H.T. SUPPLY FROM A.C. MAINS

MODERN WIRELESS

1/- MONTHLY

Edited by
NORMAN EDWARDS
M.I.R.E., M.R.S.L., F.R.G.S.

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ECHO EFFECTS IN BROADCASTING

An exclusive article packed with " inside " information.
By Capt. H. J. ROUND, M.I.E.E.

SOME time ago when discussing the question of reproduction I expressed the opinion that under most circumstances faithful reproduction was impossible, partly because the expression " faithful " has no real meaning. The microphone takes a snapshot of the performance from one angle and one position, and it is illogical to expect from our loud speaker a reproduction of the original in entirely different acoustical conditions.

For one thing, we can seldom get a strength equal to the original, and that is also against exact reproduction; but, providing we can obtain intelligibility of voices and music, and a pleasing " picture," we should be fairly well satisfied.

Such a term as " faithful reproduction " really means nothing, because what you hear in the loud speaker at the present time from the London studio very often bears no resemblance to the original. Transmission is now deliberately faked to give the pleasant picture at your end. It all came about from the observation that transmissions from certain halls such as the Grand Hotel, Eastbourne, the Piccadilly Hotel, various churches, etc., were much more realistic than from the studio; but nothing we could do to the studio would give the same grand special effect.

Simple Arithmetic

In the first broadcasting a small studio was used without any special furniture; the results were pleasant enough provided the artistes were quite near to the microphone, but with an orchestra the resultant transmission was quite muddled, and certain notes of the piano and orchestral instruments had a bad way of showing up with exaggerated strength, sometimes blasting the transmitter in consequence. The next stage in the development was to drape the room, and in this way transmission was easier and more distinct, but had now lost the live characteristic of the natural room.

No variation of draping gave the right effect, even with the much larger studios which came into use later, and in view of the wonderful effects obtained from outside broadcast halls, we had to sit down and try to make out what these effects were due to. It turned out in the end to be a question of simple arithmetic.

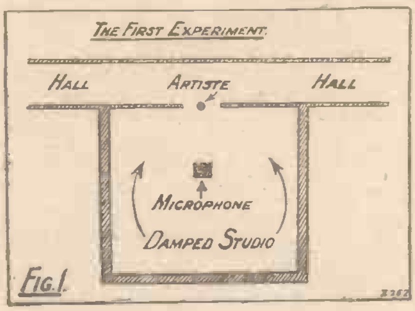
We recognised that the pleasant effects were due to reverberation, but the reverberation of even moderately large rooms would not do, and damping reverberation down in a small room was not the same thing as using a large concert hall. In a small room, if the artiste were near the microphone, the result was quite pleasant, because the direct voice and the room reverberation could be adjusted in ratio by simply altering the distance of the artiste from the microphone. Thus, an artiste in almost any position produces in a room the same strength of reverberation, so that by bringing the artiste near to the microphone the direct sound can

ECHO EFFECTS IN BROADCASTING

—continued

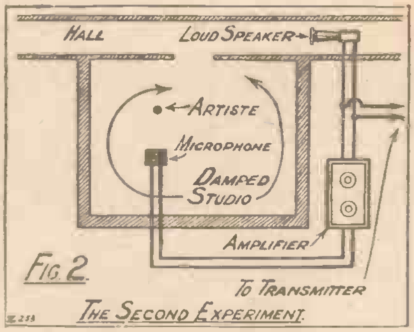
be made large compared with the echo, and by slowly removing the artiste the direct sound can be made small compared with the echo.

It must be remembered that absolute strength of sound makes no difference to the broadcasting engineer, as he has an amplifier with which he can bring up all sounds to the same strength, so that if in this experiment he brings the voice always



to the same strength, the reverberation can be varied by merely altering the artiste's position. There is a place which the average ear likes best, but, of course, it is difficult to put every artiste in that one place, especially when one has an orchestra of artistes.

Damping the room with curtains had the effect of enabling the artistes to go further away from the microphone, but progressively as the room was more and more damped the



general effect got less and less pleasant.

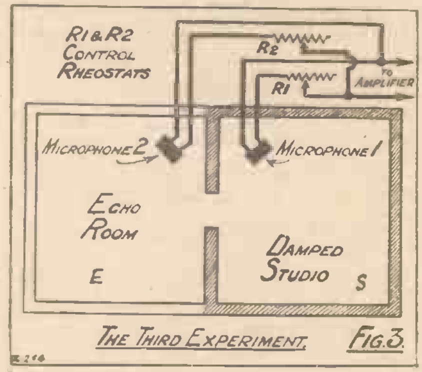
We have never yet determined how long the reverberation can be allowed to go on, but rooms which go on echoing for six or seven seconds give very pleasant effects, providing the ratio of the initial strength of the echo to the direct sound is progressively reduced as the damping becomes less and less. How to get these two factors of echo strength and prolongation under control was the problem, and it has been solved in a limited way at the London station, although some of the effects are still not quite understood.

The "Railing" Effect

When we are dealing with a problem which is half psychological the difficulties are very great. Thus, some people heartily dislike reverberation, but I think there is no doubt that the great majority prefer a limited amount of it, and I think the criterion to apply is that the intelligibility of speech and music must not only be retained but must be improved, and also that the reverberation must give a musical effect. Impulsive sounds can very easily become unmusical sounds—you will remember the peculiar scrunching sounds one gets when walking pass railings, due to the irregular reflections from these railings of the sound impulse produced by the feet.

Harmonious Blending

An impulsive sound produced between two walls results in a series of echoes at equal intervals. Thus, with two walls 10 ft. apart, if a sharp sound is made at a position half-way between, the result is a series of sharp sounds following one another at intervals of about 1-100th of a second. This analyses out into a series of notes as follows: 100, 200, 300, 400, 500, 600, 700, 800, 900, 1,000, etc., vibrations per second. Now, of course, the 100, 200, 400, 800, etc., form one note with harmonics; 300, 600, 1,200, etc., form another note with harmonics which will blend with the first one fairly well. Then we have 500, 1,000,



etc., which will blend less well with the others; and, finally those of 700, 1,400, etc., 900, 1,800, etc., 1,100, 2,200, etc., which would only be used in combination with the others in really modern music, that is to say, they will not pleasantly blend to the ordinary ear. I take the last case to show that any such type of reverberation in an ordinary room must be avoided.

Echo Under Control

What seems to be wanted is a perfectly irregular room with practically no damping. I will, however, before going any further with this point, discuss the interesting question of how the amount of reverberation and direct sound were got under separate control, so that placing the artiste in an exact position was no longer necessary.

The first attempt was made by standing the artiste in a doorway between the damped studio and a

The main studio of W P G, a famous American station. Note the two additional microphones on the table.

ECHO EFFECTS IN BROADCASTING
—continued

large hall. (See Fig. 1.) Some of the artiste's voice then went into the hall and came back into the microphone, mixing with the direct sound from the voice. Very pleasant effects could be made like this, the adjustment being given by altering the position of the artiste.

The next step was to put a loud speaker connected to the microphone amplifier in the hall, and trust to some of the sound in the hall getting back to the microphone. (Fig. 2.)

It did all right, but unfortunately for the experiment it annoyed the artiste and also tended to "sing round the circuit," that is, if the echo were made strong enough, the whole system just oscillated, due to the echo being again amplified, and so on.

The next experiment was along the same lines, but slightly differently arranged.

The Echo Room

An empty room (E), Fig. 3, was chosen next to the studio (S), with an open door between. M_1 and M_2 were microphones placed as shown. Some of the sound from the singer or the piano reached M_1 and some went into E, where after reverberating it was picked up by M_2. M_1 and M_2 were connected in parallel through variable rheostats (R_1 and R_2) and in this way the transmission could be altered from the very weak echo to all echo, if necessary. Unfortunately, a great deal depended upon the position of the singer, as this determined the amount of sound going into E, and an orchestra was difficult to handle. The practical solution of the problem was obtained by what is really a combination of two of these preliminary methods, and is illustrated in Fig. 4. The artiste actuates a loud speaker in the echo room, but instead of that echo being allowed to act on the artiste's microphone it acts on a separate one in the echo room, and these microphone currents are mixed with those due to the direct sound. Two microphones only are necessary, but it is usual in practice to use three merely for convenience. The echo room need no longer be adjoining the studio—a great convenience—as it can now be used as a unit for attaching to any studio requiring echo. Referring to Fig. 4, the direct sound from the point marked Artiste goes to M_1 and M_2. M_1 carries on to the main amplifier and transmitter; M_2 carries on to its special amplifier designed to work the loud speaker in the echo room. The echo now acts on M_3, and the resulting currents are mixed with the "direct sound" currents in the right ratio by means of rheostats R_1 and R_2.

This illustration shows the studio draping at the Berlin broadcasting station.

Faking the Loud Speaker

A loud speaker of the Rice-Kellogg make is the best type to use, as a fairly large volume of sound is necessary to overcome noises coming through the echo-room windows and doors. Sometimes a little faking of the tone of the loud speaker to correct the effect of the room is necessary, but ideally it should not be done.

I have used with some success the "echo" in bars of iron instead of an echo room, and it is probable that in the end echo will be added by some simple reverberating device such as a bar, rather than by a room. In practice a room is not only expensive to maintain, but it is rather difficult to obtain with the right musical character of echo.

A London broadcast for which two microphones were suspended on the wall.

ECHO EFFECTS IN BROADCASTING
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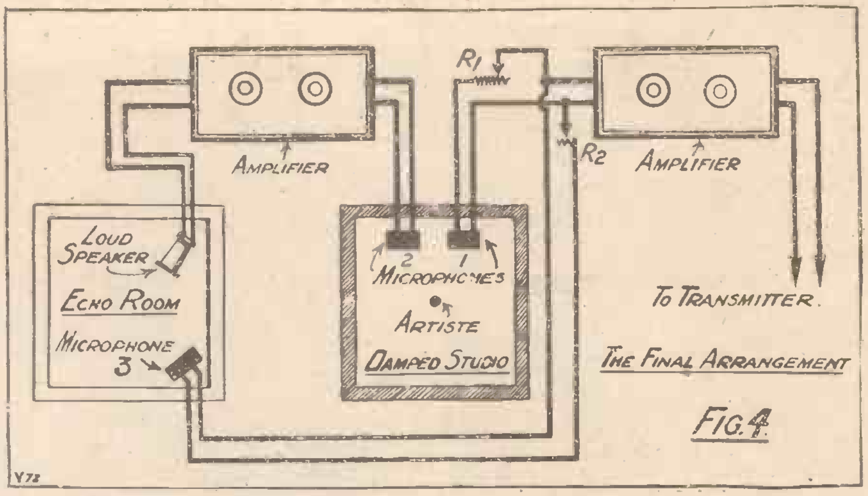
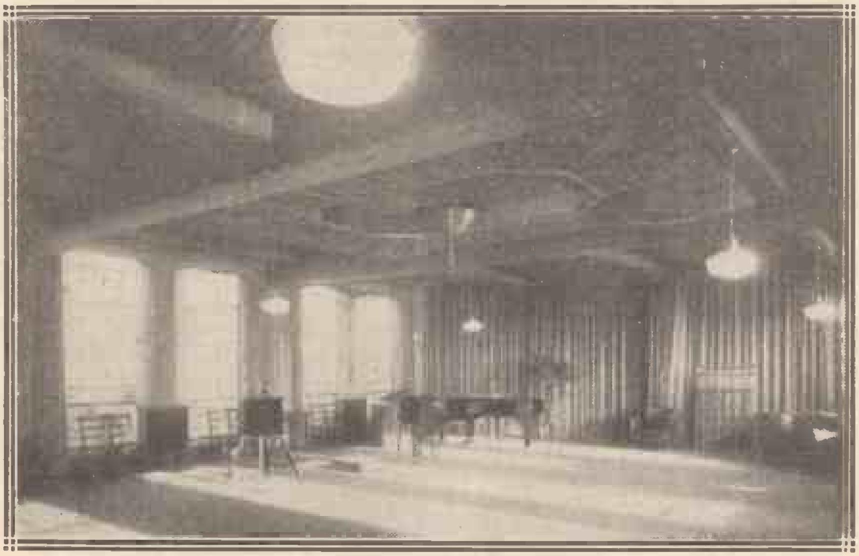


THE FINAL ARRANGEMENT

FIG. 4

The faults of artificial echo are many, but the two chief ones can be easily understood. The advantage of echo to the artiste is to some extent lost because he still operates in a dead room, but this is not very serious, as the larger modern studios are quite all right for the average performance, and in a very small dead room it is quite easy to arrange for a single reflecting surface to reflect the singer's voice back to him to give him confidence. The second fault is up to the control engineer, and lies in the problem of "How much echo shall I put in this?" He has it, of course, quite under control, and his judgment may be wrong; but, of course, the same argument applies to the man who chooses a hall for broadcasting. It may not be acoustically right, that is to say, the echo may be too strong for any practical placing of the microphone from the orchestra. Have you noticed how good the Albert Hall is? It is possible, on account of the enormous size of this hall, to get the microphone well away from the orchestra, so as to obtain an excellent balance, and yet not to get too much echo.


Studio arrangements and draping at 5 I T, the Birmingham station.

The Final Problem

The final problem to be settled is what is the nicest kind of echo chamber, and the experiments to determine this will take a very long time, as the problem is a very involved one. It is very probable that different types of echo room will suit different transmissions. Thus, a brilliant echo will be best for concert parties, whereas one with fine echoes in the lower tones will be best for orchestral music.

The trick, if it may be so called, undoubtedly gives a new weapon to the broadcasting engineer and possibly also to the gramophone engineer.

RADIO NOTES AND NEWS OF THE MONTH

A feature in which our contributor brings to your notice some of the more interesting and important Radio news items of the month.

Conducted by P. R. BIRD.

New Station for Poland

I HEAR that all the Poles are putting up new poles a-plenty—complete with aerials—as fast as funds will allow, in order to listen to their new station at Posen. The preliminary tests have been completed satisfactorily, and the Polish programmes are being sent out regularly on 270 metres.

Hans Across the Sea

Congratulations to Holland upon the short-wave broadcasting from P C J J. The Dutch transmissions have been picked up not only in Australia, but in India, America, and other widely separated points, with sufficient regularity to show that this short-wave working is not in the nature of a freak, but has very promising programme possibilities. Well done, Hans!

Germany's Super Station

A good sign which shows how well the wave-length gaps are filling up nowadays is the recent increased activity on long waves. New stations keep slipping into place, and the voice that breathed o'er 1,000 metres is now no longer solitary, but has become one of a cheery crowd.

Amongst these lofty spirits the new German station at Zeesen promises to be a star turn. Its power will exceed that of 5 X X, and the wave-length (1,250 metres) is a good one for daylight range, so that it will probably prove a very popular programme-provider. When working,

(*Continued on page 662.*)

THE "B.B.C." FIVE

This receiver employs the "four-stage" circuit recently recommended by the B.B.C. It must be understood, however, that although the values of components are substantially those advocated by the B.B.C. the choosing of the makes employed and the *constructional* design of this set are due to the author. The set built and described by

A. JOHNSON-RANDALL.

ONE of the most interesting quality receivers of recent months is the 5-valve set which was used by the B.B.C. for demonstration purposes at the Ideal Home Exhibition at Olympia.

Readers will remember that three sets were shown and demonstrated. These were a 2-valve, a 3-valve and a 5-valve set. Although the last-named receiver employs five valves it is really a 4-valve set, since the last stage consists of two power valves in parallel.

Each receiver employed perfectly standard components such as could be bought by any listener so inclined. The circuits, together with the values

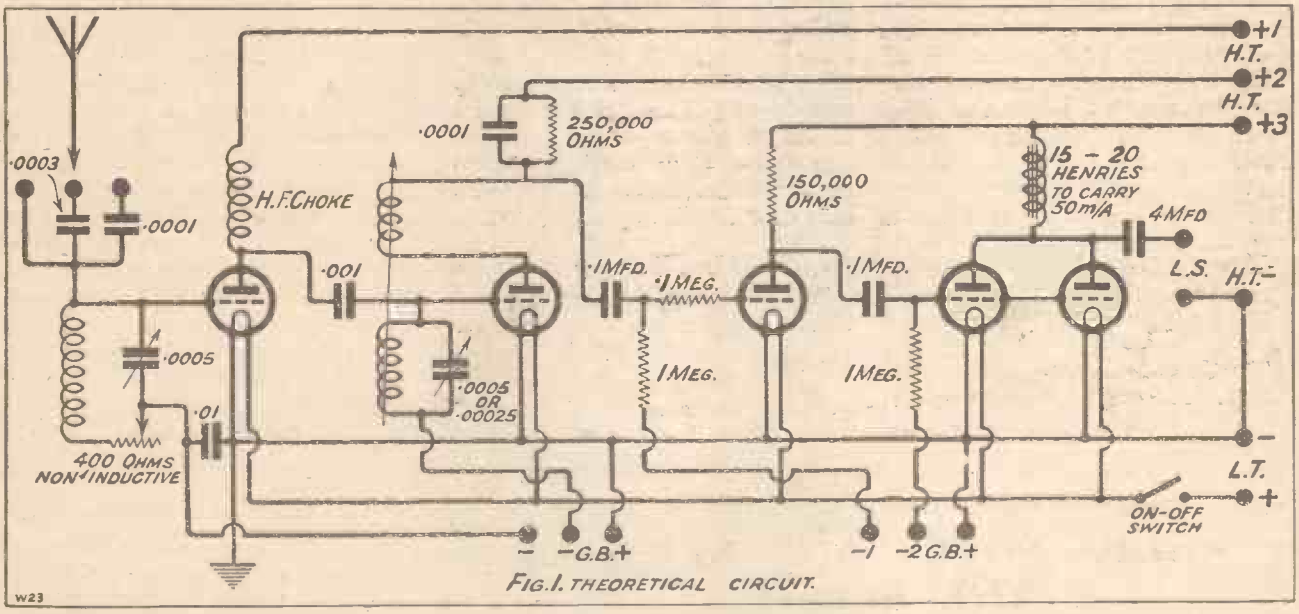


FIG. I. THEORETICAL CIRCUIT.

COMPONENTS REQUIRED.

- 1 panel, 21 in. × 8 in. × ¼ in.
- 1 cabinet and baseboard, 21 in. × 8 in. × 12 in. deep. (Peto-Scott.)
- 2 angle brackets.
- 1 coil socket for baseboard mounting.
- 2 S.L.F. variable condensers, one ·0005 and one ·00025 or ·0005 (see article). (Jackson Bros.)
- 5 valve holders. (Benjamin or any good make.)
- 1 back-of-panel 2-coil holder. (Peto-Scott.)
- 1 H.F. choke—60,000 micro-henries. (McMichael.)
- 2 ·0001 fixed condensers
- 1 ·0003 fixed condenser
- 1 ·001 fixed condenser
- 1 ·01 fixed condenser
  (Dubilier or Lissen.)
- 1 400-ohm Centralab potentiometer. (Rothermel Radio Corpn.)
- 1 250,000-ohms anode resistance. (Varley.)
- 1 150,000-ohms anode resistance. (Varley.)
- 2 0·1 mfd. mica coupling condensers. (Dubilier.)
- 2 Dumetohm holders and two 1-meg. grid leaks.
- 1 0·1 meg. grid leak and holder. (A 0·1 meg. anode resistance can be used if desired.)
- 1 4-mfd. Dubilier-Mansbridge condenser and two of 2 mfd. each.
- 1 15-20-Henry L.F. choke. (Pye.) (See note.)
- 15 terminals and a length of ebonite for terminal strips.
- 1 on-off switch. (Lissen.)
- 4 fixed resistors to suit valves.

THE "B.B.C." FIVE

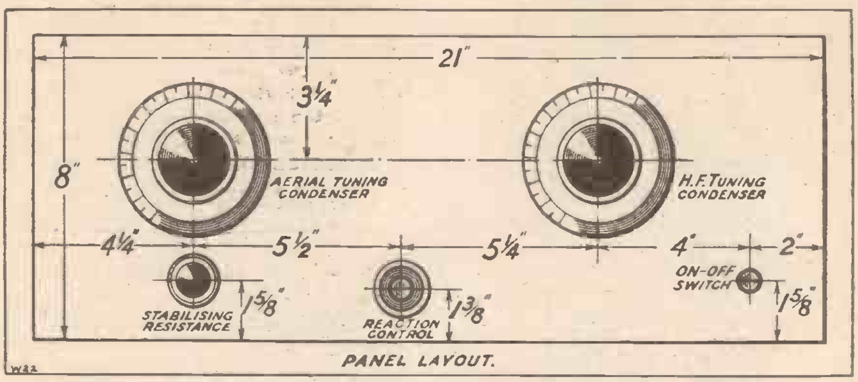
—continued

of the various components, were available to any who wished to construct similar receivers for themselves.

The B.B.C. for obvious reasons could not give details of the actual components used, but the circuits were so straightforward that various makes could be chosen which could be relied upon to give equal results.

The method of the H.F. coupling is the well-known shunt-feed arrangement. Its use enables anode rectification to be employed, and in addition it has certain other advantages. Many experts are of the opinion that it is superior to the "straight" tuned anode from the point of view of selectivity and stability. To improve the sensitivity of the receiver magnetic reaction can be applied to this second tuned circuit.

The L.F. stages are fairly straight-



PANEL LAYOUT.

In view of the interest aroused by these demonstrations it was decided to make up a receiver on the lines of the B.B.C. 5-valve set.

The circuit is virtually the same as that published by the B.B.C. and the values are those recommended by them. It will therefore be seen that the set described is simply a design similar to the original B.B.C. set, and it has been constructed for the benefit of those readers who desire to make up such a receiver for themselves.

The Circuit

The theoretical circuit is shown in Fig. 1. It consists of a stage of H.F. amplification followed by an anode rectifier, preceding two stages of resistance-capacity L.F. magnification. The aerial tuning circuit is a very simple and effective arrangement. A plug-in coil is tuned to the desired wave-length by means of a ·0005 variable condenser, resistance damping being introduced into this tuned circuit with the aid of a non-inductive variable resistance. Three aerial terminals are provided. One of them connects the aerial direct to the grid end of the tuned circuit, whilst the other two terminals permit the use of a ·0003 or ·0001 fixed condenser in series with the aerial. This is useful, since different degrees of selectivity are obtainable, and the set can be suited to various types of aerials. The use of the variable resistance enables perfect stability to be obtained on all B.B.C. wave-lengths.

forward, and it will be seen that a 0·1 meg. resistance is connected in the grid circuit of the first L.F. valve in order to prevent H.F. from getting through into the L.F. stages, a frequent source of trouble in resistance amplifiers.

The last stage consists of two paralleled valves with a choke-condenser feed.

H.T. Supply

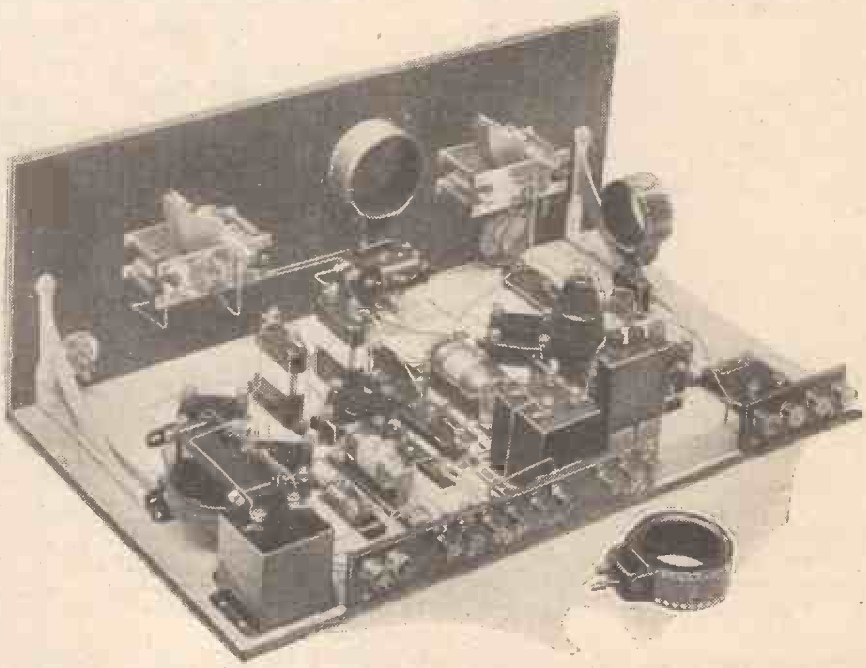
The paralleling of valves is a convenient means of increasing the power in the output circuit, but it is essential that either H.T. accumulators or the mains should be employed. Dry cells will not stand up to the current demand, which is twice that of one valve. Anode current is fed through a 15–20 henry choke which is designed to be capable of carrying a current of 50 milliamps.

The choke shown in the set is a Pye and has a special winding of low D.C. resistance, together with a substantial iron core. It will carry currents in excess of 50 milliamps. without saturation.

Refinements and Alternatives

The set differs from the original B.B.C. circuit in three small details. First, a separate small grid battery is placed inside the cabinet for the purpose of applying a negative potential to the H.F. and detector valves. This is simply an alternative to using the common grid battery, and, if desired, one grid battery can be used for all the valves. Secondly, a 4-mfd. condenser has been placed across the H.T. + 3 tapping and earth (which is connected to L.T.—). This is a refinement and merely supplements any external shunting condensers. It is not by any means essential unless the H.T. supply is of a doubtful character. Lastly, fixed resistors have been connected in the positive filament leads. These can be short-circuited if desired.

The components chosen are not by any means the only makes suitable. Any of the first-class makes can be used equally well. For instance, the

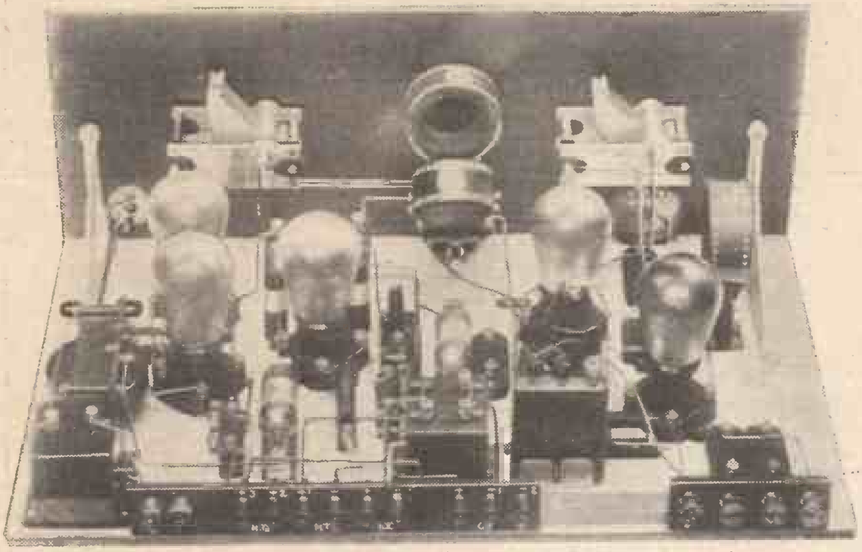


Owing to the depth of the baseboard there is no crowding of components and ample space is available for the swinging reaction coil.

THE "B.B.C." FIVE

—continued

H.F. choke can be replaced by a 600-turn plug-in coil or any good choke with sufficient turns to cover the B.B.C. and Daventry wave-bands satisfactorily. The same applies to the other components, but it is essential for the insulation of the ·1-mfd. coupling condensers to be above suspicion. Faulty insulation here is a frequent cause of distortion in resistance amplifiers.



The "B.B.C." Five with coils and valves inserted and all ready for use.

The H.F. tuning condenser can have a capacity of ·00025 or ·0005. Tuning is slightly more critical with the latter, but a bigger wave-band can be covered with a given coil. For those who prefer to have easy tuning the ·00025 is probably better.

The Layout

The baseboard used has a depth of 12 inches and a smaller size is not to be recommended. In laying out the components on both the panel and baseboard, adequate clearance-space should be allowed for the largest-sized tuning and reaction coils that are likely to be used. The set, as described, will take Gambrell and similar large-diameter coils without danger of fouling any of the components, and it is important to remember that the swinging reaction coil must clear the detector valve in all positions. When placing the components in position it is a sound scheme to insert the H.F. and detector valves in their holders and to place large coils in the aerial, H.F. and reaction sockets. The spacing can then be arranged accordingly.

The terminal strips are secured to a length of wood strip on top of the baseboard. This seems to give a firmer mounting than does screwing the terminal strips to the edge of the baseboard. Here, again, however, it is simply a matter of individual choice.

The panel is secured along its bottom edge by means of five small screws and the weight of the baseboard is taken in the usual manner by two angle brackets, which incidentally should be placed so as to clear the fillets in the cabinet itself.

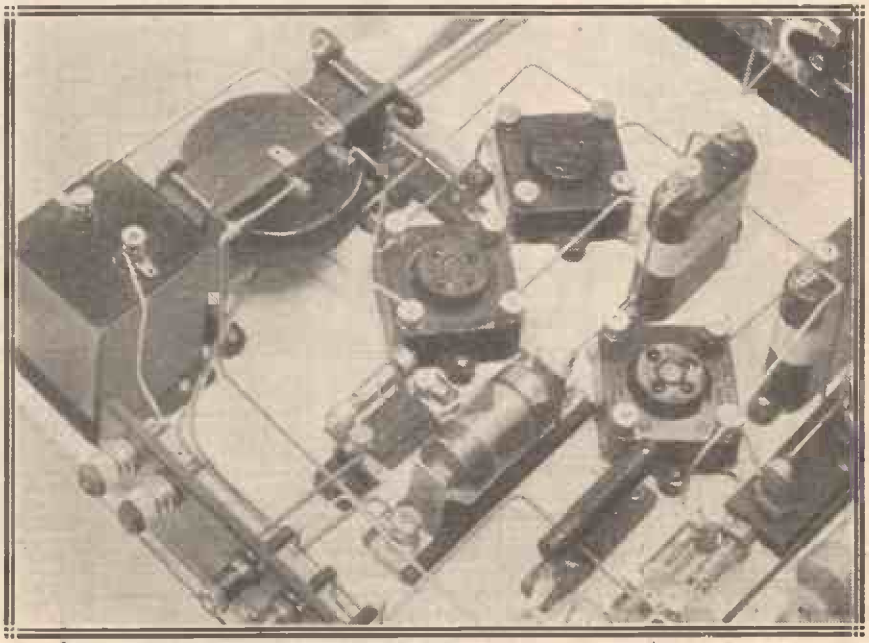
Wiring-Up

The wiring is perfectly straightforward. For the battery leads it is advisable to use one of the insulated wires such as Glazite, and it is a good plan to employ red covering for the positive leads and black or blue for the negative leads. In the case of the remaining wires, 16-gauge bare tinned copper is rather convenient, but, if desired, covered wire can be used throughout. With the particular components employed, most of the leads can be secured with the aid of the terminals provided; hence the amount of soldering to be done is quite small.

To make a good soldered joint it is necessary to employ a well-tinned and really hot iron, with a fairly heavy copper bit. Only the merest trace of flux should be used and of the various types available resin is the best for this type of work.

Operating the Receiver

For the first tests connect the aerial direct on to the aerial coil—that is, to terminal A1. Insert a No. 35, 40, or Gambrell "B1" into the aerial socket. Place the variable resistance about half of the way round. In the fixed socket of the two-coil holder insert a No. 50 or Gambrell "B" coil, and for reaction use a small coil such as a No. 25, 35, or Gambrell "a." Keep the two coils well apart. Among the valves which give good results are those with an amplification factor of about 20 and an A.C. resistance of 20-30,000 ohms for the H.F. and detector. The Marconi or Osram D.E.5b, and the Mullard P.M.5X, gave satisfactory results, whilst the Cossor 6-volt H.F. valve worked efficiently in the H.F. socket. The detector grid bias is not very



A "close-up" of the L.F. end of the baseboard, showing the disposition of the paralleled valve holders and other components.

WIRING INSTRUCTIONS.

Join L.T. + to one side of "on-off" switch, and connect the other side of the switch to one side of each fixed resistor. Join the remaining tags of the fixed resistors to the plus filament terminals of the valve holders.

Join the L.T. − terminal to the filament negative terminal on each valve holder, to one terminal of the ·01 fixed condenser and to earth. Join A_1 to one terminal each of the ·0003 and ·0001 aerial condensers, thence to grid of the H.F. valve, to the socket of the aerial coil holder, and to the fixed plates of the aerial tuning condenser. Join A_2 and A_3 respectively to the remaining terminals of the ·0003 and ·0001 aerial condensers.

Connect the moving plates of aerial tuning condenser to centre terminal of non-inductive variable resistance and to remaining terminal of ·01 fixed condenser. This same terminal is also joined to a length of flexible wire for the H.F. valve grid bias. Take one of the outside terminals of the variable resistance to pin of aerial coil holder.

Connect anode of H.F. valve holder to top end of H.F. choke and to one side of ·001 fixed condenser. Other side of fixed condenser to grid of the detector valve holder, to near terminal of fixed coil socket of two-coil holder. Thence to fixed vanes of H.F. tuning condenser. Other terminal of fixed coil socket to moving vanes of same condenser and to a length of flexible wire for detector valve grid bias. Anode of detector valve to near terminal of moving coil socket. Other terminal of moving coil socket to one terminal of ·1-mfd. condenser, to 250,000-ohm anode resistance and to one side of ·0001 by-pass condenser. Other terminal of by-pass condenser is joined to remaining terminal of anode resistance and to H.T. + 2 terminal.

Remaining terminal of ·1-mfd. coupling condenser goes to one side of 1-meg. grid leak and to one side of 0·1-meg. resistance. Other terminal of 0·1-meg. resistance is joined to grid of third valve. Remaining terminal of 1-meg. grid leak is taken to G.B. −1 terminal.

Anode of third valve goes to one terminal of 150,000-ohm resistance and to one side of second ·1-mfd. coupling condenser. Other terminal of this condenser goes to grids of fourth and fifth valve holders which are joined together. Grids of fourth and fifth valves are joined to one terminal of second 1-meg. grid leak, the other side of which goes to G.B. − 2 terminal

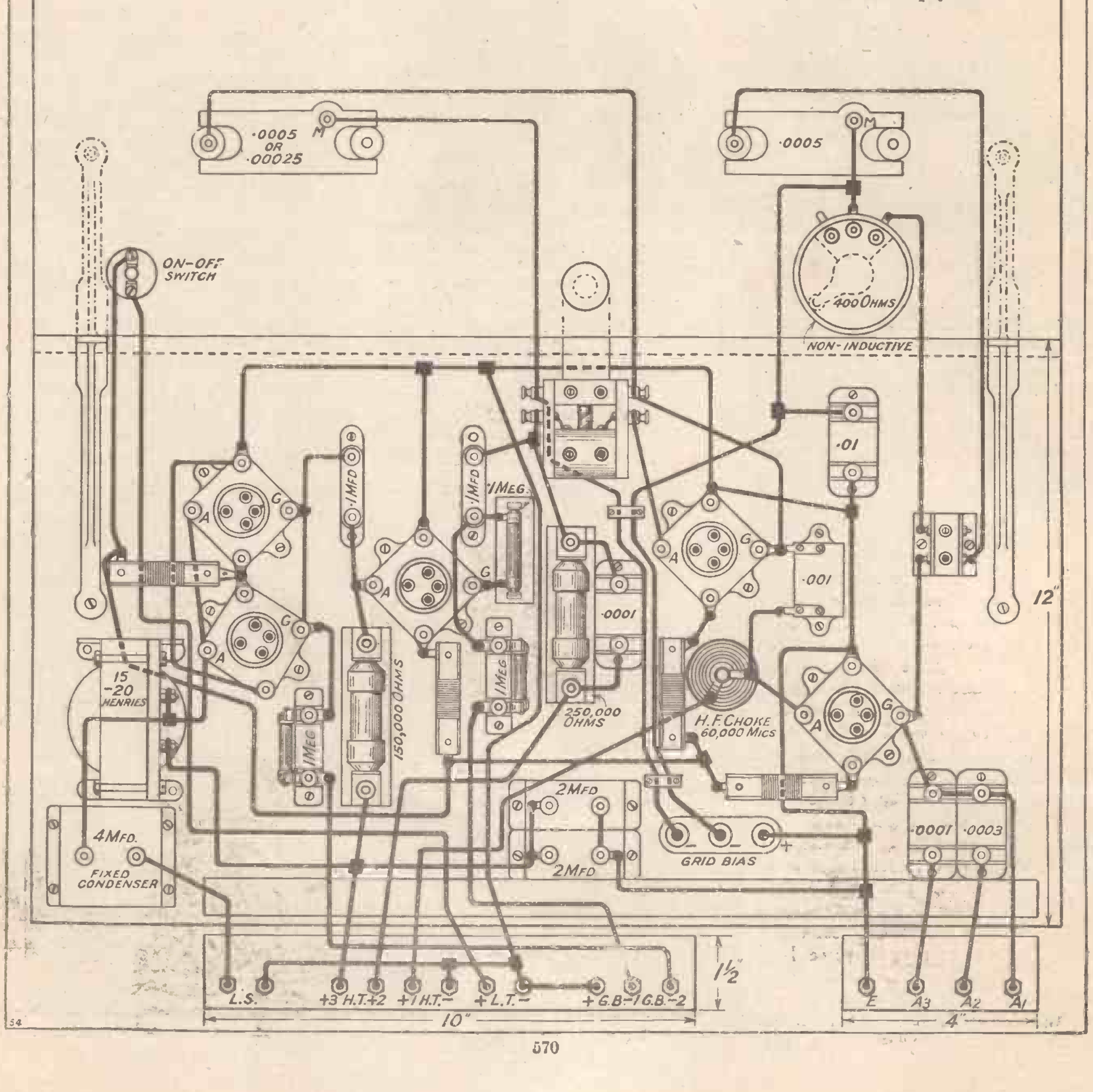
Anodes of these two valve holders are joined together and taken to one side of 15-20-Henry choke, and to one terminal of 4-mfd. condenser. Other terminal of this condenser to one L.S. terminal. Remaining L.S. terminal to L.T. −.

L.T. − is joined to H.T. − and G.B. + terminal. H.T. + 3 goes to remaining terminal of 15-20-Henry choke, to remaining terminal of 150,000-ohm resistance and to one side of the two 2-mfd. condensers (which are joined in parallel).

H.T. + 1 goes to the bottom tag of H.F. choke. Remaining side of the two 2-mfd. condensers is joined to earth.

Grid bias + flexible lead for the H.F. and detector valves is also joined to earth.

Article continued on page 652.



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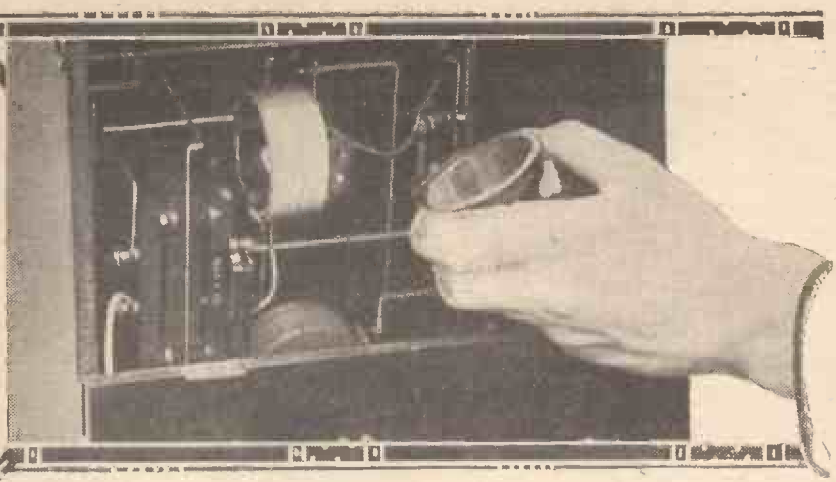
Taking Care of Your Coils



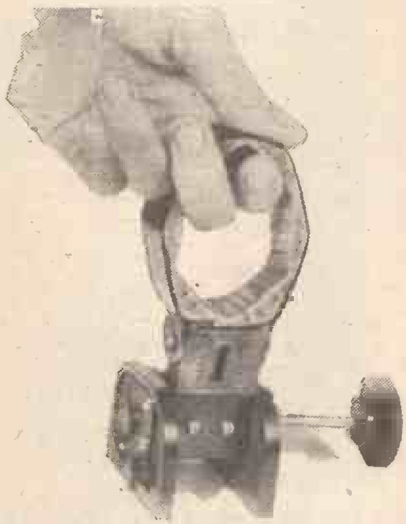
By C. A. J. MEADOWS.

THE high state of efficiency to which the modern receiver can be brought is only made possible by the individual efficiency of each of the components used in its construction, and to ensure this a great deal of research work is carried out by manufacturers and others who are interested in this section of the industry. To maintain the efficiency of some of their components, manufacturers to-day employ some form of protective casing wherever possible, to prevent damage through careless handling or through damp.

Decreased Efficiency

Some of the parts lacking in this respect are, strangely enough, those which play a most important part in any set, whether crystal or multi-valver; namely, the inductance coils. Some coils, such as the screened or the binocular types, and even certain makes of plug-in coil, are admirably protected, but the general run of plug-in coil falls far short of the ideal in this direction. They are undoubtedly efficient, but do not possess sufficient mechanical strength to survive a great deal of rough handling while still retaining their efficiency.

Each time a coil is removed from its holder it is subjected to a considerable strain unless care is taken to hold the strongest part, which in most cases is the ebonite plug. By simply gripping the first part of the coil which comes to hand a great deal of damage may be done to the windings by pressing them together, and to the connections by gradually pulling them away from their contacts on the plug.



Pulling the coil out by this means seriously damages the windings.

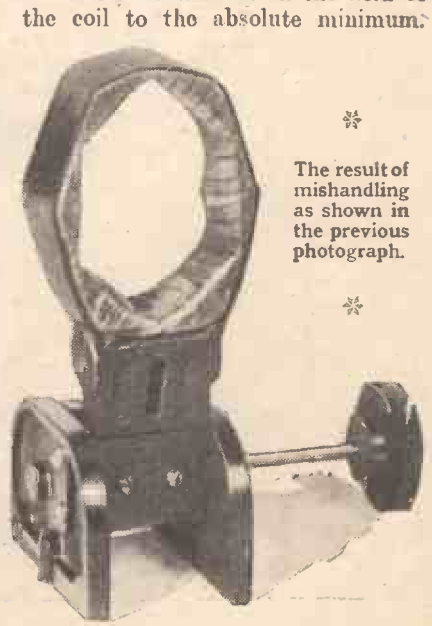
Distorting the windings in this way alters the whole characteristics of the coil by (a) upsetting the spacing between the turns and, perhaps, increasing the self-capacity of the coil and causing the tuning to become flat; (b) by pulling the coil out of shape and thus altering the magnetic field. The connections will gradually give as they are strained, and probably crystallise, with the effect that after a spell of terrific crackling noises a total breakdown will result.

Careful Handling Essential

There are now on the market special coils, wound on low-loss formers with heavy-gauge wire; they are an excellent proposition, but if given bad handling for a few months would be only fit for the scrap heap.

It is only natural that these components cannot be so heavily made as L.F. transformers, for the trend of modern design is to reduce the amount of solid dielectric within the field of the coil to the absolute minimum.

The correct way to remove a coil from its holder.



The result of mishandling as shown in the previous photograph.

TAKING CARE OF YOUR COILS

—concluded

We no longer find that coils are immersed in wax or varnish to afford additional strength.

When coils have been pulled out of shape through rough or careless treatment, they should be first restored to their original form. This will probably take a lot of time and considerable skill, but can certainly be done by anyone possessing a little patience and the usual amount of wireless enthusiasm.

Assuming that this operation has been satisfactorily concluded, the connections should be examined, and if necessary made good.

The binding between the coil itself and the plug may be loosened, although this very rarely happens and is in any case quite easy to replace.

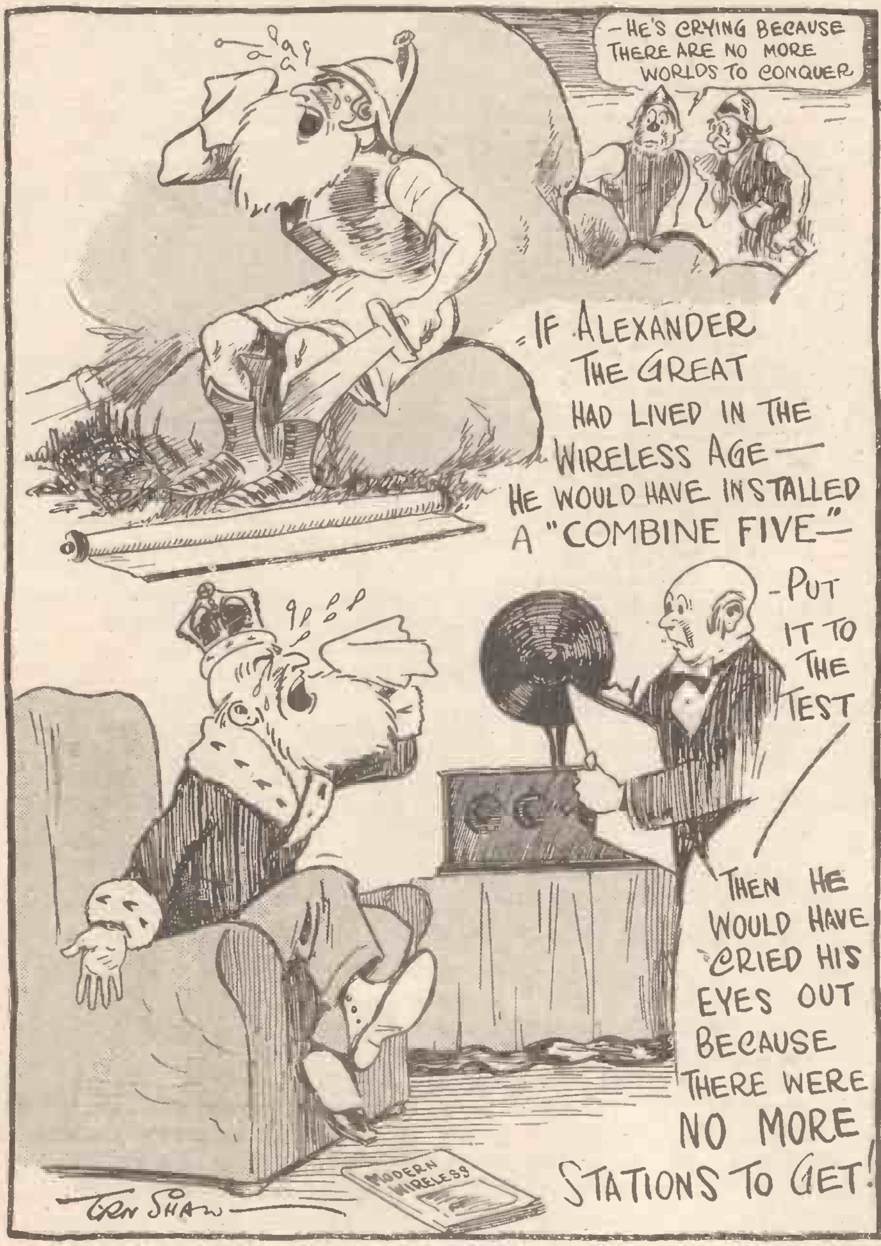
These are the chief faults which may be expected to develop in ill-used plug-in coils. A few words concerning the various other types of coils in use to-day might not come amiss.

Screened Coils

Little need be said about screened coils, as they are wound solenoid-fashion on ebonite tube, have strongly attached plates at either end, and in many cases the windings are further protected by means of a strip of celluloid or some similar substance, so that unless treated with absolute brutality no trouble should develop either in the windings or connections.

Six-pin coils with skeleton formers need careful use, otherwise after a little while the windings, which are usually of fairly fine wire, will begin to sag inwards, owing to the wire having been stretched when gripped; these coils must be held either by the rim at the top or by the base. The windings are not intended to stand such a strain, and if subjected to such misuse will soon be absolutely useless.

Always remember that upon tuned circuits depends the efficiency of the set, and that therefore the coils are among the most vital parts of any set. Look after your coils and they will continue to render service with the unfailing dependability that has always characterised British products.



LOW H.F. RESISTANCE

Sir,—When reading Capt. Eckersley's interesting article in a recent number of your paper, I notice that he states that the average plug-in coil has a resistance of 10, 20, 30 or some 60 ohms. Further on he mentions that the value required should be 20 or 30 ohms for long waves and 5 or 10 on the shorter wave-lengths.

Whilst I quite agree with Capt. Eckersley that the figures mentioned by him may represent the average for plug-in coils, I should like to point out that commercial plug-in coils are available having H.F. resistances considerably below the practical figures given by Capt. Eckersley as being suitable. I have in mind, of course, the Lewcos Inductance Coils manufactured by my company.

The following examples of N.P.L. figures may be of interest to you.

The 35 coil on a wave-length of 264 metres gives 2·8 ohms.

The 50 coil on a wave-length of 406 metres gives 3·3 ohms.

The 60 coil on a wave-length of 472 metres gives 4·4 ohms.

On the longer wave-lengths—

The 150 coil on a wave-length of 1,250 metres gives 15·8 ohms.

The 200 coil on a wave-length of 1,580 metres gives 19·7 ohms.

I trust that you will find these figures of interest.

Yours faithfully,
C. H. Burnand,
Sales Manager.
For the London Electric Wire Company and Smiths, Ltd.

BUYING BROADCASTING TALENT

A Criticism of the B.B.C.'s Policy.
By A Special Correspondent.

THE outcome of the argument between the B.B.C. and the Music-Hall Combine is being awaited with considerable interest. By the time these words are read by readers of MODERN WIRELESS possibly a distinct basis for negotiation will have been arrived at, but it seems to be the general opinion that if the B.B.C. negotiate on the lines suggested by Mr. Charles Gulliver and Sir Oswald Stoll, they will be making a grave mistake.

Useless Without Atmosphere

It has always been the policy of the B.B.C., and in our opinion the correct policy, to refuse to acknowledge that the theatres and the music-halls have in any way suffered from the effects of broadcasting. It is possible that the concert-hall managers have felt the effect of broadcasting, for listening to music beside one's own fireside and listening to music in a concert-hall offers a choice of method which may certainly incline a good many people to prefer the former course.

But when it comes down to music-hall entertainment, there is a big difference. The average music-hall artiste is only really appreciated and enjoyed when on the music-hall stage and when one is sitting in a music-hall surrounded by other people enjoying the turns and affected by the atmosphere of jollity, etc., which one expects to find in a music-hall.

Sir Harry Lauder, one of Britain's best broadcasters.

Sir Oswald Stoll.

And to take the average music-hall artiste away from his natural atmosphere and place him in a broadcasting studio and expect him to be funny and amusing when he cannot be seen, and when he lacks that surrounding atmosphere so essential to his craft, is expecting too much.

Not Worth It

If we consider all the music-hall favourites who have broadcast during the last two or three years it will be found that very few of them have really come up to expectations. Most of them have "got across," as the saying is, but not to such a degree that the average listener does not wonder whether the B.B.C. has been justified in paying substantial fees for that particular broadcast; and certainly on this past experience the average listener does not seem to feel that the B.B.C. is justified in paying huge sums of money every year to Mr. Gulliver, Sir Oswald Stoll, or the Music-Hall Combine, as "compensation" for the services of certain music-hall stars for broadcasting.

Astounding Suggestion

As these words are written it has been suggested by Mr. Charles Gulliver that if the B.B.C. pay him ten thousand pounds a year he would withdraw his objection to his artistes broadcasting. He considers that such a sum should be paid to him because, if he allows his stars to broadcast, he thinks their appearance before the microphone will adversely affect the success of his music halls where these stars appear from time to time.

Sir Oswald Stoll goes one further and suggests that his compensation should be fixed at a minimum of fifteen thousand pounds a year.

Mr. Charles Gulliver.

BUYING BROADCASTING TALENT

concluded

These astounding suggestions seem to have been received by the B.B.C. almost with a certain amount of gladness, and although they have not yet definitely committed themselves to the payment of these sums of money, they have certainly welcomed the suggestions of Mr. Gulliver and Sir Oswald Stoll on the grounds that they offer a basis for negotiation. And we can only interpret this as meaning that the B.B.C. are not unfavourably inclined towards a suggestion which entails the payment of thousands of pounds a year to either individual music-hall managers or to the Music-Hall Combine.

Negotiations seem to be going on with regard to this proposal.

The suggestion raises two important points :

1. Whether the B.B.C. are going to recant and admit that their arguments about the adverse effect of broadcasting are wrong—and if they pay these sums of money they will be tacitly admitting that some recompense is due ; and

2. Whether or not they are making a bad bargain. In other words, will they be getting their money's worth ? Instead of spending twenty or thirty or forty thousand pounds a year in recompensing music-hall managers, and on top of that paying substantial fees for the occasional services of music-hall artistes, many critics think they would be doing much better if they devoted that money to the encouragement of new talent and the developing of artistes specially trained for broadcasting technique.

Because Mr. George Robey, for instance, can entertain thousands of people week after week on the music-hall stage, it does not mean to say that he can continue to entertain millions of listeners via the microphone. Mr. Robey depends a great deal upon his appearance and upon his actual presence in the theatre, but Mr. Robey behind the microphone would have rather a limited repertoire, and we doubt whether he would be in the long run such a success as, say, Mr. John Henry.

A B.B.C. Competition?

There is no doubt that broadcasting requires a new type of artiste, an artiste who can depend entirely upon amusing an audience without appearing before them in the flesh—voice, intonation, dialogue and an amusing programme, these are the ingredients which will help to make the broadcasting star of the future.

In appearance, the star need not be at all funny, for nobody will see him, but it would be a mistake if the B.B.C. were to decide that their variety talent is to be bought second-hand from the music-halls. We suggest the B.B.C. should organise a big competition, encouraging new humorists to get in touch with them. Auditions could be given, and we feel certain that if some of the money which might otherwise flow into the pockets of the Music-Hall Combine were devoted to an organised search for new variety talent for broadcasting, and if prizes were offered in the usual competition way, for humorous dialogues and sketches, etc., specifically for broadcasting, the B.B.C. would undoubtedly reap a greater reward and a greater benefit, and incidentally so would listeners.

New Talent Required

We can only hope that this policy of buying broadcasting talent from the music-halls just because the music-halls have a ready-made type of talent which they exploit successfully, will be dropped.

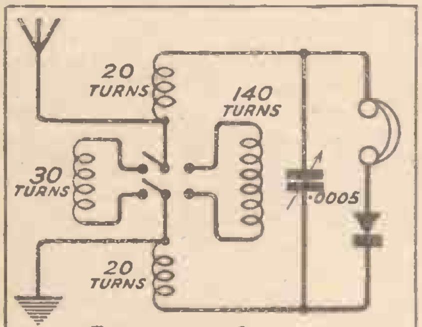
A new talent is wanted—not a second-hand talent ; and when that is realised, and when a deliberate and serious attempt is made to encourage this new talent, to organise it and to train it, then perhaps the variety programmes issued by the B.B.C. will be more original, more entertaining and more acceptable by the general public.

The MODERN "ULTRA" CRYSTAL SET

In this article "Modern Wireless" readers are introduced to a new wiring scheme devised by Mr. Dowding. This should considerably lighten the task of the less expert constructor and makes it impossible for him to omit or wrongly connect up any of the leads. The value of the wiring scheme will be even more appreciated when, in due course, it is applied to the construction of multi-valve receivers.

This receiver embodies an up-to-date version of a circuit noted for its "pick-up" and selective qualities. The set designed, built and described By G. V. DOWDING, Grad. I.E.E.
(Technical Editor.)

It is a fairly generally accepted idea that one can get a certain amount out of a crystal set and then no more, and that its sensitivity is more or less limited to the sensitivity of the crystal detector employed. Further, the impression seems to be that selectivity in the case of a crystal receiver can only be obtained at the expense of sensitivity. In a broad sense these are undoubtedly facts. A crystal detector is merely a current-rectifying device; it does not amplify. But some long time ago I proved that more could be made of received energy by introducing a method of voltage stepping-up on an auto-transformer principle which incorporated balanced end effects. Incidentally, this results in a considerable increase in selectivity, and so there is a double gain.



THEORETICAL CIRCUIT.

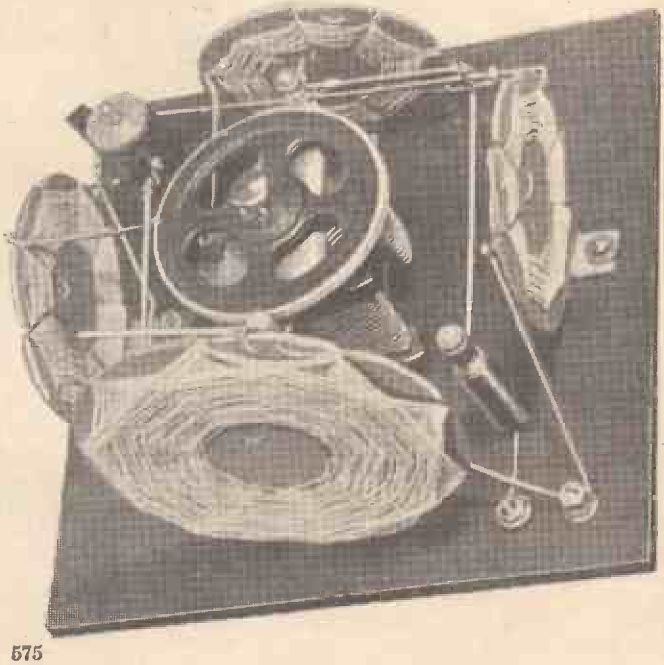
Tested By Time

I called my system the "Ultra" method of tuning. It was patented in 1924, and subsequently the Igranic Electric Co. acquired the patent rights. Since then a very great number of crystal sets have been built which incorporated "Ultra" tuning in one form and another, and its efficiency has been thoroughly proved. Many amateurs have commented on the "pick-up" qualities of "Ultra" sets, and some really extraordinary results have been obtained. Perhaps in cases reradiation played its part, but, although some dozen or more "Ultra" crystal sets have been described in "Popular Wireless" during the past three years, I cannot recall a single complaint from a dissatisfied constructor!

This Modern "Ultra" embodies quite a new version of the circuit. The novelty is the method adopted of catering for Daventry. It should be pointed out, however, that on the long waves the Ultra method loses its efficiency. It reaches its "peak" on wave-lengths between 300 and 600 metres. As a matter of fact, I really do not think that an Ultra crystal set is any better, if as good, on Daventry as many other crystal hook-ups. Nevertheless, this awkwardly wave-lengthed station must be available, although when Daventry "junior" is operating well, then we will be able to "Ultra" to the limit all round!

COMPONENTS REQUIRED.

- Ebonite panel 8 in. × 8 in.
- Cabinet to fit (at least 4½ in. deep).
- ·0005 mfd. variable condenser (with vernier).
- Push-pull type double-throw, double-pole switch.
- Panel-mounting crystal detector.
- 4 oz. 24 S.W.G. D.C.C. wire.
- 4 oz. 26 S.W.G. D.C.C. wire.
- Cardboard for coil formers (see text), screws, etc.

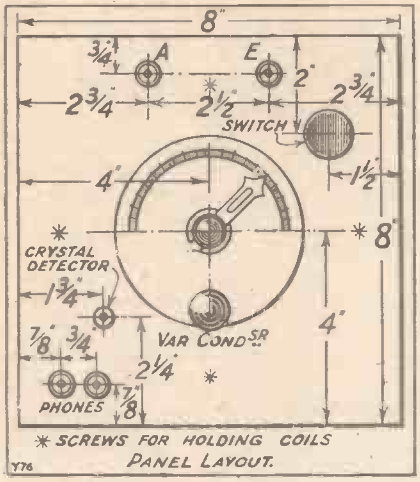


Four coils are needed, but these cover 5 XX as well as the lower wave-lengths. Full details for making these simple coils are given in the accompanying article.

THE MODERN "ULTRA" CRYSTAL SET

—continued

Now glance at the accompanying theoretical diagram of the circuit employed in the Modern "Ultra." You will see that two small coils, consisting of 20 turns each, take their



places in the secondary circuit of an auto-coupled arrangement one at each end, as it were. For the normal wave-length band a 30-turn coil is brought into the centre of these two small coils, while for Daventry a 140-turn coil occupies this position. It will be appreciated that these "switched in" coils form the aerial circuit on the one hand and on the other constitute a secondary circuit with two other coils (20 turns each) in series.

Very Selective

It is very much like an ordinary tapped aerial-coil system, with this difference—that there is both an aerial and an earth tap and that these are centrally and evenly spaced. It might be as well to point out that the system was in use before commercial plug-in double-tapped coils were on the market and that the only one of these which incorporates "Ultra" tappings is the Igranic "Ultrynic," which is, of course, produced under the above-mentioned patent rights. Further, I must also point out that although neither the Igranic Co. nor myself have ever attempted to prevent amateurs making the fullest use of the system, "Ultra" sets must not be produced commercially without reference to the holders of the patent.

Now for the construction of the "Ultra" crystal set illustrated in this article. A list of components is as usual given and requires but little comment. Perhaps the inclusion of a fine-tuning variable condenser may occasion a little surprise among those who reckon crystal sets as a class to be anything but "fine tuning." But for constructors residing a few miles away from a broadcasting station it is really necessary, extraordinary though this may seem in view of the simplicity of the circuit. Those very close to a station might not experience razor sharpness of tuning, but then who does in the "swamping areas" unless they use valve receivers of extraordinary keen selectivity?

The Component Parts

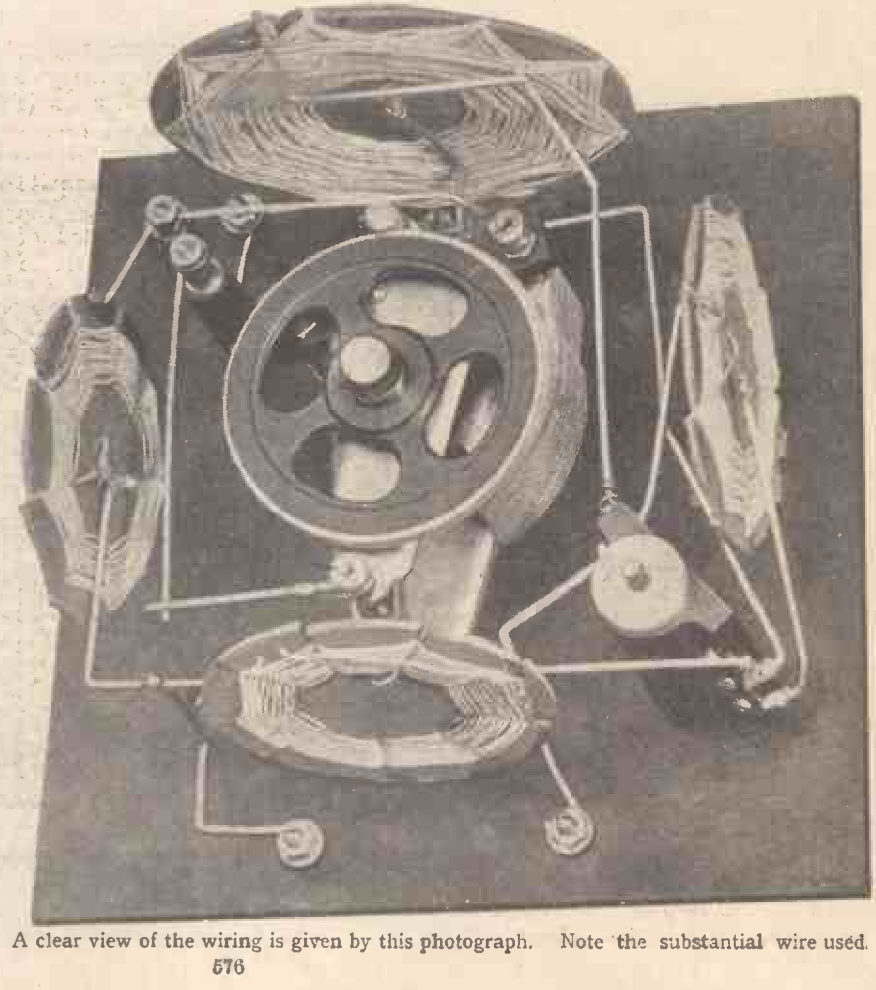
By the way, I must not let my natural enthusiasm lead anyone astray. Don't expect this "Ultra" to deliver loud-speaker signals! There is a very wide margin between very good crystal strength and medium loud-speaker results, and although the "Ultra" might go a fair way towards the latter under *exceptional* circumstances, don't expect it to give you anything beyond quite good crystal strength, together with rather an unusual degree of selectivity. Then you won't be disappointed and anything above this will be so much gain!

But to revert to the subject of component parts. The variable condenser can be one of any good make having a capacity of ·0005 mfd. and vernier tuning. There is a wide enough choice among the Brandes, Lamplugh, Ormond, J.B., Cyldon, G.E.C. and many others that are advertised from time to time. You won't miss the local station if you use an ordinary direct-drive variable, but you will have a better chance of tuning him in at optimum strength if you have a vernier movement or dial on your variable.

Any type or make of crystal detector can be employed. I rather like the "Griphco," which is of quite a permanent character and, despite its marked sensitivity, never requires adjustment. Indeed, no provision whatever is made for this. But there are many other excellent detectors available. I have found the R.I. to be very good indeed, while even the cat's-whisker type has much to be said for it if it has a good mechanical adjustment.

Important Items

Although an "M. H." push-pull type of switch is shown in this Modern "Ultra," it is not essential



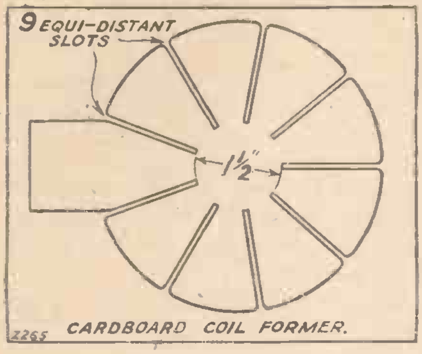
A clear view of the wiring is given by this photograph. Note the substantial wire used.

THE MODERN "ULTRA" CRYSTAL SET

—continued

that this should be used. Any type or make of double-pole, double-throw switch will answer the purpose. Well, that exhausts the subject of the components with the exception of minor details and the coils. These latter, however, are very important items, as will be guessed.

These coils can be made at home,



2265 CARDBOARD COIL FORMER.

and the task is quite a pleasant, easy one. About the hardest job in connection with the making of the coils is the cutting out of the formers. But, as diagrams are provided which will help you to space out the slots, your job will not be as hard as mine was when winding the original coils. I had to measure the things out without guides, and marking out with equal spacing the unequal number of nine radial lines is a tricky business.

Cutting the Coil Formers

I think that, as it is the most important part of the work, I will deal with the coil-winding first. The formers can be cut from fairly thick cardboard, and if this cardboard is waxed so much the better, although I cannot say that omitting this seems to cause much trouble. Three circles having diameters of 3 inches should be cut, but, in each case, a small tag should be allowed, as shown in the coil sketches, for mounting purposes. On each of these circular pieces of cardboard a 1½-in. circle should be drawn in the centre with compasses. These circles mark the ends of the slots. The slots (nine on each former) can be marked out by placing one of the accompanying sketches over the former, and pricking holes through with a pin or some other sharp-pointed article.

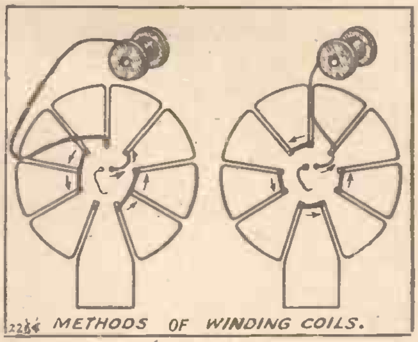
The slots should be real slots, and not mere cuts. They should be from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. in width. The exact width is of small moment. Now a fourth former should be cut. This must have a diameter of 4½ inches, but the number of slots and the centre diameter will be the same as in the case of the other formers.

Winding the Coils

A quarter of a pound of No. 24 S.W.G. D.C.C. wire will be needed. If you obtain good measure all of this will not actually be used, but the stuff is fairly cheap these days, and it is as well to be on the safe side. Additionally, a quarter of a pound of No. 26 S.W.G. D.C.C. wire will be wanted for the large coil.

Now, using the 24-gauge wire and with the three smaller formers, the following coils should be wound: two of exactly 20 turns each and one of 30 turns. Do not forget that you wind in and out of each successive slot, as shown in the appropriate diagram, and that a "turn" means one complete voyage round the former. When a 20-turn coil is wound you can only count ten turns from the centre to the outside on the one side, although there are another ten on the reverse side. Still, you will be able to see this clearly enough in the photographs.

The end of the wire can be secured at the beginning of the winding by passing it through two small holes pierced in the former, and the same



2264 METHODS OF WINDING COILS.

at the conclusion of the winding. Owing to the method of winding in and out of slots, the wire will retain its position very strongly with only this anchoring.

We must now wind the large coil. For this the No. 26 wire is required, and the larger (4½-in. diameter) former. If the wire were to be wound on in the same way as on the three small coils this coil would be rather too

The use of a "fine-tuning" variable in a simple crystal set may appear to be rather incongruous, but it is really needed in this selective little "Ultra."

THE MODERN "ULTRA" CRYSTAL SET

—continued

bulky for a reasonably sized cabinet. Therefore, the "every other slot" method of winding must be adopted. This is quite simple; you merely pass the wire through every other slot as you travel round the former. I have had a small sketch prepared to make this quite clear. Although the coil is wound so that every other slot is missed, only the 140 voyages round the former are needed to complete the coil. See that the wire lies well down in the slot, otherwise you will not get the turns on. The 4½-in. diameter former only just manages to accommodate the required number.

Drilling The Panel

The coils wound, these can be laid aside, and the panel marked out and drilled. It will be noticed that I have placed the 'phone terminals to the left. The reason for this is so that the telephone cord hangs well clear of the right hand, and does not get tangled up when the set is being tuned. Left-handed people will not like this, but then, they are the minority!

For this particular panel I did not use drills. I came across a tool known as the "Multi-borer" some time ago. It only cost about 1s. 6d. and it gets through ¼-in. ebonite panels with the greatest of ease, boring any one of three or four different and useful sizes of holes as required. This and a ninepenny reamer seem to do wonders, and I recommend the combination to constructors.

New Wiring Scheme

The four terminals, the variable condenser, the crystal detector and the change-over switch are all very easy things to mount. The coils can be held in position by means of small nuts and screws passing through their tags and the panel. The tags should, of course, be bent back at right angles for this purpose. This fixing alone would hardly be sufficient to make the coils rigid, but I am going to insist that you use No. 18-gauge square-section wire for the wiring, as this will, if used for connecting the coils up properly, supplement the above method of mounting and make the coils quite firm fixtures.

In order to make the wiring as simple as possible I have evolved a checking system which will, I hope, considerably facilitate the task. It will be seen that every lead shown in the wiring diagram carries a number. All these numbers correspond with those given in the wiring instructions.

As you make a connection you should check it up by both the wiring diagram and these wiring instructions, and when the lead is connected at both ends the corresponding number

WIRING INSTRUCTIONS.

Join earth terminal to outside end of one 20-turn coil (1) and to switch point A (2). Join inside end of same 20-turn coil to moving vanes of variable condenser (3) and to one terminal of crystal detector (4).

Join aerial terminal to inside end of other 20-turn coil (5) and to switch point 1 (6).

Join remaining (outside end) of 20-turn coil to one 'phone terminal (7) and to fixed vanes of variable condenser (8).

Join remaining terminal of crystal detector to remaining 'phone terminal (9).

Join switch point 2 to outside end of 30-turn coil (10).

Join switch point B to inside end of 30-turn coil (11).

Join switch point C to inside end of 140-turn coil (12).

Join switch point 3 to outside end of 140-turn coil (13).

(Thirteen leads in all.)

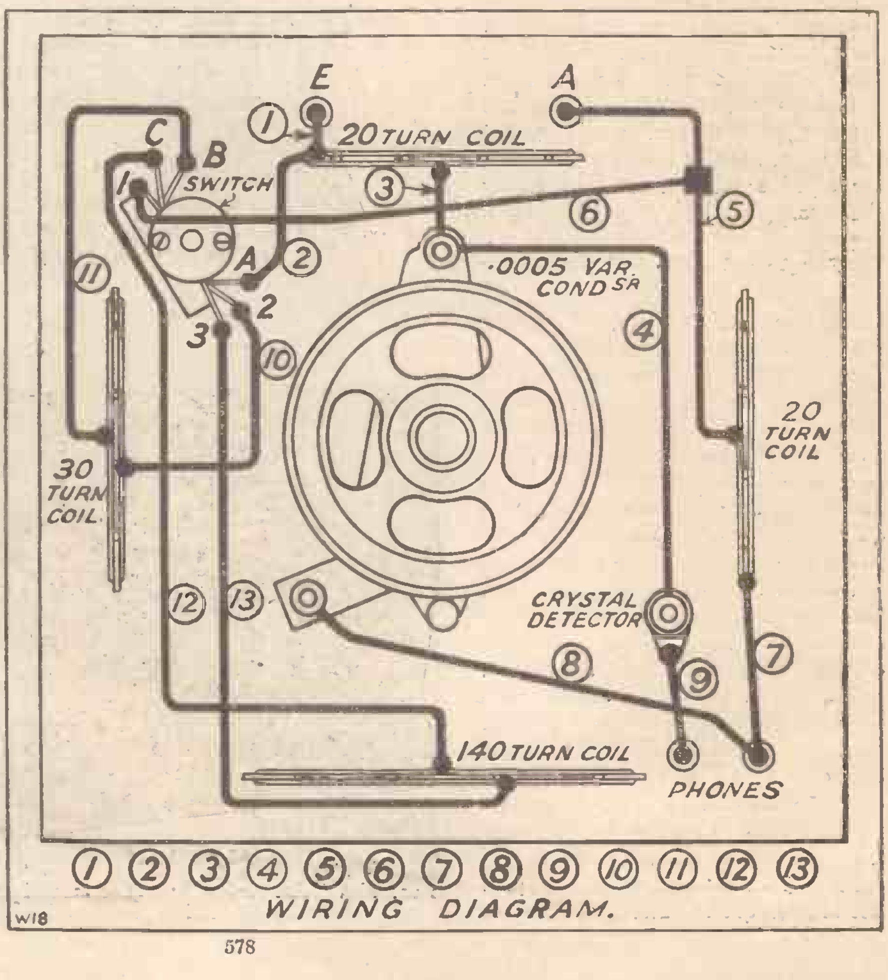
in the line of numbers given beneath the wiring diagram should be crossed out. When all these numbers are crossed out you know that every lead is in position and not one can have been missed.

There is a great temptation to take the ends of the coil and connect them direct to their various points, but please do avoid this lazy practice, for the result is both untidy and "tishy" generally. The ends of the wire on the coils should be cut off quite short and soldered firmly to the square-section wire. I won't say that my original Modern "Ultra" is a model from the point of view of appearance—some of you may make a much cleaner and neater job of the wiring—but I am satisfied, inasmuch as my set is a "Rock of Gibraltar" under the panel, passing pleasing in point of appearance, and works quite well.

The Change-Over Switch

If you use an M.H. switch treat it kindly when wiring up. It is an excellent component, but it has one fault, and that is that its soldering tags are continuations of the switch contacts which are mounted each with but one screw threaded into ebonite. I recommend you to carefully remove these contact tags when soldering the leads to them, otherwise there is a danger of softening the ebonite and making it impossible for the single screws to hold the contact pieces in position. And,

(*Concluded on page 654.*)



W18 WIRING DIAGRAM.

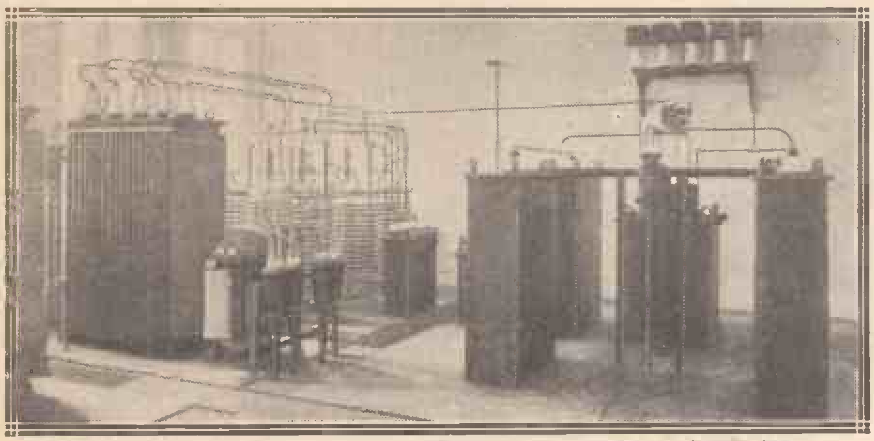
LANGENBERG

An interesting article on Germany's most powerful broadcasting station.

By

Dr. Alfred Gradenwitz.

INASMUCH as the highly industrial country around Essen, Bochum, Cologne, Elberfeld, etc., comprising what is known as the Rhineland and Ruhr District, is the most densely populated section of Germany, it was considered desirable to install there the most powerful German broadcast transmitter, so that a maximum number of listeners might be able to obtain reception with simple and cheap crystal sets, even now by far the most popular type of receiver used in Germany. At the same time there were many drawbacks encountered, viz. the large iron masses, extensive railroad system, and numerous mining and metallurgical works, necessitating a very cautious choice of the proper site, and comprehensive and lengthy radiation tests.



A general view of the rectifier room at the Langenberg broadcasting station.

Thickly Populated Area

The results of the latter eventually showed that the top of a hill about 850 ft. above the level of the sea, near the little town of Langenberg, midway between Essen and Elberfeld, would be the most suitable place. Supposing the range of a crystal set and indoor antenna to be only about 20 miles, this choice would permit of crystal reception within an area populated by millions. Valve receivers should, of course, enable the transmitter to be heard throughout Europe.

Plans for the immediate construction of a high-power broadcast transmitter were made immediately after the prohibition of wireless broadcasting in the occupied area had been repealed. The Langenberg transmitter, which was tentatively inaugurated at the end of 1926, has a feed-current telephone output of 20 kw.

The Transmitter

The Rhineland Transmitting Station is in a hangar about 45 metres long and 24 metres wide, which contains in one of its wings all dwelling-rooms and offices, and in the other the transmitter plant, comprising a high-pressure room, a rectifier room, a transmitter room, engine and

The generator room with its huge "panel" and controls.

LANGENBERG

—concluded

switchboard rooms, an amplifier room, etc. It is situated midway between two isolated and insulated iron framework masts about 300 feet high,

Some of the trenches in which the earth-wires are buried.

serving as aerial supports. The distance between the two masts is approximately 800 ft.

The Aerial

The aerial is of the T type, being about 300 ft. long and 25 ft. wide. Comprehensive tests made by the Telefunken people in conjunction with the Bureau of Telegraph Engineering have shown that the most favourable ratio between the natural and operating wave-lengths of the aerial is 1 : 0·6. As a wave-length of 468·8 metres is likely to be definitely adopted for operation, the natural wave-length of the aerial was chosen at about 800 metres, its capacity being about 1,500 centimetres. The downlead from the aerial is fixed exactly in the centre of the same, and, after descending in a vertical direction, is brought to the transmitter room. The earth is a small-meshed buried network of copper wire.

The transmitter is a separately controlled Telefunken valve transmitter equipped with intermediate and tertiary tuning circuits. Its range of waves is between 250 and 600 metres; a stationary wave with 10 per cent variability can be adjusted for within this range.

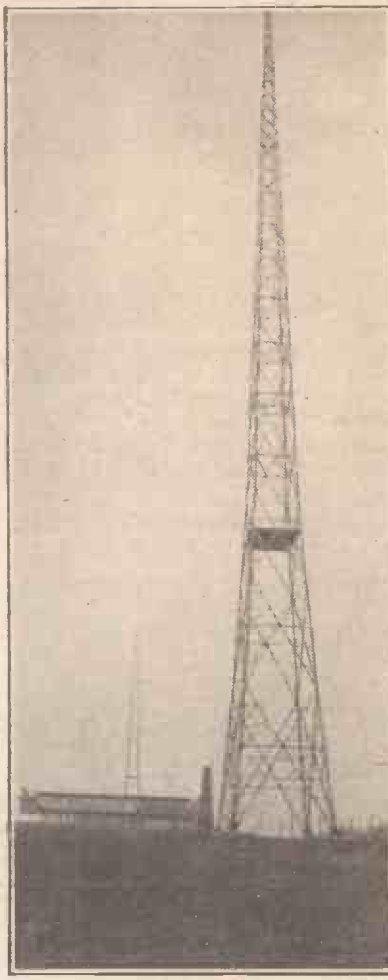
The transmitter comprises three stages, the first two operating on 4,000 volts, the third on an anode tension of about 10,000 volts.

The Current Supply

A compensating connection prevents any reaction of any stage on any preceding one, thus greatly facilitating tuning, there being no correction in the mutual tuning of the various circuits. The transmitter is operated direct from the 5,000-volt system of the Bergen electricity works, the high tension of which is stepped down to the operating tension of 3×380 volts. This low tension is eventually stepped up again to 10,000 volts for the anode tension of the main transmitter (third stage). The first two stages (control transmitter) derive their anode tension from a 4,000-volt dynamo, while the heating of the valves is also done by a direct-current dynamo. The high-vacuum rectifier valves, the valves of the third stage, and the modulating valves derive their heating energy from the three-phase current system, the tension of which (380 volts) is stepped down via several transformers to the proper heating tension.

The rectifier plant comprises six water-cooled rectifiers each of which has a filament-energy consumption of 50 amperes and 35 volts.

A particularly efficiently earthed copper tube system has been provided below the aerial so as to insure a uniform earth potential.



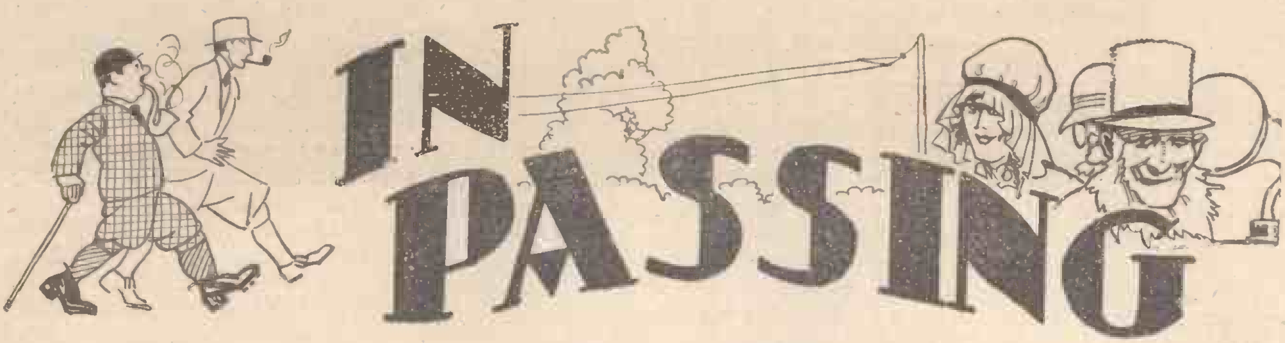
The 300-ft. masts, 800 ft. apart, support a T aerial.

Part of the transmitting gear of "Germany's 5 X X."

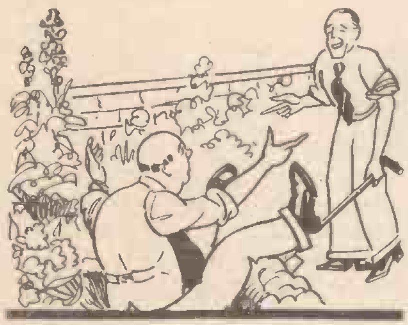
While the rectifier and high-frequency sections of the transmitter have been installed in separate rooms, their controls have all been combined on the switchboard in the transmitting room.

No Studio at Langenberg

The transmitter can receive its input at will from Elberfeld, Dusseldorf, Cologne, Dortmund, or Muenster, no special studio being provided at Langenberg, though, of course, there are both microphones and amplifiers for adjusting and experimental purposes. Standard microphones and amplifier systems have been fitted at every one of the studio stations. Special cables are generally used for connecting the input stations with the transmitter, though the central quads of existing transmission cables or (in the case of shorter distances) even overhead conductors are occasionally used.



BY dint of weeks of intensive effort I had got my friend Ambo to such a pitch of nervous enthusiasm about his first effort—a straight two-valver—that he used to get up in his sleep and bore holes in the furniture or solder wires to the parrot's cage. But as this zeal had been produced by methods resembling the "third degree" it bore in itself the seeds of decay, and with the approach of summer his bump of agriculture began to heave restlessly. Potatoes again!



... He stepped back a pace and fell into the hole ...

We were digging a hole in the Ambo estate for the reception of a new and improved earthplate, and Ambo was just explaining to me how in that particular brand of dirt a pinch of this and a ha'porth of t'other would bring up "Honeyball Wonders" or "Floury Watkins's" as big as swedes, when I remarked that we ought to make a holiday walking tour.

Ambo's Retrospect

"We can take observations of aerials and sich," I said, "and to enlighten the miles I will put you thoroughly through '*Inductance: Cause and Effect. With a mathematical discussion of Van Poot's three-ply, double-rove, back-to-back, anti-calorific doughnut coil.*'"

"It sounds fine, my boy," he replied. "But I have a feeling that I ought to slow down a bit in case my bearings seize up. I am getting on famously, and I want to pause, as it were, in full career, for a survey, a brief retrospect. I want, so to speak, to step back a pace——"

Further adventures of Ambo, the Potato Specialist, who is being tempted from his tubers to radio "tubes."

Here he stepped back a pace and fell into the hole.

"Ah, precisely!" I said. "That makes it quite clear, but I am afraid that your—er—*retrospect*—when you come up from the mine, daddy—will need scraping. I've seen 'em catch elephants like that in Burma. A deep hole is lightly covered with bamboos, and these are camouflaged with the beast's favourite veg. As Jumbo approaches the trap the head *boobah* (hunter), seizes a *jugglewalla* (sharp stake) and plunges——"

"Dry up and pull on my starboard fin," said Ambo briefly, but with force.

"Absolute indifference to the acquisition of new facts is a mark of a conservative soul," I replied, pulling stoutly at his arm. "Here I am, ready to endow you with the riches of my unique experience and well-stored mind, and you cannot even rest quietly in your narrow cell and receive learning."

Gentlemen Prefer Loud Speakers

I heaved him out—all except his carpet slippers, which insisted on remaining to be fossilised—and while he retired to scrape his southern aspect, I planted the earthplate *and added two dozen seed potatoes to keep it company.*

Presently Ambo returned, and enquired whether I expected better results from the new and improved "earth." I told him the results would surprise him, though they might not be noticeable at first. Then we planned our walking tour.

One fine Friday we took train to West Bunstead. Ambo sported a knapsack as large as a medium-sized lady's reticule—or *etui*, as they say in the crossword puzzles. He wore knee-breeches of shameless and shapeless cut, altogether balloon-like, and a tweed cap which I think belonged to his son—it covered about one-third of his scalp. In his mouth was a calabash pipe which looked like one of the jauntier sorts of instrument in a jazz band. This I barred at once.

"Gentlemen prefer loud speakers," I told him, "but they keep them at home."

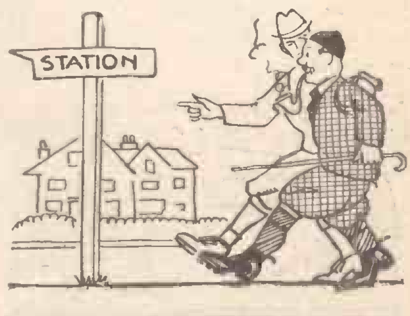
The Way to Walk

After an hour of nature talk, mainly about potatoes, inspired by the views from the window, I gave him back his pipe and told him to light it and ponder on

$$E \text{ (unless cell dud)} = C \text{ (if switch on)} \times R \text{ (for rheostat)}$$

At West Bunstead we limbered up and set forth to walk.

"The way to start a walking tour," I said, as I got out the map, "is to study the route well and then catch the 'bus. I use 'buses very freely on all my tours, and I find it spares the feet and enables one to walk much



... Ambo wore knee-breeches of shapeless cut and in his mouth was a calabash pipe...

farther. There's a jolly 'bus at two-fifteen which will take us to Cagbury Green in time for tea."

But Ambo said he was out walking, and suggested that we should take to the field paths and thus avoid the procession of £198 3s. saloons complete with push-pull engines and non-steering drivers. He said the first path led o'er a daisied mead and ended at Gubbs' Farm, "where I have

IN PASSING
—concluded

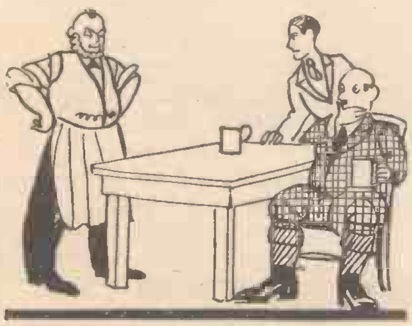
reason to believe the new wireworm toxin is being tried out."

"Actually," I replied, speaking from experience, "it will lead us into a patch of mud as sticky as a fly-paper, and land us into a collection of ruined barns, populated by mute, inglorious peasants and the baser types of domestic animals. Let's go by the main road. It passes by the 'Goat and Compasses' as well as Lord Bloot's experimental short-wave station, and I want to see his famous combined earth-screen and chicken run."

Taking Tea

We tossed for a decision, and the coin went down a drain just as the 'bus came round the corner. We got very desirable seats and continued our walking tour feeling that some overruling power was directing us, though occasionally Ambo was moved to mourn his florin, aloud and at some length.

While we were taking tea on Cagbury Green, in company with an admiring crowd of children with freckled faces and adenoids, and an ancient goat which ate Ambo's cap, Ambo said he kept feeling a wave of foreboding pass over him, an intermittent sense of uneasiness. He could not account for it except by supposing that something had got into the beer at the "Goat and Compasses." Once he met a man who,



... The landlord, in answer to my anguished bellow, came hastily ...

having drunk of cider in which a stoat had perished, was visited by fits of melancholia, and eventually became a swimming-bath attendant, etc., etc.

"Cheer up, man," I said, sneaking the other half of the heart of the lettuce. "I expect you are subconsciously fretting about that florin or your cap. Look at the goat; see what sunshine you have brought into his life. Give him your calabash pipe and watch the smiles chase away his gloom. Here's another 'bus. We had better hop on and walk to Futley. I know a rattling little hotel there where you can get the kind of ale that inspired Shakespeare to write 'The Fireman's Wedding.'"

Ruined by Radio

But he would not be comforted until I had introduced him to that nut-brown ale brewed at the "Czar of Russia" at Futley. Then he brightened up, took a long pull, and said the trouble was probably imaginary.

"By the way, my dear fellow," he added, taking a second pull at his pewter, "did you say there was something special about this neck-oil? Can't say I notice anything superheterodinky about it."

I tried mine. The bloke was right. The magic touch was not there. The landlord, in answer to my anguished bellow, came hastily and scraped a nervous forefoot in the sawdust.

"What have you done to it, oh, least among froth-blowers? Here I walk miles—absolutely miles—to take in a gill or so of your home-brewed, and you try to palm off this stuff. Where is the real juice, you thirty per cent under, water-spoiling, cooper's ruin?"

"Ar!" he said. "Ar! It ent same's us did brew to wunge. My zun, he larned arl bout brewin', offen thik wiryless. Zo we be dewin' it carden to noo rools 'n reglashuns, like. Zee?"

"Yes," said Ambo. "Jolly useful, this wireless. His son would have done better to have gone and attended to the potato-patch. I've got that rotten depression again. Let's turn in."

The "Willies"

After breakfast next morning, while Ambo was inquiring about the 'buses to Williston, the next place we were to walk to, I registered a burst of deep gloom myself. It was an eerie feeling, a cross between the someone-walking-over-your-grave fit and the wife - told - me - to - do - something - can't - remember - what sensation. Ghastly!

"This is a warning," I said to myself. "I've been overdoing the walking."

However, the cloud passed, but Ambo told me on the 'bus that his own private blues had returned, and that he thought it was time for him to telegraph his wife, as he felt certain that Mr. Twipe had hanged himself in the spare bedroom or that Aunt Harriet had made another will.

Half-way through lunch Ambo said the willies had settled down on him again, and he would have one more round of beef and perhaps another jab or two at the pickles, and then go straight out and telegraph to his wife.

At this stage the serving-wench volunteered the news that the "tally-graffer" at the nearest P.O.—six

... I'll just have to—sort of—let her run down ...

miles distant—had gone to a wedding. So that was that!

I had just strolled back to my chair for a final interview with the nuttiest Gorgonzola that ever ran amuck, when Ambo cried aloud in anguish.

"Everlasting thunder!" he added, in a tense voice. "I've got it at last. *I left my accumulators on charge forty-eight hours ago, and forgot to tell the wife to switch off.*"

I sprang two feet into the air on hearing this, and smote my forehead. *Forget to tell his wife, eh?* Holy smoke, he was lucky to get off so easily!

"Nosey" Skelton to the Rescue!

For my wife was absent on a visit when I left home—*and I had forgotten to let her know anything about our tour!*

"I *thought* there was something hanging over me," remarked Ambo.

"It's nothing to what is hanging over *me*," I answered. Then a wave broke on my massy brain. "Ambo, my boy, we've got to tramp back to Lord Bloot's place by the very next 'bus, and get him to call up 'Nosey' Skelton on his wireless. Then 'Nosey' can buzz round to your place and switch off your current, and call in at my place——"

"And switch off your wife, eh?" laughed Ambo.

I wiped my brow at the thought of it.

"No," I said, with conviction. "I guess I'll just have to—sort of—let her *run down*."

NOTES ON REFLEX CIRCUITS

Will there be a revival in popularity of the reflexed circuit? The modern type has many advantages in purity and economy, as explained in this article.

Permanent and Semi-permanent Crystal Detectors have solved the problem of adjustment.

By C. P. ALLINSON, M.I.R.E.

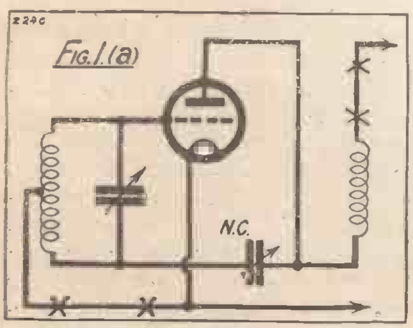
I HAVE been carrying out some experiments in reflex circuits consisting of 1-valve reflex followed by a rectifier, either crystal or valve, with a view to determining which was the most satisfactory circuit to employ in either case.

Reflex circuits seem recently to have fallen into disrepute somewhat, and this is a great pity. A valve-crystal reflex will give one quite satisfactory loud-speaking from the local station up to ten or fifteen miles under average conditions, while I have found that with a reflex valve followed by a detector valve using reaction, it is possible to tune in a number of distant stations on the loud speaker.

Many Circuits Tested

Certainly, the results are not so good as those given by a 3-valve set, but that is largely owing to the fact that it is necessary to use a small power valve for the reflex valve, so that the full degree of amplification as regards the H.F. side of the receiver is not obtained, due to the low amplification factor of the valve.

By suitably designing the H.F. side, however—for instance, by choosing a suitable turn ratio for the H.F. transformer, etc.—it is possible to obtain the maximum H.F. amplification, taking into consideration the valve that is being employed.



In the course of my experiments I must have tried something like 20 or 25 circuits, and it is, of course, obviously impossible to give all these. I am therefore giving those which are of major interest, and which serve to give an outline of the work carried out.

The first point for experiment obviously was what circuit should be employed; since it might be presumed that one type would be more suitable for reflexing than another. A neutralised circuit was, of course, chosen, and this presented two alternatives, either the split-secondary or the split-primary type of neutralising circuit.

A "fixed" Crystal Detector often used in reflex circuits.

Skeleton diagrams of these two circuits are shown at "a" and "b" in Fig. 1, for the benefit of those who are not entirely familiar with the schemes employed.

Split Secondary Type

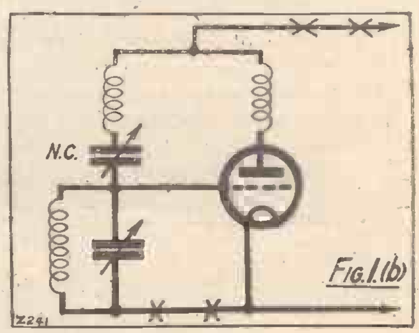
Now in considering these circuits for reflexing, we will take the one shown at "a" first. The most logical place for the L.F. input to be introduced is between the two points marked with crosses in the lead which is connected between the centre point of the grid coil and L.T. and we see at once, under these circumstances, that not only is the H.F. component in the grid circuit of the valve neutralised but the L.F. component, too, so that it would appear that this circuit would be far less liable to give howling or buzzing than other circuits. The L.F. output, of course, is taken from between the two points marked with crosses in the H.T. lead, the loud speaker, 'phones or transformer primary being shunted with a fixed condenser. In the case of the "b" circuit the L.F. input would be introduced in series with the grid return, as shown, the output being taken from the H.T. leads as before. It is clear, however, that in this case the L.F. component will not be neutralised in the same way as the H.F. component, and we should imagine, therefore, that this circuit would be more liable to L.F. instability than the other.

Greater H.F. Amplification

This was actually found to be the case, and in a large number of circuits which I tried out, both the crystal-valve and the 2-valve reflex circuit were found to give the same results in showing the split-primary circuit was more liable to buzz.

In the case of the "b" circuit in Fig. 1, the effect was also tried of using shunt feed for the L.F., and although this was found to be a trifle better as regards buzzing than the other form of L.F. feed, it was definitely less satisfactory in operation than the Fig. "a" circuit.

At the same time, where it is desired to use just a single-valve reflex at no great distance from a broadcast station for purely local work, where little or no reaction is



NOTES ON REFLEX CIRCUITS

—continued

required, then the use of the split-primary circuit might prove of advantage, as it is usually claimed that a greater degree of H.F. amplification is obtained with this circuit than with the other; a point, however, that to my mind is not yet definitely proved.

Further Circuits

Figs. 2 and 3 show two circuits which may be used, and the choice of them will depend to a certain extent on the distance from the local station at which the set will be used, as well as the listener's desire for purity of reproduction.

It will be seen that in both these circuits shunt feed has been employed, a fixed condenser of ·0002 mfd. being connected in the grid lead, and the L.F. input taken directly to the grid through an H.F. choke. In the crystal circuit a crystal tap is employed, and this was found greatly to increase the output obtainable from the receiver.

The Fig. 2 circuit is transformer coupled on the L.F. side, and this, of course, is more suitable for reception at a greater distance from the local station than the Fig. 3 circuit, and a very excellent degree of purity may be obtained from this, providing that a good make of L.F. transformer is used. In view of the fact that a crystal rectifier is being employed, this transformer can have a much lower primary impedance, and therefore a higher step-up turn ratio than would be used with a detector valve, and this is therefore useful in obtaining the maximum signal strength from the receiver.

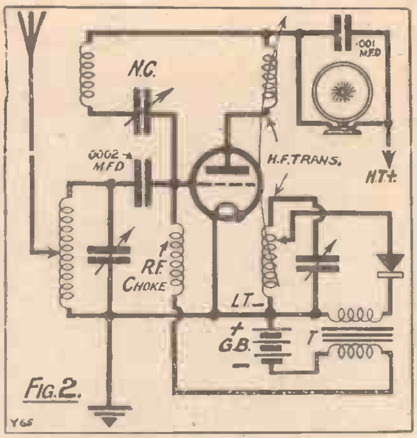
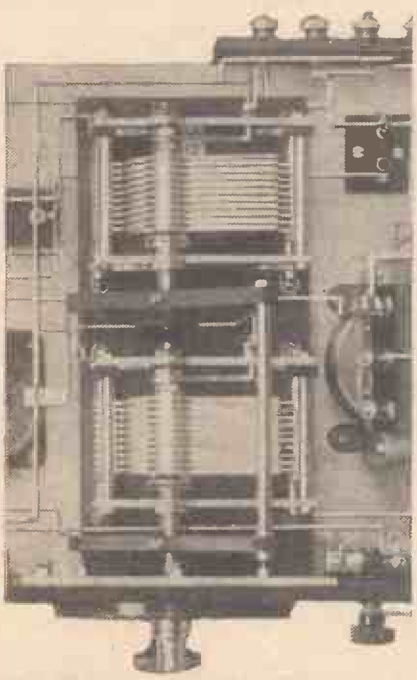


Fig. 2.


When two similar circuits have to be tuned the "gang" condenser simplifies handling.

For those residing at a short distance from the local station the Fig. 3 circuit is certainly to be recommended. The scheme of feeding the output from the crystal back to the valve for L.F. amplification is one that has been employed for a number of years by experimenters, and is too well known to need comment. I found that when using a super-power valve in this circuit a very excellent degree of loud-speaking was obtained from this set, enough to fill a fairly large room, while the faithful reproduction left little to be desired. I would like to point out that a super-power valve was found necessary if it was desired to obtain distortionless amplification when using the valve in a dual function at a close distance from the local station.

Long-Distance Reception

Where, however, it is desired to carry out long-distance work, employing a valve rectifier with reaction, I found that the type "a" form of neutralisation of Fig. 1 is far to be preferred. It enables a smooth control of reaction to be obtained in the detector-valve circuit without any signs of buzzing of the L.F. side of the receiver. It was noticed in particular with the split-primary circuit that when buzzing was obtained it was on the edge of oscillation, and therefore, just at the point where it was least desired.

I tried the effect of using both transformer and resistance-capacity coupling for the L.F. side of the receiver, and, naturally, for distance work the former was greatly to be preferred. It was found important for maximum volume and quality to use a suitable transformer in which the primary impedance was carefully matched to the impedance of the detector valve. The use of a high-ratio transformer with a low primary impedance definitely showed a falling off in amplification when a high-impedance detector was used, while the quality was greatly impaired, the lower notes being lost and the reproduction of speech and music being poor and thin.

Improved Quality

While the use of resistance-capacity coupling definitely resulted in a drop in signal strength on distant stations a noticeable improvement was observed in quality on the local station. It was also found possible to receive one or two distant stations at moderate strength on the loud speaker. Fig. 5 shows the circuit employed.

It will be seen from the theoretical diagram that special precautions have been taken to prevent any feed-back of H.F. currents occurring between the detector and H.F. valve, and the choke which is placed in the plate circuit of the detector in order to enable capacity reaction to be used was not relied on entirely to eliminate all the H.F. component, and a further H.F. choke was therefore placed in the L.F. feeder, as shown. A small capacity was also shunted across the coupling resistance as a further safeguard. The dual valve in this receiver was either of the D.E.5 or D.E.5A type, depending on how far from the local station the receiver was being employed, while the detector could be either of the ordinary resistance-capacity type or one of the new high-magnification valves which are being manufactured with an amplification factor in the neighbourhood of 40. When using leaky-grid condenser rectification with one of these latter valves and a resistance of

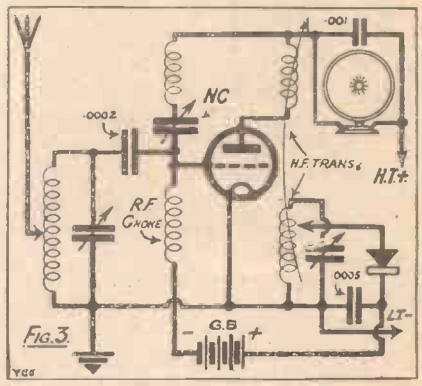


Fig. 3.

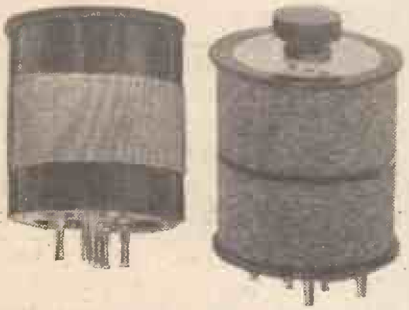
NOTES ON REFLEX CIRCUITS

—continued

250,000 ohms, quite satisfactory long-distance work would be accomplished, while the control of reaction was found to be delightfully smooth and free from backlash.

An interesting circuit with which to work is that shown in Fig. 4. This is a form of Prince Trigger circuit adapted for reflex work, so that the present arrangement shows one or two modifications of the original Prince circuit. Owing to the low damping of the detector circuit quite a good degree of selectivity is to be obtained, while this low degree of damping further helps to compensate to a certain extent for the fact that it is not possible to obtain reaction on the detector valve with the Prince arrangement.

In the circuit shown in Fig. 4 it will be seen that I have not used the potentiometer and biasing battery



Examples of modern coils which were not in use in the days when reflex circuits were generally employed.

which are generally used to give the correct potential on the grid of the detector valve, but have simply placed a condenser in the grid lead, thus leaving the grid of the detector entirely free. This has been found by other experimenters as well as myself to produce a very satisfactory arrangement for use with this scheme.

Coupling the Detector

The anode of the detector valve is coupled back to the grid of the H.F. valve through the battery "A," which is adjustable and may have any value between 9 and 24 volts. I have generally found that the best value lies between 12 and 15 volts, and I think that a number of experimenters are inclined to use too high a value here.

The resistance R acts both as a coupling resistance and grid leak, and its value will depend to a certain extent on the strength of the signals being dealt with and the valve which is being used in the dual function, as well as the valve being used for the detector. I am rather inclined to use a resistance in the neighbourhood of ·5 to 1 megohm for all-round work, since if the value of this resistance is too low a loss in signal strength will probably result.

Such reaction control as I did require was obtained by means of a neutralising condenser, and I was able to receive several distant stations at quite reasonable strength when using the circuit shown in Fig. 4.

Pure Reproduction

This circuit, needless to say, gives an extraordinarily fine quality of reproduced music and speech, since the L.F. portion of the receiver is entirely aperiodic, so that even amplification of the whole gamut of musical tones and speech is obtained. A little experiment is, of course, needed before the circuit is made to function efficiently and satisfactorily, but the little time which may be spent in this way is well repaid.

An examination of all the circuits accompanying this article will show that they each contain two identical tuned circuits, an H.F. circuit and detector circuit. With a view to obtaining simplicity of operation I determined to see whether these could not be gang controlled, for by suitably matching the inductances the use of a gang condenser would reduce the tuning controls to one.

I found that very little difficulty was experienced in doing this, and that every one of the circuits accompanying this article could be gang-controlled without any appreciable loss in efficiency. Especially was this the case when a crystal detector was employed, for the extra damping

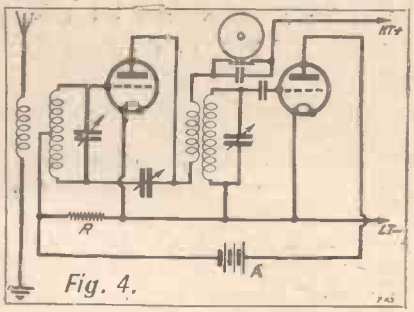


Fig. 4.

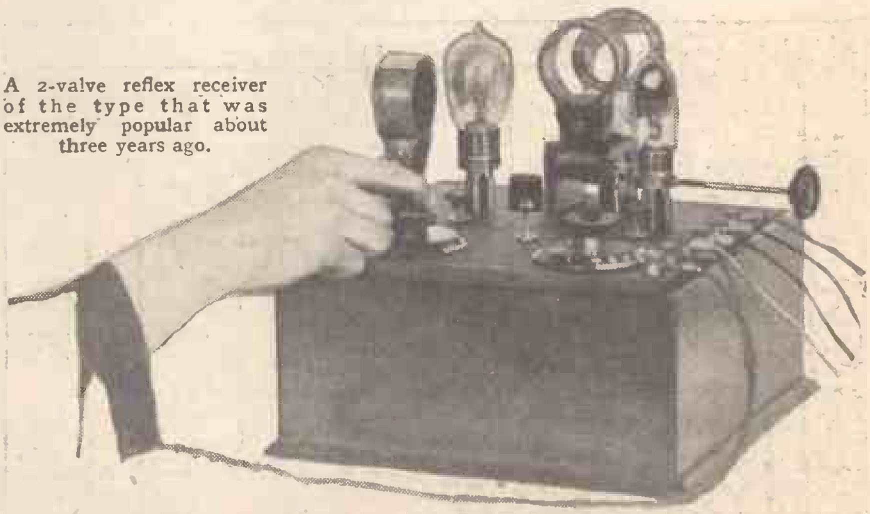
introduced by this flattened the tuning of the detector circuit so that a slight lack of adjustment of the detector portion of the gang condenser, which would have seriously affected a circuit employing a detector valve with reaction, had no effect at all on the efficiency where a crystal rectifier was employed.

Before closing, I would like to point out one defect from which the crystal-valve circuits suffer, and that is, of course, unavoidable when a crystal detector is employed. That is, that there is no positive control of reaction. The only control that is available is by the use of the neutralising condenser, and in cases where heavy damping may exist in the circuit difficulty may be experienced in getting the set to go into oscillation.

Best for "Local" Work

It is, of course, absolutely necessary to have a positive control of reaction if the maximum range is to be obtained from the receiver, and distant stations will not be received with the crystal-valve receiver if the set cannot be induced to oscillate. The combination is, of course, ideal for local-station work, but many wish to reach out for foreign stations, and it is well known that long-distance work has been done with this combination.

A 2-valve reflex receiver of the type that was extremely popular about three years ago.



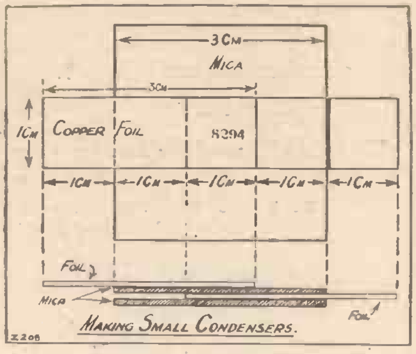
MAKING SMALL CONDENSERS

From a Correspondent

Though the home-made fixed condenser cannot be expected to have the accuracy of a condenser manufactured by a first-class firm, it is often desirable on the score of economy to make up these small components for oneself and fit them, temporarily at any rate, to the receiving set, replacing them later on with condensers of the best make. If you cannot afford first-rate condensers do not buy cheap ones. Their capacity is seldom near the stated figure, and often the material used is so poor that they are responsible for all kinds of defects in reception. It is much better in such circumstances to use home-made condensers.

Necessary Materials

The materials required are a supply of sheets of the best ruby mica ·002 inch thick, some copper foil, and a bottle of the best shellac varnish. Some stouter mica should also be obtained to make the outside coverings for the condensers. It is most useful to remember that if the mica *is* of the quality recommended and *is*



MAKING SMALL CONDENSERS.

·002 inch thick, then two plates with an overlap of 1 square centimetre will give a capacity of approximately ·0001 mfd. To obtain larger capacities we may increase either the size of the plates or their number. The total approximate capacity can always be worked out by multiplying the number of dielectrics by the overlap in square centimetres of one pair of plates, and then multiplying the result by ·0001.

The drawing shows a simple way of making small fixed condensers. Cut out two pieces of the thick mica each 3 centimetres square and as many pieces of ·002-inch mica of the same size as you will require for dielectrics. For the " plates " of the condenser cut out as many pieces of copper foil measuring 3 centimetres by 1 as will be needed. Lay one of the thick end-pieces on the table and coat it lightly with shellac. Upon it place a piece of the copper-foil, arranging it so that one centimetre of its length protrudes beyond the edge of the mica to the left.

Simple Procedure

Apply a little shellac to the copper and press one of the thin sheets of mica firmly down upon it. Shellac this, and upon it lay a copper-foil plate, arranging it so that it lies immediately over the first plate but protrudes one centimetre to the right. Continue in the same way until you have as many plates as you need. Then fit the second outer cover of thick mica. Place the condenser under a warm flat-iron and leave it until the shellac is set hard. The protruding ends of each set of plates may now be bonded together with solder, and the condenser is finished.

NOTES ON REFLEX CIRCUITS

—concluded

This has, of course, been with the original circuit in which tuned-anode H.F. is employed, and the tuned anode is coupled back to the grid coil of the H.F. valve for reaction. Unfortunately this type of receiver, being un-neutralised, is liable to buzz and can create a lot of interference to others, while every adjustment of reaction seriously affects the tuning, so that the set is none too easy to handle, especially when compared with a modern neutralised H.F. circuit.

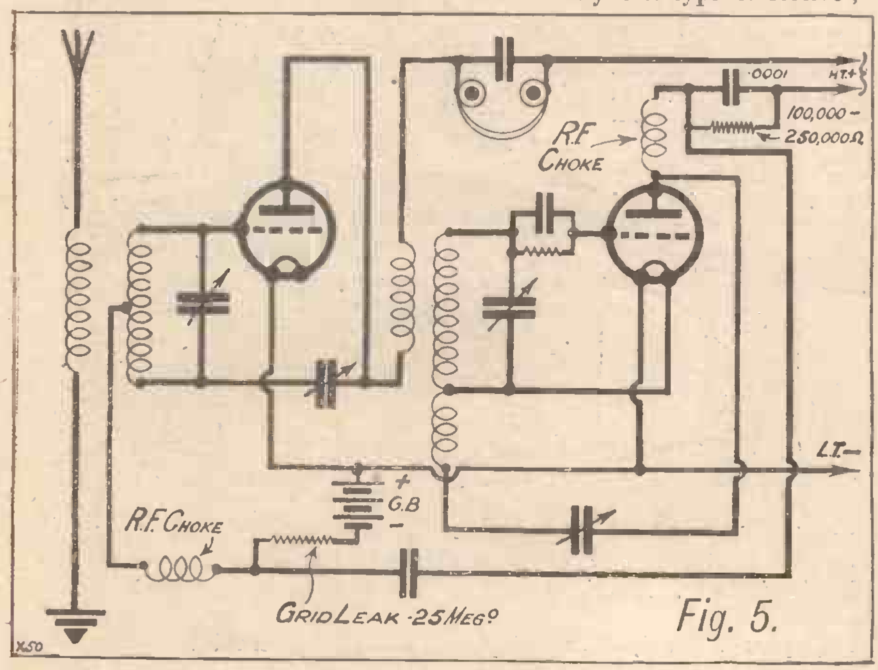


Fig. 5.

The problem is further complicated by the varying damping of the crystal, and every time this is adjusted the reaction and tuning are likely to be affected.

I trust the foregoing notes will be of interest and value to those interested in reflex problems and will show that the idea of using a valve in a dual capacity is not by any means played out, and can be employed in many cases to give full satisfaction and efficient reception.

MORE ABOUT THE SUMMERDYNE

By PERCY W. HARRIS, M.I.R.E.
(Editor of the "Wireless Constructor.")

Some details of practical tests with the 7-valve heterodyne set described in last month's "Modern Wireless."

In the last issue of MODERN WIRELESS I gave particulars of how to build the "Summerdyne"—a portable 7-valve super-heterodyne with certain unique features. Since writing this article, I have continued to use the set in a variety of circumstances, and carried still further the experiments with valves and general adjustment. I am glad to say that after bumps and bangs which would have dislocated many a portable set, the "Summerdyne" has not needed even a single minor repair in joints or connections.

Choice of Valves

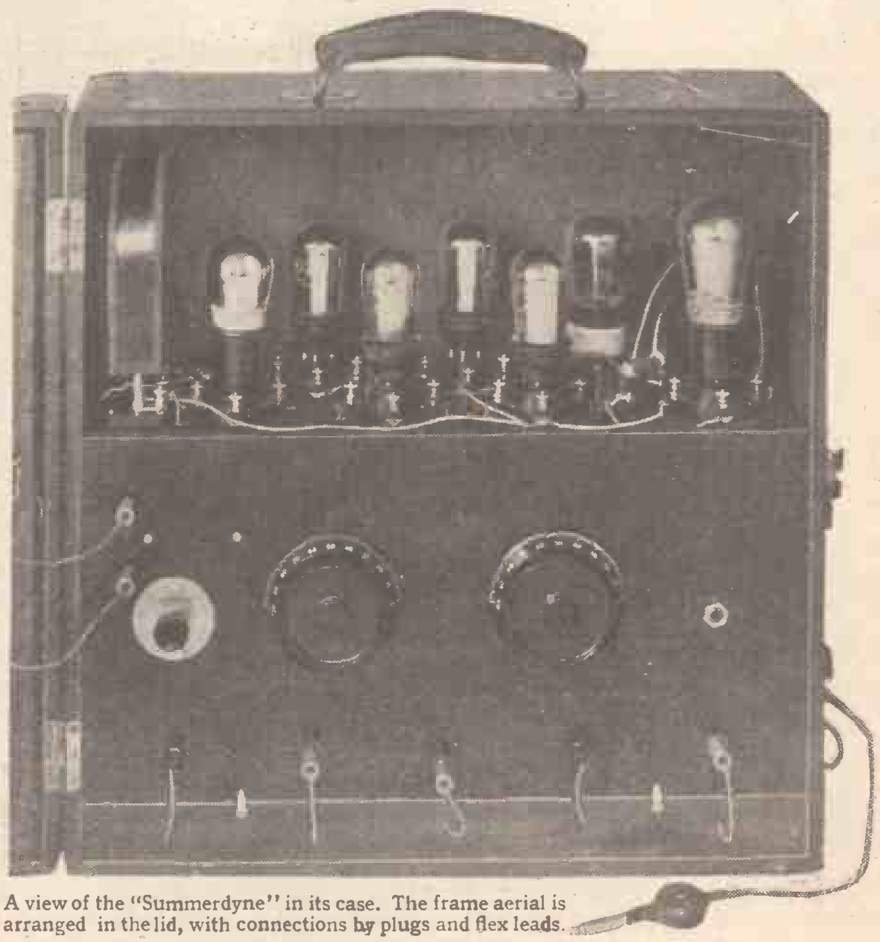
As indicated in the first article, the choice of valves is particularly important in a super-heterodyne—much more so than in the ordinary type of set. It must be remembered that the intermediate stages are what is sometimes called "self-tuned," a rather unscientific way of indicating that there are no separate tuning condensers for these stages. This being so, variations in valves are much more important than would be the case where the tuning capacity is considerably larger than that of the valve itself, as happens in the ordinary type of receiver.

L.F. Types Better

It might at first be thought that the H.F. type of valve would suit the intermediate stages, but my own experience shows that with the 2-volt series this is not the case with the particular intermediates used. Probably owing to the fact that they are designed for American valves, which have relatively low impedances compared with those of ours designed for high-frequency work, the General Radio Co.'s intermediates seem to work best with valves of an impedance of round about 20,000 ohms, and on examining my valve stock I find that the Marconi or Osram D.E.2 L.F. and the Cossor 210 (Det. and L.F.) fall under this heading.

An Important Point

Practical tests show that both types of valves suit the intermediates excellently, although you must not mix the makes. This would give poor results owing to differences in construction of the two valves. By this I mean that three Cossor 210



A view of the "Summerdyne" in its case. The frame aerial is arranged in the lid, with connections by plugs and flex leads.

More About the Summerdyne
—continued


The H.T. and L.T. batteries employed in the original set.

L.F. or three D.E.2 L.F. give good results, while two Cossors and one D.E.2 L.F. or two D.E.2 L.F. and one Cossor prove unsatisfactory. I am stressing this point as I do not wish the set to be blamed for troubles which might arise owing to a wrong combination of valves.

The Two Detectors

Other 2-volt valves with characteristics suitable for the intermediates are the Burndept H.L.213 (although this takes a little more current) and the Mullard P.M.1 L.F. The choice of the oscillator valve is important. Having tried a number of valves in this socket I have had best results of all with the P.M.1 H.F. In general the H.F. type of valve is the one to use in this socket; for example, the Cossor 2-volt H.F. works quite well here.

For the two detectors either the H.F. or the L.F. types of valve will work well, but slightly better results, however, are given by the H.F. type, such as the D.E.2 H.F., Mullard P.M.1 H.F., or Cossor H.F. The last valve, of course, can be any 2-volt power valve.


The designer testing the "Summerdyne" on a Surrey hillside.

Experiments should be carried out to find the best H.T. voltage on the valves, and such experiments are much simplified when we remember that the last tapping should have the highest value H.T. voltage available in all cases. This means, therefore, that the only plug you will have to vary is the H.T. + 1. A few trials will give you all the information you need.

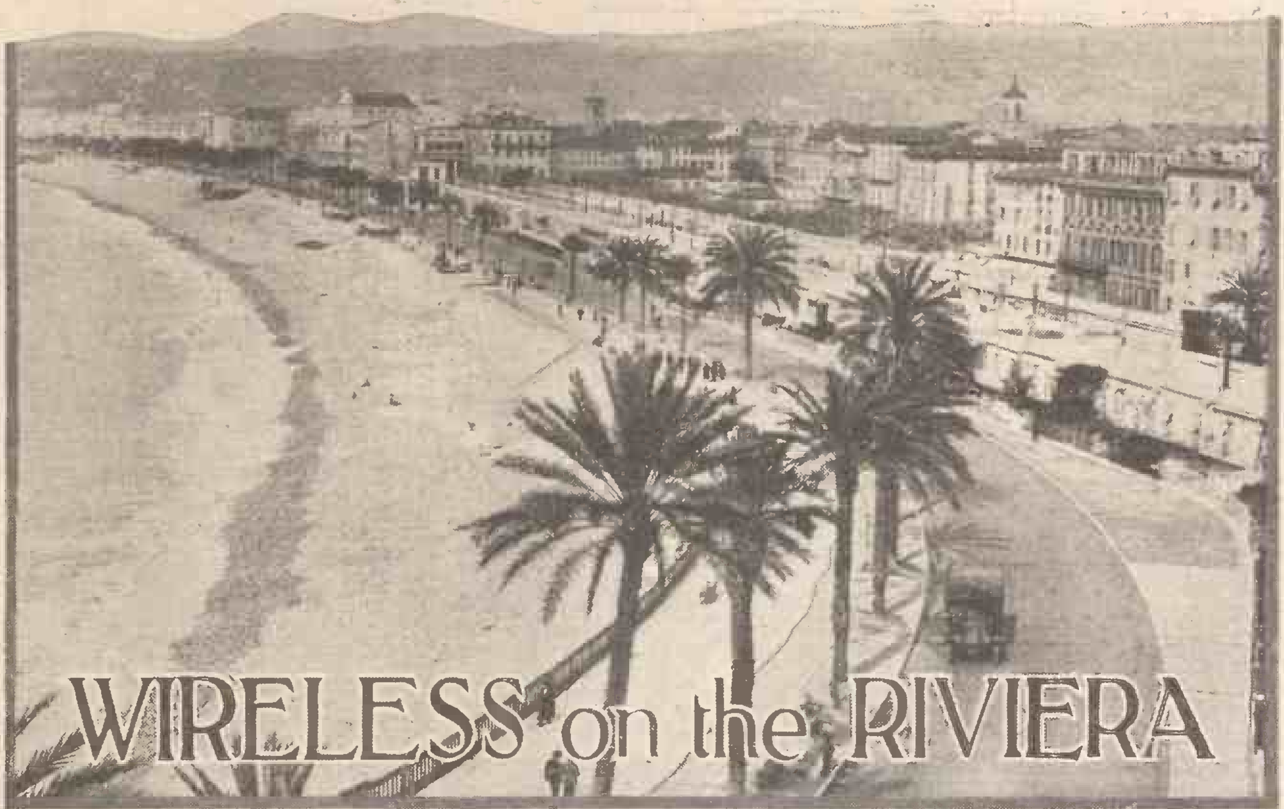
In view of the closeness of the frame to the oscillator coupler, it may be found that reversing the plug from the frame to the panel will improve results. Generally one way round is better than the other. As mentioned in the previous article, best signals are generally obtained when the lid of the cabinet is at, approximately, right angles to the cabinet itself, and as the frame must point in the direction of the station from which signals are being received, the whole cabinet should be moved round to obtain the position indicated.

Experiments can also be carried out with grid-leak values, particularly for the first detector. While generally a 2-megohm leak in each case will give good results, better results are sometimes obtained with a 3- or 4-megohm leak.

Using External Batteries

Many readers will wish to use the "Summerdyne" at home for general reception, and in such cases I would strongly advise economy with the batteries inside the cabinet. For home use the plug connection method adapted in this set is particularly convenient. The 2-volt accumulator, H.T. batteries and grid bias battery within the set can be taken out and the five plugs disconnected from the front panel. Exterior batteries of the same voltages as those in the set described can then be connected up quite simply, by means of five exterior plugs, with consequent saving of the portable batteries for "field" use. Do not forget to wire up the external batteries in the same way as those internally. Those who have the valves available can also experiment with the 6-volt

(Concluded on page 653.)



WIRELESS on the RIVIERA

An interesting report upon radio on the shores of the Mediterranean.
By
L. P. SELLS.

"AND what is wireless like on the Riviera?" This question has been frequently put to me by friends in England, and for the benefit of those who are thinking of bringing a set out to these parts the following article may be of interest.

Broadcasting in Italy may be said to have commenced with the opening of the Rome station on October 6th, 1924, but for the first year the programmes were more or less of an experimental nature. The fine Milan station was opened in December, 1925, the new and more powerful Rome station in March, 1926, and the third Italian station, Naples, was only opened in October last.


The 4-valve set, with batteries, etc., arranged below.

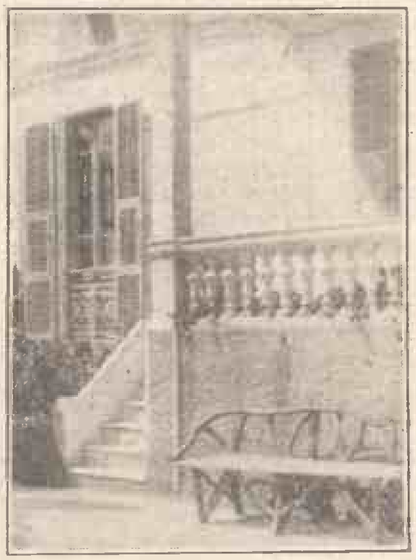
From this it will be seen that wireless in Italy has not yet had a very long life, and it is still in rather a backward state compared with other countries. This was, at first, very largely due to the excessive and vexatious prohibitions, restrictions, etc., not to mention taxes of all kinds, that were imposed on anything to do with wireless. Now, however, much more liberal regulations are in force and amateurs are granted reasonable liberty in the construction of their own sets, so that the wireless trade in Italy should now develop rapidly.

It must be confessed, however, that the quality of the transmissions sometimes leaves much to be desired, and it is a pity that the best station for quality of music, Milan, should be so difficult to receive on the Italian Riviera. (Owing to the position of the Alps "fading" is very pronounced in the reception of this station.)

Compared with England or Germany the Italian stations do not seem to keep very accurately to their advertised time-table or programmes, and the very lengthy "intervals" of the Rome station are apt to be annoying at times. The Naples "tic-tac" is useful in this respect.

Present Conditions

The lot of the listener on the Italian Riviera is not altogether a happy one. Wireless conditions here differ greatly from those in England in that there is no "local" station,

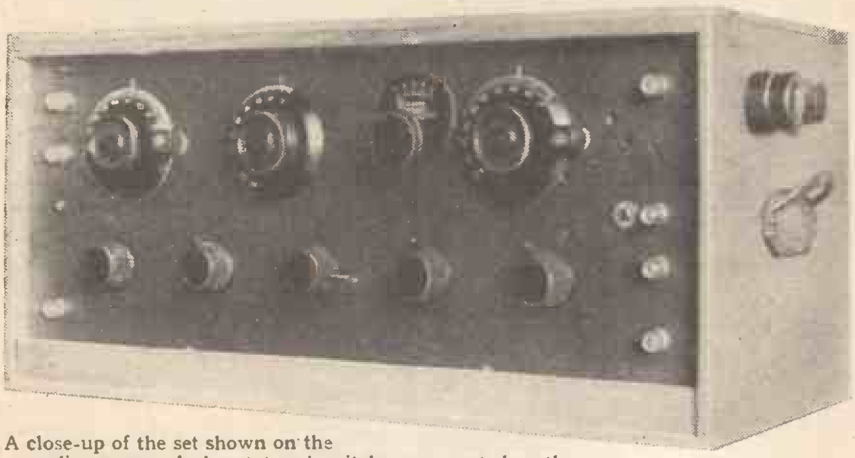

The author's house, showing the aerial lead-in.

WIRELESS ON THE RIVIERA

—continued

the nearest being Milan about 140 miles distant, but, for the reasons stated above, it is not of much use. Naples seems to be the best Italian station, as although it is nominally of only half the power of Rome it generally comes through quite as strongly, and its wave-length is less liable to be jammed by Morse. But at the present time the best and most reliable station for receiving regular programmes is Stuttgart.

One gets to look on this as the "local" station, to be turned to whenever a good programme is required for demonstrating one's set to friends. This station's wave-length is about midway between those of the various Morse stations along this coast, and so one gets a measure of relief from the appalling jamming that goes on almost incessantly on some evenings.



A close-up of the set shown on the preceding page. A rheostat and switch are mounted on the case.

The Morse nuisance is the most serious handicap to the development of wireless in this region, as will be realised very soon by any listener. Rome on a wave-length of 449 metres is, of course, hopelessly jammed by spark messages on the 450-metre wave-length and there seems to be a 300-metre wave-length station on the French Riviera which nicely interferes with the music over that portion of the condenser dial!

Spark Interference

As to the fine programmes from Vienna, of course, anything over the 500-metre wave-length brings one near to the normal ship wave-length of 600 metres, with a consequent background of innumerable ships talking to each other up and down the Mediterranean. And even Daventry cannot be relied on for relief, for this is liable to interference from certain Spanish spark stations on an identical wave-length.

Atmospherics, too, are generally very bad during the summer months, and the prevalent custom of stringing electric high-power mains all over the countryside and on both sides of the main roads is a source of many parasitic noises, especially after dark. It is a curious thing that reception is often quiet and good just before sunset, whilst an hour or two later the atmospherics and other noises make listening hardly worth while.

Extraneous Noises

From the above remarks it will be seen that the limiting factor to successful wireless reception on the Riviera is chiefly that of extraneous noise, and this is, of course, a matter about which the operator of a set can do little or nothing. One would naturally have supposed that a "super-het" with its small frame aerial would pick up less atmospheric noises, but from actual tests made here with both English and Italian receivers of good makes there appears to be nothing in it. The atmospherics, if bad, remain sufficiently loud to drown all signals, and on many a night one has to give up listening entirely.

On one evening, when the atmospheric "crashes" were particularly bad, the writer tried a small indoor aerial with a view of receiving the nearer stations with the minimum of interference, but whilst several transmissions could be heard at comfortable 'phone strength on a 3-valve set the "crashes" were still so loud as to make listening a painful affair.

Loose coupling in the aerial circuit makes practically no difference either, and greatly cuts down the signal strength. The first set constructed by the writer was the "Coastal Three," described in MODERN WIRELESS for November, 1925. This is an ordinary tuned-anode circuit with reaction on to the anode coil and with "trap" tuning in the aerial circuit. This latter feature was not found to be of any advantage out here, so the set was used without it.

Successful Sets

With this set very satisfactory results were obtained and good selectivity was possible. On one or two occasions during the winter of 1925–26 Bournemouth, 386 metres, Dublin, 390 metres, and Hamburg, 392 metres, were tuned in one after the other, which is good enough for most purposes. Of course, such selectivity, with but one stage of H.F., is only possible in a position like this, where, owing to the distance, all stations come in on more or less equal terms.

Even under present conditions it is generally possible to receive 2 L O without interference from either Leipzig or Prague, although on some evenings these latter stations seem to "spread" somewhat. It is only fair to say that the aerial and earth system in use with the set is a thoroughly efficient one, which probably accounts as much as anything for the good results obtained. This 3-valve set is still in use as a broadcast catcher for short and long waves, and from actual comparisons with many other sets out here, for efficiency, simplicity, and ease of operation it wants a lot of beating.

Another successful set for these conditions is a modification of the "Quality Four" described in MODERN WIRELESS for January, 1926. This circuit is a tuned anode incorporating a "Radio Instruments" tuned-anode reactance unit. As described in "M. W." the set has provision for loose-coupling and C.A.T., but as these both make the set difficult to handle and are not required out here, the writer uses "Reinartz" reaction on to the aerial, using plug-in coils in a 2-coil holder. A 300-turn coil serves as H.F. choke, and control is effected most conveniently and delicately by a condenser on the panel.

Reaction

By the way, it seems best from the point of view of selectivity to use rather a large reaction coil and keep it at an angle of 45 degrees to the aerial coil. The first L.F. stage is an A.J.S. choke unit, and the second a Eureka Baby-Grand transformer. This combination works a Sterling

WIRELESS ON THE RIVIERA

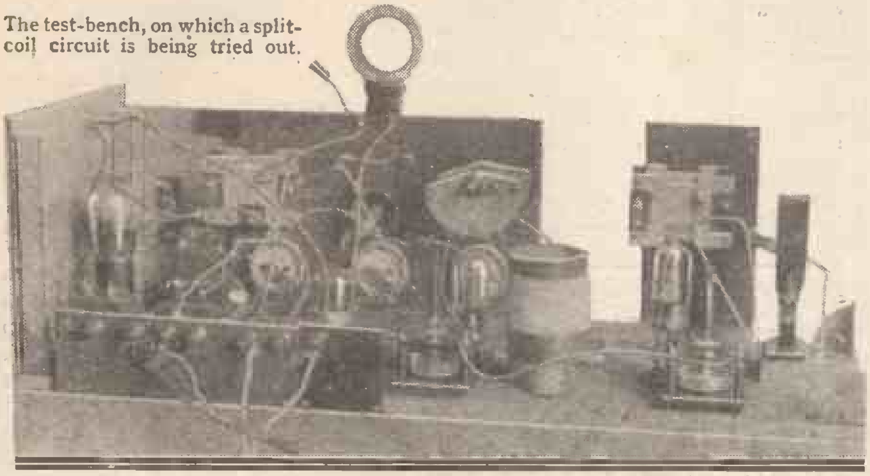
—continued

"Dinkie" loud speaker very satisfactorily and with good quality of reproduction. For listening with 'phones a jack is fitted to cut out the last valve.

Valves

It is as well to realise that out here one has not the wide choice of different types of valves that are available in England, and that sets which depend for their successful working on a particular type of valve are not so suitable for bringing abroad as those which work well with a wide range of valves. For the same reason it is necessary to do a little experimenting with valves and transformers, chokes, etc., to find a suitable arrangement on the L.F. side which will suit the type of valve it is possible to buy.

The test-bench, on which a split-coil circuit is being tried out.



Each of the sets described above is fitted with a potentiometer for stabilising purposes, if required, and this should be regarded as an essential fitting for any tuned-anode set that does not embody the neutrodyne principle. In localities like this, where no transmission comes in really strongly compared with reception of a "local" station in England, a potentiometer is quite capable of stabilising a set properly, and it is generally not required to be used much, except on high-power stations such as Daventry. (Presumably it is the strength of Daventry's carrier-wave that sets up the tendency to oscillate, as the signal strength is generally inferior to that of 2 L O.)

The "Huntsman Two"

There is no doubt, however, that a potentiometer is not a sound method of stabilisation in sets employing an H.F. stage of amplification in conjunction with "loose" or "auto" coupling, or with series aerial tuning, and in cases where one of these arrangements must be used in order to get greater selectivity, a properly neutralised circuit is essential.

The drawback to circuits of this sort rests in the fact that tuning is often rendered uncomfortably sharp, and out here it is also very difficult to know when the set is neutralised properly, owing to the absence of a strong transmission by which to adjust the neutrodyne condensers. The writer has lately been experimenting with the "Huntsman Two" circuit, plus an L.F. stage. This circuit, described some time ago in the "Wireless Constructor," uses a split coil in the first grid circuit, and reaction is applied on to the tuned-anode coil. The split coil is home-made on a shellacked cardboard tube, aerial winding 18 turns and grid coil 80 turns tapped at the centre, and half an inch space is left between the aerial and grid windings. The results are promising for a first attempt. 2 L O and 6 B M have both been received at good strength on 'phones and with a quieter background than usual, but the circuit has two drawbacks—very critical reaction is required to bring the signal strength up to normal, and tuning is so sharp as really to require slow-motion condensers or vernier dials. And unfortunately the Morse gets through as strong as ever, or very nearly so.

Selectivity Desirable

This circuit is, however, non-radiating, which is a good feature, and further experiments are proceeding, since there is no doubt that with the present crowded state of the ether sets even out here will require to be more selective than in time past.

The writer has tested out on his aerial several sets of foreign make with from three to five valves, but so far has not met with anything more satisfactory as a *general-purpose* set than his own 4-valver. The only set of English make tested was an old-pattern A.J.S. 4-valve, with a tuned transformer H.F. stage. This gave most excellent results, showing that British design and construction in wireless sets is still far ahead of Continental.

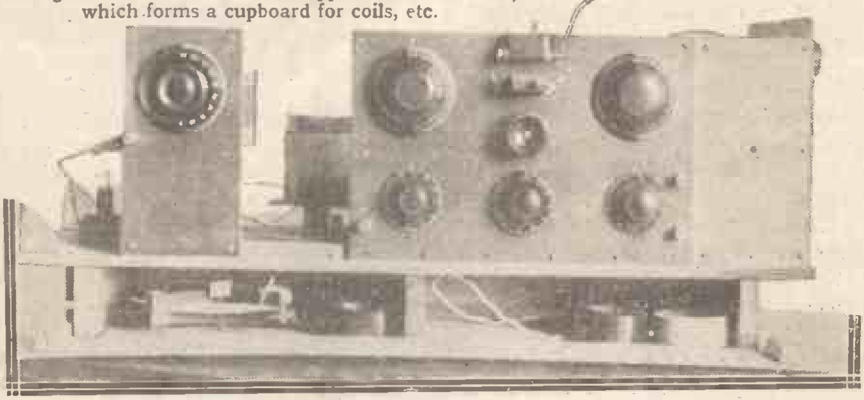
The volume and purity given by the two L.F. chokes was a revelation, after the raucous noises produced by the average foreign set. Unfortunately the selectivity on this set was not as good as could be wished, but for reception of a local station it would be all right.

Price a Consideration

There would seem to be a good opening in Italy for British wireless sets and sets of components of good quality, but they must not be too expensive. Manufacturers who can combine good quality with a moderate price will do the best. "De luxe" components cannot have a large sale in Italy, and, after all, the extra efficiency obtainable with them is largely a doubtful quantity. It is surprising what can be done with simple apparatus, provided that

(*Concluded on page 592.*)

This 3-valve set stands on a support with fall front, which forms a cupboard for coils, etc.



A Tuning Improvement

FROM A CORRESPONDENT

THE provision of degree scales on the dials of variable condensers and variometers makes it possible to note the readings of stations and to set the dials to predetermined points, but it is to be feared that a great many dials are the reverse of helpful when accurate settings are needed. Four-inch dials are usually reasonably good in this respect, owing to the wider spacing of the degree markings. The older pattern of three-inch dial, for which there was no substitute until comparatively recently, is too often characterised by blurred engraving, with degree lines quite broad enough to cover a considerable movement of the condenser vanes.

This defect can, of course, be overcome by the substitution of larger dials for those existing on a receiver, but this involves extra expenditure on an alteration which, after all, affects the operator more than the receiver itself. The modification of the existing three-inch dials to be described here should make an appeal

to those who prefer the adaptation of the material already at hand to the purchase of new components. It is not troublesome to make the alteration, and the result is both pleasing to the eye and an improvement from the operator's point of view.

The photograph shows the appearance of the converted dial. It will be seen that the scale engraved on the dial is not used; it may, in fact, be blacked out. A "hair-line" pointer is introduced into the dial, and this passes over a fixed scale, which can be as finely drawn as desired.

A turned ebonite dial is preferable to the moulded type, since it will be found difficult to work the latter without cracking it. Also the dial should have a recess underneath, although this feature is not essential.

The first operation is to cut the "window" through which the scale will

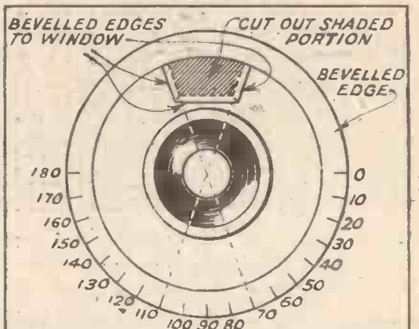


FIG. 1. MARKING OUT OF "WINDOW".

be read. One inch from the centre of the dial, and diametrically opposite to the 90-degree mark on the engraved scale, a ⅜-in. hole is drilled. The lines marking the edges of the window are then scribed on the ebonite round this hole. The base of the window will be parallel to a line joining the 0- and 180-degree marks, while, for the sides, lines should be produced through the centre of the dial from the 110- and 70-degree marks. The edge of the bevel of the dial bounds the remaining side of the window.

The window is cut out up to the scribed lines and finished with a small file. The three straight edges of the window are then bevelled off at the top, in order to give a clearer view of the scale.

For the hair-line a piece of celluloid, shaped as shown in the drawing (Fig. 2), will be required. The line

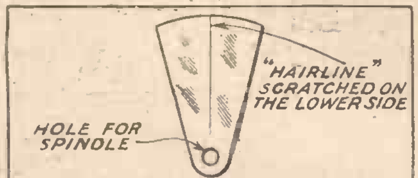


FIG. 2. PIECE OF CELLULOID TO FIT UNDER THE WINDOW.

is ruled on this with the point of a needle, and a trace of Indian ink is rubbed into it to make it show up better against a white background. The celluloid is glued to the underside of the dial, additional security being provided by the lock-nut on the spindle. If the spindle on which the dial is to be used is not threaded, it will suffice to make the piece of celluloid only slightly larger than the window, reliance being placed on the glue to secure it. The hair-line should come as nearly as possible in the centre of the window.

The scale, which is to be glued to the panel of the receiver underneath the dial, may either be drawn by hand on a piece of thin card, or it may take the form of a celluloid protractor. A mount of thick card will probably be needed between the scale and the panel. To obviate any sticking of the dial as it is rotated, the scale and its mount should be circular.

WIRELESS ON THE RIVIERA

—concluded from previous page.

unnecessary losses are avoided. As regards reception of English stations, London, Bournemouth, Cardiff, and Daventry are the strongest out here, and one can generally get one or other of them except on unfavourable nights. The other B.B.C. stations are hardly worth trying for on ordinary sets, as they are either all swamped by Continental transmissions or too weak to be worth listening to. Of course, one can go "round the dials" late at night and hear the Savoy Bands being relayed from the various stations, but this sort of thing is not of much use in getting the earlier programmes. The satisfactory reception of the English broadcast programmes is naturally the criterion by which the performance of a set is judged from the point of view of English residents in these parts. In conclusion, it is as well for manufacturers to realise that this district is a decidedly bad place for wireless reception, and that it is inadvisable for them to make extravagant claims for their sets which may not be able to be verified in practice.

THE "FEATHERWEIGHT" THREE

An easily constructed portable receiver capable of giving excellent results.

Designed and constructed By L. H. THOMAS.

THOSE who wish to use portable sets during the summer season may be divided into two distinct classes. On the one hand there are those who look upon a radio receiver and loud speaker solely as a means of amusement while picnicking in the country or on the river, and are not concerned with the technical side at all; and on the other hand there are those who are radio enthusiasts in their "home-life," and wish to see what can be done with a portable receiver in the way of tuning-in distant stations, etc. In short, the latter class would use their portable for the sake of radio, and the former for the sake of amusement.

COMPONENTS REQUIRED.

- 1 panel, 12 in. × 6 in. × $\frac{3}{16}$ in.
- 1 "Portable Super-heterodyne" cabinet. (Camco.)
- 2 ·00035 square-law condensers.
- 2 single-coil holders.
- 3 Benjamin "Clearer-Tone" valve holders.
- 1 "Multi-Ratio" L.F. transformer.
- 1 baseboard-mounting rheostat, and 1 L.F. choke (Lissen, Ltd.)
- 1 H.F. choke.
- 1 ·0003 fixed condenser.
- 1 ·015 fixed condenser.
- 1 ·0001 fixed condenser.
- 1 2-meg. grid leak.
- 1 1-meg. grid leak.
- 1 single-circuit jack.
- 1 L.T. switch.
- 1 pair panel brackets.

The set described in this article has been designed primarily for the former type of person. It is intended chiefly to work a loud speaker at fairly good strength within 30 miles or so of the local station, and, although it is quite capable of giving good results from many other stations when there is a member of the party sufficiently energetic to climb a tree and erect a good aerial, this is not claimed for it in the ordinary way.

Bearing in mind the above, the circuit chosen for the set is nothing more complicated than the old favourite consisting of a detector and two "note-mags." This lends itself to arrangement in quite compact form and gives the veriest novice no trouble in operation. In addition to these qualities, it is very easy indeed to construct.

Cutting Down Weight

The chief thing to avoid in the construction of portable sets is the use

Carrying out tests with the "Featherweight" Three and a frame aerial.

THE "FEATHERWEIGHT" THREE

—continued

of unnecessarily large or heavy components. One would think this sufficiently obvious to be taken for granted, but it is mentioned because the author has seen more than one set in which the weight could have been reduced to about half by the exercise of a little more care in the choice of components and batteries, etc.

In the "Featherweight" Three all the batteries are housed within the cabinet, the only accessories to be carried being a small coil of wire for an aerial, and, sometimes, another short length of wire and an earth tube, for obvious reasons.

Question of Aerial

In the initial tests of this set both a frame and an "open" aerial were used, but the latter is to be preferred for several reasons, whenever it is convenient to erect one. It is surprising, when one gets well out into open country, how well a short and low stretch of wire will behave itself as an aerial. At a distance of some 30 miles from 2 L O, with a length of wire stretched at a height of 15 feet between two trees about 40 feet apart, quite good loud-speaker reproduction was obtained. With an aerial of this type, about 20 miles out, results were distinctly better than they were at the writer's home on a 70-foot aerial with an average height of 38 feet! It is, as a rule, no trouble to spend ten minutes or so erecting some sort of aerial, and for this reason no great amount of attention has been paid to making the set specially suitable for use with a frame. For the purpose of reducing the weight, one transformer-coupled stage and one choke-coupled stage have been employed. It might be thought that resistance-capacity coupling for the note-magnifiers would have been an advantage, but the extra H.T. batteries necessary when this system is used were found to weigh considerably more than a choke and a transformer, so that the present arrangement was decided on.

The cabinet used allows the layout to be quite well arranged without the necessity of cramping the components at all. It is always desirable in a portable set to have as large a baseboard and as small a panel as possible, and it will be seen from the photographs that this condition has been complied with. The only components on the panel are two variable condensers, a jack for the loud speaker and a filament switch.

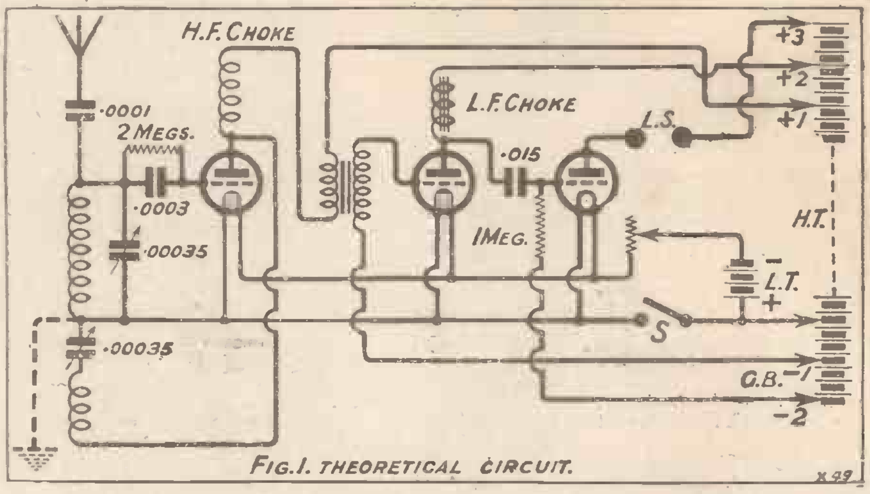


FIG. 1. THEORETICAL CIRCUIT.

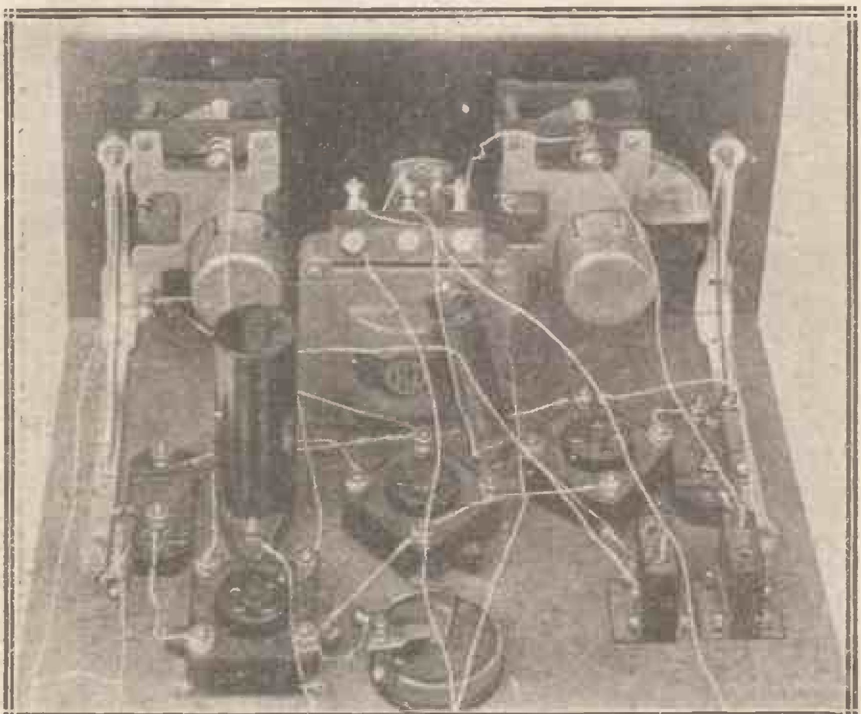
Reinartz-type reaction is employed. This was decided on as with a fairly compact portable set there is usually not very much room for "flopping-coil" methods to be used. Two coil holders are therefore fixed in position relative to one another, and a fair amount of extra space is thus made available.

Flexible Wiring

The wiring has been carried out with No. 26 D.C.C. wire, since the original set had been used several times while travelling in a car, and the vibration was found to render reception almost impossible when stiff tinned copper wire with the usual soldered connections was used. There is, however, no particular need for the reader to adhere to the method of wiring shown in the photographs. This method, by the way, is not conducive to very neat appearance, but this is unavoidable.

Needless to say, it was found necessary to use valve holders of the non-microphonic type. The actual valves used also need to be chosen with some care, since those of the type employing fragile filaments are rather apt to have a short life when subjected to the amount of jolting which the writer's set received.

Those actually used were of the 1·1 volt, ·25 ampere type, which have very stout filaments indeed, and can be worked from a small 2-volt



The wiring is carried out with semi-flexible wire to avoid damage due to vibration.

THE "FEATHERWEIGHT" THREE
—continued

accumulator of the unspillable type inside the cabinet. Valves of the 2 volt, ·1 ampere class would of course, be much more economical as regards filament consumption, and sometimes happen that when home-made coils or even manufactured coils of larger dimensions, and therefore with larger fields, than usual are used, the set will not stop oscillating even with the reaction condenser all out. In this case, of course, it is only necessary to loosen the coupling between the coils.

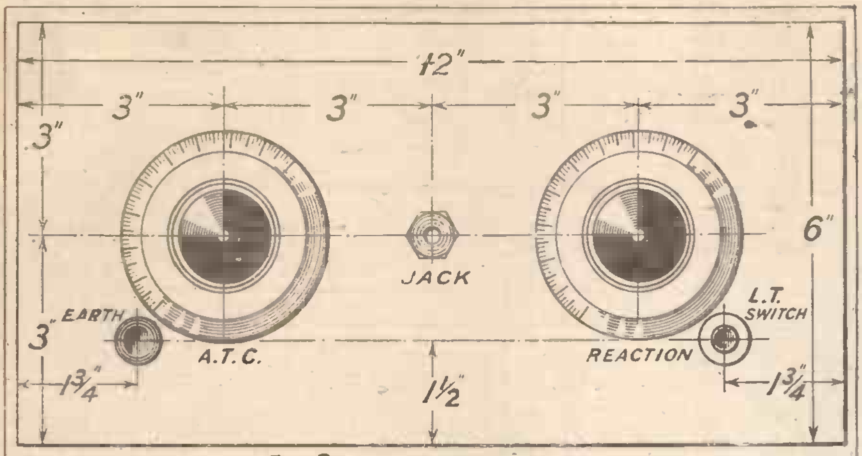


FIG. 2. FRONT OF PANEL.

could be worked from two small dry cells, but the gain in weight would hardly be appreciable.

About 90 volts of H.T. is necessary to obtain really good loud-speaker results, but 75 volts is sufficient for ordinary purposes. The grid bias is derived from the negative end of the H.T. battery, as will be seen from the theoretical and back-of-panel diagrams.

Constructional Details

As regards the actual construction of the receiver, the only point that needs particular care is the order in which the components are wired up. It will be found best to mount all the components on the panel before fixing this in position. The wires to the various components on the panel should then be attached to them, the rough lengths required being gauged from the photographs and back-of-panel diagram.

The transformer, L.F. choke, valve holders, etc., may then be mounted on the baseboard and wired in circuit. The jack is only incorporated for the purpose of providing an easy method of connecting the 'phones or loud speaker in circuit, although there is no reason why another should not be used for the cutting out of one of the note-magnifiers when it is desired to do so.

The coil holders are mounted as closely as possible to one another; this will in general be found a satisfactory arrangement, although it may

Regarding the grid condenser and leak for the last note-magnifier, the values finally adopted were ·015 for the condenser and one megohm for the leak. These values might not be suitable if the set were to be used on a standard aerial within a short distance of a broadcasting station, but as the set will usually be working with a small aerial, the signal-strength therefore not being so great, the values given will serve, and a greater degree of amplification seemed to be obtained with these on the original set than with a larger condenser and leak of lower value.

Alternative Aerial Connections

An earth terminal, connected to L.T. +, has been provided on the front panel for use when desired. On most of the tests no earth was used, but there are circumstances when an earth is desirable, and a small earth-tube or copper spike of some sort can generally be taken with the set for use as an earth. The aerial is connected either directly on to the top end of the A.T.I. or on to this point via a condenser of ·0001 capacity, according to its size and surroundings. If it is no longer than 35 feet and fairly high, the better plan is to connect it direct.

If, however, it is of a rather high capacity (whether this is due to great length or lack of height), or even if it has been erected in the neighbourhood of some source of interference, the ·0001 condenser will be found useful. Selectivity, however, will not often need to be considered, in view of the fact that this is essentially a "one-station" receiver. If

Fixing a temporary aerial during a day's outing with the "Featherweight" Three.

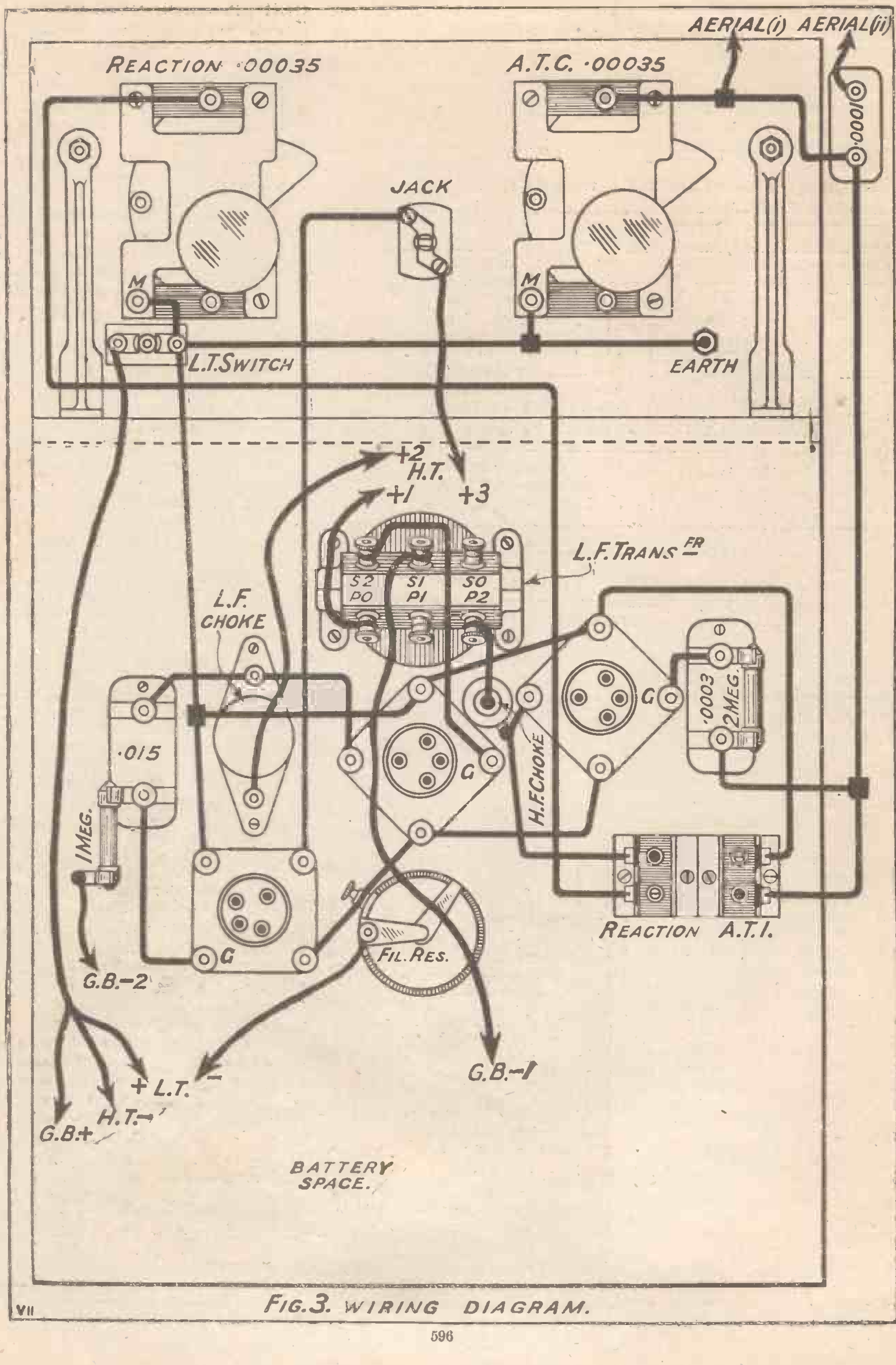


FIG. 3. WIRING DIAGRAM.

THE "FEATHERWEIGHT" THREE

—continued

D.C.C. wire is used on a dry day no other insulation is really necessary.

No difficulty at all should be experienced in placing the components in such a manner that the lid of the cabinet may be closed without the use of a shoe-horn, but a few words regarding the batteries may prove useful. The writer found that if ready-made "block" type batteries were used, 66 volts was the maximum that could be accommodated. If, however, flash-lamp batteries were made up by connecting them together with battery links and tying the whole together with adhesive tape, 108 volts could be taken with ease.

When the case is closed the panel and all the 'works' are well protected by the rigid wooden cabinet.

The appearance of the set is such that it makes a handsome receiver for indoor use if required.

H.T. Voltages

Although a "block" type battery is shown in the photographs, it is preferable, where possible, to use the flash-lamp variety. The method of deriving the grid bias is as follows: Take the lead from the free end of the grid lead of the last valve (G.B.—2) to the negative end of the battery. That from the transformer secondary (marked G.B. — 1) should go to the positive side of the same cell (*i.e.* 4½ volts up). The H.T. — and L.T. + lead should now be about 9 volts higher up the battery than the G.B. — 1 lead.

H.T. voltages suitable for use are as follows: On the detector, about 45–60 volts. On the first note-magnifier, about 70 volts, and on the second 80–90 volts. This is, of course, assuming the reader uses valves of a similar type to those mentioned below. If the 1·1-volt valves previously mentioned are employed there is not very much choice available, but three Cosmos "D.E. 11's" are quite suitable. In the 2-volt class, however, there is a greater variety, and the following are suggested:

Detector, P.M.1, D.E.2 H.F., S.T.21, S.P.18G, etc., etc.

Both L.F., P.M.2, D.E.2L.F., S.T.22, S.P.18R, Cossor Stentor Two, Ediswan P.V2., etc., etc.,

Valves of this class needing a higher filament current than about ·25 should not be used if it can be

(*Concluded on page 659.*)

POINT-TO-POINT CONNECTIONS.

Join grid of first valve to one side of grid condenser and leak.

Join remaining side of grid condenser and leak to socket of A.T.I. coil holder, fixed vanes of A.T.C., and one side of ·0001 fixed condenser.

Join anode of first valve to bottom contact of H.F. choke and socket of reaction coil holder.

Join top contact of H.F. choke to P2 of L.F. transformer.

Join P.O. of L.F. transformer to flex lead for H.T. + 1.

Join S2 of L.F. transformer to grid of second valve.

Join S1 of L.F. transformer to flex lead for G.B. — 1.

Join anode of second valve to one side of L.F. choke and one side of ·015 fixed condenser.

Join other side of L.F. choke to flex lead for H.T. + 2.

Join other side of ·015 condenser to one side of 1-meg. leak and to grid of third valve.

Join other side of 1-meg. leak to flex lead for G.B. — 2.

Join remaining side of ·0001 condenser to flex lead for aerial.

Join plug of reaction coil holder to fixed vanes of reaction condenser.

Join moving vanes of both condensers to earth, to one side of L.T. switch, to one filament terminal of each valve holder and to plug of A.T.I. coil holder.

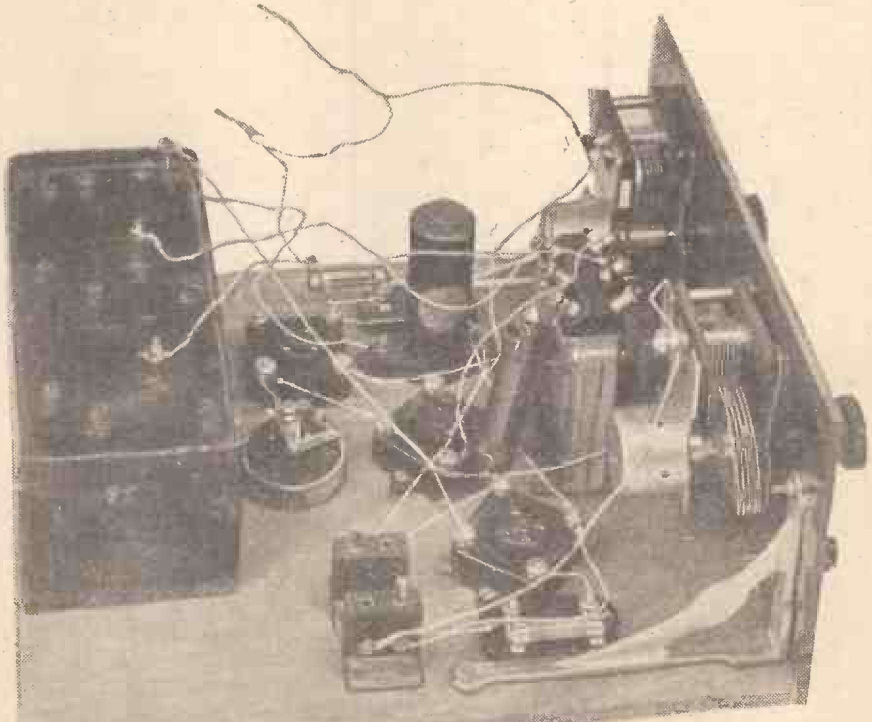
Join remaining three filament legs of valve holders together and to one side of resistance on baseboard.

Join other side of this resistance to flex lead for L.T. —.

Join remaining side of L.T. switch to flex leads for L.T. +, H.T. — and G.B. +.

Join anode of last valve to one side of jack.

Join other side of jack to flex lead to H.T. + 3.



A side view of the set with the H.T. battery in position.

WHAT READERS THINK

A Successful Short-Waver

SIR,—Reinartz sets seem to be still very popular and useful. Personally, after 5-valvers and others, I come back to this circuit with some relief; for a 2-valve set embodying it is far more pleasant for reception of distant stations, the interference of Morse, etc., dying down to a comparatively gentle purr in the background. But with all the Reinartz sets recently described I am surprised to find no mention of the Cowper Reinartz described in MODERN WIRELESS in April and July, 1926. I made this up at the time and found it highly successful. A friend, who has been a transmitter for years (since 1910), was so pleased with it that he made one at once for short-wave reception in his work, and induced others to do so, with good results.

I have recently made a set up again on this plan, using coils on Collinson formers for the broadcast band with a 6-pin base, and find it my favourite set. Being very close to the Bournemouth station I have to use a rejector circuit, which makes the Reinartz very selective (and tuned with a large condenser is far more successful than with a smaller capacity) on the shorter broadcast waves, but on the Daventry range my present set is, for some reason I have not yet discovered, not so selective as the original, as the local station persists in encroaching.

It works best on the short waves (below 100 metres) with the aerial unconnected, but brought near the rejector tuning condenser, with the rejector coil removed. If the rejector tuning condenser is disconnected from the circuit these signals are not received with the aerial in any position.

Three valves, with 2 R.C. L.F. stages, would probably form an excellent set.

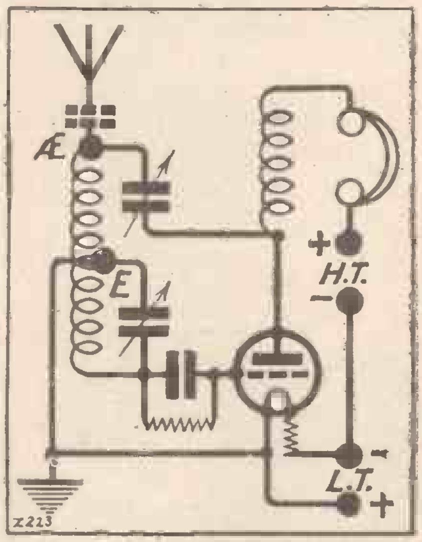
Yours faithfully,
C. F. KELLER.

Meyrick Cottage,
Meyrick Park,
Bournemouth.

The B.8 Valve

SIR,—May we take a little of your valuable space in order to comment on Mr. K. D. Rogers' notes on the B 8 valve on page 379 of MODERN WIRELESS for April?

Firstly, with regard to the high impedance, it is, of course, true that for L.F. amplification the lower the impedance the better, but with the high anode resistances used the high impedance is not sufficient to offset the advantage of the high "mu" value. Further, in H.F. work, with tuned anode circuit, Mr. Rogers will, we think, agree that it is an actual advantage from the point of view of selectivity.



Mr. Keller's circuit.

As regards the overloading of the last valve, is not this one of the limits of every receiver? While we agree that there is no use in having such high amplification that this is liable to occur if only the local station is required, yet for more distant reception higher amplification may be wanted, and is given by the B 8 valve up to the limit of the output valve, even if the latter be of "super-power" type.

Regarding the H.F. choke, we are much interested in Mr. Rogers' suggestions. Perhaps a word of explanation is required regarding the by-pass condenser referred to. This is provided primarily for the purpose of obtaining reaction where the latter is required (Fig. 2), but is omitted when reaction is not required (Fig. 1). It was not inserted as an H.F. damping device, as we have not found this necessary in Fig. 1 with this type of valve. In Fig. 2, however, where greater H.F. amplification is obtained, the condenser serves a dual purpose, viz.: (1) By-passes the resistance to allow of reaction, and (2) shunts the H.F. to earth, as suggested by Mr. Rogers. (The figs. refer to the instruction sheet sent out with each valve.)

With regard to the question of lower-frequency suppression, our experience has been that in comparison with transformer coupling, the low frequencies are brought through to a far greater extent, as is usually the case with resistance-capacity coupling. We are aware, however, that this is a matter which depends upon the type of loud speaker used as much as upon the circuit.

Yours faithfully,
H. C. GOODMAN.

(Manager, Radio Department),
The B. T.-H. Co., Ltd.

Quick Resistance Reckoning

SIR,—With reference to the article entitled "Quick Resistance Reckoning" in the April issue of MODERN WIRELESS, I think it should be pointed out that the method described is only suitable for measuring resistances of 400 ohms and more.

If the resistance to be measured is below 400 ohms the needle of the milliammeter will go right off the scale.

A far safer method is the following: A voltmeter of known resistance (reading, say, to 6 volts) is used instead of a milliammeter, and the circuit is connected up as before with a 4 or 6-volt accumulator or battery. The resistance required is given by the following formula:

$$R = r\left(\frac{D}{d} - 1\right)$$

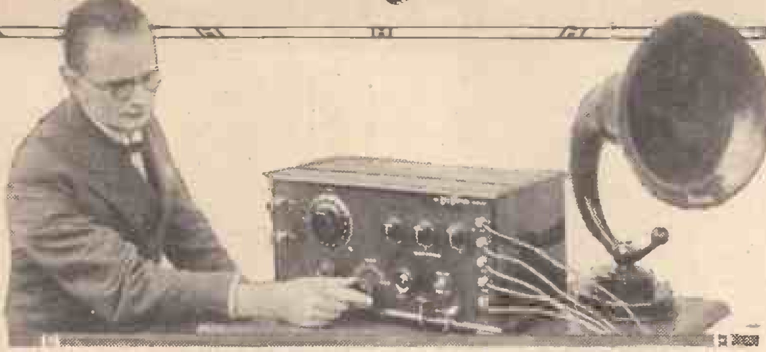
where r is the resistance of the voltmeter, D is the voltage of the battery, and d is the reading obtained.

Yours truly,
C. O. B. MAUGHAM.

Lausanne, Switzerland.

(Continued on page 663)

The Search *for* Quality



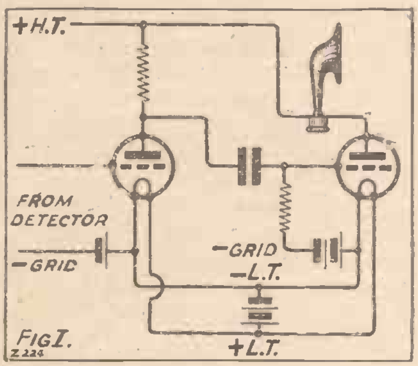
The third article in an exclusive series of great practical value to every listener.

By Capt.
P. P. ECKERSLEY
(Chief Engineer of the B.B.C.)

Part III.—
Low-Frequency Amplification

THE methods open to us to work a loud speaker by amplifying the low frequency given by the detector valve to suitable strength, are to all intents and purposes three :

1. By transformer intervalve connection ;
2. By resistance-capacity intervalve connection ;
3. By choke-capacity intervalve connection.



The supposed advantage of transformers is that they may be made to give a greater amplification per stage than any other method. That, in fact, they economise in valves. This is usually a fallacy if quality is sought after, because directly the transformer ratio is increased the characteristic becomes worse. Further, by a suitable design I doubt whether more than two note-magnifiers are ever necessary where local station listening, *i.e.* pure-quality listening, is required.

Wasteful System

It is often said of resistance capacity that it is wasteful in H.T. It can be replied at once that if really good quality is required the last valve requires at least 150 volts and the preceding valve will not be overloaded with this value, and so the argument is not a strong one. *Choke-capacity* coupling overcomes this trouble and H.T. can be slightly economised by feeding half the H.T. value to the preceding valve.

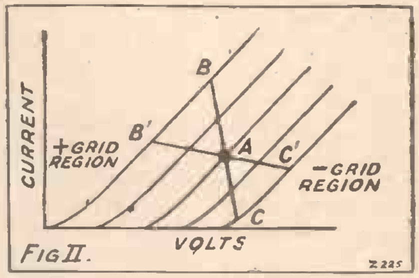
It is pertinent at this stage to make some remarks as to the desired performance of the L.F. amplifier. The audible gamut is between 16 and 16,000 vibrations a second, and ideally we may say that we should give each of these frequencies a chance to be represented electrically as they are acoustically.

Arguing on the other side, it can with justice be said that the loud speaker can never represent reality: it can do no more than give us a " picture " of what is being said and done in the studios of the Broadcasting authority.

A Wireless " Picture "

The Turner we so much admire in the National Gallery brings us no nearer Venice except in imagination. We cannot (thank Heaven !) smell the Grand Canal ; the rain in Constable's landscape does not wet us, nor can we enjoy with him the joke that makes the Cavalier laugh.

So it is with wireless. A real symphony orchestra in our drawing-room would overpower us. The

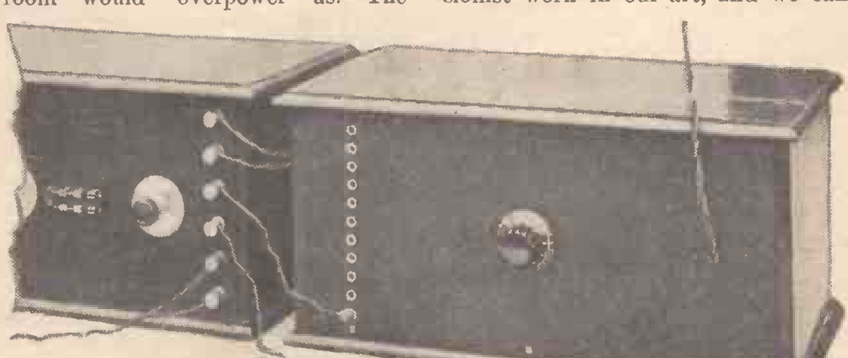


cheers of enthusiastic football crowds may remind us of other Homeric contests we may ourselves have seen, but we are not there. Sometimes, with piano solos, with people talking, and with ballad singers the illusion may be complete, but on the whole the loud speaker is giving us a sound *picture.*

This may mean that to struggle after absolute perfection in the frequency curve is wrong, and that we must learn the technique of illusion. and remember that the ear is a great imaginer, and make some compromise.

The Ideal

I, personally, shall not cease to hanker after an ideal, while still supporting the sound-picture theory. There is still far too much impressionist work in our art, and we can



To the right is a typical H.T. battery eliminator for use with A.C. mains.

THE SEARCH FOR QUALITY
—continued

still well afford to get nearer to reality.

Realising many of the difficulties, I believe that a flat curve between

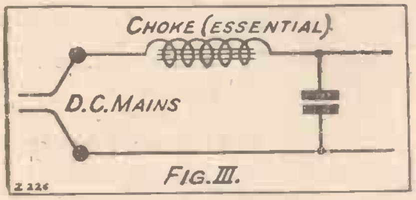


FIG. III.

50 and 10,000 cycles is essential if ever we are to produce masterpieces.

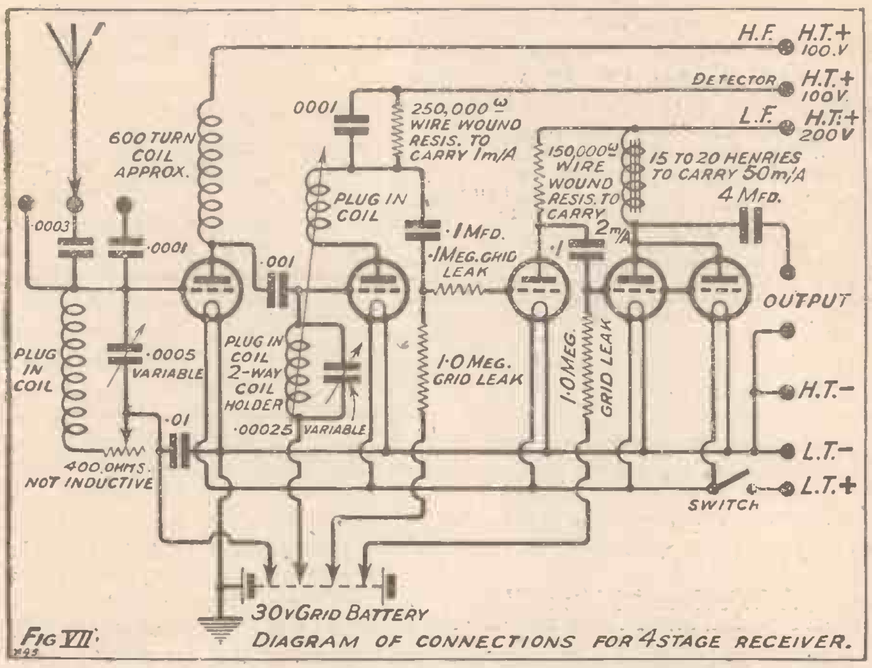


FIG VII. DIAGRAM OF CONNECTIONS FOR 4 STAGE RECEIVER.

I am opposed by some engineers who say, rightly, that the ear partly "paints in" 50 cycles even though it hears only the harmonics; that many ears fail over 5,000; and that we ought to cut off above that figure.

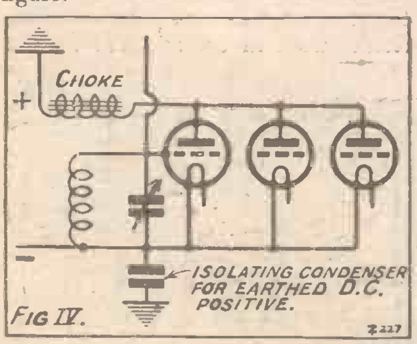


FIG IV.

There does not yet exist a loud speaker which will truly tell us the effects of cut-off, because every loud speaker already introduces distortion. Condenser 'phones may give us a chance, but certainly the experiment now would be abortive judged on nearly every criterion of mechanical reproduction known.

Let us, then, stick in receiving to the ideal aimed at in transmission; *everything* from 10,000 to 50 a second and not a cycle less! It is so easy to cut off later.

Transformer Coupling

Ten thousand interesting and useful words could be written about transformers. I simply say to my fellow idealists that we in the B.B.C. have been working on the problems of the perfect characteristic for two years, and have, at the expense of efficiency, at last arrived at a result which is almost as good as good resistance or choke capacity, but not *so* good. (Of course, in a lot of our work we have to use transformers—they need not be used as intervalve connections for receiver work.) If they are only *as* efficient as other methods and never quite so good from the quality point of view, why use them in the perfect-quality receiver? Their use can be countenanced in receivers where distant-station listening is wanted and sensitivity has to be studied, but even then I would rather see sensitivity on the high-frequency side and only to that extent which will bring in stations worth, on occasions, listening to.

In choosing a transformer it is well to ask to see the characteristic curve. The more enterprising manufacturers publish these certified by the National Physical Laboratory. Of course, and

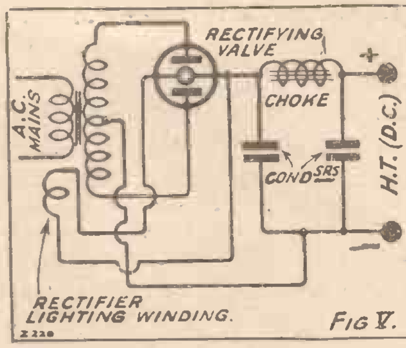


FIG V.

finally, there is nothing against a transformer if it really has a flat characteristic and does give a more than one-to-one ratio.

In the resistance-capacity method illustrated in Fig. 1 the whole thing is


An example of a choke-feed unit using two condensers.

very straightforward. The resistance should be five or six times the valve impedance and the intervalve capacity should not give a cut-off at high frequencies. In general, it may be said that the grid-leak resistance should not be greater than one megohm, otherwise any grid current will tend to produce, during blasting conditions, unpleasant effects. The value of the intervalve condenser can be chosen to

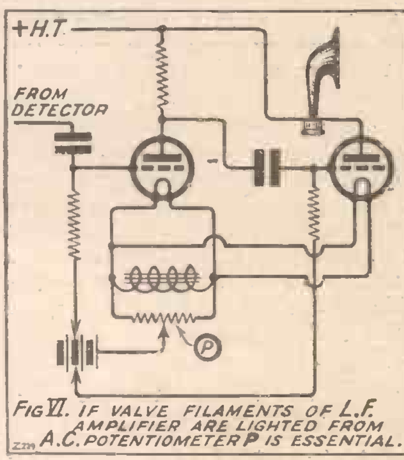


FIG VI. IF VALVE FILAMENTS OF L.F. AMPLIFIER ARE LIGHTED FROM A.C. POTENTIOMETER P IS ESSENTIAL.

prevent cut-off by realising that it is in series with the grid resistance of the valve following. This means that it must have an impedance at any frequency which is small compared with one megohm. With the value of

THE SEARCH FOR QUALITY
—continued

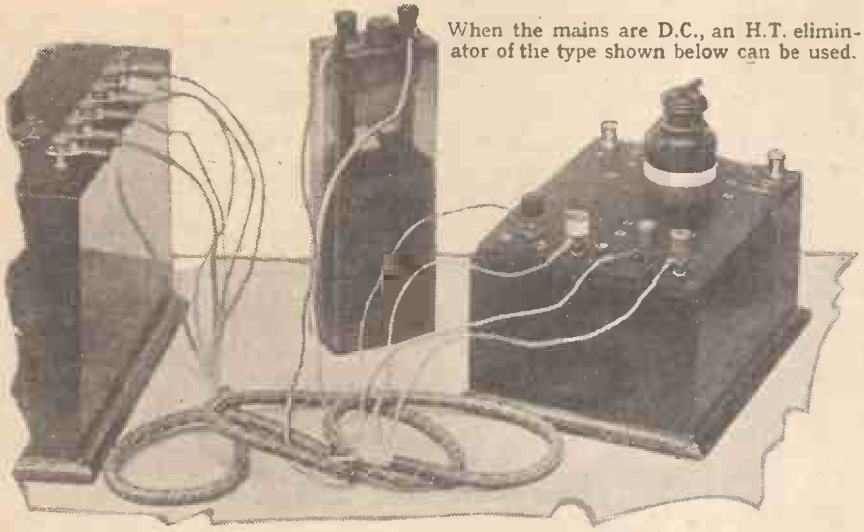
one megohm for the grid leak a good safe value for the grid condenser is 0·1 microfarad. Really this may be overdoing things, but the cost is not much greater than condensers of less value, and you are assured of a sufficient value right down to 50 cycles if you ever get a loud speaker that reproduces the bass.

As to the valves to use, this is, of course, a matter for your choice as to make. As to type, this is important. A valve has " an impedance " which increases for the same design filament, anode, etc., with the fineness of the grid mesh. This means that the fine-mesh grid has a greater control over the electron stream for a given change of grid potential. A high impedance valve allows only a small sweep of grid volts, otherwise it either stops the electron flow altogether after a certain value of grid negative or on the other positive swing introduces grid current. On the other hand, you do not need such a large sweep, because the smaller value produces a much bigger change of potential on the anode. The ratio of change of anode to change of grid volts is called the magnification factor of the valve. Thus a higher impedance valve has a greater magnification factor, and it is often a matter of " swings and roundabouts " as to what valves to use. Naturally, the higher the value of H.T. the greater the factor of safety, the straighter the characteristic, and the better the all-round results. This applies equally, however, to all valves, and we are discussing choice of valves. Too high an impedance valve introduces other difficulties and we must not go too high. Personally, I favour, for a good all-round result, a valve of 6,000 ohms impedance for the first stage and two of these in parallel on the last, or output, stage. For really good results 300 volts H.T. is desirable. A minimum of 150 volts is essential for the *perfect* receiver.

Values for Choke Coupling

There is nothing that can be added about choke capacity except that the impedance of the choke at 50 cycles must be at least five times the value of the impedance of the valve. The impedance of the choke is expressed as pL where $p = 2\pi$ (or about 6) times the frequency and L is the inductance in henries. If the valve has an impedance of 6,000 ohms the impedance of the choke must be 36,000 ohms. This means that it must be $L = \frac{36,000}{6 \times 50}$ (for 50 frequency). This is 120 henries. This value must be obtained even though there is current flowing in the windings of the choke. Furthermore, the iron must not be saturated, so that a real factor of safety is required, *i.e.* be generous in iron.

When the mains are D.C., an H.T. eliminator of the type shown below can be used.



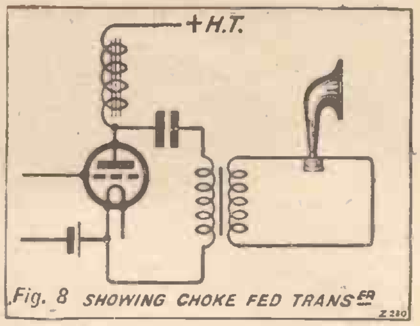


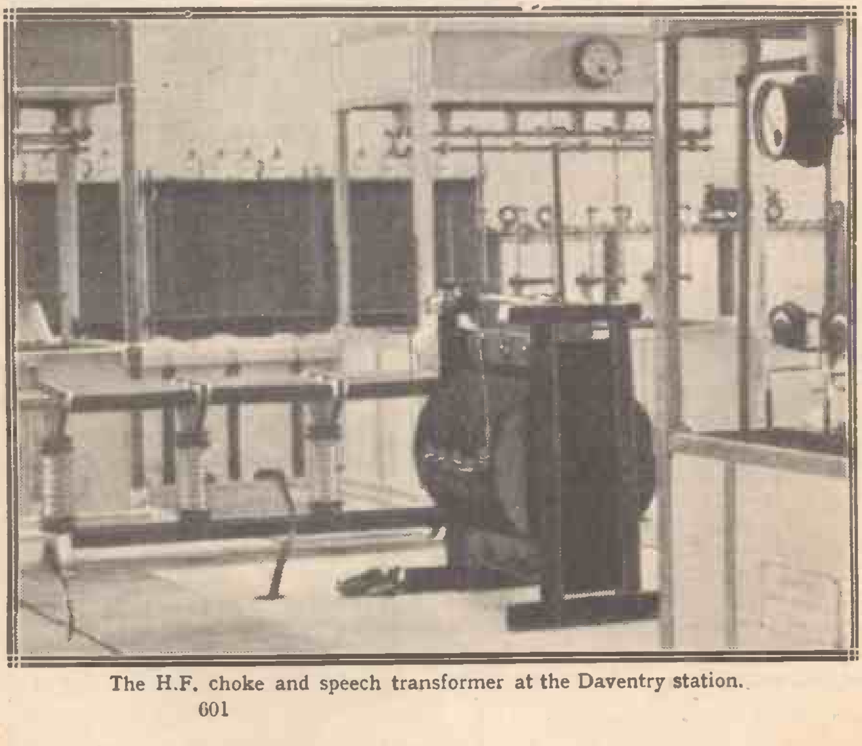
Fig. 8 SHOWING CHOKE FED TRANSᴱᴿ

The Factor of Safety

The output stage of an L.F. amplifier needs to have a really good factor of safety, and hence a medium impedance valve and plenty of H.T. The reason for this is explained, apart from the obvious necessity of having plenty of grid-sweep, as follows:

Consider a set of curves for a valve showing anode volts against anode current for several values of grid voltage. (Fig. 2.) Suppose we set ourselves at A and for a thousand cycles work up and down a curve B A C. This curve is determined by the value of the loud-speaker impedance, the loud speaker being in effect an inductance. The steepness of the

(*Continued on page 659.*)



The H.F. choke and speech transformer at the Daventry station.

WATER-PIPE EARTHS

An article of an eminently practical nature.

By OSWALD J. RANKIN.

When using a water-pipe for the purpose of making an earth connection there are three things to be carefully considered; one is the tracing of the pipe to ascertain whether it *does* go to earth within a reasonable stretch, *i.e.* without first running round the houses and up to the other end of the street; another is the thorough scraping and cleaning of the pipe at the point where the connection is to be made; and last, but not least, is the problem of making an efficient contact to the prepared pipe. The latter usually presents the greatest difficulty, and so we will consider a few simple methods of making this all-important connection.

Satisfactory Joints

Most of us are acquainted with the simple sheet-brass clip as shown at A in Fig. 1; this often gives the desired results, although a little difficulty is sometimes encountered in making an effort to obtain the much-desired hard and even grip. It is better to use two half clips, of heavier material, and arrange them as shown at B. The great advantage with this type of joint is the very large contact surface obtained when once the clip is properly adjusted.

A simple twisted wire joint, as at C, Fig. 2, is often satisfactory; much

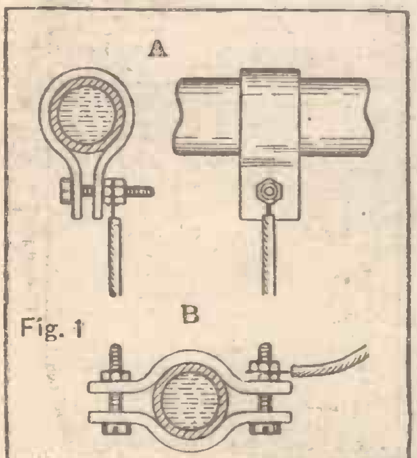


Fig. 1

depending on the amount of strain the wire will resist when the ends are twisted together. If the ends stand out about 3 in. from the pipe it is usually a simple matter to solder the earth lead to same, but if desired the ends may be looped and fitted with a terminal.

A more even strain may be applied to a bound wire joint by means of the arrangement shown at D, where two strong screws are fitted, as shown, to a stout brass link which is bound to the pipe with copper wire, a plain brass bar being placed under the ends of the screws in order to avoid piercing the pipe. A nut is previously fitted to

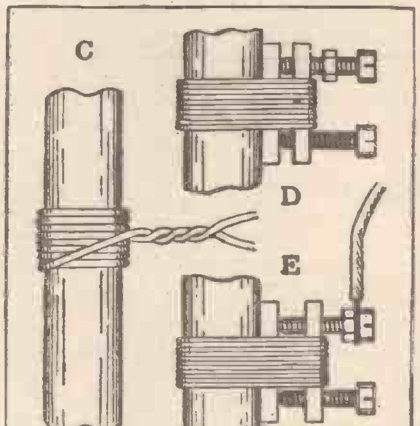


Fig. 2

one screw for the purpose of making the earth-lead connection. Both screws are then turned (clockwise) so that the link is gradually forced away from the pipe, as at E, the result being an even strain on the wire binding, and a really good joint.

Improved Methods

A piece of $\frac{3}{16}$-in. round brass rod, threaded at each end and then bent to form a staple, may be used in conjunction with a brass link in the manner shown at F in Fig. 3, but owing to the rod being round, only a very small contact surface is obtained, and it will also be noticed that a rather small contact surface exists between the pipe and the straight brass link. For this reason it will be found best to use several staples and a perforated plate, as shown at G.

In the arrangement shown at H in Fig. 4, the contact proper is made via a narrow brass bar which is pressed hard against the pipe, lengthwise, by means of a screw, or terminal shank,

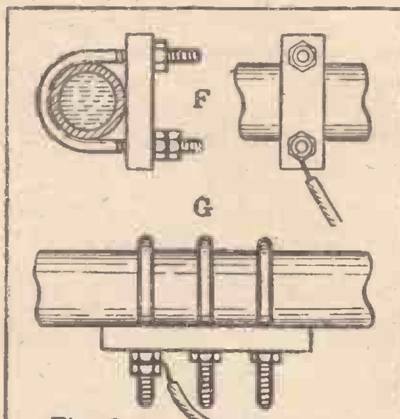


Fig. 3

fitted to the centre of the link, the idea being similar to the Fig. 2 arrangement. The simple clamp at I, Fig. 4, is mechanically perfect, but electrically it is the square peg in the round hole, for unless we use fairly long plates, instead of narrow links, the efficiency of such a device, reckoned as contact surface, will be very low. Diagram K, Fig. 4, shows an arrangement recently devised by the writer.

Efficient Contacts

The whole device consists of nothing more than an odd strip of sheet brass, an old brass fly-nut, a large telephone terminal, and a small bar of brass, copper or hard solder. The fly-nut is re-threaded, if necessary, to take the terminal shank, and the sheet brass strip is slotted at both

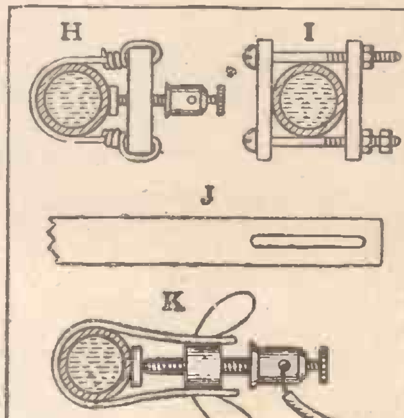
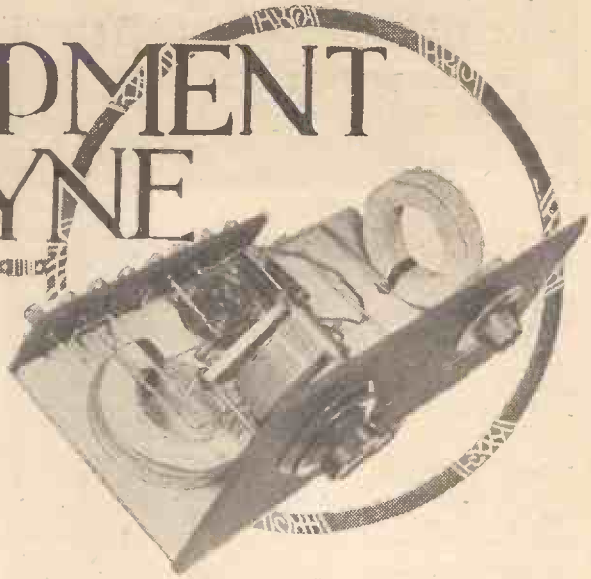


Fig. 4

ends, as at J, so that when formed into a clip the ends may be slipped over the wings on the fly-nut.

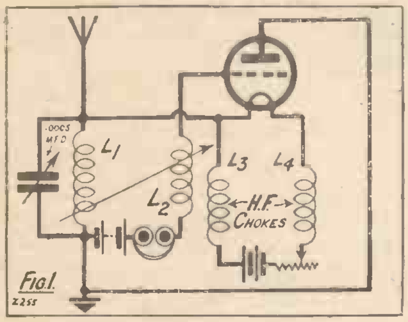
The DEVELOPMENT of the FILADYNE



The history, in brief, of a very novel and interesting circuit from the original conception up to the present, including some new and hitherto undisclosed developments.

By G. V. DOWDING, Grad. I.E.E.
(*Technical Editor.*)

SOME three or four years ago an inventor applied for a patent for an invention which he claimed would considerably increase the range of a big gun. His idea was to have, situated in front of the weapon, large magnets which would automatically cut out as shells passed them. A sound scheme—in theory;



but it was pointed out to him that in practice another pinch or two of explosive material *behind* the shell would be much more effective. Now I am not an artillery expert, but this would also appeal to me as being quite good reasoning.

Standard Practice

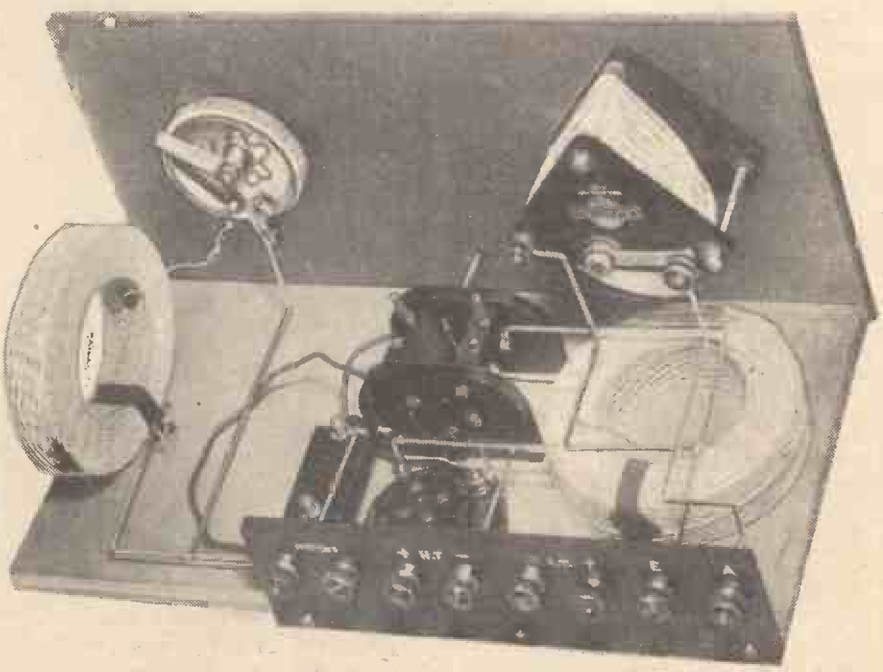
Details of this wonderful gunnery invention were forwarded to me shortly after the publication of my first article (in "Popular Wireless") on the "Filadyne," by an interested reader who thought it, as he said, "rather appropriate." I would hardly call it this, but it forms a very suggestive simile. According to standard practice a three-electrode valve detects and amplifies when the electron stream emitted from its filament is affected by a charged electrode (the grid) placed in its path between the filament and the plate. This electrode is subjected to a charge whose intensity is varied by the received energy. These variations are reproduced in an amplified form in the anode circuit. And that is that.

The "Space Charge"

But all the electrons emitted from the filament do not reach the plate; a number stray off and join those which form what is known as the "space charge." This cloud of free electrons, which is at its densest near the filament, also tends to repel other electrons back again to the filament, and forms quite an obstruction in the path of the electron stream. Decimate this space charge and you immediately increase the conductance of the valve without decreasing its amplifying properties. This is what happens to a very considerable extent in the "Filadyne" circuit, but there would be no gain if the control of the electron stream were less effective. By reversing the plate and grid connections in a standard three-electrode valve detector circuit, the impedance of the valve is considerable reduced, but there is no general increase in efficiency—according to my observations, on the other hand, there is actually a noted *decrease*.

A Logical Control

But in the "Filadyne," although the grid is made highly positive by



One of the earliest receivers made up on the lines of Fig. 1. Note the two large filament chokes.

THE DEVELOPMENT OF THE FILADYNE

—continued

connecting it through the phones to the H.T. plus and the space charge diminished, the electron stream is controlled *at the filament.* We are,

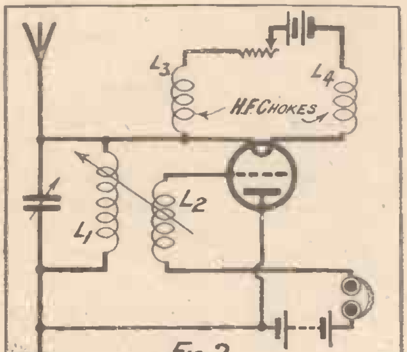


FIG. 2.

in fact, controlling the flight or projection of our shells in the barrel of our cannon, to revert to the above simile, and not at a point some distance away from their source of origin. Instead of firing off the electrons at a standard velocity or in standard numbers, and correcting their speed after leaving the starting-point, we do this right at the commencement of the journey.

The First "Filadyne"

The first "Filadyne" circuit carried these ideas into practice in a very straightforward and simple manner. You will have no difficulty whatever in tracing out the theory of operation of Fig. 1. The received energy is fed directly on to the filament of the valve, and this is isolated from the L.T. battery and its wiring by two H.F. chokes. The plate is at earth potential and the grid operates as an anode carrying a high positive potential. L_1 is an ordinary aerial tuning coil and L_2 an ordinary reaction coil. Perhaps if the circuit is redrawn, as in Fig. 2, with the valve turned upside down, it will be even clearer.

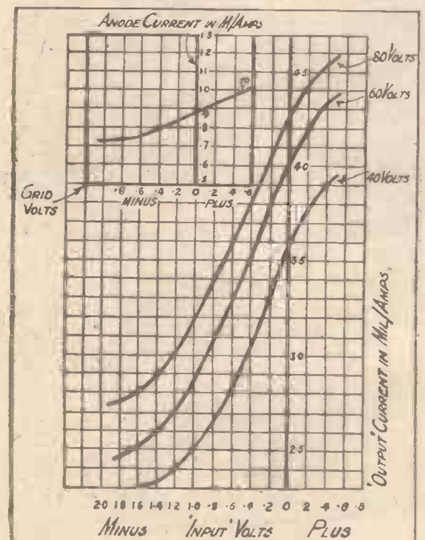


FIG. 3.

Promising Results

Now this "Filadyne" operated very well indeed; the results it gave were so promising that I was lead to spend many further hours in endeavouring to remove the one or two drawbacks it had, and of which more anon. Anyway, I found that it possessed a high degree of sensitivity, and, without forcing reaction, I was able to operate a small loud speaker eight miles away from 2 L O in quite a respectable manner, while it brought

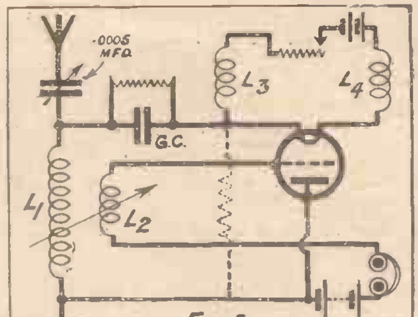
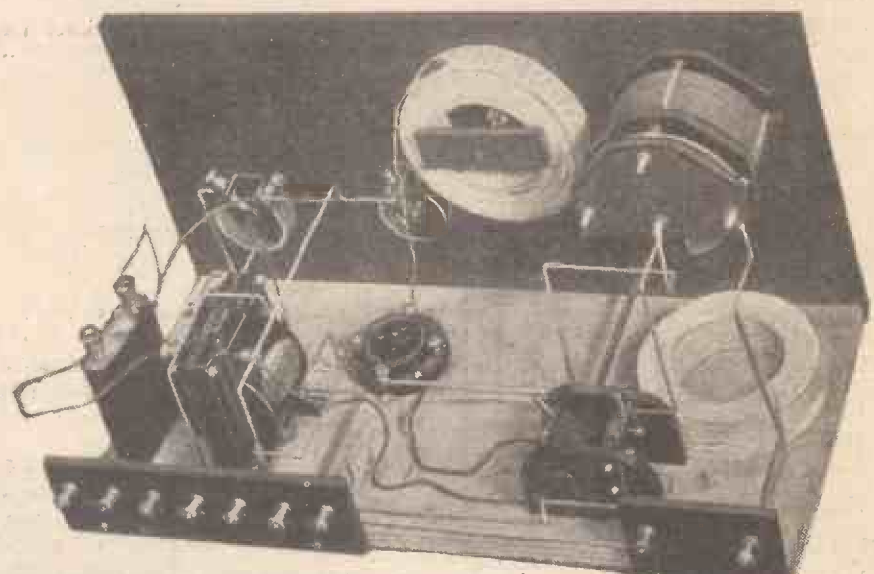


FIG. 5.

considerable food for thought. The increased conductance of the valve is indicated by a considerable increase in anode current. The small curve, which is inset in the diagram, illustrates that section of the makers' published curve which covers the "Filadyne" characteristic curves shown in the main portion of the diagram. All these curves are drawn



An early "Filadyne" receiver employing one stage of transformer-coupled L.F. amplification.

in distant stations in greater numbers than any other 1-valver I had previously handled.

It was found that the D.E.R. appeared to be the most suitable valve for this circuit. It is not a matter of ordinary characteristics—for these go by the board in the "Filadyne"—but I attributed the fact to the shortness of its filament and to the design of its electrodes.

Extraordinary "Steepening"

A comparison between the input-output curves resulting when a D.E.R. is used in the original "Filadyne" and when it is used in a standard manner is most suggestive. Fig. 3 gives this, and provides, I think, to the same standards in order to illustrate the extraordinary "steepening." So you see that although the

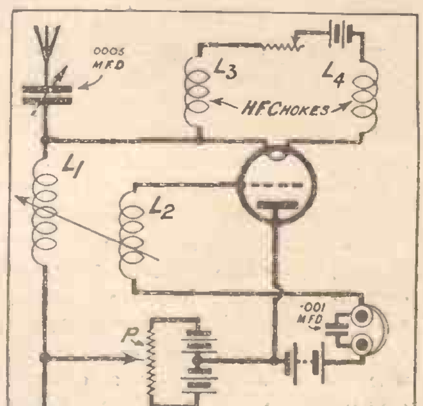


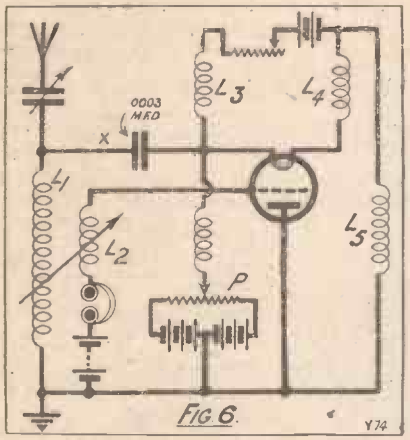
FIG. 4.

THE DEVELOPMENT OF THE FILADYNE

—continued

anode milliamps are almost quadrupled the "mu" is multiplied by some seven times!

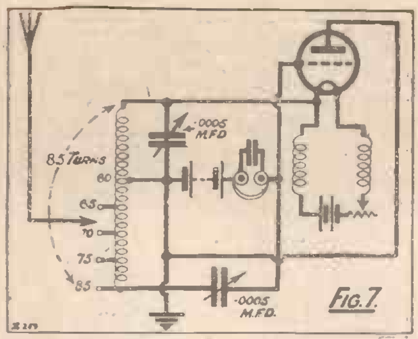
But static characteristics should not be taken too seriously—more especially when a valve is turned upside down. I do not think that signal strength increased to the extent that the curve suggests, but I can safely claim that, according to both aural and measured observations, there was well over a 100 per cent. gain in this respect.



Now after the first experiments had proved successful I set about the task of endeavouring to consolidate my position. First of all I had to formulate a more or less concrete theory to meet the new conditions, for without this further attempts at progress would be so much groping in the dark. I soon came to the conclusion that rectification was occurring on an anode-bend principle, so I introduced a filament-biasing scheme, as shown in Fig. 4, in order to discover whether or not I was operating on the most suitable portion of the curve. Apparently I was, for no improvement resulted from this, and variations of the potentiometer P were accompanied merely by decreases of signal strength, although I must add that the control could be used as a secondary reaction adjustment within certain limits.

A Grid Condenser

The insertion of a grid leak and condenser (many different values were tried), as shown in Fig. 5, caused a complete cessation of reception whether the grid leak was placed in parallel or in series to either of the L.T. points. But I toyed with the idea of a grid condenser for a long



time, for I could see that certain lines of development were definitely closed to me if I could not break the direct metallic path between the aerial and the filament.

Eventually I succeeded. I found that I could insert a filament condenser as at "X" (Fig. 6) if I connected the filament through an ordinary H.F. choke to the centre point of a potentiometer P, which was connected across a small battery and thence to earth. At this period I was also able to achieve greater stability by earthing the L.T. battery through another H.F. choke, which is shown in Fig. 6 as L_5. This was a distinct advance, for the original "Filadyne" tended to be somewhat instable.

A Distinctive Advance

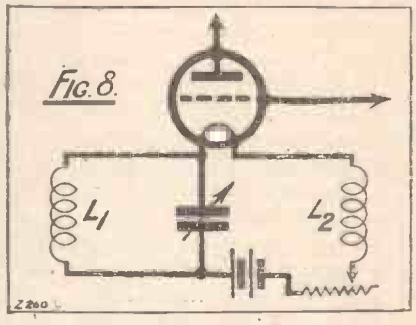
Shortly after this, a Mr. H. Roberts suggested that a Reinartz form of reaction control suited the "Filadyne" much better than the swinging-coil method. His circuit, which is shown in Fig. 7, certainly operated very well, but it was overshadowed by a very distinctive advance.

All this time Mr. J. English was working independently on the "Filadyne." He had been attracted by it right at the outset, and at this juncture disclosed a most important development. He realised that one of its drawbacks was that it was necessary to employ large H.F. chokes in series with the filament of the valve. Even although these chokes were wound with 22-gauge wire there was a considerable drop in voltage occasioned, and a 2-volt valve of the D.E.R. type necessitated the employment of a 4-volt L.T. battery.

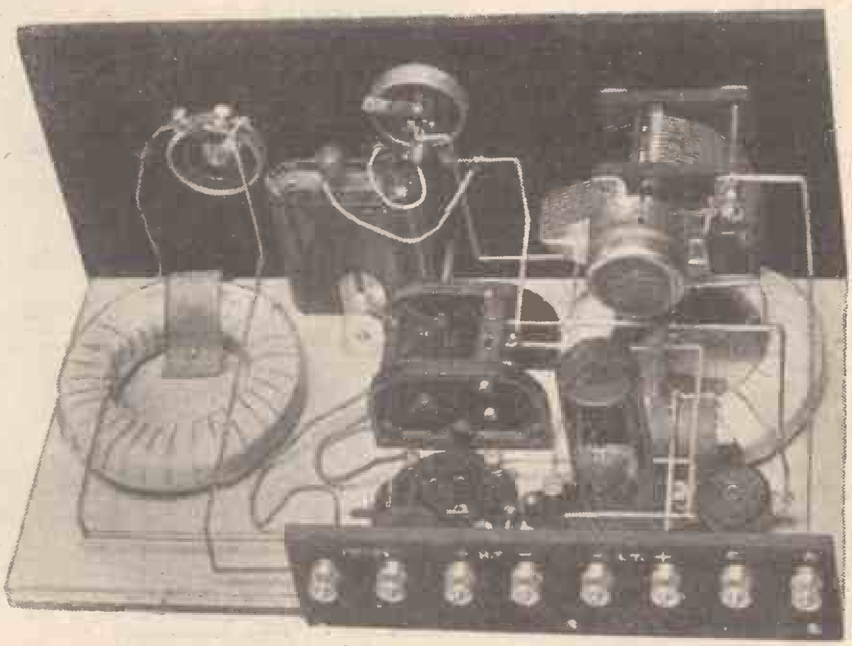
Rapid Progress

Mr. English realised that the chokes would be decreased very greatly in size, and also greatly increased in effectiveness, if they were tuned to the frequency at which they were required to "choke" by means of a variable condenser as in Fig. 8.

Further, he saw that these chokes could simultaneously function as



paralleled aerial tuning coils, and thus be tuned automatically to their required value. And so we come to



A "Filadyne" receiver embodying the circuit shown in Fig. 6.

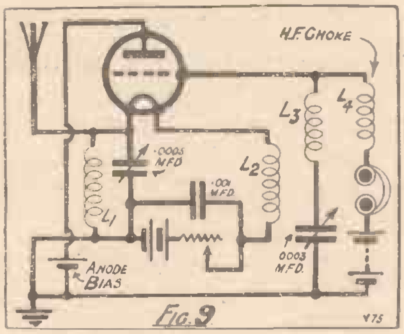
THE DEVELOPMENT OF THE FILADYNE

—concluded

Mr. English's revised "Filadyne," as shown in Fig. 9. It embodies even another improvement, for it includes a system of plate biasing. Mr. English showed that a large number of different valves could be used by introducing various positive biases of low values on the plate. These varied around about 1½ and 3 volts. Still further, he employed a Reinartz reaction, which was controlled by a ·0003 mfd. variable condenser. Mr. English must have spent many hundreds of hours of research work on the circuit, and his labours were by no means in vain.

The Latest Circuit

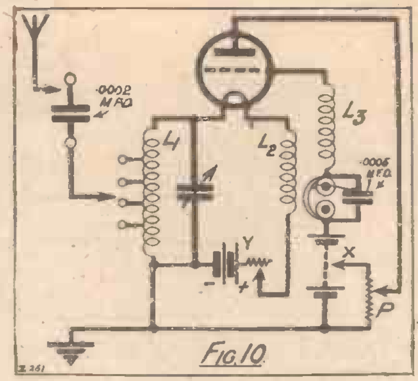
Subsequently, he brought forward still another development. He combined his plate-biasing scheme with the reaction control and originated a



most novel and efficient form of regeneration adjustment. And so we come to Fig. 10. "P" is a potentiometer which is bridged across a small battery placed in series with the H.T. battery; the first six or so volts of the H.T. battery could be used for this, although I should prefer to use a separate source of supply which could be independently renewed.

This "Filadyne" possesses all the sensitivity of the original circuit with none of its drawbacks. It is stable and easily controllable, while both its selectivity and sensitivity are both of a very high order.

But I considered that it was marred by the additional battery drain imposed upon it by the plate-biasing-reaction adjustment. After some further work on the circuit I arrived at Fig. 11. The positive bias on the plate is varied by means of a high resistance (R) connected in series with the plus terminal of the L.T. battery, which in this case is taken to earth instead of the minus terminal. I am very satisfied with this circuit,



and next month I propose to describe the construction of a 1-valver embodying it. But this is not the last word on the subject—of that I am very firmly convinced. Perhaps the next development will be brought forward by a MODERN WIRELESS reader. So far the history of the "Filadyne" has been one of steady progress. Even if we do write "Finis" to this little chapter of radio I personally shall not feel disappointed, for a most interesting circuit has resulted, and one which I have no hesitation in claiming has advantages over a standard hook-up, especially in regard to sensitivity.

Some Practical Details

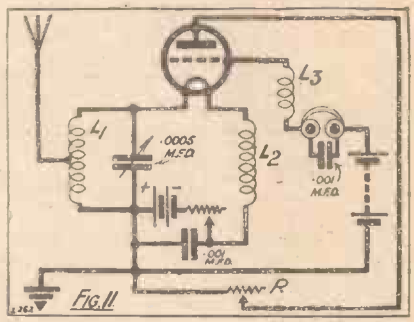
For the benefit of experimenters I will conclude by giving a few of the practical details of Fig. 11. The aerial coil, L_1, consists of 65 turns of 22 S.W.G., D.C.C. wire wound on a 3-in. tubular former tapped at about its twentieth turn from the earth end.

L_2 and L_3 are wound on the same 3-in. diameter former and consist of 70 and 40 turns respectively, using 22 and 26 gauges of wire. The coils should be separated by about ⅜ in. The resistance "R" should have a range of at least 0–1,000 ohms—a Burndept 1,200-ohm potentiometer can be used. Sixty to 90 volts H.T. are required, and of the several valves which give good results the D.E.2 L.F. for a 2-volt accumulator, and the B.T.H. B.5 for a 4-volt accumulator, are to be recommended.

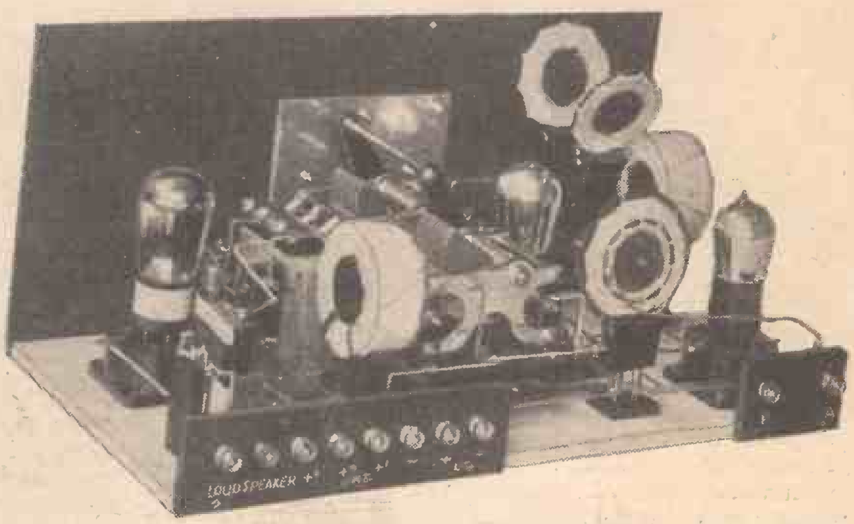
A curious fact is that quite a number of the cheap foreign valves which are on the market operate well in this "Filadyne" circuit; and some of the cheap non-combine British valves prove excellent for this set. Many readers will, no doubt, consider this an advantage.

An Advantageous Peculiarity

Another peculiarity of the circuit shown in Fig. 11, a peculiarity which, by the way, appears to be shared by the whole "Filadyne" family, is that any attempt at overrunning the filament of the valve results in an almost complete paralysis. This is a point greatly in favour of the circuit,



as readers will agree. Best results appear to be obtained when the valve is operated at a point just below its normal working temperature, although it must not be imagined that the filament control is a critical one.



A 3-valve "Filadyne" employing a stage of H.F. amplification. Plug-in filament chokes were used in this receiver.

H.T. FROM A.C. MAINS

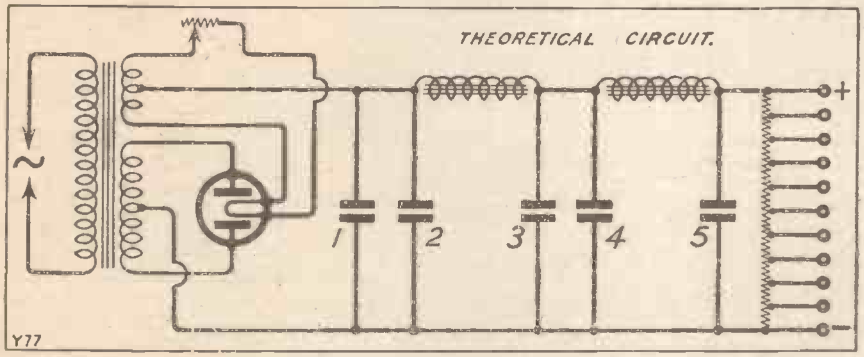
Full constructional details of an efficient H.T. Battery Eliminator.

By J. R. WHEATLEY.
(*Technical Staff.*)

MODERN radio receivers employing several valves usually have a high anode-current consumption. Power valves need a high voltage also, and in a second or third stage of L.F. as high as 200–250 may be required. Various means may be used to obtain this, but each has its own particular disadvantages.

LIST OF COMPONENTS.

- 1 full-wave transformer.
- 5 2-mfd. fixed condensers.
- 2 L.F. chokes.
- 1 potential divider (10,000 ohms).
- 1 valve holder.
- 1 10-ohm rheostat.
- 11 sockets.
- 1 strip of ebonite 5 in. × $2\frac{1}{2}$ in.



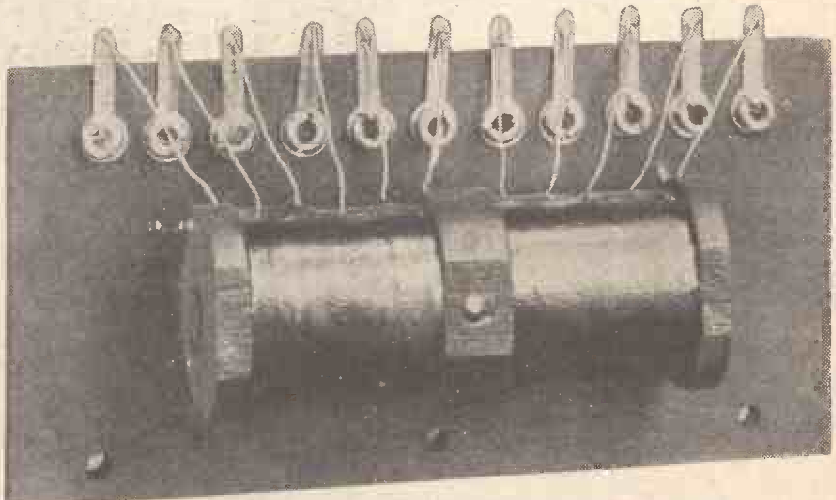
Dry batteries are high in initial cost, and their life is limited, whether they are used or not. Wet H.T. cells are cumbersome; sometimes they are messy, and call for constant attention, although with care and patience they will easily outlast even the best of dry batteries. Accumulators are really the best in the battery class, but still they also are cumbersome, and need constant attention. To recharge they must be taken away from home, unless electric power mains are available.

Comparative Cost

A really good H.T. battery eliminator, however, capable of giving a practically unlimited output from public supply mains, has most of the good points possessed by the various batteries usually employed, but certainly has not their disadvantages. If correctly designed the size need not be abnormal. The voltage output of such an eliminator where A.C. mains are available has practically no limits, and it can supply 60 volts for the detector and H.F. valves, or several hundreds of volts for the last stages.

The unit described here is designed solely for A.C. mains, and must not be used with D.C. mains, as it would fail to function. Naturally the initial cost is fairly high, and before going any further it is interesting to note the actual comparative costs of batteries and H.T. eliminators over a period of two or more years. A really good H.T. battery, capable of giving 200 volts and withstanding a drain of 15–20 milliamps, will cost, at the very least, £4 and will last, with care, six or seven months with ordinary use.

The eliminator about to be described costs approximately £6 6s. 0d. The very low cost of running such a

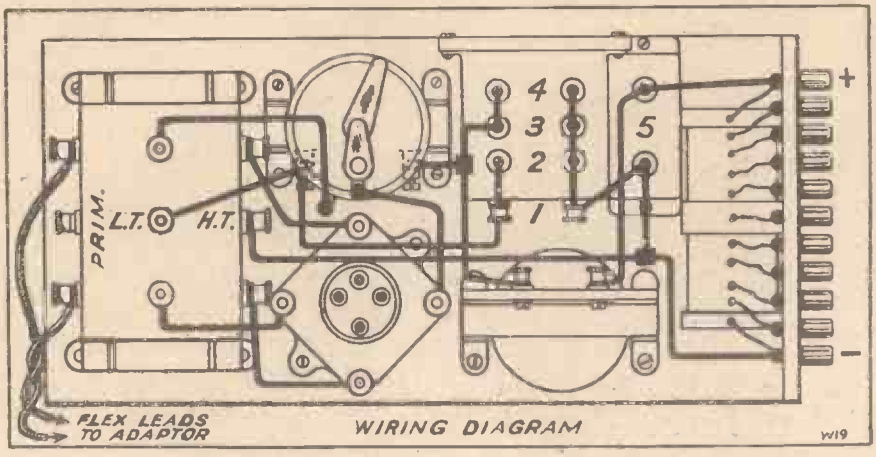


The method of taking the tappings for H.T. is clearly shown above.

H.T. FROM A.C. MAINS

—continued

unit is clearly seen from the following: For 1 B.T.U. (Board of Trade Unit), which may cost as low as 1d. in some districts, this eliminator will operate any set up to six or seven valves for a period of 140–200 hours, according to the current taken from it. When once the eliminator has been installed, and is working properly, you can really forget that the set you are using has any need for H.T. to operate it. You will never be wondering how long it will be before a further expenditure will have to be made in recharging or purchasing a new battery.



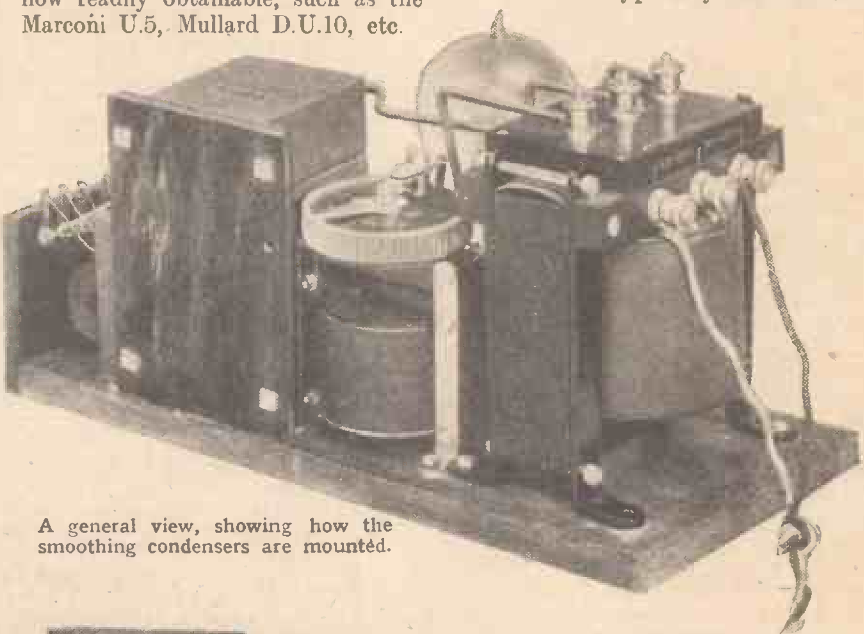
The Transformer

When designing this unit, it was decided that compactness must be an essential feature, and the primary cost must be kept low if the unit was to be an efficient proposition. There is no reason why it should not be built into the existing cabinet space at present occupied by your H.T. battery. The actual components required are given separately. They include a full-wave transformer arranged with a centre-tapped H.T. winding, and filament winding giving approximately 6 volts across the two outside terminals. A nodal point in this winding is an essential feature. By using a 6-volt filament winding it is possible to use one of the full-wave rectifying valves, which are now readily obtainable, such as the Marconi U.5, Mullard D.U.10, etc.

The total capacity of the condensers employed is 10 mfds., and for efficient results this value should not be less. It may consist of eight 1 mfds., four 2 mfds., or two 4 mfds., and a separate 2 mfd. Two fairly efficient L.F. chokes complete this section of the components. Where space is limited, it is advisable to employ special L.F. chokes which are readily obtainable from any of the well-known transformer manufacturers. When, however, size is a secondary consideration ordinary L.F. transformers may be used. Do not, however, use the small type of L.F. transformer, as these saturate when only a small current is being handled.

High Current Value

This particular rectifier employs double-wave or full-wave rectification, and it depends upon the rectifying action of a two-electrode valve. By arranging two plates inside one valve, it is possible to rectify both halves of the alternating-current cycle. Most units of this type only use one half cycle, and are known as half-wave rectifiers; these, however, are unsuitable for delivering a very high value of current.

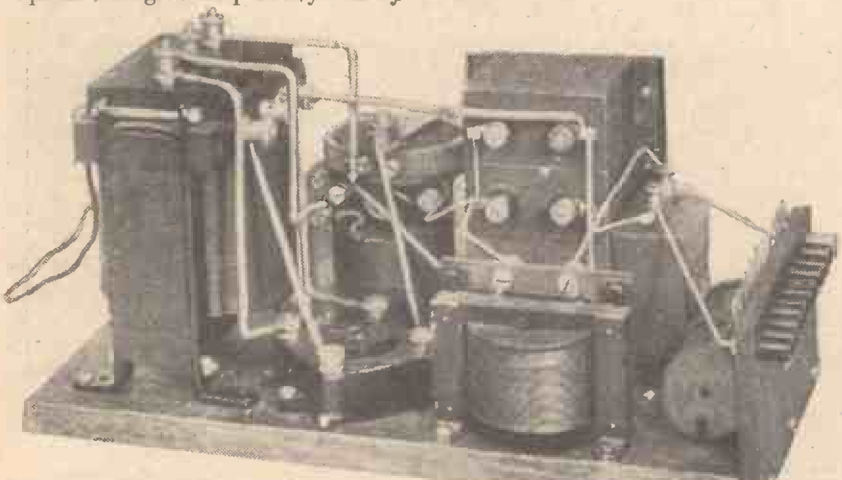


A general view, showing how the smoothing condensers are mounted.

Eliminating "Ripple"

Although the output from the rectifying valve is a steady continuous flow in one direction, it still retains a certain amount of ripple or roughness, which if allowed to pass into the set would cause a continuous hum. The smoothing or flattening of these ripples is carried out by means of the smoothing condensers and chokes.

After the current has passed through the chokes, all the ripple and



Most of the connections can be traced in this illustration.

H.T. FROM A.C. MAINS

—continued

risk of resultant hum has been removed, and the remaining condenser is charged with a perfectly pure supply of D.C. As several H.T. voltages will probably be required, a 10,000-ohm potential divider is connected across the output from the last condenser and is tapped in several places.

The actual construction of the set should offer little, if any, trouble. The components are best mounted on a flat board which, if the actual components recommended are used, need only to be $10\frac{1}{4}$ in. by 5 in., and $\frac{1}{2}$ in. or $\frac{3}{4}$ in. thick. It may be rubbed down with a sheet of glass-paper and given a coat of suitable stain. If the components recommended are not used, the size of the baseboard must be varied accordingly.

WIRING INSTRUCTIONS.

One H.T. secondary connection to grid socket of valve holder.

Remaining H.T. secondary connection to plate socket of valve holder.

Centre tap on H.T. secondary to one side of 1st, 2nd, 3rd, 4th, and 5th smoothing condensers, and one side of potential divider.

One filament secondary terminal to one side of rheostat.

Remaining side of rheostat to one filament pin. Remaining filament pin to remaining filament secondary terminal. Centre tap on filament secondary to remaining sides of smoothing condensers 1 and 2 and one side of 1st choke.

Remaining side of 1st choke to one side of 2nd choke and remaining sides of smoothing condensers 3 and 4. Other side of 2nd choke to remaining side of 5th smoothing condenser and remaining side of potential divider.

Each H.T. socket is joined to its respective tap on potential divider.

On the extreme left the transformer is mounted, which, by the way, should be securely screwed down to the baseboard. (If this should become detached, due to poor fixing, it may cost a good deal more than the cost of suitable screws to put things right.) If a choke such as the McMichael is employed in the first position, so designed that it has a small ebonite block across the top, it is possible to mount the baseboard 10-ohm rheostat on top, by means of two screws tapped into the ebonite.

Make quite sure, however, that in doing this the screws have not fouled the choke connections or laminations. As this rheostat does not need constant variation it is certainly a good way of saving space, and thus reducing the effective size of the unit. When choosing your valve holder make quite sure that it is a good one, as some valve holders give rise to mysterious leaks and faults when subjected to high voltages. After mounting the valve holder, which, by the way, should be placed in the position indicated, with the filament pins as shown, it is advisable to screw the first choke to the baseboard and wire up the transformer, valve holder, first choke and rheostat.

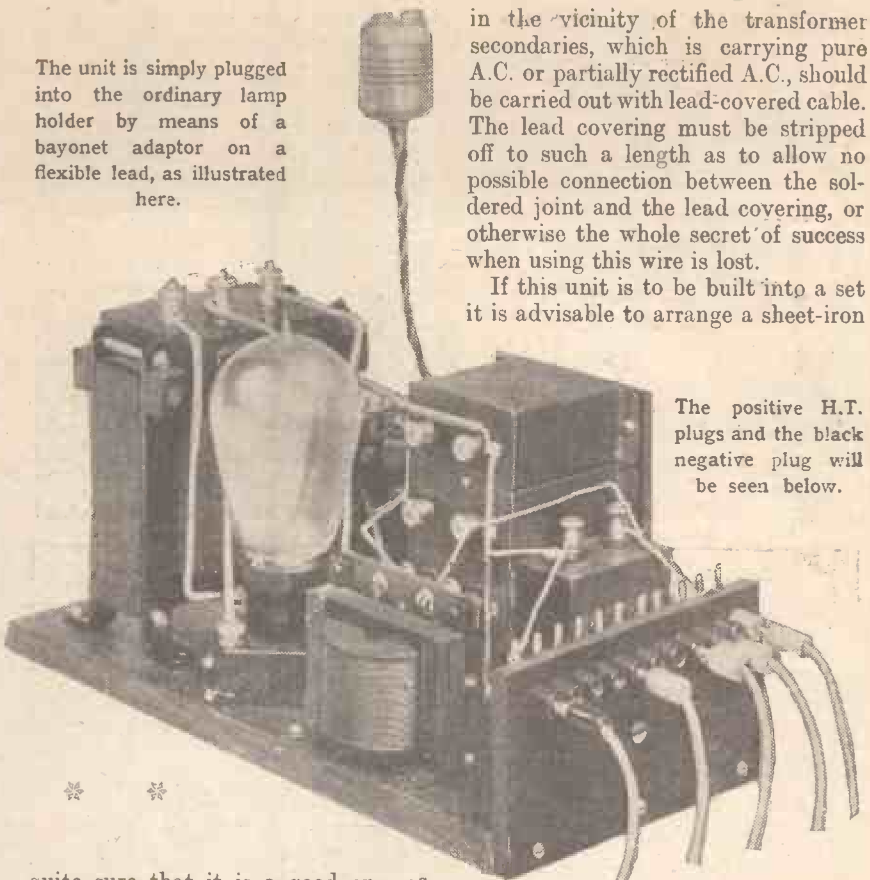
It is advisable to note the following hints regarding screening. The wiring in the vicinity of the transformer secondaries, which is carrying pure A.C. or partially rectified A.C., should be carried out with lead-covered cable. The lead covering must be stripped off to such a length as to allow no possible connection between the soldered joint and the lead covering, or otherwise the whole secret of success when using this wire is lost.

If this unit is to be built into a set it is advisable to arrange a sheet-iron container surrounding the whole unit, so as to prevent any possible interaction. The voltage output from such a unit will be approximately 200 volts, but the intermediate voltages will depend on the actual make of potential divider used.

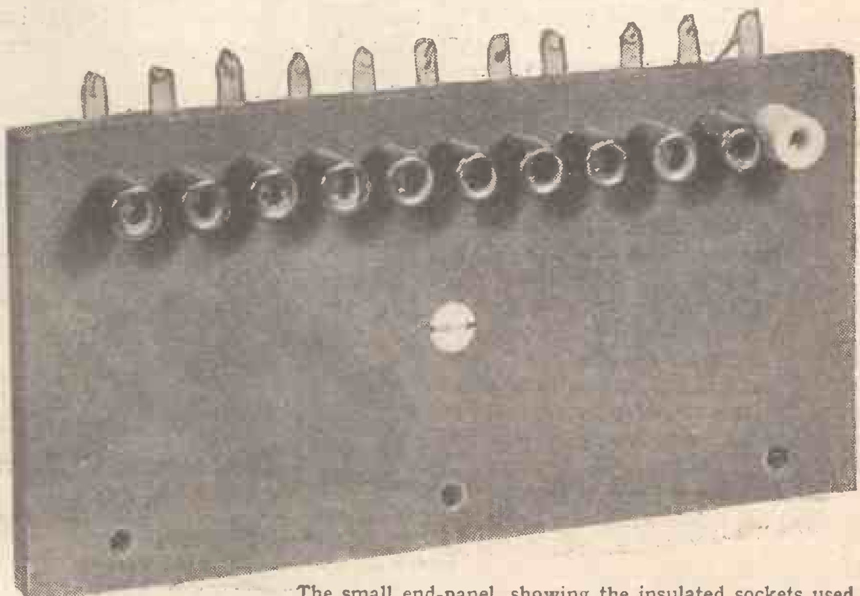
When you are ordering the transformer make quite certain that you mention the voltage and frequency of your mains.

(*Concluded on page 660.*)

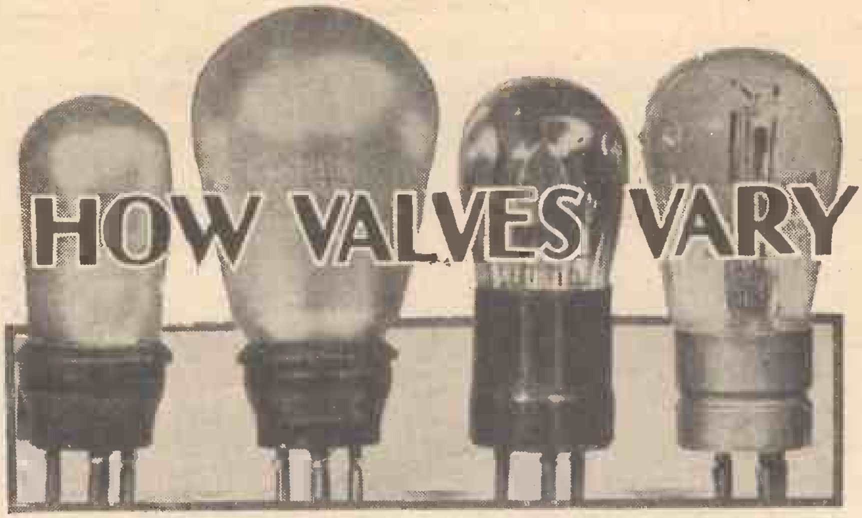
The unit is simply plugged into the ordinary lamp holder by means of a bayonet adaptor on a flexible lead, as illustrated here.



The positive H.T. plugs and the black negative plug will be seen below.



The small end-panel, showing the insulated sockets used.



HOW VALVES VARY

How to choose the valves for the new set you are building.

By KEITH D. ROGERS.

(Asst. Tech. Editor, "Popular Wireless.")

I AM frequently asked why there are so many valves on the market and how the manufacturers expect the average man to be able to pick and choose from the vast number at his disposal. It's a difficult question to answer briefly, but I must agree with many of my correspondents that it is difficult to choose valves for any one purpose unless you realise that the majority of them can be classified into four groups. These are, of course, (1) Resistance-Capacity valves having high magnification factors, (2) H.F. valves having magnification factors of 20 or thereabouts, (3) L.F. valves, and (4) Power and super-power valves.

Naturally these various classes are not divided by fixed boundaries and they merge into one another. Thus we have valves that fall into both categories, like the 15,000-ohm valves, and the 30,000-40,000-ohm valves, which latter are suitable for either H.F. amplification or resistance coupling according to the circuits being used.

A Point to Note

Most of the valve manufacturers have come into line, and, while I consider the nomenclature problem still far from satisfactory, have issued groups of valves which are interchangeable in most cases type for type and voltage for voltage. So readers who want to be sure of what they are doing must take into account impedance and magnification-factor figures when choosing valves. Never mind whether the valve is described as H.F., R.C., or L.F.—this is a general classification and does not mean that an H.F. valve is no good for resistance coupling, or an L.F. valve will not detect or even act as an H.F. in some cases. Try and get the habit of thinking in terms of "I" and "M" (impedance and magnification factor) and then you will find it much more simple when you require any particular valve for any one circuit, and vice-versa.

The "B.B.C." Five

Now let us see how we can choose the valves for the various sets described in this issue of MODERN WIRELESS. In the first place, we will take the 5-valver called the "B.B.C." Five, which is, as will be seen, a four-stage receiver using two valves in parallel in the last stage.

It consists of a stage of "shunt" tuned-anode coupled H.F., followed by a detector working on the anode-bend principle, and two stages of resistance-capacity L.F. amplification. The output is supplied by two valves in parallel, so that the set should be able to handle considerable power.

Now, in order to obtain the full results from this set the valves must be chosen with due regard to the tasks they will have to perform. For instance, the H.F. valve should be capable of good amplification, while the detector must be suitable for the anode-bend method of rectification and must also, as it has a resistance in its plate circuit, give adequate amplification.

Suitable Valves

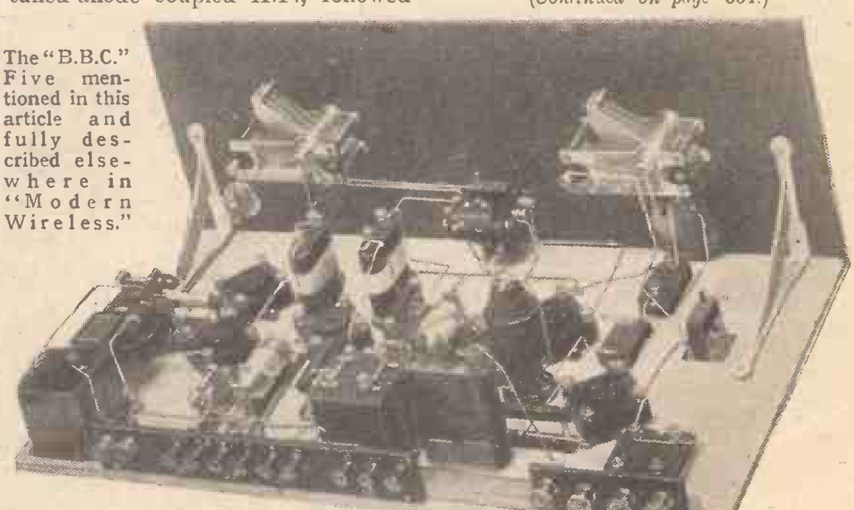
To suit these points we find that the first valve can be one of the H.F. class having an impedance of 20,000 to 30,000 or so ohms, and on test the D.E.5B, P.M.5X, Cossor 610H, and others of that category, were found to function excellently. If too high an amplification factor is used instability is liable to occur and results are not so satisfactory. Before going any further I may say that while 2- and 4-volt valves *can* be used in this set I strongly advise (and I believe Mr. Johnson-Randall does too) the use of 6-volt valves if really large volume is to be obtained.

The detector valve could be of the high-magnification type, but I am inclined to advise the medium mag. class (like the H.F. valve) for best quality and smoothest reaction.

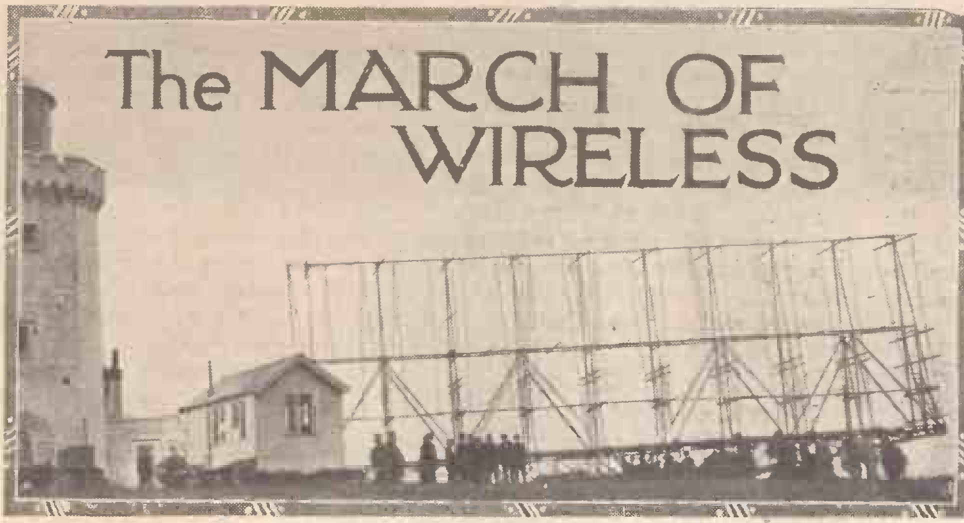
Therefore, I think that you will be better served if you use the same type of valve as in the H.F. stage for the detector, giving it suitable H.T. and grid bias to enable it to perform anode-bend rectification successfully.

(*Continued on page 664.*)

The "B.B.C." Five mentioned in this article and fully described elsewhere in "Modern Wireless."



This set utilises five valves although only a four-stage receiver, the last two valves being in parallel. The various types of valves suitable for use in this receiver are discussed on this page.



The MARCH OF WIRELESS

Some salient points in the romantic story of Radio discussed by
J. C. JEVONS.

WHILST paying due tribute to the early researches of Faraday and Clerk-Maxwell, and to the ingenious experiments of Heinrich Hertz, the fact remains that Wireless, as we know it to-day, was first lifted out of the physicist's laboratory into the realm of practical achievement by Marconi's invention of the elevated aerial.

Marconi's Aerial

Like many other strokes of genius, the use of an extended wire for launching the ether waves into space at the transmitting station, and for collecting them at the receiving end, seems at first sight to be a simple and even obvious contrivance. And yet it was just this simple inspiration which started Marconi in 1896 on the road to fortune.

It is true that a Russian professor named Popoff had previously used an extended wire, connected in series with a coherer, for the purpose of collecting and studying the effects of "static" and other similar atmospheric discharges. This was, however, little more than had been done over a century before by Benjamin Franklin.

It was left to Marconi to grasp the vital importance of throwing the signals into space from an elevated wire and so increasing their range, and of employing a similar wire for collecting them at the distant end. For this idea, together with certain improvements in the coherer as a means of detecting signals, he was granted, in 1897, what may fairly be called the first wireless "master patent."

Tuning the Waves

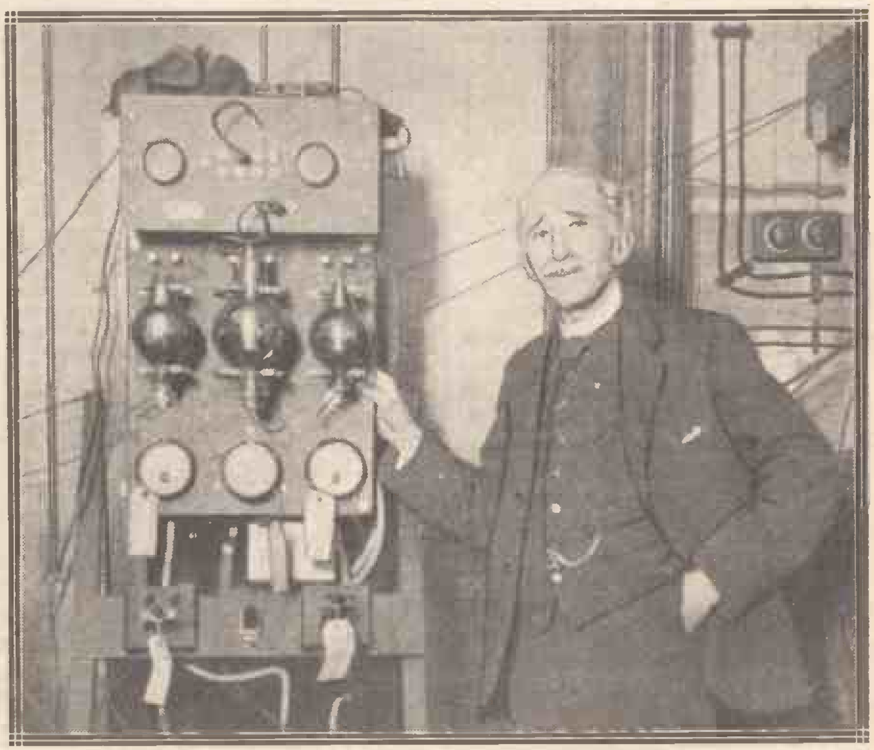
The next year Professor Oliver Lodge, as he then was, discovered the principle of electrical tuning. By loading the transmitting aerial with inductance and capacity he made it possible to transmit ether-waves of any desired frequency. By similarly tuning the receiving aerial Lodge was the first to be able to select or distinguish between messages sent on various wave-lengths from different transmitters.

Two years later, in 1900, Marconi further developed the tuning principle by coupling a "closed" circuit, energised by a spark gap and acting as a kind of power reservoir, to the "open" oscillatory circuit formed by the radiating aerial.

This apparently simple arrangement enormously increased the distances that had previously been covered by wireless signals. The next year, in fact, saw the Atlantic bridged from Poldhu to Newfoundland, a distance of 1,300 miles; whilst a few months later a range of over 2,000 miles was attained.

The Famous "Four Sevens"

The "coupled secondary" principle, as it is now called, was similarly applied to reception, the impulses collected by the open aerial from the ether being transferred to and built up in a closed circuit containing the detector.



Dr. J. A. Fleming, inventor of the thermionic valve, the device that makes broadcasting possible.

THE MARCH OF WIRELESS
—continued

This improvement formed the subject of the famous "four sevens" patent granted to Marconi in 1900. Taken in combination with the original Lodge patent, it gave the Marconi company a practical monopoly of long-distance communication for many years.

The Poulsen Arc

The next step of importance to be recorded is the development by

Signal Hill, Newfoundland, where Marconi received the first transatlantic radio message.

Valdemar Poulsen, in 1903, of the Duddell Arc as a generator of continuous H.F. oscillations suitable for radio signalling.

The chief improvement made by this Danish inventor to the work of Duddell was the immersion of the arc in an atmosphere of hydrogen, together with the use of a magnetic blow-out to increase the intensity of the H.F. oscillations so produced.

In spite of the fact that the Poulsen Arc was invented at this early stage, it did not come into extensive use until some ten years later, or just before the outbreak of war. Once installed, however, it proved a formidable competitor to all other existing means of producing radio-frequency signalling-waves. Even at the present time it remains the most powerful rival, in the field of transmission, to the thermionic valve.

The Birth of the Valve

The year 1904 saw the birth of the Fleming two-electrode valve, which, strangely enough, similarly remained for a long period in practical disuse. Four years later, in 1908, De Forest added the grid or third electrode, thus producing the prototype of the modern thermionic valve. It was not, however, until the lapse of another six years that this marvellous device really came into prominence in wireless practice, first as a detector and afterwards as a generator of high-powered continuous oscillations.

Enter the Crystal

Meanwhile, in 1906, General Dunwoody, an American, discovered the use of carborundum as a detector. About the same time another American investigator, G. W. Pickard, found, first, that silicon would answer the same purpose, and subsequently that a combination of zincite and copper pyrites, christened "Perikon," gave even better results than carborundum without the necessity for using any biasing voltage.

From that time the number of suitable detector crystals became legion. Carborundum and perikon crystals at once commenced to replace the older forms of detector, such as the coherer, the magnetic recorder, and various forms of electrolytic combinations, which had up to then been in general commercial use, particularly at sea.

The First Heterodyne

In 1907 Fessenden invented the "beat" or interference method of reception, now known by the name heterodyne. Although it did not find extensive application until some years later, when the Poulsen Arc and the thermionic valve had brought continuous-wave transmission into common use, the heterodyne method of reception opened out an entirely new field of possibilities, and may fairly be regarded as an invention of outstanding merit and importance.

In its later developments it forms the basis of the most efficient form of selective signalling at present known to the art, particularly as extended by Messrs. Lee and Hogan, and afterwards by Levy and Armstrong, to what is now known as supersonic working.

Direction-Finding

It is somewhat surprising to find that even as early as 1907 the fundamental principles of direction-finding had already been developed by two Italian engineers, Ettore Bellini and Alessandro Tosi.

These inventors employed large loop or frame aerials, coupled to search coils, and arranged at right angles, so as to utilise the maximum or minimum effect, according as the incoming signals arrive in, or at right-angles to, the plane of the loop, in the manner that is now so well known.

The Discovery of Reaction

From 1912 to 1914 wireless investigators in various parts of the world seem to have discovered, more or less independently, the basic principle of reaction or regeneration, in which, by coupling together the input and output circuits of a valve, a feeble applied impulse can be automatically strengthened to a degree that is only limited by the current-carrying capacity of the tube.

It is doubtful whether any other single inventive step has played so important a part in the progress of radio science as did this discovery. It certainly revolutionised the functions and importance of the thermionic valve.

From a position of comparative insignificance, as an ingenious but

The Poldhu wireless station. It was from here that the historical first transatlantic radio message was transmitted.

THE MARCH OF WIRELESS

—continued

somewhat erratic and troublesome rival of the coherer and crystal, we see the valve blossoming out under the influence of "reaction" into the marvellously flexible instrument we know to-day—as delicate and sensitive in reception as it is reliable and powerful in transmission.

Claims to Priority

From amidst the confusion of claims that have been made to this discovery, it is difficult to ascertain to whom the honour is rightly due. De Forest and Armstrong in America were apparently working independently upon lines that led each in turn, about the end of 1912 or the early part of 1913, to the same goal. The question of priority has been bitterly contested in the American Courts, where the honours at present rest with De Forest.

Meanwhile, Von Arco and Meissner must be credited with arriving at the same result in Germany, some time early in 1913. So far as England is concerned the first to disclose the principle of reaction was C. S. Franklin, who, in combination with the Marconi Company, was granted a patent for a back-coupled valve receiver in June, 1913.

From the year 1914 the detailed story of wireless development is largely obscured by the circumstances of the war. Progress was, in fact, rapid and continuous in practically every direction in which wireless could serve as an aid to the belligerents. In particular the end of hostilities saw the thermionic valve paramount in reception and predominant in transmission, particularly for low-powered C.W. and telephony working.

The Super-Heterodyne

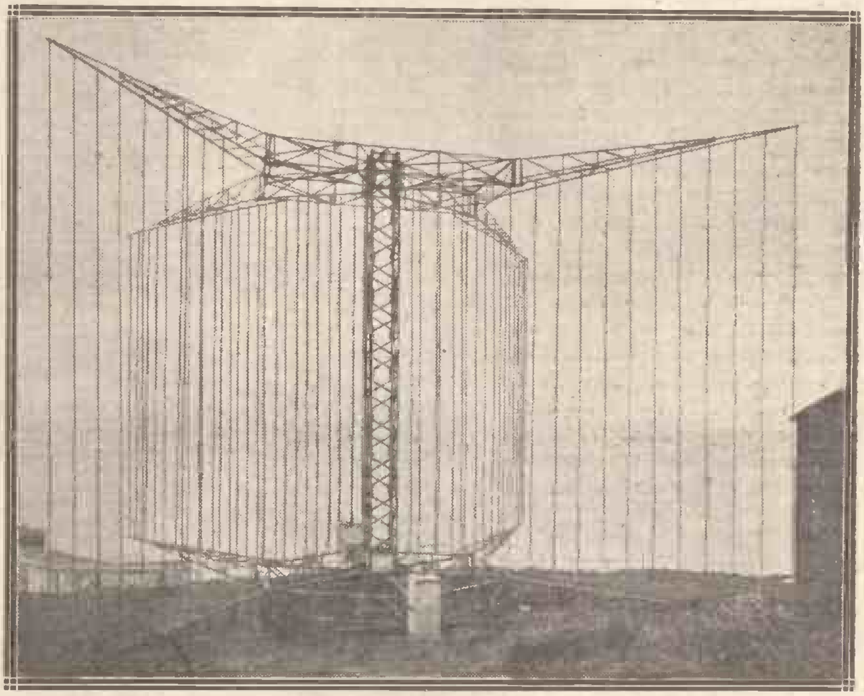
Amongst post-war improvements the development of the supersonic or super-heterodyne principle deserves first mention. In practice the system is utilised most widely in reception, where it provides an ingenious method of securing intensive high-frequency amplification free from self-oscillation. This is accomplished by converting the incoming radio frequency into a lower or supersonic frequency, which is then amplified to the required degree, the signal components being subsequently separated out by a process of double rectification.

Actually, however, the supersonic method covers generally any system of signalling in which a double modulation of the carrier-wave is employed to transmit the actual signals. For instance, an original carrier-wave, having a frequency, say, of a million cycles per second, may be modulated by a "supersonic frequency", say, of 50,000 cycles a second. The signalling components are then impressed upon the 50,000-cycle wave, and are separated at the receiving end by a double rectification of the complex carrier-wave.

Such a method of signalling has advantages from the point of view of secrecy. The fact that "double rectification" is involved constitutes the common link between "supersonic" transmission and the super-applied input, a result that had not previously been disclosed. This was accomplished by using a local or quenching oscillator which, when applied to the grid of the amplifier valve, threw it alternately above and below the critical "threshold" point of self-oscillation, and so, in effect, maintained it in the sensitive condition at which super-regenerative amplification can take place.

The Flewelling Circuit

Subsequently a series of alternative arrangements were evolved, of which the well-known Flewelling circuit is a typical example, in which similar "quenching" effects were secured by regulating the discharge



A revolving beam aerial, as used for radio direction-finding to enable ships to ascertain their positions in fogs.

heterodyne receiver as now widely utilised for selective broadcast reception.

Another remarkable expansion of the inherent possibilities of the thermionic valve must be credited to Armstrong in 1921. It had previously been noticed that a valve, when "trigged," or maintained on the threshold of oscillation, was capable of giving an abnormal degree of amplification when impulsed by an incoming signal.

Super-Regeneration

Armstrong succeeded in utilising this effect for the reception of telephony. In other words, he managed to keep the abnormally amplified output strictly proportional to the rate of the grid condenser without the use of a special "oscillator." In such circuits the abnormal amplification obtained may safely be attributed to the super-regenerative action of the valve first described and explained by Armstrong.

The Neutrodyne

Amongst amateurs of the present day, probably the most widely used of post-war improvements is the method of balancing the effects of inter-electrode capacity, generally known as neutrodyning.

With the widespread development of broadcasting, the demand for longer range and greater selectivity in reception naturally became more

THE MARCH OF WIRELESS

—concluded

insistent. One obvious solution is to increase the number of stages of high-frequency valve amplification, but this in turn introduces fresh problems of stability.

Owing to inherent capacity coupling across the valve electrodes, interaction takes place between successive stages when these are connected in series, so that the whole system is thrown into self-oscillation and becomes useless for reception. As previously stated, the super-heterodyne receiver provides one method of overcoming this difficulty.

The "Neutrodyne" Patents

Neutrodyning, or "balancing," affords a much simpler alternative for stabilising a number of stages of high-frequency amplifiers arranged in tandem. The name of Professor Hazletine is now generally associated with the standard method of connecting the plate and grid circuits through a special coupling designed to neutralise or balance out the undesirable capacity-effect existing inside the valve. Hazletine's invention was first patented in America in 1919, though it must be admitted that a very similar arrangement, attributed to Rice, was protected in this country early in the year 1918.

Beam Signalling

No record of recent improvements would be complete without reference to the new system of directive short-wave signalling now generally known as the Beam.

The general idea of using a parabolic or "sheet" screen of aerials so as to reflect the radiated energy into a directed path or beam, instead of allowing it to spread outwards in all directions, probably dates from the year 1916 In 1917 Senatore Marconi and Mr. C. S. Franklin described an arrangement of reflector aerials arranged about a central oscillator, which corresponds very closely to the system now in practical use between this country and Canada.

Piezo Crystals

Since that time, however, many detail improvements have been effected, both in the actual aerial arrangement, as well as in the methods of feeding and controlling the short-wave energy which goes to form the radiated beam, with the result that the beam system threatens to render obsolete all other methods of long-distance signalling.

In conclusion, a word may be said of certain other recent developments, some of which have already proved their worth, whilst others still await the test of time.

In the first category must be placed the discovery of the oscillating properties of piezo-electric crystals, and their application to frequency-control in transmission. It now appears likely that such crystals may find a further useful application in enhancing the selectivity of receiving sets.

Television

Tribute must also be paid to the vast amount of pioneer work that has been carried out in the fascinating field of "radio vision." Although the goal has not yet been reached, the prospects of final success appear much nearer to-day than they did a year ago, mainly owing to the labours of Baird, Belin, Jenkins and Alexanderson.

Polarised Waves

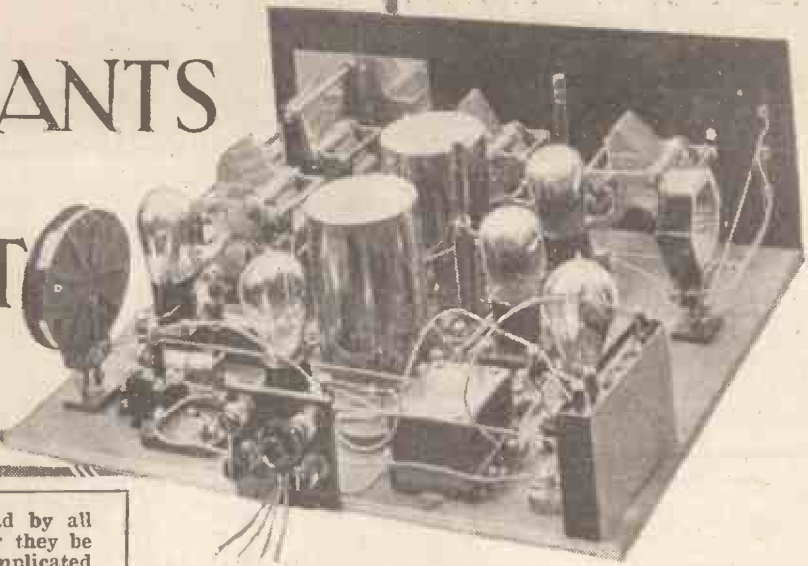
The use of polarised-wave transmission as a remedy for fading is still in the experimental stage, though it undoubtedly opens up a new and interesting field of possibilities in the latest technique of ultra-short-wave working.

The Oscillating Crystal

Unfortunately the discovery of the oscillating crystal detector, which first opened up the prospect of high- and low-frequency amplification without the use of valves, seems for the moment to have disappointed public interest. It is to be hoped that some inventor will come forward in the near future, and gratify the latent ambition of every crystal user to find himself on an equal footing with his more favoured brethren of the valve.

Inside the radio cabin of a modern liner.

THE H.F. CONSTANTS OF A BROADCAST RECEIVER



An interesting article that should be read by all possessors of wireless receivers, whether they be crystal sets or the more pretentious and complicated multi-valvers. Some very useful comparisons concerning aerial-earth efficiency are included, and will be of practical value to every reader.

By E. A. ANSON.

MANY owners of even expensive sets have no means of discovering whether an alteration has been an improvement or not, except by ear. Unfortunately the ear is notoriously unreliable unless the improvement has been gigantic. Most improvements in themselves alone cannot be detected by ear, but the sum of a series of improvements often amounts to quite a detectable quantity, affecting selectivity, sensitivity and signal strength.

Valve Voltmeter

It is the purpose of this article to indicate what alterations to the coils, earth and aerial are likely to be worth while. In addition, actual practical measurements will be given on broadcast wave-lengths.

The fundamental measuring instrument used was based on the principle of the Moullin voltmeter. This instrument is really nothing but a calibrated valve detector with a sensitive D.C. galvanometer in the anode circuit. The accompanying diagram gives the connections.

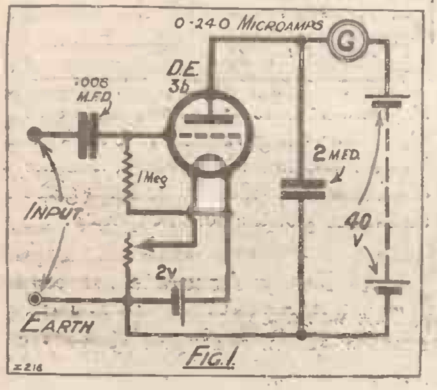


FIG. 1.

The galvanometer, a unipivot instrument, 0–24 microamps, is shunted to give a full deflection for 240 microamps. (A microamp is one-thousandth of a milliamp.) The valve

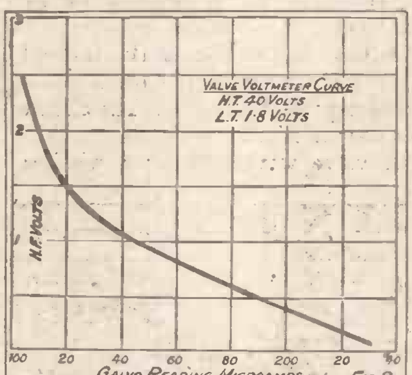


FIG. 2.

is a D.E.3b, and to ensure long life this 3-volt valve is run at only 1·8 volts. The filament "rheostat" consists of a 30-ohm and a 4-ohm in series. The latter gives fine control.

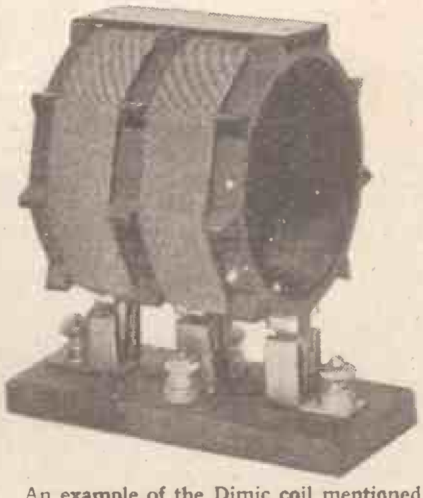
Preliminary Preparations

To use this high-frequency voltmeter the filament is switched on and the rheostats adjusted until with an H.T. of 40 volts the galvanometer gives full deflection of 240 microamps. Any H.F. voltages placed across the input of the valve cause the grid to become more negative and thus reduce the plate current through the unipivot galvo, which is, of course, shown by the needle falling to a lower reading. The greater the H.F. voltage, within limits, the further the fall of anode current. Calibration cannot be done on D.C., but although details of calibration cannot be mentioned in this short article, as a matter of fact it is a fairly simple matter.

Sensitive Instrument

These valve voltmeters are fairly sensitive, and in this case reliable readings from ·1 to 2·5 volts may be obtained. The extra capacity added to a circuit by the insertion of the voltmeter is 15 micro-microfarads, and Fig. 2 gives the voltage curve for the instrument.

The next essential instrument was a high-class condenser that did not cost too much. Although good condensers are cheap at £20, yet in this case lack of funds limited the choice to a high-class instrument as used for



An example of the Dimic coil mentioned in the article.

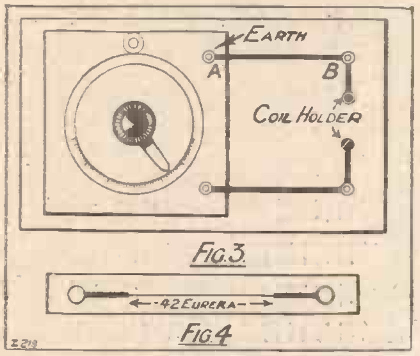
THE H.F. CONSTANTS OF A BROADCAST RECEIVER

—continued

receivers. A ·001 "Miniloss" variable condenser was used, mounted on a panel and screened by a zinc case. On the panel was a coil holder connected to the condenser by stout copper strips.

Standard Resistances

Two resistances of 5 and 20 ohms were constructed from 42 S.W.G. Eureka and mounted between terminals in a straight line. The two



resistances are almost similar in size, 1 ft. 2 in. long, the resistance wire itself being soldered to 18 S.W.G. copper wire to make up space.

These resistances must not throw any appreciable additional capacity or inductance into a circuit when they are connected. One or the other was inserted between A and B, Fig. 3. Being of small diameter and in a straight line, no noticeable alteration could be detected as regards capacity or inductance when they were inserted. Also their H.F. and D.C. resistances are identical.

Armed with these components it is possible to look the aerial-earth system in the face and really discover whether it is all that one expects.

The aerial on which tests were made is slung between two convenient

One of the older type of duolateral coil that was tested by the author.

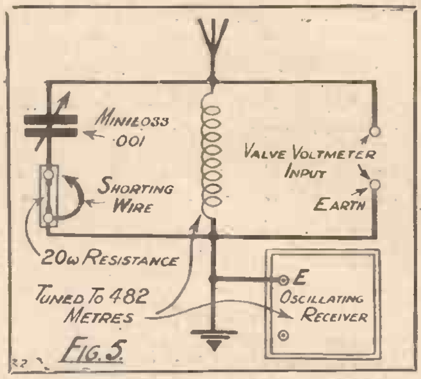
trees. It consists of two 7/22 wires spaced 10 ft. apart, average height 45 ft., and 100 ft. long. To compensate for the movements of the trees in a wind one end of the aerial is attached by a wire rope running over a pulley and supported by two 14-lb. sash weights.

Measuring Earth Resistances

The normal earth consists of a 10 ft. by 1 ft. copper sheet buried 2 ft. 6 in. deep in a very damp and mossy lawn. It is connected to the receiver by 15 ft. of 7/18 insulated cable.

A brief description of the method used for measuring the earth resistance may be interesting. The circuit is shown in Fig. 5.

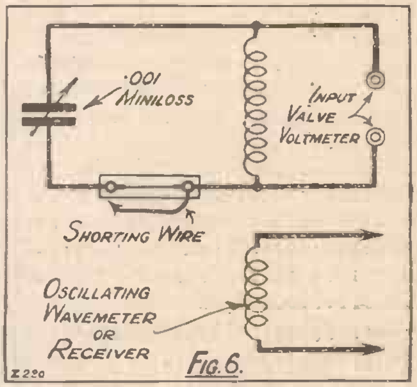
A valve wavemeter or a wireless receiver disconnected from the aerial is made to oscillate on a selected wavelength. In this case 482 metres was used. The variable condenser is connected across a suitable coil in the aerial-earth system. The valve voltmeter measures the voltage across the condenser. The oscillating re-



ceiver must be placed at least 2 ft. from the aerial coil; with a valve voltmeter this is quite practicable. Connected to the earth side of the condenser is one of the resistances, preferably the one nearest to the expected earth resistance—in this case the 20-ohm resistance. This resistance is shorted by a stout copper wire. The H.F. voltage across the condenser is noted. Then the aerial is disconnected. The circuit is retuned by the condenser in the normal way.

Aerial Capacity

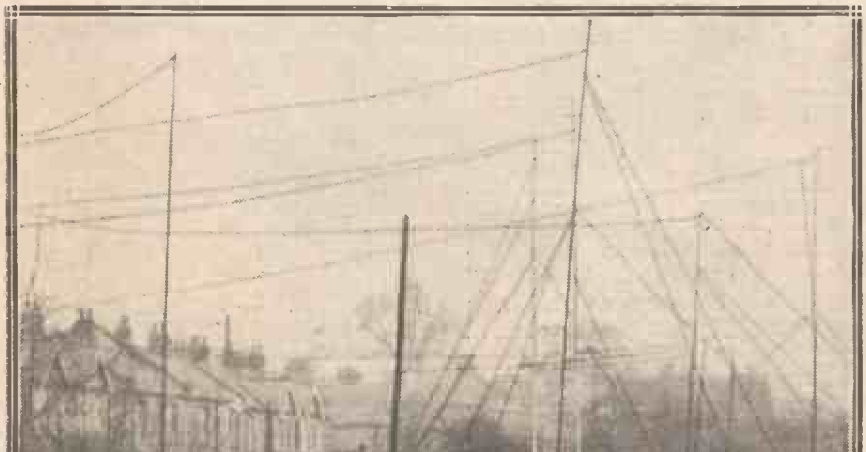
The shorting wire is undone, leaving one end earthed, and slid along the resistance wire until the voltage, which will have risen, reads the same



as before. The resistance added to make the voltages equal is the approximate resistance of the earth, and the difference in condenser readings gives an estimate of the aerial capacity.

Fairly Accurate

This was done three times and the average taken. Results could be duplicated to within 5 per cent. The actual resistance of this particular



When aerials are crowded together as shown above it is most important that the whole aerial-earth system be as efficient as possible in the circumstances.

THE H.F. CONSTANTS OF A BROADCAST RECEIVER

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earth system averaged out at 17·1 ohms, with an aerial capacity of ·00033 microfarads at 482 metres. The list below gives the results of other earthing systems:

Earth	Resistance	Aerial Capacity
	Ohms	Microfarads
Buried copper plate	17·1	·00033
Lead pipe to 25 ft. well, half full water ..	27	·00039
Plate plus well connected together ..	13	·00033
Proprietary brand copper earth pin about 2 ft. 6 in. by 1 in. diam. in flower-bed to hilt	43	·00027
1 wire counterpoise 100 ft. 7/22 copper 5 ft. high ..	16	·00013
2-wire counterpoise as above ..	10.1	·00015
2-wire counterpoise and buried plate connected together ..	18	·00028

Although the 2-wire counterpoise gave very much sharper tuning, yet the H.F. voltage from Swansea across a tuned coil was ·01 on the counterpoise and ·03 on the normal buried copper plate. Under the same conditions the rectified current in a crystal set was 1·2 microamps on the counterpoise and 2 microamps on the normal earth. Thus a low earth resistance is not everything; naturally what is wanted is the highest possible voltage built up across the grid of the first valve, and other factors influence this.

Counterpoise Causing Instability

As regards Daventry a double-wire aerial, using the buried earth plate, gave an H.F. voltage of ·03, whilst a single-wire aerial, exactly as long and high, gave ·02 volts across a tuned coil in the aerial-earth circuit. For Swansea no difference could be detected. Do not forget that the low resistance of a counterpoise earth is very apt to make unneutralised receivers oscillate persistently.

Coils were next tested for H.F. resistance. Judging by certain advertisements the ideal coil would have no resistance and no self-capacity. The result would be a coil that responded to such a minute fraction of a carrier wave that it would be untunable, except with a slow-motion condenser with a ratio of infinity to one! In addition, no side-bands would pass and speech would be impossible to receive.

The H.F. resistance of various coils was measured when tuned by the standard condenser. The H.F. voltage was injected into the coil from a wave-meter or oscillating receiver with aerial disconnected.

Measuring Coil Resistance

This voltage was measured across the coil with and without the resistance in the condenser lead. Then the H.F. resistance of the coil under test is given by the simple formula:

$$R = R_1 \times \frac{V_1}{V_0 - V_1}$$

Where R is the unknown coil resistance.

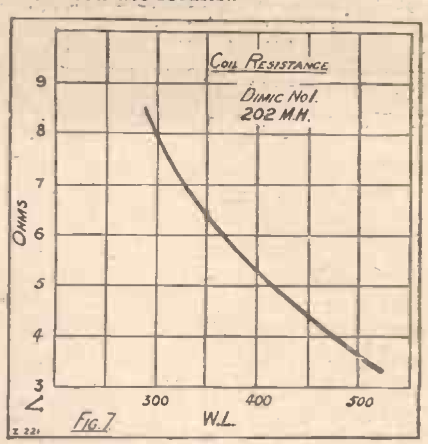
Where R_1 is the known inserted resistance measured on D.C.

Where V_0 is H.F. volts across coil with R_1 shorted.

Where V_1 is H.F. volts across coil with R_1 in circuit.

Naturally, V_0 is always larger than V_1.

If the known resistance is inserted on the earth side of the condenser, and is shorted by a stout copper wire, the constants of the circuit are not appreciably altered as regards self-capacity or inductance, and very good results may be obtained. The known resistance should be about equal to the unknown coil resistance for accurate results.



The table below gives some concrete results from tests made with old coils that, in many cases, are not now on the market.

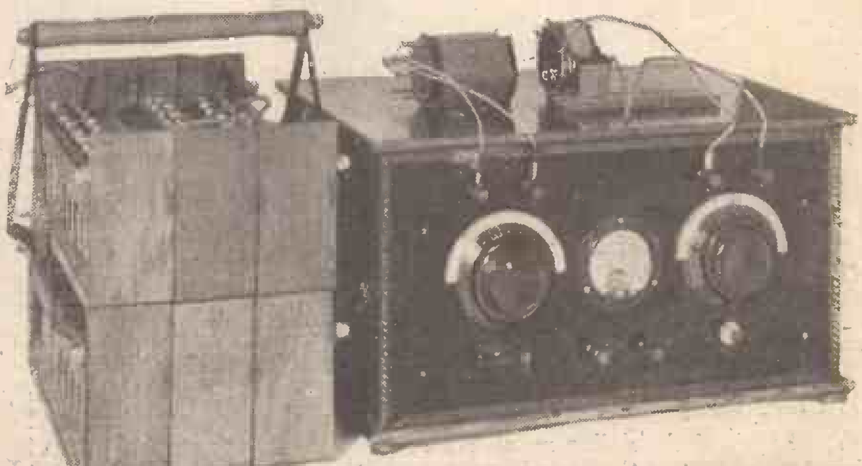
Coil	WL 330 R	WL 482 R	Apparent Inductance Neglecting Self Capacity
			Microhenries
Burndept S2	2·6	2·3	69
,, S3	6	3·6	94
,, S4	15	9·8	187
,, S5	30	23·3	364
,, 75	18	17·1	273
Igranic 50	—	6·9	107
,, 75	—	40	326
Dimic No. 1	5·6	4·0	202

This table and the resistance curve for the "Dimic" coil (Fig. 7) show very clearly the increase of H.F. resistance with decrease of wavelength.

Effect of Screening

Although it was not possible to test a screened coil, yet a few tests were made on the S3 coil to see what results might be expected.

(*Concluded on page 618.*)



An H.F. measuring device described in "Modern Wireless" recently by Mr. P. W. Harris. It is interesting to compare the method employed in this instrument with that of the arrangement mentioned above.

A SIMPLE NEUTRODYNE CONDENSER

Many types of neutrodyne condenser are readily obtainable for the purpose of neutralising, but each appears to have some drawback. In the type which employs small vanes (really ordinary variable condensers on a small scale) there is often a very grave danger of shorting should one or more of the plates become bent. In other types where two small copper discs are used, separated by a disc of mica, it is difficult to tell exactly the relative positions of the two plates, encased as they are in an ebonite tube. A modification of the latter type employing a glass tube is a good arrangement (Fig. 1). For the construction of such a condenser very thin walled glass tubing is used, which has a high dielectric value. This in itself is a great boon, as the actual size of the condenser is reduced to approximately one-sixth the size of an air-dielectric condenser. The outer tubing, which may be of any convenient size, say ½ in. in diameter and 2 in. long, is coated outside to about half its length with copper foil, which can easily be secured in place by a soldered joint.

The Connections

At the same time attach a small piece of wire for connecting to the right-hand terminal on base. An ebonite former of the required size is now coated with copper foil and inserted into the tube, there being as small an air gap as is possible between

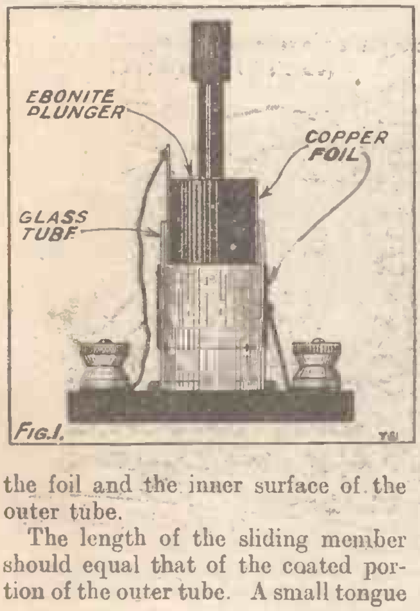


FIG. 1.

the foil and the inner surface of the outer tube.

The length of the sliding member should equal that of the coated portion of the outer tube. A small tongue of foil is left as shown to connect the left-hand terminal to by means of a flexible lead. The outer cylinder may conveniently be mounted to a small ebonite baseboard by means of two or more rubber rings placed round the bottom. A small quantity of Chatterton's compound is then placed on the rings and the whole stuck down to the small piece of ebonite which has been previously prepared and fitted with two small terminals. The plunger is completed by firmly fixing a piece of ebonite rod to the centre. If it is found that the core tends to stick, a *small* quantity of vaseline should be smeared on the inner surface of the glass tube.

SECURING PANEL LABELS

A good way to attach ivorine name-plates to a panel is that illustrated in the diagram, Fig. 2. In this method, two slender but long pins (the type used by shoemakers and repairers) are pushed through the plate and through small holes drilled with a fine drill in the panel, the ends of the pins protruding below the panel being subsequently cut off and turned back in the manner illustrated in the diagram. Labels secured to a panel in this manner will remain in place indefinitely.

If, however, it is desired to *cement* the ivorine label down to the panel, instead of using the pins suggested in the former paragraph, ordinary rubber solution is useful for the purpose. Spread a thin layer of rubber solution on the back of the label, and then allow it almost to dry. When the solution has become "tacky," press the label down on the panel, and place a heavy weight over it for a few hours.

A Useful Cement

Another useful cement for the purpose is ordinary celluloid cement, a commodity which is now much used by photographers as a negative varnish. The celluloid cement is spread in a thin layer over the back of the label, and the latter is then placed in position on the panel, and pressed down for a few hours, as before.

If by the use of either of the above cements a clean edge to the label does not result, any surplus trace of cement around the edge of the label can generally be removed quite readily by the gentle application of a soft rag moistened with a little methylated spirit.

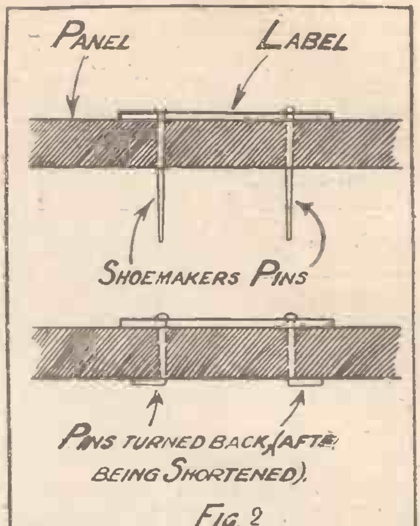


FIG. 2

THE H.F. CONSTANTS OF A BROADCAST RECEIVER

—concluded from page 617

A complete circlet of 18 S.W.G. copper wire was placed round this coil. The resistance did not alter at all, but the inductance fell from 94 to 63 microhenries. The following table for the S3 coil may be of interest:

Resistance	Ohms	H.F. Volts Injected	Inductance
			mhs.
Normal .	6	1·98	94
Wet disc of cardboard inserted	6	1·95	94
Circlet of of copper wire added, 1 turn .	6	·51	63

The constancy of the resistance is very curious; but, of course, it must be remembered that if the inductance L becomes lower a coil with the inductance kept constant would require more turns, and then the resistance would go up.

Thus a screened coil would have a lower inductance than unscreened, although it is indicated that the actual H.F. resistance would not vary much. But to reach a given wavelength more turns would be required in the case of the screened coil, unless a larger condenser were used, and this is undesirable.

The "SILVER TONED" TWO

An inexpensive 2-valve receiver designed to give loud-speaker reproduction from the local station, and good phone signals from a number of distant transmissions.

By

STANLEY G. RATTEE, M.I.R.E.

As a general rule the interests of the serious-minded wireless enthusiast are centred about the subjects of selectivity, sensitivity and purity; the first and second of these are to some extent associated with each other, while the third may be merely with the local station in view.

In the present case the object was to receive on telephones a few selected stations with an economical number of valves, and the best purity that the circumstances would permit.

COMPONENTS REQUIRED.

- Ebonite panel 16 in. × 8 in. × $\frac{3}{16}$ in.
- Cabinet and baseboard 16 in. × 7 in. × $\frac{3}{8}$ in.
- Panel brackets.
- Variable condensers, ·0005 and ·0003.
- Filament rheostat.
- Coil former.
- Valve holders.
- H.F. choke.
- 2 sockets for panel mounting.
- 9 terminals and ebonite strip 2 in. × 5 in. × $\frac{1}{16}$ in.
- L.F. transformer.
- 2 wander-plugs—one red, one black.
- 2 slow-motion dials.
- 1 lb. No. 36 S.S.C. wire.
- "Glazite," wood-screws, flex, etc.

Clear Reception

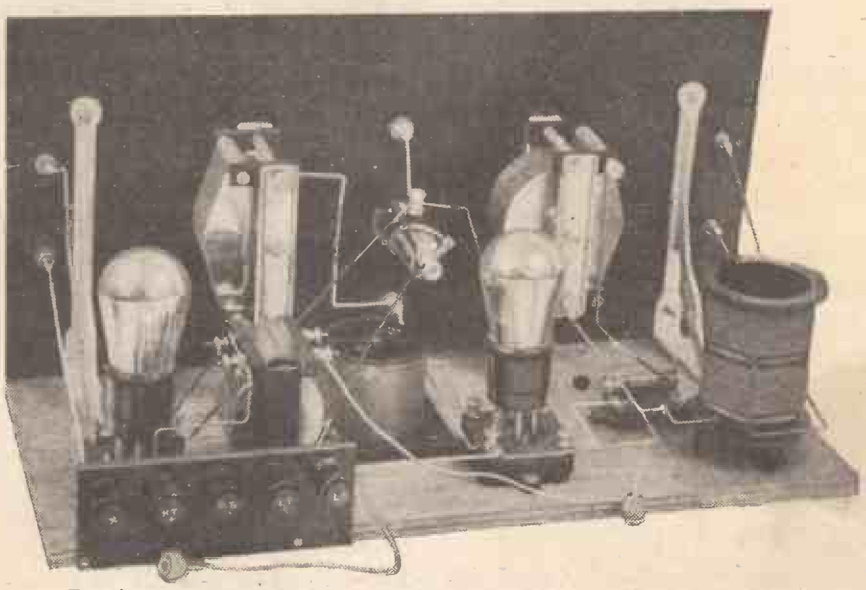
It must be fully appreciated that the set was not required for distance work beyond a few selected stations, and therefore one could afford to sacrifice a little of the sensitivity in favour of cleaner reception, and working along these lines a circuit utilising a detector followed by a resistance - capacity - coupled L.F. stage was evolved. So far as purity was concerned this arrangement seemed to be in keeping with what was required, but results were not over strong unless boosted up with reaction. It was realised that adding another valve would be an easy way out of the difficulty, but for reasons of economy it was particularly decided that two should be the maximum number used.

Many circuits of other types were tested, and though they all gave results which would have given satisfaction to many people, it was not until a modified Reinartz circuit followed by a transformer-coupled-amplifier was tried that the required freedom from mush, Morse interference, and so on, was obtained, while still preserving simplicity in operation with economy as to valves.

The set is selective, there is only one tuning control, varying the reaction adjustment does not alter the tuning, and should one desire to listen to the local station on the loud speaker, then one may do so without hesitation up to distances of about ten or so miles; where aerial conditions are good it may be more.

Simple Tuning

The particular stations the set was required to receive were Hamburg, Barcelona, Copenhagen, Rome and Berne, and the reason for this preference was to satisfy the wishes of a correspondence clerk in the foreign department of a joint-stock bank who wished to keep himself in touch with the activities and languages of those



The simple nature of the receiver will be realised from the above illustration.

THE "SILVER-TONED" TWO
—continued

countries wherein the cities named above are to be found. Obviously, reception had to be free from all kinds of interference, signals had to be clear, sharp and strong, and the operation of tuning from one station to another had to be simple.

Circuit Employed

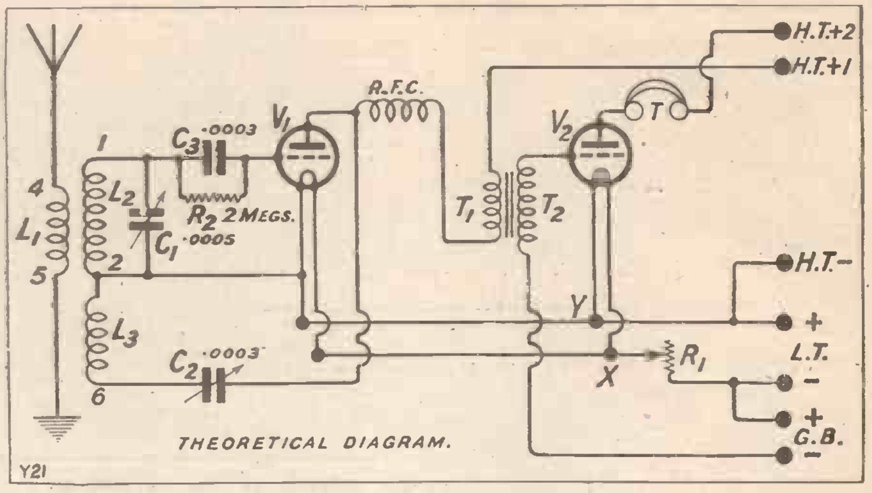
The theoretical circuit accompanying this article will show the arrangement adopted. The coils are home-wound or they can, if desired, be purchased ready wound. Details as to turn numbers and pins to use are given in a separate paragraph later.

A rather unusual feature incorporated in the present set is that since a variable filament resistance is used, provision is made for the quick reading of the voltage across the filament legs of the valves.

The two sockets X and Y (see wiring diagram), situated on the front of the panel, are connected one to each side of the valve filaments, and by connecting a voltmeter of suitable type across these two points the operator may check up the accuracy of his filament voltage adjustment by means of the rheostat.

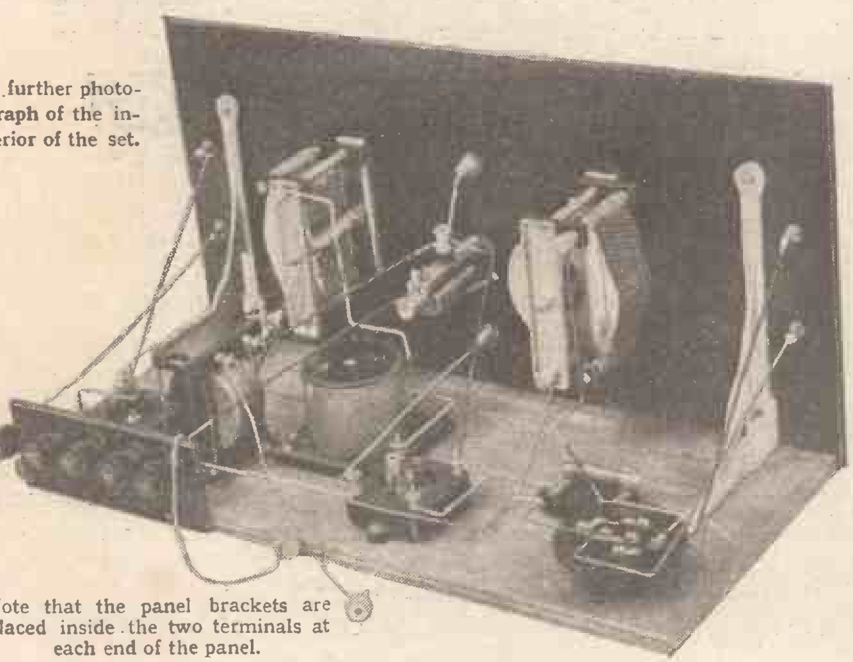
Details of Coils

The set is primarily intended for use with 2-volt valves, and since most of these types are very sensitive to any shortage of voltage, it is as well to have some speedy method by which one can bring a voltmeter into use, to see whether or not the valves are getting the required volts actually across the filament legs; hence the presence of X and Y.



As to the three coils for use with this set, these are wound upon the same former, the arrangement being as follows: The secondary coil L_2 is wound in two halves of forty-five turns each, the wire being No. 36 silk covered. The beginning of this winding is taken to pin No. 1, and the end of the winding to pin No. 2. The two halves of this coil are arranged one each side of the slots to be found half-way between the top and bottom of the "Colvern" former, and into these slots is wound the primary coil L_1. This consists of twenty turns of the same gauge wire as L_2, wound in the same direction as before, and is connected with the beginning of the winding to pin No. 4 and the finish to pin No. 5. The third coil, L_3, is the reaction winding, and this is wound in the same direction as L_2, and consists of fifty turns of No. 36 S.S.C., arranged within the slots at the bottom end of the former. The beginning of the winding is connected to pin No. 2 and the finish of the coil to pin No. 6. If after completing the set it is found that the receiver will not oscillate over the full range of the tuning condenser, then the number of turns of L_3 should be increased by, say, ten; if, on the other hand, the set will not oscillate at all, or only when the reaction condenser is turned from maximum to zero readings, then it may be assumed that L_3 has been wrongly connected and the leads to pins Nos. 2 and 6 should be reversed, taking care the right wire is taken from pin No. 2.

A further photograph of the interior of the set.



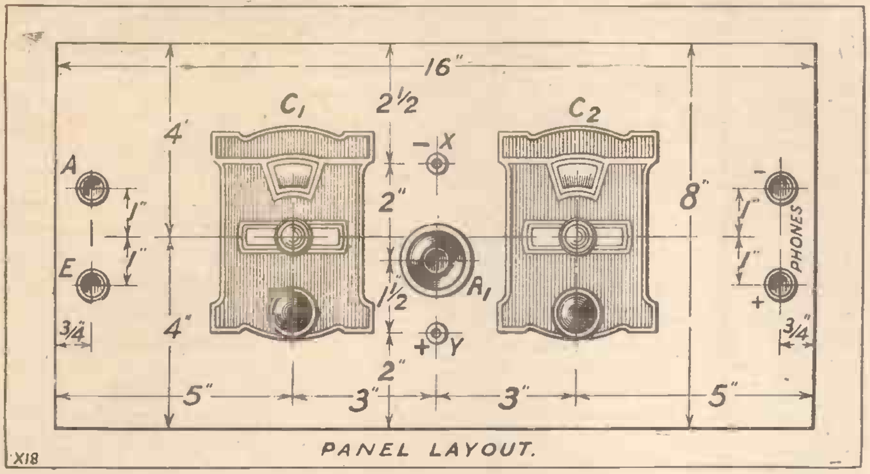
Note that the panel brackets are placed inside the two terminals at each end of the panel.

Connecting Up

The various back-of-panel photographs show those components actually incorporated in the original receiver, and though in some cases these may be departed from in favour of other makes, the values as stated in the accompanying list should be adhered to. With all the components collected together and the panel drilled in accordance with the instructions given in the drawing illustrating the layout, arrange the components upon the baseboard in such a manner as to simplify wiring. Do not seriously depart from the arrangement given, but make sure that the components chosen are placed the best way for connecting purposes before screwing them down to the baseboard. Imagine the various connections between the different components and make up your mind to as the most convenient manner in which to wire up. If the components illustrated are chosen,

THE "SILVER-TONED" TWO
—continued

then all that is necessary is to copy as nearly as possible the arrangement shown in the practical wiring diagram.



Connecting up the receiver should be carried out in conjunction with the practical wiring diagram, and so long as this is followed no difficulties are likely to arise. Particular care should be exercised with regard to wiring up the coil base, for, should one or more of these connections be taken to the wrong pins the set will not work; the pin marked 3 should be left disconnected.

Preliminary Tests

After the wiring has been carefully checked against the wiring diagram and point-to-point connections, the receiver may be tested for working. First place in position the coil and valves, turn the rheostat to its "off" position, connect an accumulator of appropriate voltage across the L.T. terminals, when, upon turning the rheostat in a clockwise direction, the valves should light up. Upon this part of the receiver proving to be wired correctly, join the two H.T. + terminals together by means of a short piece of wire, and apply the accumulator voltage across H.T. — and either of the H.T. + terminals, having first removed the accumulator from the L.T. terminals for the purpose, noting that the valves should *not* light.

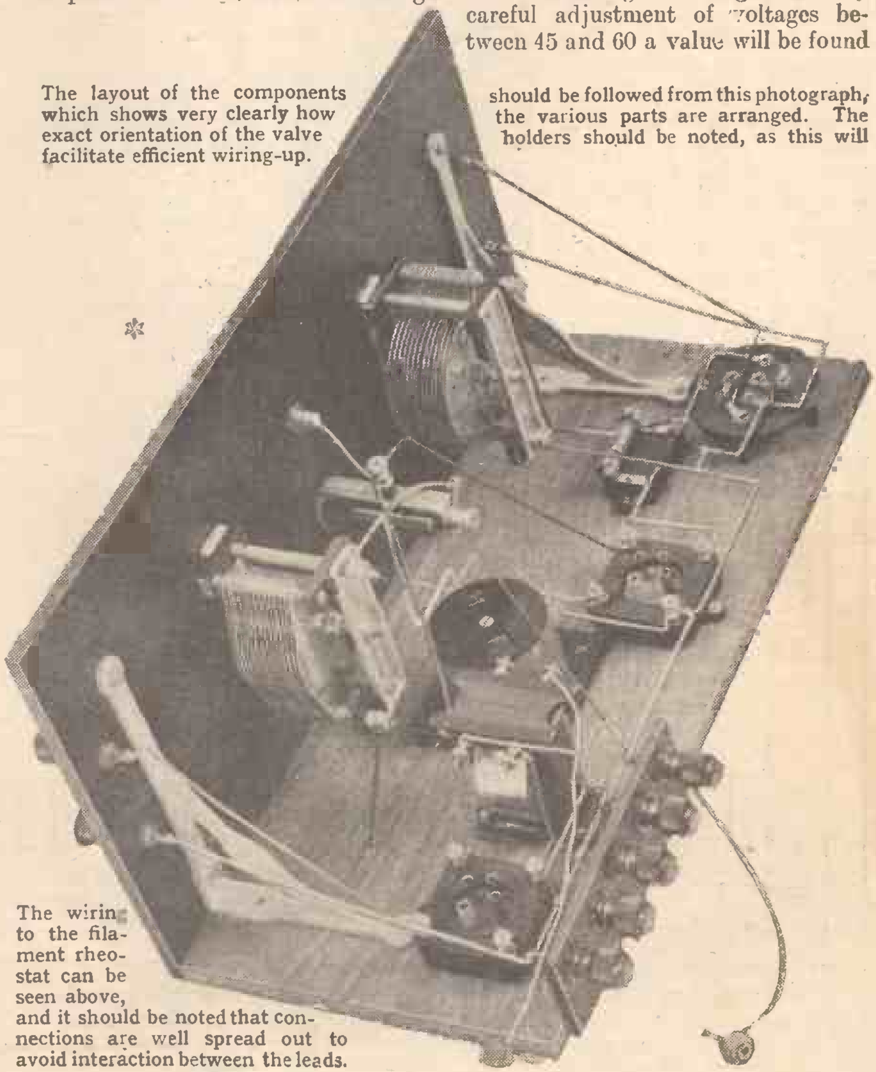
Tuning the Receiver

Assuming that everything is satisfactory, remove the shorting wire from between the two H.T. + terminals, connect the accumulator again across the L.T. terminals, and apply about 60 volts H.T. across H.T. — and H.T. + 1, and about 100–120 to H.T. + 2. If it is intended to use telephones with the set, the voltage applied to H.T. + 2 need not exceed about 75 volts; for loud speaking, however, the full 120 is recommended, in any case using suitable grid bias as indicated by the makers of the valves chosen.

At this stage connect a pair of 'phones (or a loud speaker) across the 'phone terminals, and commencing with the reaction condenser set at a zero reading and the tuning condenser at its maximum, turning the C_2 condenser so as to increase its capacity should cause the set to oscillate when about three-quarters of the dial has been turned through a given point. Should it require more condenser than this to make the set oscillate when C_1 is set at its maximum, then a few more turns should be added to the reaction winding; if the coils are properly wound and the set correctly wired, the specified 50 turns should, however, be ample.

Reaction Adjustment

It may at first be found that the reaction control is somewhat critical—that is to say, the oscillation-point is suddenly reached and indicated in the 'phones by a loud and definite "plonk." Should this be the case, then the voltage applicable to H.T.+1 should be reduced until, without loss of signal strength, the reaction control is smooth and easy. Reducing the H.T. voltage too much will, of course, also reduce signal strength, but by careful adjustment of voltages between 45 and 60 a value will be found



The layout of the components should be followed from this photograph, which shows very clearly how the various parts are arranged. The exact orientation of the valve holders should be noted, as this will facilitate efficient wiring-up.

The wiring to the filament rheostat can be seen above, and it should be noted that connections are well spread out to avoid interaction between the leads.

THE "SILVER-TONED" TWO
—continued

which gives the desired effect. After making these various adjustments again set C_2 to a zero reading, and connect the aerial and earth, whereupon turning the C_1 condenser throughout its full reading will quickly bring in the local station. With this correctly tuned, advance the C_2 condenser until the set is just off self-oscillation, when signals may be said to be at their loudest—that is, within distances of 10 miles from a main station, loud-speaker strength should be obtained.

For the reception of distant stations the operation is much the same as just given, except that the reaction condenser is kept in step, as it were, with the tuning adjustment; as the reading of the C_1 condenser is increased the value of C_2 is also increased, so as to keep the set just off self-oscillation throughout the full tuning range. In practice it will be found that the settings of C_2 hold good for a number of degrees of C_1, therefore moving C_2 each time C_1 is advanced is not always necessary. Working in this way will quickly bring in a number of foreign stations at really good strength and free from mush, while the actual tuning will be found easy and free from hand-capacity effects. When working with the set just off the point of self-oscillation as explained, it should be remembered that in the event of it being found desirable to reduce the reading of C_1 then the reading of C_2 should be reduced slightly before altering the tuning condenser, otherwise the set will be made to oscillate. Increasing the

(*Concluded on page* 658.)

WIRING INSTRUCTIONS.

Join A to 4 on coil base and E to 5.

1 of coil base to one side C_3R_2, and to fixed vanes C_1.

Other side C_3 R_2 to G on V_1.

6 of coil base to fixed vanes C_2.

F of V_1 to F of V_2, and one side R_1.

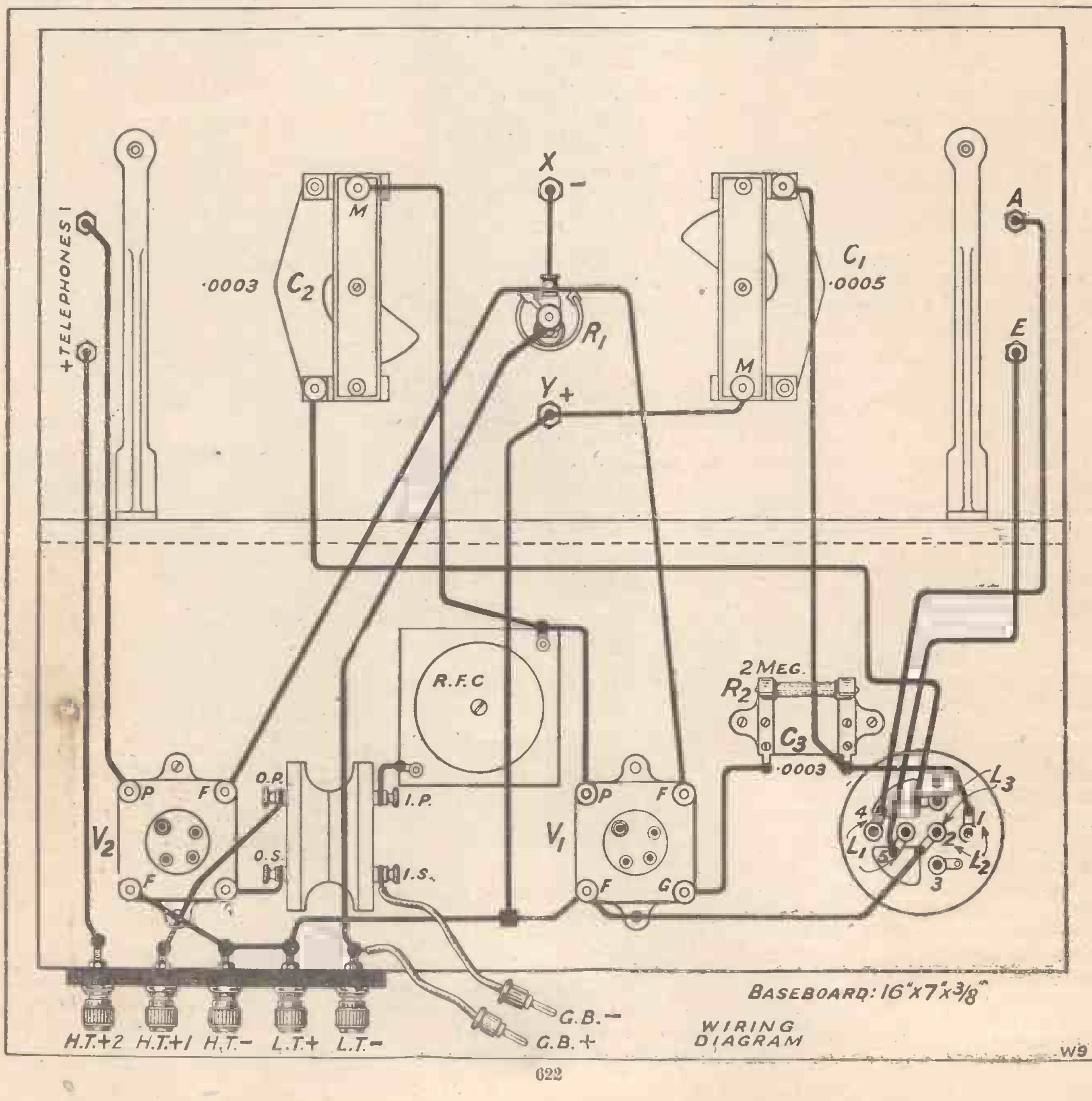
Same side R_1 to X. Other side R_1 to L.T. negative and to G.B. positive.

P of V_1 to one side R.F.C. and moving vanes C_2. Other F V_1 to other F V_2, H.T. negative, L.T.+, and 2 on coil base.

Same F V_1 to Y and moving vanes C_1.

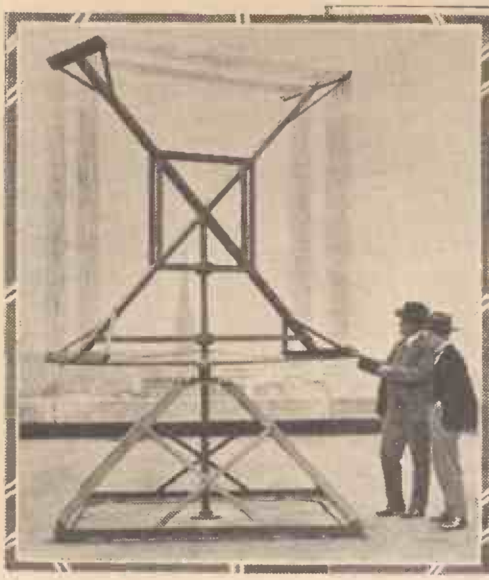
Other side R.F.C. to I.P. of L.F. transformer.

O.P. of transformer to H.T. + 1. O.S. of transformer to G of V_2. I.S. to G.B. negative. P of V_2 to one 'phone terminal. Other 'phone terminal to H.T. + 2.



WIRING DIAGRAM

W9



The Frame Aerial

A clear and straightforward explanation of the manner in which the frame aerial works, and of the reasons underlying its well-known directional properties.

By J. F. CORRIGAN, M.Sc., A.I.C.

The frame aerial forms a very important and valuable radio accessory, not only for the use of the more advanced radio amateur, but also for the purpose of commercial wireless reception. As a collector of transmitted radio energy the frame aerial is, of course, an inefficient device, as we shall see later. Nevertheless, owing to the efficient amplifying circuits with which the frame aerial may be used, and owing, also, to the marked directional properties which the latter possesses, there is no likelihood at present of the frame aerial becoming an obsolete piece of radio apparatus.

How the Frame Functions

In many ways, the frame aerial is now only just coming into its own as a collector of programmes. In many districts frame aerials are being seen more and more frequently among radio amateurs, and there is no doubt of the fact that if a frame aerial is designed along proper lines its employment will give every possible satisfaction.

Now, in attempting to explain the functioning of the frame aerial, or the working of any other piece of radio or electrical apparatus, for that matter, one has a choice of two methods. The first of these is that which we may very well term the scientific highbrow method. For instance, working on these lines we might begin by saying that the amplitude of the current flowing in a frame aerial is proportional to the phase difference, the latter being given by the expression:

$$\phi = 2\pi \frac{L \cos \theta}{\lambda}$$

which is pure undiluted Greek to the average amateur, and to many an amateur scientist, for that matter. Yet, unfortunate to relate, this tendency to introduce mathematical reasoning into popular expositions of radio principles is becoming more and more widespread (and probably in no greater instance than in so-called explanations of the functioning of the frame aerial is this the case). The result, of course, is that any man who has not gone through a long mathematical training rapidly gets into a condition of "confusion worse confounded," and finally he turns the article down with the somewhat ungentlemanly, but nevertheless perfectly justifiable expression, *Bunk!*

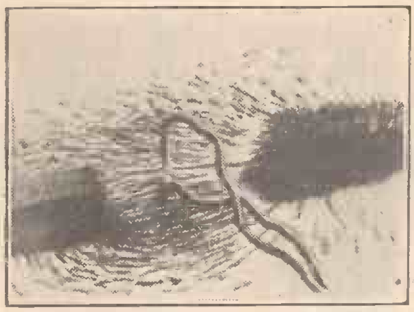


Fig. 1.—The principle of the dynamo illustrated by a loop of wire cutting magnetic lines of force between the poles of a magnet.

But I am digressing. To return to the present subject, however. In order clearly to grasp the mode of working of the frame aerial, let us first of all consider the working of a very well-known electrical instrument, to wit, the common dynamo. Reduced to its simplest principle, the dynamo consists of a coil of wire which is turned in the field of a powerful magnet. Glance at the photograph, Fig. 1, for a moment. Here we see two magnets; scattered around the pole of each is a quantity of iron filings. The filings, under the influence of the magnetic flux, take up positions which serve to indicate the presence of the magnetic field around the magnets. The photograph shows, also, a loop of wire placed between the poles of the magnets, thus intercepting some of the lines of magnetic force which pass from the pole of one magnet to the pole of the other.

An Interesting Experiment

Now, if we imagine that loop of wire to be rapidly revolved between the magnet poles, it will be obvious that the loop will speedily cut across the lines of magnetic force at right angles. The effect of this is that differences of potential are set up in the loop, and thus a current is caused to flow.

Such is the elementary working principle of the dynamo. Let us bear this explanation in mind, for it will be found to be exceedingly helpful in grasping the principle of the frame aerial.

Next, consider another phenomenon, that of electricity in motion. When a current passes through a conductor, such as a copper wire, it creates around the wire an electro-magnetic field, the strength of which depends upon the strength of the current.

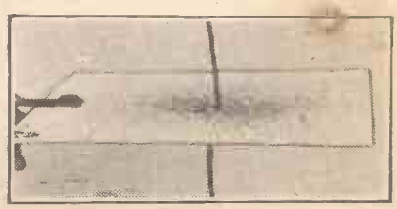


Fig. 2.—Showing the electro-magnetic field around a wire that is carrying current.

This is illustrated in the photograph, Fig. 2. Here an insulated cable carrying a fairly heavy current is pushed through a sheet of white cardboard, and a few iron filings are

THE FRAME AERIAL
—continued

scattered on to the cardboard sheet. The iron filings clearly indicate the presence of the field of magnetic influence around the wire.

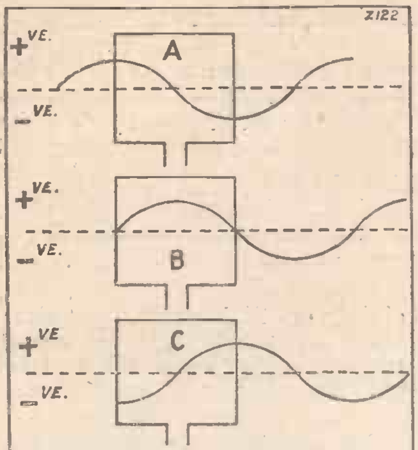


FIG. 3. EXPLAINING THE MODE OF WORKING OF THE FRAME AERIAL.

When electric waves travel outwards from the transmitting aerial of a radio station they set up pretty much the same effect. That is to say, they create a field of magnetic influence, which field expands and collapses according to the strength and intensity of the pulsations of current which are sent up into the broadcasting aerial from the transmitting gear of the station. It is this field of influence affecting the frame aerial which enables the latter instrument to perform its functions.

In the case of the dynamo previously described, the magnetic field is more or less steady, and the coil of wire moves across it. In the case of the frame aerial, the magnetic field fluctuates in intensity, and the coil or loop of wire remains stationary. But in both cases the results are fairly similar. A difference of electrical potential or pressure is set up in the

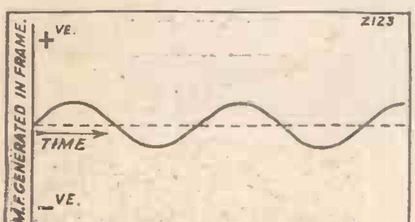


FIG. 4. SHOWING THE CURRENT FLOWING IN A FRAME AERIAL CIRCUIT UNDER THE INFLUENCE OF TRANSMITTED RADIO WAVES.

wire loops, and thus a current is developed.

Considering the case of the frame aerial still more closely, examine for a moment the diagram, Fig. 3. At A in that diagram we have a frame aerial. The transmitted wave, or, if you prefer it, the field of magnetic influence, is represented by the curved line passing across the frame. We have seen that the magnetic field or flux of a radio wave expands and collapses in sympathy with the pulsations of current in the transmitting aerial. Now, at the instant, A, shown in the diagram, the field of magnetic influence is at a maximum intensity in the one direction at the left side of the frame aerial, whilst, at the same instant, it is of maximum intensity in the other direction at the right-hand side of the frame. The consequence of this is that a difference of electric pressure is set up in the frame, and a current will tend to flow in a clockwise direction.

At the next instant, however, the wave has travelled on, and, as we see at B in the diagram, the intensity of the magnetic field is at zero at both sides of the frame. Consequently, at this instant, no current flows. At the succeeding instant of time, how-

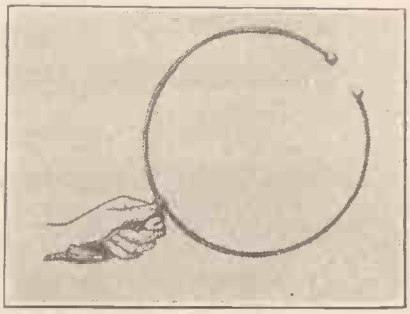


Fig. 5. The "Detector" used by Hertz.

ever, the wave has passed on another half wave-length, as depicted at C in the diagram. Here, again, the magnetic field of the wave has assumed a state of maximum intensity, and therefore a current will again flow round the frame, but in the opposite direction to the current flowing in the first diagram, A.

If, now, we plot these results on a chart, marking the strength of the current against the time, we obtain the diagram, Fig. 4, from which it will be seen that under the influence of a succession of radio waves, a fluctuating alternating current is set up in the frame aerial. This is led to the receiving apparatus for amplification and rectification.

Such is the manner in which the frame aerial picks up its radio energy. To be theoretically ideal, however, the frame must be half a wave-length in width in order that it may pick up the maximum amount of radio energy. That is to say that a frame of this ideal nature used for the reception of a 350 metre wave-length would have to be 175 metres, or something a little under 600 ft. in width, which condition, of course, is practically impossible.

Frame aerials of very much smaller dimensions have therefore to be employed, although they pick up but a fraction of the energy of an ideal frame aerial. However, owing to the efficiency of modern receiving circuits, even these inefficient frame aerials can be put to great practical use.

The Hertz Detector

Let us consider now the directional properties of the frame aerial, these being the properties for which the frame type of aerial is chiefly used. When Hertz, the German wireless pioneer, was conducting his early experiments in the 80's of last century, he used what he termed a "detector," an illustration of which is shown at Fig. 5. This consisted of an almost closed loop or circle of wire, at the ends of which were attached two small knobs. Held in the neighbourhood of a sparking coil, a minute spark was seen to pass across the knobs of the detector. But this was the case only if the detector was held in a certain position relative to the sparking coil. If held in other positions, the detector failed to detect. Here, therefore, was the embryo of the frame aerial. Hertz had devised a loop of wire which he thus showed to possess directional properties.

It was not until the publication of Round's paper on the frame aerial in 1905, and the subsequent investigations of the United States Bureau

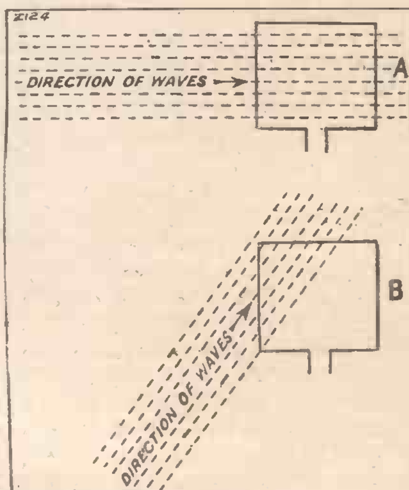


FIG. 6. EXPLAINING THE DIRECTIONAL PROPERTIES OF THE FRAME AERIAL.

of Standards about the year 1908, that the directional properties of the frame aerial were really thoroughly

(Concluded on page 661.)

Developments in Direction Finding

Some novel applications of the theory and practice of D.F. work.

From a Special Correspondent.

THE first principles of the art of direction-finding are no doubt well known to most of my readers. When, for instance, a loop aerial is arranged "end on" to the direction of the incoming signal it picks up maximum energy and gives the loudest response in the telephones.

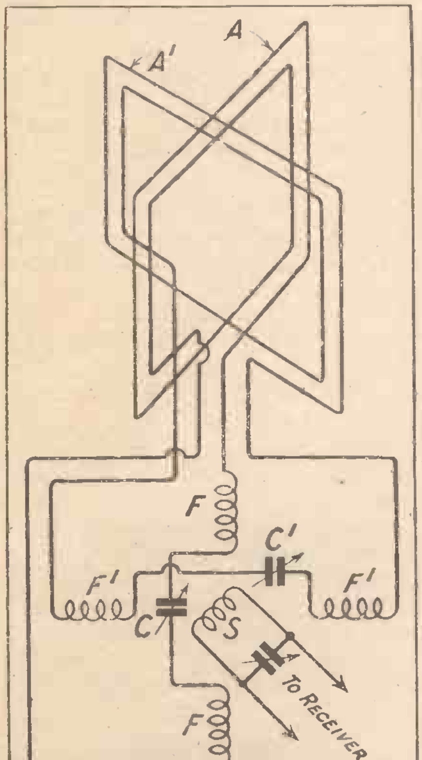


FIG. I. DIRECTION FINDER WITH FIXED LOOP AERIALS.

Conversely, when the plane of the loop is arranged so that it "faces" the transmitting station there is no effective "pick-up," and consequently no signals in the 'phones.

The reason for this behaviour can be simply explained. In the end-on position the two upright limbs of the frame aerial are displaced (by an amount depending upon the width of the frame) in the direction of travel of the received wave. They therefore intercept the wave at slightly different moments in its rise and fall, and the induced E.M.F.'s being of different values, leave a net resultant available to produce a signal in the telephones.

When the frame squarely faces the transmitting station the wave strikes both sides of the frame simultaneously. Exactly identical values of E.M.F. are induced in both of the upright limbs, and these voltages mutually balance out, leaving the telephones silent.

Directional Effect

In short, the directional effect may be said to depend upon the phase displacement of the upright limbs of the winding relative to the advancing signal wave. The received energy rises to a maximum when the vertical sides of the frame are arranged one behind the other in the line of travel of the wave, and sinks to a minimum when the wave reaches both these sides simultaneously, *i.e.* when they are both equidistant from the transmitting station.

Theoretically, therefore, the simplest form of direction-finder consists of a single frame capable of being rotated about a vertical axis. In practice, however, this simple arrangement is usually modified both for the sake of convenience and also in order to increase sensitivity.

Stationary Aerials

For instance, the larger the loop aerial is made the greater is the effective "pick-up" and the more accurate are the readings that can be taken. In this case, however, as it is impracticable to rotate large aerials bodily, an alternative method of ascertaining the maximum and minimum points becomes necessary.

For land stations, where extreme accuracy is aimed at, and where there is plenty of available room, the receiving loops are of large dimensions and are fixed in position instead of being rotatable. The currents

The receiver section of marine D.F. apparatus.

DEVELOPMENTS IN DIRECTION-FINDING
—continued

induced in each loop are then led to smaller field-coils located in the control cabin, the direction of the resultant field being ascertained by a small rotatable search-coil connected to the receiving set.

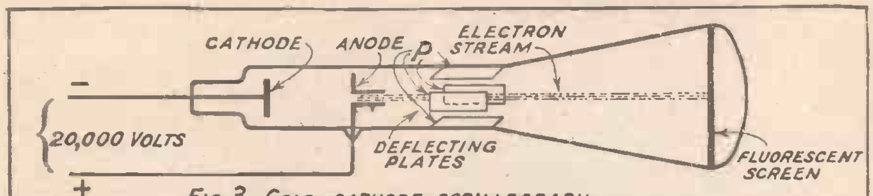


FIG 3. COLD-CATHODE OSCILLOGRAPH.

An arrangement of this kind is shown by way of example in Fig. 1. Here two large frame aerials A, A_1, are set at right angles to each other. The down-leads from each frame are taken to the operating cabin, where they are closed through the field-coils F, F_1 and tuning condensers C, C_1, as shown.

The currents induced in the aerial A produce proportional magnetic fields in the windings F, F, whilst the currents in the aerial A_1 similarly energise the windings F_1, F_1 arranged at right angles.

General Operation

The rotatable search-coil S is mounted inside the common magnetic field of the coils F, F_1, and is connected to a pointer moving over a graduated dial. As the search-coil is rotated the strength of the signals gradually varies from maximum to zero, either of which points may be taken as determining the direction of the incoming wave, according to the initial adjustments of the indicating needle.

In general the "zero-point," or position of minimum signal-strength, gives a more critical indication than the point of maximum signal intensity. This is so partly because it is easier for the human ear to distinguish between sound and silence than it is to identify the precise maximum-point in a varying swell of sound. It is also due, in part, to a mathematical cosine rule which need not be entered into in detail.

Another Method

There are, however, circumstances, as, for instance, when the D.F. set is mounted in an aeroplane, when it is not possible to utilise the sensitive "zero-point," because of the prevailing external noise. Nor is it possible upon an aeroplane to compensate for this handicap by using frame aerials of large dimensions.

Under these conditions two small frames are fixed at right angles to each other, and the arrangement is so mounted that it can be rotated bodily about a vertical axis. One frame, which is called the "searching coil," is then swung until it is pointing directly to the transmitting station.

This should, of course, give maximum signal strength in the 'phones. The second or "auxiliary" frame is then brought into play in order to enable this point of maximum signal-strength to be ascertained with more than ordinary accuracy.

If the searching coil is already pointing exactly towards the "beacon" or transmitting station, the auxiliary coil (being at right angles) will clearly be "facing" the transmitter, and in this position should be picking up no energy.

By means of a reversing switch the second coil is now brought into circuit in two ways, first to oppose and then to assist the signals already being received on the first or searching coil. If there is no perceptible difference in signal strength in either position of the reversing switch, it is obvious that the setting of the first coil must be dead accurate.

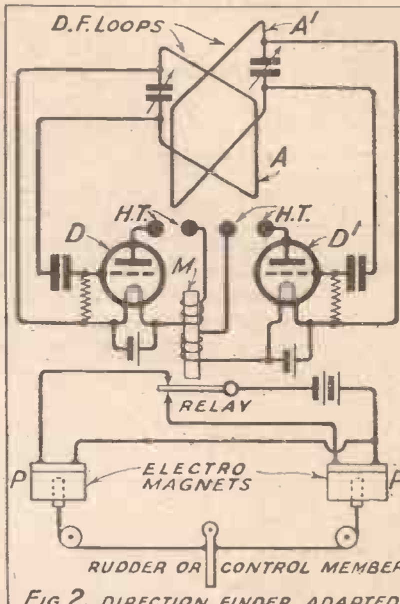


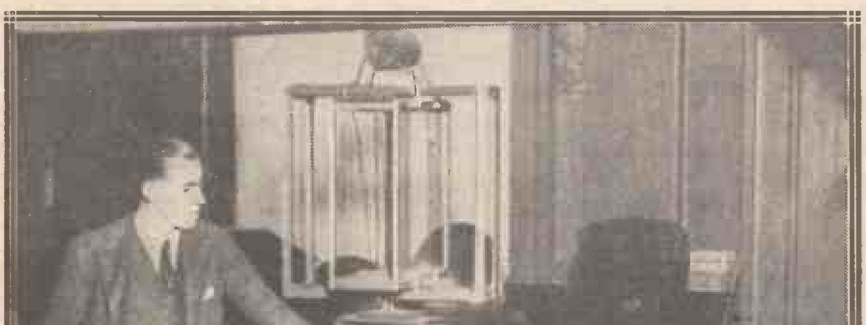
FIG. 2. DIRECTION FINDER ADAPTED FOR AUTOMATIC STEERING.

If, however, the searching coil is slightly out of the true line, then the switching-in of the second coil produces an alternate weakening and strengthening effect which can be readily detected and adjusted until a true setting is secured.

Wireless Control

From time to time accounts appear in the technical and daily press of the invention of a new aeroplane, submarine, or motor vehicle capable of being automatically controlled from a distance by means of wireless waves. In many of these cases the control is effected by utilising the underlying principles of the direction-finder.

For example, a pair of frame aerials A, A_1 may be mounted, as shown in Fig. 2, on the vehicle to be controlled, being so set relatively to a transmitting station that they both pick up equal amounts of energy.



Major Binyon, O.B.E., M.A., demonstrating his automatic direction-finder at the Institution of Electrical Engineers.

DEVELOPMENTS IN DIRECTION-FINDING

—continued

The received waves are first rectified by detector valves D, D_1, and the corresponding direct currents in the plate circuits are passed through two coils wound in opposition around a solenoid M. Under these conditions the vehicle or craft will maintain a straight course.

If it should yaw or deviate in either direction, one or other of the frame aerials will start to collect more radiation than the other. The rectified currents passing through the solenoid M will then no longer balance, so that the differential relay is made to close either its upper or lower contact. This in turn energises one of the electro-magnets P, which serves to restore the rudder automatically to its correct central position.

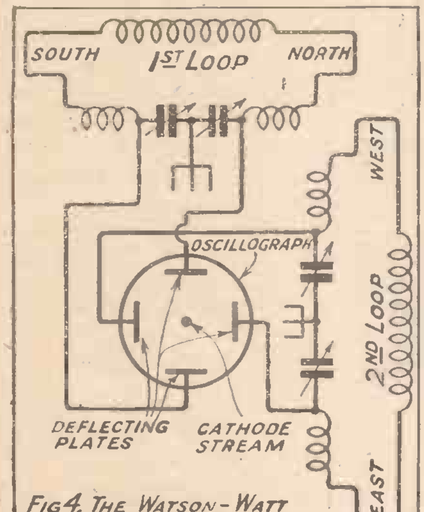


FIG 4. THE WATSON-WATT CATHODE DIRECTION FINDER.

By utilising a cathode-ray oscillograph in combination with a pair of directional aerials, Mr. R. A. Watson-Watt has recently succeeded in recording the direction of impulses lasting less than one-thousandth of a second. The apparatus is, in fact, sufficiently sensitive to determine the direction of ordinary strays or atmospherics, and has thrown valuable light upon the principal points of origin of these vagrants of the ether.

Cathode Tube Type

Cathode-ray tubes may be divided into two classes according to whether a hot or cold cathode is used as the source of the emitted electrons. The main difference between the two types lies in the voltage that is required in order to produce the desired emission.

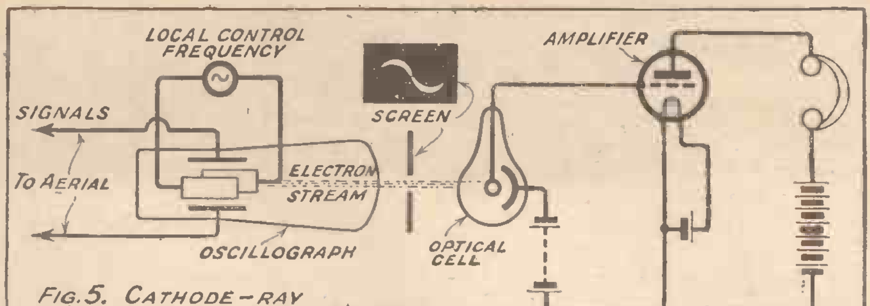


FIG. 5. CATHODE-RAY ULTRA-SELECTIVE RECEIVER

The heated-filament cathode tube is very similar in action to an ordinary two-electrode valve, a comparatively small voltage of three or four hundred volts being sufficient when applied across the anode and cathode to produce the necessary stream of electrons.

A tube of the "cold" type is shown diagrammatically in Fig. 3. It consists of a cathode, or negative electrode, and an anode. Across these electrodes a pressure of from ten to twenty thousand volts is applied. Generally, a fluorescent screen is mounted at the end of the tube furthest from the cathode.

Ingenious Device

As a result of the enormously high voltage applied across the evacuated space between the anode and cathode, a stream of electrons is sucked out, as it were, from the substance of the cathode and travels towards the anode at a very high velocity. The anode is pierced centrally, as shown, and is fitted with a short tube of extremely small bore, so that the emerging stream is concentrated into a fine pencil or ray.

As the electrons shoot through the anode on their way to the terminal screen, they are subjected to an electrostatic field from a series of deflecting plates marked P, so that instead of maintaining a straight path terminating in a single spot of light on the screen they are deflected by the plates and are drawn out to trace a sinuous curve on the screen, the precise shape of this curve being determined by the relative strengths of the charges on the plates P.

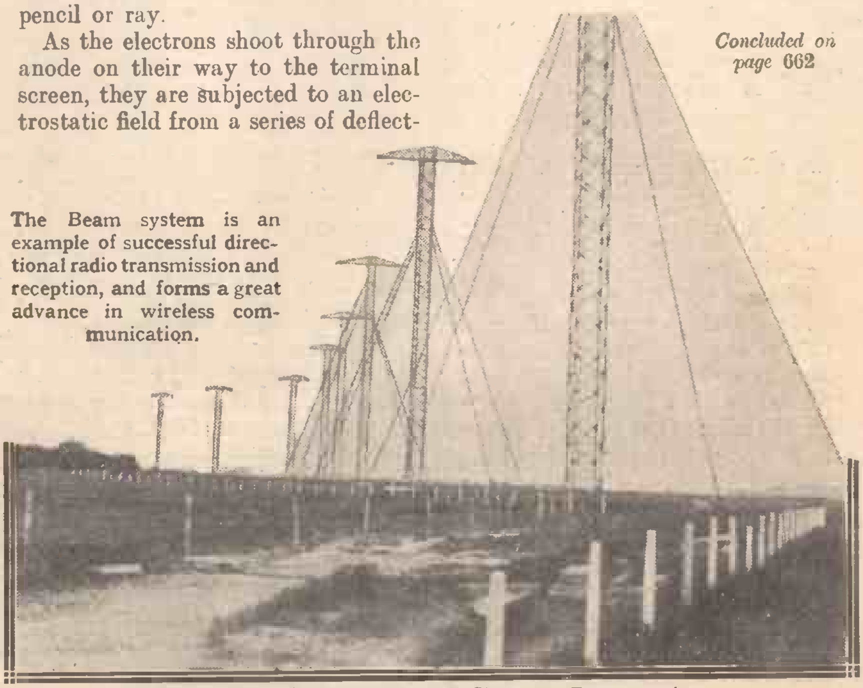
Photographic D. F.

Fig. 4 shows the method adopted by Mr. Watson-Watt in obtaining a direct visual or photographic indication of the direction of a received signal or impulse.

As previously explained, the energy picked up by each of the loop aerials will be proportional to the latter's inclination to the direction of the incoming wave. By applying the received energy directly to the deflecting plates of the cathode-ray tube, the electronic stream is deflected to a corresponding extent.

For instance, if the first loop, pointing, say, north and south, happens to be situated exactly "end on" to the incoming wave, the static field across

Concluded on page 662



The Beam system is an example of successful directional radio transmission and reception, and forms a great advance in wireless communication.

The eight aerial masts at the Skegness Beam station.

Neutralising 6-volt Valves

O. B. J. (Malvern).—"I have a 5-valve receiver having two H.F. stages and employing the split-secondary type of neutralisation. Using 2-volt valves I was able to get the set neutralised quite well, but I have recently changed over to 6-volters having similar characteristics, and these do not seem so easy to neutralise. Why is this?"

Probably the 6-volt valves do not require so much capacity to neutralise them as did the former type you were using, and the neutralising condensers if not of an extremely low minimum will prevent neutralisation from being obtained. If you find, therefore, that the more you increase the neutralisation condensers the more reaction or instability you experience, then the trouble is undoubtedly due to the cause mentioned.

To cure this you have only to increase the plate-grid capacity of the valves in order to bring it between the maximum and minimum values of the neutralising condensers. The adjustment of these latter will then allow perfect neutralisation. The additional capacity between plate and grid of the valve can be obtained either by connecting a couple of small neutralising condensers between plate and grid sockets of the valve holders and keeping the condenser at almost minimum capacity, or else by connecting two pieces of insulated wire about four inches long to the plate and grid sockets of each valve holder and twisting the pieces together. Care must be taken that the wires do not short each other or disastrous results may occur.

The Black Prince

P. S. (Brighton).—"Recently I constructed the 'Black Prince' receiver described in MODERN WIRELESS of April, but find that, while the set operates excellently, it makes no difference if the resistance R 6 (Fig. 6, page 348) is omitted, or rather shorted. Should this be the case?"

This is very often the case in such circuits. The resistance is placed in the grid circuit of the first L.F. valve in order to suppress any H.F. impulses that might get through the choke in the plate of the detector and on to the grid of the L.F. valve. Probably your choke is operating efficiently and no H.F. is getting through on to the L.F. grid. It is as well, however, to include this resistance, as it then precludes any distortion due to H.F. getting through to the L.F. stages.

Acid "Creeping"

G. W. E. (Luton).—"I use a well-known make of H.T. accumulator but am much troubled by the creeping of the acid, which causes the battery to lose its charge. What is the best method of getting over this trouble?"

Probably a thin layer of oil on the surface of the electrolyte will effect a cure and will not in any way damage the battery. A layer of about ⅛ inch of Blancol (obtainable from Prices, candle manufacturers) should be poured into each cell, and then the cells can be treated as usual. Care should be taken to keep the acid level well up in order that the oil does not foul the plates themselves. When used properly this oil is an excellent preventive of spraying and creeping and greatly retards the evaporation that so many H.T. accumulators suffer from during the warmer months.

An Eliminator Howl

M. S. (Westcliff-on-Sea).—"What is the reason for a howl in my set (having two L.F. stages following an anode-bend detector) when I use an H.T. eliminator? With ordinary H.T. batteries the set operates perfectly. The eliminator is for D.C. mains and has a well-known type of potential divider for supplying the various voltage tappings."

It is difficult to state the reason with any degree of certainty without examining the unit, but probably the potential divider is the cause of the trouble. If any coupling effect exists between the plate circuits of the valves due to the resistance (and possibly inductance) of the divider, this would cause instability. Try placing a 2-mfd. fixed condenser across each H.T. tapping, between the plus tapping and the H.T. negative connection. This will minimise the coupling effect and should eliminate the howl.

Choice of Components

P. B. (Chadwell Heath).—"I have seen it stated in constructional articles that 'other suitable components may be used in place of the makes specified.' Does that mean the results will be exactly the same?"

It means that wide variation of make can be taken advantage of, but the "type" should remain as nearly the same as possible. For instance, if a 4 : 1 ratio L.F. transformer is specified you must keep as nearly to that ratio as possible. A 2½ : 1 ratio transformer, for instance, has usually a higher impedance primary than the 4 : 1 type and so would not really be suitable as a substitute. Keep as nearly as possible to specification as regards *electrical* values and you will not go far wrong. Other "types" may work well, or they may not—it becomes largely a matter of chance when serious alterations of value and type take place.

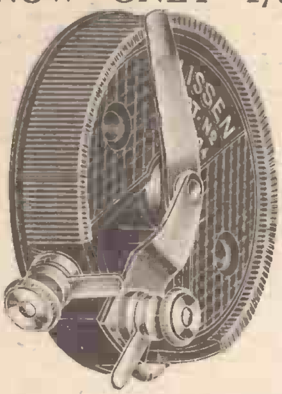
DO YOUR OWN CHOOSING

Advertising manufacturers expect their products to be used and mentioned regularly in the circuits and articles appearing in any periodical. Each manufacturer is given a turn, including LISSEN. But users have long since understood this, and know that when certain makes of radio parts are specified it does not necessarily mean that they are the best for their purpose—the corresponding LISSEN parts can be used instead with a gain in clarity and volume of signals—at no increased cost.

LISSEN parts use all the available energy and build up signals strongly. There are no losses and no leakages to be overcome in the parts themselves. The LISSEN direct-to-dealer policy of distribution cuts out big wholesale profits and passes the saving on to the users.

Do your own choosing. Compare LISSEN parts side by side with any others. If you build with LISSEN you build with a certainty of getting clearer, louder signals.

NOW ONLY 1/6



The baseboard type of LISSEN Resistor is now reduced from 2/6 to 1/6. This type has, of course, no knob, dial or pointer, but is provided with 2 holes for screwing to baseboard. 7 and 35 ohms Rheostats; 400 ohms Potentiometer, each 1/6 (previously 2/6).

QUALITY RHEOSTATS

LISSEN Panel Type Rheostats.

The wires do not loosen, the arm keeps in perfect contact, nothing ever goes wrong with this LISSEN Rheostat.

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Rheostats, 7 and 35 ohms .. .. (Previously 4/-)	2/6
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NEVER LEAK, NEVER VARY

LISSEN fixed condensers are accurate to within 5 per cent. of their marked capacities. They never leak, they never vary. You can't buy a finer condenser.

LISSEN Fixed Mica Condensers

·0001 to ·001, 1/- each (much reduced).
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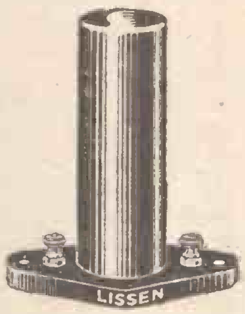
A pair of clips is included free with every grid condenser.

ANOTHER CHANGE IN FAVOUR OF THE USERS

LISSEN H.F. CHOKE

Previously 10/-



NOW 5/6

A new LISSEN H.F. Choke, made in section form, hermetically sealed so that the windings remain unaffected by atmospheric changes. A choke with high inductance value and very low self-capacity suitable for use in every case where an H.F. Choke is specified, and covering all wavelengths up to 4,000 metres, compact and neat in appearance yet with no attempt made to secure appearance at the cost of efficiency. Here is a choke which upholds the LISSEN tradition of full value to the user.

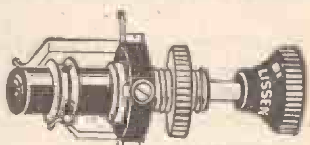
LOW LOSS, LOW CAPACITY

There is not a square inch of superfluous ebonite in this LISSEN Valve Holder. That means low capacity and low loss, and therefore stronger, clearer signals. Shown ready for baseboard mounting, but can also be used for panel mounting by bending springs straight. Patented. Previously 1/8. NOW 1/-

ABSOLUTELY SILENT

LISSEN Leaks are absolutely silent in use; their resistances never alter. This was proved some time ago by exposing them to the rain and sun on our factory roof. All resistances. Previously 1/8. NOW 1/-

LISSEN SWITCHES



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Brain Waves

The idea that the brain may act as a transmitter of radio waves is one which has gained credence for a considerable time past, and many people believe that so-called "telepathy" or "thought transference" is, in fact, carried out by a method precisely analogous to that used in wireless transmission and reception. This is why some certain individuals are "receptive" to others.

Professor Fernando Cazzamalli, of the University of Milan, Italy, has been making some public experimental tests with a wave-meter in a shielded room, as a result of which he has come to the conclusion that the wave-length of the radiations from the brain is somewhere between 4 metres and 100 metres. I do not know how these determinations were made, or what it is that causes the variation in wave-length from 4 to 100 metres, but possibly it is the size of the brain of the "transmitter"!

Nor does it seem to be clear whether a particular individual keeps to a fixed wave-length either for transmission or reception.

If the wave-length both of the "transmitter" and of the "receiver" is apt to vary from time to time, this might explain why it is that two people can only engage in thought transference on individual occasions, whilst if certain individuals happen to be more or less "tuned," and remain round or about a fixed wave-length, possibly they will be able to indulge in thought transference fairly frequently. (Such cases are, of course, well known.)

The theory put forward by Professor Cazzamalli seems a little fantastic, and is likely to be received with a certain amount of scepticism.

Radio University

The German Ministry of Education has established at Jena, in connection with the university of that city, a Radio Broadcast School which will broadcast systematic lectures in mathematics, chemistry, physics and modern languages.

A Station a Day

The number of broadcasting stations in the United States seems to be steadily increasing; if the increase continues long enough there will be more broadcasting stations than receiving stations! At the beginning of the present year there were about 670 broadcast stations licensed, whilst about 130 transmitting stations were under construction. Furthermore, 134 broadcast stations increased their transmitting power, so that there are now over 100 stations working on a power of more than 500 watts. New broadcast licences are being issued at the rate of about one per day, or approximately 365 per year.

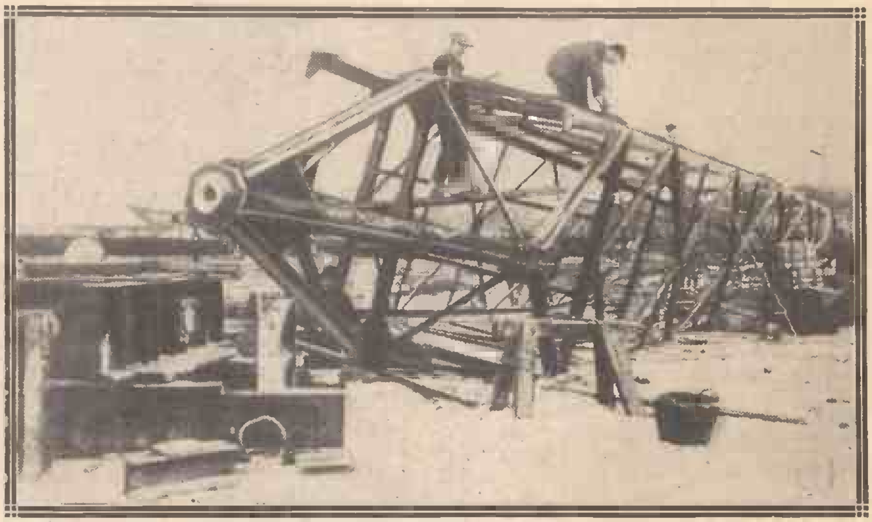
Belgian Wireless

The Belgian Government has established what is really the first national school of radio telegraphy in Europe. This is for the purpose of training operators for the Civil Service (both in Europe and on the Congo), as well as officers and non-commissioned officers of the army and air service. The Radio Telegraphy School is to be administered under the joint control of the Ministries interested, which include the railways, marine, posts and telegraphs, aviation and national defence.

D X Fans

British listeners, particularly D X fans, understand well enough the difficulty of "reaching out" when atmospheric conditions are bad, not to mention artificial interference. But the condition of things is very much worse in the United States, not only on account of the fact that artificial interference is enormously more plentiful, but also owing to the more hectic conditions provided by Nature. Consequently, research in connection with circuits and other devices for resisting or counteracting interference of all kinds has been pursued much more actively there than here.

Some of the variation in the propagation of radio waves is caused by terrestrial phenomena. A general increase in power of the broadcast stations naturally helps considerably in the reception of D X. At a given distance from a station there is now a much greater signal strength than formerly. Artificially made interference has been reduced by energetic pursuit of offenders. The number of squealing receivers has been very much reduced, but the recent international broadcast tests failed very largely on account of this particular trouble.


The giant mast at Konigswusterhausen, which was blown down during a gale.

"Ford Radio"

The Crosley Radio Corporation of Cincinnati, Ohio, which has been

RADIO ABROAD

—concluded.

described as the Ford of the radio business, has at last given its blessing and official approval to the battery eliminator. Hitherto these eliminators have been manufactured by other companies, and, of course, have been available for users of Crosley sets. But now the Crosley Corporation have come forward with their own "Radio Energy Unit," as they call it, which is produced on the mass-production system for which the Crosley Radio set is pre-eminent.

The new Crosley "Radio Energy Unit" is a very businesslike-looking job; it weighs 13 lb., and is only about half the size of an ordinary 6-volt accumulator, whilst it is claimed to operate without the slightest hum and with the certainty of an electric motor. The price is 50 dollars, or rather more than £10.

Post for Armstrong

The selection of members of the Federal Radio Commission at Washington seems to have involved a good deal of difference of opinion. It was suggested by certain senators that the Commission should consist of a professor, an expert on economics, a radio expert, and two lawyers, so that the members should have every likelihood of rising superior to political and partisan influences.

Amongst those considered for the Commission were such well-known names as John Hayes Hammond, Major E. H. Armstrong, of super-heterodyne fame, Chief Radio Supervisor W. D. Terrell, and Dr. J. H. Dellinger, chief of the radio laboratory of the Bureau of Standards.

What is the Best Wave-Length?

We have got so used in this country to broadcasting on waves between about 200 and 500 metres that we accept these wave-lengths as being most suitable without much further consideration. In the United States, however, government scientists and engineers are actively engaged in investigations as to the best possible wave-length for broadcast purposes, and a number of experts consider that a higher grade of broadcasting could be done on a band of wave-lengths between about 1,000 and 1,600 metres, whilst others consider that the best band is between 200 and 100 metres.

Dr. J. H. Taylor, chief of the Naval Research Laboratory, considers that there would be less fading between 1,000 and 1,600 metres, and this view is upheld by Dr. J. H. Dellinger and Dr. E. W. Austin, and others of the Bureau of Standards. Signal corps experts, on the other hand, are greatly in favour of the 100-to 200-metre wave-length.

Of course, once a system of broadcasting at a given wave-length has been established, it becomes a very cumbersome matter to make any great alterations. In the first place, since American receivers are designed for wave-lengths between about 200 and 600 metres, it would mean some changes in the receiving sets to render them suitable for the 1,000- to 1,600-metre band, whilst at the same time the latter band is at present used by other types of service, and it would take years to clear out the latter so that interference from them should not be experienced by the broadcast receivers.

New Zealand Moves

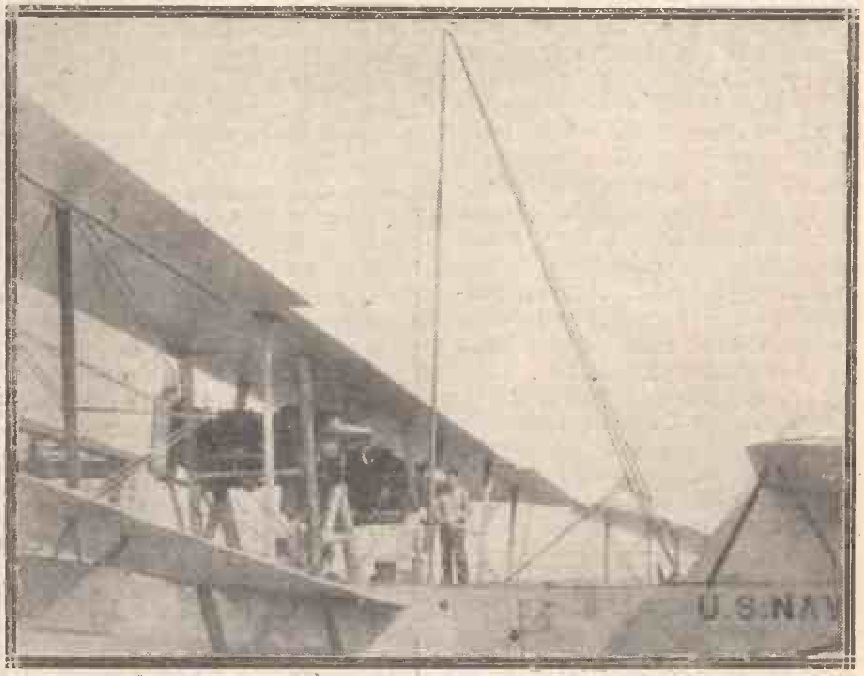
Talking about interference, New Zealand has taken very drastic steps to deal with this annoyance, and the Department of Commerce has made special regulations requiring that direct coupling to the aerial shall not be made except in the case of sets which definitely do not radiate. They have also enacted that circuits of the super-heterodyne type shall not be used with an open antenna but only with a loop, and that where magnetic reaction is employed it must be capable of smooth and ready adjustment of control.

Wired Radio

The longest "wired wireless" system in the world is believed to be that which links the 220,000-volt H.T. power lines of the Pacific Gas and Electric Company for a distance of 202 miles. A 1,000-watt transmitter is used for the purpose of coupling with the power wires by an 1,800-foot aerial. The system is used solely for communication between the power house at Pit River, and the Vaca-Dixon sub-station. Special oscillating microphones are used for calling the operators.

Radio in Australia

The number of receiving sets in Australia has increased during the past year by 100 per cent; the number of listeners now being considerably over 100,000. In order to reduce the danger of a breakdown in the programmes from 2 F C, one of the principal Australian stations, special auxiliary plant is being installed, driven by internal-combustion engines. A new 5,000-watt station, 2 B L, has, of course, been inaugurated at Sydney. In Canada there are now 67 broadcast stations, 29 of these being in the province of Ontario. According to the regulations governing broadcasting in Canada, only one station is allowed to operate at a time in a particular town or city, which, of course, curtails the number of stations operating throughout the country at any time, and greatly minimises interference.



This U.S. naval seaplane has a 30-ft. aerial, and crystal-controlled transmitter.

FIBRE PANELS

An article of interest to the constructor.

FROM A CORRESPONDENT.

EVERY radio man will be familiar with the cheap radio panels which are to be obtained nowadays, panels which feel like cardboard, and which when sharply tapped with the knuckles emit a "dead" sound, just as a stiff sheet of cardboard would. Material such as this is generally looked down upon by amateurs. Because it is cheap, the average radio constructor generally thinks that it is entirely useless. This idea is quite a mistaken one, however, and for purely temporary and experimental use panels of this material can prove to be quite serviceable.

Material of this nature is generally greyish-black in appearance, although it can be had in almost any colour. The material, known as "ebonised" or "vulcanised" fibre, really consists of a large number of sheets of high-grade brown paper which have been treated with a stiffening and parchmentising chemical, such as formalin or zinc chloride, and have subsequently been compressed together in a hydraulic press. The chemical stiffening agent is then dissolved out of the compressed material, the latter being then coloured and dried.

Peculiar Construction

If we examine a panel of this material under an ordinary hand lens it will be found to exhibit the appearance depicted in the photograph, Fig. 1. An examination of that illustration will show the cardboard-like nature of the material. Fig. 3, also, depicts a characteristic property of this material—that is, its behaviour on being roughly broken. Here we see the true structure of the material, and the laminated formation of the panel.

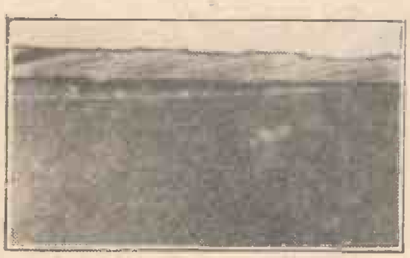


Fig. 1. The appearance of a fibre panel surface under an ordinary magnifying glass.

It may perhaps be a matter of surprise to some amateurs to know that fibre panels, *provided they are kept dry*, have excellent insulating properties.

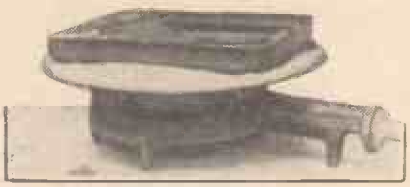


Fig. 2. Impregnating a fibre panel with paraffin wax.

Fibre panels are mechanically strong, and, surprisingly enough, they do not show any great tendency to warp. This ebonised fibre material, unlike ebonite, is not brittle. In fact, a sheet of the material may be thrown on the floor without any harm being done to it. Sheets of ebonised fibre are easily and cleanly drilled. Some care must be taken in sawing through them, however, in order to avoid giving the sawn pieces jagged edges. Nevertheless, with a sharp saw clean cuts are readily made.

Another good quality about panels of this material is their resistance to heat. Ebonised fibre panels will stand up to any amount of local heating incidental to soldering operations without showing any ill effects.

In order to impart the maximum degree of insulation to fibre panels it is best to give them a paraffin treatment before assembling the components on them. First of all, drill all the necessary holes for the mounting of the components, and square up the panel in the usual manner. Next, obtain the lid of a biscuit tin, and place the drilled panel in this. An iron tray is placed over an ordinary gas ring, and a moderate layer of sand is scattered over it. The biscuit-tin lid containing the panel rests on the sand, and a few pieces of paraffin wax are placed in the tin lid.

The gas is then lit, and in a short time the paraffin wax will melt. At this stage of the proceedings, turn down the gas until a very small flame is obtained. This will be just sufficient to keep the paraffin wax in a molten condition. The whole operation is a perfectly safe one, provided the process is attended to continually, and if the gas flame is kept low no objectional fumes will be emitted from the molten wax.

The photograph, Fig. 2, illustrates two strips of ebonised fibre undergoing this treatment. The fibre panel should be allowed to remain in the molten wax for about half an hour, or even longer, if time permits, after which the panel should be removed from the wax. Much of the surplus wax may be removed from the panel while it is yet molten by the vigorous application of a duster, any small amount of wax remaining on the surface of the panel after it has cooled being removed by a blunt knife and a final vigorous rubbing with a soft cloth.

Good Insulation

Fibre panels treated in this manner will retain their insulative properties for a year at least, owing to the fact that the paraffin which has penetrated them will prevent their absorption of atmospheric moisture. Of course, if a panel of this material is only required for a week or two's use, it is hardly worth going to the trouble of giving it this paraffin treatment.

Fig. 3. A fibre panel roughly broken to show its laminated structure.

My Broadcasting Diary

Under this heading month by month our Broadcasting Correspondent will record the news of the progress of the British Broadcasting Corporation, and will comment on the policies in force at B.B.C. headquarters.

Those Seasonable Programmes

THE old B.B.C. had rather a habit of holding out glowing promises of "summery programmes," which somehow were never quite realised. Thus listeners may be forgiven a degree of scepticism with the appearance of the usual forecasts of "light summer radio fare." But this year there is something more concrete to report. The new permanent concert party recently formed at Savoy Hill will appear regularly throughout the summer months. Mr. Geoffrey Gwyther is in charge. Others concerned are Donald Calthrop, Carmen Hill, Rex Evans, and Ethel Baird. Incidentally, the return of Donald Calthrop to the microphone has been generally welcomed. It was a pity, however, that he put no new material into his sketch, "Yours of the Fifth to Hand," with which he signalised his return.

This summer there are to be several Brighton Nights, as well as programmes from Margate, Blackpool, and other holiday resorts.

The Southern Command Tattoo

Military tattoos have a great vogue by radio. It is good news, therefore, that the Southern Command Military Tattoo will be relayed from Tidworth on several occasions between July 30th and August 4th. Running commentaries of the various events will be included in this broadcast. The Aldershot Command Tattoo so successfully broadcast last year is not to be repeated this year or probably ever again. Hitherto there has been no question of payment for this broadcast feature. This year, however, the Aldershot people demanded a fee. £75 was offered. This would have increased the expense bill of the B.B.C. to something like £125—admittedly the limit to which the programme value would justify the Savoy Hill people in going. But the Aldershot Command would have nothing to do with such a low offer, and negotiations terminated. It is unlikely that the Aldershot Command will get a chance of another broadcast for some years to come.

The Milch Cow Danger

The progress of broadcasting is beset with many dangers, internal and external. Not the least of these is the tendency on the part of sections of the Press and public to look upon the B.B.C. as a heaven-sent agency for restoring the shattered finance of all the artistic ventures which are failing either through lack of direct support or through inefficient handling. First there was the B.N.O.C., which was perhaps over-generously rewarded by the old B.B.C. Then there was Covent Garden. Then came Queen's Hall, the Shakespeare Memorial Theatre. And then, curiously enough, Mr. Charles Gulliver asks a subvention of £10,000 a year for his own private profit-making music-hall syndicate. Other enterprises are following suit. The

The transmitting room of the new New York broadcasting station W G L. This station is transmitting on a wave-length of 442 metres.

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MY BROADCASTING DIARY
—continued

theatres are thinking of a subsidy from broadcasting. One organisation of churches has tabled a resolution to the same effect. Numerous benevolent associations and organisations apply to Savoy Hill, confident of substantial relief.

It is peculiarly fortunate that the money-bags at Savoy Hill are closely watched by a canny if idealistic Scot in the person of Sir John Reith, who is fully alive to the fact that the money derived from licence revenue may be expended only to the advantage of listeners, or in other words, must be devoted either directly or indirectly to programme building. There is no room whatever for subsidising inefficiency. On the other hand, the selfish interests of the broadcasting service probably are served by a judicious financial patronage of the arts. The line between productive and unproductive expenditure under this general heading must be drawn quite arbitrarily and without regard to possible misinterpretation. It is all very well for ponderous leader-writers to challenge the statesmanship of Savoy Hill to evolve synthetical policies, when these are merely euphemisms for subsidies of inefficiency. Savoy Hill must go on making programmes and improving them with every penny that can be squeezed out of the Post Office. There is some little danger of Parliamentary pressure being brought to bear upon the B.B.C. in this matter of subsidising. Interested groups always find spokesmen in the House of Commons. All the more reason, therefore, why listeners should be vigilant.

The King and Broadcasting

Since the recent visit by the King to the factory of H.M.V. Gramophones there has been some Press comment on why His Majesty should have been advised to go to Hayes before he visited Savoy Hill. I can state on the best authority that there was no slight on broadcasting in this visit. The B.B.C. are not yet ready for a visit from the Royal Family. Perhaps it is not generally known that His Majesty has studied the microphone carefully, and there are few amateur broadcasters with equal understanding of the secrets of the miraculous little instrument.

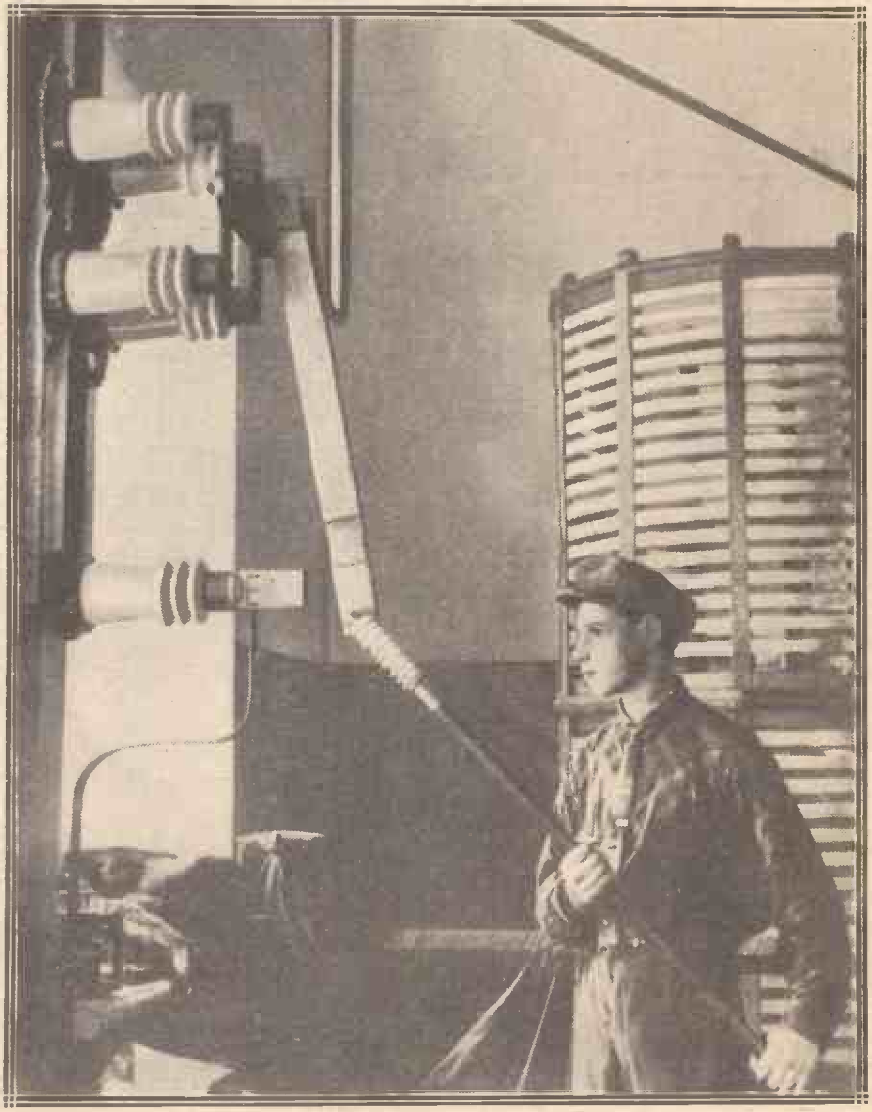
De Groot Again

An unexpected development has taken place in the relations between De Groot and the Piccadilly Hotel with the B.B.C. Readers of MODERN WIRELESS will recall that some months ago "war" broke out between these parties. The occasion was the renewal of the annual arrangement for De Groot's broadcasting. The latter held out for substantial payment; but the B.B.C. declined to offer better terms than they gave to Sandler at Eastbourne, that is, the provision of a first-class vocalist at each of the concerts broadcast. In the result, the name of De Groot disappeared from the programmes. Now the Piccadilly Hotel have revived the issue. It would appear that the hotel management are anxious to see the De Groot broadcasts resumed. It is understood that Savoy Hill has intimated its willingness to take up the negotiations at the point where they were broken off by the De Groot ultimatum some time ago. The reported change in the attitude of the hotel authorities is significant of the publicity value of relays of this kind. De Groot was undoubtedly very popular with many listeners, and the B.B.C. will be glad to have him back on reasonable terms.

The Elgar Celebration

The announcement that the B.B.C. is to celebrate the 70th birthday of Elgar with a studio production on Thursday, June 2nd, provides an echo of the debacle of the Albert Hall proposal in the same connection. The B.B.C. had been anxious to sponsor some great national gesture in honour of the birthday of the famous British composer. Mr. Percy Pitt, acting for the Savoy Hill authorities, secured the active co-operation of Sir Landon Ronald. The latter provisionally booked the Albert Hall for an Elgar Festival extending over several

(*Concluded on page* 654).



The aerial lead-in at the new Russian 40-kw. broadcasting station, the "Great Komintern."

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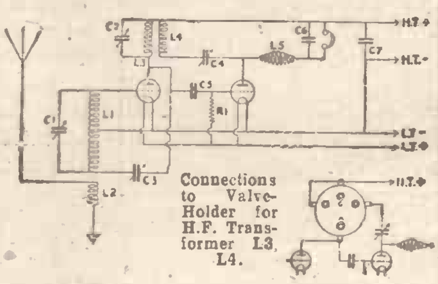

L1. Dimic Coil.
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In Our Test Room

The "Lotus" Remote Control

It is becoming more and more the practice among those listeners who can afford to do so. to wire up their houses with extension leads running to numbers of rooms. And when the set is situated at one point and feeds several loud speakers at distant points some sort of "remote control" becomes almost a necessity. Quite a number of excellent methods have been brought forward, but we must admit that one recently introduced by Messrs. Garnett, Whiteley & Co., Ltd., of "Lotus" components fame, appeals to us as being one of the most completely satisfactory solutions to the problem.

The "Lotus" Remote Control Relay.

This is what it will enable one to do. A complete outfit is obtainable consisting of cable, relay, wall-sockets and loud-speaker plugs. Any number of sockets can be mounted in various rooms, and the small relay (illustrated herewith) wired up to any ordinary receiving set. The first loud-speaker plug inserted in any one of the sockets switches on the set, while the set is automatically switched off when the last loud speaker is disconnected by withdrawing its plug from its wall-socket.

No extra battery is needed, and the main filament current does not have to run all round the extension leads. And the usual transformer or choke-condenser loud-speaker by-pass schemes can be used, as the relay is not connected to the output points in any way.

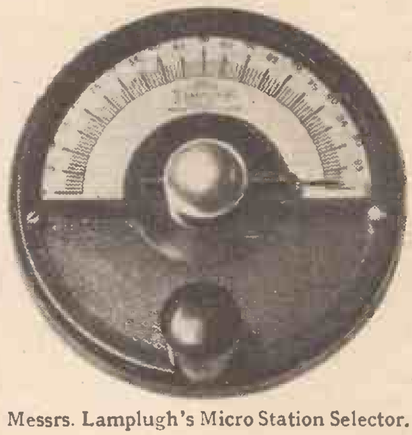
We tested the scheme very thoroughly, and could find no fault whatever with it. We tried it with abnormally long extension leads, and on a receiver carrying the abnormally large filament current (for these days) of 2·5 amperes. We switched that set off and on dozens of times, and there was not the slightest hitch.

A complete outfit for two rooms costs 30s., and this includes 21 yards of wire. Extra rooms can be catered for at an additional 7s. 6d. each complete. We can certainly recommend the "Lotus" Remote Control to the attention of our readers. It is one of those things which help to make radio really enjoyable.

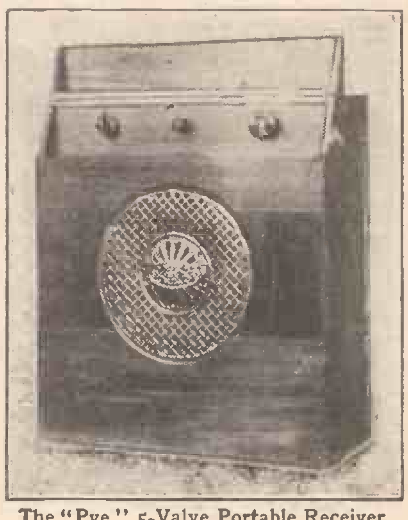
An Efficient "Vernier" Dial

We recently received a Micro Station Selector from Messrs. S. A. Lamplugh, Ltd., King's Road, Tyseley, Birmingham. It is a fine-tuning dial of an efficient nature, suitable for attachment to either variable condensers or variometers. For some time it was handled by the Cleartron Co., but Messrs. Lamplugh point out that it was always made by and produced under their patents. In future the marketing of the device, too, will be in the hands of Messrs. Lamplugh.

It is a very nice dial and has a smooth movement of a definite nature. The gear ratio is about 13 : 1. The pointer has a knife edge and this permits very close readings to be taken. As will be seen by the photograph above, this Lamplugh Micro Station Selector has a distinctive appearance and would enhance the attractiveness of any panel layout.



Messrs. Lamplugh's Micro Station Selector.



The "Pye" 5-Valve Portable Receiver.

The "Pye" Portable Set

There are really two classes of portable sets, viz. the completely self-contained type which embodies aerial, batteries, loud speaker, and everything else necessary for its operation within the one main structure, and the portable which is really a group of portable units. In the first category comes the Pye 5-valve portable receiver. It is a compact affair embodying the whole outfit in one case. But there is no space wasted and the set is of quite moderate dimensions, although—and this is a very commendable feature—the loud

(Continued on page 642.)

The Science of Listening

How do we hear? This arresting article begins where most "explanations" leave off. It introduces the *personal* factor.

By Professor D. FRASER-HARRIS, M.D., D.Sc., B.Sc. (Lond.), F.R.S.E.

THE human, vital element in wireless telephony is in a sense as wonderful as the process of the wireless transmission itself. For what have we in listening to any intelligible series of words but more transformations, transformations from sounds to thoughts?

Consider for a moment the number of transformations involved in the entire process of wireless telephony. We have first of all the thoughts or ideas in the mind of the person transmitting; these are translated into spoken words whose physical essence is the vibrations of the air; these vibrations actuating the microphone become electric waves which travel in the ether.

The Reverse Process

Now begins the reverse process; the vibrations in the ether actuate the thermionic valves in circuit with our headphones, with the result that the diaphragm of our telephone vibrates. These vibrations give rise to sound vibrations in the air (words), which in their turn actuate the living membrane of the drumhead of the ear, and these the fluid inside the internal ear, which finally stimulates the organs of the nerve of hearing. Impulses ascend this nerve and, reaching the brain, are interpreted as ideas—the words are comprehended. Ideas in the mind of the speaker, even after that long series of transformations, produce ideas in the mind of the hearer. At present we are considering only the reception end of this series of changes.

Vibrations in the ether, vibrations of the telephone plate, vibrations of the air, of a living membrane, of a liquid, nerve impulses, thoughts—such are the six distinct transformations between the ether and our mental activity or consciousness.

Varied Media

Now the media of these vibrations are all different; ether, metal, air, a membrane, some fluid, nerve-fibres and nerve-cells.

In any one medium the vibrations have a potentiality for becoming something else. Thus the ethereal vibrations are potentially vibrations of metal, the vibrations of metal are potentially sound (air-waves), the air-waves are potentially vibrations of membrane, these potentially are nerve-impulses, and the nerve-impulses are potentially brain activity, which finally is potentially thought. Therefore ethereal vibrations are potentially thought!

The rapidity of these transformations is, of course, one of the most characteristic things about them, but that is not the feature interesting us just now. What interests us at the moment is the non-resemblance between the activity of any one medium and that of the next. Thus a thought, a state of consciousness, is totally different from any brain activity. The vibrations of the drumhead of the ear are quite unlike the impulses in the nerve of hearing; they have, in fact, nothing in common except that they are both disturbances propagated in a medium.

R.A.F. wireless operators listening to aircraft. Note the earth-mat unrolled to the left of the picture.

THE SCIENCE OF LISTENING

—concluded

Perhaps a more familiar example might be useful here. Take the case of seeing and of the visual apparatus.

Waves of light falling on the retina inside the eye are focused there as an inverted image of the object that transmitted them. This image is as real a modification of the chemical substance of the rods and cones of the retina as the "negative" is of the chemical substance of the photographic plate. But this image has nothing in common with light. The next transformation is that nerve-impulses ascend the nerve of the vision (optic nerve); these rhythmic disturbances of the molecules of the nerve are totally different from the activity in the chemical substance in the retina. The impulses in the optic nerve are next transformed into cellular activity in the centre for vision in the brain. We know very little indeed about the physics of the activity of a nerve-centre beyond that it is accompanied by a change of electric potential. Finally, the seeing of an object has nothing in common with the activity of the centre for seeing, with the nerve-impulses, or with the active state of the retina.

Potential Interlinkage

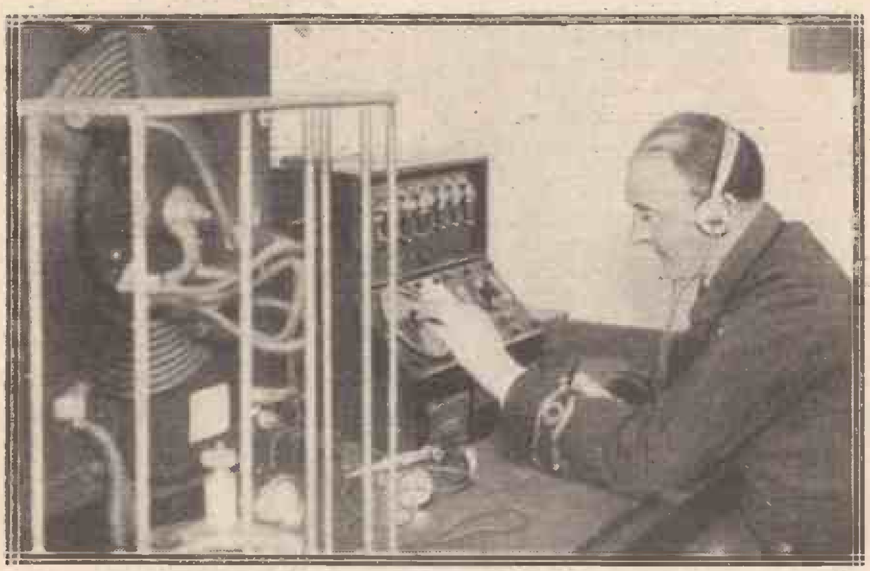
Put quite shortly, a state of brain and a state of consciousness have nothing in common, and yet the former has all the potentiality of the latter.

We say we "see" a thing, but what produces the nerve-impulses is the real minute image of that object on the retina, and even of this we are not conscious, for all our seeing is done in the darkness of the interior of the skull.

Returning to our wireless transmission; the states of consciousness of the sounds of music or of the speaker's voice have nothing in common with the nerve-impulses, with the vibrations of the drum-head—far less with the vibrations in the ether itself.

Basis of Fatigue

Although we know very little about the physics of the active state in the brain, we know a little about its chemistry. It seems that prolonged activity of a nerve centre, a brain centre, is associated with a development of an acid reaction, the chemical basis of fatigue. Prolonged activity of the brain centres inevitably leads to fatigue. Fatigue in a receptive brain centre is what we call sensory fatigue.



Operating a Marconi direction-finder on board ship.

The seat of sensory fatigue is essentially and pre-eminently in the central nervous system and not in the end-organs. The end-organ is the physiologist's name for the microscopic organs in the ear and eye (to name no others) which receive the sound-waves and the light, respectively, and which act as transformers to give rise to nerve-impulses.

Now true fatigue of the end-organ is extremely rare. To fatigue the eye, that is the retina, is in reality very difficult of accomplishment. It *can* be done by gazing at the sun or for a long time at the intense glare from snow, but it results in serious damage to the retina, and in the latter case is called snow-blindness.

Fatigue of the central organ—the brain centre—is on the other hand a familiar occurrence.

This brain fatigue will come on the more rapidly according as the activity of the centre is (a) the more prolonged; (b) the more intense; and (c) the less interesting.

Clearly the longer we have to listen to music or to talking, the greater will be the degree of brain fatigue. Here time is the main factor, and thus it is that the B.B.C. arrange for talks on special subjects not to exceed about a quarter of an hour.

The more intense the activity of the brain or, in psychological language, the greater the concentration of attention, the sooner will fatigue come on.

Naturally the more indistinct the transmission and the greater the number and loudness of the extraneous noises, the greater the degree of attention required on the part of the listener.

Choosing Suitable Programmes

All those conditions, then, tend to produce sensory fatigue which, it must be confessed, those responsible for the programmes at the B.B.C. are never responsible for inducing.

But on the other hand one psycho-physiological condition, namely interest, is altogether in the direction of minimising fatigue. The more interested we are in what we are doing, even though that be only the passive reception of impressions, as in the present instance, the less liable are we to be fatigued.

When we pass beyond mere interest to the sphere of emotion, we encounter once more a factor which is distinctly fatigue-producing. Whether the emotion be one of approbation, or disapprobation, of irritation or of indignation, fatigue tends to be induced. From all we can gather, the B.B.C. is exceedingly careful to eliminate everything controversial or that might offend or irritate.

Lastly, as regards the physiology of reception we have the case of persons who are very ill or very nervous. Doubtless it would be well not to submit these people to news or to any other sort of communication calculated to distress or injuriously affect them.

It is possible to eliminate so thoroughly that nothing striking or original is left, and it is possible to consider the idiosyncracies of some hearers so extensively that only a jejune utterance remains.

IN OUR TEST ROOM

—continued from page 638

speaker is an Amplion of a respectable size.

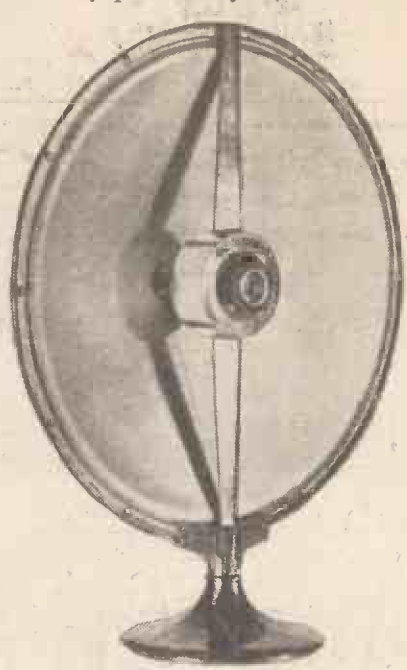
As will be seen by the accompanying photograph, a small panel contains the three simple controls. One is a switch, the centre position of which switches off the set, while in one direction it brings in four valves and moved in the other it brings in the five valves. The right-hand control is a simple wave-length adjustment, and that in the centre a volume control. This last is not a reaction adjustment, but merely a variable resistance which provides a smooth control of the strength of reproduction.

The back of the case opens to provide access to the valves and batteries. A fabric cover is provided to slip over the whole outfit. This Pye portable is designed to tune in Daventry only anywhere within about 300 miles of that station and, as Daventry is on in the mornings as well as during the normal hours of broadcasting, it will be agreed that its usefulness is by no means impaired by this limitation.

The set is extremely simple to handle. There is no necessity to fiddle about with the controls, as none of them is at all critical. The receiver can be carried about while it is in operation, and although it has directional properties these are not so acute that the set is awkward or difficult to place. We had the receiver going in our London offices, which are situated in a building containing a great deal of iron in its structure. Nevertheless, Daventry came in at full strength with but little interference from the lifts, 'phones, electric railways, etc., disposed all around.

The Aerial Switch Protector which is dealt with in a subsequent page.

In the open country the set will be



The "Sferavox" Loud Speaker.

even better appreciated, for there was no "background," and the purity of reproduction was outstandingly good for a portable. Another feature, which was hinted at above, is the stability of the set. Despite its sensitivity it is perfectly stable under all conditions.

Undoubtedly, this "Pye" is an excellent proposition and at the price of £30 12s. 6d. is good value for money. It takes a small accumulator, and this, with the low-consumption valves supplied, will run for many hours per charge. It is a set that the least technical of listeners should find to be reliable and satisfactory in all respects.

The "Sferavox" Loud Speaker

We recently had a very attractive loud speaker on test. It is known as the "Sferavox," and was sent us by a firm of that name whose address is 130, Fenchurch Street, E.C.3. It is of the disc type, although the disc is sufficiently conical for it to be styled a "Cone." The disc is formed of a stiff fabric upon which a metal is deposited. It successfully resists atmospheric changes and should retain its qualities unimpaired practically indefinitely. The disc is silvery and blends well with the bright nickel plating of all the metallic parts. As will be seen from the accompanying photograph the disc is driven by a rod projecting from a magnetic unit which is provided with an adjustment.

The outstanding feature of the "Sferavox" appears to be its sensitivity; it is one of the most sensitive speakers we have tested. It can handle quite large inputs as well without distress. It brings out fairly low notes without a sacrifice in the high frequencies, and although it is resonant at one or two periods these are placed at points where they do not appear to be frequently run into.

Attached either to sets having transformer-coupled amplifiers or to those including R. C. coupling the "Sferavox" projects a very faithful reproduction of both speech and music. It handles voices and strings especially well and, if every one made is as good as the one submitted for test, we have no hesitation in saying that the "Sferavox" is a really good speaker. Readers contemplating the purchase of such an instrument should find it interesting to hear one in operation on a good set. The price of the "Sferavox" is £2 10s.

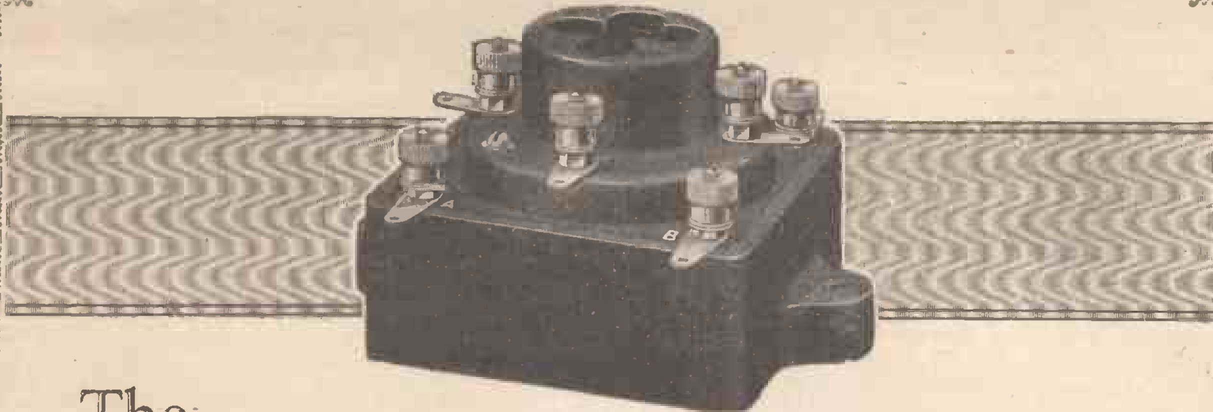
"Atlas" Double-Tapped Coils

Messrs. H. Clarke & Co. (M/c.), Ltd., of Manchester, it will be remembered, recently produced a centre-tapped "Atlas" plug-in coil. This firm has

The "Atlas" Double-Tapped Coil.

now introduced two similar coils, each provided with two tappings. A No. 60 has tappings at its 7th and 12th turns, and sells at 5s. 6d., and a No. 250 (for Daventry and other stations of a similar high wave-length) is tapped at its 28th and 50th turns, and retails at 7s. 6d. These coils are each provided with two terminals situated on their inner diameters.

(Concluded on page 651.)



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COUPLING UNIT

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P75

An Interesting Crystal Experiment

A special article describing some interesting experiments with selenium detectors.
By F. JACQUET.

SOMEHOW or other, numbers of radio experimenters have got it into their heads that the element selenium is a very expensive substance, and therefore that any experimental work with this curious material is quite out of the reckoning on account of its cost. This, however, is quite a fallacy.

Selenium at the present day, costs two shillings per ounce, which is certainly not more than the price of an ounce of good radio crystals of the galena variety. Still further, half an ounce of fused selenium is an amply sufficient amount to perform a dozen or two detector experiments with, and by this statement I hope I have dispelled the idea that selenium, like radium, is quite an unattainable commodity, so far as the average amateur goes. Incidentally, perhaps I had better add that selenium, either in the fused condition or in the form of powder, can be obtained readily from any large firm of manufacturing chemists or chemical laboratory suppliers, of which a number are usually to be found in almost every big town in the country.

Fused Selenium

So much, therefore, for the practical economics of selenium experiments. Every keen amateur would do well to procure a small quantity of this useful and in many ways remarkable material, for, as the reader may probably be aware, many experiments in the construction of light-sensitive cells may be carried out with it, in addition to the purely radio detector experiments which I am about to describe.

Fused selenium is a glassy-looking brownish solid which often possesses a peculiar greenish lustre. A photograph of the material, showing its characteristic appearance, will be seen at Fig. 1. Now, in many respects, selenium very closely resembles sulphur. Like the latter element, it is easily melted, and, in a similar manner to molten sulphur, the melted selenium gives off pungent fumes which easily break into flame. Sulphur, as every crystal experimenter is aware, is totally non-rectifying in its properties. So, also, is selenium.

A Radio-Sensitive Compound

Now, if we take sulphur and lead or copper and heat the two up together we eventually obtain a crystal-like solid, a portion of which shows very intense rectifying properties. This experiment of heating sulphur in a tin can together with lead turnings in order to prepare an artificial form of galena is well known.

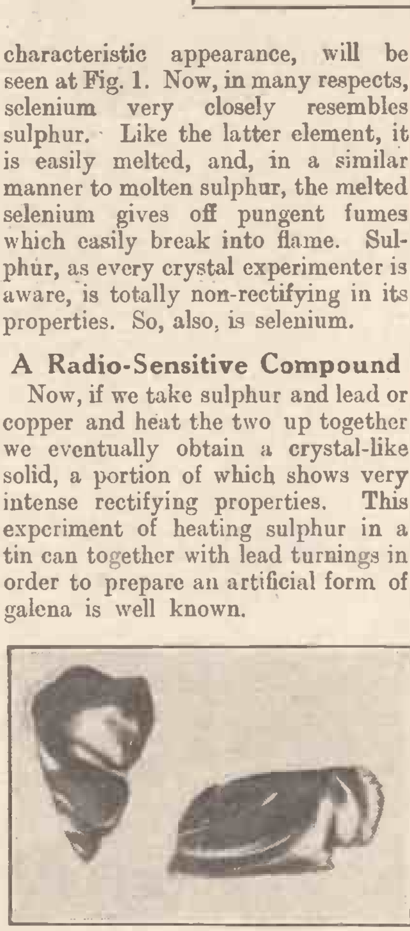

Fig. 1. The characteristic appearance of selenium is well portrayed above.

Since sulphur and lead combine together to form material of more or less strongly rectifying properties it occurred to me some time ago that there should be no real reason why selenium and lead should not do likewise. Accordingly, therefore, I entered upon a few experiments on the subject. Some of these experiments, I admit, were disappointing; but, on the other hand, others were eminently successful, and I am therefore describing them for the benefit of the crystal enthusiast and experimenter who has exhausted the possibilities of the present conventional types of crystals, and, like the noble warrior of old, sighs for fresh worlds to conquer.

When sulphur and a metal combine together they form a *sulphide*. Similarly, also, the interaction of selenium and a metal results in the formation of a *selenide*. Now, a very large number of the present-day rectifying crystals are in reality metallic sulphides, and when metallic sulphides are artificially prepared, in many cases they evince good detecting properties. Artificial selenides show similar properties, as we shall now see.

Lead turnings heated up with sulphur ultimately result in a blue-grey porous mass of crystalline structure which, as every crystal amateur knows, is generally strongly rectifying in nature. This mass is, of course, impure lead sulphide. If, however, we prepare lead selenide in the same way, that is by heating up selenium with lead turnings, the resulting product, although it is radio-sensitive to some extent, is not of any practical value, and therefore experiments of this nature are not worth indulging in.

Easily Prepared

Copper selenide, and still more, copper sulpho-selenides, are strongly radio-sensitive, however, and as they are prepared with the greatest of ease, the details concerning these substances will no doubt be of interest to the reader.

Copper selenide for rectifying purposes is best prepared in the form of a thin deposit on a rod of copper. Take a length of No. 16 or 14 bare copper wire, and after rubbing it with sandpaper in order to make it perfectly bright, cut the length of wire up into small pieces of about three or four inches in length. Now take a small fragment of selenium about the

AN INTERESTING CRYSTAL EXPERIMENT

—Concluded

size of a pea, place this in an old thimble and heat the thimble and its contents over a candle flame, the thimble being held in the flame by means of a wire handle attached to it, as indicated in the illustration, Fig. 2, or else with the aid of a small pair of pliers. When the selenium has thoroughly melted, take one of the copper rods, and dip the end of it into the molten selenium, holding it there for two or three minutes. After the elapse of this time, withdraw the rod, and then run it through the candle flame a few times in order to burn off the surplus selenium. The rod will now be tipped with a blackish deposit of copper selenide, and will be ready for use as a rectifier.

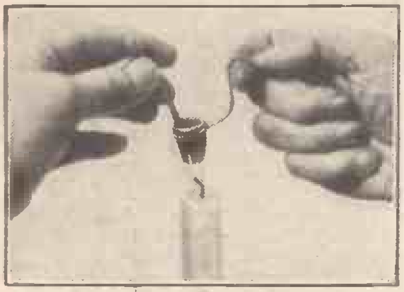

Fig. 2. Preparing the selenium.

A number of rods should be prepared in this manner, as some will be found to be more sensitive than others. The rods are then arranged in the detector and are made to form the adjustable part of the crystal contact. In passing, it should be noted that the rods should not have pointed ends. Their ends should be perfectly blunt like the ones illustrated in the photograph, Fig. 3.

Having prepared a number of these contacts, let us now see with what crystals they may be used. One of these rods, employed in contact with galena, although it gives excellent reception, demands a very critical adjustment of contact, and, therefore, for average practical purposes it is certainly not ideal. In contact with a silicon crystal the reception obtained is characterised by an extreme tonal purity.

Pure Reproduction

Crystal enthusiasts who employ a stage of L.F. amplification cannot do better than experiment with a copper selenide-silicon contact of this nature, for the purity of reception afforded is even better than that obtained from an iron-pyrites-steel contact, which crystal combination, as is well known, is productive of exceedingly good tonal purity of reception.

A copper selenide rod used in conjunction with a zincite or artificial zincite crystal makes a good and stable rectifier. Its contact pressure is not at all critical, and it will work at relatively heavy pressures. What is more, after it has once been carefully adjusted, it will retain its sensitive adjustment for weeks on end.

Sensitive Rectifiers

It is well known, of course, that copper rods which have been treated with molten sulphur in the above manner, and have thus been given a coating of copper sulphide, will form very good rectifiers. The one disadvantage of these articles, however, lies in the fact that the sensitive coating tends to flake off after a time, and, in a similar manner, this disadvantage is present also in the case of rods prepared with a coating of copper selenide.

If, however, the copper rods are dipped into a mixture of two parts of sulphur (by weight) and one part of selenium, the resultant sensitive coating will have a much less tendency to flake off. The sensitive coating formed on such rods will consist of a mixture of copper sulphide and copper selenide, or, according to some authorities, it will consist of a single compound—copper sulpho-selenide.

Now, if anything, these copper sulpho-selenide rods are even more sensitive than rods coated with copper sulphide or copper selenide alone. They give good results when used with almost any type of crystal, their contact pressures are not at all critical, and they will rectify over long periods without requiring adjustment.

Further Possibilities

There is, in fact, a good field for the experimenter in the preparation of selenium rectifying compounds. For instance, used in conjunction with a small fragment of metallic bismuth, a rod coated with copper selenide or copper sulpho-selenide makes a most sensitive rectifier, although its contact pressure needs careful adjustment.

Another field of experiment for the amateur lies in the preparation and investigation of the sensitive properties of other metallic selenides. For instance, it would easily be possible to heat up a few iron filings with a small quantity of selenium, and to determine the sensitive properties of the resulting mass of iron selenide. But, so far as I am aware, experiments on these lines have never seriously been undertaken.

Then, again, odd fragments of tellurium from old detectors could be carefully melted with a little selenium, and the sensitivity of the resulting product tried out with various sorts of crystals. There are, in fact, literally hundreds of interesting experiments waiting to be made on these lines. And, for the greater part, experiments of this nature will have to be made by enthusiastic amateurs, for the majority of professional scientists have long since ceased to interest themselves in radio-crystal work, and have given their attention to other forms of rectification on account of the obvious commercial superiority of these latter devices.

Effect of Light

An interesting possibility concerning these selenium rectifiers lies in the increasing of their sensitive powers by the action of light. It is well known that seleniumit self is light-sensitive, and that it changes in resistance under the influence of light and darkness. Amateurs in various parts of the world have reported from time to time the getting of more sensitive results from a crystal contact when a strong light was focused on it. There is just a possibility of this sort of thing happening in the case of selenide contacts, and naturally any amateur who could demonstrate such a fact would have placed himself on a very important line of investigation. Of course, such a thing may not happen, but I just mention it on account of its possibility.

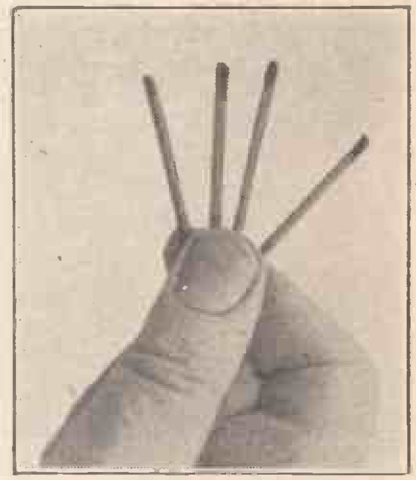

Fig. 3. Four of the special contacts for use with selenium detectors.

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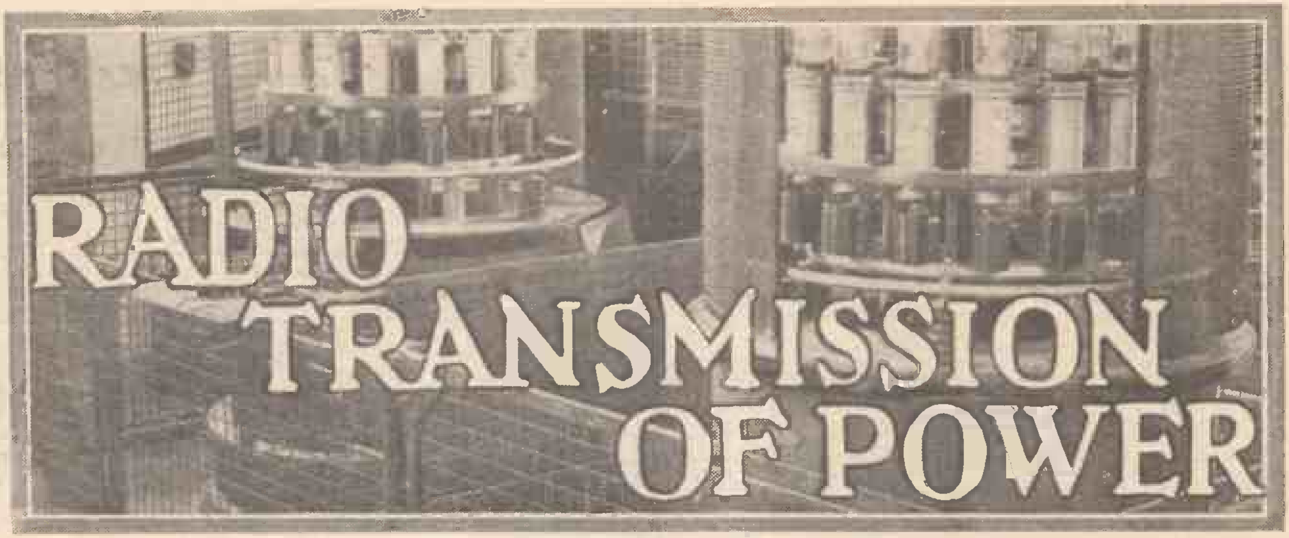

RADIO TRANSMISSION OF POWER

"Whatever has been effected for convenience or elegance, while it was yet unknown, was believed impossible; and therefore would never have been attempted, had not some, more daring than the rest, adventured to bid defiance to prejudice and censure."

A presentation of a fascinating problem given in a straightforward manner, together with details of some interesting experiments that can be carried out by every constructor.

By R. GOODE,

THUS Dr. Johnson, the wise old sage of Fleet Street, writing in the now far distant eighteenth century. But this great literary man might have written those lines of his only yesterday, for hardly any greater truism has ever been uttered. If, ten years ago, you had described the present broadcasting system to almost any individual, you would have been laughed to scorn; or perhaps, if your listener had been a little more sympathetically inclined, he would, no doubt, have directed inquiries to your admiring relatives as to the state of your bodily and mental health.

A Future Possibility

Very much the same sort of thing goes on nowadays. There are people who scoff at television, even when such an invention is rapidly being made a practical success. And as for the problem of transmitting actual power by wireless—well, there are many excellent individuals who would immediately dub you an enthusiastic old idiot if you happened to suggest the possibility of such a feat to them.

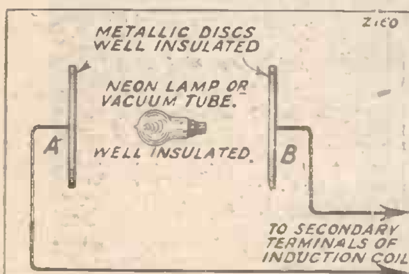

FIG. 1. THE CIRCUIT FOR THE RADIO POWER TRANSMISSION EXPERIMENTS DESCRIBED.

Although the radio transmission of power is not yet an accomplished fact—that is to say, accomplished so far as the commercial utilisation of the scheme is concerned—there is every evidence at hand pointing to the fact that within a measurable time the world's varying systems of power transmission will be revolutionised by the introduction of radio power transmission. Such a belief has been stated by Senatore Marconi, and by other less eminent men.

An early photograph of Dr. Nikola Tesla, who has carried out advanced experiments in the transmission of power by wireless.

Great Benefits

Suppose we consider the question of radio power transmission for a moment, and endeavour to appreciate the many great benefits which it will confer upon the industrial world. Under present conditions it is necessary to transmit all electrical power by land-line or cable. The enormous energy of a waterfall may supply sufficient electric current to light and heat a dozen towns; but, nevertheless, before that electrical power can be usefully applied it must be conveyed to the towns concerned by an intricate and expensive system of cables. On the other hand, if the radio transmission of power were an accomplished fact, all these cable-conveying systems would be almost entirely abolished.

Losses Eliminated

Loss of power due to resistance effects would be eliminated, and many of the world's natural sources of energy, which are at present lying untapped owing to the enormous expense of wiring them up to the necessary areas of civilisation, would be applied in order to work the wheels of industry. In a word, an efficient system of radio power transmission would be synonymous with a universally abundant supply of electrical energy, and at a comparatively low cost.

Radio power transmission would almost certainly bring into being mechanically-propelled vehicles which, instead of obtaining their supply of motive power from coal or oil fuels, would directly utilise the energy supplied to them by radio means

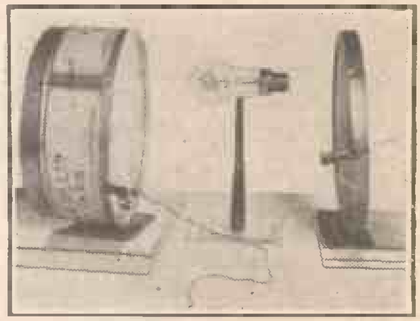

Fig. 2. A simple "hook-up" of the circuit shown in Fig. 1.

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RADIO TRANSMISSION OF POWER
—continued

from a central generating and transmitting station.

Such are a few aspects of the question, and the problem is an important one because of the fact that the world's natural reserves of coal and oil are certainly not unlimited. Civilisation demands an abundant supply of energy in one form or another. At the present time most of this energy is derived from coal and oil. Thus the reader will be well able to imagine what would happen to humanity if its coal and oil resources gave out under the present conditions of scientific knowledge. Civilisation, under those circumstances, would fade away immediately, like the note of a saxophone after the player has ceased to blow into his instrument.

Most Important

It is for reasons such as the above that I venture to suggest that the problem of radio power transmission is a far more important and vital one than any problem connected with television. Recognising these facts, many scientists are at present occupied with experiments into the problem of efficiently transmitting power by wireless. Naturally, the problem is a severe one to tackle, but it is not an insuperable one.

Let us deal with some of the technical aspects of the problem in a brief manner. Strictly speaking, the radio transmission of power is, and has been for some years, quite

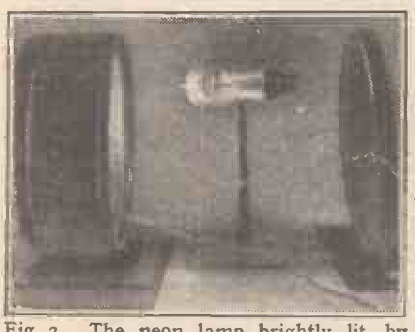


Fig. 3. The neon lamp brightly lit by radio transmitted energy.

a practical feat. A radio transmitting station transmits electrical energy during its working hours. It is the transmitted power of the broadcasting station which actuates the headphone diaphragms in a crystal receiver.

However, the amount of power which can be transmitted and effectively received in this manner is extremely small. For instance, an ordinary B.B.C. station flings out into space from its aerial an enormous amount of electrical energy. Nevertheless, a wireless receiver situated at a distance of one mile away from a broadcasting station of average power, and working at its utmost efficiency, picks up something like 1-150,000th of a *fly power*.

Remove the receiver to a distance of fifty miles from the transmitter,

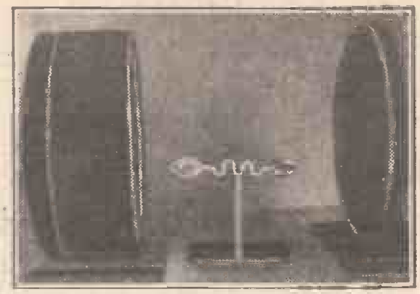


Fig. 4. A small ornamental vacuum tube illuminated by means of a strong H.F. field.

and you will have an idea of the infinitesimal amount of energy which is utilised by the receiving apparatus under those conditions. Thus, although strictly speaking a modern broadcasting station does transmit radio power, such a transmitting system is utterly useless for the conveying of electrical power in bulk.

Early Experiments

One of the first individuals to attempt to solve the problem of radio power transmission was Dr. Nikola Tesla, a scientist who is well known for his many startling and advanced electrical researches. Tesla conducted his researches about twenty years ago, and in certain respects, he met with a good deal of success. For instance, this investigator after a little patient experiment was able to light electric lamps situated at distances of hundreds of feet away from the energy-transmitting source.

It is in this direction that the amateur will be able to conduct many successful and spectacular experiments in radio power transmission, and with the minimum of apparatus. For these experiments, which I now propose to describe, the only technical apparatus necessary is an "induction" or spark coil giving a spark of one or two inches in length.

A two-inch spark coil is better to use, but nevertheless, results which are quite successful can be obtained by the use of a one-inch spark coil — a piece of electrical apparatus which, incidentally, may nowadays be obtained for only a few shillings from firms concerned with the marketing of Government surplus stock.

A Simple Example

To continue, however. Tesla succeeded in transmitting "wirelessly" sufficient electrical power to light a filament lamp by making use of a circuit designed on lines similar to the one shown at Fig. 1. In this circuit, which has been re-designed and modified for the sake of amateur experiments, we have two metal plates or discs situated at a distance of about two feet from each other. The discs rest on a thoroughly insulative basis. They are connected to the secondary terminals of the spark coil, and between them is placed a neon lamp, or small vacuum tube, which is also well insulated from the ground.

The photograph, Fig. 2, shows a crude but entirely successful "hook-up" of this circuit. A cake tin and its lid, resting on several glass sheets form the discs A and B of the circuit, Fig. 1; the secondary terminals of the spark coil being connected to these

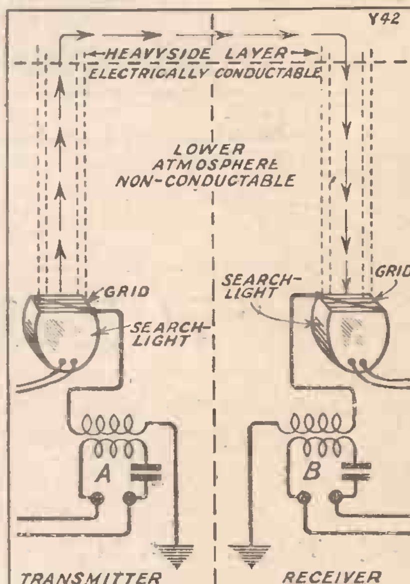
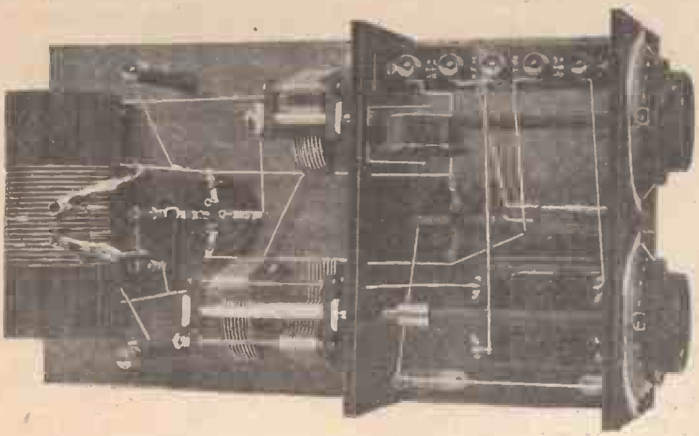


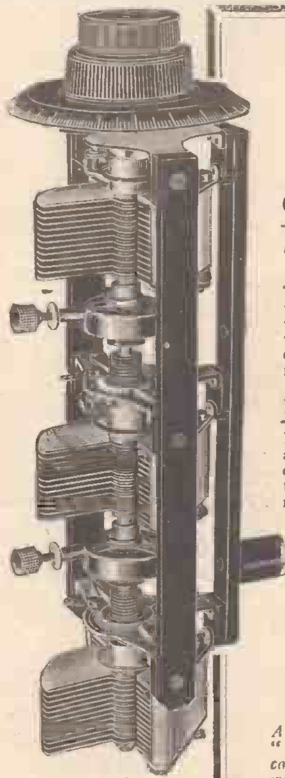
FIG. 5. DIAGRAM OF PROPOSED SYSTEM OF RADIO POWER TRANSMISSION.

discs. Between the discs, and totally unconnected to them, is placed an ordinary neon lamp, mounted on the top of a stick of sealing wax, the latter being placed on a sheet of glass in order to preserve effective insulation.

On passing a current into the spark coil from a local battery or accumulator, the insulated neon lamp will glow vividly with a very peculiar dirty-orange colouration. Here, therefore, is a successful experiment which any amateur can make in the

(Concluded on page 656)





THE "B.B.C." FIVE

—concluded from page 570

critical and 3–4½ volts gives good results. This, of course, is a matter for experiment, and the voltage will depend upon the H.T. value and the type of valve used.

For the first L.F. stage a valve of the D.E.5 or P.M.6 type can be used, and in the last two sockets suitable power valves. Owing to the high anode voltage employed it is probable that two valves of the L.S.5, L.S.5A, or B.11 type will be used. Valves of the D.E.5 A type are not designed for such high plate voltages, but if one is prepared to sacrifice part of their useful life this type can be employed. For those who wish to use the receiver for moderate outputs, one valve can be used in the last socket. The use of a plate milliammeter is desirable, since it enables the anode current to be kept within the limits of the current-carrying capacity of the output choke, and, in addition, the steadiness of the needle is an indication of the quality.

The grid battery can be one of the usual tapped dry-cell type and should have a value of between 20 and 50 volts, depending upon the valves used. The non-inductive variable resistance forms a convenient control of oscillation and volume. Both the H.F. and detector valves must be kept well away from the edge of self-oscillation and the minimum reaction coupling should be employed. It is probable that the two flex leads to the moving coil holder will need reversing, and this should be tried if any difficulty is found in obtaining a proper reaction "build-up." When the series aerial condensers are used, a larger aerial coil will probably be necessary, and this is, of course, a matter for experiment.

Daventry Coils

The H.T. voltages to the H.F. and detector valves will be about 100 volts for maximum results, but other values may be tried.

For Daventry the aerial coil (assuming no series condenser to be used) may be a No. 150 or Gambrell "E1." The H.F. tuning inductance can be a No. 250 or Gambrell "E," and a small coil such as a Gambrell "A," or No. 60 plug-in coil, should be used for reaction.

The receiver was not designed for long-distance reception, but rather for pure and powerful loud speaking from the local station. It is suitable for use with loud speakers of the moving-coil type, and it can also be used with "Kone" and similar instruments capable of reproducing the bass notes. It is difficult to predict the probable range, since so much depends upon the type of aerial employed and upon local conditions. At 15 miles from 2 L O, and roughly 100 miles from Daventry, powerful loud speaking is possible.

Hilversum can be received at quite good loud-speaker strength on a "Kone."

The coils used in this case were a Gambrell "D" in the aerial, and an "E1" in the fixed socket of the two-coil holder, with an "A" for reaction. Radio-Paris can also be received, using the Daventry coils, but in some districts a certain amount of difficulty may be found in separating these two stations. The constructor may wish to try a valve with an amplification factor not exceeding 20 in the first L.F. position. Whether the use of such a valve will impair quality is a matter for trial, but, in general, too high a magnification should not be attempted.

The Modern "Ultra" Crystal Set

—concluded from page 578

whatever you do, avoid bending these tag contacts, for they break quite easily. I broke one of mine, and I do not think I am particularly "ham-handed." I had to solder a small loop of wire to the end of the lead and hold this down under the screw. It was a nasty little operation.

Another point. The connections to the M.H. switch are rather confusing. If two centre contacts switched over to two pairs of outside contacts it would be so much easier to avoid a mistake. However, once wired up successfully, the M.H. is an efficient, smooth-working switch of a most robust, reliable character.

The wiring completed and the whole set cleaned up, panel transfers affixed, if used, the panel can be screwed down to the case. Some of you will no doubt make the case, but I do not think it is necessary to detail the construction of this, for it is an elementary piece of carpentry and any sort of wood can be used. But don't forget, you timber craftsmen, that the case must be at least 4½ in. deep in order to accommodate the large coil. It would be safer to make it 4¾ in. in case the coil exceeds the specified dimensions slightly.

When the M.H. switch is pulled out the normal broadcasting band will be available, and when it is pushed in the large coil is in circuit for 5 X X. If the set does not work right away and your aerial and earth are good and you are not dozens of miles from a station, then you should first of all suspect the crystal detector; after this the wiring, which you should check carefully, and finally the switch. You can test this last with a small lamp and battery in order to ensure that the contacts are making circuit with their correct points.

But don't let us anticipate a failure. If the construction has been carried out moderately carefully there should be no risk of that.

MY BROADCASTING DIARY

—concluded from page 636

concerts. Mr. Cochran was willing to let Sir Landon have the hall for the purpose at special rates; but he would not extend the same terms to anything with which the B.B.C. was associated. The ensuing controversy involved some hard sayings in the Press. Then Sir Edward Elgar definitely declined to have anything to do with the festival, and formally repudiated it. So the proposal fell through, and the B.B.C. were left to fall back on a studio production. This will be S.B. on June 2nd, and will occupy the whole of the evening both from 7.45 to 9 and from 9.35 to 10.35. Sir Edward has been prevailed on to conduct in person. There is naturally much disappointment among music-lovers that the more elaborate plan failed. This incident marks another stage in the hostilities between Mr. Cochran and the B.B.C. Relations are increasingly embittered, and piquant developments are bound to emerge from time to time. A member of the management of the Albert Hall is reported as having said that a movement was growing to exclude the B.B.C. just as it is excluded from the Queen's Hall. But I should doubt if Mr. Cochran would allow private animosity to interfere with good business.

I understand that important developments may shortly be expected from negotiations in hand between the B.B.C. and the film industry.

RADIO TRANSMISSION OF POWER

—*concluded from page 650.*

domain of wireless power transmission. The glowing neon lamp is shown in the photograph, Fig. 3, whilst an ordinary ornamental vacuum tube is shown glowing brightly under similar conditions in Fig. 4.

Tesla's Scheme

The whole effect, of course, is due to the fact that a powerful electrostatic field is set up between the two metal plates, and the surging electrostatic field between these energises the gas in the tubes sufficiently to make it glow.

Many small-scale experiments in this form of wireless lighting can be made. In fact, Tesla has endeavoured to carry out such experiments on a large-scale basis. In brief, his idea was that if a huge elevated disc could be charged at a sufficiently high electric potential with regard to the earth, a series of specially constructed vacuum tubes, placed around the walls of rooms within the power transmitting area, would glow continuously.

The scheme is an interesting one, but it has the one disadvantage in that it would be extremely expensive to provide sufficient electrical energy at the transmitting station. Moreover, as in the case of ordinary wireless broadcasting, the bulk of the electrical energy transmitted in this manner is lost.

Another Method

Another power-transmitting scheme which was mooted some time ago is the one due to certain English and French investigators. This is based on the fact that when a beam of intense white light (which, as my readers will probably be aware, contains a large percentage of ultra-violet rays) is allowed to travel through air, the air in the path of the beam becomes electrically conductable in nature.

Now, according to modern theories, the upper layers of the earth's atmosphere, containing air in a rarefied state, are electrically conductable, these high-altitude regions comprising the well-known "Heaviside Layer." The earth itself is more or less electrically conductable, and, therefore, it is merely separated from the upper conducting layers of air by a layer of dense air, about fifteen miles thick, which is non-conductable.

In the suggested scheme for radio power transmission, the transmitting and the receiving apparatus would both be so constructed that they were each able to throw an intense beam of light in an upward direction for a distance of some ten or fifteen miles, as illustrated in the diagram, Fig. 5. Energy from the oscillating system of the transmitter A would be fed into the path of the light beam.

It would then travel upwards for fifteen miles along the beam of light. There it would come in contact with the conductable Heaviside Layer. Travelling along that, it would reach the light-beam of the receiving apparatus, down which it would travel until it eventually came in contact with the metallic grid of the oscillating system B.

Different Means Required

This system is very ingenious, but, so far as I am aware, it has not met with any practical success. After all, supposing it to work efficiently, it would still be a matter of great difficulty to feed vast amounts of energy into the upper reaches of the earth's atmosphere in this manner, and efficiently to collect the energy at the receiving end of the apparatus. Still, all ideas have their value, and there is no doubt that some use could be made of the above system.

Other systems concerning wireless power transmission have been proposed from time to time. Unfortunately, most of them have been highly impracticable, and space does not allow of their being described here. Recent suggestions for the radio transportation of power have, more or less, embodied some variation of the original Tesla experiments. It will probably turn out to be the case, however, that none of these schemes will achieve any commercial success. What is wanted is some radically different means of energy transmission.

To take an example. The sun is a radio power transmitter, and a fairly successful one at that. In tropical regions, something like half a horse power of energy is poured down by the sun on every square inch of land surface, the energy, of course, taking the form of radiant heat.

Radiant Heat

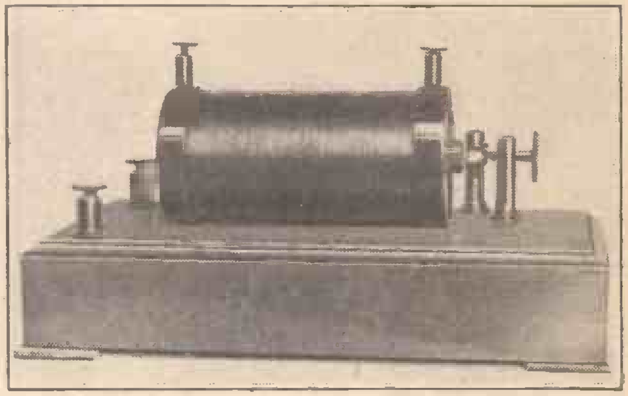
Now comes the vital and suggestive point. Radiant heat (which can readily be transformed into motive energy) is very similar to wireless waves, inasmuch as radiant heat is really the manifestation of electrical waves in the ether of definite wave-length and frequency. Recent experiments have proved that it is possible to generate artificially radio waves of a length as low as 1-140th of an inch. Such wave-lengths are approaching those of radiant heat.

There is thus no real reason why radiant heat waves should not be generated artificially by radio methods, and also transmitted by the same means.

If you can generate radio waves small enough they will cease to be radio waves (in the conventional sense of the term), and they will become heat waves. Here, therefore, is one line of attack on the problem of wireless power transmission.

Another point, in conclusion. It might be possible to devise some means of altering the length of an ether wave after it has been generated. For instance, if you have a transmitting station sending out waves 500 metres long, if some means of breaking up these large waves into much smaller waves of a fraction of an inch, or a centimetre in length could be devised, the power energy, if we may so term it, of the larger waves would thus be transformed into a more convenient form.

The problem, of course, is a big one, but, nevertheless, it will be solved one of these days.



An induction coil of a type suitable for use in the experiments described in this article. Many interesting experiments could be devised, using the coil as a basis for the transmission of energy.

MORE ABOUT THE SUMMERDYNE

—concluded from page 588

variety when using exterior batteries, and they will find that distinctly better results are obtainable with the 6-volt type.

Tuning Range

The "Summerdyne" is not intended for Daventry or long-wave reception, although a Daventry oscillator coil can be obtained from the Bowyer-Lowe Co., and a special frame wound to receive this station. Reception of long waves on the super-heterodyne is an achievement which gives me no particular thrill, for the reason that the supersonic method of reception is particularly designed for relatively short wave-lengths such as those between 200 and 600 metres, and it is not efficient on the Daventry band.

The "Summerdyne," tuning as it does down to about 200 metres and up to 500 to 550 metres, covers a relatively large band of wave-lengths, and will enable reception of a very large number of stations to be effected. In view of the smallness of the frame and the fact that reception with such a frame on a portable set differs in almost every room in the same house, readers should try a number of experiments in regard to location, outdoor reception being nearly always the best. At home I have received on the loud speaker some twelve or fifteen stations, and in the telephones many more. These stations have not all been received on the same evening or in the same house, as so much depends upon the particular locality.

Extra H.T.

So far as telephonic reception is concerned the valve sensitivity tests were made on a German station in broad daylight (about noon). Such stations, although only audible in the telephones in daylight, are heard at loud-speaker strength after dark.

Appreciable improvement in results is obtained by increasing the H.T. voltage above that of the 66-volt unit. To do this, an external battery can be connected in series, by taking the *negative* of the external H.T. battery to the positive H.T. *plug*, and the + battery connection to the H.T. + of the battery to the panel *socket* concerned.

THE "SILVER-TONED" TWO

—concluded from page 622

reading of C_1, however, does not call for this precaution.

Apart from those stations named earlier in this article, the following have also been received with the set connected to an indifferent aerial in south-east London. The stations have been actually identified by the announcers' remarks, while items in the programmes have been confirmed by published programmes. In all cases the reception was made on telephones, and in every case the reception has been successfully made with 2-, 4-, and 6-volt valves of the small power type:

Strasbourg,	Petit Parisien,
Madrid,	Toulouse,
Ecole Superieure,	London,
Muenster,	Birmingham,
Newcastle,	Bournemouth,
Oslo,	Langenberg,
Brussels,	Belfast,
Leipzig.	

A number of other stations have also been received, but these, so far, have not been identified.

The "Featherweight" Three

—concluded from page 597

avoided, since a fairly large accumulator will then be needed. Any of those mentioned above will work from two small 1½-volt cells, which will supply the current for all three valves for a sufficiently long time to hear two or three entire programmes through.

A 4½-volt grid-bias battery could be used to light the filaments of three valves of the ·06-ampere type, but it sometimes is a little difficult to make this type of valve function well as a second-stage L.F. amplifier.

Smooth Reaction

There is nothing to be said regarding the actual operation of the receiver, since the circuit and general arrangement are absolutely conventional. As a rule, with an average-sized aerial erected, a No. 50 or 60 coil will be needed for the A.T.I., while a No. 35 will suffice for reaction. The reaction condenser should then be about "half-in" and the set should be oscillating all round the dial of the A.T.C. Reaction control is very smooth if the correct H.T. and L.T. values are maintained, and the general operation of tuning-in, even on distant stations, is of the very simplest order. Reception of Daventry, of course, necessitates a very large aerial and is not very satisfactory.

A fair specimen of an aerial that yielded very good results is shown in one of the photographs. From this the reader will infer that nothing very long or lofty is at all necessary within 30 miles of a main station.

Easily Carried

A set made up on these lines may easily be carried in a small car, or even on the carrier of a motor-cycle (in the latter case it is advisable to carry the valves separately) and makes a very useful "touring companion." It is, however, equally pleasing on the river (where one always has a good earth available) or even in one's own garden, when it is not convenient to run long leads from the set that is used indoors. The reader will, however, probably be able to think of many more uses to which such a set may be put. As a final word of advice, the writer would say "*Don't forget to take a spare valve!*"

THE SEARCH FOR QUALITY

—continued from page 601

curve gets less as the impedance on the anode circuit (in this case the loud-speaker impedance) decreases. This happens as the frequency gets less. Suppose, then, that at 50 cycles, owing to the decreased effective impedance of the loud speaker, the curve becomes $B^1 A C^1$. The dynamic curve will always terminate for a given grid sweep on the same characteristic curves. But in the case given, the intercept $B^1 A$ is different from $A C^1$, whereas $BA = AC$. At the lower frequencies there is, therefore, rectification. If, however, we use high voltage there is no reason why this should happen; we shall not need to use such a large sweep A C, and hence the intercepts may be arranged to be equal in spite of the changed impedance of the loud speaker.

H.T. from Mains

The effect of rectification can always be spotted by watching a feed-meter showing the anode current. If this moves for drum or bass sounds, be sure you are getting rectification.

A common fault is to put a low-impedance loud speaker (such as the Kone) directly in the anode circuit of the last stage. A transformer exists for many loud speakers, and should always be used if such speakers are in themselves of low impedance.

Naturally all my readers will be saying that this is all quite nice, but where can they obtain 200-300 volts. I know this is a difficulty, but it is not insuperable. Some lucky people live with 240-volts mains. This (with suitable precautions as to fuses) can be used direct. For smoothing use the circuit of Fig. 3—a condenser across the mains sans choke is no good, the capacity of the cable is so high. If the positive is earthed a large earth condenser must be used and care taken in tackling the L.T. battery. (See Fig. 4.) The earth condenser is the smoothing condenser also.

Personally, but I am extravagant, although I have a 240-volts mains supply I use H.T. accumulators to the value of 350 volts, and these are charged from the mains every day!

If A.C. mains are used there is no limit to the possible value of H.T. volts. The circuit to be used is shown in Fig. 5. I cannot give values for smoothing because the mains seem to

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THE SEARCH FOR QUALITY

—concluded from page 659

vary so much, but personally I used condensers of three microfarads each and a choke of 100 henries at my old house, where I had 100 volts A.C. mains.

The cost of the whole equipment is of the order of £10 and the maintenance about one-eighth of a penny per hour. Equipment is sold which can be used for charging the L.T. when not in use. I do not think it is worth while using the A.C. mains to light the valves. If this is done, however, the grids of the L.F. valves must be brought to the centre of the filament potential by a potentiometer. (See Fig. 6.)

"No Distortion."

Many loud speakers require a transformer in the output circuit. To prevent saturation a choke feed (Fig. 8) is useful. This has two advantages—first it prevents transformer saturation; second, it isolates the loud speaker from the D.C. voltage, and one does not take nasty shocks. For instance, in my own installation I have two output circuits, one for the kitchen and nursery, another for the living rooms, while the set is in the garage (switched on incidentally by a relay controlled from a switch in the house). As much of the wiring has to run about the place one is chary of having it at 350 volts potential—children, dogs, and fire risks all making such a course dangerous. In such cases choke feed (Fig. 8) is more than desirable. A few microfarads for the condenser and a few hundred henries for the inductance are sufficient.

Having gone through all the arguments the reader will grasp the reasons for the circuits and components of Fig. 7, which for use for the local station I consider ideal. From aerial to output, this set need introduce *no* distortion. Distortion occurs only in the microphone, the necessary transformers, the land-lines, the transmitter and the loud speakers. On the whole *we* really have more problems than you, but without wanting to boast, and stating what by measurement has proved to be true, the transmitter is normally less at fault than the receiver. I hope a copying of this specification will leave you "sans peur et sans reproche," *except* for the loud speaker.

This deserves separate consideration in my next article.

H.T. FROM A.C. MAINS

—continued from page 609

The main batch of smoothing condensers is arranged so that the actual baseboard area used is only equivalent to the area of one. They should be firmly held down to the baseboard by means of a strip of ebonite or fibre, as shown in the photographs.

When the condensers have been satisfactorily fixed in position the second choke is mounted, and the wiring to these components completed. For the sake of simplicity the batch of condensers have been numbered 1, 2, 3, and 4, No. 1 being next to the baseboard.

The potential divider should be arranged on a strip of ebonite 5 in. by $2\frac{1}{2}$ in. by $\frac{1}{4}$ in., and eleven sockets mounted in a line. These may be countersunk valve sockets or any small sockets which are readily obtainable. This small, compact component is shown in the photographs.

When this has been securely fixed to the end of the baseboard and two short lengths of wire have been taken from the last smoothing condenser (No. 5), the unit is ready for testing. As this unit is readily adaptable to practically any set using any number of valves, it will be realised that it may be necessary to make some slight changes in the set to which it is to be attached. The only change is, however, the addition of extra fixed condensers.

Preventing Anode Coupling.

Between each H.T. plus terminal in the set (not the unit), a ·015 mica condenser should be joined. Unless very large 1 mfd. or so are in use, it is essential that this addition should be made, and, furthermore, that the condensers should have a mica dielectric. These condensers provide a certain measure of additional smoothing, but far more important is their action in preventing excessive coupling between successive valves.

If the condensers were omitted, the varying anode current drawn by any valve would result in a voltage drop across the divider, which would not only affect this particular valve but also other valves. The effect would be something approaching a pandemonium, for the result would be a long-drawn-out howl which would drown everything received.

(*Concluded on page* 661.)

H.T. FROM A.C. MAINS

—*concluded from page 660*

The primary of the power transformer is connected to the mains by means of a length of twin flexible lead, the other ends of which are joined to an ordinary bayonet holder or two-pin plug. A double adaptor is very useful here in cases where the electric-light point has to serve a dual purpose.

First place the rheostat in the off position and connect up the unit to the set, and arrange the switches on the set so that the minimum number of valves are in use. Close the main switch and slowly rotate the rheostat. Signals will soon be heard in the headphones on L.S., and the H.T. plugs should be rearranged and rheostat varied with the full number of valves in use to give maximum results. Never decrease the value of filament resistance in circuit unless absolutely necessary, or the life of the valve is sure to be reduced.

THE FRAME AERIAL

—*concluded from page 624*

understood and usefully applied. Since that period, however, the frame aerial's directional reception properties have been very greatly utilised for the purpose of getting rid of unwanted stations, of eliminating static, local interference, and for many other ends.

The directional properties of the frame aerial are not difficult to grasp, as a glance at the diagram, Fig. 6, will elicit. Consider two positions of the frame aerial relative to the direction of travel of the transmitted radio energy. At A in diagram, Fig. 6, we have the radio energy cutting right across the frame aerial. In this case the maximum potential difference is set up at both sides of the frame, and consequently a maximum current flows.

However, if we have a station so situated that its transmitted energy cuts across the frame aerial obliquely, the maximum potential difference in the frame is not attained. In fact, in some instances, no potential difference is obtained at all. Consequently, in those cases, no current is generated, and therefore signals proceeding in that direction are eliminated. This condition is illustrated at B in diagram, Fig. 6.

If the angle between stations is less than a right angle, the directional effect of the frame suffers somewhat considerably, and the cutting out of the one station will be followed, in very many cases, by a diminution in signal strength of the required station.

For its most successful use the frame aerial requires one or two stages of H.F. amplification, in addition to at least one stage of L.F. amplification. However, at very close ranges, the frame aerial *has* been used successfully in conjunction with an ordinary crystal set, and, therefore, there is no reason why the radio amateur possessing a 1- or 2-valve set should not make a success of a frame aerial used for the reception of a local station.

IN OUR TEST ROOM

—*concluded from page 642*

A Switch Protector

Mr. C. G. Howard, of 15, Gateside Rd., Upper Tooting, S.W.17, recently submitted for examination one of his Earth Switch Cabinets, a photograph of which appears on page 642.

As is well known (and widely experienced!) an out-of-doors aerial-earthing switch suffers considerably from the effects of the weather and atmospheric attacking elements. And corrosion and deposits of soot, etc., at such a point can cause considerable trouble and inconvenience. Some sort of protection is, therefore, really essential, although we cannot remember that the trade has risen to this occasion very nobly! It is much better to have the switch outside, and the tight little cabinet designed and produced by Mr. Howard provides ample protection. Two switches were submitted with the sample. One switch had been exposed to the elements unprotected for six months, while the other spent a period of twelve months snugly tucked away in a cabinet. The former is a wreck—nearly falling to pieces, and the latter is spick and span, and in excellent condition.

The cabinet is solidly constructed, and has two substantial ebonite tubes for the aerial and earth leads. The front of the cabinet opens on hinges to permit of access to the switch. In oak it retails at 8s. 6d., and in cheaper woods at proportionately lower prices.

DEVELOPMENTS IN DIRECTION FINDING

—concluded from page 627

the upper and lower plates will deflect the ray upwards and downwards, causing it to trace out a vertical line on the fluorescent screen or photographic film.

If, however, the second loop, pointing east and west, lies in the direct line of the received signal, the ray will in that case be drawn out in a direct line sideways. For intermediate positions of the two loop aerials the plates P will carry different charges, the resultant of which will determine the path of the ray across the screen and will thus give a direct indication of the desired direction.

The same principle has been applied to a method of selective reception which is capable of extraordinary refinement. This is illustrated in Fig. 5, and consists in using a local oscillator adjusted to a selected frequency, which, in combination with the frequency of the desired signal, causes the electron stream of the cathode ray to trace out a sinuous path of a particular predetermined shape.

The received signals from the aerial are applied to one pair of the deflecting plates, and the impulses from the local oscillator to the other pair. At the outer end of the cathode tube a screen is interposed which is cut to a particular shape, so that the electron ray can only get through to influence an optically-sensitive cell when it is tracing out a path corresponding to the shape of the slot in the screen.

Signals of any other frequency than that selected cannot therefore influence the optical cell with sufficient persistency to affect the 'phones. They are accordingly cut out, and the desired signal is received free from all interference.

VALVES AND SCREENED COILS.

The primary and neutralising windings of most of the standard screened coils and **OTHER TYPES OF INTERVALVE COUPLING UNITS** were designed primarily to suit the more freely oscillating valves of the 6-volt range (a few examples are the D.E.5b, S.T.61, P.M.5X, H.512, D.E.8 H.F., etc.), and it sometimes happens that others, notably the 2-volt types, may lead to difficulties and poor signals.

In such cases the use of at least 90 volts H.T. will sometimes help materially, and it is also well worth while to try the effect of extra capacity between the plate and grid of each H.F. valve. Connect an ordinary neutralising condenser between these points and set it to about half its total capacity. Then neutralise with the neutralising condensers proper in the usual way.

RADIO NOTES AND NEWS OF THE MONTH

—continued from page 566

this station will supersede our old friend "Connie"—whose full name, as you know, is Konigswusterhausen!

Pictures via the Ether

Europe's very first public Television picture gallery was that inaugurated recently in Berlin. On a screen at the Brangenburger Tor a record was shown of scenes in Vienna, the pictures following one another during the evening at intervals of a few seconds, and giving a kinematograph effect.

Actually only "still" pictures were transmitted, but these are claimed to be sufficiently good to be visible at a distance of over 100 yards from the screen.

Wave-Length Wandering

"What is it that causes Hilversum to come in at 23° on the dial one night, and at 126° the next night?" writes a Southend reader with a grouch and a three-valve set. By the way he lectures me about it in his letter, one might suppose that I had been monkeying about with his set; but as a matter of fact Hilversum has been having a little flutter, testing up on 1,850 metres recently, and no doubt this is the cause of the trouble.

"Rolls" Portable Receiver

The makers of the "Rolls" 5 valve-receiver, referred to in Modern Wireless for May (page 465), have notified the Editor that the price of this receiver is thirty guineas, and not £30, as stated.

The Washington Radio Conference

Undoubtedly the most important event in the radio politics of 1927 is the forthcoming International Radio Conference at Washington. It is almost exactly fifteen years ago that the first International Radio Convention took place in London, stirred into activity by the dreadful "Titanic" disaster which occurred in the preceding April.

(Concluded on page 663.)

RADIO NOTES AND NEWS OF THE MONTH

—*concluded from page 662.*

At that first Convention the business was mostly telegraphic, the SOS and other shipping safeguards being standardised by the High Contracting Parties (as the various powers then styled themselves). The advent of broadcasting has widened the whole scope of the science, and now not only the original High Contracting Parties, but you and I, and the party next door, will all have interests at stake.

An Interesting Trade Announcement

Preparations for the next winter radio season are proceeding apace, and several exhibitions have been announced. The wireless trade, too, is busy preparing an intensive campaign, as witness the recent amalgamation of "R.I." and "Varleys"—two popular firms that will in future combine forces and pool their radio resources.

The Inventor of Tuning

June 12th is the birthday of Sir Oliver Lodge, who was born in Staffordshire 76 years ago. Knighted in 1902, he has greatly distinguished himself in various spheres of thought. His work is remarkable not only for originality and insight, but for the clarity and charm with which his views are expressed. Sir Oliver has a special claim on listeners because it was he who invented wireless tuning.

Sir Oliver Lodge

Amongst other claims to fame, Sir Oliver Lodge has the perfect "wireless personality." His lucid talks to listeners have disclosed not only his great knowledge, but his great humility also, and a certain fine friendliness for all his fellows that no mere microphone could disguise.

All readers of MODERN WIRELESS will, I am sure, join with me in sincere Birthday Greetings to Britain's distinguished wireless pioneer.

Effect of the Eclipse

Preliminary arrangements for observing the effects of the eclipse on radio signals are now completed. The Newcastle station, 5 N O, is geographically just right for testing purposes, so time signals and speech will be transmitted from there. In addition, there will be transmissions from stations situated to the north and to the south of the zone of totality. (The work of the latter will probably be handled by 2 N M, the Caterham station belonging to Mr. Gerald Marcuse.)

A SIMPLE METHOD OF NEUTRALISING.

The following method of neutralising is recommended for use in sets employing one stage of H.F. and provided with a reaction control.

Set the reaction control at minimum, and likewise the neutralising condenser. Now, on setting the tuning condensers so that the two tuned circuits are in step with each other, it will probably be found that the set is oscillating. To test for oscillation, touch one or other of the sets of plates of the tuning condensers (this may be either the fixed or moving, according to the particular set). You will probably find that the set will only oscillate under the above conditions when the two circuits are in tune with each other, and this can be used as an indication. It is convenient to perform the operation at some point near the middle of the tuning range. Now increase the capacity of the neutralising condenser. (In the case of such condensers as the Gambrell "Neutrovernia" this means screwing downwards.

Test at intervals for oscillation as this is done, and you will presently find that the set has ceased to oscillate, and will not recommence even when the tuning dials are slightly readjusted. Now increase the reaction a little, until the set once more oscillates, and again increase the neutralising condenser setting until oscillation ceases. Slightly readjust the tuning condensers again to make sure that the set is completely stable once more.

Proceed in this way until it is found that the correct adjustment of the neutrodyne condenser has been overshot. Once this point has been passed it will be observed that further increases of the neutrodyne condenser setting no longer stop oscillation but cause it to become stronger.

The object is to find such an adjustment of the neutralising condenser as will permit the greatest setting of the reaction condenser to be used without producing oscillation. It will then be observed that when the two tuned circuits are in step and the set is brought to the verge of oscillation a slight movement in either direction of the neutrodyne condenser will cause the receiver to break into oscillation.

It is to be understood that in the preceding notes, where a reaction condenser is spoken of, any form of reaction CONTROL may be understood.

WHAT READERS THINK

—*concluded from page 598.*

SIR,—My attention has been drawn to your May issue in which appears an article concerning wireless in Ceylon. I have found this very interesting, but your correspondent is wrongly informed when he speaks of Colombo's population as 160,000. As a matter of fact, Colombo's population now numbers 250,000.

Yours faithfully,
H. H. BENNETT.
The Times of Ceylon Co., Ltd.,
London Advertisement Manager.

HOW VALVES VARY

—concluded from page 610

The first L.F. valve will have a fair grid-voltage swing to deal with, and therefore should have a characteristic curve that has a reasonably long straight portion to it. True, it has an anode resistance of a high value, but even so I would not advise the use of a valve having a greater impedance than 10,000 ohms or a magnification factor of more than 12. This means that the D.E.5, P.M.6, etc., give best results.

The last stage, consisting of two valves in parallel, can carry large grid-voltage variations, and so fairly large power valves should be used here. The L.S.5 valves (one in each holder for the last stage) could be used successfully if plenty of milliamps are available for the anode current, and a pressure of 200 volts or so can be obtained. For the average man, however, two super-power valves should be quite successful, valves such as the B11, D.E.5A, P.M.625, or even P.M.6, and so on, being suitable. By pulling one valve out of its socket the last stage can be used as a one-valve stage if desired, though more power is obtainable when two valves are used in parallel.

The "Featherweight" Three

Portable-set enthusiasts will find the "Featherweight" Three an interesting and efficient little receiver. It is somewhat restricted as to the type of valves that can be used, but this is only natural where portability is concerned, because the size and weight of the L.T. battery have to be kept as low as possible, and therefore we have to choose our valves from either the 1·1-volt, 2-volt ·1 amp., or 3-volt ·06 amp. class.

There is a fair range available, but as dry cells are to be preferred in the place of portable accumulators, if only from the point of view of weight, constructors would do well to confine themselves to 1·1-volt valves or ·06 amp. valves. In the former case two dry cells are connected in parallel, as the valves take about ·25 amp. each. A D.T.G. accumulator filled with glass wool to prevent spilling is quite successful for use with these valves or with the ·1 amp. 2-volt type, but it is, of course, rather on the heavy side.

The main consideration when choosing valves for a portable set is concerned with the strength of the filaments. If these are not mechanically strong then all sorts of troubles may occur. That question of the mechanical strength of the filaments rather precludes—to my mind—the advisability of employing ·06 valves, as these have fine filaments and, although wonderfully efficient, must be guarded against shock in a way that is not necessary where the more robust ·1 amp. or 1·1-volt types are concerned.

Suitable Valves

The D.E.11 Cosmos are quite O.K. for the "Featherweight" Three, or similar valves of the Wecovalve class, while ·1 amp. valves of "general-purpose" type can be employed if the 2-volt valves are to be used. Moderate impedances and magnification factors should be the rule in a set of this description, as one does not want to make it too critical, and I should say the S.P.18G would do well in the first two stages, with a valve such as the S.P.18RR for the last stage, if accumulator L.T. is being used and plenty of H.T. can be carried. Valves with similar characteristics, 17,000 ohms and 4,500 ohms impedance values respectively, can be found among most of the manufacturers' lists, but in the case of the L.T. supply being from a dry battery or batteries I should use a valve with an impedance of somewhere round 8,000 for the last stage and a filament consumption of not more than ·15 amp, and needing less H.T.

Absolute purity of reproduction is not wanted in a portable set so much as sensitivity to weak signals, or under adverse conditions—almost inevitable when portable receivers are being used—so that the use of a super-power valve or one capable of dealing with tremendous volume is not usually worth the extra filament current and H.T. voltage required.

"Silver-Toned Two"

Little need be said about the "Silver-Toned Two" except that I might point out that owing to the circuit employed (Reinartz detector and transformer-coupled L.F.) a valve of moderate impedance, 20,000 ohms or so, would be best as the detector, and one of ordinary low impedance (6,000–8,000) as L.F. Except in cases where the set is used near a broadcasting station an ordinary power valve will be best in the last stage; there is no need to use the super-power type with its heavy H.T. current drain unless very unusual volume is obtained. You should have no trouble with this set with regard to the valve question; almost any general-purpose valve will work well, though the types I have intimated would be best.

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