an a.m. detector circuit in an r.f. probe unit. The main use of a signal tracer is for finding which stage has gone duffy in a radio set that's completely dead. You apply the r.f. probe unit to the aerial circuit, establish that a signal is present there, then continue on past the frequency-changer and through the i.f. amplifier up to the detector. After that you use the signal tracer as an a.f. amplifier and apply the probe to successive points in the receiver a.f. stages. If the signal disappears at any point as you work through the set from the aerial to the loudspeaker, then you have obviously located the stage in which the fault appears."

"Blimey," said Dick enthusiastically. "That sounds to me like a really useful bit of test gear. Why haven't we got a signal tracer in the Workshop?"

"To be quite honest," admitted Smithy, "I've never even thought of using one here. We don't get a great deal of radios that are completely dead, and the faults in the ones we do get can usually be located pretty easily with a testmeter and a signal generator anyway. Don't forget that you can use a signal generator to go through the stages of a dead receiver in the reverse direction to a signal tracer."

Dick looked unconvinced.

"The idea of using a signal tracer sounds better to me," he stated. "With the signal generator you'd have to set it up to the intermediate frequency and things like that, which you don't have to do with a signal tracer."

Smithy shrugged his shoulders.

"Perhaps you're right," he said dispassionately. "I don't really feel strongly enough about the matter either way to argue about it. I'll merely agree that some people prefer to use a signal tracer whilst others prefer to use a signal generator. *Chacun à son goût.*"

"*What* did you say?"

"I was just repeating a little saying in French," replied Smithy airily. "I like to introduce a bit of tone to the Workshop every now and again."

"What," asked Dick suspiciously, "does the saying mean?"

"It's difficult to translate without losing the French idiom," explained Smithy loftily. "Literally, it means that 'everybody's got the gout'."

"Blimey," snorted Dick in contempt. "That's a darned silly thing to come out with, I must say."

"No, it isn't," retorted Smithy. "What happens is that, when people have an equal choice of different things you just remark '*chacun à son goût*'."

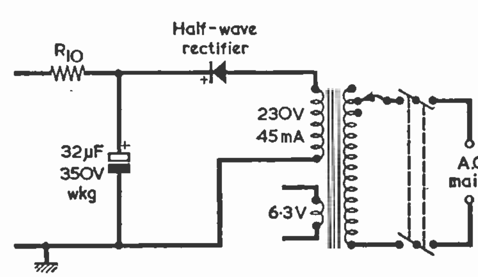


Fig. 2. A half-wave h.t. rectifier may be employed instead of the bridge rectifier, if desired. C9 should then be increased to 32μF

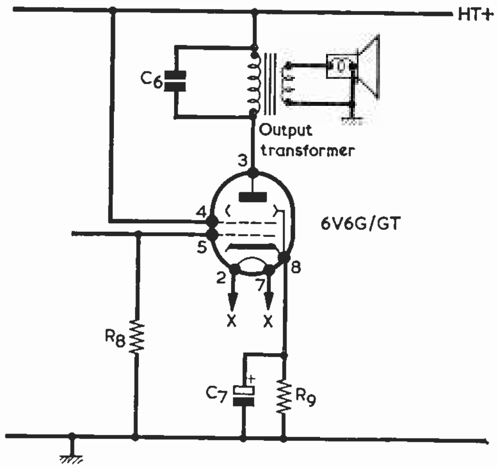


Fig. 3. A suitable alternative for the output valve is the 6V6G or 6V6GT

"Like," said Dick, his interest aroused, despite himself, at this unexpected new facet in the art of social conversation, "when in Joe's Caff he offers me either beans on toast or spaghetti on toast? What I say is what you said just then?"

"The saying *could* apply to that situation," replied Smithy, a note of uncertainty entering his voice. "But I think you'd be well advised not to use expressions of that nature there. I don't want to sound snobbish but I do rather feel that Joe's Caff doesn't offer *quite* the right background for the higher class of chat."

CIRCUIT DIAGRAM

Dick absorbed this information.

"Perhaps your'e right," he said eventually. "Anyway, let's get back to this signal tracer business."

"So far as the subject of signal tracers is concerned," responded Smithy promptly, his mind reverting to his neglected paper-work, "there isn't a great deal more to add to what I've already said."

"I was thinking," said Dick, "of *making* a signal tracer. I'm fed up with having nothing to do and there's still most of the afternoon left. What I'd like to do is to knock up a really super-dooper sort of signal tracer which has inputs for a wide range of different amplitude signals, both at a.f. and at r.f. Could you draw me out a circuit for a signal tracer like that, Smithy?"

"All right then," replied Smithy resignedly. "It seems I'll have to do *something* if I'm ever to get any peace today! Now, let's think for a moment. What you want is something that caters for a wide range of signal input levels, isn't it?"

"That's right," responded Dick eagerly.

"Well," said Smithy musingly, "all the a.f. inputs will need to be at high impedance, of course. The r.f. input impedance will be around 100kΩ or so if we're to use an ordinary germanium diode probe unit, and this should be adequate in practice. There's another important point to bear in mind. This is that the audio output fed from the signal tracer amplifier to the speaker will require a fair bit of power behind it."

"Why's that?"

"Because," explained Smithy, "when you apply the probe to a new circuit point in a receiver you will quite often pick up a signal which is higher in amplitude than you'd anticipated. You'll find that service work with a signal tracer is far more pleasant if the output stage can handle occasional loud bursts of sound without distortion, rather than if it kept on introducing distortion due to overload. I'd say that you'd need an availability of something like 3 watts in audio output power."

"Stap me," remarked Dick forlornly. "If we use transistors, that means the tracer will need an output circuit with heat sinks, driver stages and all the rest of it."

"I know," said Smithy, a little irritably. "And there's also the question of the high impedance a.f. inputs, too."

"F.E.T.'s?"

"F.E.T.'s with protective input diodes," replied Smithy, "would represent quite a good choice, I think."

The Serviceman scowled prodigiously and beat an irascible tattoo on the bench with his fingers.

"I know," he said suddenly, "that

you'll think me an old fuddy-duddy but, as soon as you mentioned what was required of this signal tracer, my mind immediately started working in terms of an amplifier using valves instead of semiconductors."

"You sound quite worked-up about it," said Dick, surprised. "What's so wrong about using valves?"

"Nothing much," admitted Smithy. "It's only that I've been trying to dream up a *simple* semiconductor circuit which will do the job just as easily, and I haven't been successful. With valves you have the whole project made from the start – your high input impedances are given at the valve grids and you haven't got to worry about adding protective diodes to prevent gate breakdown, as you'd have to do with f.e.t.'s. Also, you can get a good 3 watts or more to the speaker from any reasonably sized output pentode or beam tetrode with no difficulty whatsoever. What's more, the signal grid of the output valve can provide one of the high impedance inputs for the signal tracer as well."

"I can't see," commented Dick, "any point in straining semiconductor circuits to do something that valves can do without any problems at all, so let's just use valves!"

"Very well," said Smithy decisely. "We'll do just that, then. I suppose my objections to using valves are that I don't want to give the impression that I'm starting to become anti-semiconductor-minded in my old age."

"I know you well enough not to believe that."

"Do you?" replied Smithy, pleased. "In that case I'll now show you how easy it is to make up this signal tracer with valves. The only snag is that the tracer will have to run from the mains instead of from batteries. However, the mains transformer required need only be a small component."

Dick carried his stool over and sat alongside Smithy as the latter took out his pen and set to work drawing out the main circuit of the signal tracer. After some five minutes or so, the Serviceman placed his pen on the bench and indicated that the circuit diagram (Fig. 1) was now complete. Dick looked at it with interest.

"It certainly looks simple enough," he remarked.

"I'm glad you've noticed that," returned Smithy, a note of gratification entering his voice. "It's the simplicity that vindicates the use of valves. Anyway, let's go through the circuit in detail, starting from the mains input end. As you can see, the mains goes into a standard mains transformer, the one I've

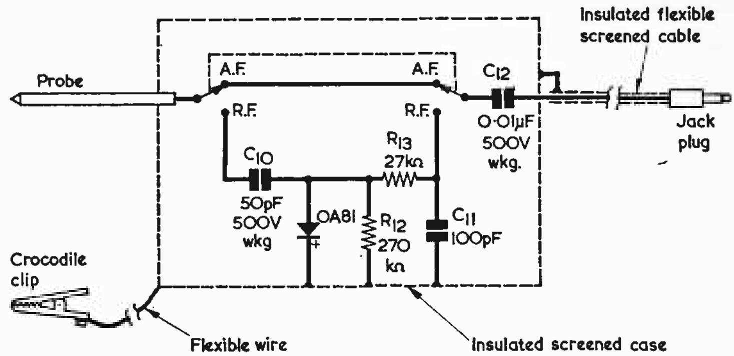


Fig. 4. The probe unit for the signal tracer

shown here having a 230 volt 45mA h.t. secondary. However, the secondary voltage isn't at all critical and any mains transformer with a secondary offering 200 to 250 volts will do instead. For 230 to 200 volts, the h.t. secondary current rating should be 45mA or more. Above 230 volts it would be better to work to a minimum rating of 50mA. I've shown a bridge h.t. rectifier, but you could alternatively have a half-wave rectifier if you liked. (Fig. 2). If you're using a half-wave rectifier it would be preferable to increase the value of the reservoir capacitor to 32μF. In other words, the h.t. supply circuit is not particularly important provided that it offers something of the order of 200 to 250 volts, reasonably well smoothed. So far as heater current is concerned, the two valves draw 0.75 amp at 6.3 volts."

"The power supply section is easy enough," said Dick. "What about the valve stages?"

"First, there is the output stage," replied Smithy, "and it incorporates a 6BW6 beam tetrode. If you've got an old 6V6GT or 6V6G knocking around this could be fitted instead. (Fig. 3). The output transtransformer should have a ratio of 45 : 1 or thereabouts for either type of valve, and the function of the 0.002μF capacitor across its primary is merely that of reducing the harmonics an output stage of this nature produces. Preceding the output valve is a high gain two-stage voltage amplifier incorporating the two triodes of an ECC83. Their anode circuits are supplied by way of R7 and the bypass capacitor C3."

"I see you've given R7 a rating of 1 watt. Isn't that rather high?"

"It would appear to be," replied Smithy, "when you consider that R7 will normally be passing slightly less than a milliamp. On the other hand, it passes a relatively high current for a very short period after switching on. What happens is that C8 and C9 will charge up to the peak voltage across the mains transformer h.t. secondary almost immediately after the signal tracer is switched on, whereupon R7 will momentarily pass some 20 to 30mA charging current to C3. Because of this, it seemed reasonable to me to give the resistor a wattage rating of 1 watt. Apart from R10 and R9, which are 2 watts, all the other resistors in the circuit can be ¼ watt."

"Making R7 1 watt is a good design point," remarked Dick, impressed. "Why have you put the gain control between the two triodes of the ECC83?"

"Because," explained Smithy, "you'll be doing most of your signal tracing work with the signal input applied to either Input 1 or Input 2, and the gain control functions with both these inputs. There isn't much point in having a gain control immediately after Input 1, incidentally, because the sensitivity at this point will be very high and your main preoccupation here will consist of keeping down hum pick-up. Adding a gain control at the Input 1 position would merely mean that more wiring was available for hum pick-up. By the way, you'll see that I've given C2 the low value of 500pF. This means that any hum that *is* picked up in the Input 1 wiring is partly attenuated before being passed to the succeeding stages. You won't need a full audio frequency response when you're using Input 1, and so you might as well take advantage of this fact to ease the hum pick-up problems you'll get there."

"I assume that the idea of using three inputs," put in Dick, "is that you can select whatever amount of a.f. gain you require from the amplifier."

"That's right," confirmed Smithy. "Each input is provided by a jack into which you fit a jack plug coupled to the probe unit. I'll be showing you the probe unit circuit in a minute, but for the time being, I'll merely mention that, when it's used for a.f., it has a built-in d.c. blocking capacitor of 0.01μF."

PROBE UNIT CIRCUIT

"I've just noticed something else," remarked Dick, peering closely at the circuit. "Input 1 uses a closed circuit jack."

"That's intentional," said Smithy. "What you'll find is that a small amount of self-generated noise appears in the grid circuit of V1(a). This noise won't be troublesome when you're actually using Input 1, but there's no point in having it break through to the later stages when you aren't. So, when Input 1 isn't in use, the noise at the grid of V1(a) is automatically shorted down to chassis."

"That seems to clear up my queries so far as the amplifier circuit is concerned. "What about the probe unit?"

Smithy picked up his pen once more.

"That," he remarked, "is very straightforward. Hang on a jiff and I'll scribble out its circuit for you."

Smithy soon had the circuit drawn (Fig. 4) and he then passed his pad over to his assistant for that worthy's scrutiny.

"This probe unit," said Smithy, "has a 2-pole 2-way switch on it which is set, as required, for a.f. and r.f. input signals. When the switch is set to 'A.F.' the probe couples straight through to the jack plug via the 0.01μF capacitor C12. When the switch is set to 'R.F.' the probe couples to a standard a.m. detector circuit, the output of which is similarly fed to C12. I've indicated the detector diode as being an OA81, but pretty well any germanium signal diode could be used instead. The circuit is not at all fussy in that respect."

"What's the crocodile clip for?"

"You clip that to the chassis of the set you're working on," said Smithy. "After which you simply apply the probe to the circuit points you want to check."

Dick looked thoughtfully at Smithy's sketch.

"I see," he remarked, "that I'll have to make up the probe unit in some sort of screened case."

"Oh, definitely," said Smithy. "The only bit of the probe unit that's unscreened is the probe itself. This needs to poke out from the unit for about 3 inches or so, and it can consist of a length of metal rod about $\frac{1}{16}$in. in diameter with a spike on the end. What you haven't mentioned yet is the very important point that all the outside of the probe unit must be *insulated,* as also must the flexible screened cable coupling the probe to the jack plug. The reason for this is that you'll be holding the probe unit in your hand whilst you're using it. If you're working on a receiver with a live chassis then the probe unit screening will be live also; so it's *essential* that the unit be completely covered with insulation suitable for mains voltages. The a.f.-r.f. switch should be a rotary type, since it can then be fitted with an insulated knob."

"That probe unit shouldn't present too much trouble," said Dick musingly. "I'll hunt out a stout plastic box and put all the stuff inside that. With a bit of luck I should be able to find a small tin that will fit inside the plastic box and provide the screening."

"Good boy," returned Smithy approvingly. "The components required in the probe unit are all quite small, so the tin you require needn't be large in physical size. The resistors, for instance, can all be 1/8 or 1/10 watt. Don't forget, though, that C10 and C12 should be 500 volt working. These capacitors need this working voltage in case the points in the receiver being checked carry a high h.t. potential."

"Well," remarked Dick, "it certainly seems that, at long last, I've got something to occupy me today! I'll make the main amplifier unit first. Any hints there?"

"You'll need," said Smithy, reaching for his pad once more, "a sensible layout for the valves and jacks, of course. I'd suggest something like this."

Smithy sketched out a suitable layout (Fig. 5).

"Another point," he added, "is that the chassis returns in the grid circuit of V1(a) should all be taken to the same chassis point. This can conveniently be at the chassis tag of the Input 1 jack (Fig. 6), which must be mounted very close to V1 valveholder. The lead-out of Ri connecting to the grid tag of the valveholder should be kept very short, as also should the bit of central wire poking out of the screened lead. The latter will, of course, be quite short in length. Also, make sure that the heater wiring to V1 is well-twisted and kept well away from the grid pin and from the Input 1 jack."

"Blow me," said Dick, returning to the circuit diagram of the amplifier. "It's only just occurred to me that the heater circuit has a humdinger!"

"Do you mean R11?"

"That's the joker."

"R11 is adjusted for minimum hum," said Smithy. "All you need there is a skeleton preset."

"Should the speaker be in the same cabinet as the amplifier section?"

"It would be better to have it separate," said Smithy. "Otherwise you might get acoustic feedback problems due to microphony in V1(a). In your case, all you need to do is to make the amplifier up on a small chassis and couple it to your bench speaker. A point I haven't mentioned here, by the way, is that the amplifier shouldn't be used without a speaker connected. This is because you'll get some pretty hefty a.f. voltages across the primary of the output transformer if the secondary isn't loaded, and these could cause damage."

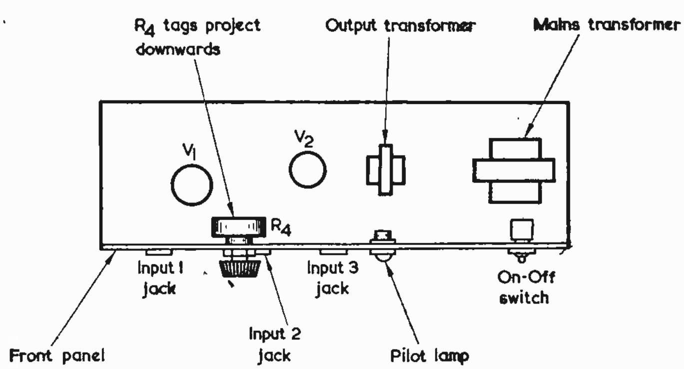


Fig. 5. Top view illustrating a suitable chassis layout for the signal tracer amplifier. The three jacks are below chassis deck level

TRYING OUT

"Righty-ho," said Dick cheerfully. "From now on I'm devoting the afternoon strictly to chassis-bashing and wiring up!"

And such, indeed, was the case. Smithy returned thankfully to his paper-work, his subsequent concentration being interrupted only by the sounds of Dick's exertions in the manufacture of the signal tracer. These consisted initially of the screech of Dick's file on sheet metal, the scream of Dick's electric drill, and the battering of Dick's mallet against the vice bending-irons. This session terminated in a period of violent cursing, followed by a trip to the First Aid box for Elastoplast. Relative silence ensued, broken merely by the busy rattle of box spanner and screwdriver. Proceedings warmed up after this as Dick next swung into a rhythmic performance made up of first, the snip of his side-cutters, second, the sizzle of the solder and, third, the crashing of the iron as it was returned to its rest. The passage was unexpectedly interrupted by one sizzle louder than the rest, this being immediately followed by a roar of anguish and a further visit to the First Aid box. After that, the cadence of side-cutters, sizzle and soldering iron became audible once more.

Eventually, the sound of deep and concentrated breathing betokened the checking, by Dick, of his completed wiring against Smithy's circuit. A triumphant grunt of satisfaction indicated that all was well, and it was succeeded by the eager clatter of mains plug in socket and the click of an on-off switch. The final movement called for visual as well as aural perception, and commenced with the holding up in the air of the second finger of Dick's right hand (the first finger having now become completely insulated by Elastoplast) followed by its downward insertion into the underside of the amplifier chassis. A deep-pitched grid hum at once resounded from Dick's bench loudspeaker.

It was at that instant that Smithy put to one side the last of his paper-work.

"All done, Smithy," called Dick proudly.

Smithy walked over to Dick's bench and examined his assistant's handiwork. The completed amplifier chassis was upside-down, with the probe unit alongside it.

"You've certainly been industrious," remarked Smithy, impressed. "Blimey, you've even made up the probe unit as well."

"I've done the lot."

"Have you tried it out yet?"

"I've only checked the amplifier from Input 2 to the speaker," said Dick. "I got a smashing loud hum when I put my finger on the 'tip' contact of the Input 2 jack."

"Good," commented Smithy.

The Serviceman put his hand on the gain control knob, and found that Dick had already put it to its maximum setting. He then bent forward and listened critically to the output from the speaker.

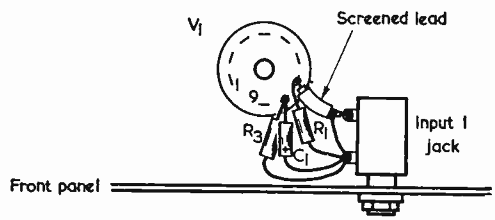


Fig. 6. A single chassis return should be employed for the components in the grid and cathode circuit of V1(a). The jack employed is of the type whose 'sleeve' contact connects to the metal panel by way of its mounting bush

"That sounds nice and quiet," he announced. "Just a very faint hiss. I'll switch the probe unit to 'A.F.' and plug it into the Input 1 jack."

As Smithy inserted the jack plug, a much more noticeable hiss, accompanied this time by hum at a low level, became audible from the speaker. Smithy picked up a screwdriver and adjusted the humdinger potentiometer. The hum dropped to a level that was barely audible above the hiss.

"Hmm, quite reasonable," he said. "Bring your finger up to the probe."

Dick cautiously advanced his finger to the probe on the probe unit. When it was several inches away the hum level started to increase, reaching an ear-shattering level when his finger actually touched the probe.

"Hell's teeth," remarked Dick, "there's some gain there."

"Switch the probe unit to 'R.F.'," said Smithy, "and do the same again."

Dick clicked the switch on the probe unit to 'R.F.' whereupon the hiss from the speaker became noticeably reduced. He looked at Smithy enquiringly.

"Don't worry about that," said Smithy. "It's merely because you've reduced the impedance between the grid of V1(a) and chassis."

Reassured, Dick brought his finger forward and once more touched the probe. To his utter amazement the bench loudspeaker at once reproduced at unexpectedly high level, the local B.B.C. Radio 4 transmission, together with a background accompaniment from Radio 2.

HIGH GAIN

"Ye gods," stuttered Dick, snatching his finger away. "What happened then?"

"You were acting," chuckled Smithy, "as an aerial, and all the a.m. signals you picked up were being applied to the detector in that probe unit. As it happened, our local Radio 4 transmission was the strongest, and that's why it predominated in the signal from the speaker. The very high gain in the signal tracer amplifier did the rest. So there you are, Dick. You've now built yourself a signal tracer with probably sufficient gain to reproduce the signal picked up on at least some ferrite rod aerials, and certainly with enough gain to pick up the signal after a receiver's mixer stage."

"I'm going to have some fun with this," said Dick gleefully. "Can you think of any other low-level signals this tracer will work with?"

"The a.f. stages," said Smithy, "have got about the same gain as the a.f. stages of a valve tape recorder playback amplifier. The tracer should, therefore, be capable of amplifying the signal from virtually all medium to high impedance tape recorder playback heads, when the probe unit is switched to 'A.F.' The only other applications I can think of are the standard ones you use a signal tracer for, and many of these will require the probe unit to be plugged into Input 2 or Input 3 instead of into Input 1."

With these words, Smithy applied his own finger to the signal tracer probe, whereupon the Radio 4 programme once more resounded around the Workshop. Allowing himself a satisfied smile, Smithy switched the signal tracer off with a flourish.

"That action," remarked Dick, who had been watching Smithy closely, "made a very nice little gesture to finish off with."

"Did it?" returned Smithy. "Then I suppose it could be referred to as *a coup de grâce*."

"You and your French sayings! What does that one mean?"

"Once again," replied Smithy, "there is difficulty in translating from the original French. The literal meaning is 'lawn-mower' but, when used in the correct context, the expression carries quite a different association of ideas."

■

LATE NEWS

★ AMATEUR BANDS

● HUNGARY

According to the latest information, there are some 300 call holders in Budapest and new calls are being constantly issued. The most active Hungarian amateur station last year was HA5CQ with 6.000 contacts on s.s.b. Second on the activity list was HA5FE using both the s.s.b. and r.t.t.y. modes. The Hungarian Radio Amateur Association has just arranged with their Post Office for the release of new r.t.t.y. machines for purchase by amateurs.

● LUXEMBOURG

LX1BW has been very active on **21385kHz** using the s.s.b. mode.

● TRISTAN da CUNHA

ZD9BN has been heard on **14203kHz** using s.s.b.

● AUSTRALIA

If you hear the prefix AX you will be listening to an Australian station. The prefix is being used this year to mark the 200th anniversary of the landing of Capt. Cook on the mainland. A Centenary Award is being issued to overseas amateurs who work 50 AX stations. For checking purposes QSL's are not required, just list log book data, get it countersigned by two amateurs who verify that entries agree with the logbook and send to Awards Manager, W.I.A., POB67, East Melbourne, Victoria 3002. Awards are free. Write on envelope own address and "Cook Award".

★ BROADCAST BANDS

● BRITISH HONDURAS

Radio Belize on **3300kHz** has raised its power from 1 to 5kW.

● QATAR

Radio Qatar, Doha, in the Persian Gulf, listed on 9570kHz is currently operating on **9500kHz** and has added several new channels. These are **5150, 6135, 9770** and **11710kHz.**

● HAITI

5050kHz 4VOD Radio Valparaiso, Port-de-Paix (0.15kW) in a recent letter to a Dx'er stated that the often quoted station on this channel (4VGA Radio Capois la Mort) has been silent since 1967 and that they, 4VOD, are the station being heard on this frequency.

● INTERNATIONAL WATERS

Radio Norge, a new commercial radio pirate is now on the air on 6210kHz with announcements in English and German.

● CANADA

The CBC International Service, Sackville, New Brunswick will soon increase the power of its short wave transmitters from 50 to 250kW.

● CONGO KINSHASHA

Radio Lubumbashi (100kW) "The Voice of African Brotherhood" is again transmitting on the usual frequency of **11866kHz** after being off the air during November and December of last year.

Acknowledgements to our own Listening Post, Swedish Dx'ers and Radio Budapest.

'CQ' CONTEST

The 1970 *CQ* WW 160 Metre CW contest took place from 0001 GMT on Saturday, 24th January to 1500 GMT Sunday, 25th March.

European activity was apparent from 1855kHz down to 1810kHz, and in the case of one OK station even lower – right on the U.S.A. 'Dx Alley'. Warming-up activities commenced in earnest at around 2330 GMT and by the starting time of the contest European Dx contacts were taking place. Conditions for Eu Dx were good, during a listening session from the contest commencement until 0130 GMT, the following were heard.

CW: DL9KRA, EI9J, GD3SVK, GI3JXS, GM3IAA, GM3IGW/A, GW3UCB, GW3UPK, HB9CM, HB9NL, HB9QA, OH2VO, OK1ATY, OK1AWQ, OK1AZZ, OK1DVK, OK1IQ, OK1KU, OK2BFN, OK2BMR, OK3CDO, OL2AIO, OL5ALY, OL5AMT.

A search for W signals from 0530 until 0700 GMT produced only K2GNC (1802kHz, 0543); K2IXJ (1820kHz, 0650); W1HGT (1804kHz, 0600) and W4BGO (1803kHz, 0545).

But for the two fish-fone carriers which are unmodulated for most of the time and are apparently on the air continually, one on 1800 and the other on 1806kHz, more trans-Atlantic signals would be heard.

LAST LOOK ROUND

● TRUTH TO TELL?

George Washington, first President of the U.S., could not tell a lie – at least that is what we are led to believe.

In his day Lie Detectors, other than human, were unknown but in these modern times such instruments are used in this country by students of psychology engaged in experimental work and research. Would you care to preside over a lie detecting session? If so, you should first build the *Transistorised Lie Detector.*

Truth to tell, this article will appear in our next issue – and we are not prevaricating! Just to put the record right, ignore the first paragraph. The cherry tree legend was dreamed up by "Parson" Weems – it's an untruth!

● GOGGLE-BOX CONVERSION

If you are the owner of an early U.K. 'One-Eyed Monster', or can obtain such a model, why not blow the dust off the thing and convert it to receive European TV Dx? After all, their programmes can hardly be worse than some of ours!

Intended for the constructor who is familiar with TV operation, *European Systems TV Conversion* **provides the information required to successfully look into Europe – see the April issue and change that old 'idiot's lantern' into a new role. New lamps for old?**

● 464

A look round to this page will show that we have not forgotten the comparative beginner during the publication of our 23rd volume. Over the 12 issues, August to July inclusive, we try to include constructional articles aimed at all levels and interests. It is hoped that the receiver described will encourage further adherents into the hobby.

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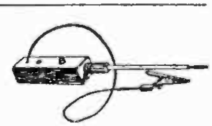

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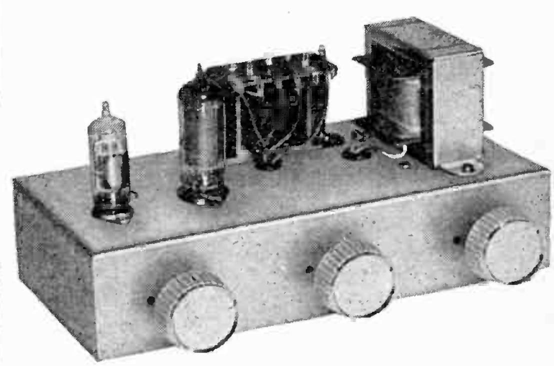

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(Continued on page 513)

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(Continued on page 515)

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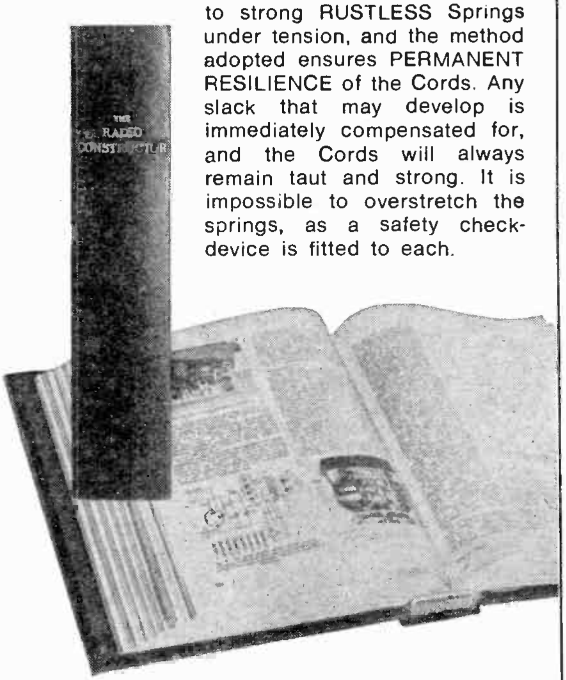

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Continued from page 513

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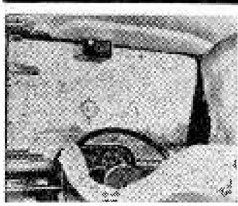

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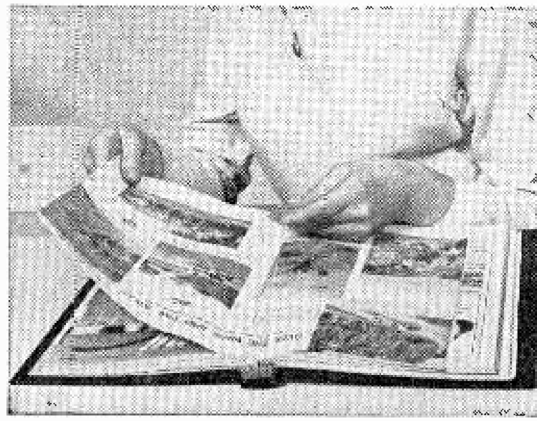

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The Table lists R values to two significant figures for frequencies from 50Hz to 15kHz against values of C from 100pF to 0.5µF.

Frequency	100pF	200pF	500pF	1,000pF	2,000pF	5,000pF	0.01µF	0.05µF	0.1µF	0.5µF
50Hz		6.5MΩ	2.6MΩ	1.3MΩ	650kΩ	260kΩ	130kΩ	26kΩ	13kΩ	2.6kΩ
100Hz	6.5MΩ	3.3MΩ	1.3MΩ	650kΩ	330kΩ	130kΩ	65kΩ	13kΩ	6.5kΩ	1.3kΩ
150Hz	4.3MΩ	2.2MΩ	870kΩ	430kΩ	220kΩ	87kΩ	43kΩ	8.7kΩ	4.3kΩ	
200Hz	3.3MΩ	1.6MΩ	650kΩ	330kΩ	160kΩ	65kΩ	33kΩ	6.5kΩ	3.3kΩ	
300Hz	2.2MΩ	1.1MΩ	430kΩ	220kΩ	110kΩ	43kΩ	22kΩ	4.3kΩ	2.2kΩ	
400Hz	1.6MΩ	810kΩ	330kΩ	160kΩ	81kΩ	33kΩ	16kΩ	3.3kΩ	1.6kΩ	
500Hz	1.3MΩ	650kΩ	260kΩ	130kΩ	65kΩ	26kΩ	13kΩ	2.6kΩ	1.3kΩ	
750Hz	870kΩ	430kΩ	170kΩ	87kΩ	43kΩ	17kΩ	8.7kΩ	1.7kΩ		
1kHz	650kΩ	330kΩ	130kΩ	65kΩ	33kΩ	13kΩ	6.5kΩ	1.3kΩ		
2kHz	330kΩ	160kΩ	65kΩ	33kΩ	16kΩ	6.5kΩ	3.3kΩ			
3kHz	220kΩ	110kΩ	43kΩ	22kΩ	11kΩ	4.3kΩ	2.2kΩ			
4kHz	160kΩ	81kΩ	33kΩ	16kΩ	8.1kΩ	3.3kΩ	1.6kΩ			
5kHz	130kΩ	65kΩ	26kΩ	13kΩ	6.5kΩ	2.6kΩ	1.3kΩ			
7.5kHz	87kΩ	43kΩ	17kΩ	8.7kΩ	4.3kΩ	1.7kΩ				
10kHz	65kΩ	33kΩ	13kΩ	6.5kΩ	3.3kΩ	1.3kΩ				
15kHz	43kΩ	22kΩ	8.7kΩ	4.3kΩ	2.2kΩ					

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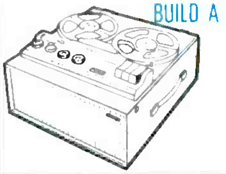

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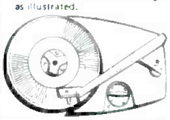

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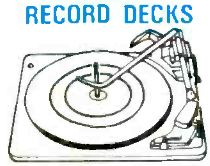

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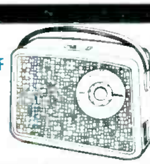

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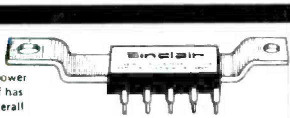

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*Data sheets 3/6 set for these, for others see catalogue

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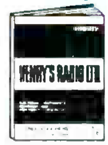

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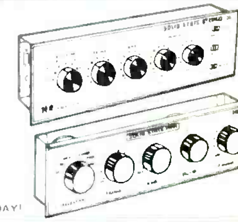

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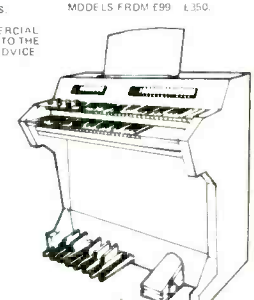

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