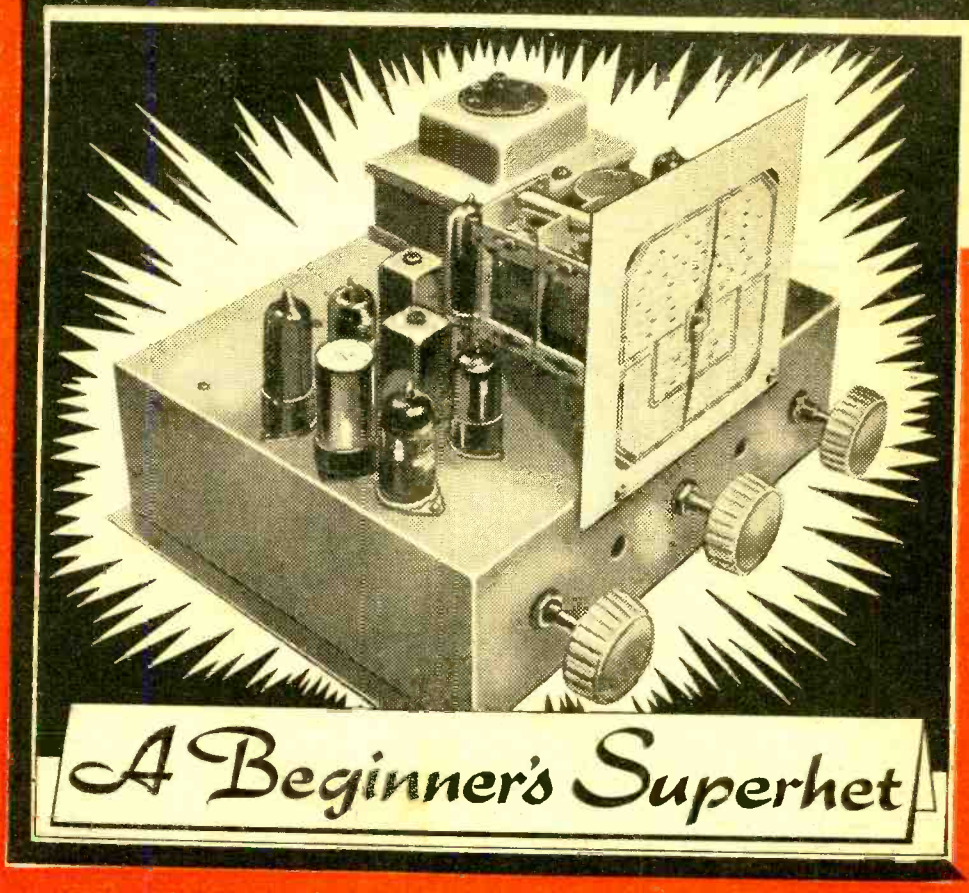
A LOCAL STATION RECEIVER

1/-

Vol. 29 No. 561
JULY, 1953

EDITOR:
F. J. CAMM

PRACTICAL WIRELESS



A Beginner's Superhet

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NOISE AND THE R.1155

Practical Wireless

EVERY MONTH
VOL. XXIX, No. 561, JULY, 1953

Editor F. J. CAMM

21st YEAR OF ISSUE

COMMENTS OF THE MONTH

By THE EDITOR

Small Firms at the Show

AN APPEAL TO COMPONENT MANUFACTURERS

WE have often commented that small firms do not support the National Radio Show at Earls Court. In view of the hundreds of thousands of constructors still actively engaged in building receivers, we are somewhat surprised that they do not take space and meet some of their customers in person. This journal has consistently taken space in every Radio Show since it commenced publication 21 years ago. During the run of the exhibition large numbers of constructors call at our stand to discuss designs and purchase blueprints. Year after year we are confronted with the question as to whether the firms making the components are exhibiting. In most cases they are not.

Accordingly, after the last Radio Show we made a careful analysis of the position and, as we suspected, we were told in every case that the reason for not exhibiting was the high cost of the space, apart from the additional high cost of having a special stand built and the incidental expenses of lighting and staff. We immediately, therefore, discussed this matter with those responsible for organising the exhibition, and this year a special section has been set aside for the smaller manufacturer, at specially reduced space prices.

We are astonished to learn from the Radio Industry Council that at the moment of going to press only one manufacturer has availed himself of this offer. We appeal, therefore, to all those firms supplying components for home constructors to reconsider the matter, so that this year there will be a representative section at the Show.

We appeal, too, to our advertisers to take space. The constructor market is lively, large and ever expanding, as our circulation figures prove. This important market should not be neglected nor the impression conveyed that it is moribund. Firms should find that their sales at the Exhibition will at least cover their costs.

In the short space of three years over 300,000 constructors have built TV receivers. Home-built radio receivers, however, have been in existence for over 30 years and it is fairly certain that there are at least 1,000,000 home-built receivers in use to-day. Great Britain has one radio set per house compared with two and a half sets per house in the U.S.A. We have one television set per six houses against one set per two houses in America. This shows that the market has by no means reached absorption point and that there is a profitable untapped market awaiting firms with vision.

These smaller firms have apparently overlooked the publicity value of exhibiting, quite apart from the question of cash sales. Newspapers and periodicals devote considerable space to reviewing the exhibits, and this year we hope that a representative section dealing with an important national hobby, one responsible for training the skilled personnel for the services and the trade, will be there. Examples of kit sets could be shown and we are prepared in this journal to devote a special supplement to reviewing this section of the Exhibition alone.

We promise to give these firms all the support and advice they require and we invite them, therefore, to get into touch with us on the matter. We are quite prepared to offer our services to help make the constructors' section of the Exhibition a great success.

Components manufacturers are independent of radio and television only to the extent of 50 per cent. of their production. They could quite easily expand sales by returning to the market from which they originally built their business. This especially applies to those who are not manufacturing components for television receivers. We hope we shall see a considerable number of our friends in the trade at the Show this year.

INDEXES FOR "P.W."

A REMINDER to readers that each year we publish an index for each volume and it may be obtained from us for 1s. 1d. by post. We can supply most of the indexes for past volumes and they provide a ready means of turning up an article to which you may wish to refer without a long search. Whether you have your copies bound or not you would be well advised to purchase the indexes.—F.J.C.

ROUND the WORLD of WIRELESS

Increased Charge for Irish

THE cost of radio licences in Eire has been increased by five shillings to 17s. 6d. a year.

New Singapore Factory

CABLE and Wireless, Ltd., has announced that its new £232,000 submarine cable factory and depot, at Singapore, began production early in April.

The new factory is at Bukit Chermin. It will replace the company's old factory at Singapore, which was opened in 1887, and will be capable of manufacturing between eight and nine hundred nautical miles of submarine cable of all types annually, for the maintenance and development of the 20,000 miles sections in the Far East, of Cable & Wireless, Ltd.'s 155,000 miles Commonwealth cable system.

Broadcast Receiving Licences

THE following statement shows the approximate number of sound receiving licences issued during the year end, March, 1953. The grand total of sound and television licences was 12,892,231.

Region	Number
London Postal ...	1,756,506
Home Counties ...	1,475,324
Midland	1,331,943
North Eastern ...	1,761,826
North Western ...	1,368,511
South Western ...	1,035,009
Welsh and Border ...	681,890
Total England and Wales	9,411,009
Scotland	1,123,583
Northern Ireland ...	215,187
Grand Total ...	10,749,779

Better Service Needed

ADDRESSING members of the Radio and Television Retailers' Association at their recent conference, at Eastbourne, Mr. E. Cave, of E.M.I. Sales and Service, said: "Service can be one of your greatest assets. Your whole staff should be interested in service and the better service you can offer your customers, the happier they will be."

Linked with this idea, the importance of a good window display was emphasised by another speaker.

Moon and Back

TWO American amateurs, Ross Bateman and William Smith, have transmitted short-wave signals at the moon on their own home-made apparatus using only 650 watts of power and have recorded the echoes received.

Their success follows three years of experimenting in their spare time, this being the first time that an amateur's limited finance and power has enabled him to perform such a feat.

Longer Components Exhibition ?

THE success of the tenth Components Show, organised by the Radio and Electronic Components Manufacturers' Federation at the Grosvenor Hotel in April, may induce the Federation to extend next year's exhibition from three days to four.

Sunday Variety

ON June 7th there will be a change in the Light Programme's Sunday night variety pattern when the "Pleasure Boat" series, starring Freddie Sales, Lee Lawrence and Julie Andrews, is replaced by Tony Hancock in a new "Star Bill" programme.

With Hancock will be Geraldine McEwan, Graham Stark, the Stanley Black Concert Orchestra, and the George Mitchell Glee Club. In the first programme of the series Ted Ray will be the guest comedian, together with three visiting musical artists. The show will be run on the same lines as "Forces All Star Bill," which ended on May 26th.

Decca Radar

IN their annual report, Decca state that the company exported a million pounds' worth of marine radar equipment in the past year.

Protonic Microscope

THE College of France is now using a new microscope, the protonic microscope, ten times more powerful than the existing electronic microscope. The protonic microscope can magnify 600,000 times. The wavelength associated with the proton is much shorter, thus giving more separation than that of the electron. Molecules to be examined in the

Terry Thomas, the radio star who appeared in pantomime in South Africa last winter, was heard in the Bank Holiday variety show "Hip-hip-holiday." He is seen here showing some of his African spoils.

microscope have to be held in balance in a fine mesh metal screen or in holes of a fraction of a micron pierced in metals. Otherwise the instrument is like the electronic microscope. The proton used is that of the hydrogen atom, deprived of its satellite electron by a 100,000 volt discharge.

Requests from the Services

FOR some time the BBC has been examining the possibility of including in its domestic services a programme of request records chosen by serving men and women abroad for their families in Britain.

Trial programmes have already been broadcast and a regular series presented by Franklin Englemann, himself an ex-army man, under the title of "Link With Home," began in the Light Programme on June 15th, continuing on Monday evenings between 7.30 and 8.0.

The signature tune is a significant one for servicemen—"I'll Be Seeing You," and the messages will be read in the studio.

Uniaxial Microphone

FROM America comes the announcement of a new type of microphone, designed to be blast-proof. It is most sensitive to sounds arriving along the axis of the instrument—hence its name. It is claimed that it will withstand the blast from a .45 calibre pistol fired only five feet away.

3-D Radio

THE increasing interest in three-dimensional pictures, for cinema and television, is resulting in a parallel development for radio and cinema sound. This is known as "polyphonic," "stereophonic" as well as other names, and is merely the switching of a number of loudspeakers corresponding with the direction of sound in the picture. It is also stated that a new form of sound recording is being developed to give greater "depth" to sound broadcasts.

Hundred Up

THE popular "P.C. 49" series, with Brian Reece and Joy Shelton, has passed the "hundred programmes" mark and is still as successful as in the early days.

Produced by Vernon Harris, the first episode in the series, entitled "The Case of the Drunken Sailor," was broadcast on October 27, 1947, and it is a compliment to the producer that so many well-known actors and actresses take pride in playing supporting roles in the serial.

Amateur's Bravery

THE Edison Radio Amateur Award has been awarded to D. L. Mullican, of Searcy, Arkansas, U.S., for staying at his transmitter for five days without a break for rest.

A tornado had struck Searcy in March, 1952, causing destruction in the neighbouring towns of Judsonia and Bald Knob and Mr. Mullican took over relief communications during the crisis.

Obituary

IT is with deep regret that the death is reported of Mr. Sidney Gernsback in Chicago, Illinois, at the age of 77.

He was the former vice-president of Gernsback Publications Inc., and the elder brother of Hugo Gernsback, publisher of "Radio-Electronics." Born in Luxembourg in 1876, he studied at the College of Luxembourg and the Lycée de Nancy in France, obtaining distinctions in chemistry and electricity. He went to the States in 1912 and from 1933 was the Chicago representative of "Radio-Electronics." His books included "Wireless Course in Twenty Lessons," "The Electrical Experimenter" and "S. Gernsback's Radio Encyclopaedia."

He leaves two adopted children, George Gernsback and Mrs. Marguerite Flegenheimer, who live in New York City.

Digit Recogniser

AN automatic digit recogniser has been developed in America by Bell Laboratories which translates spoken numbers directly into selective switching operations.

The numbers must be pronounced clearly into the telephone before the correct circuit can be selected.

Midget Transmitter

USING only a small 22½-volt hearing-aid battery for power, Mr. G. M. Rose, of New Jersey, contacted three stations, one over twenty-five miles away, on a transistor-transmitter on the 146 Mc/s amateur band.

Mr. Rose, who manages the advanced development group at a transistor factory, says that the complete transmitter, including the quartz frequency-control crystal, occupies no more space than a packet of cigarettes.

New British Standard

BRITISH Standard B.S. 1927: 1953, which has been prepared under the authority of the Acoustics Industry Standards Committee, is intended to promote the interchangeability of circular cone diaphragm loudspeaker units of similar size.

It is considered neither practicable nor advisable to attempt to include all types of loudspeaker in this standard and is limited to the type produced in the greatest quantity and for which the feature of interchangeability has greatest importance.

On the left messages are transmitted on an automatic Creed transmitter at the Civil Aviation Communications Centre, Croydon, Surrey. The messages are received on a reperforator (right), also made by Creed, Ltd.

The Beginner's Guide to RADIO

The Third of a Series of Articles for Those New to Radio. This Month I Explain How to Add a Further L.F. Stage By F. J. Camm

LAST month I showed how to convert the One-Valver into a Two-Valver. This month I take the basic circuit a stage further, by adding another low-frequency stage so that the receiver will operate a loudspeaker.

The additional parts required are a valve, a valve-holder, a resistance, a fixed condenser and a *volume control*. They are illustrated in theoretical and actual form on this and the following page. Experienced experimenters will notice that I have not introduced grid bias, because the valves employed will operate quite satisfactorily at the high tension voltage specified without it. Next month I shall explain how to apply grid bias and the changes which are necessary.

I must, however, explain here the purpose of this bias. In low-frequency amplification, which we are employing here, it is essential that the grid of the valve shall be at a *potential*, of such a value that the applied signals will vary by an equal amount on the *anode curve*. When we come to deal with the characteristic curve of a valve we shall understand what this means; for the present it can be explained that all low-frequency valves normally require a *negative bias*. In battery sets, such as the present, the bias is generally applied by connecting a small battery between the grid return lead and the low tension lead. In some forms of mains-operated receivers, however, the bias is applied automatically by the insertion of resistances in the cathode lead.

Volume Control

Now regarding the volume control. A powerful local station will, of course, give a much stronger signal than a distant one and, therefore, it would overload the output stage of a receiver operating without grid bias. To give the operator a means of preventing this overloading a *volume control* is used. The volume control is a variable resistance incorporated in the resistance capacity coupled stage, which we dealt with last month. The loudspeaker will only handle a certain volume of sound, and if too strong a signal is fed into the valve connected to it overloading will take place, and there are two remedies for this. The first is to increase the handling capabilities of the valve by applying more high tension, and the second is to cut down the signal strength.

A number of receivers have the reaction control labelled "Volume Control," but this is not strictly correct. A volume control should be able to cut down the strength of any signal, but the reaction control can only build up the strength of received signals, and cannot cut down below the original strength received by the detector. There are several different forms of volume control.

In conjunction with the ordinary type of low-frequency transformer there are two possible arrangements. One is to employ a variable resistance *shunted* across the primary of the transformer, and its value should be chosen so that when "all in" it does not have too great an effect upon the quality of reproduction. Of course, when the transformer is a high-class component, the presence of an external resistance across either primary or secondary will materially affect the response curve and the reproduction will be affected. In some cases, particularly in the cheap transformer line, the reproduction may be improved owing to the flattening of the curve. The value of the resistance should be about 100,000 ohms—not more. The second method is to shunt the secondary with a component of the type shown in Fig. 15 (part 17).

The loudspeaker, which replaces the earphones hitherto used, works on precisely the same principle. It is, indeed, a glorified earphone. The type of loud-speaker selected will depend, of course, on the circuit.

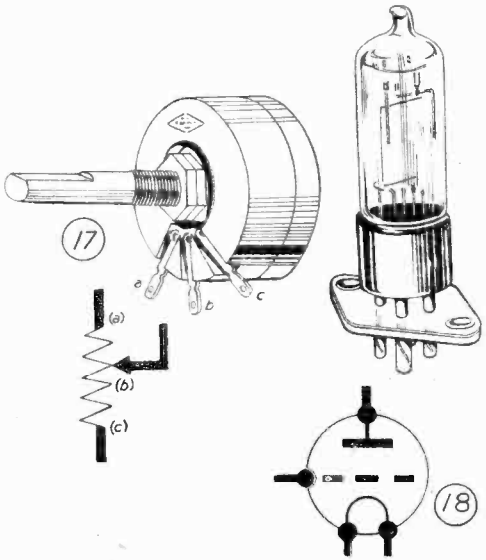


Fig. 15.—A volume control and the extra valve.

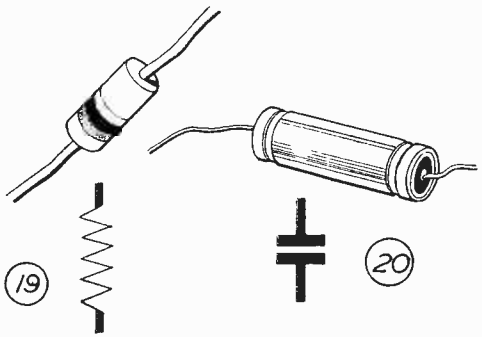


Fig. 16.—Two of the new components which form part of the R.C.C. coupling.

The early types of loudspeaker consisted of a strip of iron, fixed at one end, the free end being above and close to the pole of a small magnet. To the strip of iron, or armature as it is properly called, was fixed a thin rod on to which a cone diaphragm may be fixed. The windings of the magnet are connected in the output circuit of the last valve of the set. As the current changes, due to either speech or music passing through this magnet winding so the pull on the armature is varied, with the result that the vibrations are transferred to the cone, and so the sounds are made audible. It will be obvious that the armature will always tend to return to its normal position and this natural restoring force gives rise to its first fault, namely, resonance. Again, the current fluctuation due to a very low note, such, for instance, as the beat of a drum, are very great and should result in a large movement of the armature. As the armature is rather rigidly held, it must be arranged close to the pole piece in order that the weak impulses may affect it.

The *balanced armature* loudspeaker was introduced to avoid the principal fault of the first type of speaker, namely, resonance. The armature is less rigidly arranged in between two magnets. There is therefore an equal pull in each direction and this tends to make the armature move about a central position, avoiding the natural restoring force which was noticed in the simple type of movement. The gap between the magnets may be fairly large and so greater signal strength can be handled without risk of "chatter."

The inductor dynamic was the nearest approach obtained to the ideal in moving-iron speakers. In both of the previous movements it is obvious that as the iron armature is fixed at one end, there must necessarily be a certain amount of resistance to overcome in order to vibrate the armature and the tendency of the armature to return to its position of rest will always be present, no matter what electrical impulses are at work. This prevents the slow oscillation necessary to produce, say, a pedal note on the organ, and, in addition, the cone is not operated in a direct push-and-pull movement. The actual direction of the movement of the cone, to produce the true tones, should be what might be termed a "piston" movement; that is, it should move in a horizontal plane. Now, as one end of the armature in the speaker movements so far described is fixed, it is obvious that the operating reed is taken through a small arc during its to-and-fro movement. This gives rise to a form of distortion.

To overcome all these defects in a moving-iron loudspeaker the moving-coil was produced.

Moving-coil Speakers

The moving-coil speaker is, of course, the best type of speaker yet designed and provided one of the best makes is obtained, either permanent magnet or mains energised is capable of giving reproduction identical with the original. At the point of the cone diaphragm a light ring of paper is fixed, round which is wound a coil of wire known as the "speech coil or winding." In the mains energised speaker a metal cylinder, having a central rod (the "pot" and "pole-piece"), contains a large winding which has to be connected to some source of direct current. The actual voltage depends on the design of the speaker and varies from 4 volts to 150 volts. In the other models the winding is replaced by a powerful permanent magnet. The speech winding is supported in a small gap surrounding the pole piece and this gap should be as small as possible. Usually it is approximately $\frac{1}{8}$in. When the field is "excited," which means when the current is applied to it, a magnetic field is set up across the gap. The speech coil is connected to the output valve of the receiver and when the signal impulses flow through this speech winding it vibrates, travelling in and out of the gap. The edge of the cone is supported in some way, either by a ring of leather or rubber and, therefore, the cone makes a true "piston" movement, resulting in a faithful reproduction of the received sounds. The only faults with this type of speaker arise from faulty design and are: too heavy a speech coil and cone; resonance set up by the rubber or leather fixing ring; resonance due to the material of which the cone is made and one or two other little points.

To get the very best from a moving-coil speaker, a fairly strong signal is desirable, and as it can give such a good performance, the receiver should be

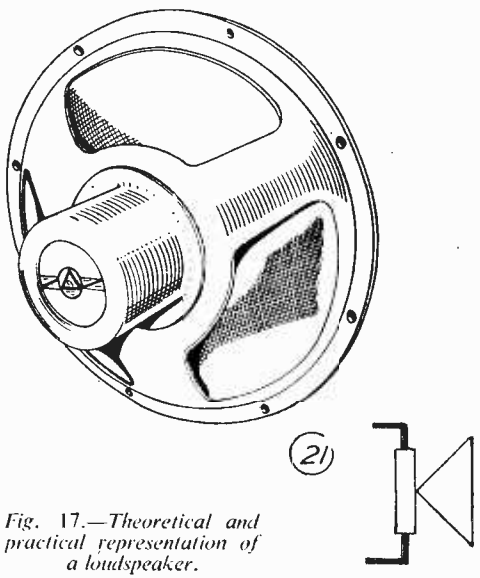


Fig. 17.—Theoretical and practical representation of a loudspeaker.

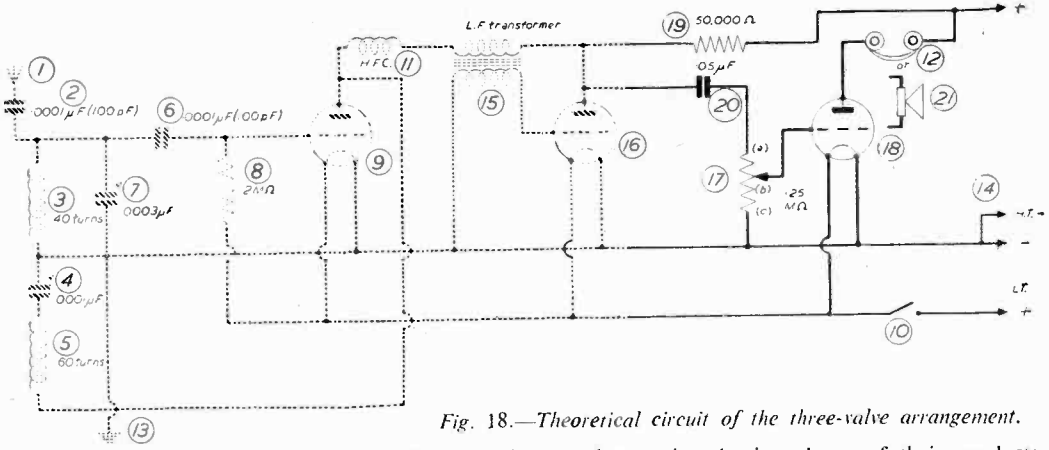


Fig. 18.—Theoretical circuit of the three-valve arrangement.

designed to give out a signal to justify the use of such a speaker. Particular care should be taken to look after the lower notes in the musical scale, as these can be dealt with so effectively by the moving-coil speaker.

Matching the Impedance.—No matter which type of speaker it is intended to use there is one point which applies to the *correct* employment of any speaker and that is, the impedance of the speaker must be matched to the output valve. This means that a certain valve will only give straight-line reproduction with a certain impedance in its anode circuit, and although valve manufacturers give this impedance figure in the leaflets accompanying their valves, unfortunately loudspeaker manufacturers do not always give the impedance of their products. Usually, only the D.C. resistance is given and this does not enable one correctly to match up the speaker. There are on the market, however, certain output matching transformers which have various ratios, and if the listener desires to get the best from the set, one of these transformers or matching units must be included in the output circuit, and by adjusting it to various values it is possible suitably to match up the speaker. One final word. As the speaker can only reproduce what is fed into it, the choice of circuit should receive as much, or even more, care than the choice of speaker.

(To be continued)

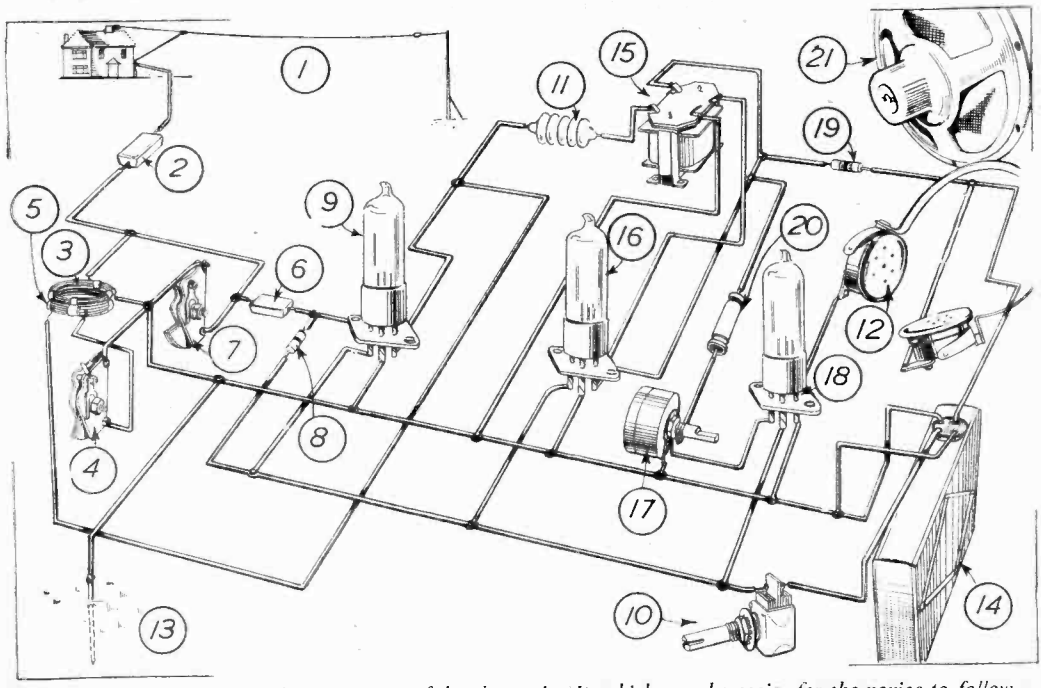


Fig. 19.—This is a pictorial arrangement of the above circuit, which may be easier for the novice to follow.

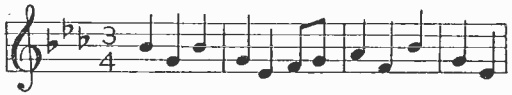
Musical Identification Signals

A SUMMARY OF SOME OF THE MORE POPULAR MUSICAL INTERVAL AND IDENTIFICATION SIGNALS USED BY FOREIGN TRANSMITTERS. A SPECIAL ARTICLE FOR THE LONG-DISTANCE LISTENER

MANY amateurs find their greatest interest is in the logging of long-distance stations, and the smaller and less unpretentious the receiver, and the farther away the station the greater the satisfaction. Unfortunately, for many, the language difficulty prevents satisfactory identification, but there is one form of signal which is fairly easily recognised and many foreign stations use these signals, in some cases at short intervals between items, and in other cases they are repeated for long intervals between separate transmissions. An interesting form of short-wave logging may consist of tuning the various musical items, but it should be noted that these may be heard on a number of different frequencies. Although many foreigners give details of the frequencies in use, these change according to the time and in some cases they are beamed in different directions, and thus may not be heard at a stipulated time owing to the signal being too weak on account of its directional properties. No guide can be given as to this, as listeners will reside in different parts of the world, and therefore the following data should be taken only as a guide.

Types of Signal

In some cases the musical item will be played on a piano, in others on an organ, by an orchestra or a solo instrument peculiar to the country. As a good instance most listeners will be familiar with the old English tune "Oranges and Lemons," and this is played by the BBC in four different ways. One may be heard on the Novachord and three on a Novachord-Celeste, these being of different duration. The tune is unmistakable and this is the pitch and timing :



Another familiar British signal which is familiar to listeners at home as well as in all parts of the world is that used during the war to identify this country and which consists of the first few notes of the Beethoven ———— thus :

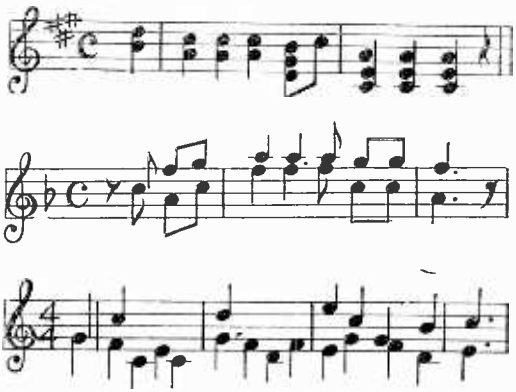
This is played on a pair of tympani.

Austria

Dealing now first with the principal European countries (in alphabetical order) the well-known "Blue Danube" of Strauss is unmistakable.

These four bars are repeated *ad lib*. It may be heard on a musical-box as well as in orchestral versions.

Other musical signals may also be heard from Austria and are as follows :

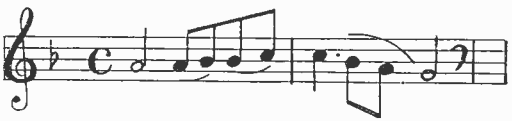


Again, these are generally played on a musical-box and are national or local folk tunes. As relays are made from different stations we do not propose to detail the individual stations but merely to give the country as in most cases this will suffice for identification purposes.

These are the principal musical signals heard from Austria, although one should not be surprised to hear "Rule, Britannia," which will identify a transmission by the British Forces Network in Austria.

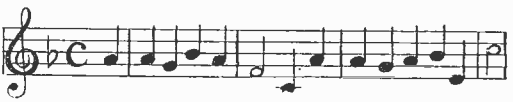
Belgium

In Belgium there are transmissions in French and Flemish, each being identified by its particular melody. The French network plays the following extract



which is from Gretry's famous melody "Ou peut-on être mieux."

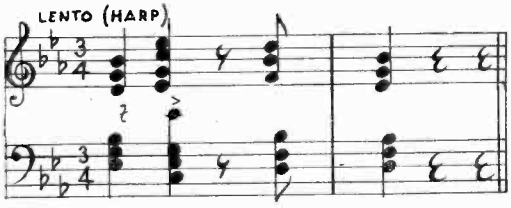
The Flemish network plays an extract from Rubens' cantata by Peter Benoit :



Czechoslovakia

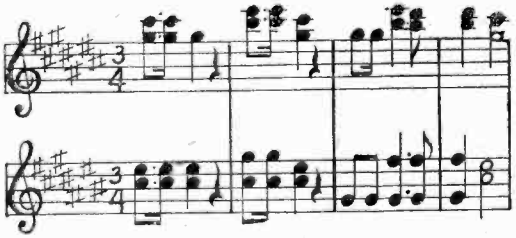
There are a number of tunes played from Czechoslovakian stations, the principal ones being those played on harp, trumpet and a carillon. They are

quite unmistakable. From Prague the harp may be heard playing a Smetana air thus :



Macedonian relays are made from Prague centre with the trumpet fanfare from the march " The New Life," by Josef Suk, as follows :

Relays from Brno use the carillon, which plays the beginning of a folk song " Moravo, Moravo," which sounds like this :



Again, frequencies or wavelengths are not given, but the signals may be heard on long and medium waves as well as on the short waves.

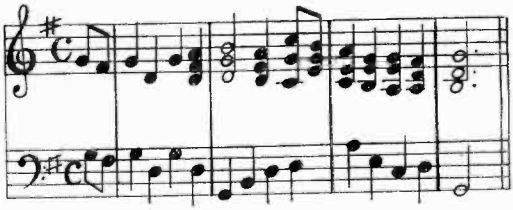
Denmark

There are two programmes (somewhat corresponding to our Home and Light) broadcast from Copenhagen and certain relay stations, on medium and short waves. In addition to the announcements which generally include the word " Danmark " which will readily be identified, the Programme I transmission uses as an interval signal part of an old Danish folk-song :

Chimes, recorded from the Town Hall, Copenhagen, are also interspersed as an interval signal.

Programme II relays the following short air :

An overseas service is radiated on the short waves and each of these transmissions commences with the chimes of the Town Hall already mentioned, followed by the National Anthem. For their interval signal these transmissions take the first movement from " Som en rejselysten Flaade," which sounds like this :



Again most announcements introduce the name of the country followed by other identifications but in Danish.

Finland

Broadcasts from Finland may be heard on long, medium and short waves, Lahti on 1,181 metres being quite a popular long-wave signal. Amongst other stations, Finland also broadcasts the orchestral A, usually at 8.45 a.m. From Lahti and Helsinki the usual interval signal, based on an old Finish melody, " Kantelemelody," sounds like this :

From Vaasa the first notes of " Vasa March " are heard :

whilst from Kuopio the first notes of a well-known song about the beauty of " Kallavesi " are played. The following is the air :

It will not be difficult to recognise Uleaborg which radiates the following melody in the form of Lapp yodelling :

It should be pointed out for those who have some knowledge of languages that confusion may exist on these stations (without the benefit of the musical identification) due to the use of Swedish in many of the announcements.

(To be continued.)

A Small Local-station Receiver

USING DEAF-AID VALVES THIS IS A MOST COMPACT RECEIVER FOR HEADPHONE RECEPTION ONLY

By N. J. Wadsworth, B.Sc.

THE receiver described below fills the need for a very small simply-operated receiver which will receive local stations at good earphone strength, using only a short flexible wire aerial. It may also be used as a high gain audio amplifier if desired. By using "deaf-aid" type valves it is possible to build a 3-valve, battery-operated receiver with continuous tuning covering both medium and long waves which, complete with batteries, measures only 4in. x 2.4in. x 0.9in. over knobs. Owing to the very low current consumption (500 μA. at 22.5 v. and 25 mA. at 1.4 v.) the running cost is less than 0.4d. per hour. The controls are On/Off, Tuning and Wavechange. It is found that a volume control is unnecessary as to reduce volume it is only necessary to detune slightly (selectivity being low enough not to give "side-band slash") or move the aerial. The tuning gives continuous coverage, this being preferred to the pre-set type in that the received stations are not fixed and when one changes one's district no adjustments are needed.

Circuit

The circuit is shown in Fig. 1. It will be seen that it consists of a 3-valve resistance-capacity coupled A.F. amplifier using deaf-aid type valves. No grid leak is provided for V3 as it is found that when connected as shown, the grid potential is that of the negative end of the filament, which is the recommended operating point, and that when a large signal is applied it moves negative so the positive peaks just reach this potential. If there were a grid leak the behaviour would be the same, and a larger grid current would be drawn, possibly resulting in increased distortion. Thus a component is saved with no loss of performance. The paralysis time after a large overload proves to be short enough not to matter due to inevitable leakages and grid current (a resistance of 1,000 MΩ to earth would give a time constant of 0.1 sec.). C8 is necessary to prevent the high-frequency oscillation which otherwise occurs due to the high gain, high impedance, and small size of the amplifier.

V1 is used as a leaky grid detector with R1, its grid leak, returned to the positive side of the filament. Only one tuned circuit is used in order to keep the size as small as possible and to simplify tuning arrangements. As the coils are, of necessity, mounted very close to the walls of the case, some damping is inevitable, but it is found that by using wave-wound Litz wire coils, together with careful construction, the Q, including the losses due to the aerial, is over 50 on both medium and long waves. This is sufficient to separate all but very close stations, and in practice proves satisfactory if only local stations with high field strength are wanted. Owing to the low working mutual conductance of V1 (about 30 μA/V) it was found impossible to obtain a significant amount of reaction, and so none was used with a consequent simplification of switching problems.

In the original model the now obsolete Hivac type XWO.75A was used for V1 and V2 and took a filament current of about 30 mA. at 0.625 v. each. These may be replaced by the more recent, and smaller, XFW30, which only consume 12.5 mA. at 0.625 v. and give approximately the same gain. The output valve is Hivac type XFY21, which has an anode current of 380 μA at 22.5 v. and a filament current of 12.5 mA. at 1.25 v. with a mutual conductance of 410 μA/V. The dimensions of these valves (excluding leads) are XFW30 8.0 mm. x 6.0 mm. x 27 mm., XFY21 9.8 mm. x 7.2 mm. x 38 mm. The anode current of the output valve is quite sufficient to produce adequate volume in a normal 2,000 Ω earphone, and, if desired, a number of earphones may be connected in series in the anode lead.

CONSTRUCTION

The Amplifier Panel

The audio amplifier V1-V3 with associated components is constructed on a $^1/_{32}$in. paxolin panel. The layout of components on the underside is as shown in Fig. 2. Along one edge are 14 12 BA nuts and bolts, as shown, which make the connections to the valves on the opposite side of the panel. Connections to the 'phones are made by two 8 BA nuts and bolts in the position shown. In order to keep the total size small, miniature components are used throughout. The 0.01 μF capacitors C3 and C6 and the 0.005 μF C8 are Hunts' metallised paper type W99, which measure only $^3/_{16}$in. in diameter by $^7/_{16}$in. long, and C4, 0.04 μF, is the same type, size $^1/_4$in. dia. by $^9/_{16}$in. long. They are 150 v. working. The intervalve coupling capacitors, C5 and C7, must

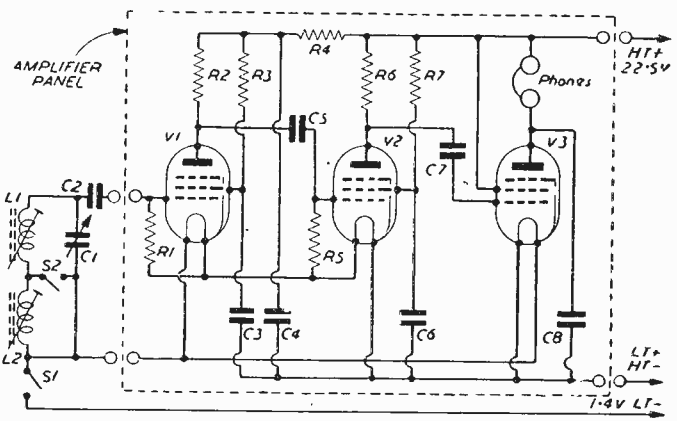


Fig. 1.—Theoretical circuit of the receiver. An aerial is joined to the junction of C1 and C2

have very high insulation resistance, which rules out some miniature types. The same Hunts' type may be used or other thinner and longer ceramic types. The resistors used are Erie type 5B, which measure 7/64in. in diameter by 9/32in. long and must be covered by a length of sleeving as they are uninsulated. If desired, one or two may be of the more easily obtainable "⅛ watt" type, Erie type 16, but owing to their larger size, 5/32in. dia. by 7/16in. long, the layout gets very crowded if many are used. Wiring should be kept as short as possible, and care taken to keep the input and output well separated.

The panel is removable and connections to it are made by means of wires brought out as shown. The details of this arrangement will be considered later.

The valves are mounted on the other side of the panel, as shown in Fig. 3. The wires are cut off at a suitable length and hooked round the appropriate bolt. Those going to the far row of bolts should have short lengths of sleeving slipped over them to prevent their touching the near row. It will be noted that the common filament leads of V1 and V2 are taken to the same bolt. When mounting the valves it is, of course, essential to get them the right way round and the red mark on the valve pinch, indicating the anode, should be used as a guide. To hold the top of each valve down a loop of cotton, or preferably thin elastic, is tied through small holes in the paxolin and slipped over the valve.

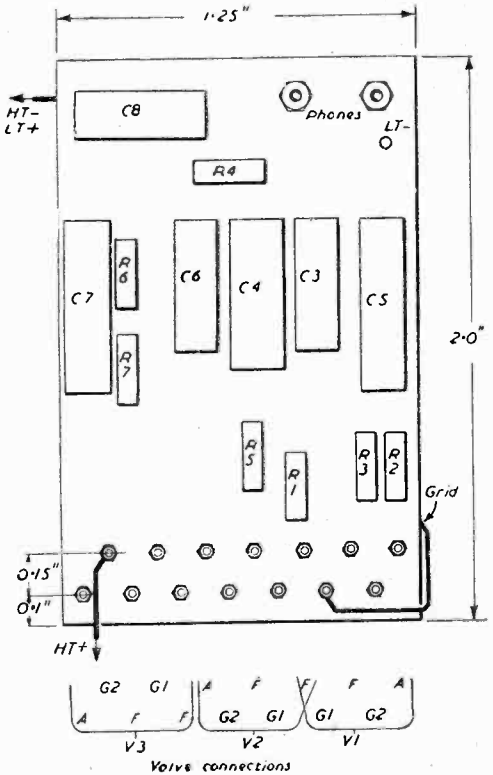


Fig. 2.—Underside of amplifier panel.

The Case

The layout of the case is shown in Fig. 3, its inside dimensions being 3.5in. x 2.1in. x 0.75in. It is made of thin wood, the bottom, the end opposite the controls and the lid being 1 mm. thick plywood, the control panel is made of $\frac{1}{16}$in. paxolin and the remaining two sides of slightly thicker ($\frac{1}{8}$in.) plywood. The bottom and ends are glued to the sides, and the lid is fixed on by two pieces of black plastic tape. This makes a firm box and the plastic tape acts as a hinge. When completed the box may be painted with black, glossy dope, or any other finish preferred applied.

COMPONENT VALUES

R1—1 M Ω.	C1—see text.	C8—0.005 μF.
R2—1 M Ω.	C2—100 pF.	L1—M.W. tuning coil.
R3—3 M Ω.	C3—0.01 μF.	L2—L.W. tuning coil.
R4—150 K Ω.	C4—0.04 μF.	S1—on/off } see
R5—5 M Ω.	C5—100 pF.	S2—wave change. } text
R6—1 M Ω.	C6—0.01 μF.	V1, V2, XFW30.
R7—3 M Ω.	C7—100 pF.	V3, XFY21

Inside at the right is the battery storage space. The batteries used are Ever Ready B122 for the 22.5 v. H.T. and either half a 3 v. pen torch battery or the Vidor Kalium V0107 for the L.T. The Kalium cell costs considerably more than the half pen torch battery but lasts much longer. On this load it is slightly more expensive in the long run but is more convenient as it does not need changing so often. The bottom of the box is raised here by 0.15in. by a piece of wood fixed to the bottom, so the batteries cannot rattle. Connections are made to the batteries by pieces of spring metal bent as shown and fixed to the walls by small nuts and bolts. These springs can be made from the remains of an old mica compression trimmer. A wire is taken from the L.T.— connection to the switch S1. The H.T.+ connecting spring is bent, on the other side of the bolt to the battery, into a small spring hook. The H.T.+ connection from the amplifier panel consists of a piece of bare wire projecting downwards which engages in this hook. The spring connecting H.T.— and L.T.+ is left loose on its fixing bolt and the long bare H.T.— L.T.+ connection from the amplifier panel placed behind it. When the batteries are inserted the spring keeps good contact between them and the wire.

The variable tuning capacitor C1 is a mica compression type and is constructed as follows. Two 250 pF compression mica capacitors, of a small type with a low minimum capacity and few plates, are taken to pieces and the ceramic base from one of them used as a template to drill fixing holes in the paxolin end in the position shown. Both ceramic bases are then broken to get the brass inserts that the controlling screw goes through. The central hole in the paxolin is then enlarged till the insert is a tight fit and the insert glued in position. The plates and mica from both trimmers are then reassembled in the one place on the paxolin, taking care to bend the plates slightly alternately one each way so they will spring apart when pressure is released. The place of rivets in the original trimmer is taken by small nuts and bolts. A small knob is now fitted to the centre screw of one of the trimmers, or a longer one

of similar thread, and this is screwed into its hole from the outside. When it is right through the plates a nut is put on its end, over a washer, and soldered on. If this is done securely it will be found that as the screw is screwed out the stack is compressed and its capacity increased. If any trouble is experienced due to movement of the plates or mica, a small paxolin strip may be glued to the paxolin panel on each side of the stack to prevent movement. In the writer's model the capacitor so formed had a capacity range of 70 pF to 350 pF, the low maximum capacity probably being due to kinking the metal plates while mounting them.

At the other end of the paxolin a hole is drilled and the remaining brass insert fixed in position. As with the other it should be pushed in from the outside, so the flange stops it slipping right through. A plate from another trimmer is then stuck flat on the inside of the paxolin with its hole clearing the screw to be put through. A second plate is then fastened at one end by a nut and bolt and bent to be parallel to but not touch the first. A screw with a knob on is then screwed through as before and a nut soldered on the end over a washer. When this screw is unscrewed the two plates are forced together and make contact. This is the on/off switch S1. If suitable knobs are not available they may be made from ebonite sheet.

The coils should now be mounted. Osmor "Q" coils are used as they are of small physical size, have adjustable iron-dust cores, and are wave-wound with Litz wire. L1 is type QA8 with the aerial coil, the smaller one at the top of the former, removed together with the tag ring. The mounting projections have to be cut short to fit the box and the continuation of the former below them removed. The remaining coil and former is then fixed to the wall as shown. This may be done by two 12 BA nuts and bolts passing through new holes drilled in the shortened mounting projections or by "Durofix" cement. If possible, a combination of both methods should be used. Previous to finally sticking it in position, a hole should be drilled in the wall permitting adjustment of the dust core when mounted. This allows the range covered by C1 to be varied slightly.

L2 is Osmor "Q" type QA9 with the aerial coil, tag ring, mounting projections and continuation removed as for L1. Owing to the larger coil size it is not possible to fix this with nuts and bolts, and "Durofix" alone must be relied on. It seems quite satisfactory. No hole is made for adjusting the core, as it never needs touching after the initial setting up, and then it can be got at by removing the core from L1 and passing the blade of a screwdriver through L1 to reach it. Before finally fixing L2 in position, a small hole is drilled in the former at the top end and yet another plate from a trimmer is fixed on with a small nut and bolt. If the head of the bolt is inside it will still be possible to get a small screwdriver past to adjust the core. The plate projects beyond the end of the coil and a tapped hole is made in the paxolin opposite the end, enabling a screw to be screwed through to press against this flexible plate. A small piece of spring metal soldered to the coil side of S1 presses against this screw to earth it. This is S2, the wave-change switch. When soldering wires on to the plate mounted on L2 it is necessary to do it very quickly to prevent the coil former melting. When wiring up the coils, care should be taken to ensure that the outside of the coil is made the earthy end to reduce dielectric loss.

A hole is drilled in the paxolin by L2 to admit the aerial, a few feet of thin flexible PVC covered wire, and a notch is made in the exposed edge to allow the earphone cord to pass out.

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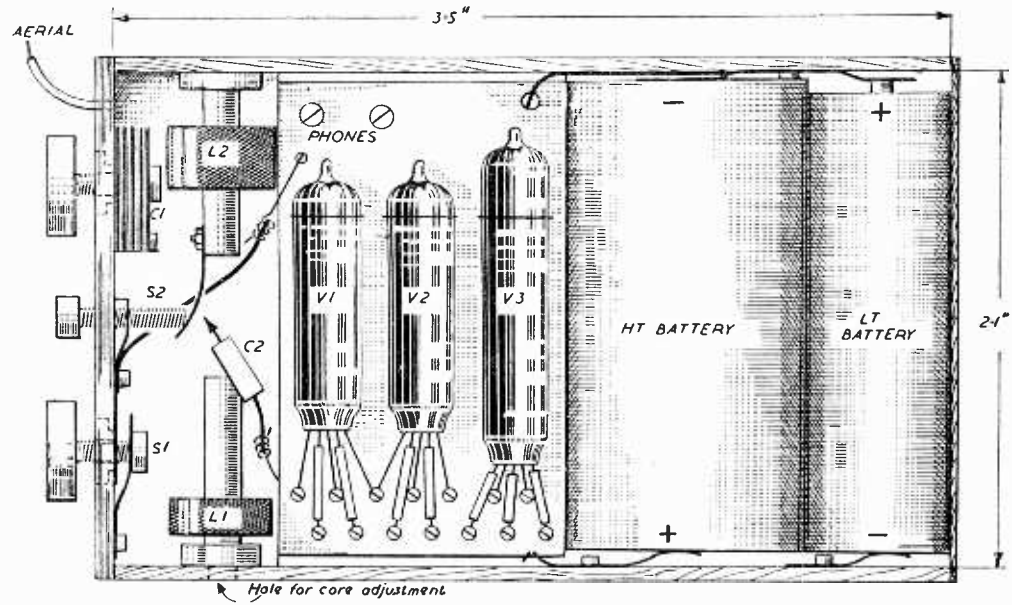


Fig. 3.—Pictorial illustration of the layout used in the original.

NOISE AND THE R.1155

IMPROVING THE PERFORMANCE OF THIS POPULAR EX-R.A.F. RECEIVER

By C. B. Cruickshank

THE main complaint against the ex-R.A.F. receiver R.1155 has been its high noise level. As most of the noise is generated within the valves, particularly the R.F. stage, the obvious thing to do is to install modern miniature tubes. For the average amateur this would be fraught with difficulties, mostly mechanical, though the cost of miniature valves will stop many reaching the stage of mechanical difficulties. There is also the problem of adjusting plate, screen and bias voltages, to say nothing of realignment.

It has been found that by substituting VR91's (EF50) for the R.F. stage and both I.F. stages, a considerable improvement in signal-to-noise ratio can be achieved without altering plate or bias arrangements. Alteration to the screen voltage is achieved by shorting out the 27KΩ resistor connected between H.T. line and pin four of the existing valveholder.

Unfortunately, EF50 valveholders (B9G) require larger holes in the chassis than international octal holders, and as the hole for the R.F. stage holder would have to be enlarged over the coil pack, with consequent possibility of cuttings shorting switching arrangements, the following method was adopted.

Changed Valves

Obtain three international octal valve bases—your local radio dealer will let you have three dud Int. Oct. based valves if you approach him properly—break the glass envelope and prise the bottom of the envelope away from the plastic base. Inside the base you will find a layer of brown-coloured cement (used for fixing the envelope to the base) which can be scraped out with a file. The wires from the envelope to the base are removed by applying a soldering iron to the pins and pulling the wire with pliers. After this operation it should be possible to see through each pin.

Set the prepared bases aside and solder short lengths of wire—say 3 in.—to pins 1, 2, 3, 7 and 9 of a ceramic B9G valve holder. Connect pins 4, 5, 6 and 8 together and take the wire to the centre tab on the holder so that there will still be about 3 in. of wire loose. Push the lead from pin 1 of the ceramic holder into pin 2 of the octal base and so on, as per the following table:

EF 50 Ceramic Holder		*Int. Oct. Base*
Pin 1	into	Pin 2
„ 2	„	„ 4
„ 3	„	„ 3
„ 4, 5 6 and 8	„	„ 8
„ 9	„	„ 7

The lead from pin 7 of the ceramic base should be taken through a hole drilled in the side of the octal valve-base. The best position for this hole can easily be seen after the various leads have been entered into the base.

Twenty-four gauge enamelled wire was used in the original conversion, and it should be emphasised that only the minimum amount of enamel should be removed for soldering purposes to avoid shorting valve electrodes.

By means of the wire ends pull the holder down on to the base. It will be found that the tags on the underside of the holder will fit inside the octal base. The next step is to scrape the enamel away from the wire where it protrudes from the valve base pins and solder the wire to the pins, clipping off excess wire. The adaptor is now ready, but should be checked with an ohm meter or torch bulb in series with a suitable battery, e.g., with one prod in pin 1 of the ceramic holder, continuity should be obtained only from pin 2 of the octal base, and so on.

EF50's are designed to operate with 250 volts on both screen and anode, so the screen resistors should be shorted as already described.

Operation

Insert an EF50 in the adaptor and put it in the R.F. stage first, solder the lead which sticks through the valve base to the lead which was formerly on the top cap of the replaced valve. Connect up to the power pack and be surprised at the vast improvement. Some indication of the improvement may be obtained when you consider that in the writer's set it was possible to hear a harmonic of TV sound around 17.3 Mc/s, which was just readable and no more with all controls wide open. After the conversion the harmonic was *partially closing the tuning indicator*.

Depending on the type of octal valve base obtained, it may be necessary to remove the screening can base from the chassis of the set to permit the valve to seat properly. In any case, the original screening can may be put in the junk box.

The conversion will result in a maximum increase of about 12 milliamps in H.T. consumption although heater current remains the same.

Ceramic holders have been specified because their tags are closely spaced and fit inside the valve base, whereas most Paxolin holders do not.

A SUPERHET FOR BEGINNERS

CONSTRUCTIONAL DETAILS OF A 6-VALVE A.C. RECEIVER USING MINIATURE VALVES

By R. Hindle

THE receiver here described has been specially designed for the beginner who has never made a receiver before or for the reader who has not previously constructed any but the simpler type of receiver. At the same time, the results are very good and the design can be well recommended to the more knowledgeable constructor who is looking for a good sound receiver following more or less conventional lines but making use of the latest components and valves.

Circuit

It will be seen from Fig. 1 that six valves in all are used if the rectifier (V6) is included. V3 is a double-diode detector and V4 is an audio amplifier, and the two functions are commonly combined in a double-diode-triode so the circuit boils down to the popular four-valve plus rectifier variety. Separate valves are preferred for the present design because a better layout is obtained and the beginner will find it much easier to wire and to set up the receiver satisfactorily. It is technically preferred also because the need to adapt the circuitry to allow for the common cathode for diodes and amplifier is avoided, and a pentode can be employed for audio amplification, properly biased and set up to give high gain with a minimum of distortion.

The design has been developed round the new miniature valves. The beginner will most probably have no stock of valves and he will prefer to begin his set-constructing career with the latest components. The more experienced man, too, will find it refreshing to contemplate the use of these types in place of the more common octals.

Undoubtedly, the greatest difficulty of the beginner is to align his receiver correctly after construction, and clearly the first step is to choose tuning components that will require the minimum of adjustment and no special test gear. The easiest way is to purchase the tuning coils in pack form, prealigned by the manufacturer. The final adjustments have then merely to allow for the slight variations in wiring and construction, and these variations can be minimised by careful design so that leads are short and direct and cannot vary greatly as between one constructor and another. A coilpack fulfilling these requirements is the well-known and efficient Osmor, used in popular designs previously published in these pages.

The standard coilpack used in this design gives three ranges, i.e., long, medium and short wavebands. This will suit most people, but the pack is made also with two short wavebands and without the long waves. This could be substituted if more suitable to the constructor's purpose. On medium and long wavelengths the aerial is coupled into the grid circuit of V1 by virtue of C1. The aerial current develops a signal voltage across the condenser which is also in the tuned grid circuit, and consequently the voltage across it is injected into the tuned circuit. This circuit has a high Q and consequently a well-amplified signal appears at the grid of V1. The primary of the short-wave aerial transformer, however, is too small to have much effect at these frequencies, even though it remains in the aerial circuit, but at the higher frequencies covered by the short-wave range the tables are turned; the reactance of C1 now becomes negligible and the short-wave primary takes control. This circuit avoids the need to introduce switching, with possible resulting loss, into the aerial circuit. A switch has to be used, of course, to select the appropriate tuned circuit for connection to the grid of V1.

The only difficulty with this "bottom end" coupling circuit is that the aerial lead tends to pick up hum interference, to which C1 presents a high impedance so that the hum potentials are passed to the grid of V1 and (via the AVC circuit) to later valves, where cross-modulation takes place and no subsequent measures can remove the hum. The R.F. choke across C1 completely eliminates this trouble, providing a comparatively low impedance to hum potentials, whilst having an impedance to R.F. signals sufficiently large not to upset the coupling arrangements. The self-capacity of the choke becomes part of the coupling capacity and so has no ill-effects. For this reason it is better to put the choke across C1 as shown, and not across from aerial to earth, because in the latter position the self-capacity of the choke is across the short-wave primary to the detriment of short-wave results. AVC is lead to V1 via the bottom ends of the aerial coils. Trimmers are shown across all coils, these being incorporated in the coilpack and consequently have not been given a "C" number. C1, C6, C7, C8 are also in the coilpack. VC1 is the grid-tuning condenser which is ganged to VC2, the oscillator tuning condenser.

V1 is a noval-based 12AH8 triode-hexode frequency changer. The usual 465 kc/s I.F. is used and so the triode section has to be made to oscillate at 465 kc/s above the signal frequency. The usual padders and trimmers are employed for the purpose of tracking (i.e., to ensure accurate ganging of the two tuning condensers), all these being in the pack. The padders (C7, C8) are also used for bottom-end coupling on medium and long waves, being common to both anode and grid circuits of the oscillator. On short waves a transformer is again used. The 100-ohm resistor R6 is introduced to stabilise the oscillator grid current at about the optimum value. This grid current serves to bias the oscillator by virtue of the voltage built up across the grid resistance, stabilised by the grid condenser C4.

V2 is a B7G based 6BA6 and is used as a normal I.F. amplifier, coupled by I.F. transformer to preceding and succeeding valves. AVC is fed via the secondary of the first transformer to the grid of the valve.

The signal rectifier is the right-hand half of V3, a B7G based double-diode type 6AL7, working into a series load, the volume-control VR1 being the load and R11, C13, C14 forming a filter to eliminate the intermediate frequencies that have now done their work and are no longer required. The AVC

COMPONENTS LIST

C2, 5, 9, 12, 15, 19.—.1 μF. 250 v. Dubilier type 410.
C3, 11, 13, 14.—100 pF. Hunts type B822.
C4.—50 pF. Dubilier type S635.
C10.—.05 μF. 250 v. Dubilier type 410.
C16, 18.—8-8 μF. B.E.C. miniature elec.
C17, 22.—25 μF 25 v. elec. Dubilier type BR252A.
C20, 21.—16-8 μF. Dubilier type CT16850. elec.
R1.—100 KΩ. ½ watt.
R2, 3, 7.—33 KΩ. ½ watt.
R4.—220 Ω. ½ watt.
R5, 11.—47 KΩ. ½ watt.
R6, 9.— 100 Ω. ½ watt.
R8, 10, 12.—1 MΩ. ½watt.
R13.—500 KΩ. ½ watt.
R14.—22 KΩ. ½watt.
R15, 18.—220 KΩ. ½ watt.
R16.—2.2 KΩ. ½ watt.
R17.—4.7 KΩ. ½ watt.
R19.—220 Ω. 1 watt.
VR1.—½ MΩ. Volume control with two-pole switch.
I.F.T. 1, 2.—2 I.F. Transformers. Wearite type M800.
One H.F. Choke. Osmor All Wave.
Ch.—1 L.F. Choke. Osmor Smoothing Choke.
One Output Transformer. Osmor single ratio for 6AQ5 to 3 ohms.
One mains Transformer. 250-0-250 and 6.3 v. Osmor.
One two-gang Condenser. 500 pF. Osmor.
One Coilpack. Osmor type HO.
One Dial. Osmor metal type LMS.
One Drum, cord, drive, spring. Osmor.
Two Valveholders. Noval (B9A).
Four Valveholders. B7G.
One Coaxial Plug and Socket. Belling.
One P.M. Speaker, without transformer. 8in.
V1.—12AH8. Brimar valve.
V2.—6BA6. Brimar valve.
V3.—6A1.5. Brimar valve.
V4.—6BR7. Brimar valve.
V5.—6AQ5. Brimar valve.
V6.—6X4. Brimar valve.
One Chassis. Aluminium 10in. x 8in. x 3in. deep.
Three Knobs. 1½in. diameter.
24 S.W.G. tinned copper wire.
Sleeving. Coaxial cable and screened cable. 6BA nuts, bolts, washers. One soldering tag, with one insulated tag and earth. PVC transparent twin flex.

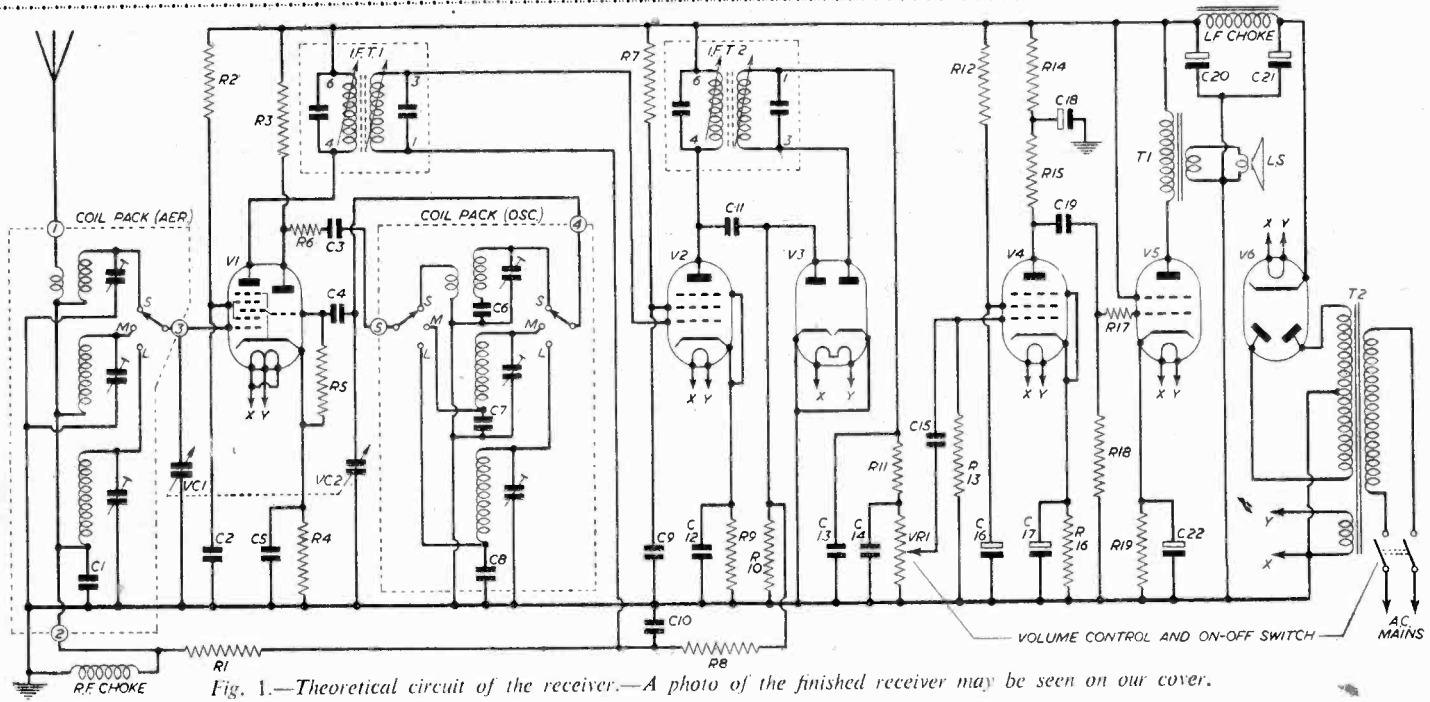


Fig. 1.—Theoretical circuit of the receiver.—A photo of the finished receiver may be seen on our cover.

diode is fed direct from the anode of V2 to reduce the tuning hiss and uses the usual parallel load, R10, R8 and C10 being the AVC filter and time-constant determining network.

The audio signal passes to V4, a pentode amplifying valve type 6BR7, which has a noval base. The anode of this valve is decoupled by R14 and C18, R15 being the load and R16, C17 providing cathode bias. The output valve, V5, has a B7G base and is a type 6AQ5, resistance-capacity coupled and with a grid stopper (R17) in its grid circuit to prevent parasitic oscillation. The output transformer is selected to match the speaker speech coil to 5,000 ohms.

A miniature rectifier valve, V6, is also used, being a 6X6 with B7G base. This valve requires 6.3 volts for its heater but can stand 450 volts between heater and cathode so consequently a separate heater winding is not required. The transformer used has a 5-volt heater winding, but this will not suit the 6X6 and consequently is left unconnected.

Construction

The receiver is built on an aluminium chassis 10in. x 8in. x 3in. deep and as most constructors will buy this ready made Fig. 2 shows the drilling plan as on the top of the chassis. The handiman producing his own chassis may prefer to drill it " in the flat " and he must remember that if he marks out according to Fig. 2 he will have to fold it so that the marks are outward. There is also the element of doubt that the components actually to be used may not conform exactly to the sizes of those used in the prototype and it is as well to make sure of this before drilling the metal. The best way for the beginner or less experienced person and, in fact, a method used often by the more experienced, is to draw out the drilling plan in full-scale on a piece of stout drawing paper rather larger than the size of the chassis so that there is a margin all round the drawing. The components are then tried for size on this drawing. When satisfied that all is in order the margins are bent down so that the paper sits snugly on the top of the chassis with the margins down the sides of the chassis, holding the paper firmly in contact with the upper surface of the chassis without a tendency to slip. The paper is then used as a template, the position of the holes being punched through with a sharply-pointed centre-punch. The round holes for valveholders and electrolytic condensers are best cut with a punch such as the Q-Max or Osmor, but if these are not available good results can be achieved, with care and patience, using a smaller drill and filing out with a round file or, for the larger holes, by drilling a series of small holes inside the circumference, again finishing off with a file. If these more laborious methods are to be used remember to scribe the hole to be cut out before commencing to drill so that an accurate guide is available whilst filing. Note that two sizes of valveholder are used, the B7G base, requiring $\frac{5}{8}$in. holes and the noval base requiring $\frac{3}{4}$in. holes. The hole for the main smoothing electrolytic condenser alongside the rectifier valve is made $1\frac{1}{8}$in. because this is the standard octal size of hole and a punch may be available. The other electrolytic situated between V4 and V5 is one of the miniature type having a diameter of $\frac{7}{8}$in. and the hole for this is made $\frac{3}{4}$in. the same as the noval bases. A somewhat larger component can be accommodated if the miniature cannot be obtained. The square hole for the mains transformer can be made by means of a series of small holes inside the outline, the centre being then knocked out and the hole finished with a file, or alternatively a single hole can be drilled and the hole cut by means of an Abrafile. Three of the $\frac{3}{8}$ in. holes are fitted with rubber grommets and are to allow leads to pass from above to below.

The positions of the holding down bolts for the valveholders are indicated to show the direction in which the valveholders are mounted, but it is suggested that these should not be drilled until the valveholder large holes are punched or filed out. Then the valveholders can be dropped into place, rotated until the pins are in the correct relative positions and the place for the holding down bolts can then be punched directly through the valveholder holes. The lesser experienced will find this much easier than trying to mark out all holes at the beginning. A similar procedure should be adopted for the electrolytic condenser clips, which are not marked on Fig. 2 because clips vary and the exact position of the holes is not important. In the case of these clips the method is as follows. Put the clip on the condenser so that the bottom of the feet are just flush with the bottom

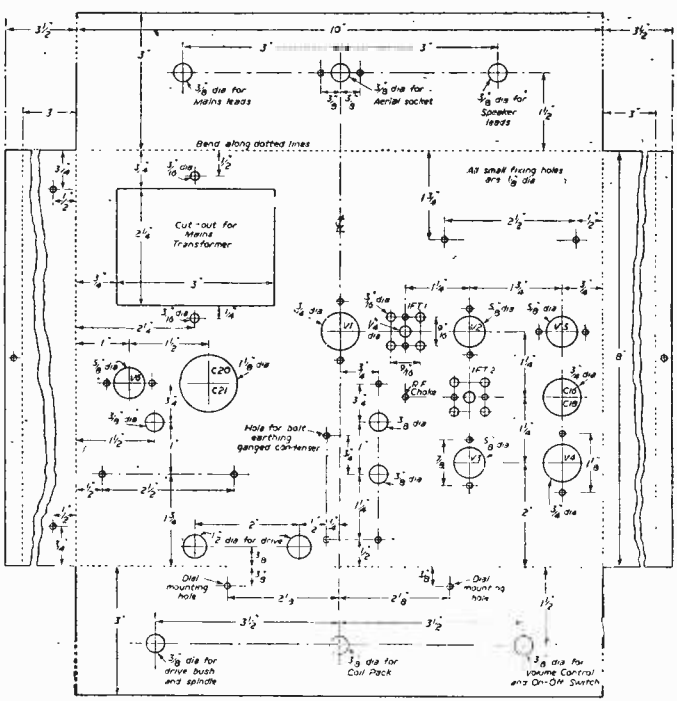


Fig. 2.—Chassis cutting, bending and drilling details.

surface of the condenser and screw up the bolt until the condenser is firmly gripped but not so tightly as to distort the aluminium can. Now sit the component over the hole punched in the chassis so that the tags are central and mark the position of the bolts with the centre-punch. As the holes for each component are completed try on the component to check the accuracy of the work and then put the component aside until all metal work is completed.

The I.F. transformers require very careful work, the holes requiring accurate placing to avoid a short-circuit of the pins to the chassis. If they are found to be slightly out when trying the component the fault can be corrected by the judicious use of a thin rat-tail file and when eventually the transformers are mounted the pins should be carefully examined to ensure that they are clear of the chassis.

The tuning condenser position is similarly critical because the spindle has to extend through the dial to carry the pointer but if it sticks out too far it will will look bad and will not be easy to read. It is a good idea, having drilled the holes in the position indicated, to elongate them with the small rat-tail file in a direction towards and away from the dial so that they become slots about ¼in. long. When mounting the condenser it can then be moved along the slots until the projection is correct. The positions indicated in the illustration are for a condenser with a 1in. spindle. All the holes for holding down bolts are ⅛in. except those for the mains transformer which are 3/16in.

Fig. 2 gives the drilling at the front and the back of the chassis. At the front are only three large holes for the controls and two small ones for the metal dial. The small holes can be slotted vertically by means of the file, as suggested in the case of the variable condenser holding down bolts, so that the dial can be moved slightly to position the spindle centrally in the dial hole.

At the back, the central hole is for the coaxial socket which is used to feed aerial and earth into the receiver. Grommets are fitted into the other two holes, the left-hand one being for the mains lead and the right-hand one for the lead from the output transformer to the speaker, which, of course, must not have a transformer itself. If a speaker with transformer is to be used and it is desired not to remove the transformer the one in the receiver can be omitted and leads from the anode of V5 and H.T. positive brought out to the speaker, but if new parts are to be bought it is better to go in for a transformer as specified and a speaker without transformer.

Mounting the Components

When all drilling is complete the grommets can be fitted in the three holes on top of the chassis and the two at the back as indicated, and then components can be mounted. Start with the valveholders, taking care that they are mounted the right way round, with the pins disposed as indicated in the wiring diagram. This is essential if the short leads aimed at are to be obtained. The valveholders are dropped into their holes from the top. Put soldering tags under the holding down bolts as indicated on the wiring diagram and in these cases the aluminium under the soldering tag should be polished clean with fine emery cloth. It is impossible to take too much care in ensuring clean contacts wherever earthing contacts with the chassis are used and failure to do so is a common cause of such faults as instability, which are very hard to trace.

Next, mount the electrolytics and I.F. transformers, making sure that connecting tags are clear of the chassis when the component is screwed on. The smoothing choke and the output transformer follow, the latter being underneath the chassis, and then the mains transformer. The variable condenser has been left until others are mounted because it is a delicate part that must be handled with care, but it should now be fitted. Before doing so, however, solder a 4in. length of connecting wire to each of the fixed vane tags underneath the condenser and bolt a soldering tag (again ensuring a clean contacting surface) to the hole indicated as ganged condenser earth so that the tag is above chassis. A piece of sleeving 2½in. long will be required on the wire nearest to the front of the chassis and a 2in. piece on the wire to the rear section. The grommets supplied with the tuning condenser (if it is the type specified, of course, otherwise the feet may not be made to take grommets, in which case it might be found necessary to put washers underneath the feet to bring up the condenser spindle to the level of the dial hole) are fitted into the holes in the feet and the condenser can then be bolted down, interposing a washer between the bolt head and the grommet to prevent the head of the bolt from being pulled through the grommet. The connecting wires are passed through the two holes in the chassis previously fitted with grommets. The bolts are screwed until they are firm but not hard down, so that the condenser can float slightly in the rubber. Locking nuts should then be run on to the bolt. The drive drum should then be put on to the spindle with the hollow side to the front and the dial tried in place to see if it will fit properly but then put the dial aside until later.

Next, mount the drive spindle and volume control on the front and the coaxial socket at the back of the chassis. Now comes the task of threading the drive cord. The old hand will have his own way of doing this but for the sake of the beginner the following method has been found easy. With the vanes fully meshed lock the drum to the spindle with the hole in its circumference at the "9 o'clock" position (looking from the front). Now take a length of cord (say about 2ft.; it is as well to have a reasonable length to work with) and pass the two ends one up each of the cord holes from underneath the chassis. Pass the loop so formed over the drive spindle and into the slot in the driving head, drawing the two ends tight and holding them firmly so that the cord does not come out of the drive slot. Now bring the ends up round the drum, past the hole in the circumference and once round again, back to the hole, through which both ends are inserted. It is a little tricky to do all this whilst holding the cord firmly in the drive slot, but with a little patience it will be done. The two ends are tied firmly on to the loop of the spring so that the loop is held up to the circumference of the dial. The spring is now extended and the loop at the other end hooked on to the projecting finger across the drum. Now slacken the grub screws to free the drum from the spindle and turn the drive spindle back and forth, seeing that the movement is free. The spring will gradually take up the slack in the cord and a tight drive will be secured. Now return the hole in the drum to the "9 o'clock" position and open the condenser vanes about halfway, locking the drum to the spindle in this position.

(To be continued)

On your Wavelength

by THERMION

"Readers from No. 1"

I HAVE received a very large number of letters from readers who have taken this journal continuously from its first issue, in response to my request last month. They are all in nostalgic strain. A typical letter is that sent by Mr. J. F. Hitchcock :

"I am prompted by your invitation in this month's PRACTICAL WIRELESS to claim continuous purchase since No. 1 in 1932. I was then aged 11, and have not missed an issue yet. Unfortunately, all my pre-1940 copies (approximately 400 of them, as PRACTICAL WIRELESS was then a weekly issue) were destroyed—but I have my vivid memories of the various sets I used to build. My two most successful ones were the A.C. 'Fury Four' and the 'Vitesse' superhet, both of which gave sterling service over many years. In pre-war days my bedroom was an untidy kind of workshop-cum-sleeping accommodation—copies of PRACTICAL WIRELESS, accumulators, radio components, masses of wires from ceiling to floor, plus acid-burned sheets and blankets led to many threats from irate parents to 'throw the whole lot out of the window.'

"My most successful short-wave set was the 'Experimenter's S.W.2'—which gave me some amazing results—I well remember setting my alarm clock for 2 a.m. and getting up and searching round the short-wave bands for stations I could not receive during the evening. No wonder I was feeling tired each day at school ; but in those days I just lived for wireless and all my pocket money was spent on my hobby. I remember the most useful gift I ever had was an eliminator—which supplied H.T. 150v. at 30 mA. plus L.T. and G.B. supplies—which eased the heavy financial drain of batteries and accumulators.

"My congratulations to PRACTICAL WIRELESS on its 21 years—here's looking forward to the next 21."

Many readers expressed their gratitude to this journal for their knowledge of radio garnered from its pages and which has enabled them in many cases to obtain important posts in the industry and the services.

Art Attack !

AS a result of my passing comment on art, in which I expressed a preference for radio classes in schools, it is only fair that I should permit one reader to answer for many who have written in similar strain.

What I really intended to convey was that it is more useful to-day, conditions being as they are, to train scholars in the practical crafts, or rather to lay emphasis on that training rather than to concentrate on the academic and the aesthetic. I did not mean to imply that I disliked art. It cannot be denied that art as a profession has few openings except for those trained in commercial art and it is, therefore, futile to train people for jobs which do not exist. Art, like music, should be a hobby or a sideline. Each can only provide jobs for the lucky few, and I think my critics will agree that even those jobs do not always go to those having the greatest skill or merit—particularly in music. However, here is a letter from Mr. P. W. Feesey, of Raynes Park :

"I, too, in common with Mr. T. W. Adams, feel that you made an unwarranted remark regarding the school art class (PRACTICAL WIRELESS, May and June). The remark is unfortunate in that some schoolmasters have helped to foster radio activities in their school. I well remember how, at my old school, we combined electrical, radio, art and handycraft activities in one of the art rooms to produce a most effective marionette theatre.

"It may be of interest to you to know that not all individuals in Chelsea to which you refer are training to be artists. Some attend an engineering college where, I can assure him, life is far from lazy.

"The world to-day may demand only commercial artists (for advertising and other utilitarian purposes) but as to what it 'requires,' that, to my mind, is one of the greatest failings of the human race to-day, in that it cannot appreciate what it really does require. This is reflected in the fact that many of the evolutions of engineering and science are misused, and also in the artless, hideous trends in design which are increasing every year.

"We technicians and scientists would be making a grave mistake by dogmatically insisting that the cold, proven facts of science are all that is needed in the world to-day ; there is equally as great a need for the more aesthetic arts (of a genuine type) and that need is becoming, at present, ever more urgent."

The Effect of TV

THE newspapers continue to draw attention to the effect TV is having on national habits and family life. It is said that children are neglecting their homework, that attendances at cinemas and theatres are falling off, that the pubs are now half empty and that people are tending more to stay at home. Very true. It is equally true that less time is devoted to listening. That is inevitable. It is a good thing that national habits should change as science reveals the secrets from its Pandora's box. The same was said in 1932 when broadcasting commenced. The gramophone industry and the newspapers feared the competition of the new form of entertainment. After 30 years, however, we now know that those fears were groundless. For a few years people did spend their evenings at home listening to Murgatroyd and Winterbottom and other radio characters. As the novelty wore off, however, so did trade return to the cinema, etc. It was but a passing phase and so it will prove to be with television. People become more choosey and selective. They make dates with their radio or TV sets rather than as in the early pride of possession just sitting, listening or viewing and taking the programmes as they come.

A.C. VALVE Signal Generator

AN ALL-WAVE MODULATED INSTRUMENT FOR THE EXPERIMENTER

By F. G. Rayer

THE utility of a signal-generator is well known. It may be used for wavelength and frequency checking, and as an aid when aligning R.F., oscillator, or intermediate-frequency circuits. It will provide a signal of uniform strength so that the sensitivity of circuits can be compared, and can be used to locate the source of some kinds of receiver faults, especially in showing which stage is not operating.

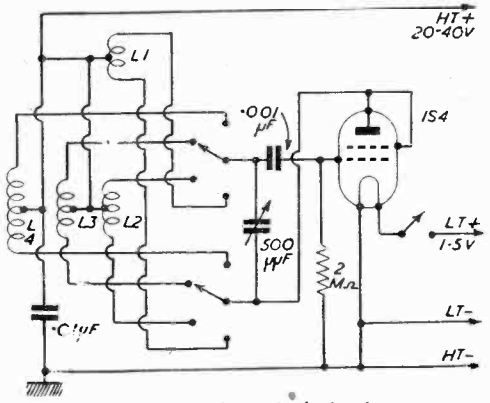


Fig. 1.—Theoretical circuit.

The signal-generator described here has four wavebands, tuning from 20 to 2,000 metres. (With lower wavelengths, harmonics may be used, as will be explained.) Since an unmodulated R.F. signal is not audible with superhet receivers of ordinary type the circuit is so arranged that it goes in and out of oscillation at audio frequency. This is accomplished by the form of coupling employed, and the value of grid condenser and leak. It makes a second, audio-frequency oscillator valve unnecessary. The audio tone is in the neighbourhood of 500 cycles, according to the H.T. voltage.

The circuit is shown in Fig. 1, four bands being provided by means of a two-pole four-way Yaxley type switch. The coils cover approximately the following wavebands: L1, 20-70 metres; L2, 60-200 metres; L3, 180-650 metres; L4, 650-2,000 metres. The high waveband coverage arises from the circuit used and relatively large capacity of the tuning condenser, where the higher frequencies are concerned

For convenience, the generator uses dry batteries. A dry cell is used for filament current, and 20 to 40 v., obtained as convenient, for H.T. purposes. Due to the grid-blocking effect which arises, the anode current is well under 1 mA., and a small, "deaf aid" type H.T. battery can be used and would have a long life.

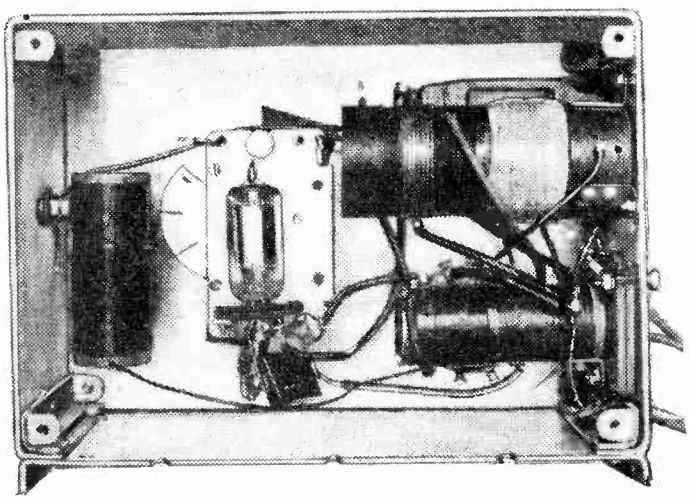
The whole generator is contained in a metal cabinet to reduce stray radiation. A reduction dial marked in degrees was used, but it would be possible to mark frequencies or wavelengths directly upon a suitable scale. In general, the dial with degree markings is easier to calibrate, since a graph may be drawn up to plot readings.

The Coils

These are wound as shown in Fig. 2, a common former being used for L1 and L4. All the required winding details will be found in this diagram.

Two of the formers are fitted with brackets so that they may be mounted against one end of the case. The remaining former is mounted by means of a long bolt and spacing piece. Paxolin or ebonite tubing is equally suitable. If it is desired to use formers of other diameters, which may be to hand, a little experiment may be required to obtain a suitable wavelength coverage. The wavelength to which a coil tunes may be increased by increasing the number of turns, and vice versa. Small formers will require more turns than larger formers.

Each winding is centre tapped, the tappings of L2, L3 and L4 being made by taking loops of wire through a suitably-placed hole. L1 is tapped by



A view of the wiring. Compare with Fig. 3.

soldering a lead to the middle of its centre turn. A slight error made in counting the turns will not materially affect results, but the tappings should be at roughly the middle turn, in each case. The windings may be held secure with cellulose tape.

Constructional Details

The containing case is 7½in. by 5½in. by 3in., the back being attached by screws passing into tapped brackets when construction is complete. The moving plates (or frame) of the tuning condenser must not be in contact with the panel. To achieve this, insulated material and bushes were used, when fixing. If an all-metal dial were used, precautions would have to be taken so that a short-circuit between condenser spindle and panel was not caused. Quite satisfactory results can be obtained by using a large control knob and dial,with no reduction drive.

The small, B7G type valveholder is mounted directly at the back of the condenser by means of small brackets. In Fig. 3 this holder is shown turned through 90 degrees so that wiring is clear. A 1S4 or equivalent valve is used. This is an output type, but the 1T4 or 1S5 types would not maintain oscillation on the higher frequencies unless the H.T. voltage were increased.

L2 is mounted directly on top of the .01 μF fixed condenser (which must not be omitted), all the centre-taps being taken to the H.T. positive tag of this component. A small push-pull on/off switch was fitted immediately below L4, for filament switching.

The " Output " terminal is insulated from the case. The very small coupling capacity required is obtained by taking one turn of connecting wire round the insulated sleeving of the lead going from tuning condenser to switch, as illustrated in Fig. 3.

With a valve inserted and batteries connected, the oscillator can be placed near a receiver to assure that it is operating. When receiver and oscillator are tuned to the same wavelength, the note of the oscillator should be heard. If the receiver is of low sensitivity, a short length of wire may be attached to the " Output " terminal, and the oscillator brought near to the aerial lead-in of the receiver. The audio note should be heard upon each waveband. If it is not, wiring and coil-windings of the affected bands should be checked.

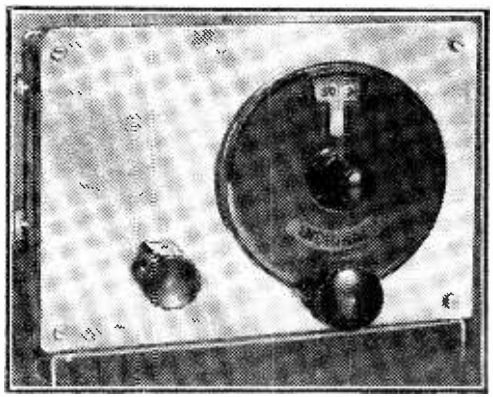
Calibration

A high degree of accuracy can be achieved and maintained, provided no subsequent changes are made to internal wiring. One of several methods may be employed.

If an all-wave receiver with dial marked in wavelengths or frequencies is to hand, this can be used. It should be tuned to various wavelengths, and the signal-generator tuned until the audio note is heard. The wavelength may then be marked down. With this method, the accuracy obtained will be that of the receiver calibrations.

A similar method is to use the receiver, but to tune it accurately to stations of known wavelength. The signal-generator is then tuned carefully to the same wavelength.

Harmonics may be used to obtain further calibration points, or to calibrate the signal-generator over wavelengths not tuned by the receiver. When the generator is tuned to a harmonic of the frequency to which the receiver is tuned, the audio note will again be heard, though at reduced volume. For example, if the receiver is tuned to 215 metres, the note of the signal-generator will also be heard when the latter is tuned to 430 metres. If necessary, the generator may then be left tuned to this wavelength, and the receiver tuned until the fundamental is heard (e.g., to 430 metres). The receiver tuning may then be left, and the generator tuned to 860 metres. In this way, a considerable number of calibration readings can be obtained.



The panel layout of the instrument.

That the generator is actually tuned to the fundamental, and not to a harmonic, may easily be established if necessary. To do this, the generator should be tuned slowly over lower wavelengths. If the note is not heard again, the fundamental was originally that tuned to. In short, the audio note will be heard when the generator is tuned to *multiples* of the receiver wavelength, but not when it is tuned to *fractions* of that wavelength. (E.g., if the receiver is tuned to 300 metres, the fundamental will be heard when the generator is tuned to 300 metres. When the generator is tuned to 600 metres, the harmonic will be heard. If the generator is tuned to 150 metres, however, no signal will be heard.)

If a calibrated signal-generator can be used, it is only necessary to set this to various wavelengths, tune in the signal on a receiver, and then tune the home-constructed generator to the same wavelength.

In all cases tuning should be

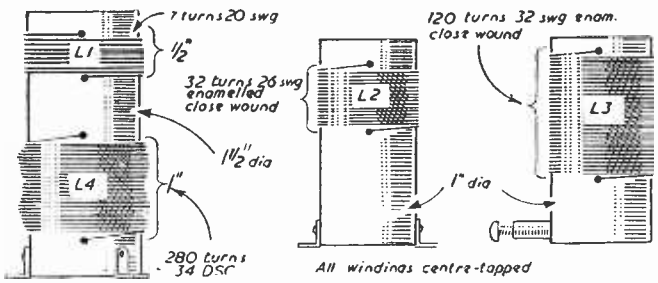


Fig. 2.—Winding details of the coils.

carried out as accurately as possible. Volume should be kept down, if necessary, by slightly removing the signal-generator from the receiver or aerial lead-in. If local stations are used for calibration, a very short piece of wire should be used for the receiver aerial. With a T.R.F. receiver with reaction, exceedingly accurate calibration can be achieved, since an error of even a few cycles per second will become audible as a beat note, if reaction is advanced to the oscillation point.

The tuning points may be marked upon a scale, or plotted on a graph. No attempt should be made to use the extreme ends of the scale, since these are not likely to be accurate. This is especially so when the tuning condenser is almost at its extreme minimum, where a movement of some degrees may make little or no difference in capacity.

Notes on Using

To align the I.F. stages of a superhet, the generator is tuned to the intermediate frequency. This is usually 465 kc/s (645.16 metres). A short lead with prod is connected to the "Output" terminal and applied to the frequency-changer anode. The I.F. transformers may then be tuned for maximum signal. The generator may then be tuned to a suitable radio frequency within the normal tuning range of the receiver, and the signal injected at the aerial socket. Trimming of the signal and oscillator circuits can then take place, with padding or core-adjustment at a high wavelength on the same band, in the usual way. The F.C. valve anode circuit should also receive any slight readjustment necessary to remove any error previously arising through the capacity of the test lead and prod.

In the case of a fault being suspected in the R.F., F.C., or I.F. stages of a superhet, the signal may be injected at various points, working backwards from the D.D.T. stage. The point at which the fault arises will then become apparent.

The back should be fitted in place before the signal-generator is calibrated. The dial should be securely fitted so that the accuracy of calibrations can be preserved.

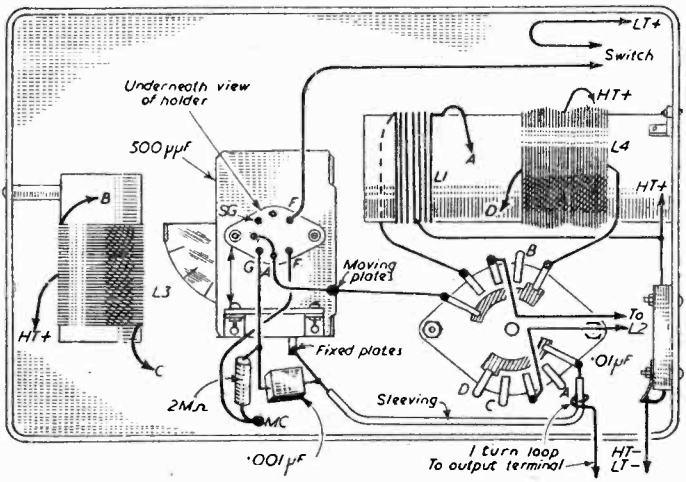


Fig. 3.—Wiring details and component layout.

A SMALL LOCAL STATION RECEIVER

(*Continued from page* 383)

The L.T.— connection of the amplifier panel is brought out in the position shown in Fig. 2 and ends in a tightly wound cylindrical spiral with an inside diameter just large enough to take a wire. A stiff wire is taken from the junction of S1 and S2 to a position near to L2, where it can be slipped inside the spiral when the amplifier is in position. The grid connection is brought out in the same way and C2, a small 100 pF capacitor, is connected to the aerial side of C1. The wire from the other end is cut off by L1 in a convenient position for pushing into the grid spiral. All these wires should be tinned to ensure good contact.

Owing to lack of any radio frequency amplification, the set is only useful for local station reception, and reception depends very much on local conditions.

The amplifier may, of course, be used as a high-gain audio amplifier by connecting the microphone or other input between the grid spiral connection and L.T.—, for instance at S1. As an example of its sensitivity the following may be quoted. If a normal 2,000 Ω earphone is connected as indicated above and the stalloy diaphragm moved a few millimeters above the magnet poles, the Barkhausen clicks, due to the movement of domain boundaries or a change of the direction of magnetisation of individual domains in the stalloy may be heard easily. This effect is normally demonstrated with a large amplifier.

Book Received

"WIRELESS and Electrical Trader Year Book: Radio, Television and Electrical Appliances," 1953. 24th edition. Published by Trader Publishing Co., Ltd., 264 pages.

Since the "Wireless and Electrical Trader Year Book," was first published in 1925, it has become firmly established as the retailers' invaluable reference book to the radio and electrical industries.

In the 1953 edition, data of practical use to dealers in the new television areas and general reference and technical information have been carefully selected. Features include condensed specifications of current 1953 commercial television receivers (with such valuable facts as valves used, I.F. values, etc.), and information on valve and cathode-ray tube base connections, with over 200 valve base diagrams. These are invaluable to radio and TV engineers.

A new feature, re-introduced at the request of readers, is the Mains Voltage Directory and covers all the principal towns in Great Britain. The comprehensive list of the I.F. values of commercial radio receivers which have been marketed during the past five years has been revised and extended.

One of the principal aims of the Year Book is to assist traders to keep abreast of the constant change in the names, addresses, telephone numbers and products of the firms engaged in the radio and electrical industries.

TRANSMITTING TOPICS

SIMPLE UNIVERSAL AERIAL TUNING NETWORK

By O. J. Russell

THE amateur transmitter is generally concerned with the provision of three types of loading circuit in order to transfer power efficiently to a radiating system. These are the Pi coupler for transferring power to wires of random lengths; a series-tuned circuit for Marconi systems, and feed systems requiring a low-impedance feed and a parallel-tuned circuit for high-impedance resonant systems. In addition, a certain amount of control is required over loading adjustments. These three basic circuits are shown in Fig. 1, and the position of suitable aerial or feeder current indicators—such as thermal ammeters—is also shown.

There is no need to construct three separate aerial loading devices, however, as the basic components shown in Fig. 2 can be combined to form a considerable number of aerial matching networks.

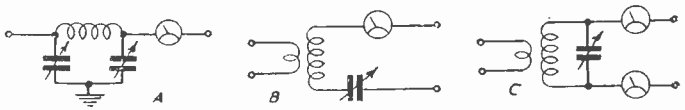


Fig. 1.—The three basic Circuits.

The cost can be very small, as suitable aerial tuning condensers of around 160 pF have long been available on the surplus market. One type with wide-spaced sturdy brass vanes was in fact used in the aerial loading circuits of service transmitters and is sold at around 1s. 6d. The wide spacing enables it to withstand high inputs without flashover. Various other suitable surplus components can be found, and in any case in default of surplus components, standard transmitting condensers may be obtained from the firms catering for amateur requirements.

In this respect, it is advised that the coil be arranged to plug in to a suitable base, which can also accommodate a link coil contact. However, details of this type are left to the discretion of the individual constructor, with the note that for powers up to about thirty watts one can very well use plug-in coil formers of the type used for short-wave receivers without difficulty. Details of coils for all bands and aerials likely to be encountered can also be left to the constructor, due to the wide variations to be encountered in practice.

The layout is also one which may be varied to suit the experimenter's requirements. As considerable variations in the connections to the basic components can be used, it is possible to use leads ending in crocodile clips as a handy but untidy means of effecting connections, or to use banana plugs and sockets to effect connections between components. In Fig. 2 the ends of the components have been lettered to identify possible connections, and the various arrangements possible may now be considered.

End-fed Wire

The first type of radiating system we may require to match into a transmitter is the simple end-fed wire. If this is of random length, or even if it is a resonant length, many amateurs prefer the Pi network. This can be achieved by connecting E to A, B to C, and connecting E to C and to earth. This is obvious

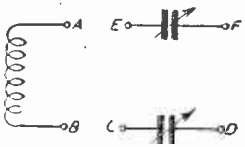


Fig. 2.—Basic components for the network.

enough, and is repeated in Fig. 3 (a). A series-tuned circuit for a single wire is shown at Fig. 3 (b), and only one condenser is used. For series-tuned feeders, or centre-fed systems, the symmetrical series-tuned system shown in Fig. 3 (c) may be used. For single wire systems requiring parallel tuning, the spare tuning condenser may be used to give a loading adjustment by placing it in series with the aerial. This can also be employed with twin feeders with possible slight unbalance in the system.

Parallel-tuned Systems

In the case of parallel-tuned systems, we have a choice of possibilities. We can use a single tuning condenser in cases where a medium value of tuning capacity is required, as upon, say, 40 metres. Where high values of tuning capacity are required, as upon the lower frequency bands, both condensers may be paralleled to give the required "high C," to retain an optimum LC ratio in the aerial tuning circuit.

Series Connection

For conditions—particular on the higher frequency bands (14 Mc/s., 21 Mc/s. and 28 Mc/s.)—where a lower value of tuning capacity is required, the two tuning condensers may be connected in series. This not only has the beneficial effect of halving the minimum capacity across the coil, but the fact that both condensers are separately adjustable is very helpful in adjusting the balance of the system. It is, in fact, at the higher frequencies where stray capacities and objects near the feeders can cause most disturbance that some control over feeder balance may be required.

Wide Scope

The range of conditions available by suitable interconnection of the components provides fairly completely for the range of frequencies from the top band of 1.8 Mc/s. to the 28 Mc/s. band. At the top band where the Marconi system is employed, the series tuning can employ one or both of the condensers in parallel, but it is unlikely that they will ever be required in series for 1.8 Mc/s. operation. It should also be noted that the alternate series and parallel possibilities with the parallel-tuned circuits is important for all of the amateur bands in maintaining a high LC ratio. In this respect the rejection of harmonics is improved by maintaining a reasonable LC ratio, so that the Q of the aerial tuning circuit is not too low. If the value of tuning capacity is maintained at about 2 pF per metre of operating wavelength, that is approximately 80 pF for 40 metres, this will be of value in keeping harmonic radiation down, with obvious benefits from the point of view of TVI troubles. A further point is that although feeders are shown tapped directly on to coils, it is, of course, perfectly permissible to tap the feeders down the coils if so desired.

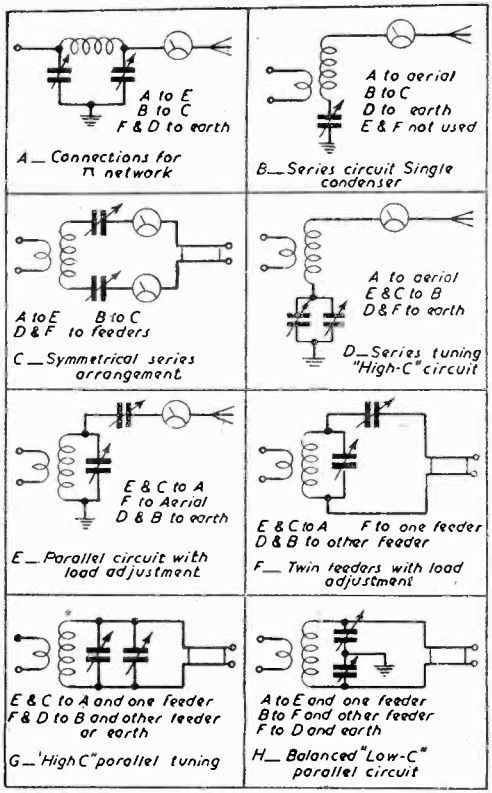


Fig. 3.—The various arrangements which are possible.

Radio on Everest

RADIO will play a decisive part during the final assault on Mount Everest which begins a few days after we go to press with this issue. More important even than the exchange of information on climatic and climbing conditions will be the morale boosting effect of regular contact between the mountaineers and their colleagues at the base camp.

Mr. George Rand, chief wireless operator to the expedition, said that whilst radio contact would facilitate load carrying, especially when low cloud made visibility difficult, the most important part played by radio would be to boost morale.

The decision to equip the 1953 Everest Expedition with portable radio transmitter-receivers was made only after exhaustive tests had been carried out to prove the reliability of batteries small enough to fit into a mountaineer's waistcoat pocket, yet robust enough to survive and perform perfectly in climatic conditions which ranged between high tropical humidity and sub-zero.

Nor were these the only qualities demanded by the expedition. Mr. Rand insisted upon delivery by air nearly three months before the batteries started their operational life.

Tests carried out in the laboratories of the Vidor-Burndept Group showed that the small radio battery used by portable radio enthusiasts in this country would operate satisfactorily for 16 hours at a temperature of minus 10 deg. Centigrade. The battery would, therefore, allow 10-minute contacts to be made no fewer than 96 times.

Further laboratory tests gave equally good results in tropic temperatures and in conditions of high humidity. But because of the long journey involved and the various methods of transportation which would be employed between Britain and the summit of Everest, special protective sealing methods were employed to ensure perfect results on the mountain ascent.

Vidor-Burndept factories at South Shields, Dundee and Brechin, produced radio batteries and non-perishable rubber torches complete with batteries.

The batteries provided for the expedition will give a total operational life of 530 hours at minus 10 deg. Centigrade.

Most of the transmissions will be made within the tents at night. The aerial will be fitted outside and the operator will conserve the life of the battery by speaking to the base whilst lying inside his sleeping bag. Because temperature plays an important part in determining the life of a radio battery, the mountaineers will carry their batteries in special waistcoats designed to derive maximum body heat.

The total radio equipment, including all batteries, is under 300 lbs.

A MULTI-RANGE TESTER—1

FULL CONSTRUCTIONAL DETAILS OF A VERY HIGH QUALITY TEST SET WITH A SENSITIVITY OF 10,000 Ω PER VOLT

By E. N. J. Marguerit

THE necessity for everyone connected with wireless to have a reliable and accurate multirange tester, whether electronic or straight moving-coil type, need not be emphasised. However, it is sometimes beyond the average pocket to afford such an instrument, especially the former. It is with this in mind that the writer has designed the instrument to be described. It is not of the electronic variety as this would undoubtedly raise the cost; ex-W.D. valves are not really reliable enough to meet such an exacting demand. The progress made in the manufacture of instrument-type metal rectifiers enables them to give satisfactory rectification up to 100 Kc/s, provided that the shape of the input wave is sinusoidal. The error they introduce in the audio range can, for all practical purposes, be considered negligible. Therefore, a well-designed moving-coil multirange tester should be able to furnish all the measurements required by the experimenter or the service engineer, including the plotting of frequency characteristics curves of any amplifier.

The instrument to be described has a sensitivity of 10,000 ohms/volt on all voltage ranges. The accuracy on all ranges is 1 per cent., except on the resistance and low A.C. ranges where it is between 3 and 4 per cent.

The largest scale is 4½in. long; it is traversed by a hair-line pointer. Parallax errors are avoided by the inclusion of a mirror.

The ranges covered are as follows:

D.C. Volts at 10,000 ohms per volt
0.1, 0.5, 1, 2.5, 10, 25, 100, 250, 500, 1,000.

D.C. Milliamps
0.1, 0.5, 1, 2.5, 10, 25, 100, 250, 500, 1,000.

A.C. Volts at 10,000 ohms per volt
0-10 volt and 0-100 volt on separate non-linear scale. 0-250, 0-500, 0-1,000.

Audio Voltages
Same as A.C. volts through an 0.1μF condenser.

Resistance
Eight ranges covering 0.01 ohm to 10 megohms. Giving indication of 50 megohms.

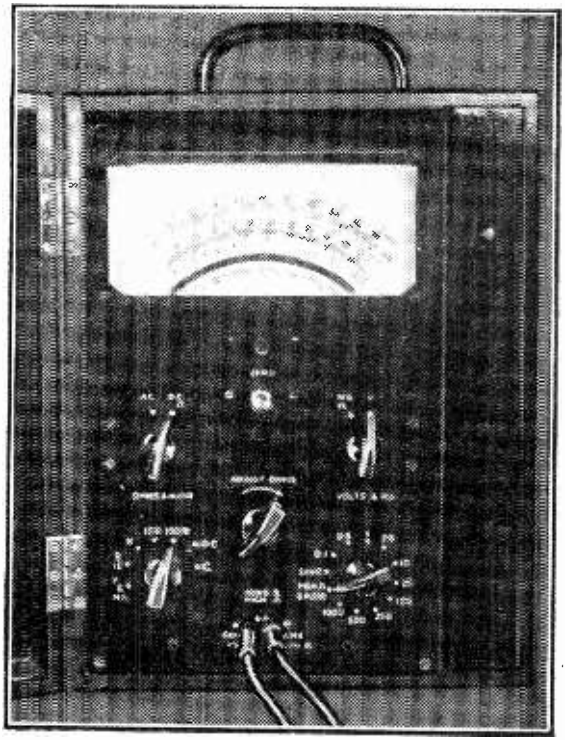
A special feature of the instrument is the possibility of mechanically offsetting the zero adjustment so that the pointer is brought on the centre of a special scale, enabling the instrument to be used as a galvanometer with a sensitivity of 50 μA on either side of the zero.

The Meter

The basis of the instrument is a 100 μA moving-coil meter obtained from ex-A.M. L/R unit No. 10Q/2, Model S52. Type 1. This unit contains two moving-coil meters having a linear deflection of 100 μA for an angle of between 70 and 80 deg.; this was checked against a standard instrument using the method described below. As they stand, the meters have 2in. long pointers, and the most difficult operation in the construction of the instrument is to equip one of the moving-coil meters with a longer pointer without altering its sensitivity.

The author carried out this modification satisfactorily by replacing the original aluminium pointer by a long thin glass pointer. This is obtained by heating a length of "Pyrex" brand glass rod in the flame of a Bunsen burner until the glass is quite soft, when the rod is removed from the flame and the ends are drawn rapidly away from each other, resulting in a length of very fine glass rod which is then cut into pieces about 8in. to 10in. long from which the pointer is selected.

There are two methods of fitting the meter with its new pointer. In each case, the existing pointer, which consists of a length of aluminium foil covered with a phosphorescent coating, is removed. Care should be taken in this operation as the coating is reputed to be radio-active. Fig. 1 shows how the original pointer is secured to the moving-coil assembly; it is removed by easing the grip of the aluminium foil on the fixed



A view of the completed meter.

part of the pointer by means of a pair of tweezers, without exercising any undue strain on the jewelled bearing.

The first method consists in dismantling almost the entire meter and unless one possesses a set of jeweller's tools, including a miniature soldering iron, the job is not recommended. The idea, of course, is to have a means of ascertaining that the centre of gravity of the assembly has not been disturbed. Indeed, if this were upset, either by an overload or an underload, the finished instrument could only be used in a horizontal position. This is checked by resting the pointer on a pin held vertically in a cork or similar material, the resting point being the fixing hole of the pointer when attached to the moving-coil. If the pointer remains horizontal, then the balance is perfect; if it tends to fall towards the counterweight side, the glass implement should either be made thicker for the same length or longer for the same thickness; if it dips towards the opposite direction, then the procedure should be reversed. When a satisfactory balance has been obtained, the assembly is mounted back on the moving-coil; this is very delicate and calls for a lot of patience.

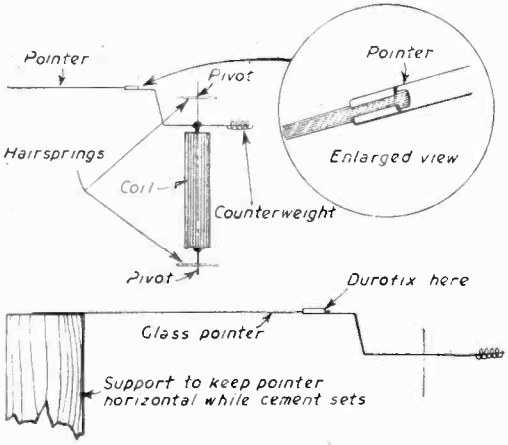


Fig. 1.—(Top) Details of the original pointer mounting.

Fig. 2.—(Bottom) Details of the modified pointer.

An Alternative

The second method is much easier as there is no dismantling to do, apart from taking off the original pointer. All that is necessary is to select a piece of glass rod drawn as described previously and having the following measurements:

Length, 4in.
Diameter, presumed uniform over the entire length, 0.006in. (measured with a micrometer).
The weight of such a pointer is 0.0040 gms.

These measurements were deduced from a series of experiments performed on several meters of this type. Having selected such a rod, it is then fixed by means of Durofix cement on that part of the original pointer left on the moving-coil as shown in Fig. 2. The other end of the glass rod is supported in a horizontal position while the cement sets, either by holding it in the hand or by letting it rest on a previously prepared support of the correct height. When the solvent has evaporated, the pointer is given a thin coat of Indian ink with a fine camel hairbrush. The meter is then ready to fit into the instrument.

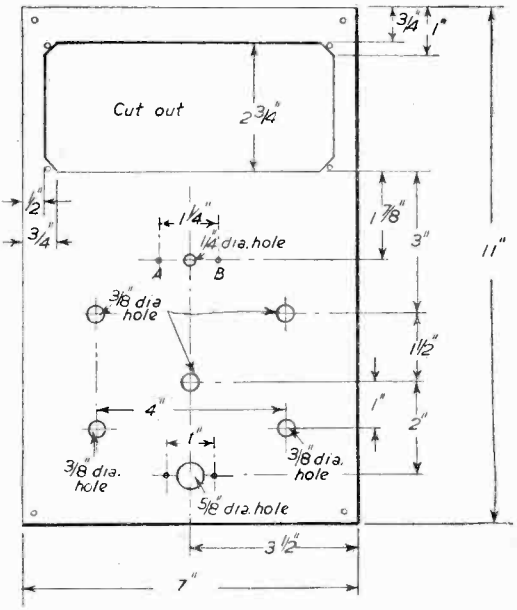


Fig. 3.—Details of the panel. Holes A and B are the fixing holes for the meter movement. All holes with no diameter indicated are to take 6 B.A. bolts.

Construction

The instrument is built on a panel of insulating material, such as Paxolin or Permali, $\frac{1}{8}$in. thick and

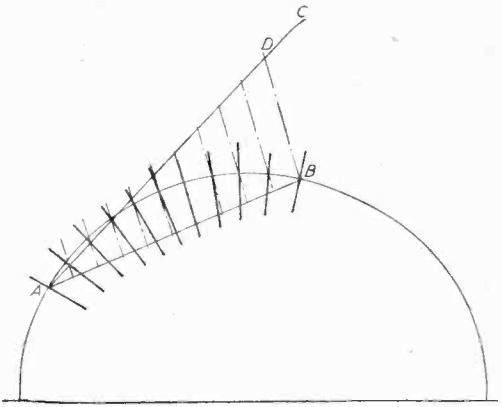


Fig. 5 (a).—Marking out the scale. Lines AB, AC, DB and all parallel to DB are drawn finely in soft pencil. When the arc is divided in ink they are rubbed out.

11in. × 7in.; a window 6in. × 2¾in. is cut with a fretsaw and the panel is drilled according to the diagram in Fig. 3. The underneath of the panel is divided across its length in two halves by a line marked with a scriber. This line is used later in the construction, as a reference point, in the positioning

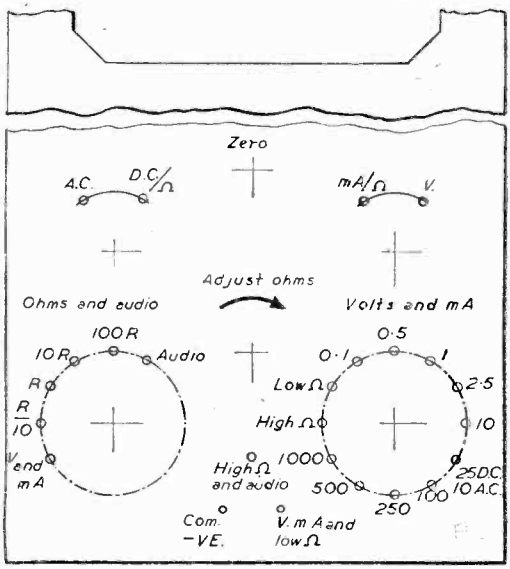


Fig. 4.—Details of panel indications. The dots and arrow are depressions in the panel filled with white paint. The legends are similarly treated. The knobs are small black pointer types.

of the scale. After drilling, the author's panel was engraved, the legends being as shown in Fig. 4. An alternative is to write the legends on a round piece of Bristol board in Indian ink; a hole is then cut in the centre to fit over the switch it is made for. A thin piece of perspex of the same size is then affixed in the same position. A rectangular piece of perspex, 6½in. × 3¼in. and 1/6in. thick is cut and drilled to fit over the window in the panel. It is attached on the underneath of the panel by means of Bostick or

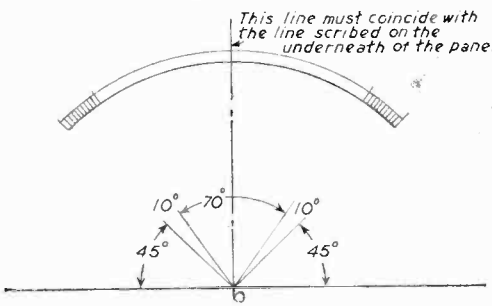
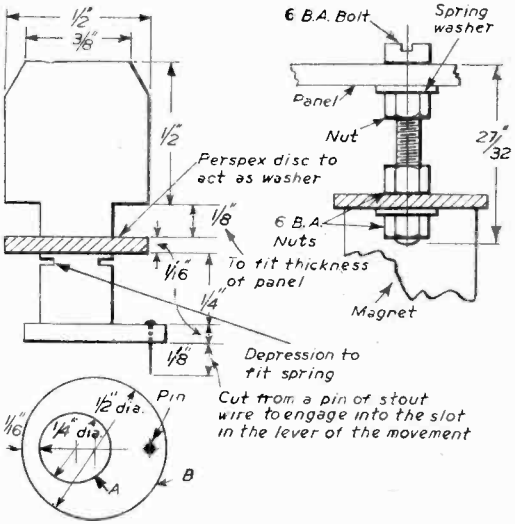


Fig. 5 (b).—Diagram of the finished temporary scale to find the angle of rotation of the pointer for a given current.

rubber cement, and four 6 B.A. bolts 1½in. long and nuts. The length of these bolts is important.

The scale plate consists of a piece of aluminium 1/16in. and 6½in. × 3¼in.; one side of it is divided into two halves by a line which is made to coincide with the one dividing the panel, and the positions of the bolts are then marked on the scale, which is drilled accordingly. A rough, equally-divided scale is then drawn on a piece of stiff, white paper. It consists of two concentric circles, the radii differing by ⅛in. The common centre of these cirlces lies on the dividing line produced, and the centre coincides with the pivot of the moving coil, which is also arranged to lie on the same line. By means of a protractor, an angle of 90 deg. is drawn from the centre, another angle of 70 deg. is then drawn from the same centre, and placed so that it forms an angle of 10 deg. on each side of the 90 deg. angle. The two angles are then divided into 10 equal parts. This is done by applying a well-known theorem of



Figs. 6 and 7.—Device for mechanically adjusting the zero of the instrument. The material is perspex. Disc B is secured to rod A by Perspex cement. The "zeroing" device is shown on the right.

geometry. To divide an arc AB of a circle into a number of equal parts, join AB by a straight line. From A draw a line AC forming an arbitrary acute angle with AB. With a ruler placed on AC, mark a point D so that AD = say, 10 cm., between A and D mark 9 points each 1 cm. apart. Join DB, and by means of a set-square and ruler, draw lines starting from each of the 9 points and parallel to DB. To divide the arc AB into 10 equal segments, 11 radii are drawn, each passing at the intersection of the parallel lines with the arc AB (see Fig. 5a). The same procedure is applied to the other 10 deg. angle (see Fig. 5b). This scale is then cut to the size of the scale plate and glued on to it in such a way that its centre line coincides with the line dividing the aluminium

scale plate. This is only a temporary scale and its purpose is to measure accurately the angle of deflection of the meter pointer when a current of 100 μA is passing through it.

Before standardising the deflection, the device for adjusting the zero of the meter has to be made. It is constructed of Perspex, and full details are given in Fig. 6. The spring clip was taken from the centring device of a disused meter. Fix the device on the panel and secure the meter by means of two 6 B.A. bolts and nuts. The bolts are 27/32in. long and the fitting is as shown in Fig. 7.

After securing the meter on the panel, the temporary scale is fixed in place by means of the four

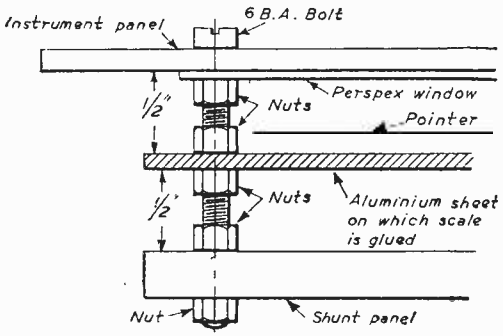


Fig. 8.—Method of mounting the scale so that it may be adjusted in relation to the pointer.

bolts securing the Perspex window. The correct spacing is shown in Fig. 8.

To exclude draught when calibrating the angle, it is necessary to enclose the whole of the instrument in a wooden box, which later on will serve as the case for the instrument. The author found that the ex-Service Transit Case No. 10C/3650 is ideal for the job. Its dimensions are 11in. × 8½in. × 4½in. The paint was scraped off, the surface smoothed with coarse and fine glass-paper and the box French polished. The case was partitioned to 7in. in width, the small partition providing a convenient compartment to store the leads and batteries.

Calibration

The principle of the calibration of the f.s.d. of the meter is to place the meter in series with a standard instrument such as the AVO Model 7 or preferably Model 8, then apply from an L.T. battery and potentiometer a current of 100 μA as read on the standard instrument. The angle of deflection can be measured on the specially prepared scale. The diagram for such a circuit is given in Fig. 9. The angle varies between 70 deg. and 80 deg. for 100 μA. Having found the angle of deflection of the meter, one can proceed with the drawing of the final scale. This is drawn on a sheet of best Bristol board. Use of different colours of ink improves the clarity. There are seven scales. One each for the high- and low-resistance ranges; one for D.C. volts and mA, including the three ranges 1,000 volts, 500 volts and 250 volts; three for A.C. volts (two only if circuit in Fig. 10b is used); one each for 10 volts and 100 volts A.C.; the third one being for voltages above 100 volts A.C. up to 1,000 volts. The ranges below 10 volts are inoperative on A.C.; they are seldom required. The last scale is an equally divided one with a centre zero for galvanometer use.

Electrical Circuit

Two possible circuits are given. Each one will be described individually.

The first one is shown in Fig. 10a. The same potential divider is used for A.C. as well as for D.C. volts measurements. This reduces the cost of the instrument but necessitates an additional scale for A.C. volts, as the values shown on the D.C. scale would be 1.11 times too small for A.C. volts. Alternatively, when measuring A.C. volts on the D.C. scale, each reading should be multiplied by 1.11, but this seems a tedious and unnecessary process when one has a series of measurements to make.

The potential divider consists of 10 Dubilier High Stability Carbon resistors with a tolerance of ±1 per cent. Tolerances less than 1 per cent. up to 5 per cent. and 10 per cent. could, of course, be used, but naturally the overall accuracy is also reduced. In the author's opinion, this is not recommended, as the completed instrument, if well constructed, is capable of giving readings accurate to ±1 per cent. on the last 40 per cent. of the scale. The values of the resistors in the potential divider are given in the list of parts on page 405.

The rectification of A.C. voltage is effected by means of four Westinghouse rectifiers, type WX1. These are connected to form a bridge, thus giving full-wave rectification. They resemble small resistors and are easily mounted on a tag-board.

D.C. current measurements are made by means of home-made shunts and calibrated on a bridge. They are made of Constantan (Eureka) wire, the temperature coefficient of which is 0.000014 deg. C. as compared with 0.00428 deg. C. for copper.

The idea of using a series-shunt circuit was not

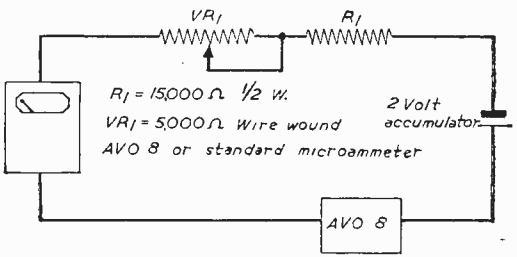


Fig. 9.—Method of measuring the angle of deflection. Adjust VR_1 until the current read on the standard meter is 100μA, then measure the angle deflected by the pointer of the instrument being calibrated.

adopted as the latter is more difficult to calibrate by ordinary means.

The values are calculated as shown in the example given below. They will naturally vary with each individual moving-coil meter as they depend primarily on the resistance of the coil.

There seems to have been quite a controversy recently in one of the wireless journals as to the best way of measuring the resistance of the coil of a moving-coil meter. The author thinks that the following is a satisfactory method for general purposes.

(*Continued on page* 405)

Continued from page 402

The principle involved is that when a shunt is placed in the circuit of a milliammeter or micro-ammeter reading full-scale deflection and adjusted so that the new reading is one half the original one, then the value of the shunt at that point is equal to that of the meter. The circuit used is shown in Fig. 11, the shunt is a wire-wound variable resistor of about 1,000 ohms. When the half-scale deflection is obtained, the variable resistor is taken out of the circuit without altering its setting and its value is measured on a standard ohmmeter or on a bridge. Hence the resistance of the moving-coil is found. It is desirable to add a resistor in series with the coil, the value of which makes a round number with the resistance of the coil. This resistor, known as "swamp" resistor, is made of insulated Constantan wire and wound on an insulated former.

How to calculate the value of a shunt for a given range :

Full scale deflection of meter : 100 μA.
Resistance of coil : say 473 ohms.
Desired resistance of coil : 500 ohms.
Value of "swamp" resistor : 27 ohms.
Range of current to measure : 500 μA.

The shunt must carry a current of 500-100=400 μA or 4/5 of total current. Therefore, resistance of shunt $\frac{500}{4}$=125 ohms.

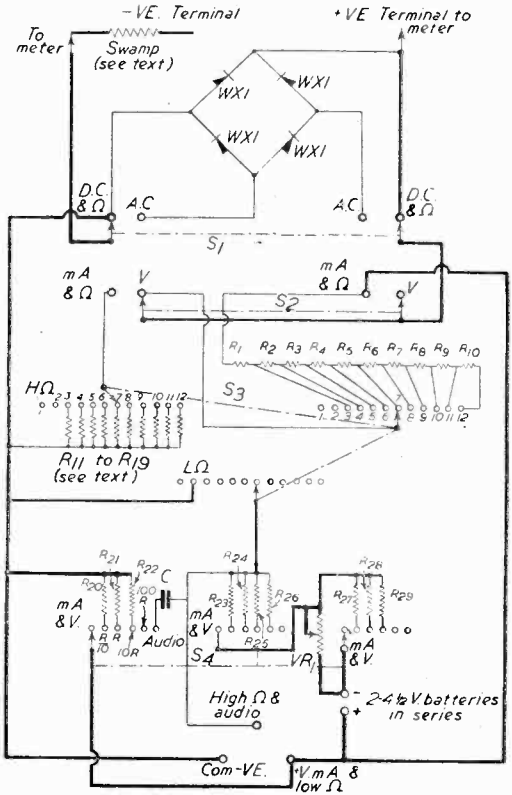


Fig. 10 (a).—One circuit arrangement of the complete meter. An alternative will be given next month.

Alternatively the following formula can be used

$$Rs=\frac{Rm}{N-1}$$

where Rs = resistance of shunt
Rm = resistance of coil and "swamp."
N = factor by which it is desired to multiply range of meter

The rest of the circuit consists of the ohmmeter and audio ranges.

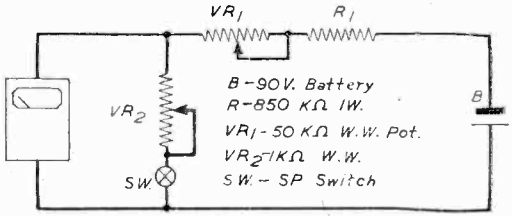


Fig. 11.—Method of adjusting the shunts. Adjust VR_1 with switch open-circuited, until full-scale deflection is obtained. Close switch and adjust VR_2 until instrument reads one half the previous current. Then VR_2 in ohms is the meter resistance. B must be a high-voltage battery.

The audio voltages are measured on the A.C. ranges by using a paper condenser, C, in series with the test leads. This condenser is automatically connected in the circuit when the instrument is switched to "Audio."

(To be continued)

LIST OF COMPONENTS
Circuit of Fig. 10a.

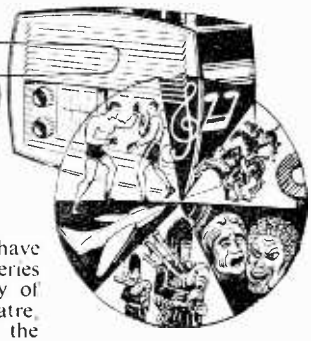
Switches
S1, S2 } 2-Pole 2-way low contact resistance.
S3—1 Pole 12-way 3 banks low contact resistance.
S4—1 Pole 6-way 3 banks low contact resistance.

Resistors (assuming meter resistance=500 ohms).
R1— 500
R2— 4,000
R3— 5,000
R4— 15,000
R5— 75,000
R6—150,000
R7—750,000
} ohms 1w. Dubilier H.S. Carbon ± 1%

R8 { 1 Megohm + 0.5 megohm } Dubilier H.S. Carbon ± 1%
R9 { 1 Megohm +1 Megohm +0.5 megohm } Dubilier H.S. Carbon ± 1%
R10—5×1 Megohm Dubilier H.S. Carbon ± 1%
R11 to R19—Home-made shunts calculated from $R_s=\frac{Rm}{n-1}$ (see text).
R20—shunts (Eureka) for meter to read 100 mA. f.s.d.
R21—shunts (Eureka) for meter to read 10 mA f.s.d.
R22—shunts (Eureka) for meter to read 1 mA f.s.d.
R23—75 ohms ½ W. Dubilier H.S. carbon ± 2%.
R24— 800
R25— 8,000
R26—87,500
} ohms ½ W. Dubilier H.S. Carbon ± 1%
R27—31 ohms ½ W. Dubilier H.S. carbon.
R28— 235
R29—3,400
} ohms ½ W. Dubilier H.S. carbon ± 1%
VR1—5,000 ohms W.W. 5 Watt
C—0.1 μF. 1,500 v. D.C. paper condenser.
WX—1 Westinghouse Westectors.

Programme Pointers

By MAURICE REEVE



Music

ENGLISH music has had a curious and chequered history. Its leanest times were contemporaneous with the glorious outpourings of the European geniuses and may be said to have lasted from the death of Bach—Johann Sebastian—in 1750 to the death of Brahms in 1897, reaching its nadir in Victorian times. Since then it has known a great revival, occasionally scaling the heights in Elgar, Delius and Vaughan Williams. But it never knew greater days than during the reign of the first Elizabeth, when a series of master musicians poured out works for the lute, voices and other instruments which brought lustre and fame even to an age which lived with Shakespeare.

Thurston Bart, a young man of enviable gifts, has been presenting a set of nine programmes of "English Lute Music, 1540-1620" which have been as fascinating education as they have entertainment. Artists, too numerous to cite here individually, have performed works by Dowland, Ford, Morley, Handford, Newman, Jones, Tallis, Byrd, and many others: as well as Henry the Eighth and the irrepressible "Anon," a gentleman as ubiquitous in those days as "A. N. Other" is in modern sport.

Was it Romeo who said "If music be the food of love, play on"? And was it Sir Toby Belch who, saying he had "a reasonable good ear for music," called for the tongs and the bones? However, though either, or both, of these extremes of thought may contain the soul of the divine art, listening to this always captivating and frequently beautiful music served to show the constant stimulation Shakespeare's great love of music was ever receiving, and which he so frequently sublimated throughout his works.

Shakespeare

Writing of Will causes me to place next in my this month's list for review the second production in a new "Coronation Curtain-up" series, which was none other than Clemence Dane's "invention," "Will Shakespeare." This brilliant and moving piece sets out to fill in, to the authoress's fancy, what might have happened on some of the many blank pages in the poet's life. Miss Dane chooses for her central fancy that Marlowe was murdered by Shakespeare in a tavern duel over Mary Fitton, one of the Virgin Queen's ladies-in-waiting, and, of course, Shaw's "Dark Lady of the Sonnets." Coupled to this is the poet's harsh treatment of his wife, Anne Hathaway, and her voice calling to him from the "far, far better land."

Val Gielgud as Shakespeare, Mary Wimbush as Anne, Joyce Heron as Mary, Nancy Price as the Queen, Alexander Davion as Kit Marlowe, Leon Quartermaine as the actor Henslowe, and Eileen Thorndyke as Mrs. Hathaway, together with the authoress as narrator, all gave us a capital show.

The Theatre

Four instalments have taken place of a series setting out the story of Her Majesty's Theatre, that famous house in the Haymarket which we have all known for so long as *His* Majesty's and which, for most of us, has existed in its present guise, built by Sir Herbert Tree at the end of the Victorian era as Her Majesty's, all our lives. On listening to the excerpts of the various plays that first saw the light on its famous boards, one fairly reels at the kaleidoscopic pageant of life, history and colour witnessed by generations of its patrons. "The School for Scandal," "Pygmalion," "Hassan," "Trilby" and "Drake" are a few of the classics or neo-classics. "Chu Chin Chow," of course, still holds the blue riband of longevity. "Joseph and His Brethren" and "David Copperfield" were magnificent entertainment and spectacle. To-day Tree and his fellow workers look down on different scenes and different players, managers and writers, as they look down on a different age with different values and standards. Their thoughts will ever remain undisclosed.

These programmes, like BBC revivals of "The Merry Widow," etc., are good entertainment to a point: they fail to recapture the past largely because it cannot be recaptured.

Talks

The revival of Sir Arthur Grimble's talks, "Tales from the Pacific Islands," was very welcome. Sir Arthur is one of the best of broadcasters, and he recounts some fascinating reminiscences and experiences.

"Marshal Ney," J. C. Masterman's clever play on a dramatic subject, tells the story of how the magic name "Napoleon" and the thrilling news "escaped from Elba" caused this famous soldier to once more change sides and to go down to ruin after Waterloo. It made good radio and Howard Marion Crawford as the Marshal aroused all the old fascination which that period of history known as Napoleonic will, we hope, always possess. A pity we can't say the same for the Hitlerian chapter.

"Electra," in Gilbert Murray's translation, afforded Joan Hart with her biggest part for some time. She accomplished her task nobly.

"Antarctic Journey" largely failed to get to grips with Shackleton's incredibly marvellous story—incredible but for the fact of its being true. The "heave-ho" of the men when launching the lifeboat off the rapidly breaking ice was more reminiscent of John Snagge at the Boat Race than of the Antarctic. Duncan Carse was, I should imagine, excellent as Shackleton.

Footnote. Why are comedians invariably so much funnier in Workers' Playtime than in studio broadcasts?

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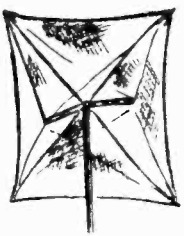

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More about TRANSISTORS

SOME FURTHER DETAILS OF THIS NEW "COLD CATHODE" VALVE

By F. E. Henderson

MANY readers of this journal are by now familiar with the modern crystal rectifier, which is finding its way into present-day radio equipment and many television receivers. The small size, robust construction and practically indefinite life of these little rectifiers have made them of very considerable interest to manufacturers of radio and television sets. Their satisfactory performance is leading to their more widespread use as replacements for the thermionic diode in many positions in the receiver.

Although the germanium crystal valve appears at first sight a very simple device, the successful manufacture of a consistent product has proved by no means simple. However, methods have been discovered to make not only crystal valves that rectify but also ones for use as amplifiers and oscillators.

We now see reports about complete amplifiers, radio receivers and even television sets functioning without the use of a single thermionic valve, and the question no doubt arises in many people's minds—is the new germanium triode, or "transistor" as it is called, really supplanting the thermionic valve?

To get our thoughts clear about this, let us briefly see how this "cold cathode" valve works, whether it can readily replace the thermionic valve, and whether it is likely to become a large-scale production reality in the near future.

What the Transistor is

Germanium is an element which is classed as a semi-conductor, that is, an element which has electrical properties half-way between an insulator and a metal.

When a metal point is brought into contact with a semi-conductor such as germanium (or silicon), there is an interchange of electrons at the point of contact, the net flow taking place from semi-conductor to metal point.

The transfer of electrons tends to accumulate a negative charge in the metal, while the semi-conductor is left positively charged. This state of equilibrium exists until an external voltage applied between the semi-conductor and the contact disturbs it and causes a flow of current.

When the metal point is made positive, the resistance offered to the electron exchange is reduced—this is the forward direction for applied voltage. The application of a negative voltage, however, gives rise to a high resistance, the value of which depends, among other things, on the impurity of the semi-conductor.

A germanium crystal of very small impurity content can withstand "reverse" voltage of the order of hundreds of volts before "breakdown" occurs at the contact. Alternatively, with high impurity contents, diodes can be made which will only withstand reverse voltage of the order of a few volts, but which give high current for low "forward" voltages. Such diodes give very high rectification efficiency at small signal levels.

Before we can proceed and consider the next step, there is an important little bit of chemistry which must be understood.

If it were possible sufficiently to magnify a photograph of a piece of germanium (or any other element for that matter) we should see that its mass was composed of atoms of the element, each atom with its electron satellites, the whole forming a crystal lattice structure. If the germanium were a perfect crystal, there would be a regular crystal pattern; if the germanium were not perfectly pure, but contaminated with another element, the resulting crystal pattern would no longer be perfect, but would either have some excess electrons which could not fit into the structure or a shortage of electrons giving rise to gaps in the structure. These gaps are known as "holes." The presence of these excess electrons and "holes" gives rise to conductor properties. A crystal with surplus electrons will more easily part up with them than absorb more of them, while one with a deficiency of electrons will more easily absorb other electrons. In other words, the resistance to the flow of current is higher in one direction than the other, depending upon the nature of the semi-conductor, and its impurity content.

A specimen which conducts by electrons alone is called n-type since the current carriers are *negative*; a specimen deficient in electrons conducts by movement of the position of the residual "holes," and is called p-type since the current carriers are virtually *positive*. Thus, if germanium contains an impurity content which results in there being an excess of electrons, it will conduct by electrons flowing out of it (or by holes flowing into it): such germanium is n-type.

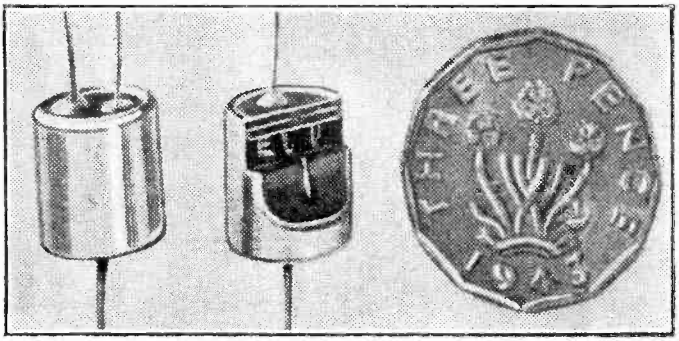


Fig. 1.—Actual sizes may be judged from this illustration.

If it contains excess holes it will conduct by electrons flowing into it (or holes flowing out of it): such germanium is p-type.

Point contact germanium diodes, we have seen, may be designed either with the purest germanium obtainable (to withstand high reverse voltage) or containing an impurity which will give it n-type characteristic (to give higher forward currents for a given applied voltage).

Elements which produce n-type germanium are arsenic, antimony and phosphorus.

Let us go one step farther.

Suppose we take a crystal of n-type germanium and apply to it *two* metal points very close together. A potential applied between the germanium and one point X on Fig. 2 will cause an electron current to flow across the contact whenever the voltage on the metal contact is positive with respect to the crystal—in other words the point contact corresponds to the anode, and the crystal to the cathode in a thermionic valve. (The above assumes the second point contact Y open-circuited.) Now suppose we apply a voltage across the second point contact Y and the germanium but in the "reverse" direction, that is, with the crystal positive with respect to the metal point. Without the first positively charged contact X present, any current passing between Y and the crystal will be very small due to the fact that in this condition the crystal rectifier is in the reverse or high resistance condition. But the moment electron current flows into X, it is found that the current flow between Y and the crystal is increased; in fact the current passing between Y and the germanium can be about the magnitude of twice that flowing between X and the germanium.

The germanium crystal in this arrangement is known as the "base," the positively-charged contact X as the "emitter," and the negatively charged contact Y as the "collector." (Fig. 3).

The arrangement described is known as a "point contact" transistor and features of its application and design will be explained later.

Next, let us revert to our p-type and n-type germanium for a moment. We saw how a germanium crystal with an impurity content to give an n-type characteristic is more ready to give than to receive electrons—in fact it has a surplus supply—while p-type germanium contains a number of spare "holes" to which electrons may fit.

From this it follows that a piece of p-type germanium in contact with a piece of n-type forms a natural rectifier, without any point contact, an arrangement which has its advantages by way of greater current-carrying capacity, but also has its disadvantages at present principally concerned with difficulties of commercial manufacture, and also in its frequency limitation in use.

It also follows that as we progressed from the point contact diode to point contact triode, so with the p-n junction diode we can move one step farther to the junction triode—or "junction transistor."

Fig. 4 shows diagrammatically how this is arranged. In this case the two metal points X and Y in Fig. 3 are replaced by two small blocks of p-type germanium, while sandwiched between them is a thin layer of n-type germanium.

In this class of transistor the basic principles we saw operating with the point contact class still hold. The one p-type corresponds to the "emitter" and the other p-type to the "collector" while the n-type is the "base." In operation, the collector is biased in the reverse direction and the emitter in the forward direction, the forward emitter current resulting from electrons attracted from the "base." A negative voltage applied to the second p-type germanium causes the desired increase to the collector current, which may be considered as a negative direction current in this case.

The junction transistor may be either of the p-n-p type, as illustrated in Fig. 4, or of the alternative n-p-n type, depending upon the method of manufacture. In operation, the n-p-n type makes the emitter *negative* and collector *positive*; the p-n-p

(*Continued on page* 413)

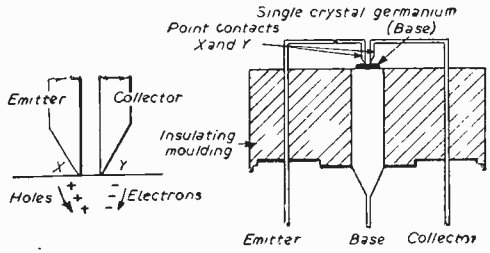


Fig. 2.—Germanium base (barrier layer).

Fig. 3.—Point contact transistor (of the construction illustrated in Fig. 1).

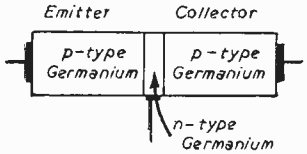
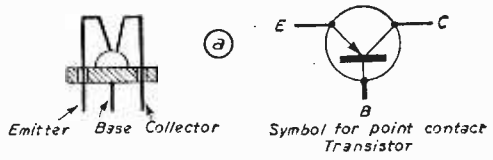


Fig. 4.—Thickness of n-type layer is less than 1/1000in. Diagram of one form of junction transistor (another form would be n-p-n, with p-type sandwiched layer).



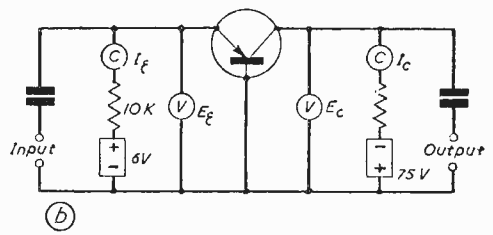


Fig. 5(a).—Diagram and symbol of transistor. Fig. 5(b).—Basic circuit for determining transistor characteristics.

(*Continued from page* 410)

type makes the emitter *positive* and the collector *negative*.

Problems

From the foregoing we can get an idea as to some of the problems facing the manufacture on a large scale of reliable high consistency transistors.

Thus, the first necessity is to obtain a single perfect crystal. To this must be added a closely controlled amount of another element to give an impurity content of about 1 part in 100 million.

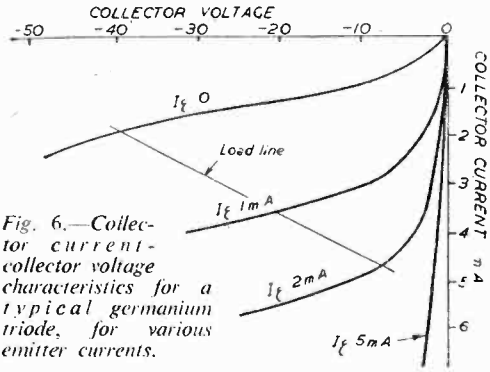


Fig. 6.—Collector current-collector voltage characteristics for a typical germanium triode, for various emitter currents.

With the point contact transistor the maximum clearance permissible between the points is only about five thousandths of an inch, and this clearance must be rigidly maintained in spite of severe mechanical shock or large temperature variations.

With the junction type transistor, not only must the degree of contamination of the p-type and n-type germanium be very closely controlled, but so must the thickness of the sandwiched layer, and all these problems must be faced and overcome before we can safely take the transistor out of the experimental field and place it alongside, and complementary to, the thermionic valve as a dependable commercial product. This day is surely coming.

How the Transistor Works

Our next stage is to apply the principles of the transistor to practical amplification circuits.

Fig. 5(a) shows diagrammatically and in symbol form a point contact transistor, and Fig. 5(b) gives a basic amplifier circuit for such a transistor. Meters are shown inserted for the purpose of measuring the emitter voltage and collector current, and by plotting a graph relating collector voltage with collector current for a number of values of emitter current we can obtain a series of curves, indicated in Fig. 6.

By inverting the page, the similarity to a typical family of Ia—Ea curves for a triode valve becomes apparent, and on these we can superimpose a load line for the value of the collector load resistance.

So far so good; but here it is important to realise that we cannot use the transistor as a voltage amplifier exactly as we would a thermionic valve. This is because whereas in a valve the anode current is controlled by the grid *voltage* (and in receiving types, other than in some exceptional cases, grid current is normally absent) in the transistor, the collector current is controlled by the emitter *current*, which may be quite considerable.

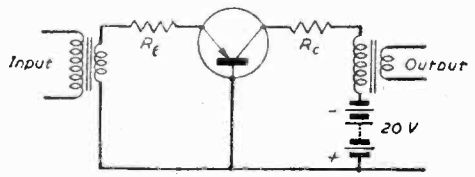


Fig. 7.—Circuit for current gain with point-contact transistor.

In a transistor a typical figure for the ratio of emitter current to voltage would be 100 to 1 mA/V.

Hence the input impedance of the device is low.

On the other hand, the ratio of collector current to change in collector voltage is low, the reverse of the condition aimed at in valve operation.

Hence the output impedance of the device is high.

From these facts we see that a situation exists in a transistor amplifying circuit different from the usual valve circuit.

Referring back to Fig. 6, we see that with a load resistance in the collector circuit the change in collector current is relatively small, but a substantial voltage can be developed across the load resistance when positively biased voltages, and, therefore, current changes, are applied in the emitter circuit.

We must, therefore, take into account both current and voltage in applying the transistor to an amplifying circuit, and for this reason the device must be looked upon as an amplifier of *power*—not voltage, as in the valve.

The greatest obtainable power output from the

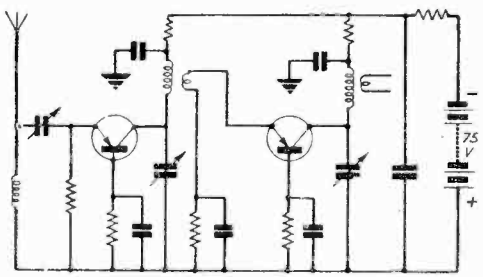


Fig. 8.—Germanium triode R.F. amplifier.

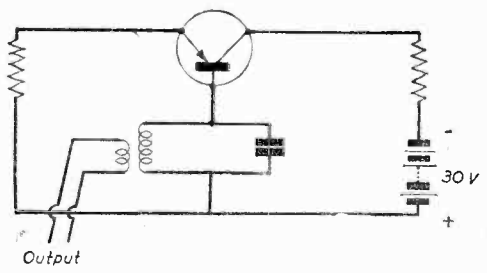


Fig. 9.—Germanium triode oscillator circuit.

crystal triode or transistor is very much less than that from a normal thermionic power valve—in their present stage only about 30 milliwatts—although with future development, particularly on the junction type transistor, some increase may be expected on this.

Practical Circuits

Now for some practical circuits to which the transistor can be applied as an amplifier or as an oscillator.

We saw that for the collector current to flow, the emitter must be positively biased with respect to the germanium base, and that in an operating condition there is a net flow of current flowing into the base from the collector. A resistance Rb in series with the base and the source of collector voltage will therefore have a potential drop across it corresponding to the current, and as this resistance is also in series with the collector current it will act as an automatic positive bias for the emitter.

Now the bias resistance is common to *both input and output* circuits, and it will be seen that here we have the condition for positive feedback, which may be enough to cause instability, and disastrous oscillation, to the point of destruction of the crystal.

This is because increase in collector current will cause an increase in voltage drop across Rb and a corresponding increase in the emitter bias voltage. This results in a rise in emitter current, a further increase in collector current, and so on, until the collector circuit ultimately becomes so large that the transistor will burn out.

Fortunately, this cumulative effect may be controlled by inserting limiting resistances in the collector and emitter circuits, and our practical amplifier becomes more like Fig. 7.

Only about 20 volts is required for the D.C. power supply if a high reactance (i.e. high A.C. to D.C. resistance ratio) load is employed, such as with an output transformer, suitably designed for matching the high output resistance of the transistor into its final load.

In the point contact transistor the current gain is greater than unity, and very convenient oscillator circuits can be developed around this device. It is, however, not very suited to an audio-frequency amplifier because normally the power gain obtained is only about 20 db per stage of amplification and because transistor noise increases with decrease of frequency. Its main applications are in computors and electronic exchanges where limitations of gain and noise do not matter. In the junction type transistor, the current gain is always less than unity, and its main application is in low-frequency amplifiers ; a low voltage (usually about 3 volts) power source only is necessary.

All the foregoing will show that it is not practicable to consider the transistor as a direct replacement for the valve in valve type circuits, but with appropriate circuit design, transistors may be connected in cascade to provide quite a considerable degree of amplification with a small expenditure of D.C. power.

A typical circuit for a radio frequency amplifier using point contact transistors is shown in Fig. 8 and a circuit whereby the device can be used for generating continuous oscillation in Fig. 9.

The germanium triode or transistor is an important development in the fields of radio communication, industrial control gear and in instruments such as computors. Its appearance will be commonplace in such equipment once the manufacturers have successfully transferred the device from an experimental to a large-scale production product, but we still have some way to go in that direction at the time of writing, and it must always be borne in mind that the crystal is complementary to the thermionic valve, and valuable service will be found for both.

News from the Clubs

COVENTRY AMATEUR RADIO SOCIETY
Hon. Sec. : K. G. Lines, 142, Shorncliffe Road, Coventry.

THE Mars/Cars Annual Inter-Club Transmitting Contest results are now being studied by the respective committees.

Mr. T. R. Theakston, B.Sc., gave one of his ever-popular talks on mathematics recently, when he guided members through the rocky path of Calculus with charm and humour.

Club Night-on-the-Air has been suspended for the summer months, but usual meetings continue fortnightly at the Y.W.C.A., Queen's Road, at 7.30 p.m.

The society were joint winners with Stourbridge and District Amateur Radio Society in the annual R.S.G.B. Affiliated Societies Contest, and thanks are due to Fred Bowman G3FAB for placing his rig at the Society's disposal for the event.

THE ROCHDALE RADIO AND TELEVISION SOCIETY
Hon. Sec. : J. Riley, 1, Darley Bank Britannia, Bacup.

WEEKLY meetings are held at 1, Law St., Sudden, Rochdale, at 7.45 p.m. and all interested in radio are invited to visit us, new members will be welcome.

The club will shortly be on the air with the club call sign of G3IYD.

HASTINGS AND DISTRICT AMATEUR RADIO CLUB
Hon. Sec. : W. E. Thompson, 8, Coventry Road, St. Leonards-on-Sea, Sussex.

The committee thought when they laid plans to get members to make a simple receiver one evening that they would catch everybody napping. How wrong they were ! From a handful of bits, two teams designed and constructed within an hour receivers to work in the 80 metre band.

The first-class communications receiver built by our member, F. Blakemore, using the CR100 tuning unit and the handbook, reflects great credit on his workmanship. Considering that he had never attempted making a radio receiver before, he fully deserved the praise everyone expressed for a fine job of work. He set himself a high standard, achieved it, and can justly be proud of it.

The club will be exhibiting at the Hobbies Exhibition, July 4th to 11th, inclusive, to be held in the Indoor Bowls Pavilion, Falais Road, Hastings, during Carnival Week.

YORK AMATEUR RADIO SOCIETY
Hon. Sec. : G. F. Nottingham, G3DTA, 51, Carr Lane, Acomb, York.

THE club is open each Tuesday and Thursday, 7.30 p.m. to 10.0 p.m. and is situated in Fetter Lane, York. (Facing the rear of The Queens Hotel.) Thursday is the general meeting night and once a month talks, lectures and demonstrations are given. The last one on "Tape Recorders," with a practical demonstration of a very good home-built instrument by Mr. Linfoot (G3GCX), was very well received by all. It was decided

from one of the knobs is laid in, taking care that the grub screw is not covered. Lead is then added to fill up the tin, and if too deep for the boss which has been selected, this latter may be raised with a pair of pliers and the gas jet turned out to permit the lead to cool. The only difficulty likely to be experienced here is in accurately centring the boss, and to assist in this the tin may first be marked out and thin wires twisted round the boss and cut to hold the boss in the exact centre. If a lathe is available the block of lead may, of course, be turned down afterwards to make an accurate flywheel, but this is not essential.

The large drive is obtained by placing two shallow lids back to back, and driving through them three brass brads, riveting them or soldering them to make a large pulley. No great depth is required in the groove, but one edge is cut away as shown to accommodate the cord which is turned in and attached afterwards to a short spring soldered to the drum. The position is not critical. The second knob boss is then attached to the centre of this large pulley, either by soldering, or any other preferred means, again making certain that it is accurately centred.

Finally, the large rectangular sheet of aluminium or other metal is obtained and a hole drilled to accommodate the one-hole fixing bush in the desired position, and a further hole at the centre where the condenser spindle will come through. This will depend upon the position of the control spindle in relation to the chassis in use. The two pulleys from the curtain railway device are held at the top corners by short bolts and lock-nuts. When completed, the metal plate should be attached to the chassis, either by means of small angle brackets attached to the top of the chassis, or by bolts through the front runner of the chassis. The nylon drive cord is wrapped round in the manner shown in Fig. 3, and the drive turned until the cord is drawn to its maximum position in one direction. Then a metal pointer is soldered to a small strip of thin brass which is clamped over the horizontal portion of the cord (at the correct end of the dial, of course), and the control rotated to wind the cord in the opposite direction. If the cord is not fully wound when the pointer is at the other pulley, a stop will have to be provided to avoid the drive being overwound with the result that the pointer will not always register in the same position. Alternatively, the pointer may be attached to the cord temporarily, and the pulleys placed in position only after the drive has been operated in order to find the scope of its travel.

When finished a piece of good quality Bristol board should be attached to the front of the metal plate and the drive attached to the condenser. Stations should be tuned on all bands and horizontal or vertical lines, as desired, should be ruled on the board and frequency, wavelength or station indications marked by logging. These may afterwards be filled in in coloured inks, and the whole protected by a sheet of glass held either behind a cut-out in the cabinet front, or on the drive plate by means of small blocks of rubber cut out and attached with suitable cement. An escutcheon may be made up in any preferred fashion, either with metal cut out, or thin picture frame moulding suitably coloured or varnished.

A New Tape Recorder

THE ELA Department of Philips Electrical Ltd., announce the release on the British market of a new magnetic tape recorder—type EL.3530; a portable, twin-track device designed for operation on A.C. mains, 50 cycles per second, on voltages between 110 and 245, and possessing a number of interesting features.

Simplicity of design, great ease in operation and quality of reproduction, are three of this new recorder's most important features among many others embodied as a result of Philips 25 years' experience in the making and marketing of sound reproducing equipment.

The twin-track recording of this new model is for a tape velocity of 3¾in. per second, giving it a tape consumption which is one fourth of that of single-track recorders with a tape velocity of 7½in. per second. Music and speech reproduction are of the highest quality. The tape length of 600ft., on a 5in. diameter reel, affords a recording or play-back time of one hour. The particularly high magnetic qualities of the Philips tape ensure the elimination of noise and distortion in the sound reproduction. The same tape can be used thousands of times without any perceptible wear of the tape, or deterioration in the sound quality.

The equipment has 2 heads, the erasing and the combined recording/play-back head. During recording, the erasing head erases any previous recording still on the tape. During play-back the erasing head is switched off. Because of the high-frequency A.C. used for erasing and pre-magnetising the tape, sound reproduction is rendered more completely noise-free. A special advantage of this recorder is that the recording play-back head is de-magnetised when changing over from recording to play-back, and vice-versa; this further eliminates noise.

A "magic eye," operative only during recording, indicates the recording level by lighting-up immediately the appropriate knob is put in the recording position. The "magic eye" serves also as a warning that the erasing head is switched on.

Play-back

The play-back amplifier has an output of 2.5 watts, fully sufficient for use in small halls. The built-in loudspeaker ensures clear and true-to-life reproduction over the audio-frequency range. There are output sockets for connection to an extension loudspeaker and to headphones for monitoring purposes. An output is provided on the recorder to enable recordings to be transmitted over lines to an existing amplifying system.

The recorder is supplied with a crystal microphone equipped with a table stand, and 1½ yards of cable. The high sensitivity of this microphone enables it to be used, if necessary, at a considerable distance.

Telephone conversations can be recorded quite easily with this recorder by the use of the Philips Telephone Coil, type EL.3970. This coil needs only to be put under the telephone and connected to the 2mV, 0.5 Megohm input of the recorder. No connection with the telephone itself is necessary.

A programme indicator, type EL.3979, can be attached, if required, to the recorder. This can be used for noting accurately and finding quickly particular parts in a recording, and is likely to be of great help for educational institutions.

The complete equipment, which weighs 32lb., is supplied in a case covered with washable plastic. There are compartments in the lid for the microphone with table stand and 2 connecting cables.

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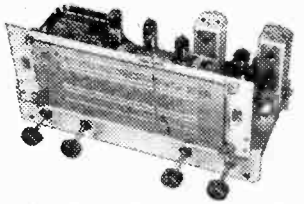

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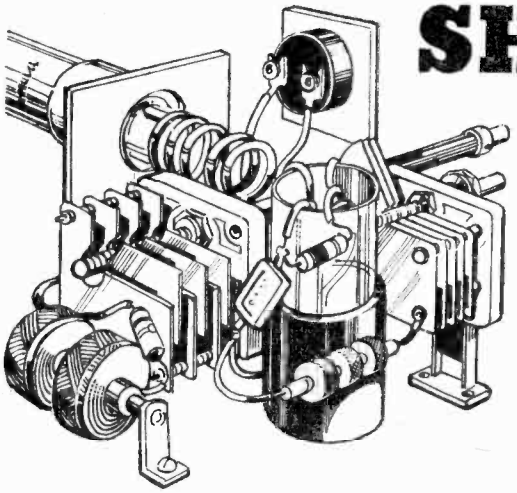


SHORT-WAVE SECTION

VARIABLE SELECTIVITY IN SHORT-WAVE RECEIVERS

By T. W. Dresser

ONE of the principal difficulties the builder of home-constructed short-wave or communications receivers has to contend with is that of selectivity. There is little fun in assembling an elaborate receiver only to find that other stations mess up the sidebands of the wanted one or, due to frequency drift, swing right across it, periodically blotting it out. With the latter it is impossible to do anything, as overmodulation of the transmitter alone will cause frequency shift up to five per cent. or more and that is entirely in the hands of the transmitter engineer, but with the former condition it is possible to remedy the situation to some extent by means of selectivity control. That some such control is necessary will be obvious to anyone who regularly listens on the congested short-wave bands of to-day.

It happens to be one of the chief advantages of the superhet receiver that almost all the selectivity characteristic is concentrated in the I.F. amplifier, the R.F. section being devoted essentially to the elimination of second channel interference and straight amplification, and since the I.F. amplifier has only to deal with a fixed range of frequencies it is possible and practical to adjust the response curve to suit our requirements or even to suit a number of differing requirements. In fact, such an adjustment is necessary when it is desired to secure a good compromise between sideband cutting and interference from adjacent channels.

There are a number of ways in which this can be achieved, the most primitive being a mechanical device which changes the distance between the coils (and therefore alters the coupling) but this is seldom encountered nowadays and, in any case, is far too difficult for the amateur to construct. This method, like most selectivity controls, has some drawbacks, principally loss of gain, but this is not of a serious nature and can usually be compensated for by driving the existing I.F. stages harder or adding a further stage if it is deemed necessary. That, of course, is at the discretion of the constructor. In Fig. 1 are given three basic circuits for I.F. couplings, in each case using two I.F. transformers placed back to back. There are other arrangements but in the main they are variations of those shown.

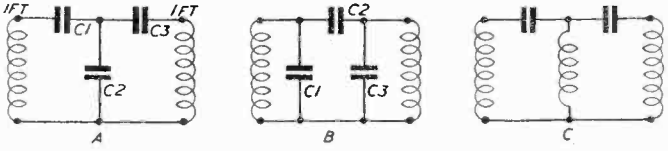


Fig. 1.—Capacitive reactance coupling.

The Circuit

The circuit in Fig. 1(a) provides capacitive reactance coupling by means of the common condenser C2, and the bandwidth may be varied by altering the value of this condenser. Fig. 2 is a practical rearrangement of this circuit which will provide bandwidths of from 7 to 12 Kc/s by switching condensers. This compares favourably with the majority of communications receivers, few of which have a narrower bandwidth than 6 Kc/s. Fig. 1(b) is a top-end coupled circuit in which the bandwidth can be controlled by varying the value of C3, and similar capacity condensers to those used in Fig. 2 will give a similar range of bandwidths. In Fig. 1(c) an inductance is substituted for the common coupling condenser of Fig. 1(a) and again, by varying the amount of

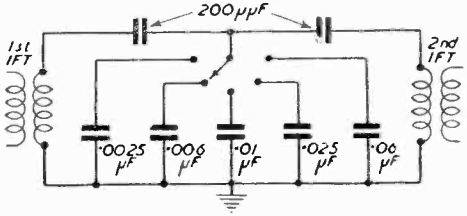
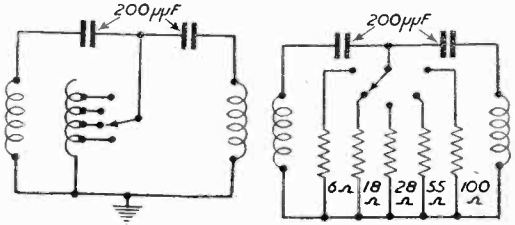


Fig. 2.—Practical arrangement of the Fig. 1 circuit.



Figs. 3 and 4.—Further practical circuit arrangements.

inductance in circuit the bandwidth can be varied. Fig. 3 is a practical arrangement using a tapped coil and providing the same bandwidths as the previous circuits. The coupling inductance is wound on a bakelite former 2in. long by $\frac{3}{4}$in. diameter with 65 turns of 24 S.W.G. enamelled wire, tapped at 11, 19, 27 and 38 turns from the earthy end of the coil. Similar control of selectivity can be secured by substituting resistors for the condensers in Fig. 2

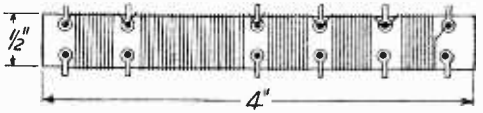


Fig. 5.—A practical coil arrangement.

and a practical circuit using them is given in Fig. 4. The values of the respective resistors are shown on the schematic, but it is possible that some difficulty may be met in obtaining such low values and it would probably be advisable to build up a resistance strip similar to that wound by the writer. The former was a bakelite strip $\frac{1}{16}$in. thick by $\frac{1}{2}$in. wide by 4in. long wound as in Fig. 5 with Eureka resistance wire. The taps were anchored to short lengths of 18 S.W.G. tinned copper wire bent tightly round the former close to the end of each section as shown. The 6 and 18 ohm sections were wound with 38 S.W.G. Eureka, the 28 ohm with 40 S.W.G. and the 55 and 100 ohm with 44 S.W.G. All windings were close wound.

There are numerous other methods for attaining the same end, such as the tertiary winding I.F. transformer, the circuit of which is given in Fig. 6. These were frequently used in older receivers but they are clumsy and cumbersome arrangements, and necessitate elaborate switching and special types of I.F. transformer which cannot readily be wound at home.

The theory underlying all these arrangements is somewhat involved—a moderate explanation would occupy the greater part of this journal—and for that reason it has been omitted, but for those who are interested reference can be made to the Radio Handbook by Langford-Smith, Radio Data Handbook issued by the Federal Co. of New York, Terman's Radio Engineering and the Proceedings of the I.R.E., vol. 23, page 594, June, 1935 and other sources.

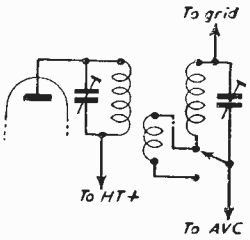


Fig. 6.—An I.F. transformer with a tertiary winding.

Electronics Equipment at Farnborough

AT the Operational Display of Military Electronic Equipment, held at Farnborough, in May, Mullard, Ltd., exhibited a wide range of valves, electron tubes and magnetic material components.

Included in the display of valves and electron tubes were transmitting valves, hydrogen thyratrons, C.Z. multi-reflection tubes, magnetrons, klystrons, ranges of B9A and B7G miniature valves, rugged and reliable valves, battery and mains-operated sub-miniature valves, flying lead valves, photocells, instrument and radar cathode-ray tubes, image converters, stabilisers and voltage reference tubes, electronic flash tubes and cold cathode tubes.

An interesting valve included in the range of sub-miniature valves was the DC70 directly-heated triode. This valve can be used as a driven amplifier or oscillator in circuits operating at frequencies up to 500 Mc/s. It therefore offers important possibilities in extremely small and compact U.H.F. communications equipment.

Another valve that should prove of value to designers of telecommunications is the QQV03-20 R.F. double tetrode. Built in the butterfly construction, this valve can be used in conventional circuits at frequencies up to and well in excess of 600 Mc/s, and it has been specially designed to operate at high efficiency with low drive power. This valve is inherently rugged and is specially suitable for use in airborne and mobile telecommunications equipment. A further development in this class is the miniature R.F. double tetrode QQV03-10. This valve has been designed to dissipate 5 watts at each anode, and is primarily intended for use as a driver, frequency multiplier or output valve in competitive mobile equipment working at frequencies up to 225 Mc/s.

Also on view was a compact experimental transmitter using QQV03-10 and QQV03-20 valves. This transmitter, using conventional valves only, operates at a frequency of 430 Mc/s with a high order of efficiency and power gain. It was demonstrated feeding 10 watts into a dummy load.

Other new valves and electron tubes shown included an inert gas-filled half-wave rectifier 3B28 for use in high-voltage rectifier circuits; a 12in. radar display tube MF31-95, and a flash tube LSD24 having an anode rating of only 1,000 volts.

Mullard magnetic materials and components shown included Ticonal cast and sintered permanent magnets, Magnadur ceramic permanent magnets, Ferroxcube core material, precision variable capacitors and displays of Varite resistors and concentric air dielectric capacitors. Also shown were protected radar magnets for magnetron applications.

Ticonal magnets are extremely stable and have a higher external magnetic energy per cubic centimetre than any other permanent magnet commercially available. As a result, they combine extremely high magnetic performance, small size and stability, thus allowing improved efficiency and a marked reduction in the size of many components used in electrical and electronic apparatus.

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OPEN TO DISCUSSION

The Editor does not necessarily agree with the opinions expressed by his correspondents. All letters must be accompanied by the name and address of the sender (not necessarily for publication).

"For the Beginner"

SIR,—Having taken in PRACTICAL WIRELESS for some time, I should like to take the opportunity to thank you for thinking a little in regard to the beginners. I myself am one and I cannot find time to go to college, as I have on previous occasions, where the subject was made boring, as teachers are on another subject before the previous one has been fully understood. Your first of the series looks to me as though they are going to be interesting—more interesting than if I was at college, but I should (if you think it wise) like you to state values of components so that beginners like myself could get down to the job from the start.

I hope in due course to obtain the two books mentioned in the first of the series so I hope, for my sake as well as others, that you will keep this good work up.—T. J. DOUGHTY (Wolverhampton).

Whilst we are always pleased to assist readers with their technical difficulties, we regret that we are unable to supply diagrams or provide instructions for modifying surplus equipment. We cannot supply alternative details for constructional articles which appear in these pages. WE CANNOT UNDERTAKE TO ANSWER QUERIES OVER THE TELEPHONE. If a postal reply is required a stamped and addressed envelope must be enclosed with the coupon from page iii of cover.

SIR,—May I congratulate you on your foresight in providing a long felt want in your new series, "The Beginner's Guide to Radio."

You must have thousands of readers like me, eager to build a radio set of their own and frustrated by lack of knowledge. But now at least—thanks to your efforts—the opportunity to learn presents itself.

Please carry on encouraging raw beginners like myself by providing as many articles as possible. Remember, the radio novice of to-day, through instructions of this nature, may well be the radio expert of to-morrow.—S. H. TAYLOR (Ramsgate).

Super-Regeneration

SIR,—As a raw beginner in wireless and having been bitten by the V.H.F. "bug," I was most interested in the article in the March 1953 issue on "Super-Regeneration," by E. G. Bulley, particularly as I am constructing to a circuit very similar to that in Fig. 2. I do feel that more emphasis should be given to the need for prevention of R.F. energy radiation, as in my possibly mistaken observation *there was no indication to the operator* that annoyance was being caused to the neighbours from a set without screening or an R.F. stage.—J. A. CUSDIN (Polegate).

L.F. Couplings

SIR,—If Mr. E. Wells, of York, wants to save himself a lot of trouble and expense, he would be well advised to steer clear of the D.C. coupling fads of Bonavia Hunt. There are strings of amplifiers between the microphone and the loudspeaker, and Mr. Hunt believes passionately in the only one that does not use condensers.

Amplifiers with condenser couplings can achieve everything, and possibly more, than Mr. Hunt claims for his directly coupled systems, and without half the trouble to the amateur in getting them in order. I would like to have some technical proof from Bonavia Hunt to explain his extraordinary claims in this direction.—G. A. KNIGHT (Chelmsford).

SIR,—There are three possibilities concerning Mr. N. H. Crowhurst's passion for A.F. transformers for coupling (May issue).

(1) That he has not heard of the modern high gain valves.

(2) That he is able to afford high-class coupling transformers.

Mr. Crowhurst suggests that the modern preference for R.C. coupling is "that bad choice of values does not usually produce such obviously bad results as can occur when a transformer is seriously misused."

Most constructors who buy PRACTICAL WIRELESS usually build the published, carefully designed and tested sets. Bad choice of values doesn't come into it.

Surely cost is the main consideration. Compare the cost, and size for that matter, with a capacitor and resistor. How one can "effect a saving" I fail to see.

(3) That he is a salesman or even a director of a transformer manfacturers and gets them cheaper!—BRYAN A. COX (Hambrook).

In Defence of Super-Modulation

SIR,—With reference to my article in the June edition of PRACTICAL WIRELESS, I should like to correct the following error. On page 326 the impedance formula should be:

$$Zo = \sqrt{K-1}\ 276 \log_{10} \frac{D}{r} \text{ ohms,}$$

the logarithm being taken to the common base 10 and not as shown $\left(\frac{D}{10r}\right)$—WM. A. HOPE (Roxburghshire).

The Amateur Transmitter

SIR,—I could not agree more with Mr. Hector Coles' letter regarding amateur transmitting published in last month's issue of Open to Discussion.

A very narrow-minded situation surrounds the man, who, with a shed full of components and a genuine

interest in radio, dares to be ambitious enough to have a go, and get on the air.

With a 2½d. stamp and a brief note, he sends to the G.P.O. for full details of how he can achieve his ambition. And I would bet any money that nine out of ten, after reading all the regulations and conditions, throw them on the back of the fire and turn to something else.

I speak, of course, for those chaps, and there must be very many, who haven't got a friend with a transmitter, or an Amateur Radio Club. Two things which make a great difference.

Our would-be "Ham" finds among other things that he has to pass a technical examination, the syllabus of which is enough to put anyone off. Then there is the Morse, which is stupid to say the least. The men who argue for this way of communications are, in most cases, ex-service men who have had to learn it.

I would suggest that the next Radio-Tele-Communications Convention clears the bilge off the thousands of kilocycles of short waves, and that the G.P.O. will create a band for the novice. A five-watt Crystal Control Transmitter would be the delight of thousands and in turn would bring the G.P.O. thousands, perhaps not with the same delight.

The whole thing reminds one of the old saying: "You can't go into the water until you have learned to swim."

We can only, once again, refer back to the good old days, when the only things you needed to get on the air were an excuse and a transmitter, and not qualifications and a morse key.—C. ROBERTS, (Worcester).

Quick Capacitor Tester

SIR,—I have built the quick capacitor tester as described in your January issue, and added a slight modification.

In the original model there is the likelihood of the condenser under test being left charged on switching off. If, however, a resistor is connected between contacts 2 on the lower two wafers of the switch (I have used a 10 K), the condenser will be automatically discharged on returning the switch to the central position, and the crocodile clips will then be safe to handle.—P. E. BAKER (N.5).

Contact Operation and Maintenance

SIR,—With reference to the article in the March issue on this subject, I would like to point out a consideration when using carbon tetrachloride in cleaning contacts. The practice of using carbon tetrachloride in cleaning electrical contacts is deprecated. Technical CCl_4 usually contains traces of free chlorine which, in the presence of moisture, may form hydrochloric acid, resulting in corrosion at a later time. Sliding contacts should, therefore, be cleaned occasionally with a lint-free cloth, either dry or moistened with a solvent such as varsol or benzol. —EINAR TOLLEFSEN (Egersund, Norway).

Watch Rate Recorders

SIR,—It would be much appreciated if you could assist me in securing some information concerning the electronic watch rate recorders there are at present in use by watch firms throughout the country.

I am particularly anxious to secure a copy of the circuit of such an instrument and perhaps a reader can suggest a source of supply of such information.

I may add that I have no intention of infringing any copyright, etc., as I am already more than familiar with the principle involved, also the practical layout, etc. The several refinements I do seek, however, are only obtainable by this method, i.e., to have a copy of a commercial circuit.—RONALD W. DYSON (Exeter).

Transistors

SIR,—Since transistors have already appeared in limited numbers on the American market, and are likely to appear at an early date on the British, experimenters will be eagerly looking forward to obtaining samples.

It should be pointed out that the price is bound to be high, probably between £3 and £4. Which definitely places them in the luxury class.

There is, too, a great pitfall in their use awaiting the unwary. They are as easy to burn out by overload—or by reversing the polarity of the applied voltage—as an instrument thermo couple.

I burnt out three of these in spite of every precaution.

So amateurs, be warned in time!

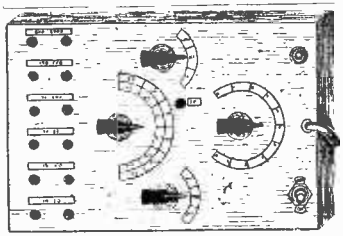
There is, unfortunately, considerable confusion of thought as to the valve parallel. In the point contact there are two whiskers and the germanium base.

The first whisker is called the emitter and is compared to the valve grid, but is *not* negative with respect to base or cathode as the valve is. It is about quarter-volt positive. Reversing this voltage won't cause damage. The second whisker is called the collector and is compared to the valve plate but is *not* positive with respect to base. It is negative. Reversing this voltage spells disaster.

There appears to be considerable confusion, too, as to proposed markings to distinguish base emitter and collector by the various British manufacturers. Is it too much to hope that they will agree on a standard marking, identical with the American? British manufacturers in the past have shown a lamentable weakness for individualism in the creation of standards and identifying letters, with the result that foreign countries invariably buy American valves, etc. Transistors are easily burnt out by surge currents such as due to deformed electrolytics, shorted or defective capacitors or to shop counter "testing," or experiments to which a lot of counter radio amateur mechanics are addicted. So when transistors do appear don't buy unless sealed. Don't use Government surplus capacitors which are, as a rule, at least 30 per cent. duds. Use only tested circuits. Pause and think 10 times before applying any voltage at all, and then only to the complete wired and checked instrument, receiver, deaf aid or whatever it may be. Used thus, transistors are asserted to have an almost indefinite life.

So much for the point contact. There is bound to be confusion, too, over the markings on the junction type.

I hope these notes will save impecunious experimenters from tragedies of transistor burn outs at three or four pounds sterling a time!—WM. J. LAW (Ealing).



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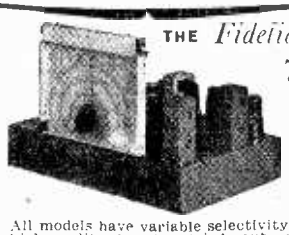

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News from the Trade

"Osmor" Components

SOME interesting new accessories are available from the makers of the well-known Osmor Coils and coil parts. These include the following:

Jar Racks. The Type 1 "Jar Rack" for wall-fixing, holds eight jars and retails at 6s. 9d. Type 2 screws under a shelf and holds six jars, price 5s. 9d. retail. Standard 1-lb. jam-jars may be used, though not supplied, and ordinary metal lids used if required. These are invaluable for holding screws, nuts, bolts, etc.

"*Two-one*" *Reversible Chassis Cutters.* Two sizes are at present available. Size 2 cuts $\frac{3}{8}$in. by $1\frac{1}{8}$in. holes (price 18s. 9d. retail), and size 3, $\frac{3}{4}$in. by $1\frac{1}{2}$in. (price 22s. 6d. retail). Other sizes will be added according to demand. These cutters may be operated with a spanner or tommy-bar and used on steel up to 18 s.w.g., brass, and dural 16 s.w.g., and aluminium and copper 14 s.w.g. Ideal for valveholders, large grommets, etc.

Tommy Bars. For use with the above, price 1s. 3d. each retail.

$\frac{3}{8}$*in. Jiffy Punches.* Hammer-operated, and for use on gauges of metal as above. Price 7s. 6d. each retail. $\frac{1}{2}$in. jiffy punches are also available, price 8s. 9d. each retail. Other sizes are being added. These are easy to use and will withstand considerable wear. —Osmor Radio Products, Ltd., No. 2 Factory, Waldron Works, The Waldrons, Croydon.

Southern Radio—Change of Address

SOUTHERN RADIO & ELECTRICAL SUPPLIES are now operating from new improved premises at Sorad Works, Redlynch, Salisbury, Wilts.

A High Efficiency V.H.F. Power Tetrode

A V.H.F. valve which is one of the most efficient of its class in the world, is now being made commercially available by the Communications and Industrial Valve Division of Mullard Ltd. It is the hard-glass power tetrode QY3-125, and it is particularly recommended for use as an oscillator or R.F. amplifier in compact communications and allied electronic equipments operating in the V.H.F. range.

The outstanding characteristics of this valve includes low driving power, low power consumption, and unusually high power gains at very high frequencies. With a maximum anode dissipation of 125 watts, the QY3-125 will give an output of 375 watts at frequencies up to 120 Mc/s. It is constructed in hard-glass on the B5F base.

The principal characteristics of the QY3-125 are as follows: Filament voltage, 5.0 v.; filament current, 6.5 A.; anode voltage (max.), 3,000 v.; anode dissipation (max.), 125 W.; cathode current (max.), 270 mA.; frequency (max.) (full ratings), 120 Mc/s.; frequency (max.) (reduced ratings), 200 Mc/s.—Mullard, Ltd., Century House, Shaftesbury Avenue, London, W.C.2.

The Philips Disc-jockey

PHILIPS ELECTRICAL LTD. announce the introduction of the first of their range of record players; it is Model No. 424A, known as the Philips "Disc-jockey." The price is 11 gns. (tax paid). Supplies are now available.

This record player is designed to play all normal and long playing records.

An outstanding feature of the Philips "Disc-jockey" is the Philips double stylus "Featherweight" pick-up. This pick-up is so light that the needle pressure is no more than one-third of an ounce. Yet this has been achieved without the need for a counterbalance because the complete tone arm weighs only three-fifths of an ounce.

It is the combination of a very light needle pressure with overall lightness of the complete arm which gives the "Featherweight" pick-up its remarkable stability, preventing groove jumping and reducing record wear to a minimum. As is well known, every record surface has very small "ups and downs" over which the pick-up must travel. The inertia of the Philips "Featherweight" pick-up is so low that it can accommodate itself to variations, whereas heavy counterbalanced types simply plough through the record material. The Philips "Featherweight" pick-up obviates all this and gives perfect "tracking."

The pick-up head has two Philips sapphire needles which are ground and finished to the most exacting specification in Philips own factories. The microscopically accurate grinding of Philips sapphire needles reduces needle scratch and "chatter" to a negligible level. One needle is used for the normal 78 r.p.m. records and the other for the long-playing types. These needles are brought into play by a slight turning of the pick-up head and therefore the single pick-up head is suitable for all records. Another refinement is the inclusion of an auto-stop lever by means of which the "Disc-jockey" can be set so that the motor automatically stops at the end of the record. It will accommodate any type of record whatever the run-off groove or label size. The turntable is activated by a special three-speed motor developed by Philips themselves. This is a precision-built silent motor which is completely "rumble-free."

The Philips "Disc-jockey" Model No. 424A is housed in its own finely finished ribbed grey case, which measures 13in. by $11\frac{1}{2}$in. by $4\frac{1}{2}$in. and weighs just 7 lbs. It has a flush-fitting handle and can be carried about in perfect safety due to felt cushions in the lid which hold turntable and pick-up in place. —Philips Electrical Ltd., Century House, Shaftesbury Avenue, W.C.2.

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RESPONSER, 3118A, less 5Z4, **64/-**; Junction Box "240," **6/-**; Amplifier, 1134A, less valves, **6/-**; Pre-amp., 227A, less valves, **4/6**; Tranx, 1083, less valves, **25/-**; Blowers, 24V, **12/6**; post free. ANNAKIN, 25, Ashfield Place, Otley, Yorks.

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PRACTICAL WIRELESS, July, 1953.

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