THE LOEWE MULTIPLE VALVE

MODERN WIRELESS

1/- MONTHLY

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

Vol. VIII. No. 8. AUGUST, 1927.

CONTENTS

Vol. VIII. No. 8. MODERN WIRELESS AUGUST, 1927

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

Technical Editor: G. V. DOWDING, Grad.I.E.E.

Scientific Adviser: J. H. T. ROBERTS, D.Sc., F.Inst.P.

COSSOR —the Melody maker

WITHOUT good valves even the best of Receiving Sets will be tongue-tied. Choose your valves with care — choose Cossor Valves, the only valves with the Kalenised filament.

Owing to the powerful emission of its Kalenised filament the Cossor Valve reproduces music that is little short of amazing. But good music is only one feature of the Cossor Valve. Its Kalenised filament is immensely strong. And being absurdly economical in current, too—accumulator charging costs are reduced to a minimum. For pure music, economy of maintenance and long service, choose Cossor Valves —and accept no substitute.

In 12 Types for all Sets

Always demand

the valve with the Kalenised filament

A. C. Cossor, Ltd., Highbury Grove, N.5

G.A. 9177

MODERN WIRELESS
Vol. VII. No. 8. August, 1927

Short-wave broadcasting—Mr. Marcuse's offer—The efficiency of the Beam—Daventry Junior.
By THE EDITOR.

THE fact that Mr. Gerald Marcuse—the well-known owner-operator of 2 N M, Caterham, Surrey—has offered to conduct a series of experimental short-wave broadcasts at his own expense, and with the express objects in view of proving the practical possibility of broadcasting to the Dominions, has aroused renewed interest in the problem of Empire broadcasting and, incidentally, in questions relating to the laws of copyright.

THE conspicuous successes achieved by P C J J, the Dutch station at Eindhoven, and K D K A, 2 X A F, and 2 X A D, the American short-wave stations, are constantly in the minds of amateurs; and the failure of the B.B.C. to respond to public opinion and to make a definite move in the matter of supplying this country with a short-wave broadcasting station, or to initiate a series of short-wave experimental broadcasts, has created the impression, both at home and abroad, that we, in this country, are again allowing foreign countries to lead us in the matter of Radio progress.

COMMENT in the foreign and Dominion newspapers—especially in the South African and Indian papers—is indicative of sad surprise that British wireless programmes can only be relayed to Dominion listeners via the medium of a foreign short-wave station.

THE situation reflects but little credit on the enterprise of the B.B.C.; but the sporting offer of Mr. Marcuse is worthy of every encouragement.

THE B.B.C. states it cannot give Mr. Marcuse permission to relay the programmes, owing to the fact that the majority of the programme items are secured for British broadcast rights only, and the relaying of them abroad would inevitably lead to trouble over questions of copyright.

HOWEVER, Mr. Marcuse's offer, even if prevented from being carried out in practice, may help to encourage the B.B.C. to show a little more initiative in the matter of short-wave broadcasting.

THE latest Beam station erected by the Marconi Co. for communication with South Africa has made it clear that while, as previously calculated, a wave-length of some thirty metres is suitable for transmission during the hours of darkness, a lower wave-length is necessary if transmission is to be carried out almost as satisfactorily during daylight hours.

CONSEQUENTLY, the Beam transmitting station in Cornwall was altered with a view to utilising two wave-lengths, i.e. sixteen metres during daylight and thirty-three metres during darkness. The resulting increase in transmitting efficiency has proved extremely surprising, and in a long test the average total hours of good transmission and reception were twenty-two hours (to South Africa) and twenty hours (to Great Britain) at an average speed of one hundred words a minute, or approximately one hundred and sixty thousand words a day in each direction. Considering that the Post Office contract only required eleven working hours out of twenty-four, the Marconi Co. has strikingly demonstrated the efficiency of the Beam—a system which has been almost exclusively developed in this country.

WE may hear a good deal about America being far ahead of us in Radio, but when it comes to Beam transmission and reception there can be no doubt about the fact that this country is far ahead of any other, and that the British Beam stations constitute the most efficient and most up-to-date transmitting and receiving units in the world.

ONE chief Radio event for August is the opening of Daventry Junior, and, subject to the approval of the Post Office, the much discussed scheme of regional high-power stations will come into the sphere of practical politics before the month is over.

The new station's power is about 15 kilowatts, and its wave-length is still indicated as being between 300 and 400 metres. Daventry Junior will certainly be given one of the exclusive wave-lengths, and this will probably mean another mild re-shuffle of wave-lengths of other B.B.C. stations.

The new station's test transmissions have not been widely heard. Very few listeners have heard them, owing to the early hours chosen for the tests.

Daventry is not to be its permanent home, for the transmitter is really one of the regional stations, which will eventually replace the present main urban stations.

In July, by the way, Daventry Senior celebrated its second birthday, and the new transmitter is the first addition to the B.B.C.'s stations in the past two years, if one excepts the Keston receiving station, which began work a few weeks after 5 X X, in September, 1925.

DAVENTRY JUNIOR, we hope, will live up to expectations, and will be followed as soon as possible by other stations of a similar character until the Regional scheme has been finally and completely established. And when it has—what then? Progress seems to be rather rapid this century, and perhaps the Regional Scheme will be " dated " even before it is completed!

THE UBIQUITOUS VALVE

Some unusual applications of the thermionic valve.

From a Correspondent.

In a recent issue of a wireless periodical a particularly interesting photograph was published showing valve apparatus being employed as a "crime detector." It emphasised how the pilfering of small metal parts from manufacturing firms is being overcome by utilising ingenious modifications of valve detecting instruments in order to indicate the presence of metal objects in the pockets of workmen as they leave a factory.

Now, in view of the valve becoming to the average member of the wireless fraternity a piece of everyday apparatus, the fact is often overlooked that there are many other directions in which the valve plays no mean part. Even conceding the point that the valve has revolutionised ordinary wireless transmission and reception, with its application to broadcasting as the most important, so far as a large section of the public is concerned, it is as well to appreciate the fact that it is used with unqualified success in the scientific world for divers purposes. Ruminating on this led the writer to jot down a few of these applications.

The De Forest "Phonofilm"

There have been many notices in the Press recently concerning the big developments taking place in "talking pictures," which is really a simultaneous reproduction of speech and music with the projection of a particular film on the usual screen. The valve has been employed with reasonable success in this direction, and the "phonofilm," as it is called, has running down one side of the separate photographs constituting the complete film a sound record. Naturally, the apparatus involved is of a somewhat complicated nature, and full details are not yet available. The main problem, however, that of perfect synchronisation, would appear to have been solved in a very satisfactory manner, and use is generally made of a light-sensitive cell—an adaptation of the ordinary selenium cell—which has a somewhat peculiar property. It

Dr. Lee de Forest, who has done much to further valve design. His latest invention is the "Phonofilm."

resists the passage of electricity in proportion to the intensity of light to which it is subjected, so a special device is incorporated in order to transform the minute varying currents from the microphone into light of varying intensity.

This affects the prepared film, and a permanent record is thereby obtained. In passing, it is interesting to notice that filter or absorption arrangements have been perfected in order to eliminate the extraneous noises produced by the mechanism of the projector itself.

It will probably come as a revelation to some people to learn that many possess what is technically called, in aural surgery, a silent zone, or deafness at particular frequencies.

When undergoing examination the patient has a pair of telephones fitted on his or her head, and when these are employed in conjunction with a valve controlling a low-frequency oscillator, it becomes a relatively simple matter to determine the audible and inaudible frequencies. This is carried a stage farther to ascertain particulars of normal and imperfect hearing by reducing gradually to inaudibility the emitted sounds. Using the details furnished by these readings, and a graduated chart, actual complaints lend themselves to a more accurate diagnosis, with the result that the prescribed treatment proves more effective in bringing about an ultimate cure.

Land-line Relays

The telephone trunk system of this country reflects to the credit of the P.O. engineers engaged in its development, but the efficiency of the present-day arrangement is indebted in a large degree to the valve. In long telephone trunk lines the inductance, resistance, and capacity of the cable combine in a particular manner to attenuate or reduce the speech currents propagated along the cable length. Thus, without any refinements, the distance over which successful telephone speech could be effected would be comparatively small were it not for the introduction, at regular intervals, of repeaters; that is, special thermionic relays which serve to amplify the speech currents to their original amplitude.

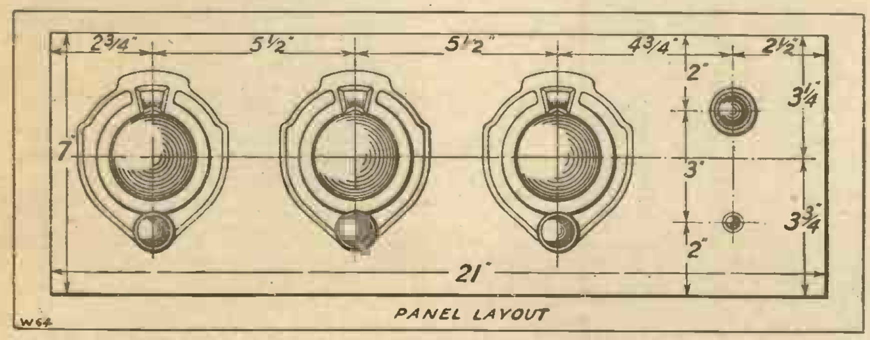
Knotty Mechanical Problems

To quote another example, there is a piece of apparatus possessing great precision and sensitivity which has been invented for the purpose of solving problems connected with mechanical stresses, without the objection of putting constraint on the mechanical members undergoing tests. In this case, the movement of a metal plate, situated close to the oscillatory circuit of an oscillating valve, causes variations in the magnitude of the induced eddy currents. This in turn alters the effective resistance of the coil itself, and the resultant changes of current in the anode circuit of the valve (after calibration) are a measure of the metal plate's movements.

The "M.W." FIVE

Designed and Described by G. P. KENDALL, B.Sc. Constructed in the "Modern Wireless" Research Department.

In the last issue of MODERN WIRELESS the first details were given of a standard screening box to contain a complete H.F. stage with the exception of the tuning condenser, and it was mentioned that it was intended to use the box in many of the more sensitive and selective sets to be described in the future. The box has been incorporated in a variety of circuits and combinations of valves with extremely satisfactory results, and the first complete design using this standard screen has been prepared, and will be found on these pages.



PANEL LAYOUT

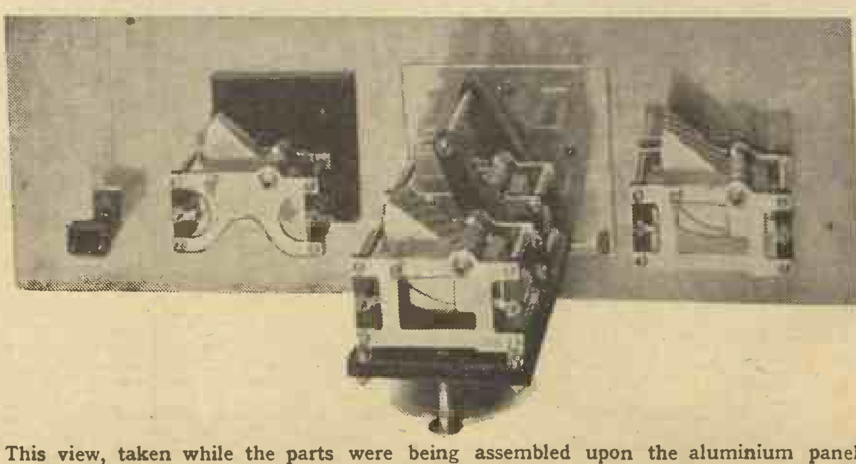
Special Features

The instrument is a five-valve receiver, comprising two H.F. stages, detector, and two L.F. valves, two of the standard boxes being used. The circuit employed is a perfectly straightforward one, and no claim to originality is made here; the merits of the set lie in the special methods of eliminating interaction and pick-up effects—as will be seen later, some special screening devices are employed in addition to the boxes—and in the special system of construction provided by the screening boxes, which latter feature makes it easy for the builder to make practically a perfect copy of the original set, even to the run of the important wires. The odds in favour of success are consequently considerably increased.

The H.F. part of the circuit commences with an inductively coupled aerial circuit, with the usual tightly-coupled semi-tuned primary and fully tuned secondary, these coils being unscreened so far as an actual case is concerned. However, it was found possible to secure a sufficient degree of shielding to minimise direct pick-up effects by placing this coil in a space between one of the shielding boxes and the metal panel of the set. It is thus overshadowed on two sides by masses of metal at earth potential, and these produce the desired effect.

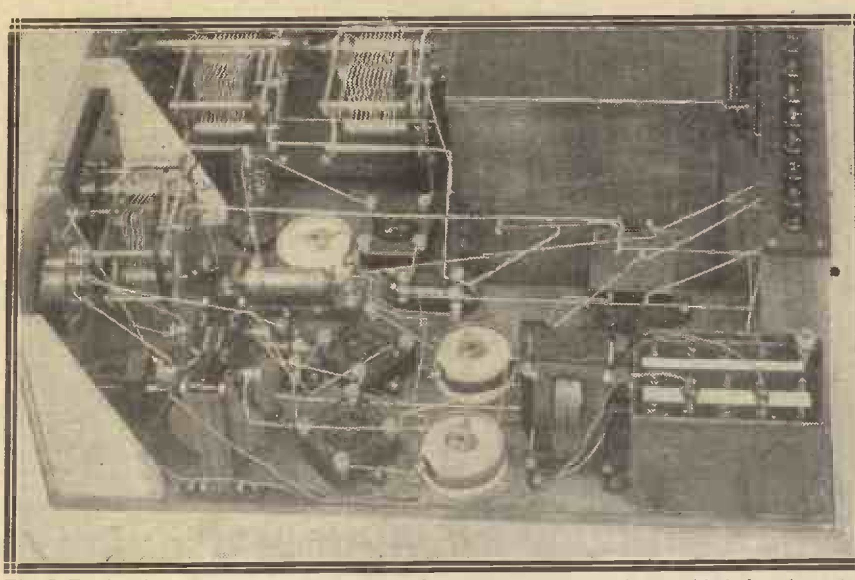
H.F. Coupling

The two H.F. valves are coupled to each other and to the valve detector which follows by means of standard six-pin H.F. transformers of the type originally developed for use inside cylindrical coil screens, the circuit being of the well-known "split-primary" type, each stage being neutralised. Reaction is provided at the detector stage, and of the L.F. stages which follow one is coupled



This view, taken while the parts were being assembled upon the aluminium panel, shows how the reaction condenser is mounted upon an insulating plate of ebonite.

on the resistance-capacity principle and the other by means of a transformer. Troubles due to the passing of H.F. currents into the L.F. circuits are minimised by the provision of a quarter-megohm grid leak in series with the lead to the grid of the first L.F. valve, and a choke output filter is incorporated since the set will normally be used with a loud speaker



The L.F. circuits are grouped at one end of the set, and space is provided for the grid-bias battery.

and a power or super-power valve in the last stage. Separate grid bias connections are, of course, provided for the two stages, but a common H.T. terminal is used, since it can be taken as a general rule that both stages will work best with all the H.T. you can give them within reasonable limits.

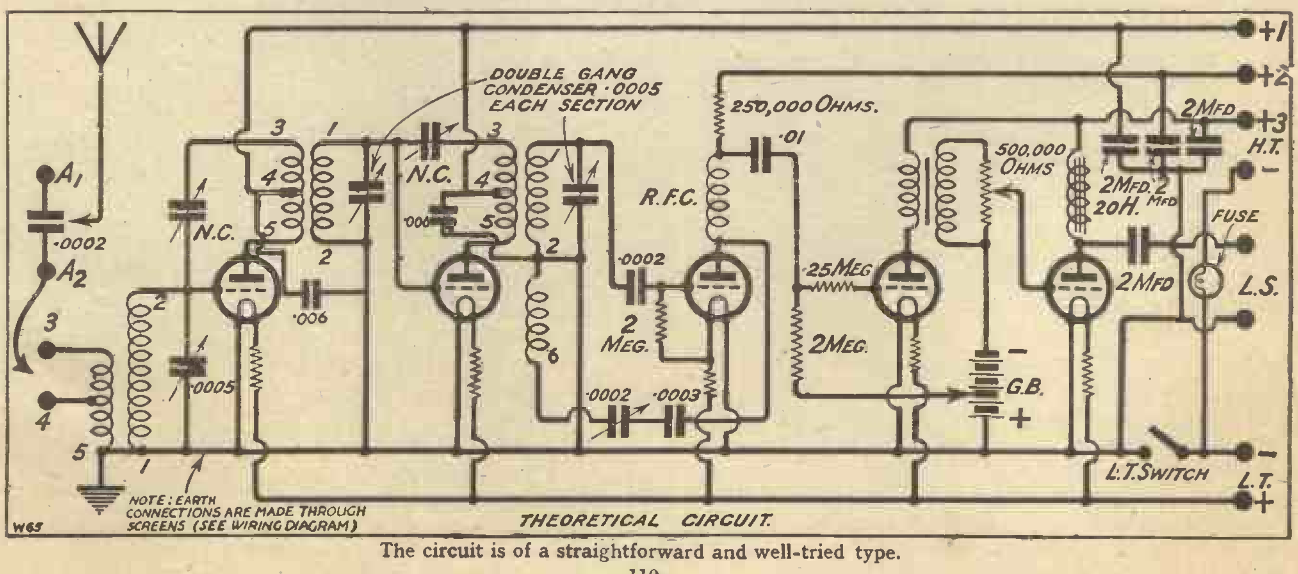
Separate H.T. terminals are provided for the detector—H.T. + 2—and for the H.F. valves—both are fed from H. T. + 1—while a separate filament control of the "semi-fixed" variety is provided for each valve.

Turning now to the practical layout of the set, it must be emphasised that the aluminium panel is an essential feature of the design, and to use a plain ebonite one is to invite trouble. It would be feasible to use an ebonite panel with a backing of copper foil, but the aluminium one is not expensive and will be found to give the set a very handsome appearance. It does, however, mean a little more work.

On the panel are mounted three variable condensers, an on-and-off switch, and a 500,000-ohm potentiometer, which is used in the L.F. circuits as a volume control in a manner which will be understood upon referring to the circuit diagram. The left-hand condenser tunes the aerial secondary circuit, and since the moving plates are to be

LIST OF COMPONENTS.

- 1 cabinet, 21 in. × 7 in. × 18 in. deep, with plain front (Caxton, Camco, Pickett, Raymond, etc.).
- 1 baseboard, $20\frac{1}{2}$ in. × 18 in. × $\frac{3}{8}$ in.
- 1 aluminium panel specially cut and prepared, measuring slightly under 21 in. × 7 in. (White, Jacobs & Co.).
- 1 special ebonite bush for Centralab potentiometer (White, Jacobs & Co.).
- 1 double-gang condenser, log-mid-line, ·0005 mfd. each section (Cyldon).
- 1 ·0005 log-mid-line condenser (Cyldon.)
- 1 ·0002 log-mid-line, with ebonite face-plate for insulating condenser from panel (Cyldon).
- 1 500,000-ohm Centralab potentiometer (Rothermel Radio Corporation).
- 1 on-off switch, type M6 (Wearite).
- 3 valve holders (Benjamin, Lotus, etc.).
- 3 filament rheostats for baseboard (Lissen, Igranic, or similar type).
- 1 H.F. choke (Wearite, Lissen, R.I.-Varley, Ormond, McMichael, etc.).
- 1 L.F. choke, 20 henries (Pye).
- 4 2-mfd. fixed condensers, Mansbridge type (Mullard, Lissen, T.C.C., etc.).
- 1 250,000-ohm anode resistance with holder (Mullard, Dubilier, R.I.-Varley, etc.).
- 2 grid leak holders (Lissen, Dubilier, etc.).
- 2 2-meg. grid leaks } Lissen or Dubilier.
- 1 ·25-meg. grid-leak } Lissen or Dubilier.
- 2 ·0002 fixed condensers } Lissen or Dubilier.
- 1 ·0003 fixed condensers } Lissen or Dubilier.
- 1 ·01 fixed mica condenser (Dubilier).
- 1 special grid-leak adapter or combinator (Dubilier or Lissen).
- 1 L.F. transformer (Ferranti AF3).
- 11 terminals, as marked on the wiring diagram (Belling & Lee).
- 2 pieces of ebonite for terminal boards, 3 in. × $1\frac{5}{8}$ in., and 8 in. × $1\frac{5}{8}$ in.
- 1 flashlamp bulb and holder.
- 1 6-pin coil base, unscreened (Lewcos, Peto-Scott, etc.).



The circuit is of a straightforward and well-tried type.

LIST OF COMPONENTS
(continued).

- 2 standard screening boxes, with usual contents (Burne-Jones, Peto-Scott, Bowyer-Lowe, Lewcos, Effesca, etc.).
- 2 ·006 fixed condensers (Lissen or Dubilier).
- 2 split-primary H.F. transformers, as per article.
- 1 special aerial coil, as per article.
- 1 grid-bias battery, 22 volts.
- Wire, screws, pieces of wood, etc.

panel it may be found that the switch fails to work, the valves remaining alight whether it is in the on or off position. If this occurs, simply reverse the connections to the switch.

The remainder of the assembly of the set is a straightforward job of attaching components in the positions marked on the diagrams, fixing the panel to the baseboard by means of three wooden angle pieces (these can be seen in the photos), and mounting the two terminal strips upon the wooden uprights which support them above the baseboard. (Convenient heights are three inches for the aerial and earth strip, and four inches for the other.)

In any big set the wiring is a very important part of the work, and much of the efficiency of the receiver depends on the way it is done. Really perfect soldered joints are vital, and too much care cannot be taken here, likewise in trying to make a really good copy of the original, using the photographs to clear up any doubtful points. This receiver is an easier one to copy than many of the big sets of the past, as a result of the use of the screening boxes with their standardised hole positions through which the wires emerge, and it is also probably less sensitive to slight changes, by virtue of the more complete screening of stage from stage, but the constructor is still urged to do his part faithfully and take no risks. In particular, he should note through which hole in each box each particular lead passes (it is marked on the wiring diagram) and take care to do likewise.

The finish imparted to the aluminium panel gives the set a very handsome appearance. The vernier dials chosen are of an insulated type to eliminate risks of shorting the spindle of the reaction condenser to the panel.

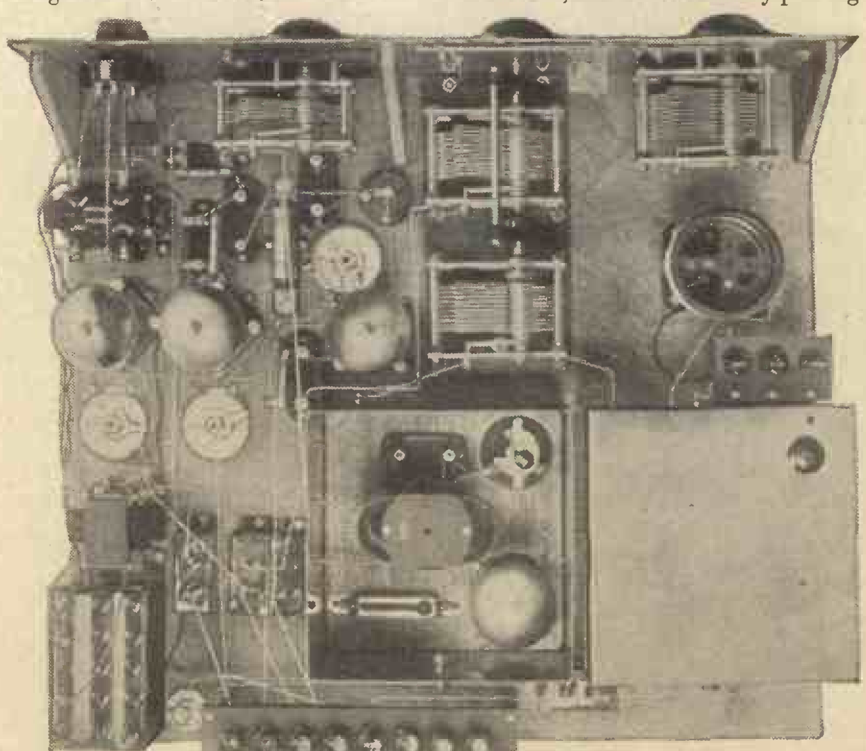
connected to earth the condenser is mounted directly upon the panel, whereby the desired effect is obtained, since there is an earth connection on the panel as well as on the screening boxes. The middle condenser is of the double-gang type, tuning the two H.F. stages simultaneously, and is again mounted direct upon the panel. The right-hand condenser, however, is the reaction control, and since both sets of plates are above earth potential it must be insulated from the panel, and this has been done by means of an ebonite plate to which the condenser is first attached as though to a panel, the plate being then fastened to the aluminium panel separately.

Precautions

The 500,000-ohm potentiometer must also be insulated from the panel, and here ebonite bushes are used which can be obtained from the suppliers of the panel. The "on-and-off" switch need not be insulated, since there is no connection between the metal frame and the various contacts. If a different pattern is used in which one contact is connected to the spindle which passes through the

Important

A point deserving special mention concerns the wiring of the boxes and the various earthing connections to them. At the back of each standard box is a special earthing terminal, and these are to be wired up as shown. Other connections are made to the boxes at various points, however, for the purpose of earthing other parts of the circuit, and this is done by putting

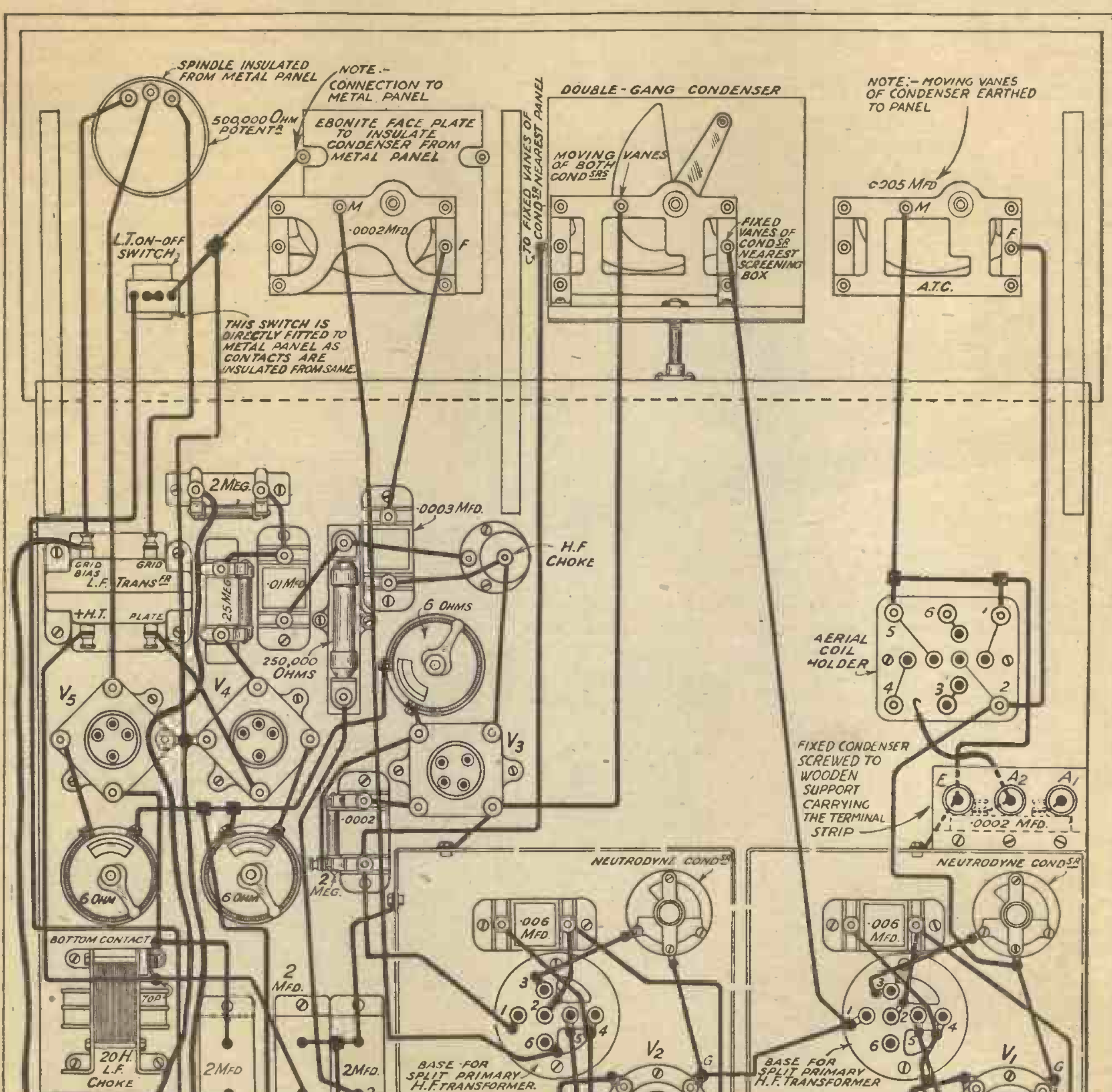


In this plan view one of the boxes is seen with the lid removed. The coil inside is a binocular type used experimentally.

a small brass screw and nut through one of the unoccupied holes and soldering to this. Due care should be taken in following these points from the wiring diagram, since the omission of a single earthing wire would lead to failure.

The wiring up of the parts inside the boxes is done by taking the inner baseboards out and working with them upon the table. All connections between parts can be completed in this way, but those connections which come out through holes in the boxes require the following procedure. Estimate how long each lead will require to be, add on a few inches for errors, then solder one end of the lead to the appropriate point on the baseboard of the box. Now fasten the base back in position inside the box and work each lead out through the correct hole, take it to the appropriate point outside the box and cut it correctly to length, but do not solder yet. Slip a piece of systoflex or other insulating sleeving over the wire so that there shall be no risk of its making contact with the box, and then solder the remaining end.

Alternatively, a covered wire such as "Glazite" can be used, but this is a little more difficult, since pains



WIRING DIAGRAM

must be taken to avoid damaging the covering by scraping it against the edges of the holes in the boxes through which it is passed. With such wire it is easier to pass each lead into the boxes from outside, soldering the ends as they arrive at the correct points inside.

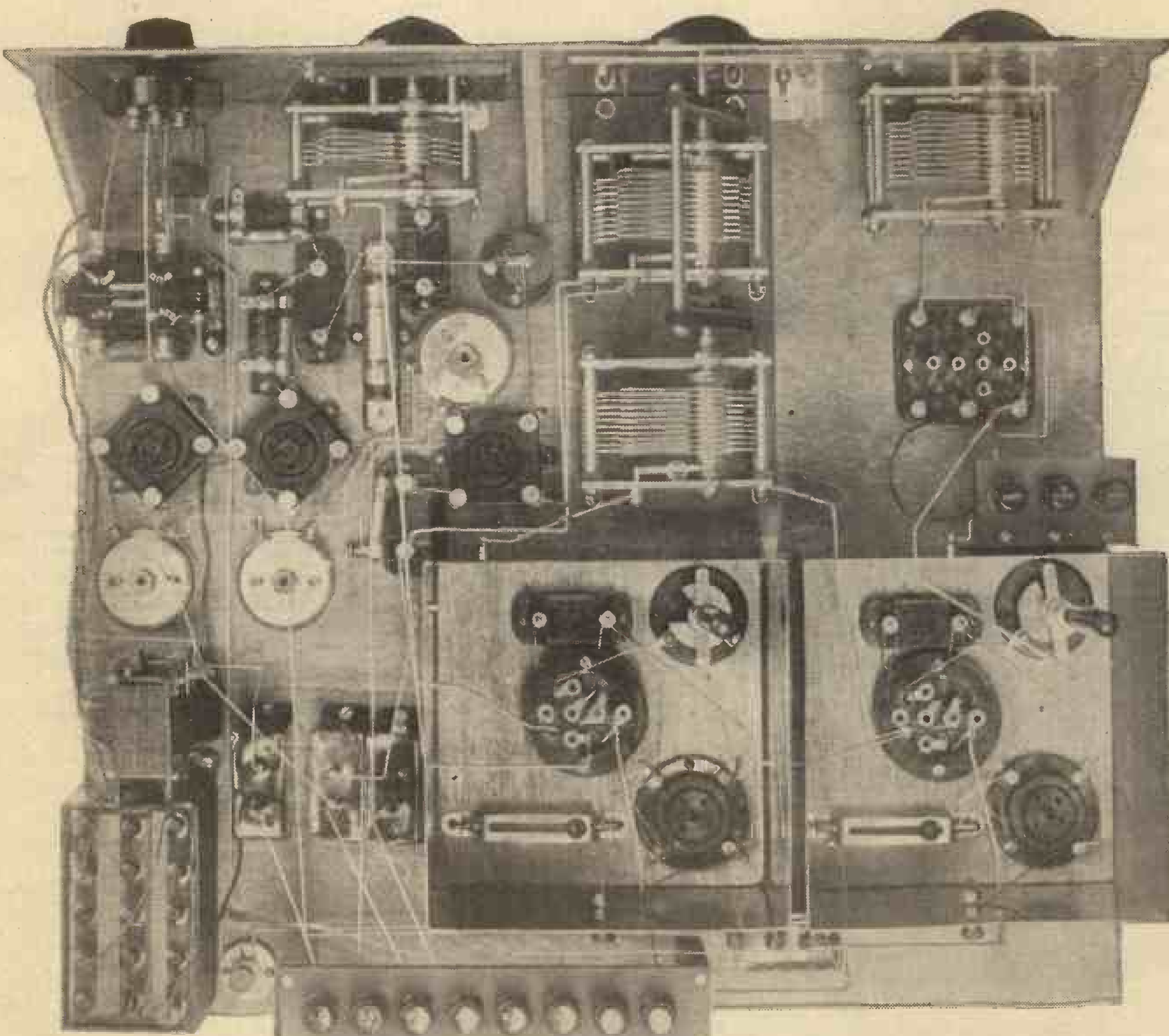
Before leaving constructional matters and passing to operating details it should perhaps be explained that as received by the constructor the standard boxes will not be found to contain the ·006-mfd. mica condensers seen in the wiring diagram, since these are a refinement used in this particular set, but not necessarily to be employed in other designs, and hence their omission from the standard specification. For the "M.W." 5, therefore, they must be added by the constructor as indicated.

The coils used in the set are standard ones, the two H.F. transformers being of the "split primary" type, now available in a great variety of makes. If these are being bought specially for this set it is as well to mention when doing so that they are intended for use in the new screening boxes, and not the original form of coil screen.

Tuning Range

The reason for this is that certain of the manufacturers are now producing coils with the windings adjusted to tune over exactly the right wave range when used in the new boxes. The original coils, of course, tuned over a suitable range when enclosed in the cylindrical screens, but when used in the new boxes (which do not approach nearly so close to the windings) they tune over a slightly higher range, and it is not easy to tune down to certain stations at the bottom of the scale. The difference is not very great, and will not cause any important stations to be missed, but it is worth mentioning in case the make of coil you choose happens to be one of those in which a type specially adjusted for the new boxes is available.

The aerial coil is one of those originally produced for a set known as the "Spanspace Four" (not to be confused with the "Spanspace Three"), and can be obtained ready wound from Messrs. Collinson's Precision Screw Co. The original coil was wound with No. 22 D.C.C. wire, but in this set it is desirable that it should be wound with No. 24 D.C.C. to obtain a shorter and more compact winding, which has been found of some slight advantage. Those who wish to wind the coil for themselves can do so by obtaining a



Compare this view with the wiring diagram constantly while you are wiring up the H.F. circuits, and try to copy the run of the wires fairly closely.

Collinson "Featherweight" former with interchangeable primary and winding it with 50 turns of No. 24 D.C.C., the start (the end nearest the base) being connected to pin No. 1, and the finish to pin No. 2. The primary consists of 20 turns of the same wire, with a tapping at 15 turns connected to pin No. 4. The beginning goes to pin No. 5 and the end to No. 3. In use the flexible lead from terminal A_2 is connected to either No. 3 or No. 4 terminal on the socket of this coil, according to whether it is desired to use the whole primary or only part.

For the Daventry range another set of coils is needed, these being two split primaries of the long-wave size, and another "Spanspace Four" coil. The latter carries a secondary of 250 turns of No. 34 D.S.C., and a primary of 100 turns of No. 32 D.S.C. with a tapping at 75 turns.

Full details of the operation of the set will be given next month, but meanwhile it may be as well to indicate that the set will be found with most valves to neutralise with a very small setting of the neutrodyne condensers.

Space is lacking for an account of the set's capabilities here, but next month I will give a report of the remarkable results achieved.

POINT-TO-POINT CONNECTIONS.

One filament socket of each valve holder to one side of each respective rheostat.

+ L.T. terminal to the remaining sides of the rheostats.

—L.T. terminal to one side of the flash-lamp-bulb fuse, and to the left-hand outside contact of the L.T. switch. Inner contacts of this switch joined together.

Right-hand outside contact of switch to a nut on the aluminium panel, to the remaining filament sockets of the valves V_4 and V_5, and to the positive grid-bias plug via a flexible lead.

— H.T. terminal to the remaining side of the flashlamp-bulb fuse.

A_1 terminal to one side of the ·0002 fixed condenser mounted on the wooden support.

Other side of this condenser to the A_2 terminal and to a flexible lead that connects with terminals 3 or 4 on the aerial coil base.

Earth terminal to a nut on the 1st copper box, to the terminals 1 and 5 on the aerial coil base, and to the moving vanes of the ·0005 A.T.C.

Fixed vanes of same condenser to the No. 2 terminal on the aerial coil base, to the moving vanes of the 1st neutrodyne condenser and to the grid of the 1st valve (V_1).

Fixed vanes of 1st neutrodyne condenser to the No. 3 contact on the first 6-pin base.

Remaining filament socket of the valve V_1, to the nut behind the terminal on the copper screening box, to one side of the ·006 fixed condenser, and to the contact No. 2 on the 6-pin base.

Contact No. 5 on same base to the plate of V_1.

Remaining tag of the ·006 fixed condenser to contact No. 4 on the 6-pin base, to one side of the 1st 2-mfd. fixed condenser. to the No. 4 contact on the 2nd 6-pin coil base, to one side of the 2nd ·006 fixed condenser and to H.T. + 1. No. 1 contact on 1st 6-pin coil base to the grid of valve V_2, to the moving vanes of the 2nd neutrodyne condenser, and to the fixed vanes of the 2nd ·0005 variable condenser of the double gang.

Moving vanes of both sections of the double-gang condenser joined together, to the remaining filament socket of the valve V_3 and to a nut on the 2nd screening (copper) box.

Fixed vanes of the 2nd neutrodyne condenser to the No. 3 contact on the 2nd 6-pin coil base.

No. 5 contact on the same base to the plate of V_2.

No. 2 contact on same base to the remaining side of the 2nd ·006 fixed condenser; to the remaining filament socket of V_2, and to the nut behind the terminal on the 2nd copper screening box.

No. 1 contact on 2nd 6-pin coil base to one side of the ·0002 grid condenser, and to the fixed vanes of the 1st ·0005 variable condenser of the double gang.

Remaining side of ·0002 grid condenser to one side of the 2-meg. grid leak and to the grid of V_3.

Remaining side of the 2-meg. grid leak to the filament contact of the valve holder V_3, which is joined to one side of the rheostat.

Plate of V_3 to the top contact on the H.F. choke, and to one side of the ·0003 fixed condenser.

Remaining side of ·0003 fixed condenser to the fixed vanes of the ·0002 variable condenser.

Moving vanes of the ·0002 condenser to contact No. 6 on the 2nd 6-pin base.

Bottom contact of H.F. choke to one side of the 250,000-ohm anode resistance and to one side of the ·01 fixed condenser.

Remaining side of anode resistance to one side of the 2nd 2-mfd. fixed condenser and to H.T. + 2.

Remaining side of the ·01 fixed condenser to one side of the 2-meg. grid leak holder, and to one side of the ·25-meg. grid leak holder.

Other side of the ·25-meg. grid leak holder to the grid of V_4.

Remaining side of the 2-meg. grid leak holder to the 1st — G.B. plug.

Plate of V_4 to the "plate" terminal on the Ferranti AF3. "+ H.T." terminal on same transformer to the top contact on the L.F. choke, to one side of the 3rd 2-mfd. fixed condenser and to H.T. + 3.

Plate of V_5 to the bottom contact on the L.F. choke and to one side of the 4th 2-mfd. fixed condenser.

Other side of this condenser to the L.S. terminal.

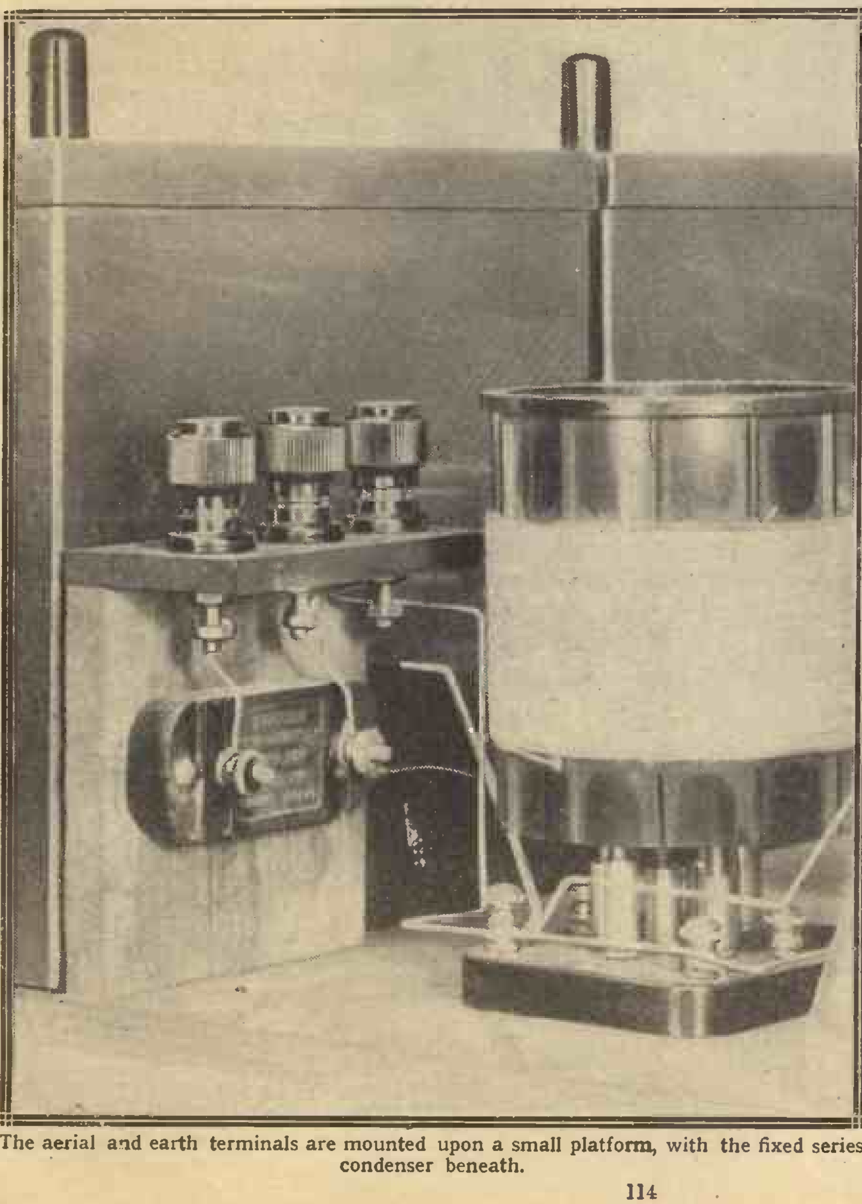
Other L.S. terminal to the remaining sides of the 2nd and 3rd 2-mfd. fixed condensers and to a nut on the 2nd copper screening box.

Grid of valve V_5 to the centre of the 500,000-ohm potentiometer.

Right-hand terminal of potentiometer to the "grid" terminal on the Ferranti AF3.

"Grid bias" terminal on the Ferranti AF3 to the left-hand terminal on the potentiometer and to the 2nd — G.B. plug via a flexible lead.

A lead connects together the two terminals on the copper screening boxes and the remaining side of the 1st 2-mfd. fixed condenser. This completes the wiring.



The aerial and earth terminals are mounted upon a small platform, with the fixed series condenser beneath.

"MY SET"

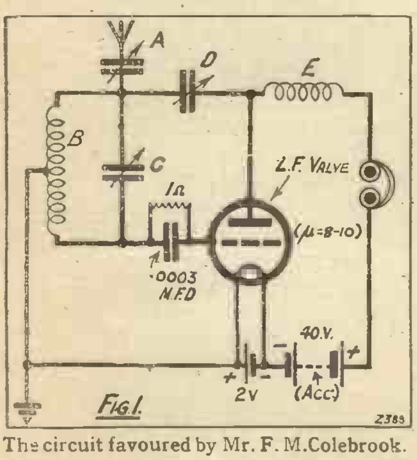
Some well-known radio authorities describe their broadcast receivers.

By F. M. Colebrook, B.Sc., A.C.G.I., D.I.C.
(The well-known radio engineer).

As you will see from the diagram, the set is a very simple detector valve with capacity reaction, for the reception of the nearest station, 2 L O. (Fig. 1.)

I make no great claims for it beyond simplicity of construction and operation.

A is a 500 m.mfd. variable. This condenser acts as a sort of variable coupling between aerial and tuned circuit. Best setting depends considerably on resistance of aerial-earth circuit. It is usually quite small—about 200 m.mfd.



The circuit favoured by Mr. F. M. Colebrook.

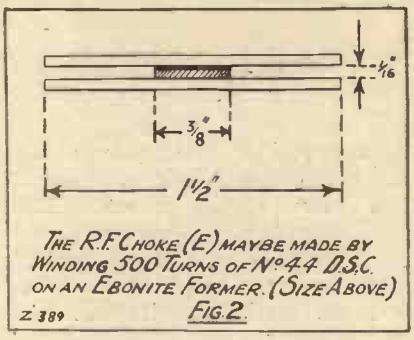
Constructional Details

B is a centre-tapped coil, *e.g.* Gambrell or Dimic.

C is a 500 m.mfd. variable, square-law, low-loss, vernier drive.

D is a retro-action condenser. Up to about 50 m.mfd. variable, with a small minimum (5 m.mfd).

E is an R.F. choke, *e.g.* Varley or Dimic—or about 500 turns of No. 44 D.S.C. on an ebonite former. (Fig. 2)



By A. G. D. West, B.Sc.
(Research Dept., B.B.C.)

My set is designed to receive two stations only, in this case the local station (2 L O) and W G Y (when conditions are favourable).

It is a four-stage set, consisting of an anode-bend rectifier without reaction, followed by three resistance-coupled L.F. stages. The first L.F. valve has an impedance of 8,000 ohms, the second an impedance of 5,000 ohms, and the output stage consists of two valves in parallel, each of these having an impedance of 2,000 ohms. Ordinary resistance coupling is used, and the output is choke-coupled through a condenser to the output transformer, which is designed for use with my coil-driven loud speaker. This loud speaker is a coil-driven cone of 7 in. diameter, placed in a baffle 3 feet square.

On the front of the set are two knobs and two switches. One knob is a tuning knob, the other is a strength control. As regards switches, one of these changes from two L.F. to three L.F. stages; the other switch changes over from "Radio" to "Gramophone." This has the effect of cutting out the detector valve and connecting the first L.F. switch direct on to an input transformer connected to a gramophone device. When there is no programme on, or the programme doesn't particularly interest me, by turning over this switch I can reproduce on the loud speaker any gramophone records I like.

American Stations Received

Alternatively, instead of connecting the gramophone I can join up with the output of a two-valve short-wave receiver, which brings in W G Y, 2 X A F, 2 X A D with ease, when conditions are favourable for reception; so that I can use the "Radio-Gramophone" switch to switch over from London to New York.

The H.T. supply is taken off the

A recent photograph of Mr. A. G. D. West.

A.C. mains by means of a transformer and rectifying valves. The output obtainable is 300 volts, 120 milliamps, but I do not usually use as much as this. A 6-volt accumulator lights the filaments. However, I have arranged a switch so that the winding of the mains transformer, normally feeding the rectifying filaments, charges the L.T. accumulator through a trickle charger when the set is not in use. It is thus an easy matter to throw this switch over from one position, when the set is in full operation, to the other position, where the L.T. battery is being charged.

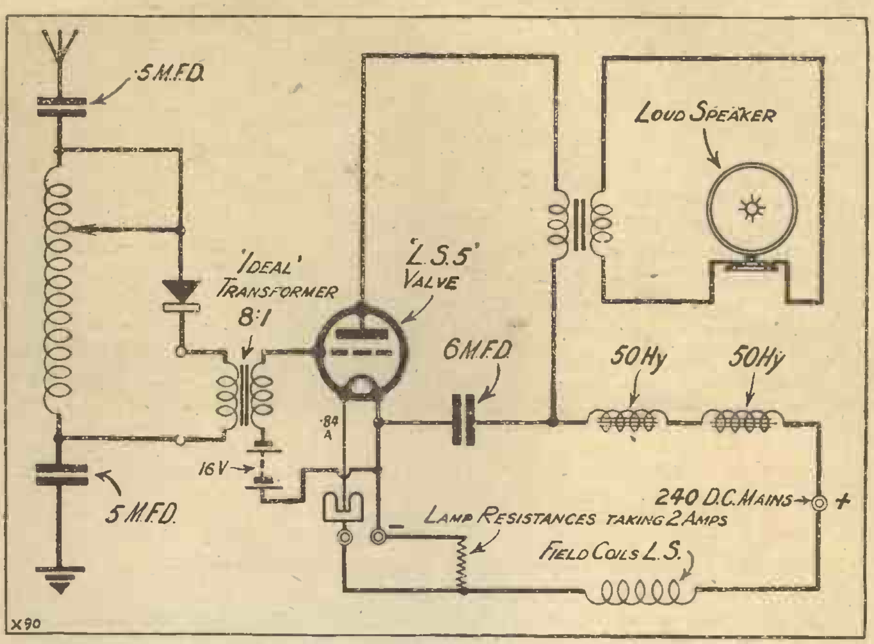
Loud-Speaker Comparisons

In addition to feeding the loud speaker that I have mentioned already, the output is also connected to a wiring system leading to different rooms. Thus I can have a loud speaker in any room I like. I have also made arrangements to switch over from this loud speaker to a good horn type. In this way I can get a good idea of the difference of reproduction between that given by the best possible type of loud speaker and the average one used by the majority of listeners. Comparison is extremely interesting. In fact, it has provided a good deal of information on the subject of judging balance and acoustic effects in transmission, and how these variations affect the ordinary listener.

By Captain Ian Fraser, M.P.

(Chairman of the Amateur Transmitters' Section of the R.S.G.B.)

MY own home-made set, which I use for 2 L O, is a perfectly straightforward crystal and transformer-coupled L.F. stage. My method of obtaining H.T., although becoming more generally used now, was quite novel when first erected; it is, of course, obtained from the mains.



This circuit gives excellent purity of reproduction, and works direct from the mains.

Before reaching the plate of the L.F. valve the H.T. is smoothed by two large chokes adapted from Ideal transformers. A 6-mfd. condenser shunts away any ripple left after passing through these chokes, and the result is quite free from hum.

L.T. is also obtained direct from the mains by inserting lamp resistances in series with the filament of the L.S.5 valve, so that only ·84 amps. pass. In addition, the magnetising coils of my loud speaker (it is a moving-coil instrument) are connected between the filament and the mains, and to mains minus through lamp resistances taking 2 amps.

So there are no H.T. or L.T. batteries at all! On an outside aerial 2 L O comes through quite well at good loud-speaker strength. The crystal rarely needs attention, as it is of the semi-permanent type.

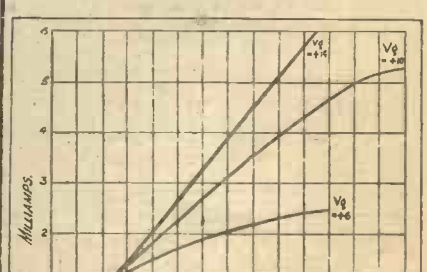
The actual receiver is situated in a shed on a balcony that also houses my transmitting gear. Leads run to the drawing-room, where the loud speaker is placed.

Capt. Ian Fraser tuning in the receiver which is described above.

By H. L. Kirke

(Research Dept. B.B.C.)

MY four-valve set consists of 1 H.F. (neutralised), detector, and 2 L.F. choke-coupled by large choke coils. The aerial is tuned by a variometer. H.T. is obtained from the



mains, but not in the normal way. I use a rotary converter.

One side is connected to the mains and the other terminals produce H.T.

at 300 volts, which is cut down in the case of the H.F. valve by a 40,000-ohm resistance.

The detector circuit is unique, and is the subject matter of B.T.-H. patent No. 147,819. The rectifier acts as an ordinary diode. Whereas with the ordinary diode the anode-current characteristic curve against anode volts obeys a non-linear law,

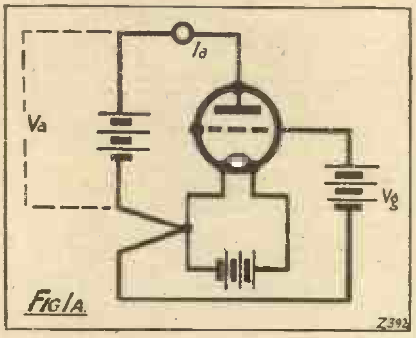


FIG 1A.

in the special rectifier used on my set the diode has been made to obey a linear law. This gives absolutely distortionless reproduction.

Referring to the anode-current–anode-volts characteristic of any triode, it will be seen that the slope of the curve varies considerably with grid voltage. Not only does this slope —and therefore the impedance—vary, but the curvature of the slope also varies. If, therefore, a three-electrode valve is used as a two-electrode valve, varying the voltage on the grid will vary the impedance of the valve and the straightness or otherwise of its characteristic.

"Undistorted Results"

In the rectifier used in this set the value of grid priming voltage is chosen so that the impedance is a minimum and the characteristic is

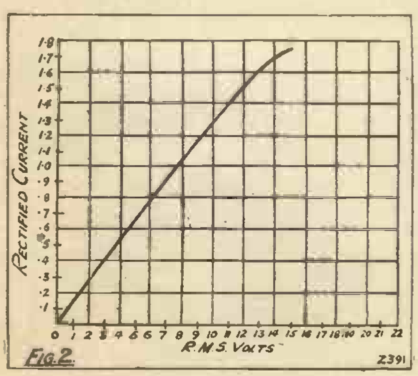
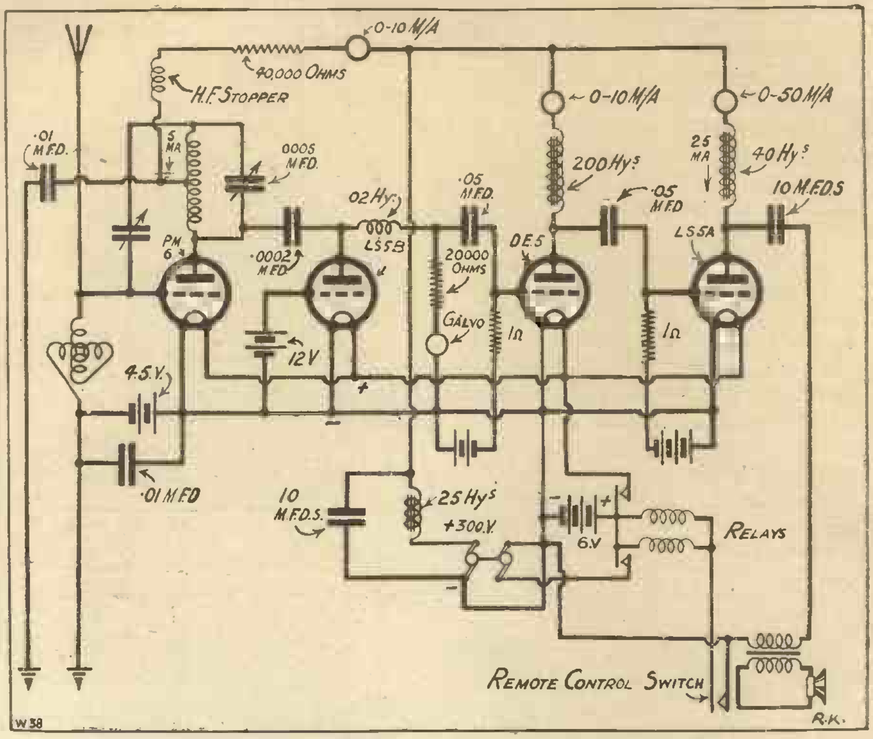


FIG 2.

straight over the range of voltages used.

It is generally found that a high-impedance valve has the most suitable characteristic with a grid priming voltage of about + 12.



The receiving system used by Mr. H. L. Kirke. The loud speaker is of the Rice-Kellogg type.

Figures 1 and 2 show the characteristics of the valve in question, an L.S.5B., also the mean anode current plotted against the H.F. applied voltage to the previous valve grid.

The set is switched on by remote-control switches. Although the special rectifier used gives undistorted results, it is very insensitive.

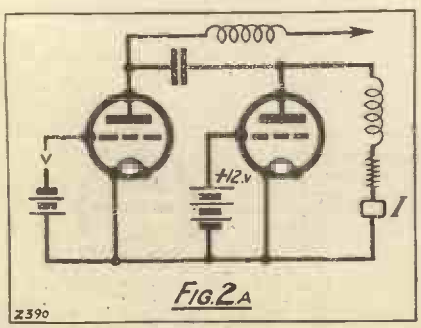


FIG 2A

By J. L. Baird

(The famous Television Experimenter).

(In an interview).

WHEN we saw Mr. Baird he was busy testing his "Noctovisor," and in the background there was a gentle swishing of strange instruments. But he managed to find time to tell us a few facts about his set.

"At present my set is a perfectly normal three-valve set, consisting of a detector and 2 L.F. But in about a year's time I hope to get out a set suitable not only for broadcast purposes, but in addition fitted for reception of television. I do not anticipate that the cost will be very much in excess of a good wireless set. In fact, it might be possible for keen experimenters to adapt their present receivers for the purpose. However, I can give no details at the moment. Until my experiments mature I find that a detector and two resistance-capacity L.F. valves give very good results on the ordinary B.B.C. transmissions."

Before we left Mr. Baird's laboratory we had been privileged to see a


Mr. J. L. Baird.

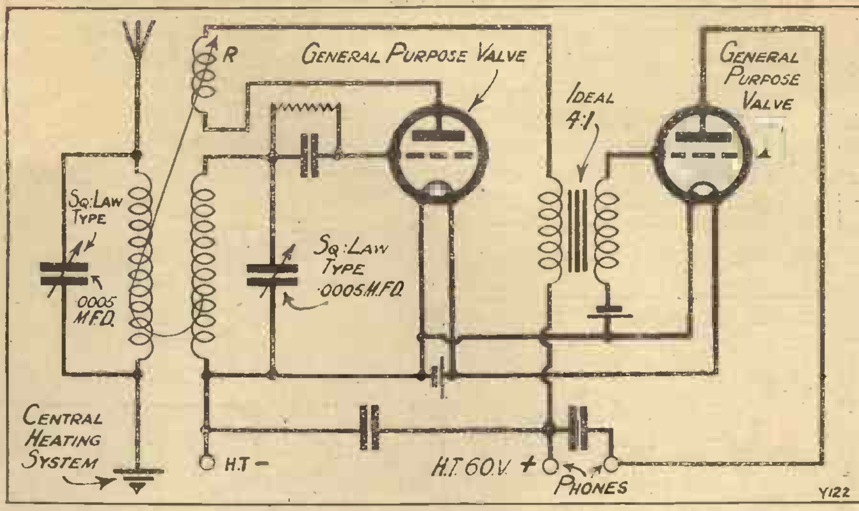
television picture of a boy sitting in a completely dark room. We could not help wondering what the future holds for the broadcast listener—when he will be able not only to hear across the world but also to see!

Professor C. L. Fortescue

(Professor of Electrical Engineering, City and Guilds Institute.)

I HAVE no permanent set beautifully housed in the last word in cabinets. A piece off an old packing-case is my baseboard, with a length of similar material at right angles to it.

When the latter board gets too many holes in it I put a new piece on. For even in the receiver used for the broadcast wave-lengths my circuit is very frequently changed. A receiver built like this can be altered with the minimum of trouble when I want to try different circuits.



Circuit "A," used by Professor C. L. Fortescue for reception on telephones.

The circuit I happen to be using at the moment (A) is connected up as in the accompanying diagram. This is a perfectly straightforward circuit, and gives good results using headphones. I am not using it with a loud speaker. With careful adjustment it is possible to separate Radio Paris from 5 X X near London.

The central heating system makes quite an efficient earth of fairly low resistance. My single-wire aerial is by no means a good one, being not more than 20 ft. above the ground.

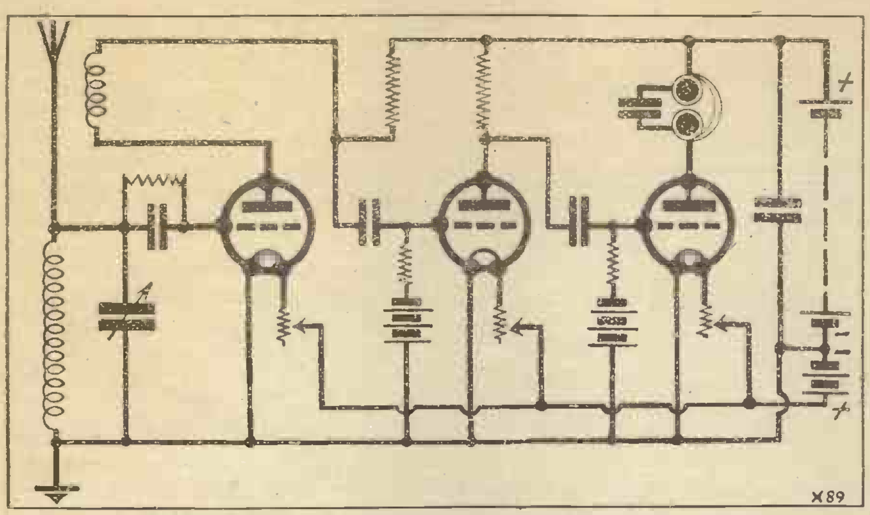
A Selective Circuit

The aerial-tuning components and the reaction coil are mounted so that adjustments are easily made, and any couplings may be tried. The filament rheostat in the filament of the first valve is useful for fine adjustments.

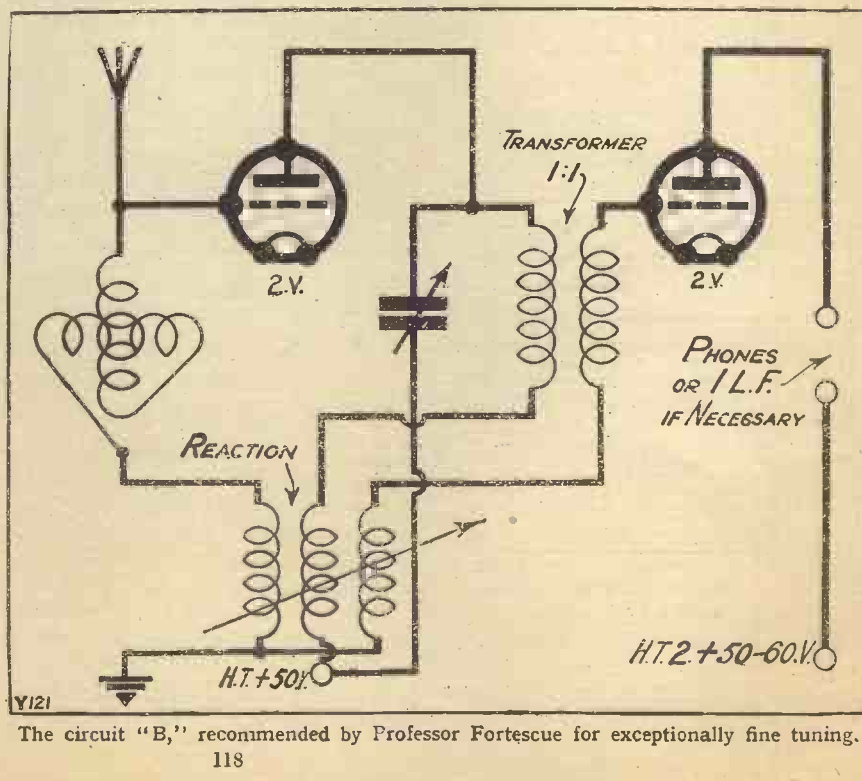
However, for really fine tuning, that will separate Radio-Paris and 5 X X quite easily, I have been using the following circuit (B).

The second valve of this is transformer coupled, the transformer including the reaction coil. Grid leaks are avoided. As the actual H.F. energy arrives in the aerial circuit it is here that reaction should be applied.

In this connection it is interesting to note that the side-bands are not cut off until the decrement ($\pi R \sqrt{\frac{C}{L}}$ falls to a value much lower than that usually given by ordinary circuits without reaction.



Mr. Baird prefers the straight, resistance-coupled three-valver.



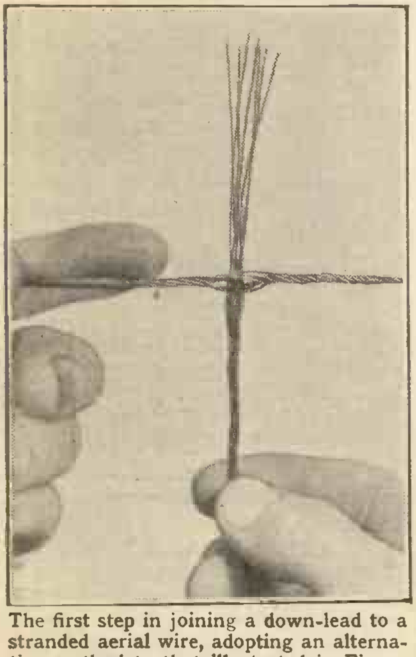
The circuit "B," recommended by Professor Fortescue for exceptionally fine tuning.

WIRING EFFICIENCY

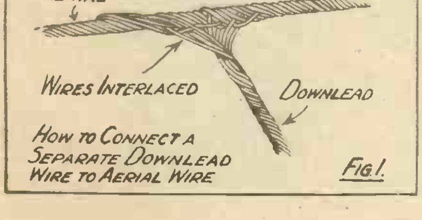
An article of interest to the practical amateur and constructor.

By R. GOODE.

DEFECTIVE wire joints and connections in radio sets and aerial and earth systems are responsible for more worries and minor troubles than one likes to think about. Yet, despite this undoubted fact, we still see home-made sets, especially those of the simple crystal variety, in which the necessary circuit connections are made by the simple but grossly inefficient process of screwing two bared ends of wire together and leaving it at that.



The first step in joining a down-lead to a stranded aerial wire, adopting an alternative method to that illustrated in Fig. 1.

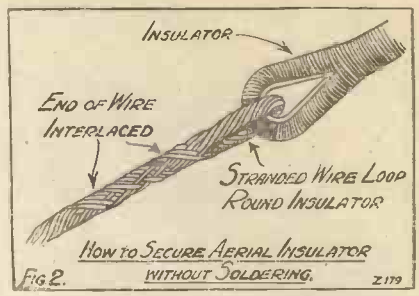


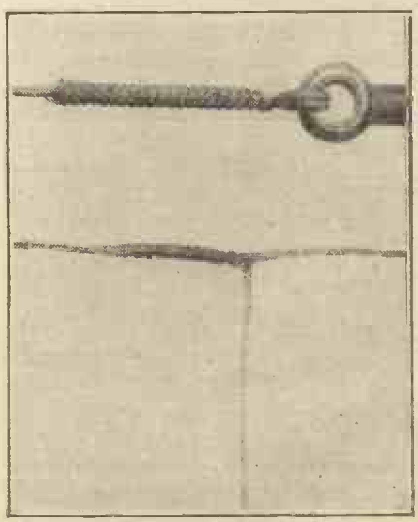
The subject of wire joints and their making is not perhaps as important as it was a few years ago when radio soldering operations were much less extensively carried out than they are at present. And, consequently, the present-day amateur has to some extent lost the knack—for a knack it is and nothing else—of making wire joints in a manner which combines neatness with strength. Of course, so far as actual electrical efficiency goes, the present-day soldered joint is infinitely better than any of the older spliced, twisted, or intertwined joints, no matter how neatly and correctly they may have been made. But the fact remains that a soldered joint is not always a strong one, and that, in many instances, it is very desirable to splice up two pieces of wire which have to be connected together before soldering them.

Aerial Connections

It is, therefore, with the aim of giving the amateur a little extra information on the subject of wire-joint making that I have summed up the information contained in this article, and there is no doubt that at least one or two of the various types of joints described will meet the needs of the amateur who is at present embarking upon a radio constructional scheme of one kind or another.

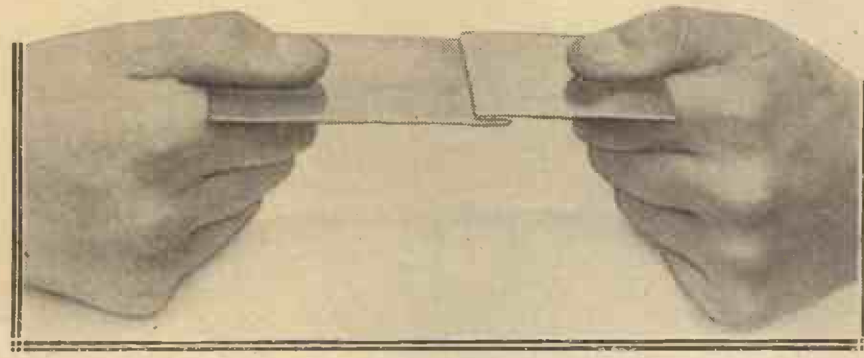
Let us deal with the joints which are generally made in the aerial and earth systems of a receiving installation, for it is in the construction of these systems that a good method of jointing two or more wires proves the most effective. With stranded aerial wires of the usual 7/22 variety the effecting of a good strong joint is comparatively simple, as will be evident from a glance at the diagram,





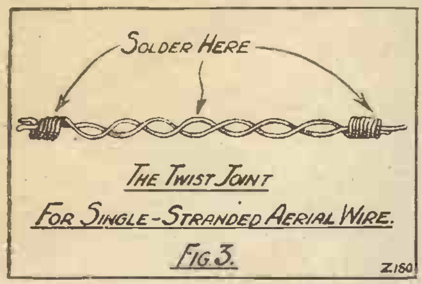
The wire is shown here neatly twisted and ready for the final stage of soldering.

Fig. 1. Here we see depicted the making of a downlead joint from the aerial wire. The strands of wire are first separated and cleaned, after which they are smeared with a little soldering flux, and, finally, interlaced in the manner shown in the diagram.



A "seamed" or "lapped" joint, made as per Fig. 10.

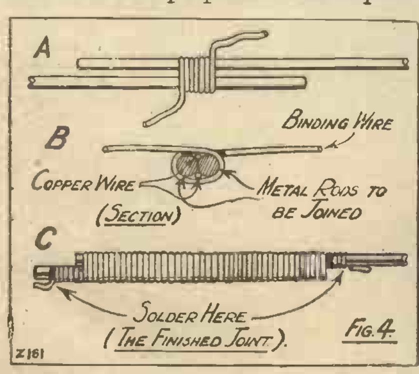
The joint should then be tightened with the aid of a pair of pliers, and finally, the whole area of the joint should be fairly heavily but at the same time neatly soldered. Such a joint in an aerial system will certainly last for the lifetime of the



aerial, and it will be electrically efficient.

Connecting Single-Strand Conductors

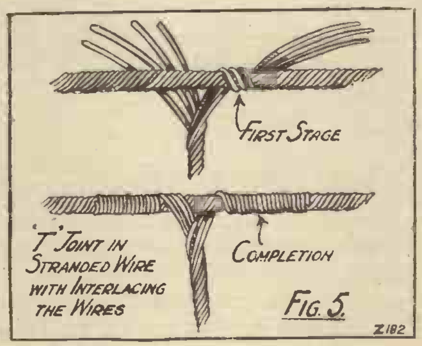
Fig. 2 indicates the method of making a stranded-wire joint for the purpose of attaching the aerial insulator. It will be seen that the usual method of interlacing is adopted. Joints for this purpose do not require



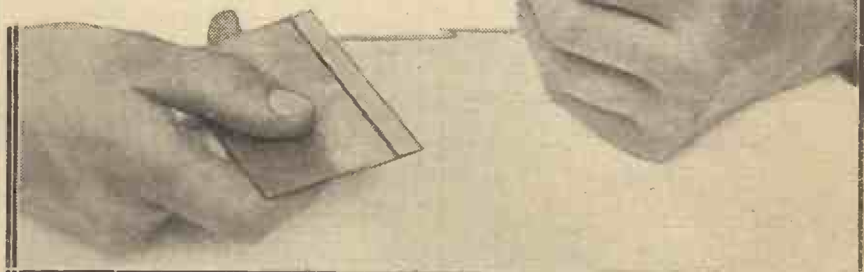
soldering, for they are not in the direct path of the current to the set and, therefore, do not impede its flow.

If single wire is used for any portion of the aerial-earth system of the receiving installation, any necessary joint in it may be effected in the manner shown at Fig. 3. Here the two wires are loosely twisted together for a few turns, and the last inch or so of free wire is tightly twisted around the second wire, these latter turns being tightened by the aid of pliers. Such a joint should be neatly soldered at the places shown in the diagram. It is not necessary to solder over the whole area of this type of joint. This joint is technically known as the "twist joint."

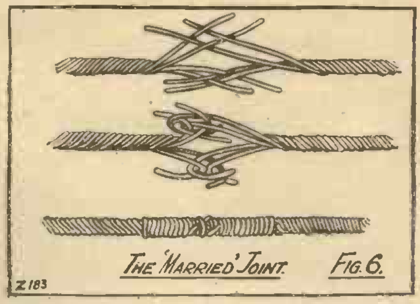
Another useful form of joint for



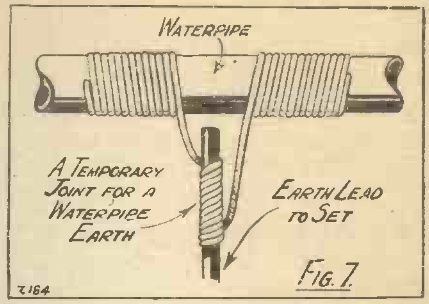
special purposes is the "Britannia joint." As will be seen from the diagram, Fig. 4, which illustrates the construction of the joint, the Britannia joint is only applicable for the connecting together of two stout conductors or metal rods. In order to effect a joint of this nature, lay the rods together



Showing how the two ends of the pieces of metal are bent to form a "lapped" or "seamed" joint.



so that they overlap a few inches. Next, take a foot or two of 20's bare copper wire, and, using the middle of this, begin to bind up the two rods in the manner shown at A in the diagram, Fig. 4. After having made about six turns of binding wire, slip a few pieces of thin copper wire under the turns in order to enable

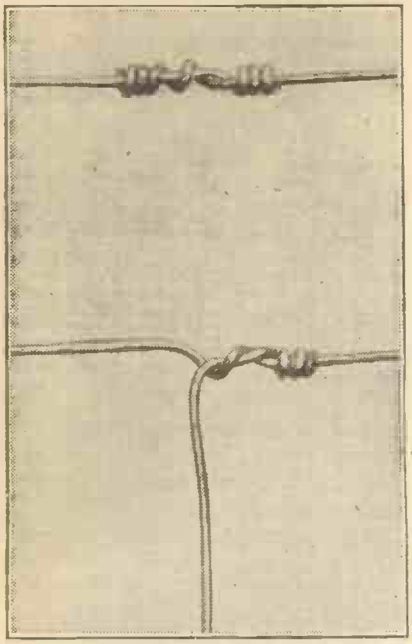


them to attain a greater grip on the two rods. This method is brought out at B in the diagram, Fig. 4, which presents a section of the Britannia joint, showing the small lengths of wire which have been slipped under the turns of binding wire.

Finally, continue the binding of the two rods until all the binding wire has been used up. Finish the joint by soldering the binding wire at both ends, after tightening up the whole structure with pliers. If the joint is to have high electrical efficiency it must also be soldered in a few places along its length.

Another method of making a T-joint in stranded wire is shown in the diagram, Fig. 5. The joint is no more effective than the neater one illustrated at Fig. 1, but, nevertheless, this type of T-joint is of use when it is either difficult or impossible to separate the strands of wire in order to adopt the method of interlacing the wire strands when making the joint.

Fig. 6 illustrates the making of what is known as the "married" joint. Joints of this nature are especially suitable for connecting up two- or three-stranded wires. The diagram



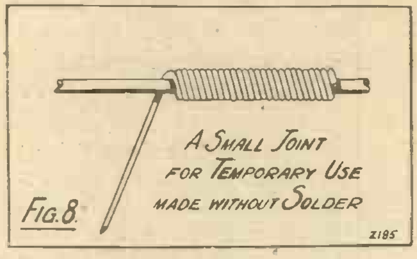
(Above) Two ends of wire twisted together. (Below) A method of twisting single-stranded aerial wires and down-leads together.

is practically self-explanatory. It will be seen that each strand of wire is tightly wound around the others. A pair of pliers is finally used for tightening the joint. Here again, of course, if electrical efficiency of the highest order is demanded, one or two areas of the joint must be well soldered.

Earth Connections

A good method of making an effective temporary connection of an earth lead to a water pipe or metal rod buried in the earth is the one illustrated at Fig. 7. Here again the construction of the joint is self-explanatory, and therefore it does not require further elaboration. It should be borne in mind, however, that the majority of earth connections rapidly corrode, and, therefore, if they are required for permanent use the soldering iron must invariably be brought into efficient operation.

Turning now to wire joints which are sometimes made in radio sets themselves, the diagram, Fig. 8, illustrates one of the most effective joints which can be made without the



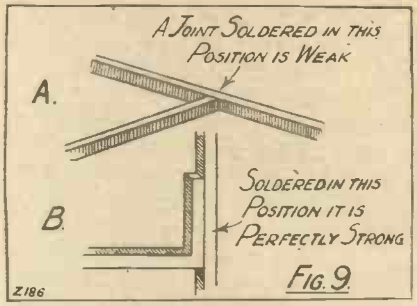
use of solder. Of course, whenever possible all joints and wire connections in a set should be well soldered. After all, the practice of soldering is not difficult, and for electrical efficiency a simply soldered joint must necessarily be far better than the most elaborately twisted together joint.

Strong "T" Joints

One point which some amateur constructors might do well to note is the making of a soldered T-joint which is illustrated in Fig. 9. At A in the diagram we have the method by which a T-joint in round- or square-sectioned wire should *not* be made. Such a joint may, of course, be electrically efficient, but nevertheless it does not possess much strength. T-joints of this nature are much better made in the way indicated at B in the diagram, Fig. 9. Here it will be seen that the two wires are soldered together for a distance of about half an inch. This construction imparts great strength to the soldered joint, a resistance to stress and strain which is, in fact, limited only by the tensile strength of the solder used in making the joint.

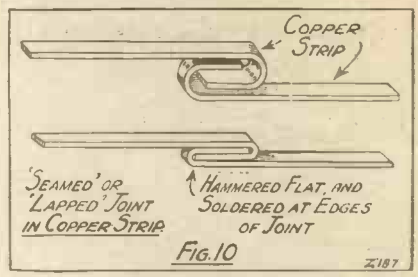
Joining Strip Conductors

Finally, a most useful joint for strip conductors is that which is known as the "seamed" or "lapped" joint. This joint is illustrated at Fig. 10. The ends of the metal strips which are to be connected up are turned over for a distance of about half an inch. These turn-overs are then inserted into each other. The joint is then laid down upon a flat surface, and the area is subjected to a thorough hammering in order to compress the joined surfaces of the strip conductors together. Finally, the joint is finished off by means of the application of solder around the edges of the joined strips.

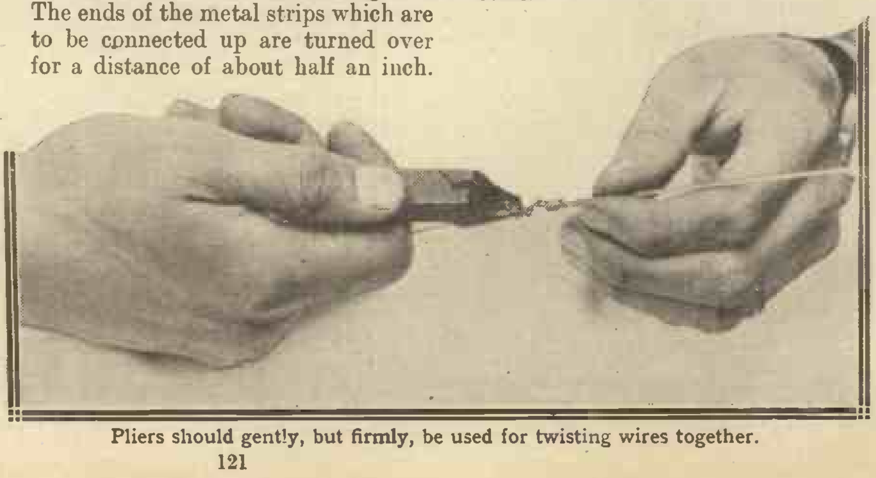


Useful in Condenser Making

This method applies only to thin metal strips or sheets, of a thickness up to about a tenth of an inch. Thicker sheets than these usually have to be riveted and soldered in the ordinary manner. The above method, however, carefully applied, is most useful for joining strips or sheets of



lead or tinfoil in the process of making fixed condensers and similar articles. It is also of use in the installation of copper-strip aerials. A lapped joint, carefully made, is extremely strong, and if a little solder is neatly applied to the joined surfaces a connection of the highest electrical efficiency will result.



Pliers should gently, but firmly, be used for twisting wires together.

A CHEAP FRAME AERIAL

From a Correspondent.

PROBABLY the one disadvantage possessed by commercially made frame aerials lies in their expense, and it is on this account that many amateurs forgo the use of this piece of radio apparatus and devote their attentions exclusively to the more universal elevated aerial.

It is a pity, because almost any valve receiver which has been efficiently constructed on up-to-date lines is capable of giving very interesting results when used on a frame aerial. Moreover, for outdoor work, for getting rid of local interference, and for all types of directional reception a frame aerial is always extremely useful. Such an aerial need not be built on expensive and elaborate lines. A frame aerial of the simplest construction will provide satisfactory results, and the aerial about to be described is an instrument of this type. Its total cost should not exceed two shillings at the most, and, of course, if the amateur already has by him some of the necessary materials for its construction, the cost of the aerial will naturally be very low indeed.

Building the Framework

The frame aerial itself is illustrated in the photograph, Fig. 1, whilst the details necessary for its construction can be obtained by reference to the diagram, Fig. 2. The base (about 4 in. square) should be solidly constructed, wood of at least an inch in thickness being used in order to avoid top-heaviness in the finished instrument. The arms of the aerial are made from two strips of wood, about 2 ft. 4 in. long, 1 in. thick, and 1 in. broad. These are cut away in the centre to a depth of $\frac{5}{8}$ in. in order to provide a suitable joint. After the arms of the aerial have been fixed in position, the central joint is further strengthened by passing a screw through it.

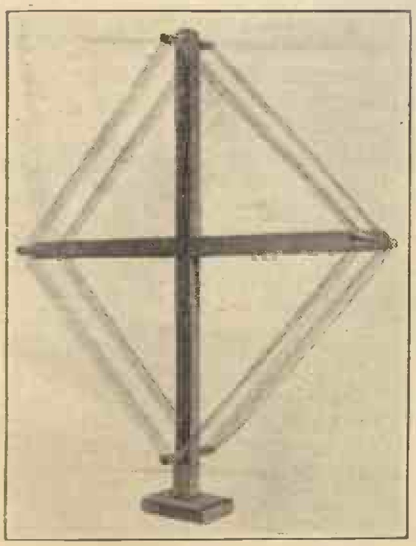


Fig. 1. The complete frame aerial.

The Winding

The upright arm can be secured to the base by means of screws, or any convenient method of jointing.

The winding of the aerial comprises 12 turns of No. 24 D.C.C. wire spaced

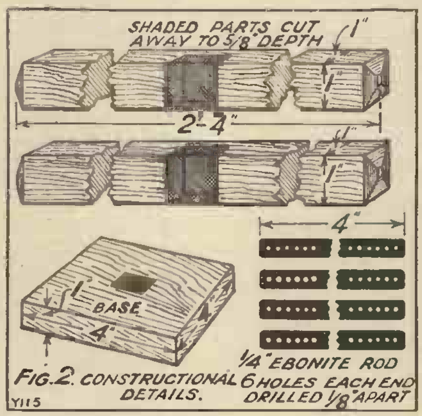


FIG. 2. CONSTRUCTIONAL DETAILS.

$\frac{1}{8}$ in. apart. Ebonite r ds, which are pushed through holes drilled in the arms of the frame, carry the winding. A detail of the construction of these latter will be seen at Fig. 3. Naturally, the frame aerial winding may be made more efficient by using the stranded frame aerial wire which is specially sold for the purpose. Such wire usually consists of 14 strands of bare 28's wire covered with silk. However, for ordinary purposes, No. 24 D.C.C. wire will serve very well for the winding of the frame.

The Frame in Use

The connections to the aerial may be made in a variety of ways, according to the requirements of the individual constructor. Fig. 4 shows one way of mounting the connecting terminals of the frame aerial. Here a strip of ebonite is secured to the bottom of the wooden upright, and terminals are mounted on this. The ebonite strip should be fairly thick, and the shanks of the terminals should be cut off short so that they do not protrude into the wood.

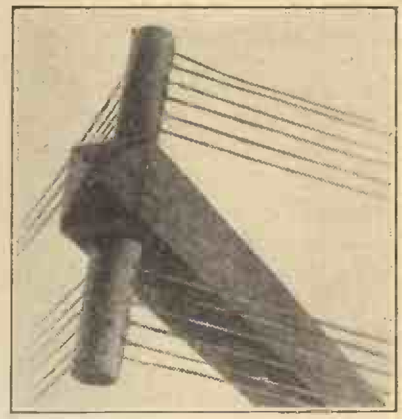


Fig. 3. Showing one of the ebonite rods carrying the winding.

An aerial of the above type will give loud-speaker results of a very satisfactory nature, when used in conjunction with an ordinary three-valve set, up to distances of five miles from a B.B.C. station.

In many cases, the frame aerial will be found to work without the use of a special tuning condenser, but, generally speaking, it is better to have a condenser of approximately ·0003 mfd. connected in parallel with the frame aerial terminals in order to utilise the properties of the aerial to their utmost extent.

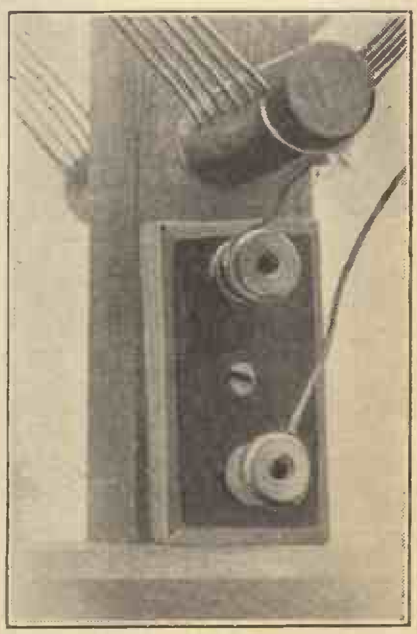
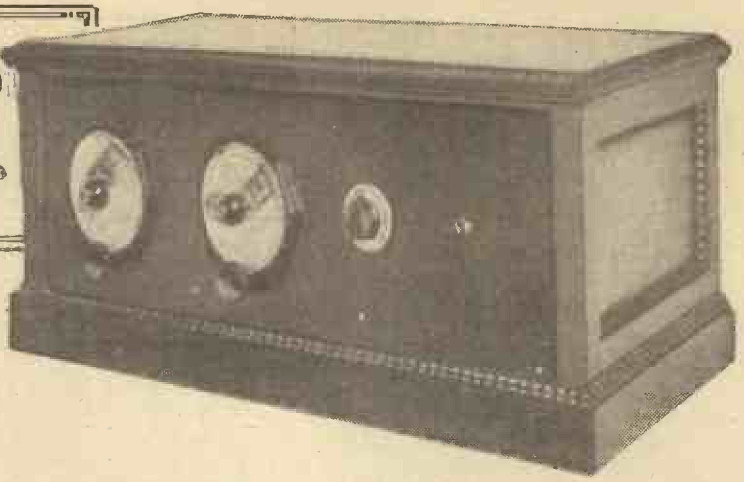


Fig. 4. How the connections can be taken from the frame.

A Filadyne Four-Valver



A powerful loud-speaker receiver incorporating several novel features. Designed and described
By J. ENGLISH.

LONG-DISTANCE reception is at its best during the long, dark, winter evenings, and most listeners realise that it requires a powerful and up-to-date receiver to compensate for the comparatively poor reception conditions prevailing during the summer months. An ordinary regenerative detector with two stages of low-frequency amplification may perform wonders during the winter season, but when daylight conditions prevail nearly all the evening it requires at least one stage of high-frequency amplification to reach out to any distance.

Sensitivity and Purity

Now, where expense is no object it is not a very difficult matter to build a suitable summer receiver, but as we can't all win the Calcutta Sweep it is necessary to look for sets which give us the most for our money. A four-valve receiver, properly put together, should produce a goodly number of stations on the loud speaker even in daylight, without necessitating any unreasonable outlay for its construction.

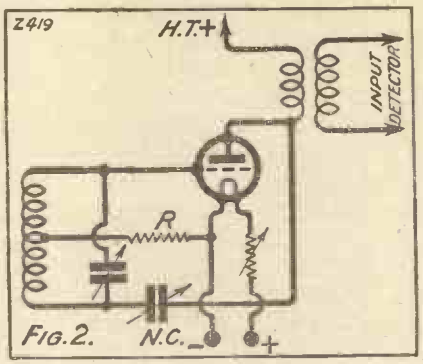


FIG. 2.

The receiver illustrated on this page constitutes one of several combinations of four valves, and is designed to get the most out of each stage without sacrificing quality.

Several novel features have been introduced, which make for easy construction and operation.

Since the programmes of distant stations are required at loud-speaker strength we cannot do with less than two L.F. valves, so that the other two valves straightway drop into the positions of detector and H.F. amplifier, the latter being essential, as we have seen above.

Very Few Controls

This binds us down to two tuning condensers, one to tune the aerial-input circuit, and another to tune the H.F. coupling. The detector follows next, and here, for reasons which I will explain later, I have made use of my version of the Filadyne circuit which was originally invented by Mr. G. V. Dowding, Technical Editor of MODERN WIRELESS.

In connection with this detector a potentiometer is used which serves the dual purpose of a reaction and a volume control, thus combining in one

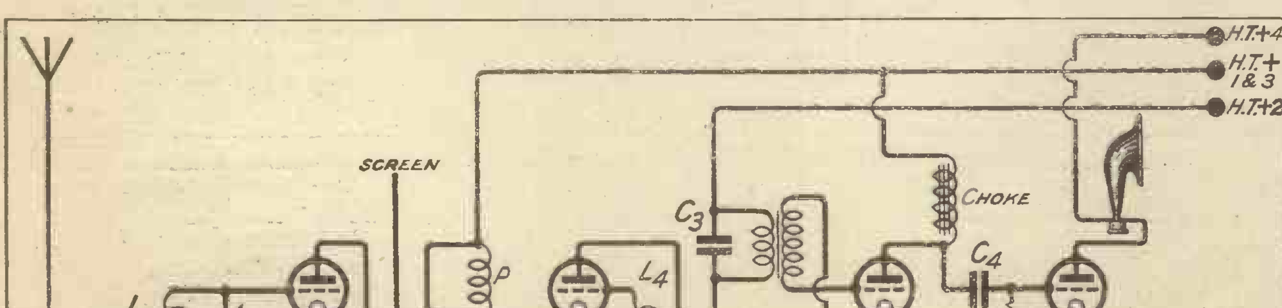


FIG. 1. THEORETICAL CIRCUIT.

the functions of two knobs. This gives us two main controls, the tuning condensers, the potentiometer being a subsidiary, while a simple on-off switch puts the set in and out of operation.

COMPONENTS REQUIRED.

1 ·0005 square-law variable condenser (Ormond).
1 ·0005 S.L.F. variable condenser (Ormond).
2 slow-motion dials (D.I.D.) (Ormond).
1 neutralising condenser (Igranic).
5 valve holders (Benjamin).
2 two-way Loriostats, 6 ohm.
1 potentiometer (Igranic).
1 on-off switch (Benjamin).
1 transformer, ratio 6 : 1 (Marconiphone).
1 L.F. choke
1 ·05 fixed condenser, Type B775 (Dubilier).
1 ·005 fixed condenser, Type 610 (Dubilier).
1 ·0005 fixed condenser (Lissen or Dubilier).
1 grid leak attachment or holder. } (Lissen or Dubilier).
1 grid leak, 1 meg. }
1 grid leak, ·25 meg. }
1 grid leak holder. }
1 coil former, 4 in. × 4 in. (Paxolin or Pirtoid).
1 coil former, 3½ in. × 3 in. (Paxolin or Pirtoid).
2 pieces ribbed ebonite former, 3 in. diameter (Becol).
4 terminals (Eelex).
Quantity wire, 24 D.C.C., 36 D.C.C., 40 S.S.C.
Panel.
Baseboard.
Connecting wire, screws, and sundries.

The two L.F. valves are set out so that one or two stages of amplification can be used. This control of amplification is obtained without using switches or jacks in any form, the method being both novel and simple.

The receiver is thus very straightforward in its general design, and on

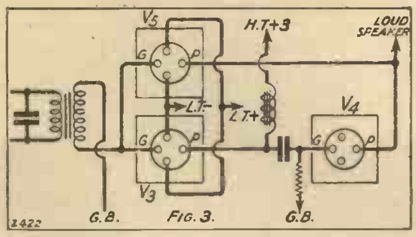


FIG. 3.

test with a good aerial has proved sufficiently powerful to bring in some half dozen stations at good loudspeaker strength during daylight. Selectivity is such that 2 L O, distant about six miles, occupies only a few degrees of the tuning scale. After dark, of course, the range of the receiver is greatly increased, showing that during the more favourable winter months a large number of foreign stations should be receivable at full loud-speaker strength.

The wave-length range of the receiver is limited to about 200 to 500 metres, owing to the requirements of the Filadyne detector, but this is in no way a disadvantage, as there is ample scope for long-distance reception on this lower band.

How Selectivity is Obtained

Having dealt in brief with the main features of this receiver I think it is worth while considering the design of the set stage by stage, as this will bring out any special features and explain such peculiarities as may appear to exist at first glance.

In my opinion, it is quite useless commencing to build a receiver until you have at least tried to grasp the reasons for using a certain circuit combination. If you understand even only a little of what is going on in each stage of the receiver then you are more likely to produce a highly successful set, and to be able to tackle any unforeseen difficulty that may arise later. This applies whether the receiver is a modest crystal set or a pretentious superhet.

Fig. 1 shows the theoretical circuit arrangement of the four valves. The first thing to consider is the tuned circuits, which are chiefly responsible for range and selectivity. You will notice that the aerial circuit consists of an untuned coil L fixed coupled to the tuned grid circuit L_1 C_1. This form of so-called aperiodic aerial coupling helps to increase selectivity, while making it possible to adjust the input circuit to the size of the aerial by

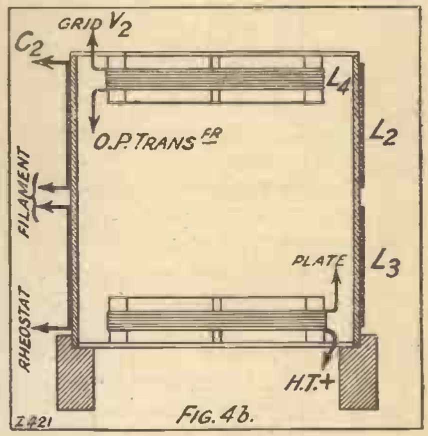


FIG. 4b.

means of the tappings on L. As the number of turns in circuit with aerial and earth is decreased, so selectivity increases while signal strength decreases. It is only necessary, however, to sacrifice volume for selectivity where the receiver is operated near to a powerful station.

H.F. Stabilisation

The low-loss secondary L_1 of the input H.F. transformer is tuned by C_1, forming the input grid circuit of the H.F. valve, which is coupled in turn to the detector by a second H.F. transformer P, L_2.

The system of H.F. stabilisation employed here is similar to that used

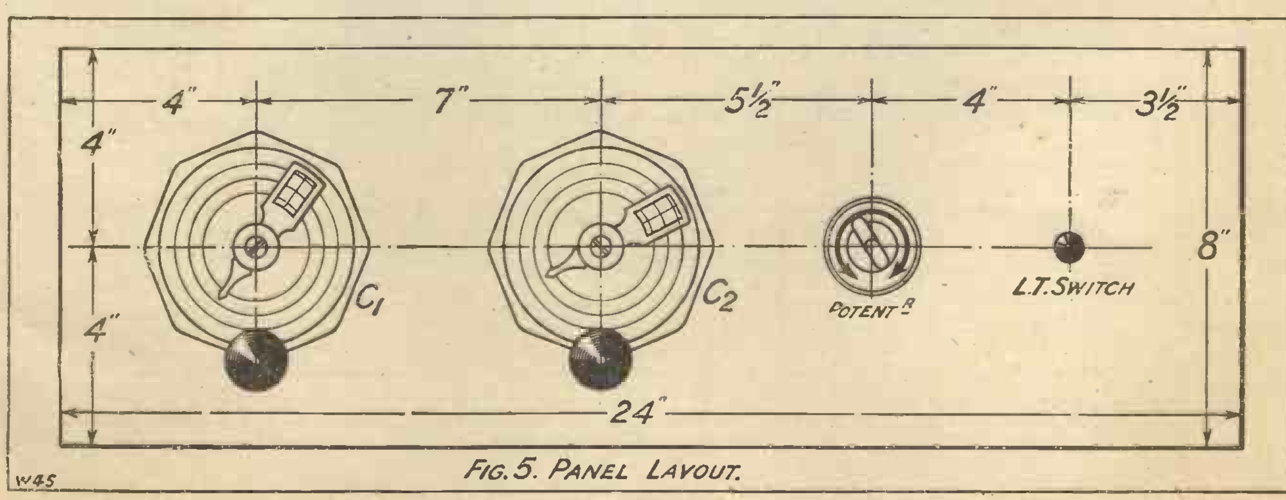


FIG. 5. PANEL LAYOUT.

with such success by Mr. P. W. Harris in the "Black Prince" receiver recently described in MODERN WIRELESS. After experimenting with several systems of stabilisation I chose the present one as being most suitable for use with a Filadyne detector.

Eliminating "Parasitics"

The basic H.F. neutralising circuit, due to one of the radio companies of America, comprises a centre-tapped tuned-grid coil, as in Fig. 2, one end going to the grid and the other to the anode via a small neutralising condenser. The centre-tap is connected to the filament through a high resistance, the sole purpose of which is to damp out parasitic H.F. oscillations. The anode circuit contains an untuned coil forming the primary of the H.F. coupling transformer. This method of stabilisation provides a properly balanced H.F. amplifying system very effective and stable in operation. One disadvantage, however,

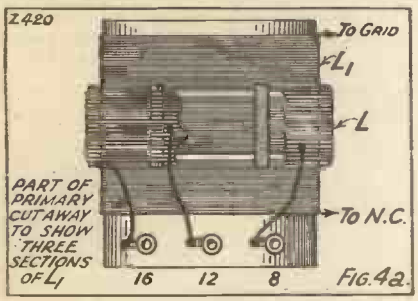


FIG. 4a.

lies in the fact that neither side of the tuning condenser is at earth potential, so that hand-capacity effects can be very troublesome. In the present receiver this difficulty has been overcome by using the Ormond slow-motion dials. The metal engraved dial on the front is actually a shield, insulated from the condenser, but capable of being earthed without increasing the capacity of the tuning condenser itself. This device works so well that hand-capacity effects are entirely absent.

The Detector Circuit

We now pass on to the detector valve, the coupling transformer P L_2 being entirely responsible for the degree of H.F. amplification while adding to the overall selectivity of the H.F. circuits. In the actual receiver this transformer is screened from the input side of the H.F. valve by means of a simple metal screen. This is effective in reducing stray magnetic couplings, thus making stabilisation less difficult. This form of partial screening introduces less H.F. damping than some forms of "can" screening.

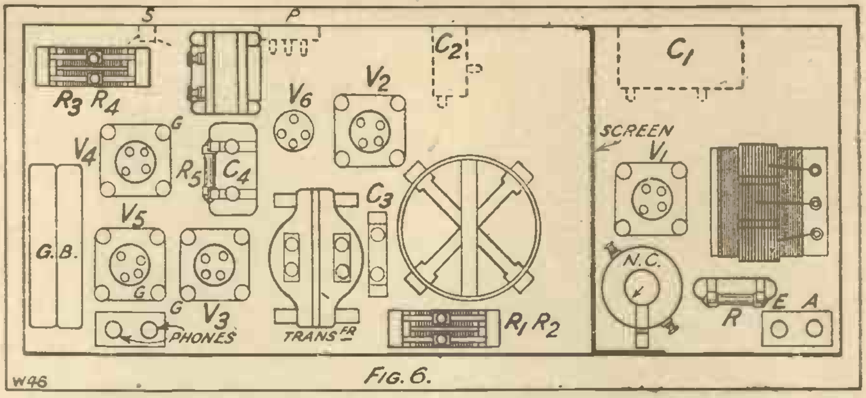


FIG. 6.

The arrangement of the detector-valve circuit is based on the receiver described in "Popular Wireless" No. 256. The reasons for choosing this type of detector will be apparent from the following considerations. Firstly, we have the peculiar advantages of reaction and volume control in one, reaction control being particularly smooth and stable. Secondly, the conventional detector valves have their own disadvantages. The "leaky grid" method is responsible for flat tuning, the flow of grid current which is essential to this method of detection imposing a load on the secondary of the H.F. transformer, which load is fatal to a high degree of selectivity. The anode-bend rectifier, on the other hand, imposes no load on the transformer secondary, but it is by no means so sensitive to weak signals as the "leaky grid" detector. The Filadyne detector, however, suffers from none of these disadvantages, while it is capable of an audio-frequency output of excellent quality.

On the face of it the connections of this detector with its reaction and input coils may seem rather a maze, but actually it is all quite straightforward. First of all, we have two low-loss coils L_2 L_3 as in Fig. 1, both of equal inductance. Through these coils the filament current passes to the valve. Both coils are tuned by the one condenser C_2, thus effecting the desired H.F. isolation of the valve filament. The coils L_2 L_3 are actually wound on the same former, the larger one seen towards the centre of the baseboard. Both these windings constitute, in effect, the secondary of the second H.F. transformer, the primary of the latter, together with the reaction coil L_4 being wound on smaller formers fixed inside the larger one. The latter may look like a gasometer compared with the usual run of coils, but the relatively large inductance required for the thick-wire coils L_2 L_3 necessitates a big former.

The Reaction Control

The control of reaction with this detector arrangement is carried out entirely with the potentiometer, the

A "close-up" clearly showing the arrangement of components at the L.F. end of the receiver.

anode potential of the Filadyne valve deciding the degree of reaction and the strength of signals.

Reaction, of course, is only provided for the reception of weak signals, as it increases greatly the overall H.F. amplification. On a near-by transmission, of course, no reaction at all is required.

The "anode" impedance of this detector being lower than the normal value for the same valve, it is possible to use a high-ratio L.F. transformer giving a large voltage step-up without sacrificing quality. If the impedance were normal in value a choke or even resistance coupling would be greatly preferable in the interests of pure music. In the present case a transformer is probably the best coupling that we can use, the component employed having a ratio of 6 to 1.

Instead of Switching

The third valve will normally be a small power valve of moderate impedance, and for the second L.F. coupling I have chosen a choke-capacity unit. In this stage the first consideration is not so much amplification as signals free from distortion.

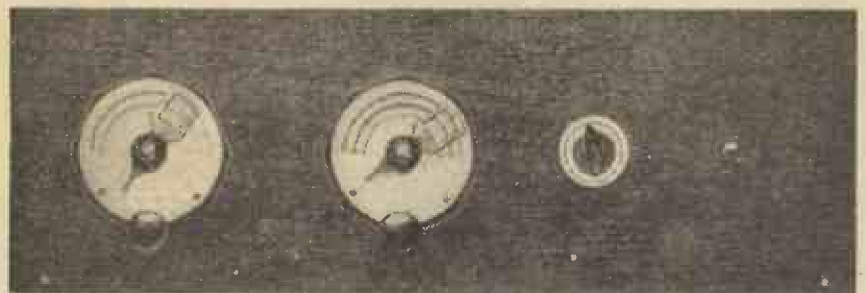
The fourth and last valve will generally be called upon to handle quite a considerable input voltage, especially when receiving the local station. In any case, a large power valve is specified here—the "bigger" the valve the better, within reasonable limits of anode-current consumption and initial cost.

In general, three valves will be sufficient to give full loud-speaker volume from the local station, provided you are not too far away. For this reason I have provided a means of cutting out the first L.F. valve, the fourth being retained, as a good power valve is essential for faithful reproduction. However, the third valve can be used as the last stage where only a moderate output is desired.

The method of selecting the number of L.F. valves is both simple and unusual. It has proved more satisfactory than switching, which I have never considered entirely reliable. In place of a switch an extra valve holder is used, the actual wiring being very simple.

Two Valve Holders Used

The method is best illustrated by reference to Fig. 3, showing three valve holders. Here the filament and grid sockets of 3 and 5 are connected in parallel and the anode socket of 5 joined to that of 4. With four valves in operation, the third is placed in 3 and the fourth in 4. To change to three valves, the last is placed in holder 5 and the third valve removed, being safely held in a blank holder close at hand. This holder can be seen in the photograph just behind the L.F. transformer. Instead of a holder four holes could be drilled in the baseboard. On making the change of valves it will be seen from Fig. 3 that the secondary of the transformer is connected direct to the last valve, the output of which is still through the loud speaker as before.



As is shown here, there are only two main tuning controls on the panel.

Filament Current Controls

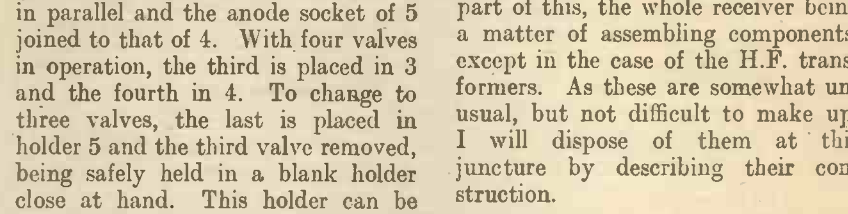
This method may seem cumbrous and troublesome, but actually it takes only a little more time than moving a switch, while one has the satisfaction of knowing that the valve to be cut out is really out of circuit, and that no trouble can occur through switches going wrong. More important still, there is no nasty intricate wiring to bother with, as there would be if a switch were fitted to carry out the same operations. The necessary additional wiring is simplicity itself, as you will see from the photograph of the L.F. end of the receiver.

In connection with the supply of filament current, two two-way Loriostats are used, one for the first pair and one for the second pair of valves. This form of variable resistor provides an easy adjustment of filament current to suit a batch of valves of any filament rating without cumbering the panel with unnecessary knobs. Separate filament control may seem archaic, but I can assure you that it is both economical and sound practice.

This completes the review of the theoretical aspects of the receiver, and we can now come down to the more practical side of construction. There is nothing extraordinary about any part of this, the whole receiver being a matter of assembling components, except in the case of the H.F. transformers. As these are somewhat unusual, but not difficult to make up, I will dispose of them at this juncture by describing their construction.

Making the H.F. Transformers

The aerial grid transformer is wound on a 3-in. former of Paxolint, Pirtoid, etc., and not cardboard unless this is thin and well waxed. At one end three holes are bored to accommodate the sockets to which the tappings of L are connected. A small piece of wood should also be fashioned so that it can be screwed to the baseboard, and then the former screwed to it as in the photograph. The secondary, which is wound on first, consists of a single layer of 61 turns of 24 D.C.C. tapped at the



A view of the completed receiver which will help you in arranging the baseboard components.

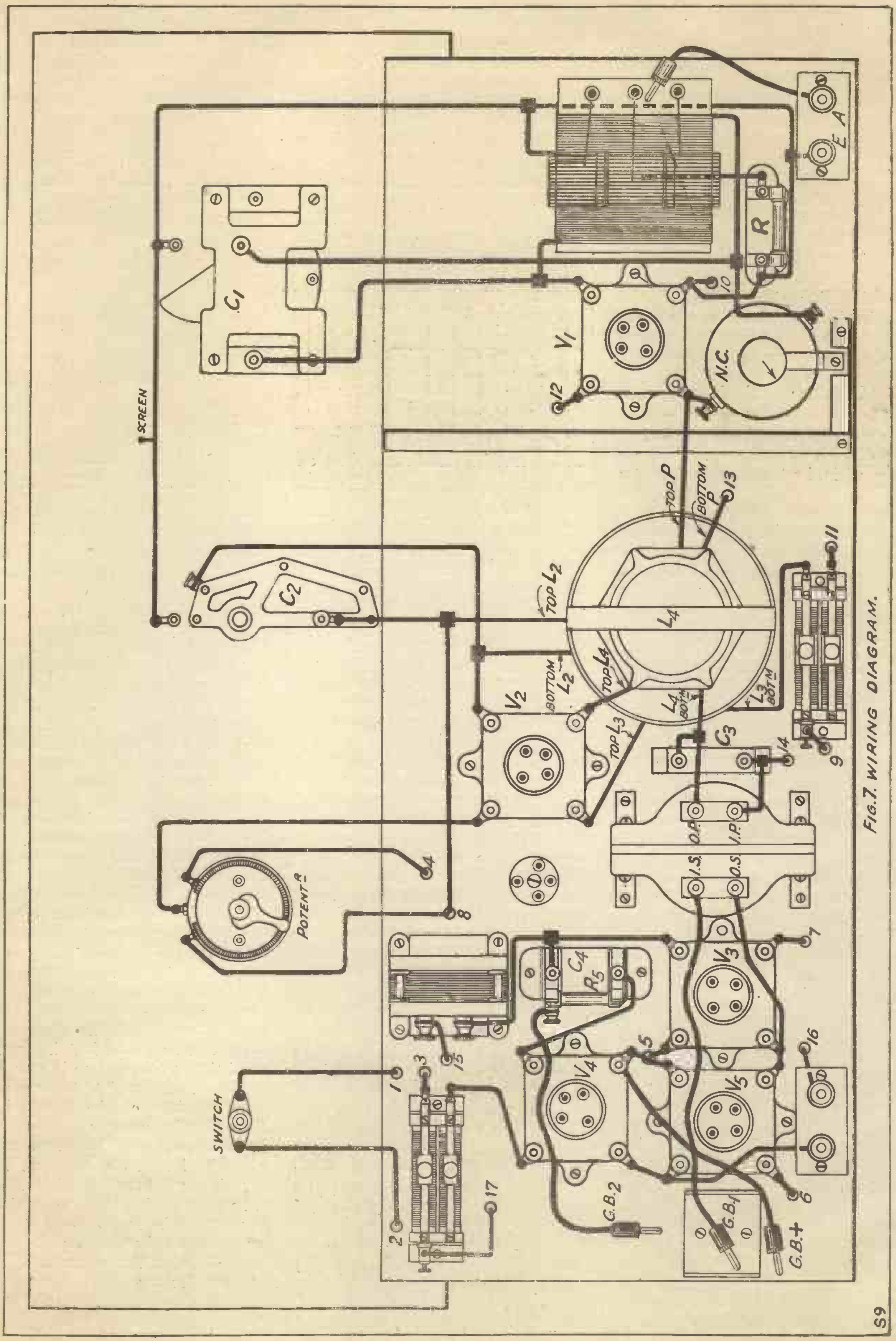


FIG. 7. WIRING DIAGRAM.

S9

centre, the turns being put on in three equal sections with a small space between each section. Next, eight spacers of wood or ebonite, each $1\frac{1}{4}$ in. by $\frac{3}{16}$ in. square, are spaced equidistantly round the former over the middle section of L_1 and held in place by rubber bands while L is wound.

The primary L consists of 16 turns of 36 D.C.C. tapped at 8 and 12 turns, each turn being about $\frac{1}{16}$ in. from the next, but there is no need to be exact about the spacing. The beginning and final ends are best secured by threading through small holes previously drilled in one or two of the spacers. The transformer is illustrated in diagram form in Fig. 4a.

Further Coil Details

The second H.F. transformer is of a more complicated nature, but is not difficult to make up. First we have a 4 in. by 4 in. former of similar material to the first. On this are wound the two coils L_2 L_3, each consisting of 60 turns of 24 D.C.C. wound in opposite directions with a small space between the coils. Each free end of wire is secured by threading through small holes drilled in the former, the idea being to eliminate metal screws and bolts, which cause some slight H.F. losses.

The formers for winding P and L_4 are $\frac{5}{8}$ in. in length and cut from a piece of ribbed ebonite former having an average diameter of 3 in. The winding P consists of 20 turns of 40 S.S.C., the turns not quite touching, the ends being secured by threading through small holes drilled in one of the ribs. The reaction coil is wound with 35 turns of the same wire, the turns being closely wound and the ends secured as before. The assembly of the three formers will be described later.

As regards the framework of the receiver, Fig. 5 shows the panel dimensions and layout, while Fig. 6 indicates the relative positions of the baseboard components. Since the parts of all components in contact with the panel are more or less at earth potential, an ebonite panel is not necessary. I have used in the original a piece of oak-faced three-ply which is very strong and rigid. It also looks very handsome when stained and polished. A metal panel cannot be used unless the panel components are bushed, as it would short-circuit part of the filament wiring and upset the neutralised H.F. stage.

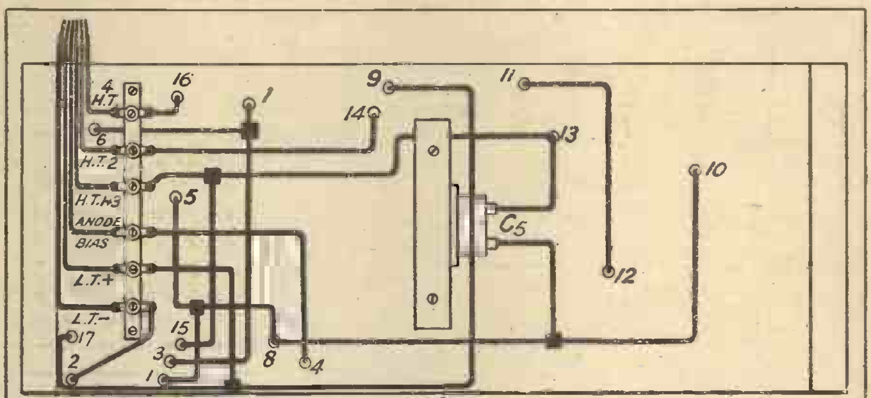


FIG. 8.

Wooden Panel Used

The best material to use for the baseboard is a piece of six-ply, which, besides being very strong, does not warp, ordinary wood being very unsatisfactory in this respect. The baseboard is screwed to two 1 in. by 9 in. wooden battens, one at each end. This raises the baseboard above the floor of the cabinet, so that most of the filament and H.T. wiring can be carried out underneath the baseboard. This makes for neater wiring above, with less cramping of leads.

A battery terminal panel is not used in this receiver, the necessary number of flexible leads being soldered direct to contact points carried on a strip of ebonite underneath the baseboard. The H.T. negative is connected to L.T. plus externally, so the only terminals used are two for aerial and earth, and two for the loud-speaker leads. Each pair of terminals is mounted on a strip of ebonite 2 in. by 1 in. raised above the baseboard by $\frac{3}{4}$-in. lengths of ebonite tubing through which the holding screws at each end pass into the baseboard.

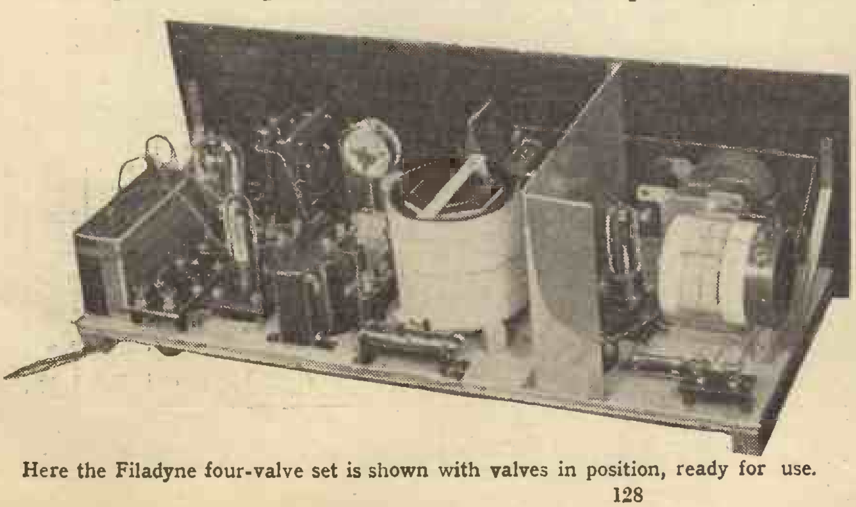
A list is appended of the types of components chosen for the original receiver, but equally suitable ones can be used if desired. If a different type of variable condenser is chosen it is essential, if it is fitted with a metal shield, that the latter can be earthed without making contact with any part of the condenser itself. Two S.L.F. condensers would perhaps be more preferable, as giving a more exact coincidence in the dial readings.

The Metal Screen

It is advisable to mount at first all the components except the H.F. transformers and the metal screen between them. This screen, by the way, can be cut from thin copper, aluminium, or zinc sheet to the dimensions of 12 in. by 7 in. It is then bent to the form shown in the photograph, a $\frac{1}{2}$-in. overlap being bent over at the bottom so that it can be screwed to the baseboard. Notice that one small hole has to be drilled through this screen in order to pass the lead (insulated) from the anode terminal of the first valve holder to the primary winding P. The exact position of this hole can be marked and then drilled before the screen is finally fixed in position.

The actual wiring of the receiver can very well be done in three stages, first the under-baseboard part, then the L.F. side, and after mounting the H.F. transformers the remainder of the wiring. If Figs. 7 and 8 are

(*Continued on page* 198)



Here the Filadyne four-valve set is shown with valves in position, ready for use.

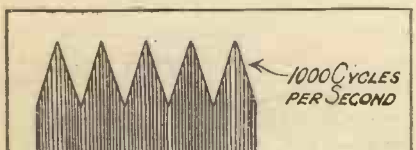
Does the Crystal Distort?

Our contributor proves that the crystal detector can be by no means a perfect rectifier.

By W. JAMES.

It would appear that one of the least understood parts of a wireless receiver is the detector. This is the more remarkable because all receivers have to use a detector of one form or other, and one would think that being so widely known the properties and peculiarities of ordinary detectors would be more or less well understood.

Most people have some sort of an idea as to what a detector is used for; at all events, they know it is absolutely essential to have one, and that it has to be properly adjusted before good results can be obtained. But it is not so widely known that detectors often distort the signal; we do not say



that *all* detectors distort, but it is safe to say that many of them do. It all depends on the type of detector and how it is arranged, and, what is equally important, on the strength of the signal applied to the detector.

The "Carrier" Wave

We shall understand the reasons for this a little better, perhaps, if we consider for a moment what the detector has to do. We know that at the broadcast station H.F. currents are generated by the transmitter, and when no signal in the form of speech or music is being sent these oscillations of a single frequency are being radiated.

A receiver tuned to the station will therefore receive oscillations of this frequency, but nothing will be heard because the frequency is right outside the range of audibility, and as we shall see presently, a continuous current only is produced in the output circuit of the detector.

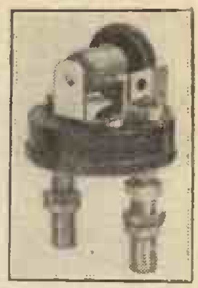
H.F. and L.F.

Thus the frequency of the currents flowing in a receiving aerial corresponding to a transmitting wavelength of 400 metres is 750,000 cycles. But when the announcer speaks at the broadcast station, currents of other frequencies are produced, these representing the speech frequency currents set up by the announcer talking in front of the microphone.

The sound waves produced when speaking ordinarily range in frequency from about 200 to 2,000 cycles per second, and these may be considered to be superimposed on the central or carrier frequency of 750,000 cycles. Thus, instead of the single H.F. current of 750,000 cycles being radiated by the transmitter, we have grouped around it currents of other frequencies which extend from 200 to 2,000 cycles above the central frequency, and from 200 to 2,000 cycles below.

When music is transmitted a much wider band of frequencies is set up, because musical frequencies range from about 20 to 5,000 cycles.

We can therefore imagine the current received to have the form



A popular type of artificial galena crystal detector which is sensitive to weak signals.

depicted in Fig. 1, where it is assumed that the central frequency is of 750,000 cycles and that a pure note having a frequency of 1,000 cycles is being transmitted. Unfortunately, it is not possible to draw this to scale, but it should be understood that the fine lines represent the H.F., and that in one complete cycle of the L.F. there

A typical crystal broadcast receiver.

are 750 oscillations. It should also be noted that the amplitude of the L.F. variation depends upon the amount of modulation which is permitted at the transmitter. If the oscillations are deeply modulated they vary very nearly from zero to the maximum value.

When speech or music is being transmitted, our set therefore receives a whole range of frequencies which are applied to the detector, and it is the function of the detector to separate the L.F. component from the signal received. It does this by cutting out, as it were, the H.F. currents and leaving the L.F. ones, which are passed to the head telephones and cause them to emit the various sounds contained in the signal. When L.F. amplification is used the speech-frequency currents are, of course, passed through the amplifier and magnified before being applied to a loud speaker.

A Detector's Function

In the output circuit of the detector we normally require the speech-frequency currents only, although when reaction is used the H.F. currents are employed. Speaking generally, however, we may say that the H.F. currents serve merely to convey the currents of speech and musical frequencies from the transmitter to the detector. Having arrived at the detector we have no further use for

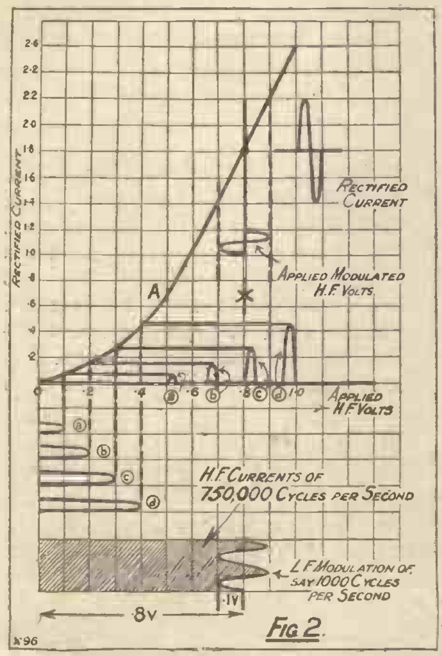
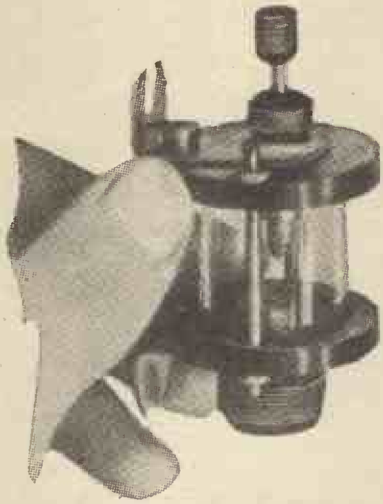


Fig. 2.

these H.F. currents (except when reaction is used), and, in fact, great care is always taken that they do not pass into the L.F. circuit, as they would interfere with the correct functioning of the receiver. To put the matter in a nutshell, we may say that at the transmitter the speech-frequency currents are mixed up with H.F. currents in order that they may be radiated and be picked up by the receiver, and it is the function of the detector to abstract the L.F. currents.

A Crystal Characteristic Curve

The simplest form of detector comprises two crystals in contact or a crystal having a wire contact. If the current flowing through such a crystal detector for various applied voltages is measured it will be found that the current does not increase proportionately with the applied voltage until the voltage has reached more than a certain value.



A type of "cat's-whisker" detector that has been very popular.

A curve drawn to show the value of rectified current for various voltages usually takes the shape of that in Fig. 2. It should be noted that we are applying H.F. voltages of known value to the detector, and that we are measuring the direct current passed by the crystal detector.

For the particular detector to which this curve applies it will be noted that the current flowing increases rather rapidly with the voltage up to a point marked A, Fig. 2, beyond which the current increases in proportion to the voltage. In other words, the bottom of this characteristic is curved, while the upper part is straight.

Output Not Proportional

In the example considered the straight part of the curve commences at an input voltage of about 0·5 volt.

It will therefore be clear that if we apply a small H.F. voltage to this detector—that is, a voltage of less than 0·5 volt—the rectified current will not vary in strict proportion to the voltage. For instance, if the applied H.F. is 0·1 volt (Curve A, Fig. 2), the rectified current is 0·06; if it is 0·2 volt (B), the current is 0·15; that is, doubling the input voltage has nearly trebled the rectified

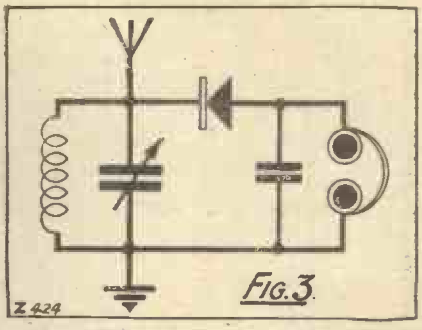


Fig. 3.

current. For 0·3 volt input we get a current of 0·28, and for 0·4 volt a current of ·45. In the latter instance, we see that, although the voltage has been increased by only four times, the rectified current has increased eight times.

It will therefore be clear that small voltages produce relatively small currents as compared with larger voltages, and therefore the strength of a sound heard in a pair of telephones connected to the detector will not vary in strict proportion to the applied voltage. This form of distortion is known as amplitude distortion, and a further practical effect is that weak applied signals are heard very faintly, whereas a little stronger applied signal is heard much more loudly in proportion.

Question of Modulation

Now, we explained above that the signals received from the broadcast station could be considered as H.F. currents with L.F. currents superimposed. If the H.F. currents were

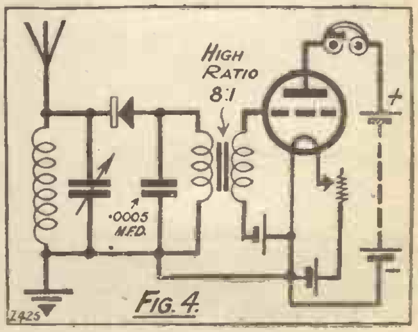
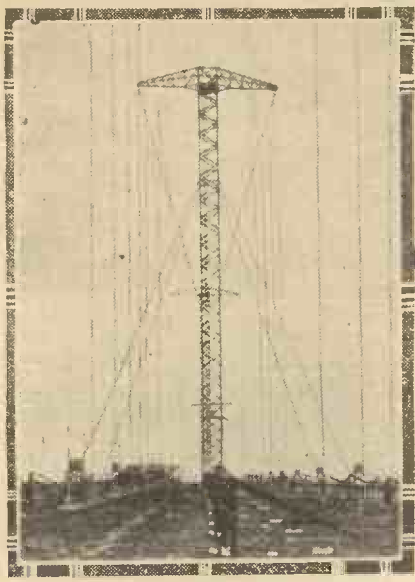


Fig. 4.

fully modulated the received signal would comprise H.F. currents varying in strength at a L.F. from zero to the maximum value. In practice nothing like full modulation is used; an average value appears to be about

(Continued on page 204.)



The Grimsby Beam Station

An article which tells the story of another Link in the Empire Wireless Chain.

From A Special Correspondent.

"DAH DAH DI—dah di di di—di di di di——" As I stood, the other day, by the Post Office's short-wave transmitter at Tetney, near Grimsby, I heard from a nearby loud speaker the Morse mutterings which told that the signals were going out from the great beam aerial which towered outside.

Speeds of Transmission

"Dah di di di——" Fifty words a minute, I estimated. It was 1.30 in the afternoon, a poor time of the day for long-distance communication round to the other end of the earth. At such times the speed of transmission is reduced. This transmitter, which works with the beam receiver near Melbourne in Australia, has done 340 words a minute, but the average speed, since it commenced the service on April 8th, has been about 100 words a minute. A greater average is possible, but at present the England-Australia service is only receiving and transmitting 60,000 words a week (not bad for a beginning), and there is no point in working at a very high speed when the messages can be got through at a more moderate one.

"Insignificant Looking" Transmitter

"Di di di di——" It was fascinating to stand there by the transmitter—quite an insignificant-looking affair compared with some, the B.B.C.'s Daventry transmitter, for instance—to watch the steady glow of the huge valves and to listen to that equally steady Morse. The note of the signal itself was rock-steady, telling of a well-sustained frequency. It is no easy matter to keep constantly to such a wave-length as this station uses—25·906 metres—and special arrangements are included in the transmitting circuit to ensure a constant frequency.

The station building at Tetney houses another beam transmitter. This is to work with India, and is at present being tested. The opening of the Indian service is delayed owing to the transmitting station in India not yet being completed. When completed it will work with the beam receiving station at Skegness which also receives the transmission from Melbourne. Skegness and Grimsby will therefore work in unison, Skegness receiving from Australia and India, and Grimsby transmitting to them.

The Australian Aerial

There are two beam aerials at Tetney, one for Australia and one, at present standing idle, for India. The visitor will notice that the Australian aerial has three masts, but the Indian one has five. There is a very interesting reason for this.

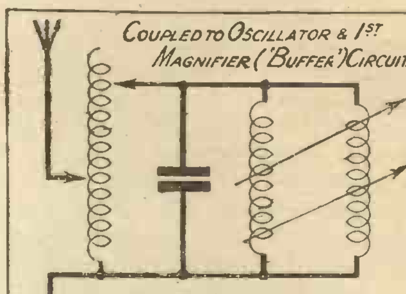


Fig. 1. THE TUNING CIRCUITS OF THE TRANSMITTER.

Consider first the Australian aerial. Fig. 3 shows its layout in plan view. The three masts are 287 ft. high, and each has a cross beam at the top, 90 ft. across. They are 650 ft. apart. Wires run from the cross beam of one mast to the cross beam of the next, right along the line of the masts, parallel with the ground. These are merely supporting wires. From them hang a large number of vertical wires, going right down to the ground. In

The transmitting room of the Grimsby Beam wireless station.

the beam system of transmission, of course, vertical aerial wires are used and another curtain of vertical wires is placed behind the aerial as a reflector. This works just like a mirror behind a light. It throws the waves forward in a concentrated beam.

The line of dots shown down the centre of the system in the diagram represents the curtain of vertical wires which is the reflector for the Australian service. On each side of it and a quarter of a wave-length away from it is another curtain. These are both aerials. There are two aerials.

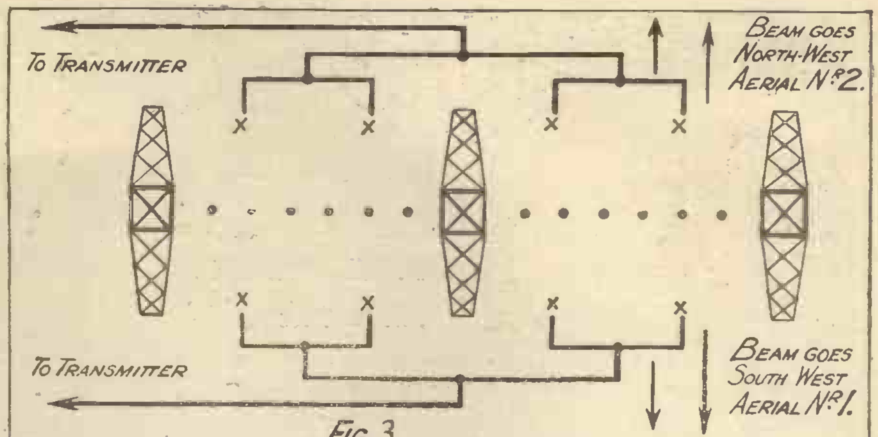


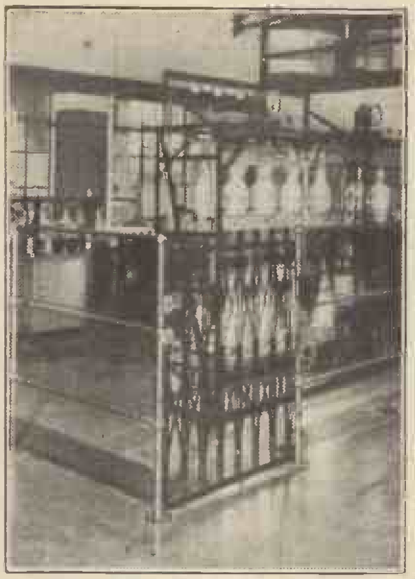
FIG. 3

Two Possible Routes

When aerial number one is in use the waves are reflected back by the reflector and are projected in a beam in the direction shown by the arrow—approximately south-east. But when aerial number two is energised the waves will be reflected by the same reflector and will go off, as shown by the other arrow, north-westerly. In each case, when it has travelled half-way round the world, the beam will fall upon the receiving station, for the Tetney aerials are arranged so that they are exactly at right angles to the great circle from there to Melbourne.

It is, therefore, possible to send the signals in either of two directions. They can go out from aerial number one, cross Europe and Asia, proceeding, roughly speaking, eastwards. Or aerial number two can be energised instead, and they will go westwards, across the Atlantic, America, and the Pacific. The eastward route is known as the short route, as it is 10,500 miles, compared with the 14,000 miles of the westward route.

Wireless waves travel best in darkness. When the best part of Europe and Asia are in darkness, therefore, the short route is used. As soon as the sun swings round enough to have brought daylight to most of that hemisphere signals begin to fade. But


A view of the rectifier plant at Grimsby.

darkness will then have fallen on most of the other hemisphere—the American side. A switch is thrown over at Tetney, transferring the transmitter from aerial number one to aerial number two, and the long route is in use. At the same time, of course, the receiving station at Melbourne has to make a similar change over.

The change over is usually made at about noon and at two o'clock in the morning. For about two hours out of the 24, however, the transmitter and receiver are usually out of touch. The long route is used approximately from midnight to midday, and the short route from midday to midnight.

The Aerials Used

It is obvious that this could not be done if Melbourne were not approximately at the opposite side of the globe. It is a very convenient way of combating the bad effects of daylight. In the case of the Indian service it cannot be done, as there would be no advantage in sending the beam westwards. Fig. 2 shows the Indian aerial at Tetney.

Again there are actually two aerials, but this time both face eastwards. Aerial number one works on a wave-length of 16·216 metres. This wave-length will be used when it is daylight over most of the route to India. At night the other aerial will be used. It is tuned to 34·163 metres. In this case the light bogey is tackled by using a shorter wave-length.

In the case of both services the vertical aerial wires are connected together in parallel, as shown in the diagrams. In each bay (the space between two masts) there are 16 aerial wires and 32 reflectors, the latter being earthed at the bottom. The connections between the aerials are made by cables carried inside pipes supported about two feet above the ground. These go to the station building, which houses the transmitters for both services and the requisite electrical plant.

(Continued on page 203)

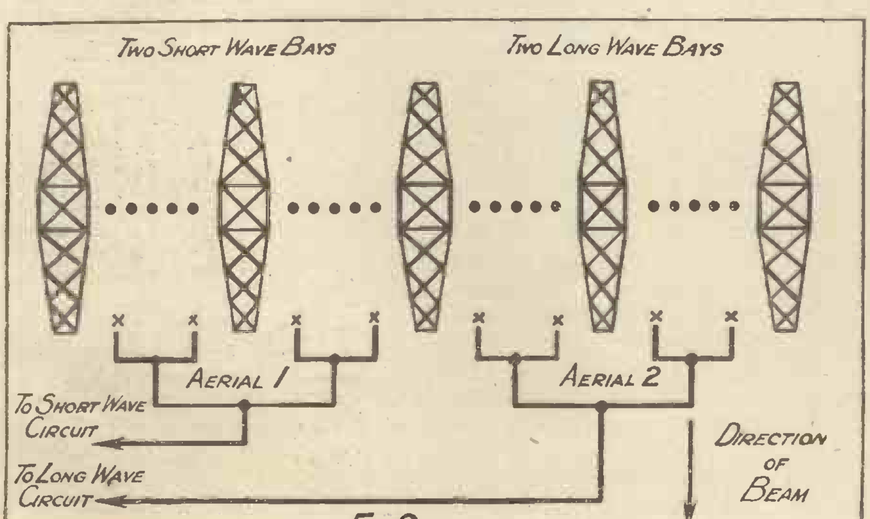
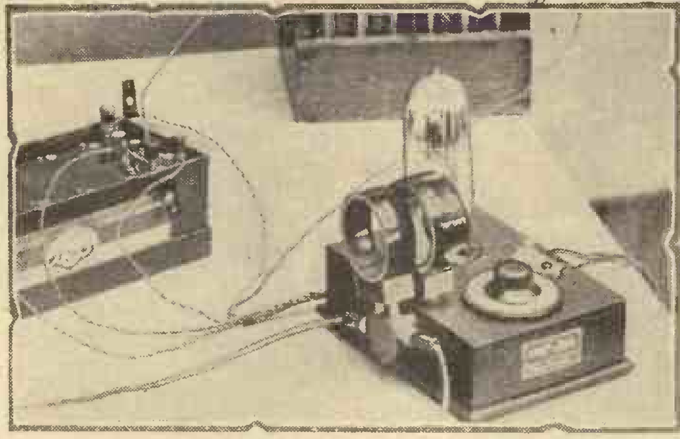


FIG. 2.

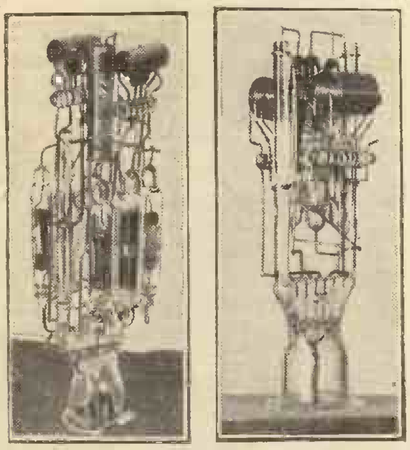


The LOEWE MULTIPLE VALVE

Full details of the recently perfected German multiple valve.

By Dr. W. REISS.

In order to obtain distortionless reception of long-distance transmissions at good loud-speaker strength it is necessary to employ a receiving set of not less than five valve stages. Of course, one can sometimes do with a smaller number than five valves, with reaction, particularly if the reaction is carried almost up to the oscillation-point. In this case, however, pure reproduction can no longer be expected.



Figs. 1 and 2. The three-stage and two-stage Loewe valve.

Every radio fan will know the great number of components and connections required, and the precautions to be observed, when assembling a multi-valve set in order to obtain perfect functioning.

Two Types

There are many who have failed with the neutrodyne. All who have not yet succeeded in long-distance reception, or have not been satisfied with it, are offered a chance by the multi-stage valves with built-in coupling elements (Fig. 2).

There are two types of multi-stage valves, viz., the three-stage valves (type 3 N.F.) and the long-distance valve (type 2 H.F.). Either type represents complete multi-stage amplifying systems. They contain as coupling links between the valve stages not low-frequency transformers, but high-ohmic resistances and coupling condensers. The principle of the interior of the valve is thus the same as with the well-known resistance-capacity amplifiers. The inner system of the three-stage valve is shown in Fig. 1, the connecting diagram of it is illustrated by the right-hand enclosed portion of Fig. 7.

Internal Construction

It will be noted from Fig. 1 that the two horizontal cylinders and the one vertical between them are the three electrode systems of the separate valve stages. The coupling components are arranged around the middle axis of the valve. The three-stage valve is used for rectifying the high-frequency oscillations and amplifying same at low frequency. In order to get a rough idea about the amplifying power it might be mentioned that in broadcasting cities and their outskirts the three-stage valve gives ample energy for local loud-speaker reception.

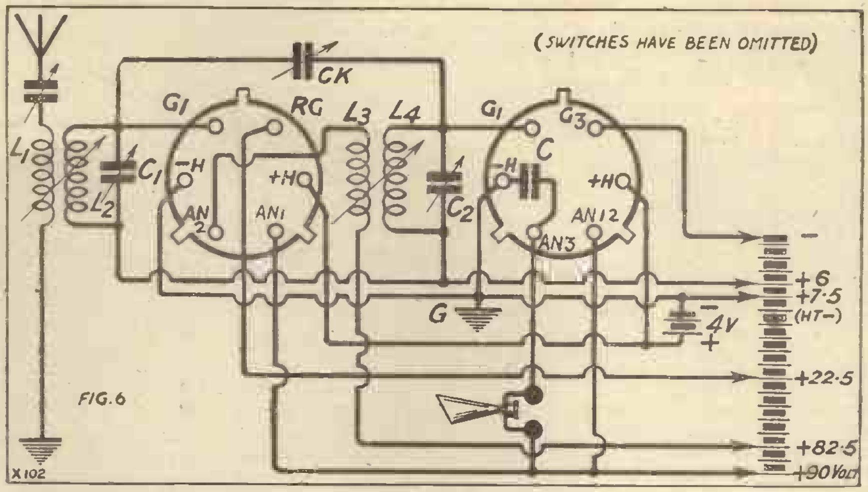
The considerations referring to the amplification of sound frequencies by means of valves coupled with resistance capacity apply theoretically to the problem of the high-frequency amplification. When practising the method, however, technical difficulties will arise. If one uses single valves when constructing high-frequency amplifiers the amplification falls off at a lower wave limit of about 800–1,000 metres.

The reason for this is that apart from the capacities of the valve electrodes those of the connecting leads between the coupling elements must also be considered.

In the long-distance valve it has been possible to place the coupling links quite close to the electrodes of two valve stages, and therefore to keep the connecting leads so short, and the stray capacities so small, as to obtain a high-frequency amplification in two stages, effective down to a wave-length of about 200 metres. The principal connection of the long-distance valve is illustrated in the smaller enclosed part of Fig. 7 on the left. The technical construction of the interior is shown in Fig. 2. The two horizontal electrode systems of the two valve stages will be easily noted in the upper part of Fig. 2.

Fig. 3. The new valve in its complete form.

When combining the long-distance valve with the three-stage valve according to Fig. 7, one will obtain an efficient long-distance receiving set. The effect of the connection is that the incoming weak signals will be so amplified by the long-distance valve as to rectify and bring the speech frequencies up to loud-speaker intensity by the coupled three-stage valve. For obtaining sufficient selectivity, guaranteeing the reception of the different transmitters without interference from the local, the circuit contains two tuning circuits C_1, L_2, and C_2, L_4, which are coupled to the two coils L_1, and L_3; the energy input of same may be controlled by the degree of coupling.



Increasing Selectivity

For increasing the selectivity the aerial can have a series-parallel tuning arrangement. For receiving the short wireless waves below about 400 metres it has proved suitable to transfer part of the output energy of the long-distance valve to its input grid circuit through a small condenser Ck. Hereby the damping of the oscillatory circuit will be reduced, and consequently the selectivity and volume increased.

For receiving longer waves of the big broadcasting stations, such as Koenigswusterhausen or Daventry, the aerial coil L_1 may be connected in parallel with the aerial condenser. The blocking condenser between – H and An 3 in Fig. 7 (see also C in Fig. 6) answers the purpose of by-passing the slight amount of high-frequency energy which may still be in the output of the valve, and of suppressing unwanted reaction which would manifest itself by whistling and howling in the set.

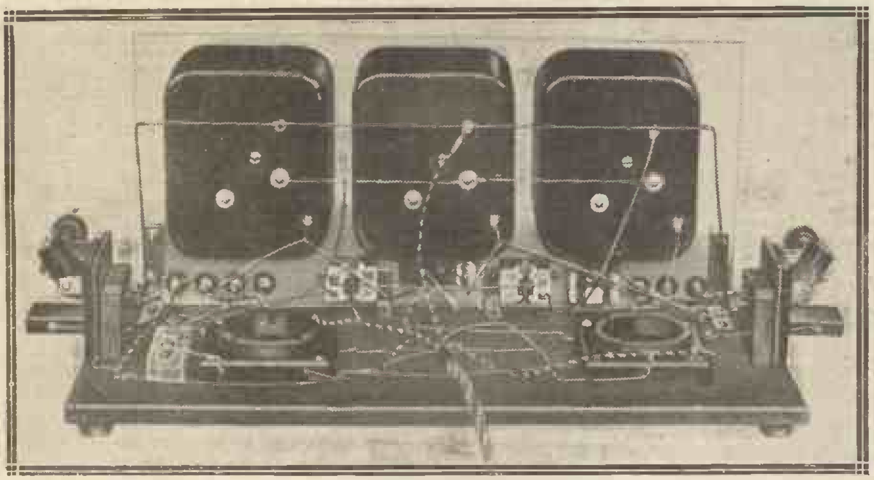


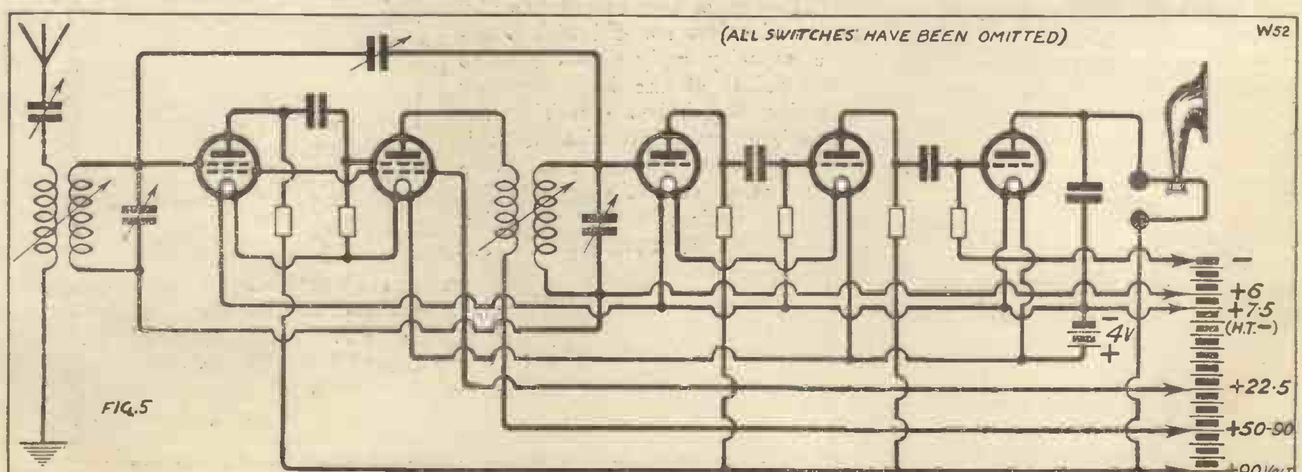
Fig. 4. The back-of-panel connections of a five-stage receiver.

The capacity of the condenser is about ·005 mfd. The earth-connection at – H of Fig. 7 (see also C in Fig. 6) refers to the metallic coating of the front plate which, however, is not earthed.

Easy to Construct

The advantages of the multi-stage valves become evident when drawing a circuit diagram (see Fig. 5) showing the same arrangement as Fig. 7, with the difference that a separate valve is used for each amplifying stage. The connection, Fig. 7, will be best transferred to the simplified illustration of Fig. 6, where instead of the principal connection of the multi-stage valves only their holders with the natural arrangement of the six connecting pins are shown.

When comparing the two Figs. 5 and 6 one will note at once the considerable simplification which is

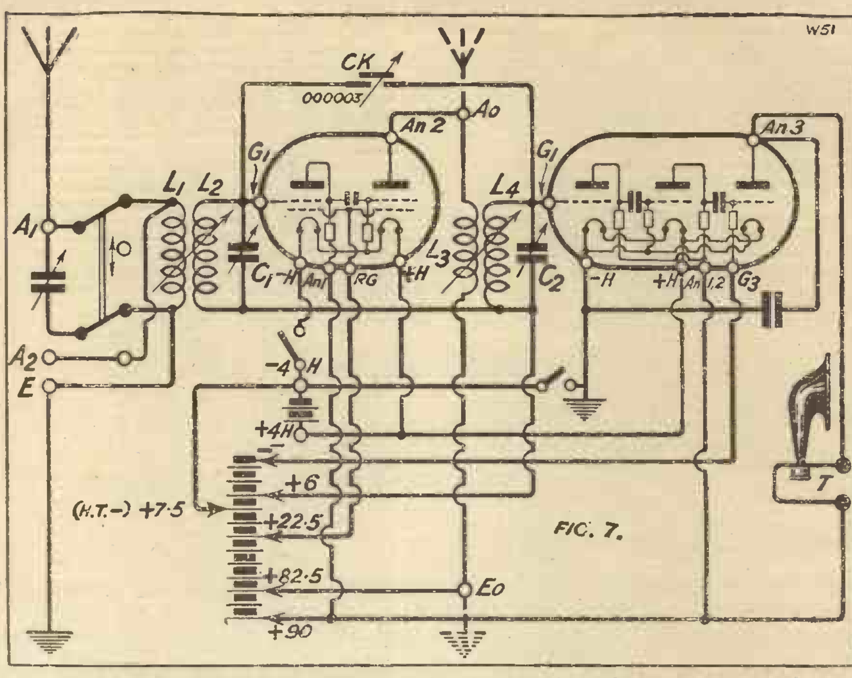


offered to the constructor by the multi-stage valves. The constructor is offered complete multi-stage amplifiers and spared the trouble of fixing five valve holders, the numerous coupling links (high-ohmic resistances and condensers) and the respective connecting leads.

Special Screening Required

In all assembled sensitive sets the valves 3N.F. and 2H.F. have to be specially covered; this is simply done by wrapping the glass bulb with some tinfoil, copper, or other metal foil, wrapping several turns of bare copper wire round it, and joining the protective cover to one pole of the L.T. battery. The static protection may be also carried on by a metal cylinder or a cylinder coated inside with tinfoil. It should be noticed that considerable trouble may arise without the blocking condenser at the output of the three-stage valve—for instance, howling of the whole set, caused by undesired reaction.

Of course, no blocking condenser should be placed between the output plate and filament of the long-distance valve, since the high-frequency current would be short-circuited by it. On the contrary, when using the high-frequency valve great care has to be taken that all stray capacities in the leads and coils are avoided. Therefore, only coils of very low capacity should be used in the output circuit of the long-distance valve—for instance, single-layer cylinder coils or basket coils. (Pancake coils and particularly the customary "honeycomb" coils give bad results.)



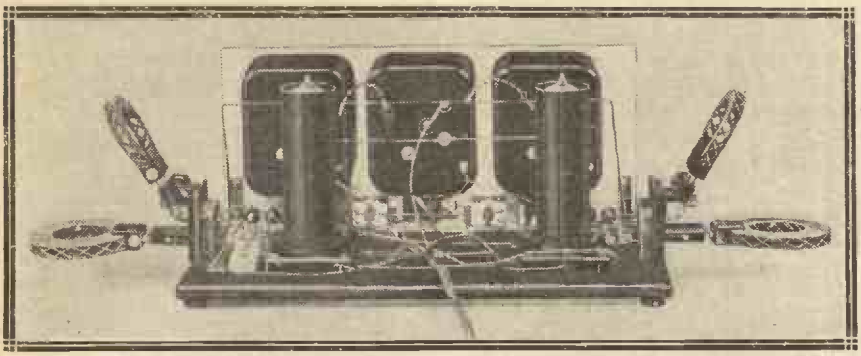


Fig. 8. Variable coupled coils in ordinary coil holders are used in the Loewe sets.

Free From Capacity

Whether the set is free from capacity will be easily judged from the fact that the apparatus allows a comparatively large plate-coupling coil (L_3) to be used without oscillating. In the range of wavelengths up to 750 metres one should be able to insert a coil of up to 75 turns in the plate circuit without the set oscillating automatically. On long waves (Koenigswusterhausen and Daventry) one must be able to use up to 200 turns, if the receiver is sufficiently free from capacity.

For increasing the sensitiveness an adjustable capacity reaction is used between the two grid circuits, especially with short waves. The reaction condenser must be small, maximum about ·000003 mfd. The so-called neutrodyne condensers may be used, but on longer waves the condenser is at zero.

Though it is advisable to employ weak reaction below 500 metres this

(*Continued on page 205*)

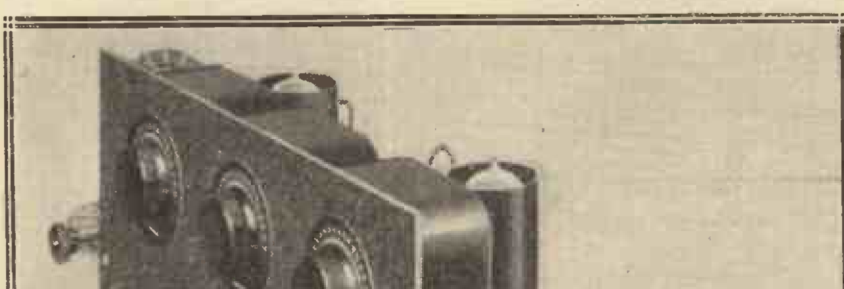


Fig. 9. The valves in the multi-stage set are screened, as are the tuning condensers.

The Experimenter's Logograph

An Interesting New Calibration Device.

By H. BRAMFORD.

THERE is no doubt that some efficient method of keeping a log for stations received, and also to assist in searching for other stations, is indispensable. The usual type of log, however, only gives a rough idea or indication, and is of little use where extremely fine readings are to be obtained.

The device which is to be described in this article is entirely new in principle and will enable the operator to log readings to a fraction of a degree, in addition to which it has several other ingenious uses. I intend first to describe how to make it. First, we will require the following inexpensive materials:

10 pieces of Bristol board, measuring 9⅝ in. by 5¼ in.
1 piece of Bristol board mounted on cardboard.
1 piece of similar dimensions, with "pull out" tag.
1 piece of stout cardboard, 10 in. by 6 in.
2 strips of stout cardboard 9 in. by ½ in.
2 strips of stout cardboard, 6 in. by ½ in.
2 strips of wood, 10 in. by ⅜ in.
2 pieces of wood, 5¼ in. by ⅜ in.

The Key Card

Having procured this material, some red and black drawing ink and some drawing materials will be required. First, build up the frame from the piece of stout card, 10 in. by 6 in., and the wood and cardboard strips. This may best be done by glueing and clamping, but small pin nails may be used if desired. The frame may be improved in appearance by blacking all over with Indian ink and finishing with shellac varnish.

Now draft out the key card, which is the one with a pull-out tag mounted upon cardboard. To do this, rule vertical lines in red at ½-in. intervals, leaving a ½-in. border on the left-hand side.

Horizontal lines are then ruled at ½-in. intervals in red, leaving top and bottom margins of 1⅛ in. Each division is then divided horizontally into ten equal parts with fine black lines. The left-hand margin should be tabulated—"Key 10–3000 metres," as the case may be. The other ten cards are all ruled in a similar manner and have similar margins.

These ten cards consist of squares ruled to half-inches in black with subdivisions in tenths each way in red, each card being marked in left-hand margin, tabulating its use, such as "Chart 0–45° dial, 200–300 metres."

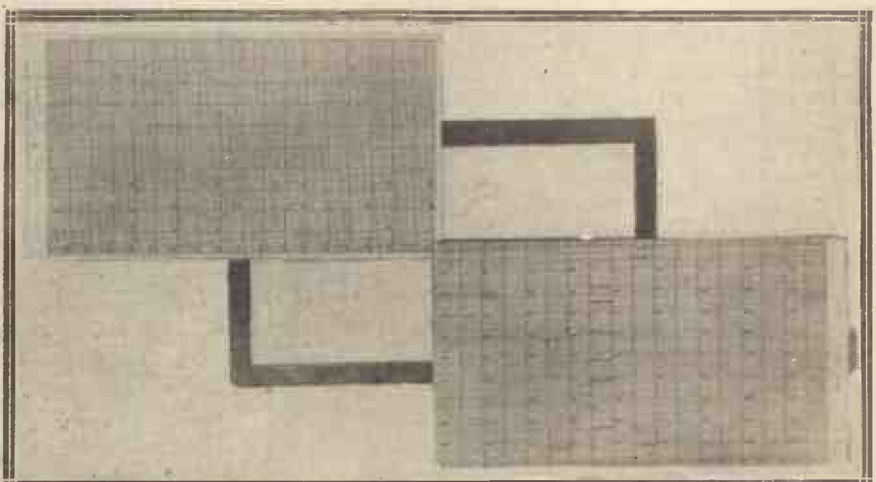
The numerical equivalent of these cards at each division is dependent on the use of the card, but the key card is numbered 0–180 longitudinally to represent the complete condenser dial readings, and 10–3000 up each alternate vertical column to represent its comprehensive range of readings in metres.

The device is simple to use once the principle is mastered, and will provide a permanent and comprehensive log of continual use and interest. Firstly, on the key card write out any number of stations opposite the points indicated on the vertical columns which correspond to each station's existing wave-length. These markings, being more or less permanent, may be done in ink, but the names may be written in pencil if desired, in view of the possibility of shifting them to different wave-lengths.

Now for the use of the chart. Ten are used in order to provide a whole range of readings of an extremely fine nature. Supposing we wish to log all stations received between 0 and 45 degrees of our tuning condenser. Number the vertical divisions of the first chart 0–45 at correct intervals. Working on, say, 200–300 metres, we log two stations at their dial readings. Thus, if one station at 250 metres comes in at 25 degrees, the point of indication would come where the 25 vertical line on the chart and the 250-metre horizontal line on the key chart meet. This point is easily found by sliding out the top key chart until the right-hand margin is on the 25 line.

Definite Readings

The same process is observed for the second station, and a line drawn between the two points gives a definite reading to the fraction of a degree on the key chart. We may, therefore, have a series of four charts reading 0–45, 45–90, 90–135, 135–180 degrees of the dial for a series of readings of different ranges of wave-length limits. Finer or coarser readings may be obtained by an allocation of less or more degrees of the dial to each chart, which incidentally would cover a lesser or greater wave-length range throughout.



Two of the cards ruled up and ready for use. The "logograph" enables accurate calibration to be carried out.

HOW TO MAKE A MODERN WAVEMETER

Designed and built by the "M.W." Research Department.

A simple and easily made instrument, which the amateur interested in DX reception will find extremely useful.

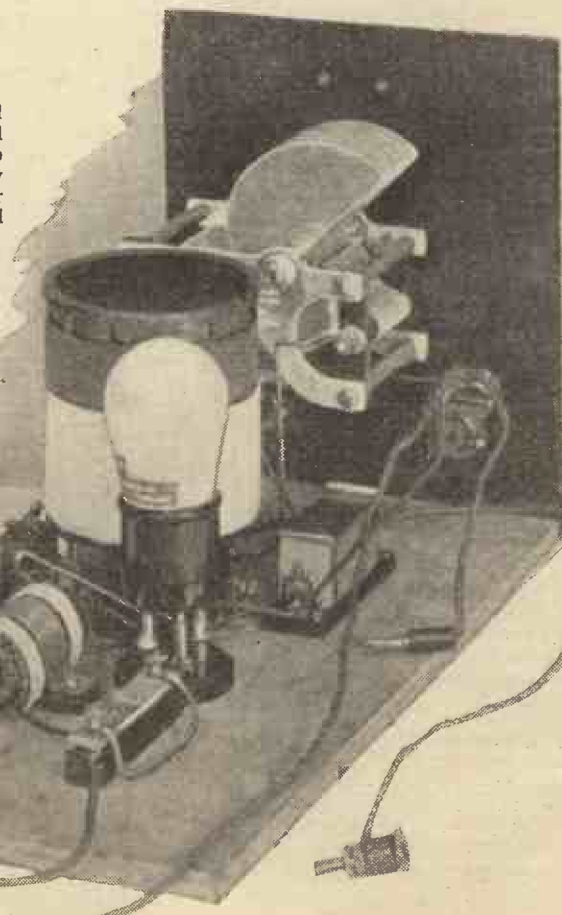
SURELY few experimenters can have fully realised the extraordinary inconvenience under which so many work in being unable to measure wave-lengths, or even to "refer back" with any certainty to a wave-length which has once been determined by picking up a known station, or home-made wavemeters would be seen in the possession of every "DX hunter" in the country.

COMPONENTS AND ACCESSORIES.

- 1 ebonite panel, 6 in. × 7 in. × ¼ in.
- 1 upright-front cabinet to fit, with base-board 11¾ in. deep. (Camco).
- 1 square-law variable condenser, ·0005 mfd. (Cyldon).
- 1 "Velvet Vernier" dial, latest variable ratio type (Rothermel).
- 2 Yaxley on-off switches (Rothermel).
- 1 high-note buzzer (Gambrell).
- 1 6-pin coil base, unscreened (Peto-Scott).
- 1 ·001 mfd. fixed condenser (Dubilier).
- 1 rigid valve holder.
- 1 baseboard-mounting rheostat, 6 ohms (Peerless).
- Bundle of iron core wires, supply of No. 24 D.C.C. and No. 32 S.S.C. wire, screws, Glazite, etc.
- 1 H.F. type 2-volt valve.
- 1 2-volt accumulator, type L.E. (Oldham).
- 1 16-volt high-capacity grid-bias battery, type G.B.3 (Ever-Ready).
- 1 "Featherweight" former (Collinson).

Indispensable

When once the convenience has been experienced of being able to measure, even if only to a metre or so, the wave of any station picked up, and of being able to adjust any receiving set to any desired wave without first being obliged laboriously to calibrate it, a complete new vista of possibilities is opened up, and it becomes a source of wonderment to understand how ever one could previously have been content to use the old blindfold methods of groping and knob-twisting. Searching for desired stations becomes the work of seconds instead of a game of patience, while the identification of transmissions need no longer involve tedious waiting in the hope of an announcement of name or call-sign, which may in the end be missed because given hastily

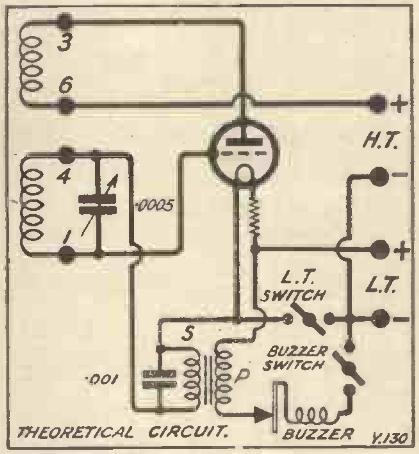


Flexible leads are provided for the batteries, and once these are attached to the appropriate points any slack is secured under elastic bands passed round the H.T. battery.

and carelessly, often in a foreign language.

Probably very many experimenters never attempt the construction of even the simplest wavemeter because there is a prevailing impression that such an instrument is bound to be complicated and difficult to make and calibrate, the latter operation being often thought to be beyond the powers of an amateur. This impression is, no doubt, true enough where laboratory instruments of precision are concerned, but there is no need whatever for such apparatus for ordinary rough-and-ready experimental work. For such purposes a wavemeter of quite simple construction is perfectly adequate, and there is no difficulty in calibrating it with sufficient accuracy to make it an enormous help in all one's work. In ordinary reception there is no need whatever to secure so exact a calibration that each metre can be split into tenths; it will usually be quite sufficient to be able to measure a station's wave to within even two or three metres, since the nature of the transmission will then practically always enable it to be identified. Similarly, there is no need to make the design very complicated in order to secure a very high degree of constancy, and very simple precautions will be sufficient.

A good deal of thought has been given to the question of a wavemeter for general amateur construction and use, and it is felt that such an instrument, to achieve its purpose, must be reasonably simple to make and calibrate, and yet must be capable

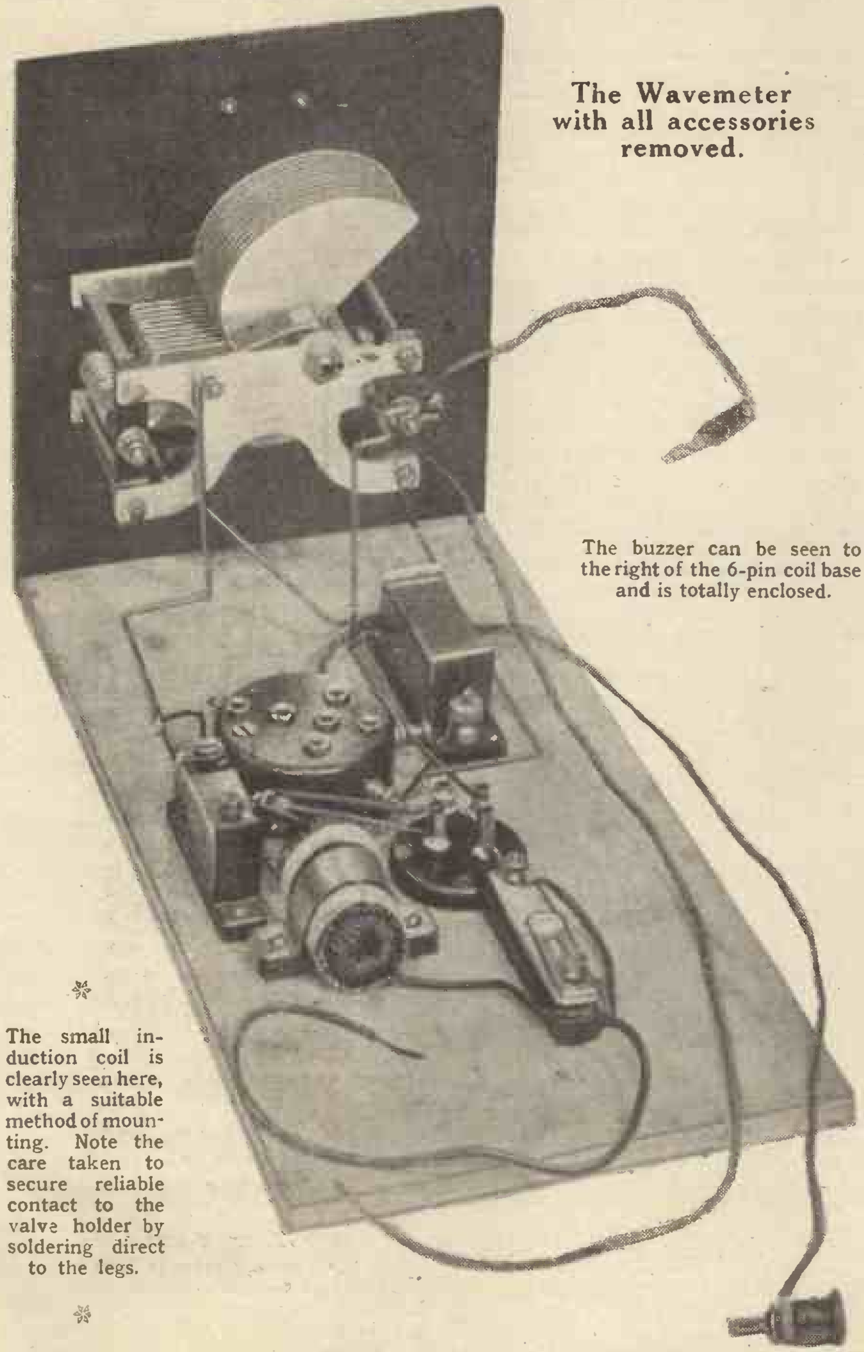


A small induction coil is used for the purpose of impressing the buzzer modulation upon the valve.

of a fair degree of accuracy and constancy, so that it may satisfy the more advanced experimenter. Furthermore, it was considered that the instrument must make it easy to take readings within very fine limits, without the necessity of placing it at exactly the right distance from the set in order to secure sharp readings. From this point of view the oscillating valve or "heterodyne" wavemeter is very attractive, since it gives extremely well-defined readings which can be taken in a moment, and which are denoted by such clear indications that it is easy to work in fractions of a degree on the dial.

Searching

The heterodyne instrument alone, however, is not ideal for picking up distant stations of known wave-length, for this reason: the procedure in such cases is to set the wavemeter to the wave of the desired station and place it close to the receiving set, thereupon proceeding to search on the set until the fairly strong radiation of the wavemeter is picked up. This is tuned in to its loudest, and then when the meter is switched off the desired station should be heard. Now, the radiation from a heterodyne wavemeter is not very easily "found" unless searching is done with the set oscillating, whereupon it will sound like a very loud carrier-wave when picked up, or unless it is making a



The Wavemeter with all accessories removed.

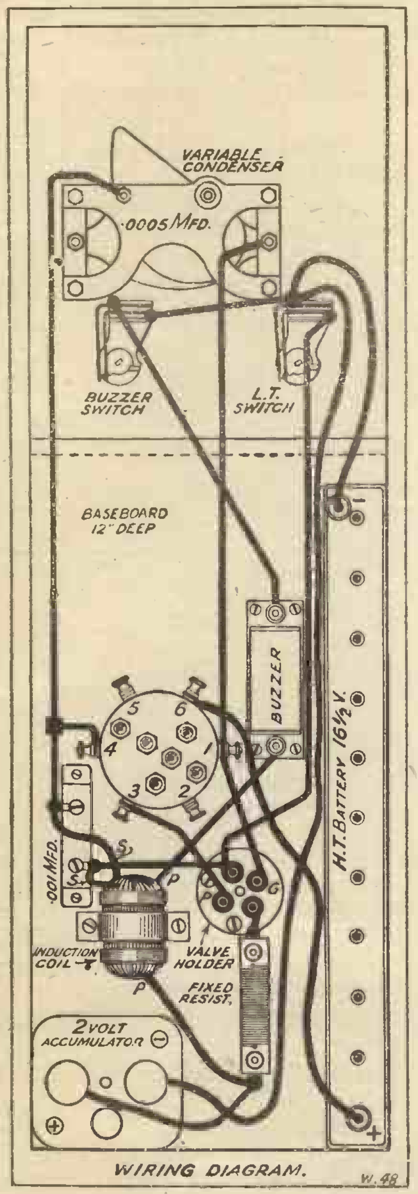
The buzzer can be seen to the right of the 6-pin coil base and is totally enclosed.

The small induction coil is clearly seen here, with a suitable method of mounting. Note the care taken to secure reliable contact to the valve holder by soldering direct to the legs.

whistle by heterodyning the carrier-wave of the desired station, and in the latter case it is easily missed.

The Buzzer Type

For this reason many people prefer a buzzer wavemeter for this purpose, since it radiates a loud buzz which is not too sharply tuned and so is readily picked up. Buzzer instruments as a class, however, suffer from the defect of rather flat and indefinite readings, i.e. the buzz can be heard over several degrees of the



tuning dials, and so it is rather difficult to decide when it is correctly tuned in. It is possible to produce a sharp-reading buzzer wavemeter, of course, but it is not easy.

It was considered that the requirements of such an instrument as it was desired to produce were that it should be capable of giving a radiation of the pure continuous-wave type of the heterodyne meter for measuring accurately the wave-length of a station which has already been picked up, and also a "buzzing" radiation for the purpose of tuning the set to the wave-length of a station which it is desired to pick up. This "buzzed" wave was also required to be a good deal more sharply tuned than that of the average buzzer wavemeter.

The Circuit Chosen

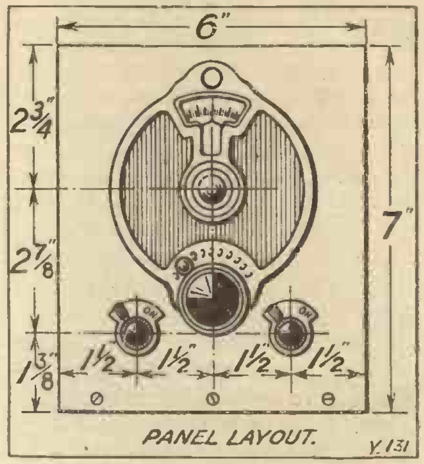
The circuit finally adopted is quite a simple one, as may be seen by referring to one of the diagrams herewith. It consists essentially of an oscillating valve circuit with magnetic reaction, and a grid coil tuned by a variable condenser, this, of course, being the circuit which is calibrated. This part of the instrument is sufficient to produce the continuous-wave radiation required for heterodyne work, and it also forms the basis of the arrangement which provides the buzzing radiation which is also desired. This is obtained by the simple but very effective device of imposing a buzzer-generated modulation upon the continuous waves generated by the valve, in much the same way as the speech and music modulation is impressed upon a telephony carrier-wave, a still nearer analogy being found in what is known as "tonic train" transmission.

Actually, what is done is to run a suitable high-note buzzer off the filament battery and to pass the interrupted current so obtained through the primary of a small induction coil or transformer. The secondary of this transformer is placed between the lower end of the tuned grid circuit and filament, so that the voltages generated in it by the passage of the interrupted primary current are impressed upon the grid of the valve, and produce the desired modulation effects. The resulting radiation is very pleasant in sound and is quite sharply tuned, so that accurate settings are easily obtained.

Constructional Work

Turning now to constructional details, it will be observed from the photographs that a narrow and deep cabinet has been used, housing all the batteries, and carrying a small vertical front panel of ebonite upon which are mounted two on-and-off switches (one for the valve filament and one for the buzzer) and the variable condenser. Upon the baseboard are mounted the two batteries, the valve socket, the buzzer and induction coil, the 6-pin coil socket, and a fixed condenser.

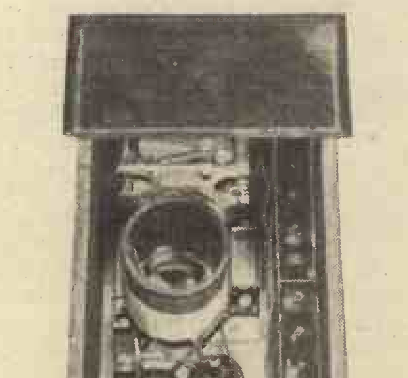
The coil is an important part of the instrument, and this is wound upon a standard Collinson "Featherweight"



former. The grid winding consists of 52 turns of No. 24 D.C.C. wire in a single layer, the end nearest the base of the coil being connected to pin No. 1, and the other to pin No. 4. The reaction winding contains 55 turns of No. 32 single silk covered wire in the same direction as the grid winding. The end nearest the grid coil is connected to pin No. 6 and the other to pin No. 3.

Damp-Proofing

When the windings are complete the coil is given a light coat of shellac varnish (the electrical variety, not the kind you get at a paint and colour merchant's), and very thoroughly dried out by baking. A reasonable degree of constancy and immunity



The layout has been designed exactly to accommodate the batteries, and it is advisable to use the specified types.

from damp under normal conditions is obtained in this way.

The only other part of the instrument requiring to be constructed specially is the induction coil, and no doubt it will be found that both these items can be obtained ready made, if desired, from the usual firms supplying sets of parts for "M.W." sets. The starting-point of the induction coil is a bundle of soft iron core wires 5 in. long, a sufficient number of lengths being used to make a bundle $\frac{7}{16}$ in. in diameter. Round this bundle is wrapped Empire cloth to cover a space of $1\frac{5}{8}$ in. in the middle, and upon this the primary winding of 30 turns of No. 24 D.C.C. wire is put on in a single layer. Over the primary then comes a further wrapping of two or three layers of Empire cloth, to provide a smooth surface upon which to wind the secondary. This consists of four layers of 70 turns each of No. 32 S.S.C. wire, in the same direction as the primary (the winding runs on more smoothly in this way).

Completing the Core

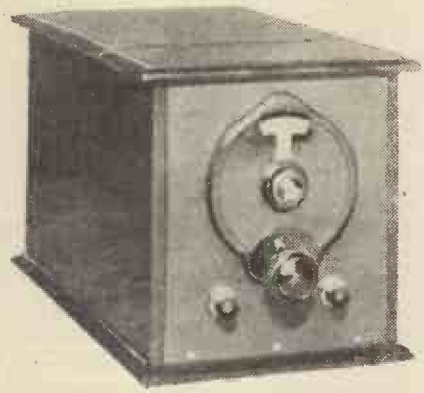
There is no need to mark the inner and outer ends in any way, since the direction of connection to the windings is quite immaterial. The next step, therefore, is to cover the last winding with a final wrapping of Empire cloth (these wrappings are easily secured in place with a spot of Chatterton's Compound), and then to bend the projecting core wires back over the windings to meet those from the opposite end, in the well-known "hedgehog" formation. (It is as well to slip pieces of systoflex or rubber tubing over the connecting wires to protect them from the core wires when they are bent round in this way.) Finally, the little transformer is secured to the baseboard by means of two screws and a strip of brass.

An Important Point

The remainder of the constructional work is merely a matter of attaching components and wiring up; but before leaving the practical side of the work it should be emphasised that great care should be taken to mount the variable condenser very securely and rigidly, and that similar attention be paid to the vernier dial, since any slipping or movement here may cause serious inaccuracies later. Similarly, it is most important that a really sound and rigid variable condenser should be used, and a dial of a type in which there is no chance of slip taking place and causing errors.

Preliminary Calibration

Next month a description of the uses of the instrument will appear, with a simple method of calibration, details of a coil for the Daventry range, etc. Meanwhile, it is suggested that the following procedure be adopted to make good use of the instrument in the interval between its completion and the next issue of "M.W." Every time a station is tuned in and identified switch the wavemeter valve on (not the buzzer as well) and turn the dial until the heterodyne chirp is heard crossing the carrier-wave, and record the reading of the "silent-point" in the middle of the chirp. By switching on both valve and buzzer at this reading you will then always be able to tune in that station on any set which is sufficiently sensitive without tedious searching, since a moment or two will suffice to find the buzz and tune it in to its loudest, whereupon the station will be heard when the wavemeter is switched off.



The placing of the batteries within the box, besides assisting in obtaining constancy of calibration, leads to a very neat appearance.

By the time you have recorded the readings for a fair number of stations you will begin to form some idea of how extremely useful a thing a wavemeter can be. Incidentally, the readings so obtained will come in useful later for calibration purposes.

HOW TO NEUTRALISE

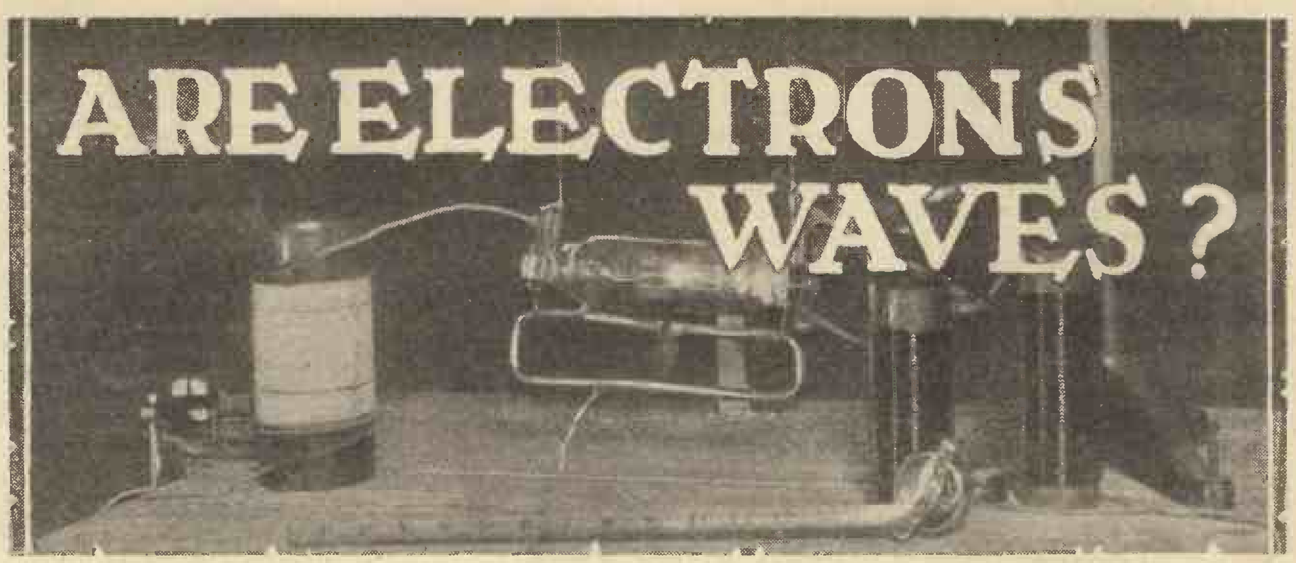
So many readers report difficulty in making sure that their sets are correctly neutralised when there is no powerful local transmission to employ in the process that it would appear desirable to indicate other simple methods. One which will appeal to those who possess a wavemeter of either the buzzer type, or the one described in the article concluding on this page, is to regard this instrument as the "local station," tune it in fully on the set, then extinguish one of the H.F. valves and proceed to adjust the appropriate neutrodyne condenser until the "signal" disappears or, at least, is reduced to a very low value, in spite of retuning. On either side of this setting of the neutralising condenser the signal should grow louder again, and when such a point has been found (the reaction control should meanwhile be set to a fairly low value) the valve can be turned on again, and the process repeated on the next H.F. valve.

In this method it is desirable to make sure that the signal is being picked up by the aerial circuit of the set, and not by the various coils, and to do this is quite a simple matter. Make a hank of any convenient wire, say ten turns, connect this in series in the earth lead, and place it close to the coil in the wave-meter. The latter should be kept well away from the set, six feet at least.

The Reaction Method

The method just given cannot, of course, be used by those who do not possess the necessary wave-meter, and, moreover, there are some sets which do not give a very definite minimum point, and consequently do not lend themselves to it. For example, in some receivers only a very small capacity is needed for neutralising, so that the neutrodyne condensers will be very near their minimum settings, and it will consequently be difficult to make sure that a true minimum point has been found, since it will not be possible to go either side of it with certainty.

In such cases, it is simpler to set out to find the setting for the neutralising condenser (or condensers) which permits the greatest amount of the reaction condenser capacity to be brought in before the set is caused to oscillate, the various circuits being all in tune while the test is made.



ARE ELECTRONS WAVES?

An account of some recent and revolutionary experiments.

By GAUTIER HANEÇON.

SINCE Einstein conceived the idea that electrons were in some sense waves, no results of more considerable or, indeed, of more revolutionary importance have attached to any experiments than to those recently made in America by Mr. C. J. Davisson, the well-known physicist, and his associates. Gradually their patient and exhaustive findings are receiving a proper appreciation in the scientific and technical journals of the world; but the lay press has, so far, almost failed to realise the significance of the tremendous advance which they afford in the realm of modern physics.

The whole of our preconceived notions in regard to light and the nature of electricity are being cast into the melting-pot. The advanced theorists, like de Broglie and Schrodinger, Born, Jordan, and Dirac, who toyed with the Einstein theory because it offered an escape from the otherwise apparently insurmountable difficulties in the interpretation of spectroscopic data in terms of the Bohr-type of atom model, are at last coming into their own.

Universal Influence

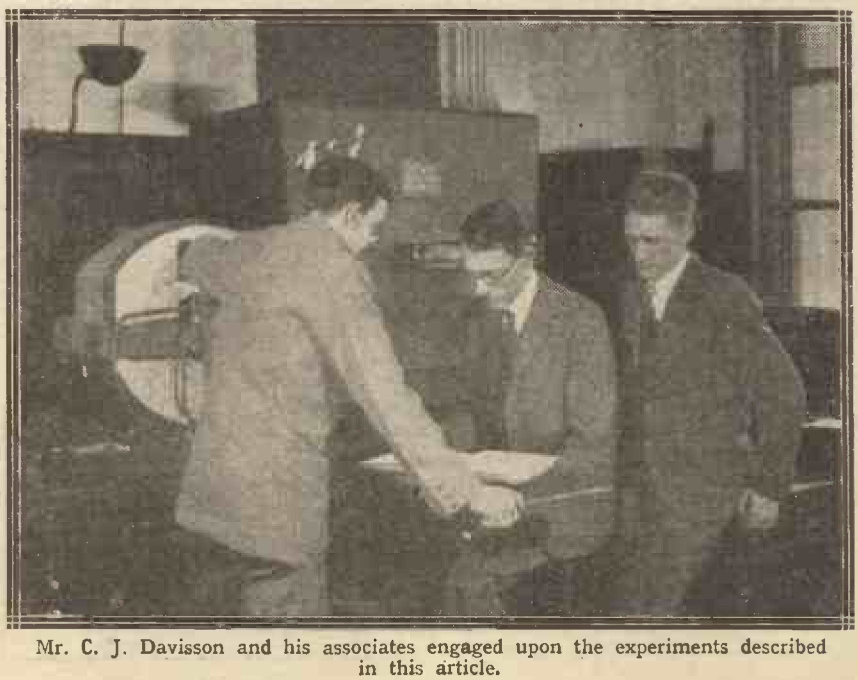
To the man in the street it may seem of little importance as to whether electrons, "the powerful advancing artillery of the air," are composed of atomic units or of streams of eddying waves. Actually, the discovery is going to mean for him an incalculable influence and effect on the ordering of his life and on many of the auxiliary curative agencies which he may need to call to his aid.

A few years ago no one would have worried overmuch as to the nature of X-rays. To-day even the uninformed young civilised peoples have recognised the inestimable blessings which have accrued from a more accurate and precise knowledge of their nature. Without that exact knowledge their far-reaching effectiveness—their capacity to be utilised for the beneficent service of mankind—would have been immeasurably stultified.

Let it be recalled that it is still only about seventeen years ago since Professor W. H. Bragg propounded what seemed an irresistible theory that X-rays were simply streams of swiftly-moving neutral particles endowed with properties giving various penetrating effects.

Theory Disproved

Almost in the twinkling of an eye—in the scientific sense—the whole of that carefully elaborated theory came crumbling to the ground. A simple experiment made about a year later, and which can be repeated in any X-ray laboratory in half an hour, brought it tumbling down like a pack of cards. A beam of X-rays was projected through a thin crystal of zincblende on to a photographic plate. What was the result? It was found



Mr. C. J. Davisson and his associates engaged upon the experiments described in this article.

that the plate was blackened, not only in the path of the beam, but in a number of other spots as well.

Moreover, these additional spots formed a symmetrical pattern around the strong central spot due to the directly transmitted beam. The conclusion was at once obvious. If X-rays were, as Bragg contended, "discrete particles," then no explanation for that pattern was forthcoming; if, however, X-rays were waves, then the pattern could be completely accounted for.

This is simply demonstrable. If a bright distant light is viewed through a tightly stretched handkerchief, one gets the impression not of a single point of light, but of a bright centre surrounded by a rectangular array of satellites, which varies in structure and size according to the wave-lengths of the light itself.

Diffraction Beams

Much the same sort of thing happens when X-rays pass through a crystal. The atoms of the crystal act in similar way to the apertures of the mesh. What are called diffraction beams issue from the crystal in directions which are determined by both the wave-length of the ray and by the arrangement of the atoms in the crystal. The X-ray phenomenon is somewhat more complicated, it is true, because the scattering centres occur in three dimensions instead of in a plane. But, in both cases, the effects observed are due to the interference of waves diffused from regularly arranged centres.

Thus it came about that the experiments made by Laue, Friedrich, and Knipping in Germany confounded the Bragg theory and established the wave nature of X-radiation. Incidentally, it did more, for it provided a means of measuring X-ray wave-lengths and of studying the arrangement of atoms in crystals.

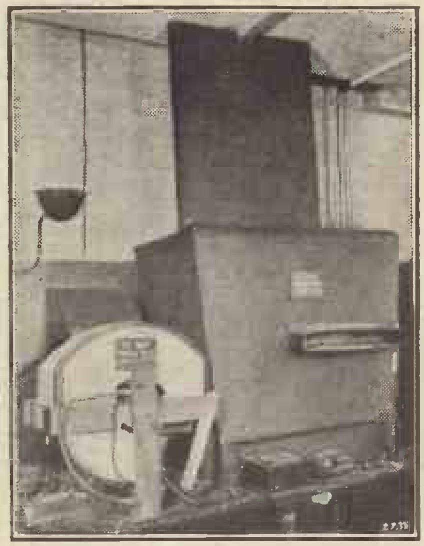
In justice to Professor Bragg it should be added that no one more quickly or readily admitted the new facts than did he, and no one has since striven more assiduously to bring the technique of X-ray crystal measurements to its present high state of development.

As with X-rays, so with electrons. For years past physicists have proceeded on the assumption that the electron is a particle. They have given us many details concerning its electrical charge, and its mass, and even postulated theories as to its invisible size and shape. They have described its behaviour under a variety of circumstances and directed attention to the tortuous track it leaves in traversing a gas.

We had become accustomed to the notion of the electrons as a bombarding army of physical units travelling at incredible speeds and effecting an incessant disintegration of the elements out of which they emerged.

Experiments with Electrons

Now suddenly out from a bright blue sky, so to speak, the greater part of this theory receives a cataclysmic shock. Quite recently a series of experiments have been conducted in the Bell Laboratories in America, the results of which throw very considerable doubt on all the so-called established data. Mr. C. J. Davisson—one of the most painstaking observers—has had charge of these new researches, and it is to him that credit must be given for the new facts, now for the first time revealed.



The apparatus employed for observing the reaction between a beam of electrons and a nickel crystal.

Keeping in mind the extraordinary history of the X-ray, one of Mr. Davisson's first experiments was to send a stream of electrons against one face of a nickel crystal and to observe carefully the nature and effects of the electrons which issued from the crystal. In principle and general method the experiment was precisely the same as that crucial test whereby Laue, Friedrich, and Knipping determined the character of X-ray radiation.

Electron Theory Wrong?

The amazing and startling result was that Mr. Davisson found himself in exactly the same position as the German experimenters. As with X-rays so with electrons. When a beam of electrons is sent against a nickel crystal its electrons issue in sharply defined beams which are disposed about the incident beam in a similar symmetrical manner. In other words, the essential features of the historic X-ray experiment have now been repeated with a beam of electrons!

For the benefit of the more technical of our readers it should be explained parenthetically that in Mr. Davisson's experiments the electrons incident upon the nickel crystal are emitted by a hot filament and are confined to a narrow beam by a system of apertures. The number of these electrons scattered without loss of energy in various directions by the crystal is then determined by means of an exploring collector which may be moved to any position in front of the target. The measurements are carried out in extreme vacuum.

Further Tests Essential

So that if we are to make any deductions at all from these startling results we must assume that just as X-rays were shown to be waves instead of particles, so electrons must now lose their identity as excessively small particles of matter and take the form of rays, whose lengths can be precisely measured. It is, of course, too early yet even remotely to foreshadow the practical effects which will accrue from this singular discovery; for these results have yet to run the gauntlet of further scientific analysis and criticism.

There will be those who will demand in what sense electrons can be regarded as waves, when it is by no means obvious that there is any sense at all in which this is possible. Mr. Davisson's plan is to cite the analogy which is said to exist between the theory of optics and that of mechanics. "In solving certain problems in optics we make use sometimes of what is known as Huyghens' construction," says Mr. Davisson. "Little wavelets are imagined spreading out from the elements of a wave-front, and the envelope of these wavelets is supposed to trace out the progress of the primary wave through whatever optical system is under consideration."

This is a perfectly good method in many ways, and it has done great service in the cause of college education, but it is really only a first step toward the complete solution of the problem of wave propagation. It fails hopelessly when the description

(*Continued on page 204*)

A Chat on Chokes

Some valuable information concerning L.F. choking devices.
By F. JACQUET.

A CHOKE coil is, as its name implies, a coil which is used for the purpose of choking out or eliminating an unwanted current from a circuit. Strictly speaking, any coil of wire can act as a choke coil to a limited extent on account of the inductance

Fig. 1. Illustrating the magnetic forces round a coil of wire.

of its windings. Naturally, however, in order to serve the very definite purpose of eliminating certain currents from circuits in an efficient manner, the necessary choke coil has to be constructed on well-defined lines.

Inductance and Impedance

A circuit which contains inductance always offers a certain amount of impedance to the passage of an alternating current. The greater the amount of inductance which the circuit contains, the greater is the impedance which that circuit

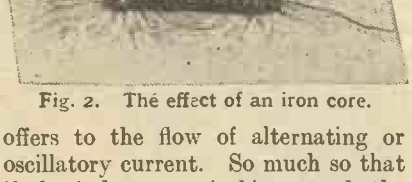
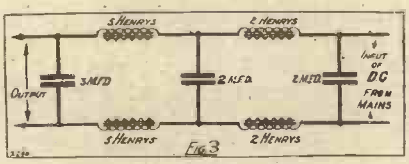


Fig. 2. The effect of an iron core.

offers to the flow of alternating or oscillatory current. So much so that if the inductance is big enough the circuit will not permit of the passage of alternating current through it. In other words, the alternating current will be choked out of the circuit.

Now, inductance is most readily created in a circuit by including coils of wire in it. Although a straight length of wire possesses inductance, the inductance of that wire greatly increases when it is converted into the form of a coil. A choke coil, or impedance coil, therefore, is merely a coil of wire which possesses a high inductance, but a low ohmic resistance. Thus, the coil offers a very great impedance to the passage of alternating current, but, on account of its low ohmic resistance, it allows direct current to pass through it with comparative ease.



Speaking generally, there are two classes of choke coils to be recognised. The first of these is the high-frequency choke, a coil which is designed to eliminate currents of very high frequency from radio circuits. This simply consists of a coil of wire of large inductance and comparatively low resistance.

L.F. Chokes

In the case of the L.F. choke the function of the choke coil is to restrict the passage of low-frequency alternating or pulsating currents, but at the same time to allow steady direct currents to pass through it freely.

Audio-frequency chokes, as is well known, consist of a large number of turns of wire wound on a soft iron core. The direct resistance of the windings varies according to their length and the design of the coil. The greater the number of turns of wire which are wound on the soft iron core, the higher the inductance of the coil, and the more complete is the choking

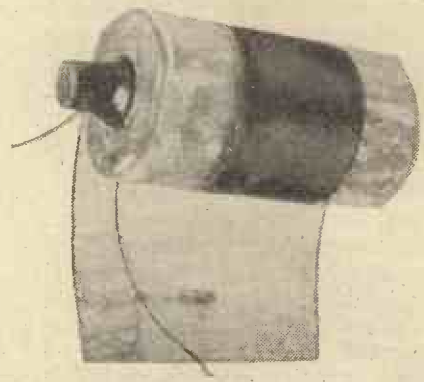


Fig. 4. The construction of a simple choke.

effect of the coil; but, of course, with this construction comes a greater increase of direct-current resistance. The ideal choke for most purposes is one which will offer as much impedance to an alternating current

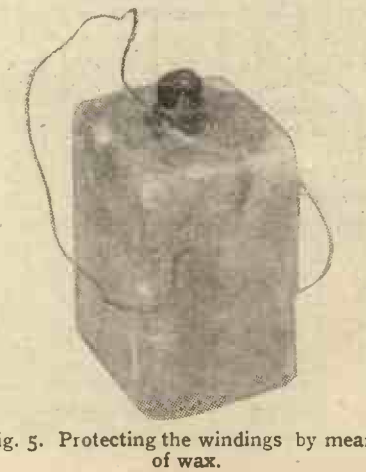


Fig. 5. Protecting the windings by means of wax.

as possible, and yet at the same time will possess as low a direct-current resistance as possible.

Turning now to a consideration of the manner in which the choke coil effects its action, let us first of all glance for a moment or two at the photograph shown in Fig. 1. Here we see the magnetic field which surrounds a coil of wire through which a current is flowing. The magnetic field attains a certain strength, the strength or intensity, of course, being governed, other things being equal, by the strength of the current flowing through the coil. In the photograph, Fig. 1, the magnetic field surrounding the coil is made manifest by the simple process of scattering iron filings on to the sheet of white cardboard on which the coil is laid.

Greater Concentration

Turn now to the photograph, Fig. 2. Here we have a core consisting of a bundle of soft iron wires pushed into the coil. In this case, we have a greater concentration of magnetic field, which is well defined in the

Fig. 6. A typical iron core.

photograph. The reason for this is not difficult to understand. Air has a certain degree of "permeability" to magnetic force. The permeability of soft iron is greater than that of air. Therefore the lines of magnetic force can crowd into soft iron to a greater extent than they can into air. This greater concentration of lines of magnetic force in and around the iron core of a coil creates a greater degree of induction in the coil. Alternating currents passing into the coil are more readily able to set up magnetic lines of force of varying intensity, and thus the choking or alternating-current eliminating properties of the coil go up in consequence.

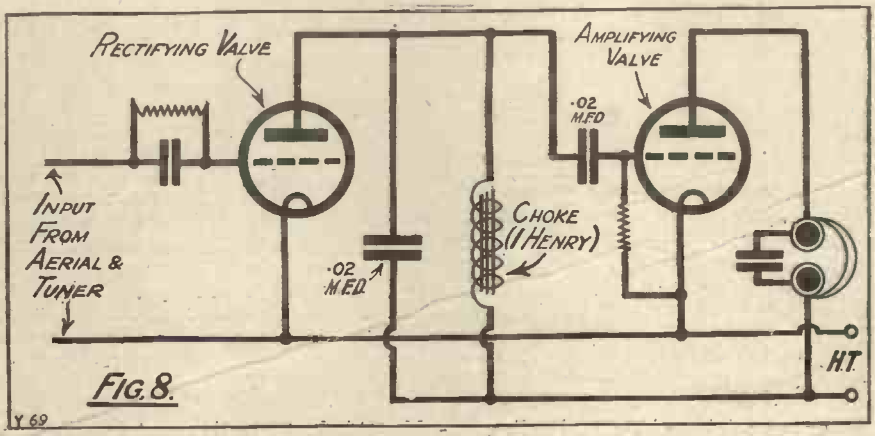


FIG. 8.

The actual constructional details of a choke coil of the ordinary type can vary within wide limits. Any coil which contains a bundle of soft iron wires as a core, and around which is wound a sufficient number of turns of fine insulated wire, will act as an L.F. choke with more or less efficiency. Either the secondary or the primary winding of an old L.F. transformer will act as a choke, for it has all the essentials of choke-coil construction. The secondary winding of an induction or spark coil will also act similarly.

In choke coils of reliable construction, great attention is paid to the efficient insulation of the windings. Fig. 4, for instance, illustrates the construction of a choke having a direct-current resistance of 1,500 ohms. It will be noted that each layer of winding is insulated from the succeeding layer by a wrapping of waxed paper. Finally, in order to make the insulation thoroughly effective and mechanically strong, the whole coil is embedded in wax, as will be seen at Fig. 5. The coil is then fitted into a case. Fig. 6 shows the nature of the iron core used in chokes of this description. It will be noticed that this core consists of a number of straight iron rods, which are insulated

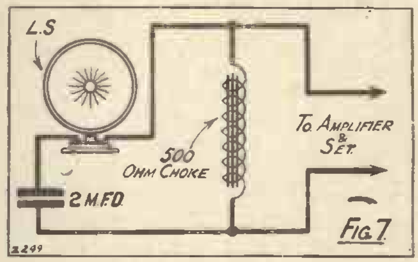


FIG. 7

from one another, the reason for this being that if a solid iron rod were employed instead of the bundle of wires small local currents, known as "eddy currents," would be set up in the core, which currents would be very undesirable.

Uses of Chokes

Now let us consider very briefly some of the more important uses to which L.F. choke coils can be placed. In the first place, by means of an arrangement of choke coils and condensers, direct current which has a superimposed "commutator ripple" can be effectively smoothed out for wireless use. The necessary arrangement of chokes and condensers is shown in Fig. 3. Here the chokes allow the steady direct current to pass freely, but they stop passage of the fluctuating "ripple" current the function of the condensers being to by-pass any of the fluctuating current which may escape the chokes. It is for smoothing purposes of one nature or another that chokes find a most frequent use.

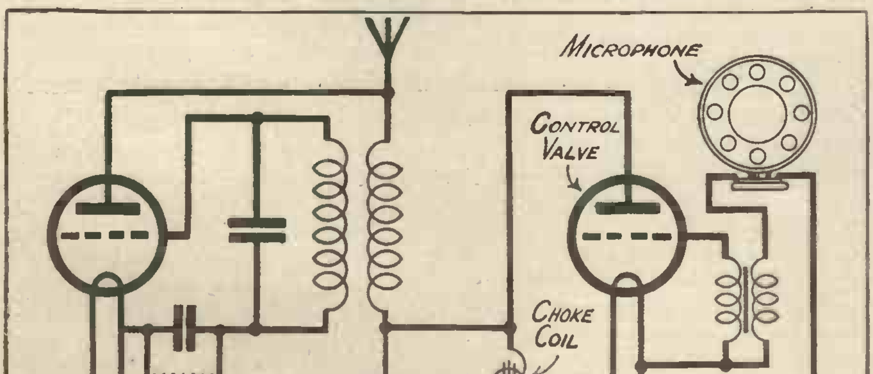


FIG. 9.

(Continued on page 208)

HUNGARY'S HIGH-POWER STATION

From a Special Correspondent.

HUNGARY is now playing her part in the modern competition for large wireless stations, and in Czepel, some nine miles from Budapest, she is building her first super-broadcasting transmitter. The Government has wisely decided right from the beginning to construct a very powerful station, and not to waste money on building smaller stations first. It has thus learned from the experiences of other countries, which have shown that to make wireless popular the public must, with simple apparatus, be enabled to pick up everywhere the programme broadcast. An important consideration, too, is the fact that a powerful station is so much better in a position to overcome atmospheric disturbances, and these are particularly frequent above the hill-environed plain of Pest.

The Aerial and Earth System

The new Hungarian station is equal in size to the Rhineland station of Langenberg in Germany. It possesses a total power of 60 kilowatts. Its valve input capacity is 25 kilowatts. The aerial is carried by two insulated iron masts 450 feet high and about 900 feet apart. These masts are four-sided narrow pyramids, weighing about 40 tons each, and are based on four mighty concrete blocks.

The insulation is being effected by porcelain, and the whole of the earthing system is exactly the same as that used at Langenberg, consisting of a star-net of copper cables, within an elliptic ring of broad copper ribbon.

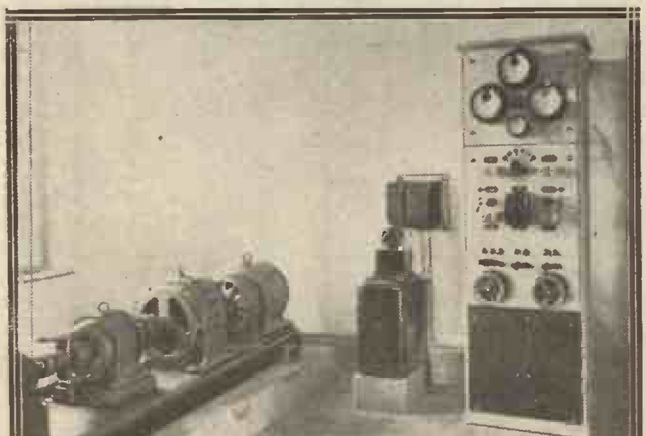
The aerial, which, by the way, is not in position yet, will be a five-wire T-aerial. It will be possible to raise it or let it down according to electrical conditions.

The current necessary for working the station will be supplied by the Royal Electricity Works in Budapest. The transmitting valves require 1,200 gallons of cooling water per hour, which will be specially softened. Again, similar to the Langenberg station, there is a second transmitter in reserve should a breakdown occur.

The Studios at Budapest

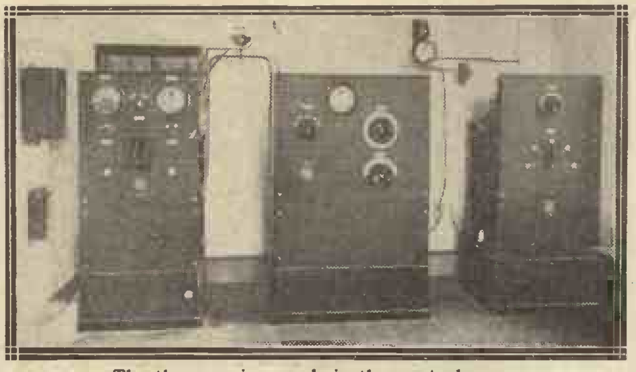
The broadcasting studio is connected by landline from Budapest, but provision has been made to arrange for programmes to be given direct into the microphone at Czepel. The station building itself will be about 150 feet in length and 75 feet in width.

A tremendous impulse will be given to wireless all through Hungary by the erection of the new station, since the old Budapest transmitter worked with a power of only 3 kilowatts, and thus covered only about one-twentieth of the territory of the new station. The most



The generators and power switchboard at the Czepel station.

important mission of Czepel will be to act in an educational direction. It will also be possible now to start some sort of economic education of the small farmers, and give them expert advice as to modern methods. It will be

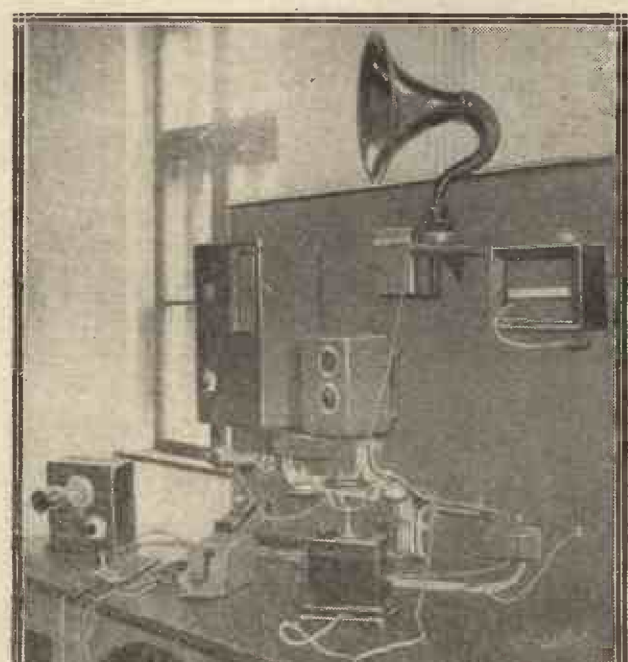


The three main panels in the control room.

possible to hear the Czepel programme within a radius of 30 miles with a crystal set and frame aerial only. With a better aerial, crystal sets will be able to receive it within a radius of 80 miles. The importance of the new station for an agricultural state like Hungary is immeasurable.

Difficulties Being Overcome

The Telefunken Company is building the station, but Hungarian firms are constructing the masts and the station buildings. Free import of all articles for the new station has been permitted, and generally, the import rules and regulations regarding wireless apparatus are being enforced much less rigorously. The former troublesome business with special permits has been mitigated, and now either the addressor or the addressee must just prove



The modulation-control apparatus.

that he is entitled to trade or to build, etc., without any further formality being necessary. This relaxation will be a great boon to the wireless trade in Hungary.

L.F. TRANSFORMER RATIOS

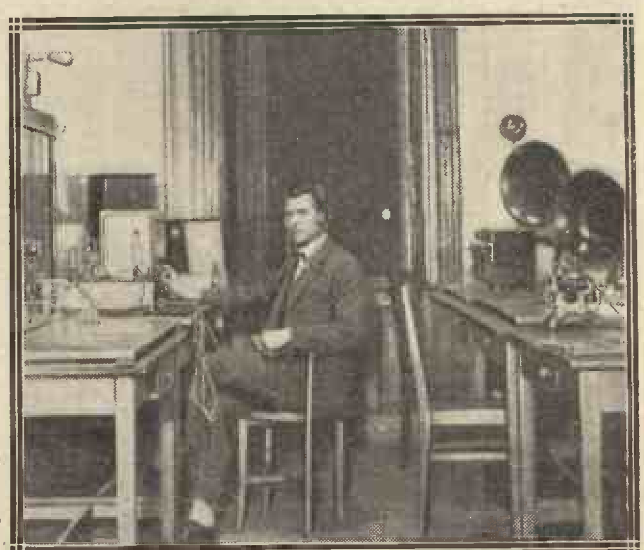
By A. JOHNSON-RANDALL.

READERS are sometimes rather puzzled as to what ratio L.F. transformer should be used immediately following a detector valve.

The answer is, a low ratio in every case if the detector valve has a fairly high impedance. The reason for this is that a low-ratio instrument, if of first-class make, will have a primary winding with a very large number of turns and in consequence a high inductance.

High Impedance

In order to keep the bulk of the transformer within reasonable limits, the large number of turns will necessitate a low ratio. It will therefore be seen that it is really a



The amplifying room at the Czepel station.

question of primary inductance rather than ratio which decides the position of the transformer in the set.

The suitable detector valve for a good modern receiver is one with an impedance of 20,000–30,000 ohms and an amplification factor of about 20. Assuming that such a valve is employed, one would choose a ratio for the transformer of 2·5–3 to 1. The primary inductance of instruments of this type will be in the neighbourhood of 50–80 henries.

In cases where a low-impedance valve is used as a detector a transformer having a ratio of 4 : 1 can be employed.

With Crystal Detector

The term low impedance applies to valves having an A.C. resistance of 8,000–12,000 ohms, and it is not intended to imply that valves of the "super-power" class are suitable for use as rectifiers in normal circumstances.

A stage of transformer coupling immediately following the detector valve should only be used when grid leak and condenser rectification is incorporated in the receiver.

With the anode-bend method it is desirable to use a resistance-coupled stage first, unless quality is to suffer.

If the L.F. transformer is used in conjunction with a crystal rectifier it is possible to employ a ratio of 6 : 1 with satisfactory results.

Radio and the Atmosphere

In this article a scientific correspondent discusses some of the discoveries made during recent investigations in the world of radio.

By a Special Correspondent

TIME and again wireless men have been surprised at the results achieved by amateurs in transmitting signals over considerable distances on extremely low power. Many explanations have been offered for these interesting results. They have, on the one hand, been criticised as "freak" transmissions, and on the other hand explanations have been advanced attempting to show that when short waves are used communication over great distances can be carried out because of the reflecting properties of the Heaviside layer.

But these amateur short-wave, low-power successes, although more or less frequently cropping up, do not seem to be consistent. For example, there was a case the other day of the amazingly high efficiency with which radio communication may sometimes be effected over comparatively long distances. Mr. L. A. C. Lawler, a London amateur owning a transmitting set (call sign G 6 L R), had been in two-way communication with a Belgian amateur at Mons—a distance of about 190 miles.

Flash-Lamp Power

While conducting some tests, Mr. Lawler's generator suddenly developed a fault. Rather than close down he continued transmitting, using a small H.T. battery of 20 volts.

He had not much hope that his signals would be heard, but he was amazed to hear a Belgian amateur reply reporting that his signals were being received at good strength. Mr. Lawler continued the test, reducing his H.T. voltage step by step until he was working on four volts—"flash-lamp" power—and the Belgian amateur still reported readable signals although "rather faint"!

Now this is the sort of thing which makes most amateurs sit up and take notice, and it urges them to apply for transmitting licences. But it is also the sort of success which, although it may be encored, cannot be repeated with guaranteed success a second time. Every amateur who has listened-in to short-wave stations has, at one time or another, had excellent reception; but probably the next night very bad reception or no reception at all. The vagaries of amateur long-distance communication are indeed very puzzling.

According to Professor E. V. Appleton, it is becoming more and more evident that the atmosphere has a profound influence on the transmission of electro-magnetic waves, especially in the case of amateur transmissions.

This influence is sometimes favourable, sometimes unfavourable, to communication. The earliest indication of atmospheric influence on radio communication was encountered when Marconi successfully transmitted, by spark wireless, messages across the Atlantic in 1901. Marconi's previous transmissions had been over such short distances that it was thought that the wireless waves travelled *in straight lines*, but when radio

Short-wave work is affected to a great extent by atmospheric conditions. The photograph shows part of the transmitting gear at 2 N M, Mr. G. Marcuse's famous amateur station.

communication with America was first established the question was raised as to whether these waves could bend round the protuberance of the earth just as sound waves bend round a corner.

Professor E. V. Appleton, who is making investigations into the effect that atmospheric conditions have on the propagation of radio waves.

Many eminent physicists began to examine this problem, and their results showed that some influence other than that of the diffractive bending was at work, and eventually it was a sort of agreed point among physicists and other investigators that the chief influence was the so-called Heaviside layer, that ionised belt of atmosphere which is supposed to exist some miles above the surface of the earth, and which guides long waves round the curvature of the earth.

Two Sets of Waves

Professor Appleton, in a very interesting paper which he read before the Royal Institution recently, declared that more recent intensive study of wireless transmission, especially on the shorter wave-lengths, had shown that the effects of the Heaviside layer can be detected only a few miles away from the transmitter, and as these effects increased with increased distance their importance with regard to broadcast listeners whose receivers were 100 to 150 miles away from a transmitting station was enhanced.

Professor Appleton thinks the phenomenon of fading experienced by amateurs is due to the arrival of two sets of waves in the receiver, one travelling along the ground and the other from the upper atmosphere after reflection by the Heaviside layer.

A good deal of investigatory work in connection with the Heaviside layer has recently been carried out by the National Physical Laboratories, and from the results of these experiments it would appear that the Heaviside layer varies in distance from the earth. For example, it has been found to have a height of about 70 kilometres in the day-time, but after the sun has set the height of the layer seems to rise often as far as 120 kilometres and then to fall again to its day-time distance when the sun rises.

Most of my readers know that experiments show that the Heaviside layer affects electro-magnetic waves more seriously at night-time, while in the day-time there is practically no reflection at all; and consequently listeners a long way away from a transmitting station are often only able to receive signals from distant stations during the night-time, and even then with a variation in strength and quality which makes reception by no means reliable.

A Gift!

It seems that the amateur is only really entitled to the day-time signal, the night-time signal being a gift—a freakish gift, if you like—due to atmospheric conditions!

With regard to the very short waves, about which we have heard so much lately, especially in connection with PCJJ, 2XAF, the Beam stations, etc., experiments have shown that the ground waves from these short-wave stations die away very rapidly, and that reception at great distances can only be accomplished by means of waves deflected by the Heaviside layer.

One-Metre Waves

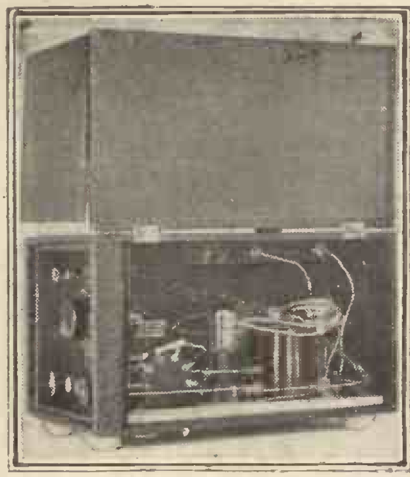
Further, with the decreasing of wave-length the amount of bending the atmosphere can accomplish becomes less, with the result that with very short waves the possibility of penetrating the Heaviside layer comes into the realms of practical possibilities, more especially at night-time when the amount of electricity in the upper atmosphere is at a minimum.

Arguing on these lines the reader will see that it is logical to assume that communication with Mars, for instance, is possible if waves of one metre are used; for with a wave-length of one metre it would be possible to penetrate the Heaviside layer at night-time.

Results have yet to be published showing what effect the eclipse had on radio communication, but some very interesting data has been collected lately in connection with the

(*Continued on Page* 207)

Capt. A. G. West (left), of the B.B.C., taking observations during the recent total eclipse.



The "Transportable" Two

Full constructional details of a semi-portable receiver designed for loud-speaker reception of the local station.

By H. J. BARTON CHAPPLE, Wh. Sch., B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E.

THERE are no doubt countless occasions on which the readers of this journal have desired a handy receiver which could be classed amongst the "semi-portables." By this term I wish to infer a set which is capable of being transported with ease, and consequently does not house the H.T. and L.T. batteries, loud speaker, etc., in its own cabinet. A good deal of controversy exists as to whether it is a wiser plan to design a set so that all the accessories are inside one case, or to split the whole arrangement into two smaller cases of approximately equal weights.

COMPONENTS AND MATERIALS.

- 1 special cabinet to dimensions shown in Fig. 3, together with wooden frame. (Pickett, Camco, etc.)
- 1 ebonite panel, 6 in. × 6½ in. × ¼ in. and wooden baseboard 6½ in. × 11¼ in. × ⅜ in. (Pickett.)
- 1 ·0005 S.L.F. variable condenser with dial. (Formo.)
- 2 Dimic coils Nos. 1 and 3, with bases. (McMichael.)
- 1 multiple fixed condenser. (·0001 to ·0015 mfd.) (C.A.V.)
- 1 auto-choke, 1st stage. (Watmel.)
- 1 balancing condenser. (McMichael.)
- 2 anti-microphonic valve holders. (Magnum.)
- 1 radio-frequency choke. (R.I. and Varley.)
- 1 combined grid leak and condenser, 2 meg. and ·0003 mfd. (Lissen, Dubilier, Watmel, etc.)
- 1 six-point change-over switch. (McMichael.)
- 1 five-way cord. (Lewcos.)
- 4 "Absorbos" (Eddystone.)
- 4 T.2 L.C. terminals marked "aerial," "earth," "'phones +" and "'phones –," 2 T.14 plugs, and 5 indicating labels. (Eastick.)
- 1 dial indicator and 1 tapping clip.
- Quantity of Glazite for wiring up, short length of flex, wood-screws, etc.

There is much to be said on both sides, but it cannot fail to be admitted that by adopting the latter plan transport difficulties are really minimised, since the total weight can be shared between two or more people when there is a party. Failing this it will be obvious that if the carrying of a set and its attendant accessories devolves on one person, then a pleasing balance is obtained and less effort is required when equal use can be made of both hands at once, instead of having a dead weight on one side of the body.

Compact Design

This fact was borne in mind, primarily, when designing the "Transportable" Two, and it will undoubtedly meet the needs of many people. The size of the cabinet or case was, in this particular instance, governed by the fact that I had an Amplion portable loud speaker available. If such a spare case can be secured, nothing is simpler than to press it into service; but, failing that, the sketch and dimensions given in Fig. 3 will suffice for any cabinet maker to undertake the work. We thus have our set and a 2-volt unspillable accumulator, with a 60 volt H.T. battery can be strapped conveniently, one to each side, and transportation, when desired, is under these circumstances readily undertaken.

The receiver is completely protected, since when the two flaps or doors, at the front and side, are closed no damage can take place and the whole is dustproof. A glance at the accompanying photographs reveals the fact that the receiver is of neat appearance and is no bother to carry, since the total weight, with coils, valves, and grid-bias battery in position is only 9 lb. The battery leads take the form of a five-way multiple cord, and can be tucked away out of sight when not in use. When connected to the batteries a small slot under one of the side-flap clips allows the lead to pass through, and yet the flap in question can be kept shut.

Apart from these features, however, the performance of the set is also particularly good, and amongst the most outstanding of its points mention must be made of (*a*) the extreme simplicity of the operation of range changing, i.e., from high to low wave-lengths or vice versa; (*b*) an absence of coil changing with range changing; (*c*) ease of control, with the provision of a smooth reaction adjustment to be used when desired.

An objection which is often levelled at what is otherwise a good receiver is the fact that one or more coils have to be substituted for existing ones when, say, the Daventry station is desired, the set being previously capable of receiving stations on the ordinary broadcast band. To the expert it is only the work of a moment or two to effect the change, but to the uninitiated the task savours of pitfalls and detracts frequently from the adaptability of the set.

Wave-length Changing

With the "Transportable" Two, however, the necessary coils are already positioned on the baseboard, and the movement of a barrel switch and retuning brings in the desired station in "the twinkling of an eye," especially if the set has been calibrated previously.

The complete set is exceedingly compact. as this photograph shows.

When in use out of doors a temporary aerial slung over a tree branch or any convenient support, together with an earth consisting of a metal spike driven into moist ground, will prove sufficient to bring in the main local station and the Daventry station at loud-speaker strength, with other stations at 'phone strength, up to a twenty-miles radius with the former and a fifty-miles radius in the case of the latter.

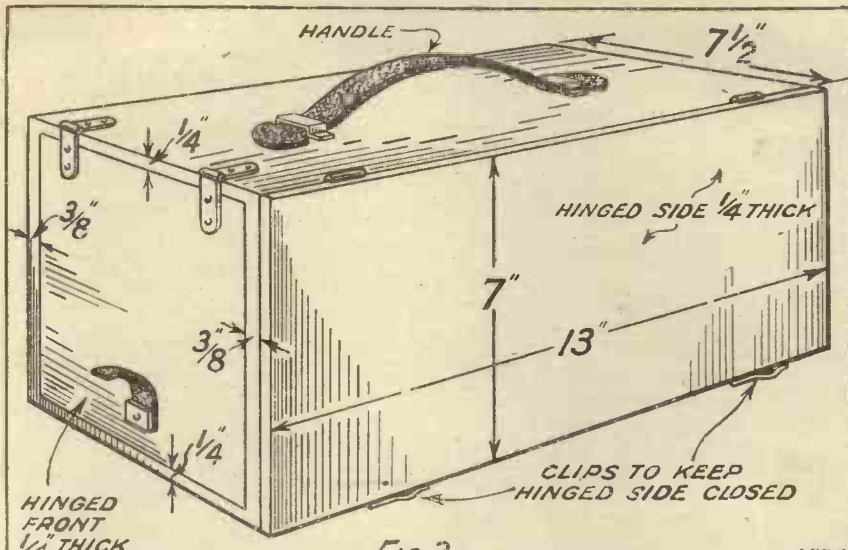


FIG. 3.

The Circuit Employed

Before proceeding to details of construction, it is advisable to examine the theoretical circuit of Fig. 1 in order to become quite conversant with the details. C_1 is a multiple fixed condenser, ·0001 to ·0005 mfd., in series with the aerial lead to provide a better tuning range and a measure of selectivity. The clip enables various capacity values to be tried out. L_1 L_2 is a standard No. 1 Dimic coil, and L_3 L_4 a standard No. 3 Dimic coil, the split contacts in the case of the former being brought out to points A and 2 of a multiple barrel switch, and 1 and B in the case of the latter.

For the reception of stations on the ordinary broadcast band, coil L_3 L_4 is shorted out, but for the higher wave-lengths is brought into commission by opening the switch and thus placing the two coils in series. The required tuning is effected through the medium of a ·0005 S.L.F. variable condenser. The usual grid leak and resistance rectify the incoming signals which, when amplified in the valve V, pass to the plate.

In series with this anode is a radio-frequency choke L_5 which serves the purpose of forcing the impulses back to the end of L_2, via a balancing condenser of small capacity C_3. By joining the coil centre-tap to earth this scheme provides a very smooth and efficient reaction control, so that the signals can be brought up to full strength, the most sensitive condition of the set being just off oscillation-point. For the L.F. amplification there has been included a Watmel auto-choke, and with correct H.T. and grid-bias voltage adjustments excellent reproduction is secured.

L.T. Connections

It will be noticed that no filament resistances, either fixed or variable, have been incorporated. This step was taken owing to the small compass of the set, coupled with the fact that modern dull-emitter valves do not suffer in any way when run at 2, 4, or 6 volts direct, according to their rating. There is an ample margin of safety allowed in the manufacture of the valves, so that the constructor need not fear any trouble accruing from this source.

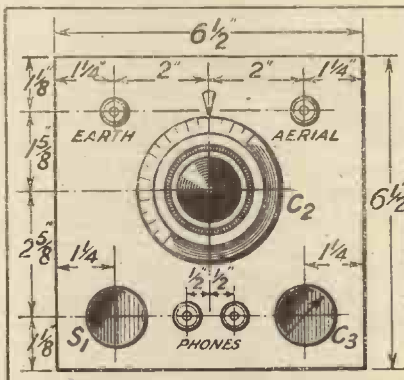


FIG. 2. PANEL LAYOUT.

No L.T. switch has been put into the circuit, the cutting off of current supply to the valves being effected by disconnecting the battery leads.

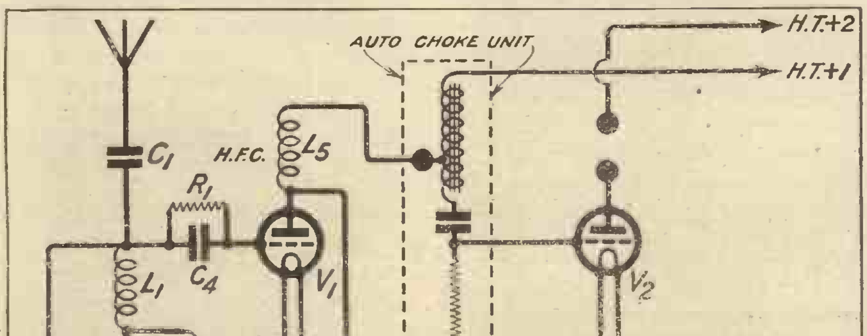


FIG. 1. THEORETICAL CIRCUIT.

Simple to Construct

We come now to details of construction with the "Transportable" Two, a task which will not call for any undue effort on the part of the potential constructor, owing to the simplicity of the whole arrangement. A reference to Fig. 2 will serve to indicate what holes are required in the ebonite panel for mounting the few components. The symmetrical finish of the panel will only be maintained if great attention is paid to the dimensions shown. See that the holes for the screws securing the panel to the baseboard are countersunk just enough to permit the screw-heads to be flush with the panel surface, as any projection will mar the finished appearance.

It was not thought necessary to include panel brackets as there is very little weight, and the three screws were found sufficient to make a strong "joint" between the baseboard and the panel. Component-mounting on both the panel and baseboard can now be undertaken. In view of the compact nature of the set the constructor is strongly advised to study carefully the positions allocated to each component (see Fig. 5), as this will be of inestimable value when the wiring is undertaken.

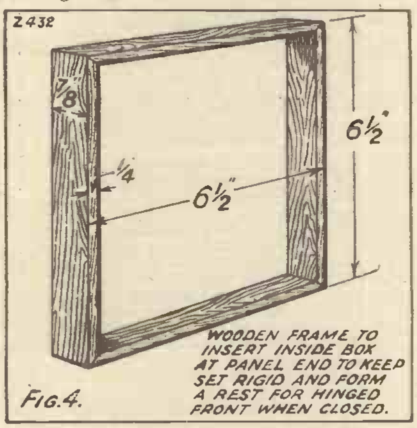


FIG. 4.

Elsewhere in this article will be found a list of the components and material actually used in the construction of the set. It must not be inferred, however, that these are the only ones capable of performing the specific functions required. When any deviation is made just be careful to see how the layout is affected, but be sure to choose apparatus of proved merit, otherwise the performance of the receiver on aerial test will naturally fall short of expectations.

The Cabinet

It will be noticed that the Watmel combined grid leak and condenser is mounted so that the holes in the two junction tags pass over the screw of the grid terminal on V_1.

Compensating ebonite washers are inserted between the McMichael change-over switch and the baseboard, the required thickness in this case being $\frac{5}{16}$in. By maintaining the components in their proper juxtaposition the wiring is kept short and neat and the receiver performance improved thereby.

Before attempting any wiring a word should be mentioned about the special cabinet.

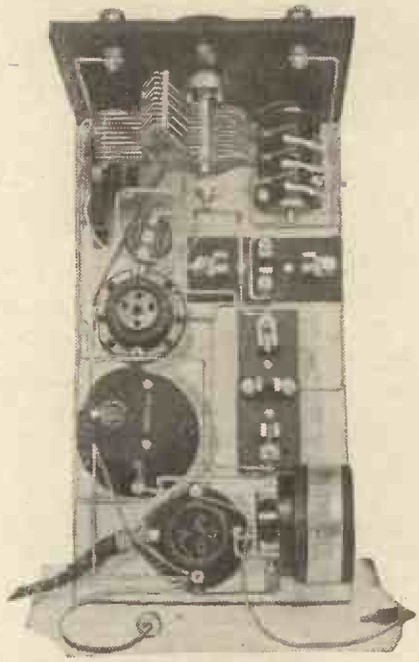
Complete dimensions are given in Fig. 3, and any of the well-known cabinet-makers advertising in the columns of this journal will make one up, or those readers skilled in carpentering can attempt the job themselves. The hinged front flap enables the controls on the small panel to be protected when the set is not in use, while the side flap will be useful for getting to the valves, coils, grid-bias battery, etc., as occasion demands. In the cabinet shown the outside is covered with leatherette thus giving it a well-finished appearance. Note that a set of four "Absorbos" (Sorbo ball feet) are placed at the bottom of the cabinet.

A Wiring Tip

This course is recommended since they are effective in keeping the case away from the surface of the ground or table where used and thus preventing damage by scratching. In addition, they save the apparatus from any shock, and hence form an additional safeguard to that provided by the anti-microphonic valve holders.

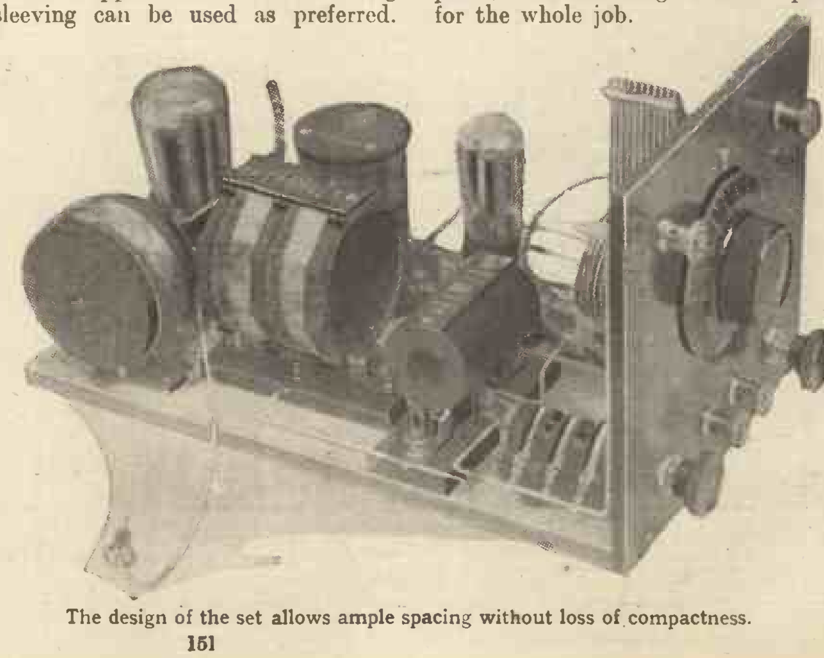
The simple wooden frame shown in Fig. 4 is provided to give an improved finish to the panel, and will hide any want of fit between panel and cabinet. It also provides a seating for the front flap when this is closed. The judicious use of a small brush and a little black paint or Indian ink gives a very good finish to the frame and matches the black ebonite panel.

Once satisfied that a good sliding fit is obtained between the set and cabinet, attention can be turned to the wiring. The wiring diagram of Fig. 5 and the accompanying photographs, when used in conjunction with the tabulated wiring instructions, will simplify the work to a large degree. There are not many wires to put into position, and Glazite or tinned copper wire with insulating sleeving can be used as preferred. The whole operation will only occupy a short time, but be sure to keep the


An end view of the set, showing the layout of the components

wires as short and as straight as possible.

When necessary, bridge the wires with proper right-angled bends. Well clean and tin each junction point to ensure good soldered joints, while advantage may be taken of the terminals on the components as occasion demands. When following the latter course screw the nuts or terminal tops well home to prevent any loosening of the joint as a result of transport. Also carry out as much of the wiring as possible with the variable condenser removed from the panel, as this will give more space for the whole job.


The design of the set allows ample spacing without loss of compactness.

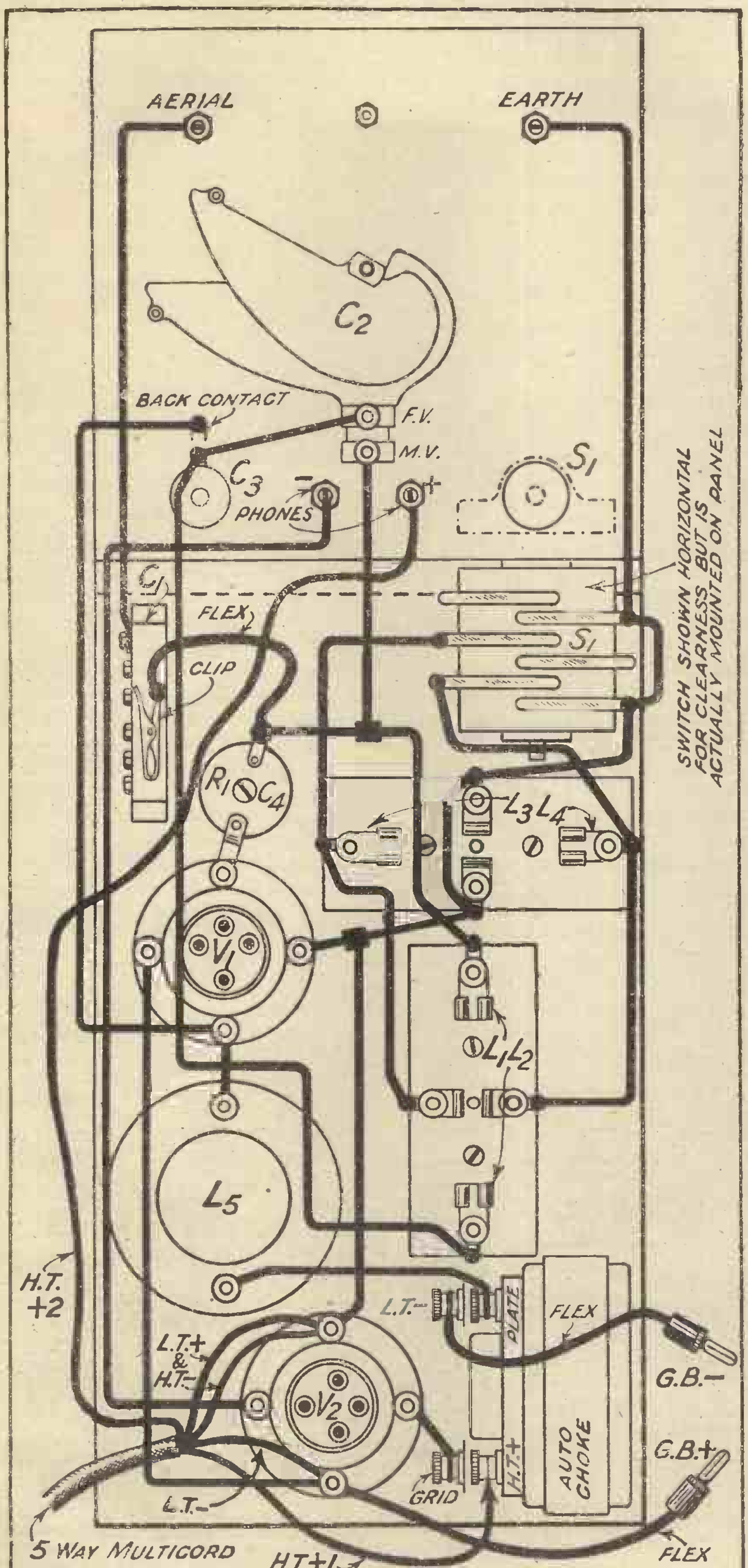


FIG. 5. WIRING DIAGRAM.

Attach to the plug ends of the Lewcos five-way lead, and the flexible leads for the grid-bias battery, the necessary indicating tabs, as this will prevent any accidental wrong battery connections. The grid-bias battery is mounted in the top right-hand corner of the cabinet, being held in place by a right-angled brass clip screwed to the wooden sides.

Valves Required

When tucked away in the corner it will not foul any of the components on the backboard, but is easy of access for adjusting the grid-bias voltage when testing for signal reproduction. The multiple lead is fixed to the baseboard by an insulated staple to prevent any strain coming on the individual wires should the lead be tugged inadvertently.

WIRING INSTRUCTIONS.

From aerial terminal to 000 of C_1.

From earth terminal to tags marked 1 and A of switch S, passing thence to both the centre-point tags of base for coil L_3 L_4, and continue to one filament tag on each of valve holders V_1 and V_2.

From tag 2 of switch S to one end tag of coil base for L_3 L_4, passing thence to one centre-point tag on L_1 L_2 coil base.

From tag A of switch S to remaining end tag of coil base for L_3 L_4, continuing to remaining centre-point tag on L_1 L_2 coil base.

Join 'phones – terminal to plate terminal of V_2.

Join together remaining filament terminals on V_1 and V_2.

Join the soldering tag of C_3 nearest the panel to plate terminal of V_1, and join together plate terminal of V_1 to one terminal of R.F.C. L_5.

Join together fixed plates terminal of C_2 and remaining soldering tag of C_3, passing thence to one end tag of base for coil L_1 L_2.

Join junction tags of C_4 R_1 to grid terminal of V_1.

Join together remaiuing tags of C_4 R_1, passing thence to moving plates terminal of C_2, and continuing to remaining end tag of base for coil L_1 L_2.

Join remaining tag of R.F.C. L_5 to plate terminal of auto-choke.

Join grid terminal of V_2 to grid terminal of auto-choke.

Join one end of a short length of flex to moving plates terminal of C_2, the other end terminating in a spring clip for attaching to C_1.

Join H.T. + 2 lead of multi-cord to phones + terminal.

Join both H.T.− and L.T.+ lead of multi-cord to "Earth" filament terminal of V_2.

Join L.T. − lead of multi-cord to remaining filament terminal on V_2.

Join H.T.+1 lead of multi-cord to H.T.+ terminal of auto-choke.

Join one end of a short length of flex to L.T.− terminal of V_2, the other end terminating in a G.B.+ plug.

Join one end of a short length of flex to the L.T.− terminal of the auto-choke, the other end terminating in a G.B.− plug.

When the constructor has completed his wiring for the "Transportable" Two, and checked it over with care to ensure no mistake has been made, he can proceed at once to an aerial test. As far as valves are concerned, I have tried out a variety of combinations with conspicuous success. The 2-, 4-, or 6-volt class can be chosen, but when considerations of transport are the dominating factor, only the first named, i.e. the 2-volt, should be used. A reasonably high impedance valve should be accommodated in the first valve socket V_1, and choice can be made from the following:

V_1 (detector), H.L.213 (Burndept), H.R.210 or H.210 (Octron), 210 H.F. (Cossor), D.E.L.210 (Marconi or Osram), P.M.1H.F. (Mullard), etc.

The Aerial Test

For V_2 (the L.F. amplifier) any good low-impedance valve will suit, and amongst these mention may be made of:

V_2 (L.F.), L.240 (Burndept), 210 Det. or L.F. (Cossor), L.210 (Octron), P.V.2 (Ediswan), D.E.P.215 (Marconi or Osram), P.M.2 (Mullard), etc.

Their equivalents in the 4- and 6-volt classes are recommended if the set is being used as a "home receiver" without transport difficulties entering into the calculations.

For the aerial test, place the No. 3 Dimic coil in the coil base parallel with the panel edge, and a No. 1 Dimic coil in the remaining base, joining the aerial, earth, and telephone leads to the terminals so marked. Connect up the L.T. battery supply and arrange about 50 to 60 volts for the H.T. + 1 and 80 to 100 volts for H.T. + 2 (even as low as 70 volts works quite well), with about 3 volts grid bias.

For the initial test, C_1 can be made ·0002 mfd., and if the local station is on the ordinary broadcast band see that the McMichael barrel switch knob is pushed in, thus cutting out the coil L_3 L_4.

Results Obtained

Turn the knob of C_3 in an anti-clockwise direction so that only the minimum reaction capacity is started with, and then the local broadcasting station can be tuned in on the C_2 dial. To increase volume turn the C_3 knob slowly in a clockwise direction, being careful to avoid oscillation.

If there is any tendency for the set to oscillate unduly reduce the detector voltage, and a smooth reaction control will be the outcome. On a reasonably efficient aerial full loud-speaker strength will be secured up to at least 20 miles from a main station. When tried on an average aerial ten miles north-west of London, that station came in at full loud-speaker strength. Later, Bournemouth and one or two Continental stations were heard at fair loud-speaker strength.

On the telephones, of course, much wider choice of programmes is open to the constructor. To change over to the long waves it is simply necessary to pull out the switch knob and retune. At the situation mentioned previously, Daventry was heard at good loud-speaker strength, with Radio-Paris at weak loud-speaker strength, and Hilversum on the telephones.

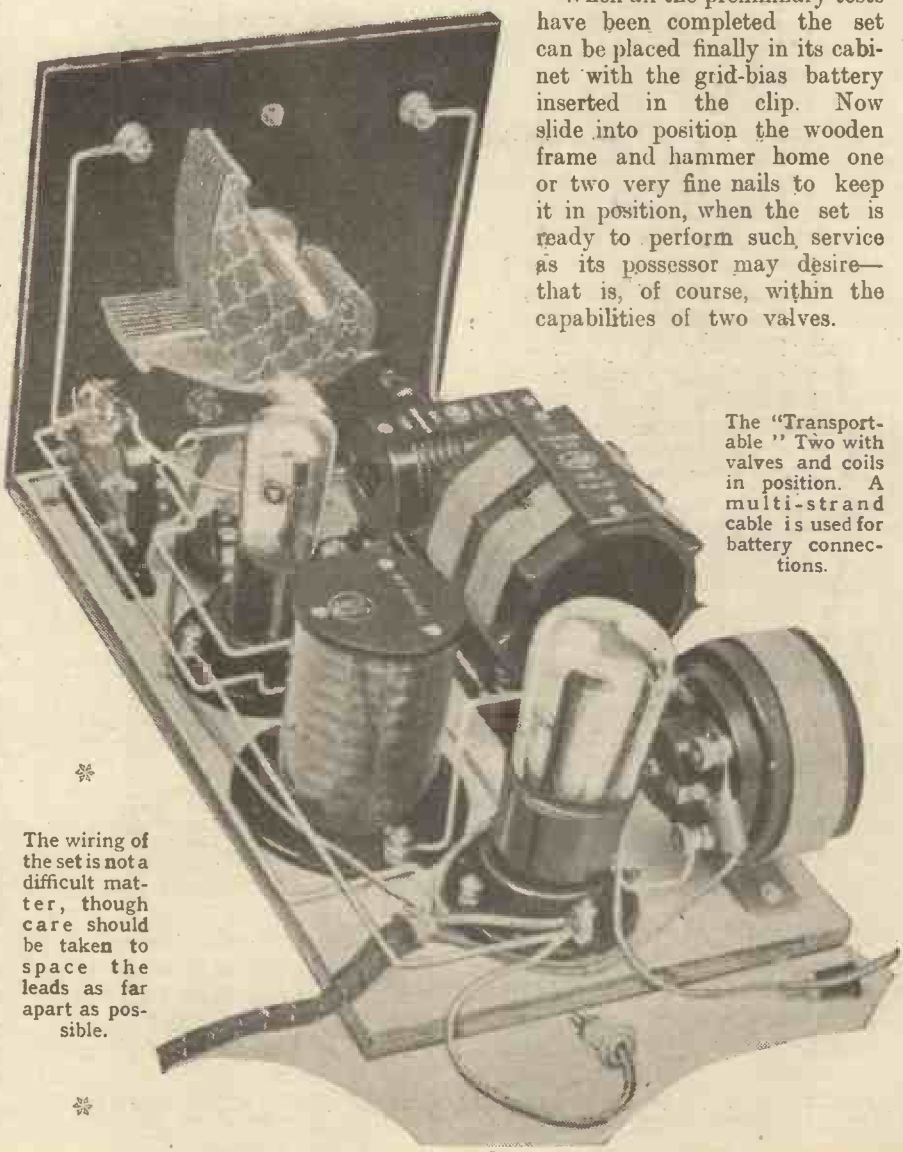
Variable Series Condenser

It is advisable to try out the various available aerial condenser values for C_2, the greatest selectivity, of course, being found with the minimum capacity of ·0001. With some aerial situations it may be found better to to cut out this condenser altogether, but its inclusion in the set is a desirable feature. One cannot fail to be impressed with the easy handling of this set, while the quality of reproduction leaves nothing to be desired once the proper voltage adjustments have been made.

Sharp Tuning

The tuning is reasonably sharp, so that care must be exercised in searching, and some constructors may prefer to replace the plain dial on C_1 with a vernier dial, the McMichael vernier dial being one of the several which can be included if desired. On both ordinary and temporary aerials the "Transportable" Two will give its full measure of pleasure, and fully repay the owner for the small labour and cost involved in its construction. The measure of portability has been stressed in the opening paragraphs, so will not be reiterated here, and the writer can confidently recommend the scheme outlined to the earnest consideration of the many readers of this journal.

When all the preliminary tests have been completed the set can be placed finally in its cabinet with the grid-bias battery inserted in the clip. Now slide into position the wooden frame and hammer home one or two very fine nails to keep it in position, when the set is ready to perform such service as its possessor may desire—that is, of course, within the capabilities of two valves.



The "Transportable" Two with valves and coils in position. A multi-strand cable is used for battery connections.

The wiring of the set is not a difficult matter, though care should be taken to space the leads as far apart as possible.

Correct Output Choke

J. U. (Bexley).—" I am about to build a four-valve receiver in which a choke-feed output circuit is employed. I am told that the choke should have a value of approximately 15 henries and a low D.C. resistance. The valve to be used in the last stage will be of the ' super-power ' type. How am I to tell whether I have the correct choke ? "

You will be quite safe if you purchase your choke from a manufacturer of repute. A first-class maker is always willing to state the saturation figure, D.C. resistance, etc. For really good quality it is necessary to use an H.T. voltage of from 150 to 200, and in these circumstances, with a valve having an A.C. resistance of 3,000 ohms, your choke will be passing 20 to 25 milliamperes. Therefore, when ordering the choke specify that it must be capable of passing up to 30 milliamperes or more without saturating. Also choose a make which actually has a inductance of 15 henries at, say, 20 to 25 milliamperes, and not at some very small value.

You can measure the D.C. resistance of the winding yourself if you have a milliammeter. Place this in series with the choke and a small dry battery of, say, 3 volts. Suppose the reading on the meter to be 10 milliamps. Then, by Ohm's law the resistance of the choke winding is equal to the applied E.M.F. divided by the current in amperes, i.e. the current in milliamps divided by 1,000. Our choke therefore has a resistance of *nearly* 300 ohms, since 3 divided by $\frac{10}{1,000}$ is equal to 300. To be quite accurate one should subtract from the answer the resistance of the milliammeter winding and the remaining external resistances. The milliammeter resistance is frequently marked on the instrument and the other external values may be considered negligible. With 25 milliamperes passing the voltage drop across the choke winding will be $\frac{25}{1,000} \times 300$, which is equal to $7\frac{1}{2}$ volts. This is a low figure, and a 20-henry choke with a resistance of 300 to 400 ohms is quite suitable for use in an output circuit of this type.

Reaction on Daventry

S. T. (Ilford).—" I have a single-valve set, which employs a conventional circuit, reaction being obtained by means of a plug-in coil and a ·0002 variable condenser. Reaction control is very satisfactory on the lower B.B.C. band, but on 5 X X and similar long-wave stations, increasing the value of the reaction condenser has no appreciable effect on signal strength. I am using a coil of 200 turns for the H.F. choke."

It is evident that your trouble is due to the use of a choke having too few turns. For satisfactory reaction build-up on the longer waves (above 1,000 metres), it is necessary to employ a radio-frequency choke having a very large number of turns. If a plug-in coil is employed a No. 500 or 600 is about right. As the wave-length increases it becomes necessary to increase the size of the choke. In choosing a commercial H.F. choke, a value of about 40,000 micro-henries should be taken as a minimum figure for satisfactory results on 5 X X.

Direct Pick-Up

R. T. (Birmingham).—" I have constructed a receiver employing two split-primary H.F. stages. By careful spacing the H.F. transformers have been arranged in a position of minimum coupling, and the set works very satisfactorily. I am puzzled, however, at the apparent lack of selectivity on the local station, which is five miles away. It is very difficult to eliminate this powerful transmission and receive stations on near-by wave-lengths, although the tuning appears to be extremely sharp on many of the Continental stations, which can be received at loud-speaker strength."

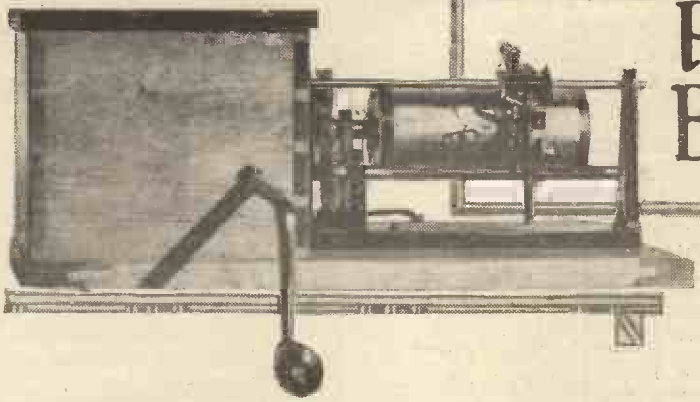
It is highly probable that the trouble from the local station's transmission is caused by the use of an unshielded receiver. With a sensitive set employing unscreened tuned stages, operated within a few miles from a local B.B.C. station, it is usually found that good loud speaking can be obtained without aerial and earth. In such cases, if minimum local interference is required it is advisable to place the set in what may be termed a metal cabinet. The existing cabinet can be lined with sheet copper, which should include the underside of the lid and baseboard in addition to the sides. The panel should be of metal, or of ebonite with a lining of thin copper sheet. The whole of the shielding should be connected electrically and earthed. An alternative scheme is to employ screening boxes for each tuned stage, keeping all wiring as short as is practicable.

Volume Control

T. Q. (Barnet).—" I have an efficient four-valve set, the last stage of which is transformer coupled. The volume from the local station is too great for an ordinary living-room. Can I control the strength without introducing distortion ? "

Yes. Connect a high-resistance potentiometer in circuit across the secondary winding. Join the two outside terminals, i.e. the whole of the resistance strip, to O.S. and I.S. of

(*Continued on page* 207)

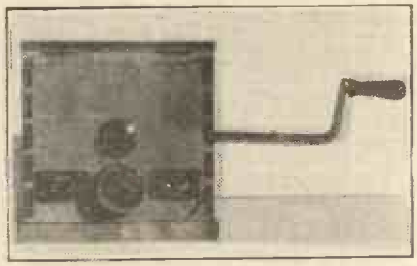


Picture Broadcasting

Details of the latest method of the wireless transmission of photographs. The system is likely to be widely used in Germany.

By Dr. ALFRED GRADENWITZ.

WHILE the wireless transmission of photographs, with their wealth of details of outline and shading, requires an elaborate apparatus worked on a photographic process, the broadcasting of rough sketches, maps, weather-charts, schematic diagrams required, e.g.



An end view of the receiving apparatus.

for illustrating a lecture, etc., is an incomparably more simple task, which only entails a rather primitive outfit. In fact, any photographic method can in this connection be dispensed with, the sheet of diagrams being supplied direct to observers at the receiving end.

The Dieckmann Method

When first developing apparatus of this kind for military purposes (during the world war) Prof. Max Dieckmann, Director of the Graefelfing, near Munich, Radio Research Laboratory, was rather pessimistic as to the eventual commercial possibilities. However, recent developments, particularly in radio broadcasting, have changed the situation, and the use of simplified apparatus for the receiving of drawings, sketches, maps, etc., has become most desirable for many purposes, such as the broadcasting of weather charts which, if sent by mail, often take twenty-four hours or more to reach the subscriber.

On a suggestion by the director of the Bavarian Weather Bureau, comprehensive tests on the wireless transmission of weather charts were, therefore, commenced about two years ago, and the promising results thus obtained induced the German Post Office to authorise the daily broadcasting of weather charts from the Munich transmitting station, and the installation of picture receivers connected up to wireless receiving sets.

The Dieckmann picture broadcast receiver is in principle an improved copying telegraph of the type tentatively used as far back as the middle of last century for the transmission of pictures over telegraph lines. The drawing to be transmitted is traced with a rapidly drying insulating ink, or else with a wax pencil, on a metal foil inserted in the transmitting outfit, which, in the place of the usual microphone, is installed at the studio of the broadcasting company.

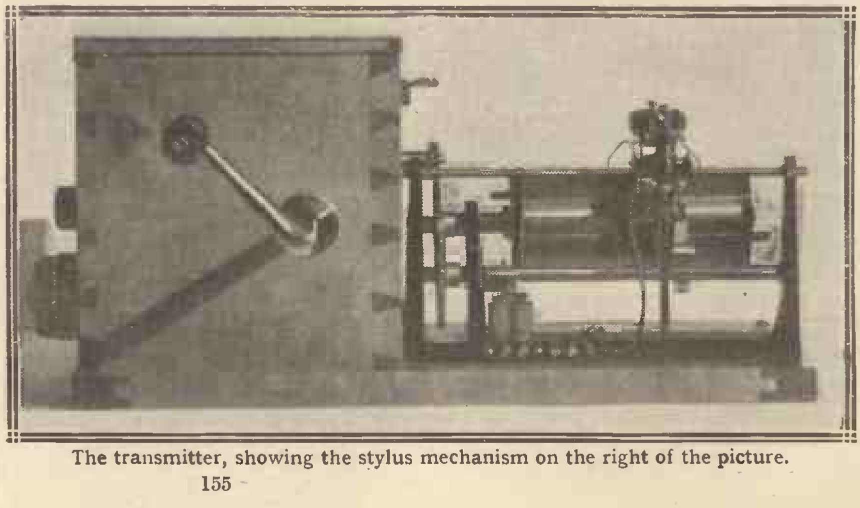
The metal foil is put around a rotating cylinder and a contact searches, one after the other, the various sections of the drawing, closing or opening the circuit according as it happens to pass over conductive or non-conductive portions. These periodical circuit closures then serve to control the transmitter, a current of medium frequency (500–1,000 cycles) being preferably chosen. A sequence of such picture signals is, in a receiving set comprising either headphones or a loud speaker, heard as a confused sequence of short and long sounds which partly resemble the signals emanating from an automatic transmitter.

If, on the other hand, a picture receiver be connected up in parallel with the telephone (or substituted for it), this will convert the sequence of impulses into a drawing, a sheet covered with the sketch in question being taken out of the apparatus after about five minutes.

Some technical details of the transmitting and receiving apparatus are given in the following. Inasmuch as the picture telegraphs proper are but accessories to existing transmitting and receiving sets, the high-frequency connections at the transmitting and receiving ends may here be left out of account.

The Circuit Employed

A sketch of the apparatus used at the transmitting and receiving ends respectively is shown. A switch enables the generator at the transmitting station to be controlled not by the usual microphone but by a sound modulator, which in turn is switched in or out by a sequence of contacts produced by the stylus



The transmitter, showing the stylus mechanism on the right of the picture.

searching the picture. In a similar manner there is provided at the receiving end a switch substituting a rectifier arrangement for the loud speaker L. The relay of the rectifier will operate the picture receiver by way of the local battery B.

The synchronising method, of course, is of paramount importance for the working of the electrical copying telegraph. The D'Arlincourt principle, which is used in this connection, consists in having one of the two rotating axles terminating each rotation just a little before the other, after which it is stopped until the other has made up for the delay.

As the use of several forms of current of different directions, wave-lengths, or intensities would have been objectionable, part of the time available for each rotation of the cylinders is used exclusively for purposes of picture transmission, the remaining time being available exclusively for purposes of synchronising. Under these circumstances a single wave-length and a single intensity will be sufficient.

Insulating Ink

The use of Alizarine ink, as manufactured by the Bayer chemical works, has been found particularly suitable for preparing the drawings, while, in an alternative arrangement, Faber's wax pencils are employed on heated metal foil.

Fusing paint melted by the heat of sparks was, according to an early method, transferred to the metal foil. This having proved unsatisfactory, another method was, after comprehensive tests, eventually adopted, a magnetically moved and electrically heated stylus being used to transfer by a slight pressure the fusing paint from carbon paper (as employed in typing) to the metal foil, i.e. the recording surface proper.

No difficulty is experienced in heating the brass or copper stylus, which is surrounded by a coil of heating wire, the heating current being derived from the accumulator which, at the same time, serves to heat the valves of the amplifier and rectifier. The maximum current intensity is about 0·5 ampere, the temperature of the heating coil being well below incandescence, so that the life of the stylus is practically unlimited.

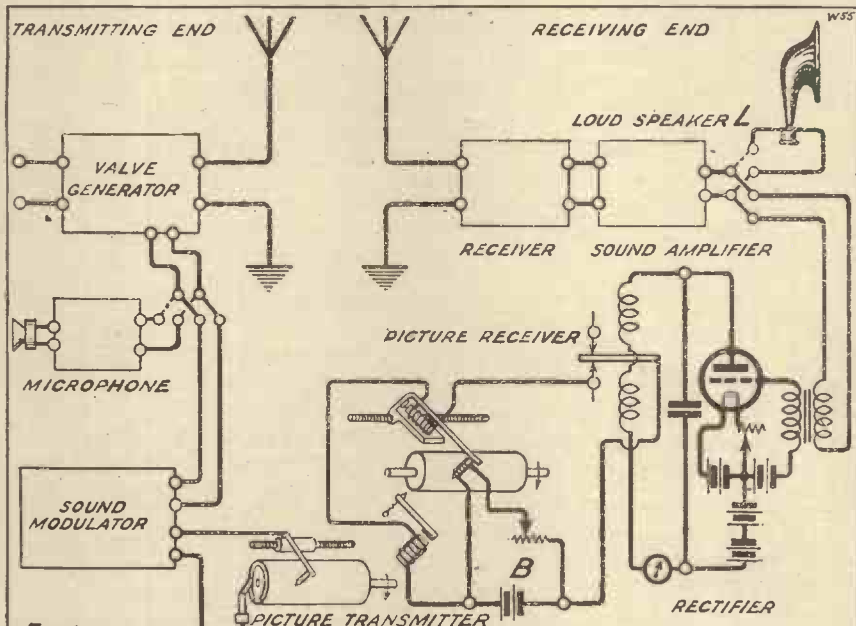


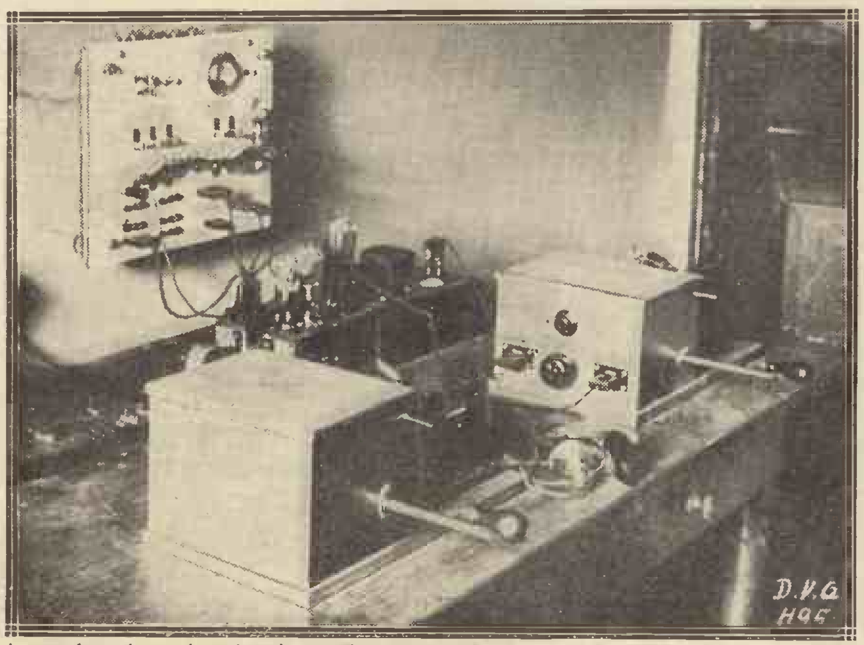
FIG. 1. SCHEMATICAL ARRANGEMENT OF TRANSMITTING AND RECEIVING STATIONS

One photograph shows the picture transmitter, the protective casing of the clockwork being seen to the left. Electric motors designed for 110, 220 volts direct current or 110, 220 volts alternating current can be used instead, the speed of rotation being adjusted to about thirty-three revolutions per minute. The transmitting cylinder and the slide of the searching spring are seen to the right.

The Sound Modulator

The holder of the transmitting cylinder carries at the left a sliding ring against which a contact spring is pressing; this ring comprises over about one-sixth of its circumference an insulating interruption, whence no picture elements can be emitted, only the synchronising magnet being actuated. Convenient stops will ensure the coincidence of the overlapping section of the picture foil with this synchronising section.

Contacts between the searching stylus and the conductive portions of the metal foil are used, not to actuate the transmitter direct but to control the sound modulator above referred to. A number of different arrangements of connections between the sound modulator and the picture transmitter can be adopted. A buzzer, small frequency machine, or valve circuit can be used as generator of sound frequencies.



A complete picture broadcasting station used by the Bavarian Weather Bureau at Munich.

The rectifier outfit is intended to convert the alternating current impulses coming from the receiver or sound amplifier from audio frequency to a sequence of direct-current impulses, which are supplied to a relay for closing the more intense local currents used to actuate the magnets of the synchronising device and the recording magnet of the picture receiver.

The Receiver

This, according to the most simple arrangement, comprises a low-frequency amplifier stage and repeater valve for a high-current intensity, the negative grid bias being so strong as to reduce the anode feed current to practically nil. The rectifier current will be actuated sufficiently for the reception of broadcast pictures whenever the receiving set in the loud speaker sets up a moderately strong sound intensity. A receiving current of 2 to 4 milliamperes will ensure a reliable reception of pictures.

A sketch poster transmitted by the method described.

Stylus Mechanism

The picture-receiving cylinder outwardly resembles the transmitting cylinder. A rough adjustment of the clockwork or electric motor to thirty-five to thirty-seven revolutions per minute of the cylinder is readily obtained by means of an adjustable brake in the centrifugal regulator. The magnet of the synchronising arrangement is seen in the lower part of one of the pictures, on the left, the recording device being visible on the top.

A magnified picture of the same recorder is also reproduced showing the slide from the right, back, and left respectively, and the threaded portion which, as the lever is adjusted in an upward direction, engages with the spindle is not visible in the figure. The plate rotating around a joint is fitted to the slide and carries in front a small pulley which, even with irregularities in the shape of the cylinder or recording surface, ensures a constant relative distance between the stylus and paper. The recording device proper is free to turn round the joint and can be adjusted by means of a screw. This carries a small electro-magnet, to the armature of which the recording stylo is fixed.

Operating Details

Lifting or lowering the lever will allow the stylus to be lifted and the slide to be shifted freely. The cylinder carrier and brake clutch, as well as the synchronising arrangement, are plainly visible in another illustration. The longitudinal bars of the cylinder carrier are split at their ends so as to allow the cylinder spring to rest there. Two pegs ensure the accurate coincidence of corresponding portions of the pictures at the transmitting and receiving ends respectively. A 6-volt accumulator is used to feed the magnets and heating. The knob enables the heating of the stylus to be regulated.

The arrangement and starting of the picture receiver can be inferred from the above. The rectifier is connected by a double conductor to the terminals coming from the amplifier, in the place of the loud speaker, while another two-wire line leads from the terminals marked "picture receiver" to the terminals of the picture receiver marked "relay."

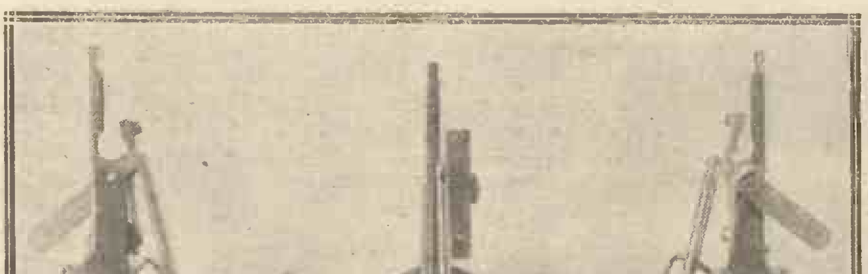
A 6-volt accumulator is connected up to the terminals of the rectifier marked "+6" and "−6" respectively. The tension of the anode battery of the rectifier should be from 60 to 90 volts, the grid bias being about 30 volts. The grid bias should be so regulated as to have the milliammeter of the rectifier showing a nearly negligible deflection (0–0·5 milliampere). As long as the transmitting station is broadcasting music or speech the indicator of the milliammeter will be fluctuating corresponding to the actual intensity of emissions.


The type of weather charts sent out by the Munich station.

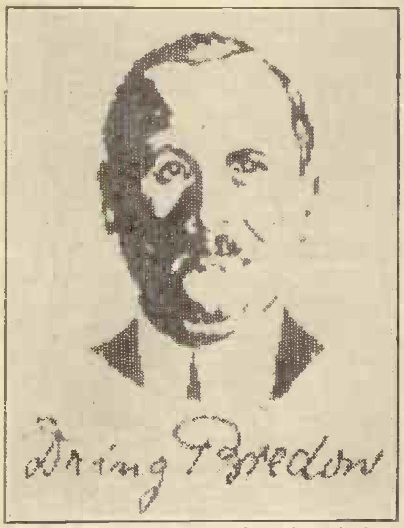
Preliminary Preparations

As soon, however, as the transmitting station gives out the signal announcing the broadcasting of a picture, viz., a long-continued sound of constant intensity, the milliammeter will show a constant permanent deflection of 5–6 milliamperes as a maximum; in fact, a current of 3–5 milliamperes is amply sufficient to attract the armature of the polarised relay towards the operating contact. The rotary switch of the picture receiver having been operated the magnet of the synchronising device and the recording magnet will be excited and will attract their armatures, while the heating stylus is raised to its operating temperature.

As the armature of the synchronising magnet is kept attracted the


The sliding mechanism carrying the stylus—seen from the right, back and left.

toothed wheels will be set rotating, though the receiving cylinder, if the cam has been applied against the nose of the ratchet, will not perform any rotation. The stylus having then been applied to the receiving cylinder on the left, the deflection in the milliammeter disappears as soon as the announcing signal in the transmitter has ceased, there is no longer any current flowing



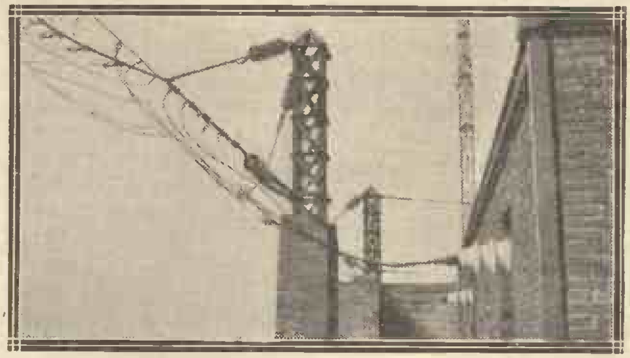
A sketch portrait as received by wireless.

through the magnets, the picture cylinder is carried along by its friction clutch, and transmission of the picture begins.

Successful Over Long Distances

After four to five minutes, during which the slide of the stylus has moved towards the right, the transmitter again gives out a long-continued signal, announcing the end of the picture transmission. The receiving cylinder having stopped automatically, the picture, as reproduced at the receiving end, is taken off the cylinder.

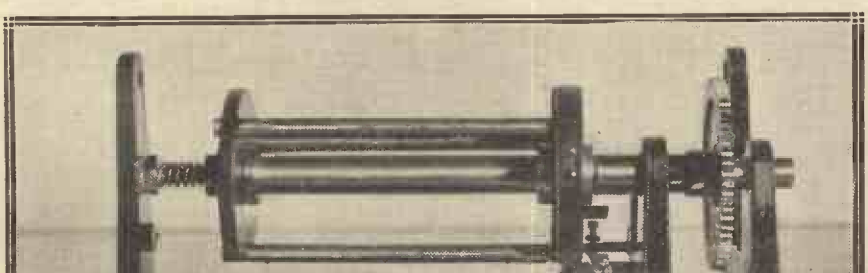
The new service is preferably resorted to in connection with the transmission of weather charts. Subscribers are supplied with maps printed with translucent colours on a celluloid or glass plate kept in a wooden frame, the weather chart being clamped fast



Successful reception over long distances has been obtained when high power was employed. This photograph shows the lead-in of the famous Nauen station.

by means of four small springs at the proper places behind the translucent plate.

Weather charts sent from the Norddeich transmitting station have recently been received without any fault across the ocean over a distance of 2,500 miles. The picture transmitter in this case was installed at the Nautical Observatory, Hamburg, from where the Norddeich radio transmitter was operated. Receiving tests were made under Prof. Dieckmann's supervision, aboard the s.s. "Westphalia."



The brake clutch and synchroniser, an important section of the apparatus.

R.C. AND HIGH "MU."

By K. D. R.

DURING the last few months we have heard a great deal about resistance-coupling for L.F., and how pure are the results obtained from that type of amplification. This is certainly justified, but readers of these eulogistic reports should not imagine that R.C. coupling is all that is desired *every time* it is desired. As a matter of fact, it is capable of giving an amazing amount of distortion if wrongly designed,

Now, although R.C. coupling is not easy to get to operate perfectly, it can be made to do so if care is taken in the choice of values of resistances and condensers, and of valves. It must be remembered that a valve with a high magnification and high impedance cannot deal with large input voltages, and herein lies one of the greatest "snags" that R.C. enthusiasts have to meet.

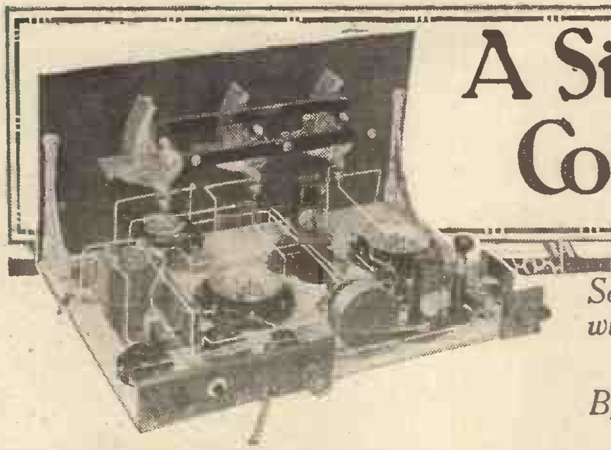
It is all very well to say we can use a 500,000-ohm anode resistance and a high "mu" valve and obtain almost the same amplification we can get with transformer coupling. So we can, *but*—and that but is, in my opinion, a large one. We shall run a risk of cutting down the amplification of the higher tones rather seriously, and also of overloading the next valve, which if it has a resistance in its plate circuit, will have to be carefully chosen.

Care Needed

Personally, I prefer to use nothing larger than 250,000 ohms in the first (the detector) stage, and then drop to about 100,000 or so for succeeding stages. As a matter of fact, I often use only 125,000 for the detector with a valve having an amplification factor of 20, followed by a valve with a magnification of about 10–15, with a resistance of 80,000 in its plate circuit.

If the first valve is of higher "mu" then the second is likely to be overloaded and distortion will be more difficult to avoid.

I think we are likely to look at things rather out of proportion now that such developments in high "mu" valves have been made; to become sheep-like, and to follow blindly where a little reasoning would enable us to obtain the *best* instead of merely *good* results. High "mu" valves and R.C. coupling are both excellent, but they must be used judiciously or chaos may result.



A Simple Constant-Coupling System

Some further notes on the variable capacity feed used with such success in the Fleetway Four, described in our July issue.

By H. J. BARTON CHAPPLE, Wh. Sch., B.Sc. (Hons.), A.C.G.I., D.I.C., A.M.I.E.E.

In last month's issue of MODERN WIRELESS readers saw described a four-valve receiver called the "Fleetway" Four. Amongst many of its features was introduced a somewhat new departure which I called "variable capacity feed," and it is my purpose this month to dwell upon this phase of the set, to point out the reason for its inclusion, and in what way the principles involved can be efficiently applied to other circuits and receivers.

For the purposes of explanation part of the theoretical circuit of the "Fleetway" Four is reproduced again, and the fixed condenser C_5 in parallel with the ·0005 mfd. variable condenser C_4 in this case constitutes the medium by which the amplified oscillations from the high-frequency valve V_1 are fed to the tuned grid coil L_4 of the rectifying valve V_2.

At the outset of this article I want to make it perfectly plain that the arrangement shown is not the best one—this is indicated later in the article—but served to improve the performance of the receiver with the material available, the semi-automatic adjustment of the capacity of this condenser combination being a feature to note

Effect of Frequency

To deal with all the problems involved in amplification with a valve and its associated circuit, together with the means adopted for passing on these amplified signals to the neighbouring valve, is entirely outside the scope of an article of this length. The reason for introducing a variable condenser in lieu of the more usual fixed condenser in the feed position suggested itself to me, however, after reading the interesting discussions that have been taking place in the correspondence columns of "Popular Wireless."

The protagonists of the various types of amplification have been championing their own particular fancies, with the result that much useful information has been propagated amongst the ranks of the wireless fraternity.

In their search after the ideal straight-line amplification for all frequencies, however, many readers seem to have overlooked the possibility that if such a condition can be reached what is going to occur during the process of passing these amplified signals on to the next valve?

Now, in a large number of cases a condenser provides the necessary path, and it is here that trouble will ensue. It is one of the characteristics of a condenser that its impedance or "resistance" to the flow of alternating current depends upon the frequency of the oscillations passing through it. As the frequency increases (corresponding to a decrease in wavelength) so the impedance decreases, and vice-versa. If we express this fact in a simple symbolical form we have:

$$Z = \frac{1}{2\pi f C} = \frac{A}{fC} = \frac{B\lambda}{C}$$

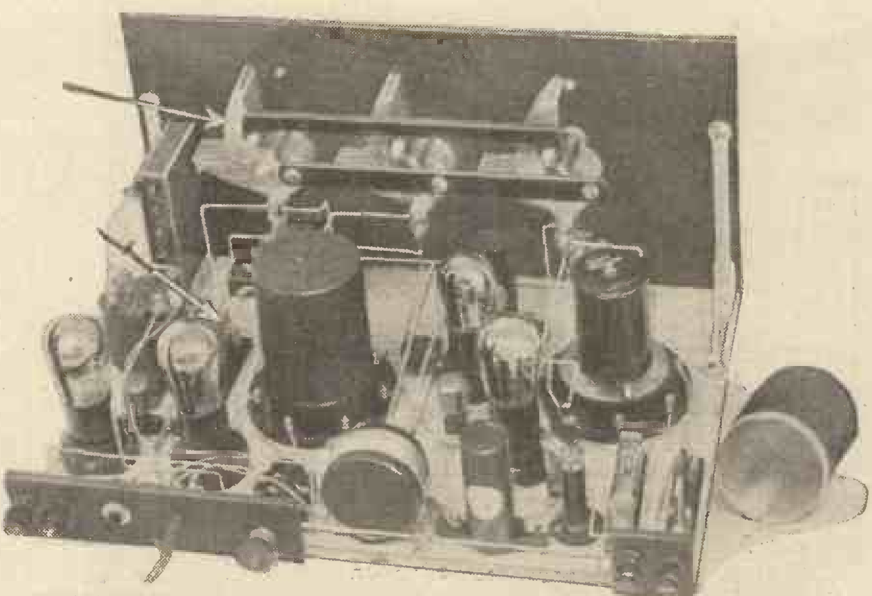
where,

Z = Impedance of condenser in ohms.
C = Capacity of condenser in farads.
f = Frequency of oscillations in cycles per sec.
λ = Wave-length in metres.
A and B = Constants.

Best Impedance Value

The best value for the impedance of this feed condenser is governed by many factors which need not be gone into here—indeed, it would form the subject for a very enlightening and useful investigation by any serious-minded wireless enthusiast.

As far as high-frequency circuits are concerned a very common value which is recommended is ·0001 mfd. Taking this value, and assuming that the set is tuned to 250 metres, then the impedance in ohms offered by this condenser is given by the expression



The arrows indicate the variable capacity feed and fixed condensers, C_4 and C_5 respectively in circuit diagram.

$$Z=\frac{250 \times 10^6}{2\pi \times 3 \times 10^8 \times \cdot 0001}=1{,}330 \text{ ohms.}$$

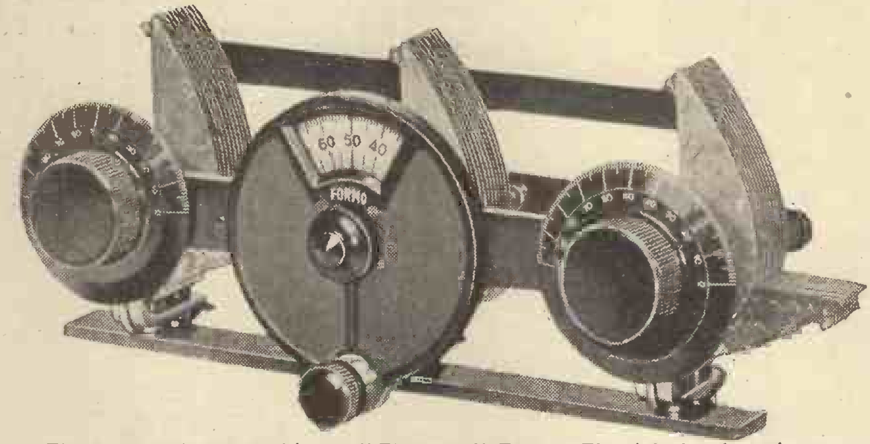
An intelligent observer might immediately ask why the capacity of this condenser was not arranged to be very large so that the impedance was only a few ohms. If this were done with the circuit shown in Fig. 1, however, we should get a partial short-circuit between the plate of V_1 and L.T.—, the remaining impedance being supplied by a portion of L_4.

Obtaining Constant Value

Taking this same capacity we find that the impedance at 550 metres is now increased to 2,920 ohms, the range of 250 to 550 metres being that suitable for covering the ordinary broadcast band. Now, if we can arrange by any means that this ohmic value *does not change* with every change of wave-length (or frequency) then we shall be a step nearer to our "ideal amplification" condition.

An examination of the previously-quoted formula shows that if we increase or decrease the capacity of the feed condenser in the same proportion as we increase or decrease the wave-length, then the impedance *change* of the feed circuit, as far as the condenser is concerned, is zero.

It is possible to have this feed condenser continuously and separately adjustable so that it constitutes another control on the receiver, but if such a step can be avoided it will be advantageous, since modern practice tends towards the elimination of as many of the controls as can be conveniently arranged, a practice which has manifested itself by its popularity. It is noticed that we must increase capacity as we increase wave-length (and vice-versa) to keep this "feed constancy," but with any tuned circuit it is necessary to increase the tuning capacity to resonate with the increased wave-length (and vice-versa). Thus, a suitably designed condenser could be ganged to the existing tuning condensers and thus perform its function automatically.



The gang condenser used in the "Fleetway" Four. The right-hand section was used as C_4.

An attempt to do this has been made in the "Fleetway" Four. It will be seen that the feed-capacity alteration is not the same as the tuning-capacity alteration, otherwise the process would have been very simple. For example, to tune to 250 metres the condensers C_2 and C_6 of Fig. 1 must be set approximately at zero, i.e., the capacity is practically zero, but if the feed capacity were as low as this the impedance would be far too high for adequate qualitative and quantitative signal reproduction, particularly the latter. That is why the clip-in condensers have been provided in parallel with one portion of the gang condenser (see one of the accompanying photographs), and it was left to the constructor to make a trial in situ to ascertain the differences with various fixed-capacity values in parallel.

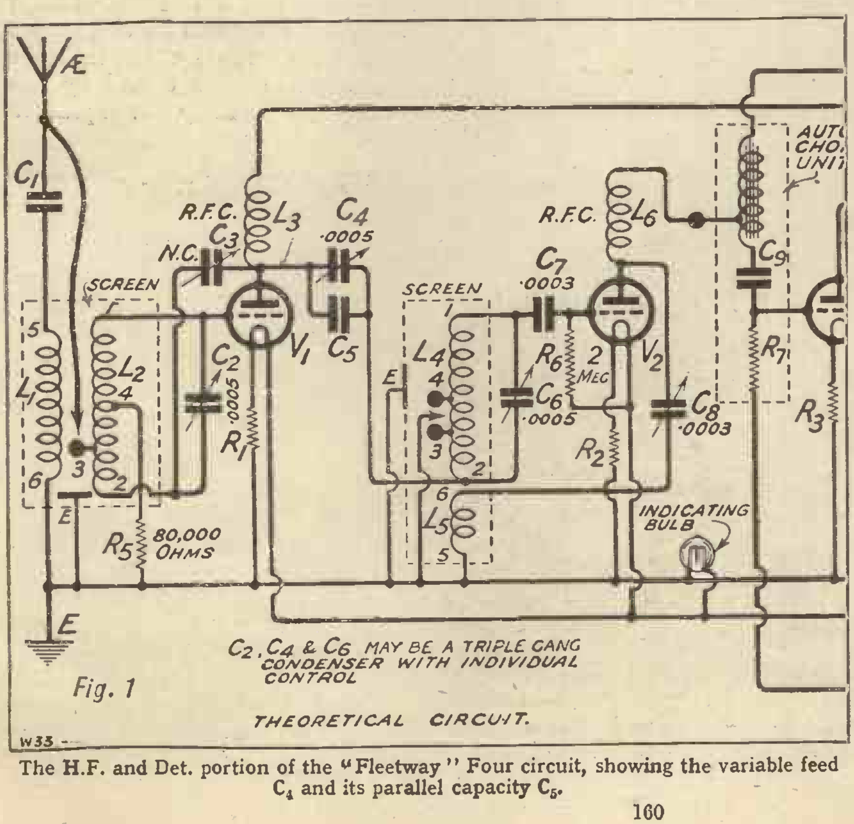
Small Changes

Assuming that the variable capacity is zero at 250 metres and ·0005 mfd. at 550 metres, then the impedance changes, instead of being 1,330 ohms to 2,920 ohms as calculated with the ·0001 mfd. fixed capacity only, are as shown below:

C_5 parallel capacity	·0001	·0002	·0003
Impedance at 250 metres	1,330	665	445
Impedance at 550 metres	490	415	320

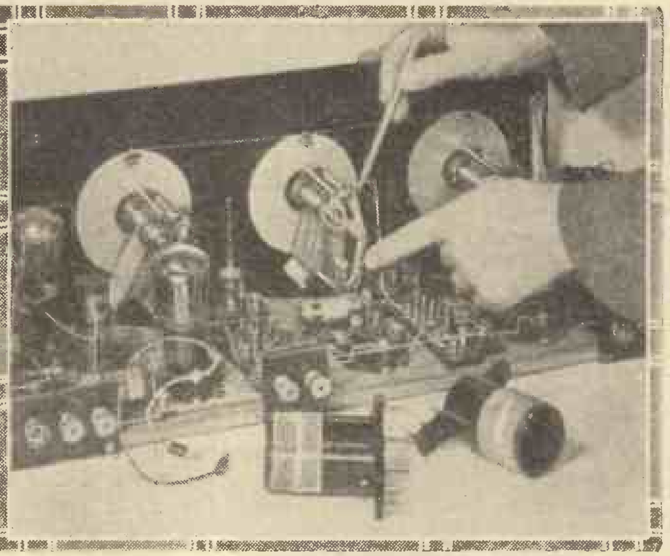
While the total impedance has been reduced the *change* in impedance is not so excessive, and thus better signal reproduction is secured. With the Formo Individual triple-gang condenser incorporated in the set, and illustrated separately in this article, it is possible to adjust this capacity independently when so desired,

(*Continued on page* 208)



The H.F. and Det. portion of the "Fleetway" Four circuit, showing the variable feed C_4 and its parallel capacity C_5.

A "Combine Five" Modification



Owing to slight alterations in layout and wiring some readers have experienced difficulty in handling their "Combine Five" receivers. The modification described here will enable easier tuning to be obtained.

By PERCY W. HARRIS, M.I.R.E., and G. P. KENDALL, B.Sc.

A STUDY of the queries received by the Technical Department of this journal shows that certain readers of MODERN WIRELESS have experienced some difficulty in getting results equal to those of the original model. The aim of the designers, as explained in the booklet, was to produce a receiver with a very

All the accessories necessary to carry out the alterations are a knife, wire, Empire tape, and Chatterton's compound.

high degree of selectivity, while maintaining a very high standard of audio-frequency reproduction.

A Probable Cause

To achieve this aim something had to be sacrificed in signal strength, for although high selectivity is possible by the excessive use of reaction, this is bound to be accompanied by distortion, which would nullify the good work of the designers of the audio-frequency end. At the same time, the loss of signal strength was not so great as to account for the troubles experienced, and the difficulty must therefore be sought elsewhere.

All sets in which efficient H.F. amplification is used are liable to big changes in results with small changes in layout. This appears to account for the difficulty many readers have found in neutralising the two stages of H.F., and also in tuning sufficiently accurately to get the requisite signal strength.

The writers have now worked out a means of making the set less critical in the hands of the average user, and as a result of a number of experiments have been able to produce a modified type of coil, which renders the set less susceptible to slight changes of layout and wiring, with only a very slight sacrifice of selectivity compared with that of the original form.

While the new specification is given in this article, and commercial forms of the coil have already been produced, it has been found possible to modify the original coils with the greatest of ease and at practically no expense, so that these easier effects can be obtained at once. Indeed, the method of modifying the original coils can be carried out by anyone in half an hour or so, and with only one slight modification of the

Removing the primary winding at the top of the coil.

A dab of Chatterton's is placed on the secondary before winding on the tape.

wiring of the set, to allow for certain effects which will be mentioned later.

When two stages of H.F. are used with modern low-loss coils we have to allow for two separate and distinct effects.

Wiring Changes

First of all, we have instability due to the feed-back caused by the inter-electrode capacity of the valves; and secondly, instability due to stray fields and wiring. A change of the shape and disposition of coils may considerably alter the latter effect, and for this reason a slight change in wiring is made in the present case.

This change is simply to reverse the

leads to the three variable condensers. The three connections which now go to the fixed plates are taken to the moving plates, and similarly the three connections which now go to the moving plates are taken to the fixed plates. When the change is made all other wires remain the same and the screening plates are connected together and to earth just as shown in the original description.

The writers have found with others that it is advantageous in H.F. transformer design to get the highest efficiency in magnetic coupling with fairly low capacity coupling. This can well be done by winding the primary with very fine wire (as fine as can be conveniently handled) and

Several layers of tape are wound over the secondary.

placing it as close as possible to the secondary winding.

If now the "Combine Five" H.F. transformers are modified so as to remove the present primary winding and replace it by a similar number of turns of finer wire wound over one end of the secondary, the set can be rendered less critical and much easier to handle with very little sacrifice of selectivity. Fortunately the original coils are so made that the change can be effected with the greatest ease, and in order that readers may see every stage photographs have been taken to show how a set of the original coils were modified.

Preliminaries

The first step is to remove any outer covering of celluloid or ebonite which may have been placed by the makers over the original winding. Some makers have used a thin celluloid tube which can be slid off, and others thin sheet ebonite. This latter should be carefully split and taken off. The two windings will then be revealed, the secondary being the larger and the lower.

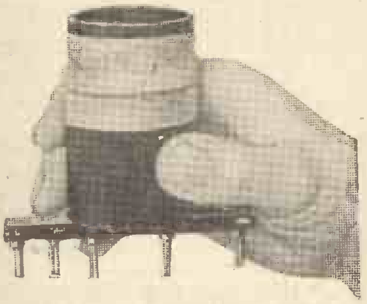
An examination of the transformer will show that two wires are brought up inside the tube and connected to the two ends of the primary winding. The tube is pierced at two points to allow for the passage of these leads. Take a sharp knife, and at about an inch from the top hole cut the original primary winding, which will then spring off. Cut off the other end of this winding about an inch from the lower hole, and you will then have a tube carrying the secondary winding, with two ends of wire sticking out of the tube—the two wires which were originally the primary leads.

Now take a roll of "Empire" tape (this is a yellow semi-transparent tape used by electricians; the width chosen for this work is about $\frac{7}{8}$ in.) and a stick of Chatterton's Compound —this can be obtained from any wireless dealer. Melt a little of the Chatterton's and dab a few drops on to the secondary winding, making a sticky strip for the full width of the winding. Now attach one end of the Empire tape by pressing it on to the Chatterton's, and wind three layers. Twenty inches will give about the necessary length. Secure the end with Chatterton's as previously.

The New Winding

On top of the joint rub a little more melted Chatterton's. Now take some No. 36 enamelled copper wire and solder one end to the lower projecting wire. Wind over the Empire tape, and in the position shown in the photograph, 30 turns of the No. 36 wire. Wind the turns as closely as possible, but do not take very great pains, as when you have wound on the 30 turns you can press the turns closer together with your finger-nail. At each turn the wire will pass over the sticky Chatterton and this will help to secure it in place.

When you have wound on the 30 turns, cut the wire and solder the remaining end to the upper projecting wire on the tube. When you have done this, wind a single layer of Empire tape over the secondary wind-



The coil is covered with another layer of tape and is then complete.

ing and secure it in place with Chatterton's as before, and another single layer of tape over the part where the primary winding was previously placed. This upper piece will protect the fine wires which are soldered to the new windings.

The new winding, by the way, should be wound in an anti-clockwise direction looking at the tube from the top.

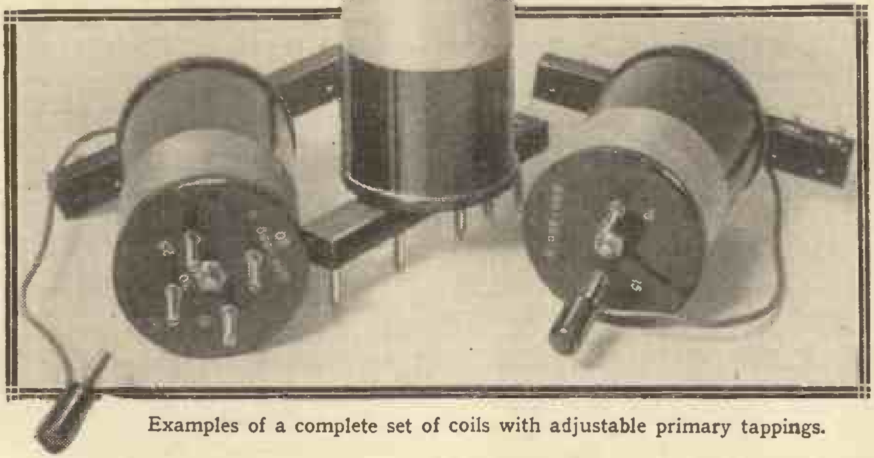
The Aerial Coil

You will get slightly easier tuning by making a new primary winding on the aerial coupler. In this case, of course, you will need to take tappings.

Another dab of Chatterton's keeps the primary in place during winding operations.

The general manner of winding should be precisely the same as that for the H.F. transformers, and the total number of turns should be 30, with tappings at 15, 20, and 25.

Those readers who do not wish to make their own coils may care to buy them made to the new specifications. Those made by Messrs. Burne-Jones & Co., Ltd., to our new specification are shown on one of the photographs. In the case of the commercial coils, where manufacturing facilities are available, the new winding is placed on a small tube immediately inside the secondary, the same efficiency being obtained with either type of coil. In order that readers may experiment in selectivity, the commercial coils are made with 30 turns of fine wire with a tapping at 20, and by means of pins on top of the winding either a 20- or 30-turn primary can be used at will. This gives the reader an opportunity to increase the selectivity at times when he is very close to a station. Generally, the 30-turn will be found to suit all purposes.



Examples of a complete set of coils with adjustable primary tappings.

H.T. Adjustment

In order to obtain the best results with the new coils, the value of the H.T. for " H.T. positive One," should be carefully adjusted. In most cases about 30 or 36 volts should be tried at the beginning, and the neutralising condensers varied until stability is obtained over the whole range. When the set has been stabilised in this way increase the H.T. voltage step by step until the set is no longer stable, but oscillates slightly when the three condensers are in tune. When this point has been found, reduce the voltage again until you get high sensitivity without the sacrifice of quality. In this way you are allowing for a little reaction in each case to give a signal " boost " without giving unwanted distortion.

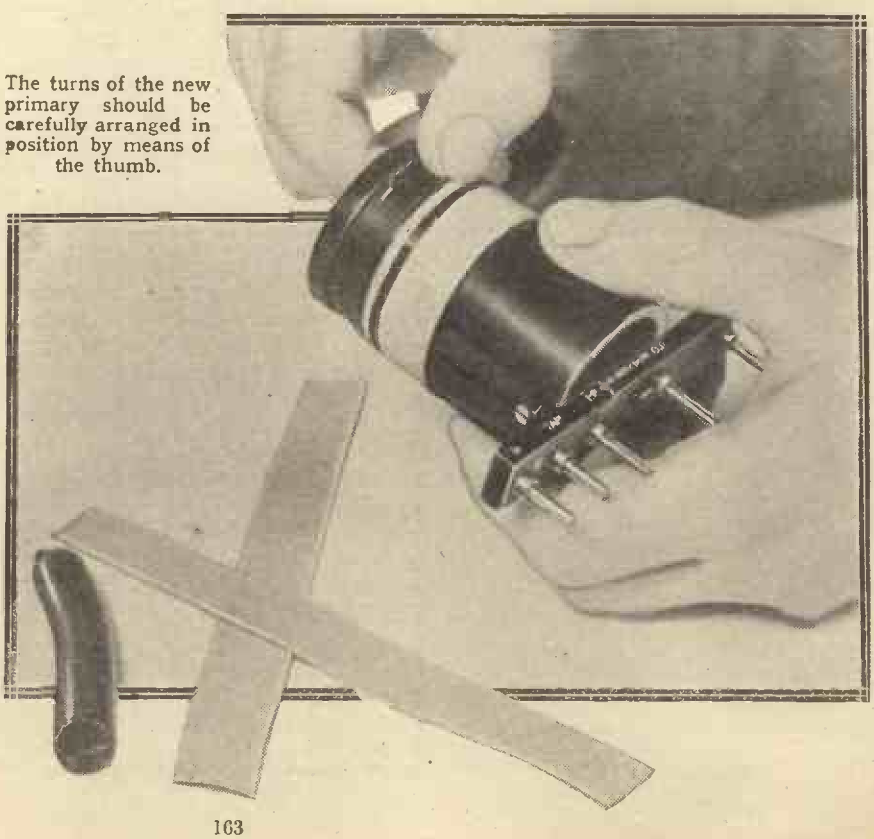
With these coils and the reversal of the condenser leads as previously explained, the set is completely free from hand-capacity effects and the sensitivity is very high.

Although it is understood that reaction was advisedly omitted from the original design, so many readers have asked how it may be incorporated that it seems that a description of the process would be welcomed. It would appear that the extra sensitivity conferred by reaction is desired by many constructors whose main interest is long-distance reception, although it is understood that if very full use is made of the regenerative principle a certain loss of quality is liable to occur.

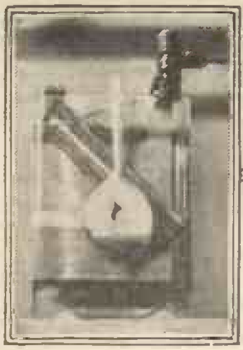
Reaction

The addition is a very simple one, and the first step is to alter the connections of the H.F. choke so that reaction of the so-called Reinartz type may be obtained. At present the choke is connected in series with the lead from the anode of the detector valve to the grid condenser of the first L.F. valve. Instead, the choke must be connected in series between the anode of the detector and the anode resistance. There will be a common point between these two components, and from this point a lead will go off to the grid condenser of the first L.F. valve. The by-pass condenser, which is at present connected between the anode of the detector valve and filament, will now be connected between the aforementioned common point and filament. The actual point-to-point connections will be as follow: H.T. + 2 to one side of anode resistance. Other side of anode resistance to one side of H.F. choke, one side of grid condenser of first L.F. valve, and one side of by-pass condenser. Other side of H.F. choke to anode of detector valve.

(*Continued on page* 206)



The turns of the new primary should be carefully arranged in position by means of the thumb.



A CONSTANT L.T. SUPPLY

A simple method of keeping your accumulators charged.

By A. P. SUMMERS.

FOR the amateur who has not the electric-light supply at his disposal there is always the annoyance of having to trudge to the nearest electrical stores to have his accumulator charged. Some enterprising wireless firms will collect and deliver the accumulators free, but even then the charging of the L.T. battery has always been an unwanted expense.

It is only natural, therefore, that the wireless enthusiast will turn his attention to some other source from which to light his valves. The amateur who owns a multi-valve receiver, using dull-emitter valves, and possibly an additional power valve taking anything from ·5 to 1 amp., cannot successfully work his set using dry batteries for the L.T. It is obvious, therefore, that an accumulator, and a means of charging it at home, which is efficient and at the same time inexpensive, will be necessary.

An Easy Method

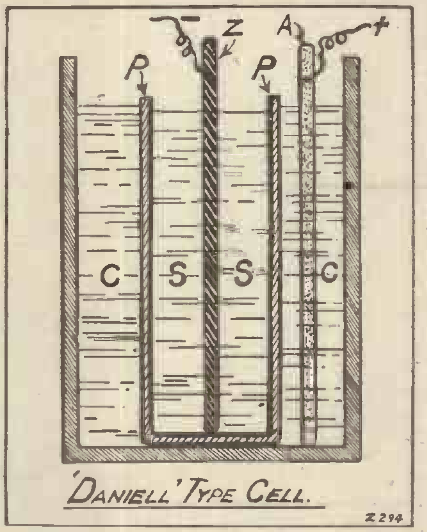
A reliable charging set could be installed, using a gas engine and direct-current dynamo; but as the accumulator only needs charging at intervals of, say, once a week, it would be ridiculous specially to purchase such an expensive piece of apparatus.

The writer has obtained excellent results—although only after much experimenting—by using primary cells to charge secondary batteries, selecting, after due consideration, the Daniell cell as being most suitable for the purpose. The Daniell cell consists of a zinc plate or rod Z, in a dilute solution of sulphuric acid S, separated by a porous pot, P, from a saturated solution of copper sulphate C, in which is immersed a thin copper plate A. (See sketch.)

The component parts of a cell—zinc, porous pot, jar, and copper.

The cell in question will work for weeks on end without the inconvenience of dismantling, giving a steady current of ·3 to ·5 amps at 1·1 volt. All that is necessary is to replenish the zincs as they become exhausted and to renew the supply of copper sulphate when the liquid loses its blue colour.

It will be necessary to connect six cells in series, i.e. the positive of one cell to the negative of the next, and so on, in order to produce 6 volts to charge a 4-volt accumulator, or eight cells for a 6-volt accumulator. A battery of Daniell cells may be constructed as follows:



First procure six glass jars about 4½ in. in diameter and 8 in. high, the tops of which should be painted over with a coating of boiling paraffin wax in order to prevent the solution from creeping. Six empty porous pots such as those used in Leclanché cells should next be obtained, also six heavy amalgamated zinc rods and six pieces of copper foil 6 in. by 6 in. The above components can then be assembled as illustrated in the sketch. Pack the outer jars with crystals of copper sulphate, and fill the porous pots and outer jars with water, afterwards adding a few drops of strong sulphuric acid (H_2SO_4) to the water in the porous pots. The copper of the first cell should be connected to the positive terminal of the accumulator, and the zinc of the last cell to the negative of the accumulator. The battery will then be ready for use.

The battery should be left thus connected across the accumulator day and night; leads being taken from the accumulator to the set, which can be used whenever it is required, as the storage battery will always be more or less charged.

Chemical Action

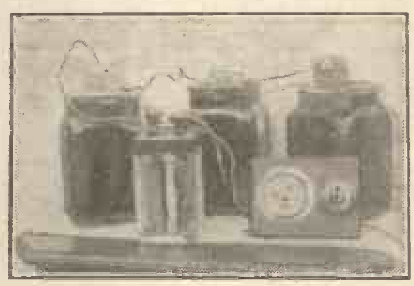
When the Daniell cell is producing a current it is subject to the following action:

The sulphuric acid dissolves some of the zinc rod, forming zinc sulphate; hydrogen is liberated, travelling with the current through the porous pot towards the copper plate. On meeting the solution of copper sulphate the hydrogen displaces some of the copper, forming sulphuric acid, and the copper passes on and is deposited on the copper plate. No polarisation takes place.

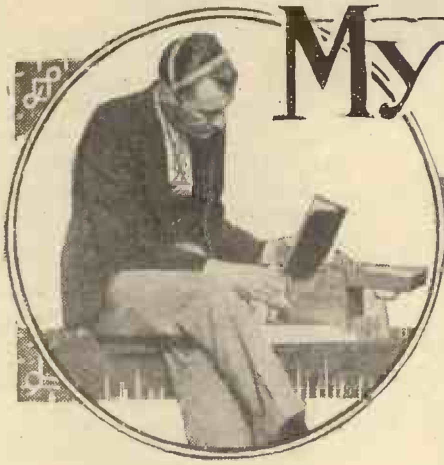
WATCH THAT "EARTH"

ALTHOUGH at the time of writing it does not appear as if we shall be having any summer weather this year, yet from a radio point of view, summer conditions already exist. DX reception is more or less at a discount, and atmospherics have recently been very troublesome.

One thing that has not made itself so generally manifest, owing no doubt to the wet weather, is the dry earth connection, which usually commences to worry us at about this period of the year. But all the same keep an eye on that earth and keep it as wet as possible during the warmer weather, and you will avoid many little "untraceable" troubles and poor reception.



A complete charging unit of three Daniell cells.



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.

LIEUT. B. WALTON O'DONNELL, the recently appointed conductor of the London Wireless Military Band, joined the B.B.C. with the definite purpose of creating and maintaining the finest military band in the world. He realised that the attainment of this ideal will take time; but provided he is given the necessary facilities and support at Savoy Hill, there is little doubt that he will succeed. This is a project important alike to the B.B.C., to listeners, and to British prestige. It is fittingly complementary to Mr. Pitt's idea that Sir Henry Wood's new orchestra will be the best in the world.

Music for Military Bands

Mr. O'Donnell was telling me about his work the other day. He emphasised the peculiar difficulty of maintaining a high standard under military service conditions. No sooner would he get a good band together than his personnel would be changed. Now, however, he will be able to stick to his talent, and nurse it up to maximum efficiency. I had not realised before that there are embarrassing limitations to the music available.

This deficiency Mr. O'Donnell will repair not only by encouraging new composers but also by composing himself. "If only composers realised how much better a chance they had of getting their work performed by a military band than by an orchestra there would soon be no shortage of the music we need," he remarked. Incidentally a bit of Mr. O'Donnell's discipline on service lines will do a lot of good at Savoy Hill. Good luck to him in his great enterprise!

B.B.C. Music Next Season

Perhaps partly by way of concrete reply to the highbrow enemies of Broadcasting, the B.B.C. is launching a most ambitious and far-reaching musical programme in October. This will run straight through to Easter, and perhaps later. Now that the B.B.C. "Proms" have been such a success, the main Queen's Hall Symphony Season is being prepared. There will be twelve principal concerts at the Queen's Hall at fortnightly intervals, normally on Friday nights.

Light orchestral seasons will run on other days at suburban and provincial centres, including the People's Palace, Crystal Palace, and other well-known places in London and Greater London. Effective co-operation has been achieved with the Halle Orchestra at Manchester, the Welsh musical organisations at Cardiff, and the Scottish National Orchestra at Glasgow.

Thus the main former elements of friction have been removed, and the B.B.C. has at last focussed all the music of account throughout the United Kingdom. There should be some interesting developments in connection with the finances of the various musical societies which are now associating themselves with Broadcasting for the first time. The conspicuous financial success of the B.B.C. "Prom" season has already confounded the prognostications of the confirmed pessimists.

Sir Evelyn Murray on the B.B.C.

Sir Evelyn Murray, Permanent Secretary to the Post Office, has just published a book on his Department in a semi-official series. In giving a general review of the work of the Post Office he touches upon Broadcasting. Sir Evelyn was understood not to be altogether enthusiastic about this branch of wireless telephony.

It was also believed that he was the arch-priest of the school of thought

One of the station engineers testing the apparatus at the new 40-kw. broadcasting station at Moscow.

which would resist any extension of Broadcasting to include controversy. It may be that this was the case at some earlier period, but from his book it is patently clear that Sir Evelyn thinks well of Savoy Hill, and is not disposed to interfere with its development.

For instance, when he deals with the relations between the B.B.C. and the Post Office, he restricts the P.M.G.'s authority to the allocation of wave-lengths. No censorship of any kind is suggested or inferred. The B.B.C. would be well advised to exploit this new definition of its relations with the Post Office. If these were to be interpreted in this broad and easy fashion, there would be no need for fresh Parliamentary intervention at the end of the so-called extended probationary period.

I.B.C. Difficulties

The Indian Broadcasting Company is encountering many difficulties and setbacks, the chief of which seems to be the vacillation and hesitation of the financial backers. Some caution in such a speculative venture is no doubt natural and excusable. But apparently some of the former B.B.C. officials who went out to join the new I.B.C. are already "feeling the draught."

Pay is low and prospects are vague. But they are sticking it, and should pull through in the end. It is known that a few of them are turning longing eyes homeward; but this is useless. The forthcoming contraction in B.B.C. organisation will involve a considerable reduction of staff both in London and in the provinces. There is no room for recruits or former employees.

The Broadcasting Governors

The B.B.C. Governors do not say much in public, apparently submitting to the self-restraint of the staff. This is all to the good. But perhaps they might be allowed to "open up" a little now and then. A friend of mine met a B.B.C. Governor at a dinner-party in Scotland recently. The atmosphere was friendly and almost intimate.

The host was "twitting" the Governor about his job and his reticence in public. The latter replied that he was glad that the chief thing he had to do for his money was to keep his mouth shut until allowed to open it by official preceptors at Savoy Hill. He added that he had never before encountered anything half as well run as the B.B.C. His only criticism was that it was too much a "one-man show"—it was all Sir John Reith. Nobody else seemed to matter or to carry any responsibility.

This is an interesting opinion. It is perhaps an exaggeration to say that nobody matters but Sir John Reith; but it is true that he is so far above any of the other members of the staff or of the Board that the rest seem to be of no account whatever. It is not a case of a brilliant mind and a mass of pulpy mediocrity; it is rather a case of a demi-god in the midst of a group of quite formidable "principalities and powers."

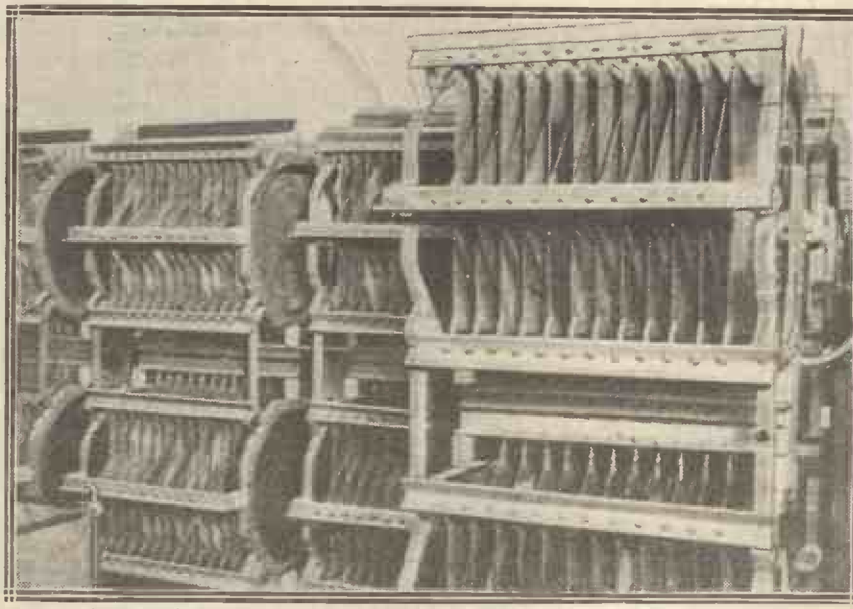
Religious Broadcasting

By a curious paradox the B.B.C. is now getting into trouble over that part of its work which previously was regarded as in many respects the most satisfactory and popular. I refer to the religious broadcasts. These gained a great hold on the public imagination and affection, chiefly because of their successful embodiment of that kind of religious conception of commonsense, manly ethics so well described in Sir John Reith's book "Broadcast Over Britain."

But the B.B.C. developed their religious work in consultation and agreement with the organised churches, maintaining good relations through the various religious advisory committees. These committees, composed of clergy and ministers of the various "respectable" denominations, naturally saw to it that the religion broadcast was supplementary and not substitutional.

For instance, there was to be no direct competition during church hours, nor was there to be any challenge by a new brand of religious teaching. And now, after nearly five years, listeners are wanting more substantial and stimulating religious diet. They are getting restive about the alleged subservience of Savoy Hill to the churches.

This discontent is manifesting itself in various ways. For instance, the Listeners' Committee has sponsored it. Many letters are reaching B.B.C. stations on the subject. Those best qualified to judge in this matter are in agreement that the best solution from the public angle would be the appointment of the Rev. H. R. L. Sheppard, as soon as his health permits, to be the real "Broadcast Vicar."



A bank of the condensers used at the new Komintern station at Moscow.

H.T. ELIMINATORS

The use of H.T. eliminators is rapidly becoming more general, and this method of providing the anode current for your set is rightly popular. There is one thing concerning the D.C. H.T. eliminator that should be borne in mind, and that is to do with the resistance used to provide the necessary potential drop to give separate H.T. voltages.

If one tapped resistance is employed there is a danger of coupling taking place between the plate circuits of the valves, and thus causing interaction and consequent howling. A better plan is to use separate resistances in series with each plate lead, thus avoiding the coupling effect.

AN EFFICIENT THREE VALVER

An easily constructed and highly efficient household receiver.

Designed and described by L. H. THOMAS.

It is very often found, in the case of receivers employing one stage only of tuned radio-frequency amplification, that it is undesirable to screen both or even one of the two tuned circuits in any of the normal ways. The screens marketed commercially for the purpose are admirable when used in multi-stage receivers, and are, in point of fact, real necessities; but in the case of the set with only one H.F. stage there is usually not sufficient margin to allow for the losses necessarily introduced by screens of this type.

There are two alternatives: either to screen the entire H.F. stage—valve, coil, neutralising condenser, and rheostat—or to place the coils so that interaction between them may be supposed to be very slight and, in fact, negligible.

Only Two Main Controls

In the receiver described in this article the standard and useful six-pin bases, with the pins arranged in the well-known "Southern Cross" formation, have been employed, and the standard coils are used *without* the screens.

To compensate for the removal of the latter, slight modifications in the coils have been necessary, but these will be dealt with in detail at a later stage.

The receiver employs one neutralised H.F. stage (neutralising being achieved by the "split-primary" method of coupling), a "leaky-grid" type detector, and a resistance-coupled L.F. amplifier. "Reinartz" type reaction has been provided on the detector.

As will be seen from the front-of-panel photographs and diagrams, there are only two main tuning controls, the adjustments of which are reasonably well balanced. The third small knob is that of the reaction condenser, which may be left in one position for quite a wide band of wave-lengths, and does not require adjustment very frequently.

The baseboard layout is so arranged that the coils are separated by rather more than six inches from centre to centre, so that interaction between the tuned circuits, if any, is certainly not great enough to cause any noticeable ill effects.

The standard "American" practice has been adhered to, all the battery terminals being at the rear, while the aerial and earth terminals occupy one end of the panel and the loud-speaker terminals the other.

As regards the actual construction and wiring, there is really very little to be said. The vast majority of the wiring up of the components on the baseboard can be carried out before the panel is fixed in position. A "trial" fit will, however, have to be made in the usual way, the positions of the panel brackets being decided, the brackets fixed, and the drilling and fixing of the components performed.

Wiring Up the Coil Bases

Fixed resistors have been employed, and the convenient manner in which these can be "inserted" in the leads to the filament terminals of the valve holders simplifies the wiring very considerably.

The wiring up of the Collinson six-pin bases should be tackled with care; the great point is that, although it is sometimes necessary to bring the leads above the actual level of the bakelite, they must not be raised sufficiently to foul the bottom

A back-of-panel view of the set, with coils and valves in position.

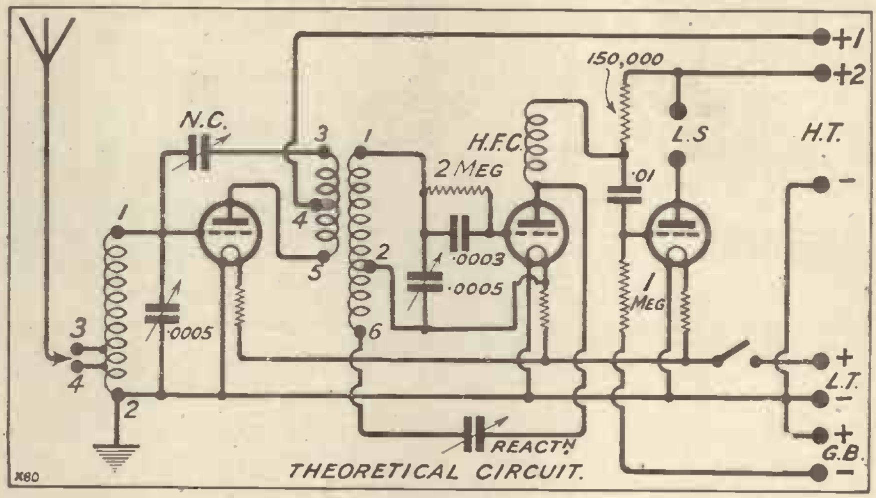
of the coil itself, or to foul the pins of the latter as it is being inserted.

The wiring of the L.F. end of the set is particularly simple, and this is due largely to the use of the resistance-capacity method of coupling. No particular note on this is needed until the operating details are reached.

COMPONENTS USED.

1 ebonite panel, 21 in. × 7 in. × 3/16 in.
Cabinet for same, with baseboard 7 in. deep.
2 aluminium brackets.
3 valve holders (Benjamin).
2 six-pin bases (Collinson).
(For details of coils see text.)
2 ·0005 S.L.F. condensers with dials (Ormond).
1 " Neutrovernia " (Gambrell).
1 " Midget " condenser, panel-mounting type (Peto-Scott).
1 push-pull switch (Igranic, Lissen, etc.).
3 Amperites to suit valves used (Type 1A for six-volt valves).
1 seven-terminal strip.
1 ·0003 condenser with 2-megohm leak (Dubilier, Lissen, etc.).
1 150,000-ohm anode resistance, wire wound (Varley).
1 ·01 condenser (Dubilier, Lissen, etc.).
1 1 megohm leak (Lissen, Dubilier, etc.).
1 H.F. choke (Lissen).
4 terminals—" Aerial," " Earth," " L.S.+ " " L.S.—"
Wood-screws, bolts, Glazite, tinned-copper wire, etc.

It will be seen that the Ormond condensers used are provided with metal shields. These have been left in place, but not connected up, since the moving plates of both condensers are at earth potential. The reaction condenser is small, its maximum capacity being a shade under ·0001, but it is quite large enough for the purpose. The reader should note, however, that although this is in reality marketed as a neutralising condenser it is much larger in capacity than most, and it must not be assumed that *any* neutralising condenser will serve the purpose. There are some on the market which most certainly will *not*.



Coil Alterations

The coils needed are an aerial coil and a split-primary transformer. As bought, the aerial coil consists of 90 turns of No. 30 D.S.C. tapped at 10 and 15 turns. With a screen over it, this winding covers the wave-length range of, roughly, 250–550 metres—in other words, the whole of the normal band. When the screen is removed, however, the whole range moves bodily upwards, so to speak, the minimum wave-length, as tested with one coil, rising from 252 metres to about 280 metres, and the maximum from 540 metres to 600 metres. A few turns may therefore have to be stripped off. In the case of the coils used by the writer, the removal of 15 turns had the desired effect, but some cases have been met in which as many as 30 turns have had to be removed before the lower stations of the broadcast band could be tuned in.

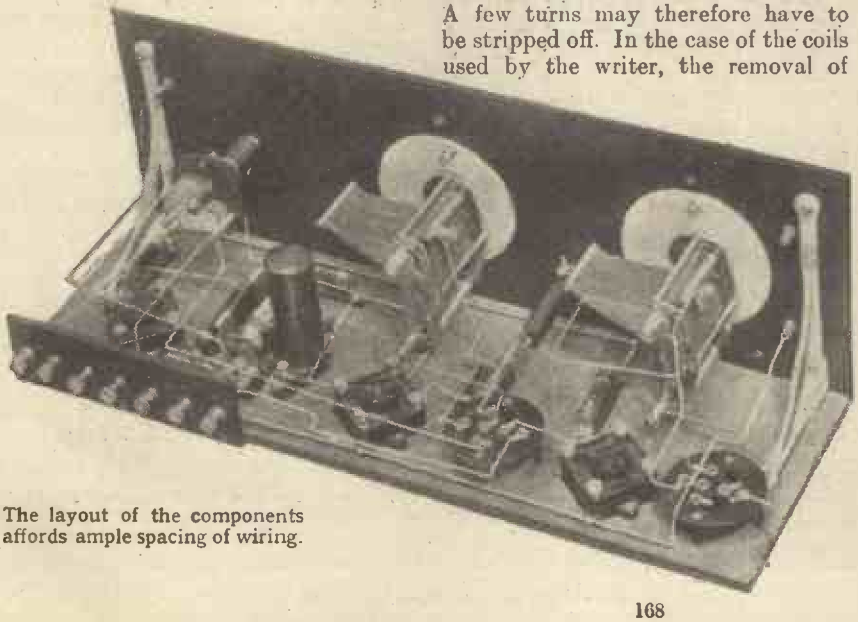
The secondary—outside—winding of the split-primary transformer is absolutely identical with the aerial coil, and the *same* number of turns must, of course, be removed from this winding. In both cases the best method is to remove the bottom end of the winding from pin No. 2, strip off 15 turns, and make a new connection with the end of the remaining winding.

When this has been done, it should be found that the coil with a ·0005 condenser covers the desired waveband. On the original set, with 20 turns removed from each coil, and S.L.F. condensers in use, 2 L O was received with both dials set to approximately 115°.

The Valves To Use

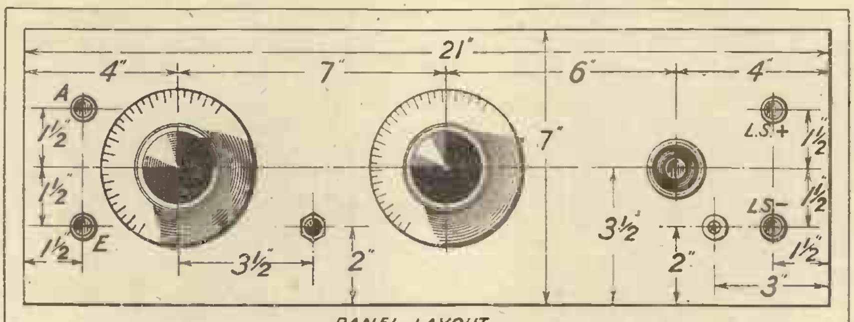
When the wiring has been completed the usual tests should be made, i.e. about 10 volts H.T. should be connected and each pair of filament terminals tested with a voltmeter. If no reading is obtained in any case, the full H.T. and the L.T. supply may be connected up, also the aerial and earth, and the valves inserted.

The valves used in the author's set were of the 6-volt type, and the following are suitable: H.F. valve S.T.61*, D.E.5b, P.M.5X, Cossor 610 H.F., D.E.H. 612, E.S.5. etc. Detector, S.T.61a, P.M.5B, S.P.55/b, Cossor 610 R.C., or any other valve with a high impedance and high amplification factor. For the last valve suitable power types in the 6-volt class are the D.E.5, D.E.P. 612, S.T.63, P.M.256, Cossor Stentor Six, S.P.55/R, S.S.11, B4, P.V.5, etc.



The layout of the components affords ample spacing of wiring.

Regarding the H.T. voltages, it will be seen that the same voltage is used for the detector and the L.F. valve. This is necessary on account of the voltage drop across the 150,000-ohm resistance in the anode circuit of the detector. A separate tapping is provided for the H.F. valve. About 70 or 80 volts should be used for the latter, and 100 to 120 for the other two. Roughly, 7½ volts grid bias should then be required for the last valve.



PANEL LAYOUT

Tuning Adjustments

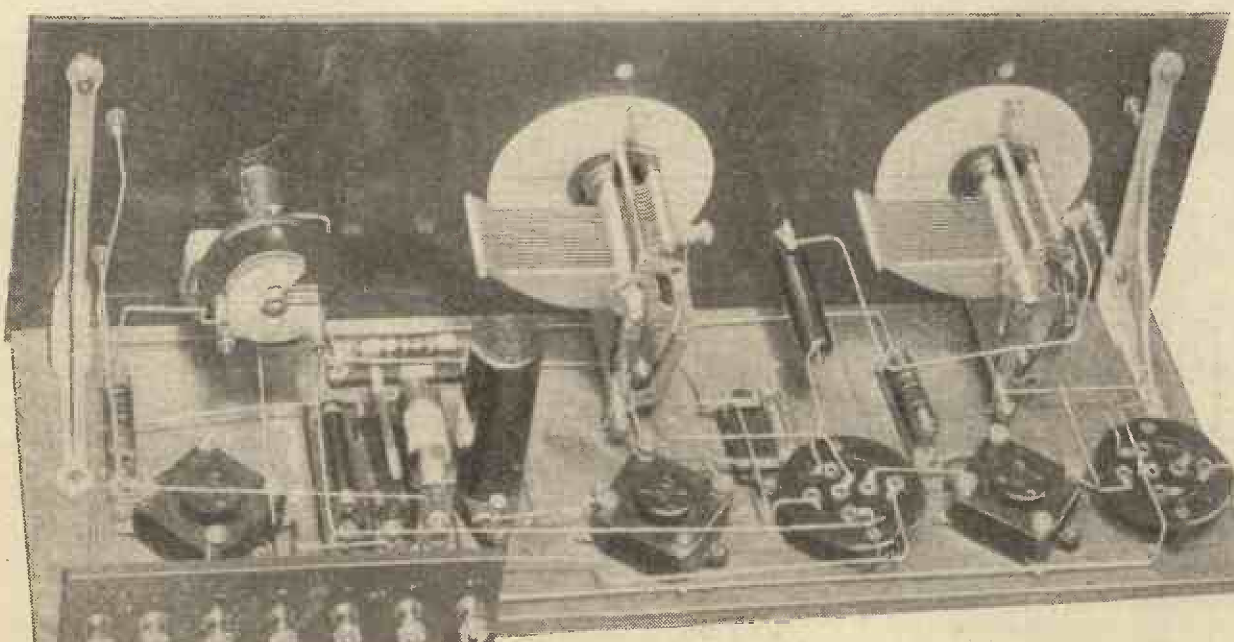
If the 2-volt type of valve is used a slight difficulty may possibly occur when neutralising the set. This will be dealt with later.

Having connected everything in readiness, connect the flex lead from the aerial terminal to one of the tags "3" or "4" on the aerial coil-base. It will be seen that two short "spikes" of wire have been soldered to these points to facilitate quick changes. Generally speaking, if the aerial used with the set is at all inclined to be long, tapping "3" will give the better results. Placing the reaction condenser at zero and the neutralising condenser in the middle of its travel, rotate the two main dials slowly, keeping them as nearly "in step" as possible. At about 115° (or probably at about 95–100° if no turns have been removed from the coils) the local station, in the case of London listeners, will be heard. This should give an indication as to the probable reading for the "local" in the case of others.

Having carefully tuned this station in to the maximum strength, a very simple operation indeed, proceed to neutralise the set by the usual method. Remove the fixed resistor in the filament circuit of the H.F. valve, leaving the valve in its socket. On slight readjustment of the two main dials the local station should be heard at fair strength, if within 15 miles or so. Now rotate the neutralising condenser slowly until a point is found at which the signals from the local station disappear completely. It may be possible now to tune in again, weakly, by rotating one or other of the main controls very slightly. If this is so, readjust the neutralising condenser again until no sound of the local station is to be heard. Now re-insert the fixed resistor and proceed to search for other stations, as the set should now be correctly neutralised. The reaction condenser may now be brought into use, and it should be found that the set will run smoothly into oscillation when the latter approaches the maximum position. The set should not be oscillating while actual searching is in progress, but should be just short of the oscillation-point. When the two main controls are correctly in tune a slight "hiss" or rushing noise is audible, and this serves as a useful guide in tuning. As distant stations are tuned in very faint speech or music will probably be heard at first, and the two main tuning condensers must be rotated very slowly indeed until the maximum volume is obtained. Then the reaction condenser may be rotated very slightly towards the maximum position. By this means, with care, stations that are apparently "too weak to worry about" when first picked up may be brought up to good telephone strength.

Two-Volt Valves

If the set will not oscillate when the reaction condenser is set to its maximum position it may be taken for granted that not enough H.T. is being used on the detector and L.F. valves. Incidentally, it is as well to remind readers that the anode

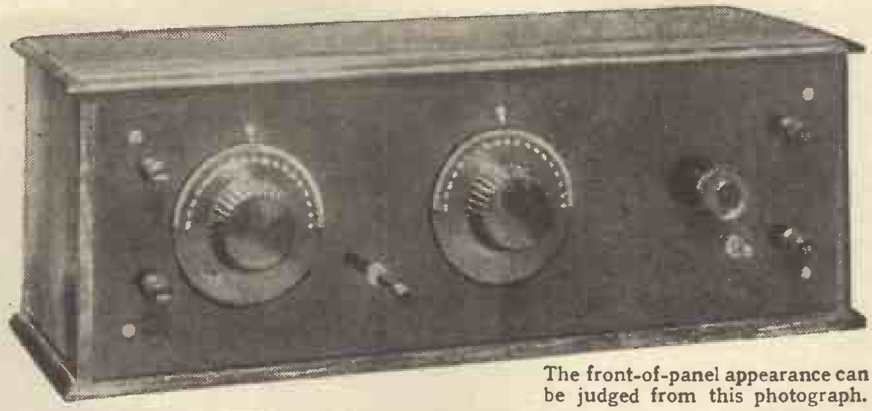


The filament control switch is hidden by the neutrovernier condenser used for the reaction control.

resistance, coupling condenser, and gridleak for the note-magnifier should all be of good quality, particularly the coupling condenser.

The difficulty that sometimes occurs with 2-volt valves is as follows: The windings of the standard types of screened coils and transformers were designed, in the first place, for use with valves of the well-known 6-volt classes. The primary and neutralising windings, in particular, were designed to work with these freely oscillating valves. It sometimes happens, therefore, that others, particularly the 2-volt type, will not neutralise properly with these windings. Difficulties of this kind may sometimes be overcome by connecting a small extra capacity such as a neutralising condenser between the plate and grid of the H.F. valve. Another, and probably more satisfactory, method is to dismantle the primary and neutralising windings of the split-primary transformer (consisting of 20 turns each), and to substitute windings of 32 turns each.

For Daventry the existing windings are usually quite suitable.



The front-of-panel appearance can be judged from this photograph.

POINT-TO-POINT CONNECTIONS.

Connect aerial terminal to flex lead for terminals 3 or 4.

Connect 1 on aerial coil to grid of first valve, fixed plates of A.T.C., and one side of neutralising condenser.

Connect anode of first valve to terminal 5 of H.F. transformer.

Connect 3 on H.F. transformer to remaining side of neutralising condenser.

Connect 4 on H.F. transformer to H.T. + 1.

Connect 1 on H.F. transformer to one side of grid leak and condenser and fixed plates of H.F.C.

Connect remaining side of grid leak and condenser to grid of second valve.

Connect anode of second valve to one side of H.F. choke and moving plates of reaction condenser.

Connect fixed plates of reaction condenser to 6 on H.F. transformer.

Connect remaining side of H.F. choke to one side of 150,000-ohm resistance, and one side of ·01 condenser.

Connect remaining side of 150,000-ohm resistance to H.T. + 2 and L.S. + terminal.

Connect remaining side of ·01 condenser to grid of last valve and one side of 1-meg. leak.

Connect other side of 1-meg. leak to G.B. —.

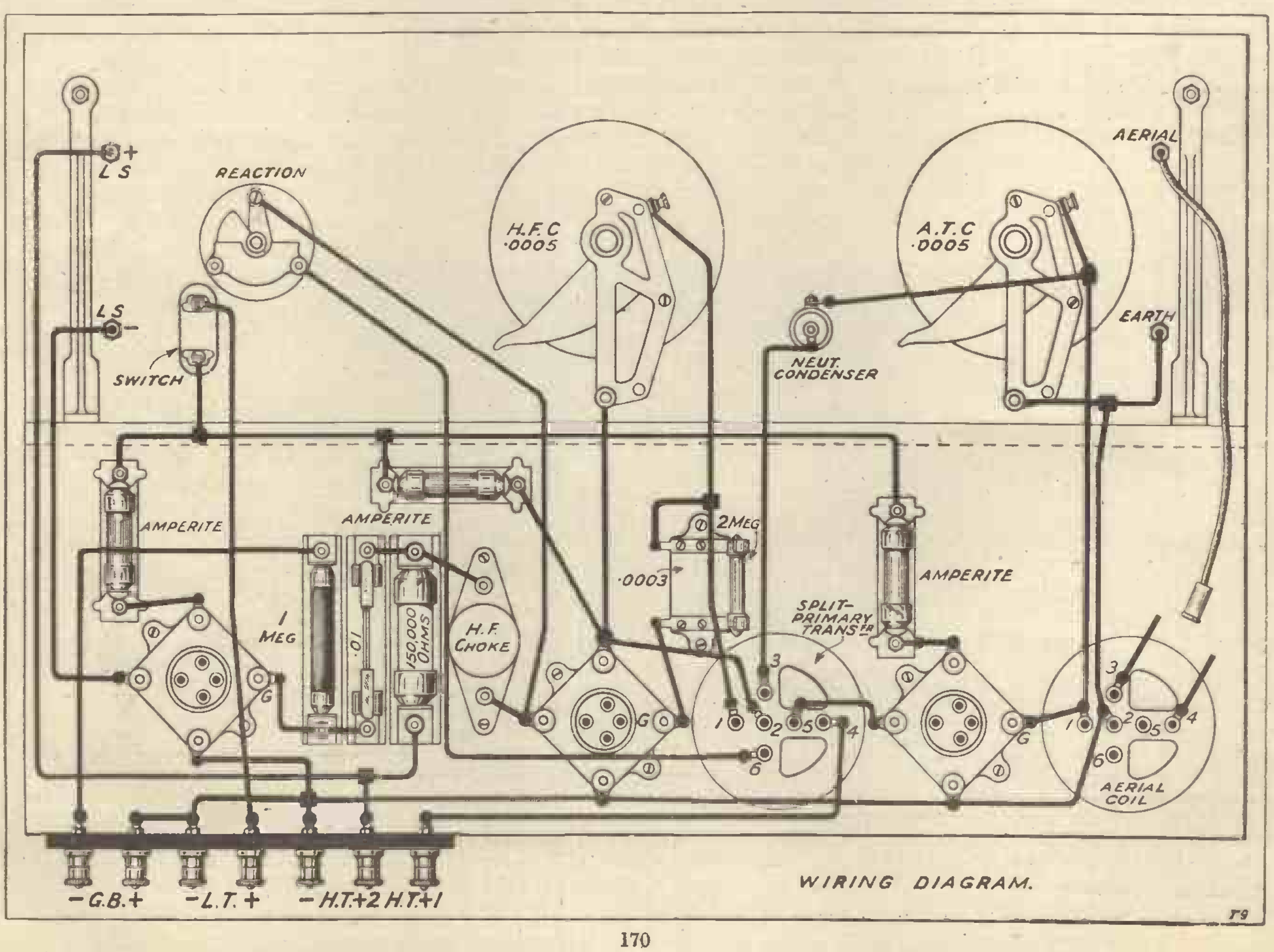
Connect anode of last valve to L.S. — terminal.

Connect L.T. + terminal to one side of switch.

Connect other side of switch to one side of each Amperite and other side of each Amperite to one filament leg of each valve.

Connect L.T — to three remaining filament contacts, to H.T. —, to moving plates of A.T.C., 2 on aerial coil, G.B. +, and earth.

Connect 2 on H.F. transformer to moving plates of H.F.C. and to positive filament terminal of second valve.



WIRING DIAGRAM.

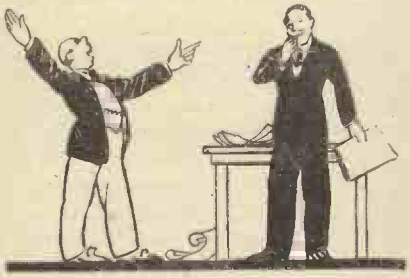
In Passing

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

"It isn't," as Ambo said, "as if they were a good variety."

I am inclined to agree that to have an A1 O.K. DX exhibition ruined by a family of "Buswiddle's Billiard Balls" is absolutely "the caterpillar's calves."

"If it had been 'Mrs. Parker,' or even 'Honeyball's Floury Wonders,'" said Ambo, "I could have contemplated the affair with something approaching equanimity. But as it is——"



. . . Ambo announced the thought, claiming that it was entirely original . . .

Well, listeners all, you will have deduced that potatoes have crept into the scene again; and quite incorrectly. They have *burst* in. I told Ambo emphatically that his new earthplate would show results after a time. However, let's begin properly.

Ambo's Great Idea

I think I have done it! I can't be certain. Nothing is certain about Ambo except his pa-in-law, Mr. Twipe. Still, I guess old Julian Ambo has had a nasty jolt over those spuds. Oh, perhaps I ought to explain that I have been trying to wean my friend Ambo from the vice which prevents him from becoming the perfect, corn-fed, flap-eared, unveracious, valve-sneaking radio fan. Said vice being an enthusiasm for the history, culture, and classification of potatoes. Potatoes *grip* a man, it seems. And the first law of the radio fan is "Radio first and business afterwards—if there is any time left."

As I was saying, before you interrupted to ask what I was driving at, Ambo conceived the idea of making the most wonderful receiver in the world. That is a complaint which seizes the growing "fan" as certainly as a baby is annoyed by his first set of teeth. I've had it. You've had it. I expect Mr. Marconi has had it and suffered in silence.

When Ambo announced the thought, claiming that it was entirely original, I said, "Do." I did not think it was for me to quench the smoking flax. I've work enough quenching an hereditary thirst which I have greatly improved by care and attention. "Do," I said, "and I will read a paper about it before the I.E.E., the Institution of Electron Exaggerators. But what *is* the most wonderful receiver in the world? Be careful! No free advertising is allowed by my Editor."

"The receiver of my dreams," went on the unfortunate idiot, "is as sensitive as a Hebrew Armenian who has just nationalised in America; as selective as a woman in a draper's when she wants fourpennyworth of ribbon; as non-distorting as a £100 microscope, as powerful in amplification as a seaside landlady describing an operation on her married niece; and as easy to control as—as —as a——"

"As a potato-masher," I added.

"Quite so! And if I read aright," went on the poor sucker, "there are at least thirteen men who have got the dope on it."

A "Tall" Order

I may say that "got the dope on it," means "have the requisite information." Ambo had been reading transatlantic literature— and when I say *literature*, I mean articles on radio receivers published in the U.S.A. Perhaps I may add that "dope" is the all-nations word for narcotic drugs —a very good description in this instance.

"Which of the thirteen do you favour, Jambo?" I asked.

"All of them, I fear. And I have calculated, on that basis, that the World's Receiver would require a cabinet large enough to contain a grand piano, and would cost £493."

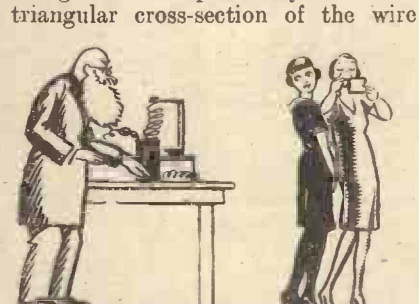
"Are you going to sell your rights in 'Wormdeath' (a wire-worm killer) "and borrow the rest on your insurance policy?" I enquired. "Or shall you form a company and start on the steep path to radio ruin?"

"No, sir," he replied, somewhat severely, I thought, in speaking to a man who had been his guide and philosopher, and had shown him how to mix cocktails like Albert at the Blackbottom Jazz Club.

World-Famous Sets

"No, sir, I propose to combine the best points of all of 'em," he said.

"Splendid," I replied. "But don't you know that all the points are equally prickly? These men—er—these circuit-designers, are the cream of radio. Drop one point and you are bound to lose. For instance, take the 'All-Noise Family Three.' Are you prepared to sacrifice the remarkable series of progressive but intermittent short-circuits which are the main feature of this *chef-d'oeuvre?* Again, take the 'Left-in-Black Receiver.' Can you overlook this and expect to get the goods? Emphatically no! The triangular cross-section of the wire



Prof. van der Pfimpf carries out experiments to determine whether flappers radiate.

and the peculiar insulating properties of the pigeon's milk varnish alone stamp this as one of the greatest advances in radio technique evolved since Marconi left school."

"I see," said Ambo. "And I think I'd better put them all in a hat and get Mr. Twipe to draw."

Acting on this idea, we drew lots. Unfortunately, the winner was Caxton Cutts's famous "35 Thousand Metre Mars," a receiver designed for the "Daily Scoop," when it ran that remarkable series of articles by Professor Blow, "If Only I Were In Mars."

"Pretty deadly," I remarked, as the card came out of the hat. By the way, Mr. Twipe said he was married in or about that hat. I can well believe it.

"Ah, well!" said Ambo. "We must try again."

We tried again, and drew the circuit used by Professor van der Pfimpf in his experiments connected with the question, "Do Flappers Radiate?" propounded by the "Weekly Batch."

A Visit to "Asia"

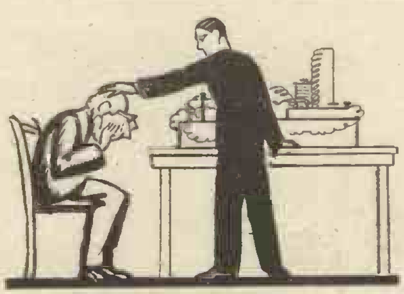
"My poor Ambo," I said, "you may make this receiver, with my help. But who do you think is going to transmit from New Zealand on 0·2756 (recurring) metre?"

"Pah! Take your hat and go to the pictures," said Ambo. "This lottery is a wash-out!"

So we went up to Ambo's den, where he touched a button, and found that the map of Asia was a secret panel covering a cavity in the wall. Out of the cavity came soothing, inspiring fluids. So we got down to brass tacks in about four minutes.

"It must be a five-valver," I said, with deep conviction, pushing the bottle back again.

"You sound pretty dogmatic,"



Prof. Penticosh cried like a child.

replied Ambo. "What's the matter with six valves?"

"My dear old Jambo," I answered, "when I come to a problem I bring to it a trained intelligence. Try to follow me. Let us consider that valve receivers range from one to ten valves; at least, that is a reasonable basis. Very good! This gives you no less than nine main problems to solve before you can eliminate the nine types and fix on the one. Am I right?"

"I believe so. Proceed, Solon."

Taking An Average

"Don't be sarky. To resume. I see that by the time you have solved your nine problems you will be a lunatic. That would be regrettable. So I take the average, which gives us a five-valver. Am I right?"

"Um—lessee. Er—no! I make it five and a half," said Ambo.

"You can't count."

"Wodger mean? The total is fifty-five, and you divide by the number of items, namely, ten. Answer, five point five."

"Oh, man," I sighed, "use your head! There are eleven items, because you must take crystal sets into account. These, as is notorious, employ no valves at all, and so we get ought plus one plus two plus three plus four plus five plus six plus seven plus eight plus nine plus ten, equals fifty-five, which divided by eleven gives five."

"You pass. A five-valver. Go on!"

"Oh, it's your move now, Ambo! Proceed!"

"Well—er—I suppose we'd better have a couple of H.F. stages and—er—so forth," stuttered he.

"Tut, tut!" I cried. "First things first. What circuit and wave-range? Super-het, reflex, Unidyne, straight, crooked, comic, or what?"

"I was thinking of a set covering, say, ten metres to fifty thousand metres."

"No harm in thinking," I said briskly. "Now stop thinking and talk sense. We will do fifty metres to five hundred metres. Not a millimetre more or less."

A Startling Creation

"If you say so, old man, I've no doubt it's right."

"Now, what circuit?"

"That's done me," moaned Ambo. "I am in love with thirteen."

"Well, my advice to you is that you pick out everything in each of the thirteen which don't appear in the other twelve, and combine them into the 'Ambo Ne Plus Ultradyne' circuit. I expect you will win a Nobel prize with it for the finest problem story, or the most unintelligible poem of the year. Got any more soda?"

Ambo took my advice, and the circuit he evolved would make a Nebraska *ping-ping* snake die of envy. It looked like a map of Wapping, and when I showed it to Professor Penticosh of the Radio Board of the League of Listeners, he cried like a child, and said the Hampton Court maze was the last place his father took him to before he died. Fact! So far as I can make out, it embodies a sort of reversible or disappearing super-het principle, for long and short-wave reception, grafted on to a slow-motion, reflex arrangement involving a Jack-in-the-box coupling.

. . . In less than fifteen minutes they had divided into two camps . . .

Anyhow, it worked, though a trifle too nervously for my particular touch. It was the sort of set that howls if you clear your throat. Mr. Twipe sneezed near it one evening, and the thing turned into a kind of beam transmitter, getting excellent reports from Omsk and Nairobi, strength R6.

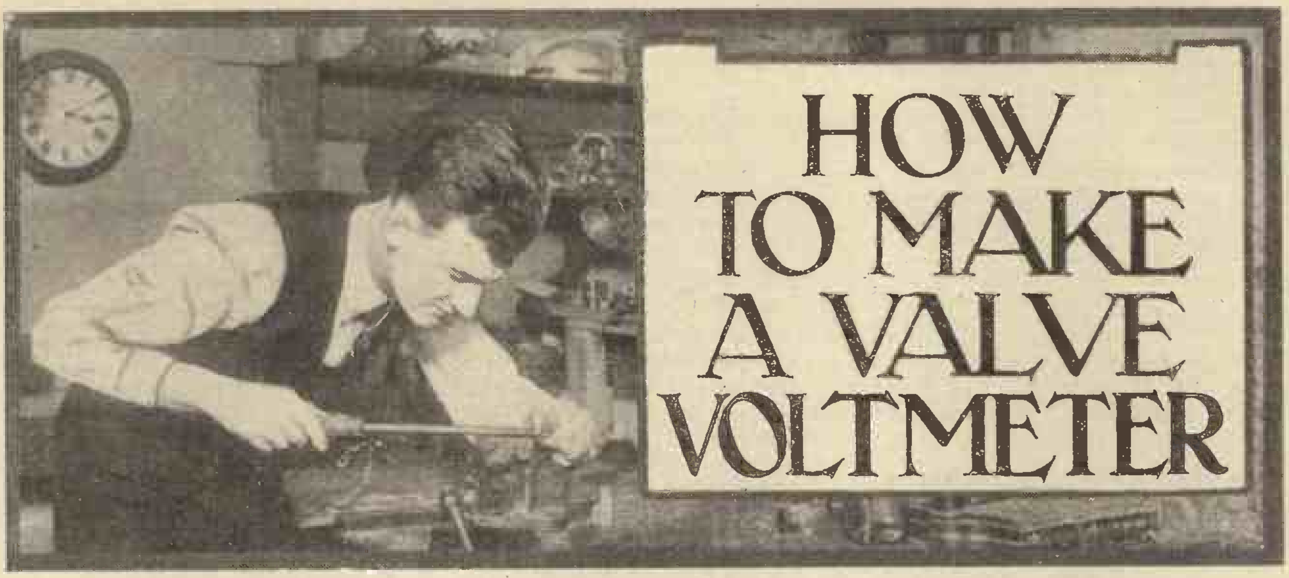
Ambo's Exhibition Night

When Percy W. Harris saw it, he said he feared that all his pains to spread the light had been wasted, and he doubted whether the Post Office would let him use the transatlantic telephone to describe the horror to Mr. Loftin-White, because it might be construed as a *casus bellum*, and he was anxious to keep the English-speaking peoples pally till Esperanto had come into its own.

The monstrosity exhibited such winning ways that Ambo determined to hold a show night, a decision to which I urged him shamelessly. I was educating him, you see. So we got the B.B.C. to have a "silent night"; we warned amateurs all over the world to bring their safety switches into operation. We got a New Zealand amateur to promise to transmit at stated times, with an input of half a watt, and we invited the *élite* of the radio community to come and hear the loud-speaker signals.

When the great night arrived I sloped round to Ambo's place early, in case he wanted assistance. I found

(*Continued on page* 206)



HOW TO MAKE A VALVE VOLTMETER

Details of a very useful instrument for the more advanced amateur.

By E. A. ANSON.

THE Moullin-type valve voltmeter described here will be found to be an extraordinarily useful instrument. With it you will be able to measure elusive H.F. currents, or rather voltages, that most of us take for granted. After the first excitement of making the set work we all want to try little improvements in the hope of making it more efficient still.

Without some method of measuring radio frequencies the results of alterations are often problematical, and, in many cases, dependent on that most unreliable thing the human ear.

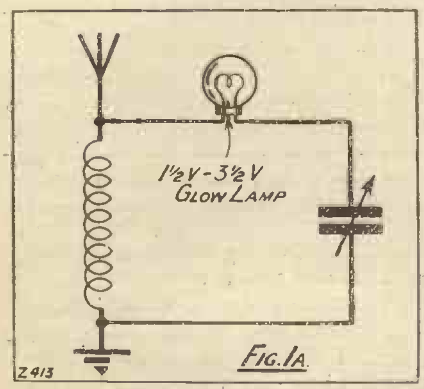


FIG. 1A.

Measuring D.C. Voltages

There is absolutely no difficulty about measuring our L.T. and H.T. voltage. A small and compact instrument connected across the battery will cause a hand to move to the voltage being tested, and we know whether another trip is impending to the charging station. Now, the actual energy that moves the voltmeter hand comes from the battery under test, and the less this energy the better the instrument. A good instrument for D.C. tests takes about five milliamps at full deflection. At six volts this represents ·03 of a watt!

"Hot Wire" Meters

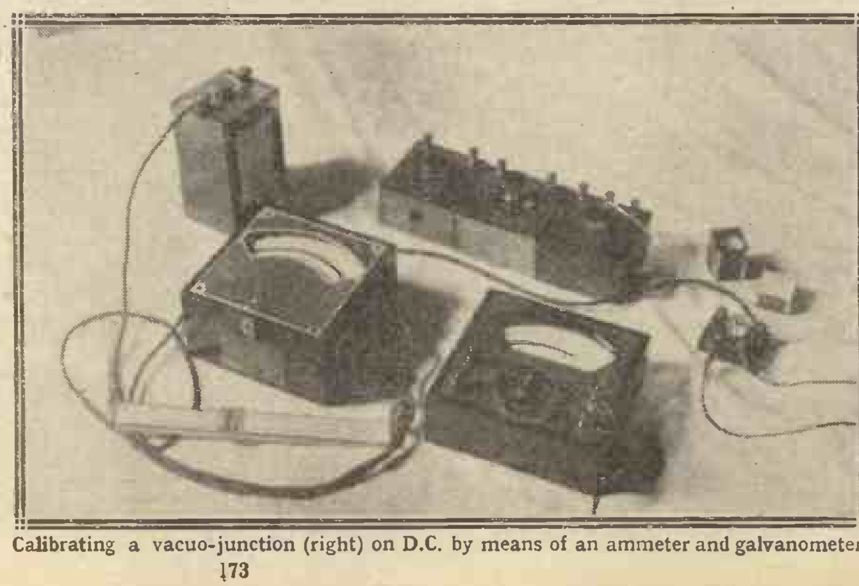
Not much! But the energy that our valve voltmeter must measure is some thousands of times less than this, and direct-current instruments are quite unsuitable. This is one reason why H.F. voltages are generally so very difficult to measure—there is such a minute amount of power to be measured. Another difficulty is that no solid matter can respond to something surging to and fro at a million times a second (300 metres). The hand of the D.C. voltmeter merely points to "0" whatever the H.F. voltage it is asked to read.

Fortunately, our direct-current instruments may be tricked into measuring radio frequencies with the aid of that wonderful little component—the valve.

LIST OF COMPONENTS.

- 8 4 B.A. terminals
- 1 7¾ in. × 5½ in. × ¼ in. ebonite panel.
- 1 ·05 mfd. mica condenser (Dubilier).
- 1 2-mfd. condenser (T.C.C.).
- 1 metallised grid leak (Ediswan).
- 1 B.T.H. B.8 valve, or D.E.3b., or D.E.R., or any high μ valve.
- 1 5-ohm rheostat (Burndept or Igranic).
- 1 30-ohm rheostat (Burndept or Igranic.
- 1 "Versatile" galvanometer, 10-ohm coil (Cambridge Instrument Co.).
- 1 2-volt accumulator (C.A.V. glass case).
- 1 45-volt H.T. battery (Siemens).

Before the advent of the valve the only means of measuring H.F. currents or voltages was by heating



Calibrating a vacuo-junction (right) on D.C. by means of an ammeter and galvanometer.

effects on thin wires. In fact, we had the good old hot-wire ammeter still used by many amateur transmitters. As a matter of fact, anybody fortunate enough to live close to Daventry's or 2 L O's aerial could obtain free illumination by inserting a glow-lamp in their tuned aerial circuit as in Fig. 1A.

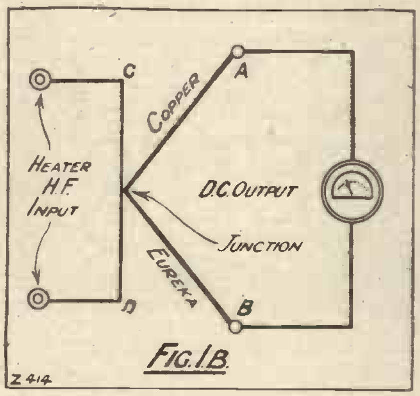


FIG. 1B.

When this circuit, which need not have any detector, is tuned to Daventry at short range, quite a heavy current, even half an amp. or so, can flow in the circuit connecting the coil to the condenser. Perhaps someone living close to a B.B.C. aerial might try this experiment and report results. Use a good aerial and earth.

A Thermo-Junction

This method is often used by radio engineers for rough tuning purposes when checking a transmitter. When close enough no aerial at all is required!

Another method still in use depends upon a little-known law of Nature that probably still remains largely unexplored. If two wires of, say, copper and "Eureka" alloy are joined in a cross, as illustrated in Fig. 1B, a direct-current voltage is generated at the two ends AB when the junction is heated. This heating may be effected by a radio-frequency current through CD, a resistance wire. A sensitive D.C. instrument in series with AB will detect this small voltage, often only a few milli-volts. The junction is sometimes mounted in a vacuum and called a vacuo-junction. Mention is made of this property of a thermo-junction because later on we shall see how our valve voltmeter may be calibrated with its aid.

The Only Expensive Component

The circuit for the valve voltmeter is delightfully simple. It will be seen from Fig. 2 that no difficulties may be expected when connecting up. All joints should be soldered, and the very best components used throughout. The grid leak of one megohm must be capable of retaining its resistance constant indefinitely, otherwise calibration will be upset. Metallised grid leaks appear to be the most suitable in this respect, and should be used. The 2-mfd. condenser across the H.T. and D.C. plate-meter is vitally important, as the plate H.F. load on the valve must be kept constant by this shunting condenser.

The measuring instrument in the plate circuit is the only expensive component. In order to ensure a long and constant life for the valve the filament is run at a voltage lower than

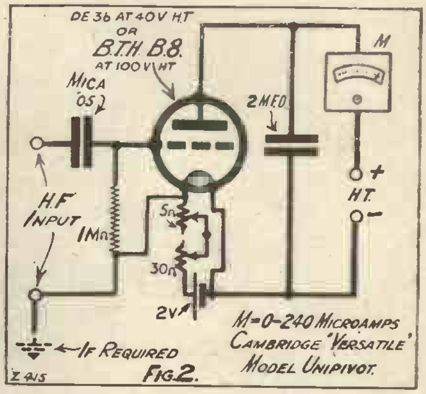


FIG. 2.

normal. Naturally, the plate current will be small, and as the plate current meter must give full deflection for 240 microamps (·24 milliamps) under normal working conditions it must be very sensitive.

A Useful Instrument

Unfortunately, this means money. A suitable instrument may be obtained from the Cambridge Instrument Co.: types L or I are suitable.

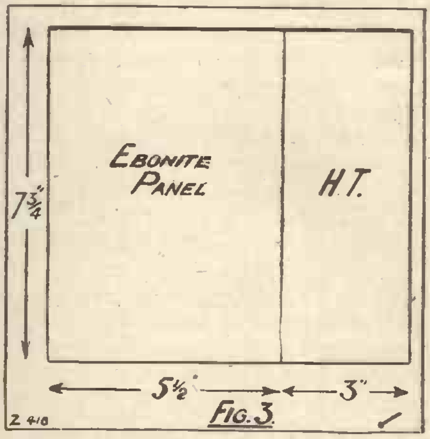
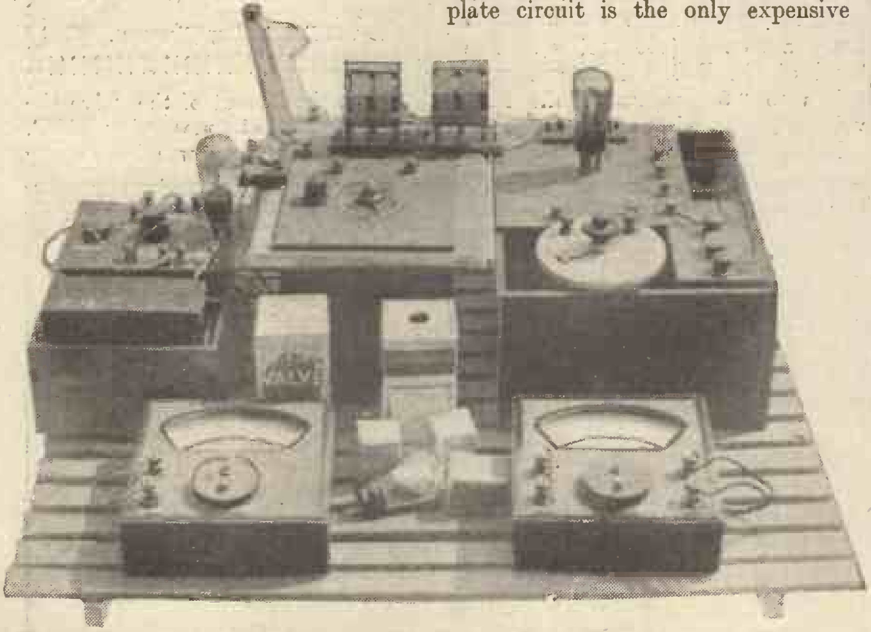


FIG. 3.

The "Versatile" galvanometer, type L, is the instrument used in the valve voltmeter being described. Although expensive to buy, yet this instrument can be employed to measure, with suitable cheap home-made shunts and resistances, any voltage or current desired, from a few microamps to hundreds of volts. In the long run it is better to own one good D.C. instrument than a multitude of cheap ones. In addition, these unipivot instruments give full deflection for 2·4 millivolts (·0024 volts), and are invaluable for use with thermo-couples, which have been mentioned already.

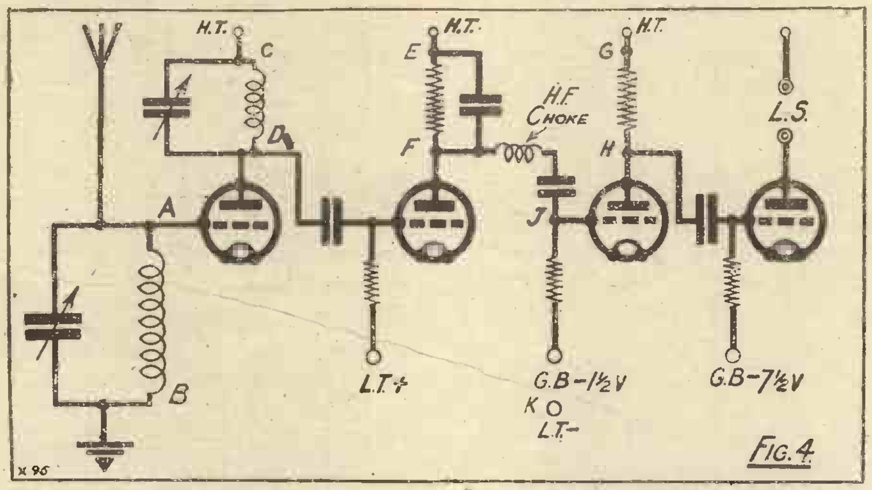
The Valve to Use

Almost any valve is suitable, but more sensitive results are obtained with high-amplification valves having



Calibrating the valve voltmeter. In front on the left is the meter connected in the plate circuit of the valve voltmeter. On the right beside it is a similar instrument connected to the vacuo-junction. The long ebonite "plank" in the background carries the Eureka resistance across which the valve voltmeter is connected.

a sharp bend in the grid-current curve. Unfortunately, some of the very high amplification valves, as used for resistance-coupled amplifiers, tend to give an unstable zero. After taking a reading the hand of the meter fails to to full deflection of 240 microamps by the 30-ohm rheostat, giving final touches with the 5-ohm one. The value of the low-resistance rheostat will be appreciated in these final adjustments.



H.F. TESTS.

When station is not transmitting, there should be no H.F. voltage across A B or C D. If there is, you are oscillating.

When station is transmitting, the greater the H.F. voltage across A B and C D the louder the result.

L.F. TESTS.

When station is not transmitting there should be no L.F. voltages across E F, G H, or L S. If there is, some parasitical oscillation is marring results.

When station is transmitting, and "standing by," between items, there should be no H.F. voltage across J K. If there is, look to your H.F. choke, which is passing unwanted H.F. currents to L.F. valves.

return to exactly zero for H.F. volts. As will be seen later, this corresponds to a D.C. plate current of 240 microamps.

However, the new B8 B.T.H. valve gives very satisfactory results in this respect, besides being very sensitive, and can be used with a 2-volt accumulator and 40 volts H.T. when it is desired to measure very small H.F. voltages. Its only disadvantage is its high internal resistance; this permits only about 24–50 microamps plate current. For normal work a DER, Cosmos Blue Spot, or any other well-known valve will do, such as a DE3b run at 2 volts.

How the Instrument is Used

A rheostat in series with the negative leg of the filament is used to adjust the filament current. As a matter of fact, very delicate adjustment will be required, and two rheostats were used in series, one of 5 ohms and the other 30 ohms. The high-resistance rheostat gives rough adjustment, and the low can be used as a vernier to give very fine control indeed.

Before using this H.F. voltmeter connect up the 40-volt H.T. battery and galvanometer. As the 2-mfd. condenser charges up the galvo will give a flick. Light the valve filament by turning both rheostats to the "on" position. The galvo needle will start to move up the scale. Roughly adjust

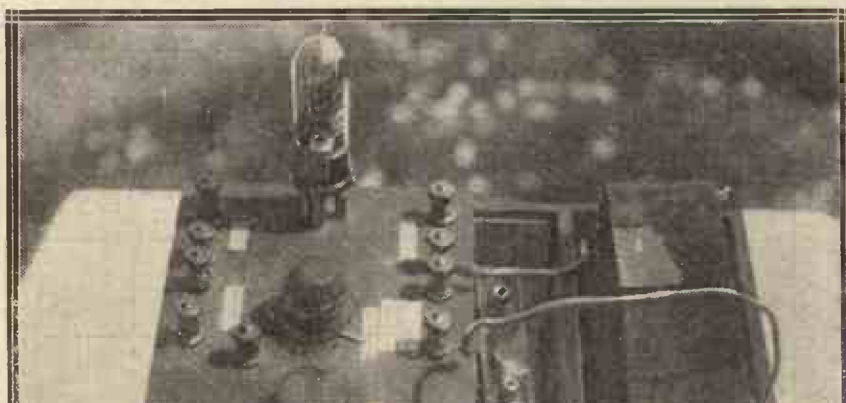
Any H.F. voltages across the input terminals will cause the grid of the valve to become more negative, and the D.C. plate current will fall according to the H.F. voltage impressed. This will occur at any frequency, and the instrument will give good results from as low as 50 cycles to wavelengths in the vicinity of 23[illegible] metres. This type of valve voltmeter will even measure H.F. voltages superimposed on D.C., and can be used, for instance, to measure the H.F. voltage across a tuned anode coil. On the broadcast waves this instrument has an input resistance of about 90,000 ohms, and adds roughly about half an ohm to the circuit being measured.

The various photographs give a very good idea of the constructional details, which require little explanation. The wiring should be done with bare 18 S.W.G. tinned copper wire, and the components should be mounted on the highest quality 7¾ in. by 5¼ in. by ¼ in. ebonite panel it is possible to buy.

Constructional Details

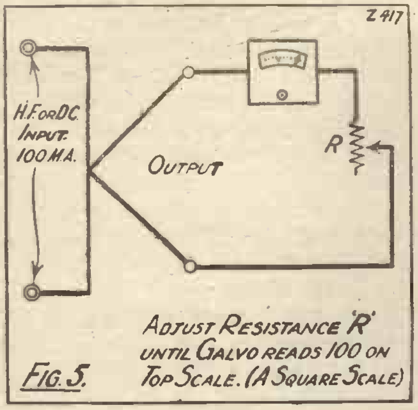
No nuts are used for the valve legs or terminals, as they are tapped into the ebonite instead. Do not solder the grid leak from one wire to another; do the job properly and fit it into clips screwed to the panel. The valve was made purposely to stand up on the panel top, for easy removal. A calibrated valve for this voltmeter has had a lot of work done on it; it should never be used for any other purpose, and always should be removed when not in use and kept in a special case filled with cotton wool.

The panel screws on to a $\frac{5}{16}$-in. thick containing case, 7¾ in. by 8½ in.,



The completed valve voltmeter. Note the two rheostat knobs down the centre of the panel.

with a compartment 3 in. by $7\frac{3}{4}$ in. to hold the H.T. battery, which may be of the small-cell type, as the discharge is very small (see Fig. 3.)



It would be possible to fit the L.T. accumulator into another similar compartment, but accumulators are heavy things and sulphuric acid messy stuff. For this reason it was found preferable to connect the L.T. supply through short flex leads.

Extraordinarily Sensitive

It is extraordinary how sensitive this valve voltmeter is on test. It is even capable of measuring the H.F. voltage across an aerial coil tuned to Daventry in South Wales. In fact, although it is very desirable to calibrate the instrument, yet all manner of really useful tests may be made with the instrument uncalibrated. The better the aerial and the lower the earth resistance and coil resistance, and the lower the tuning condenser setting, the larger the voltage measured across the aerial tuning coil.

Detecting "Oscillation"

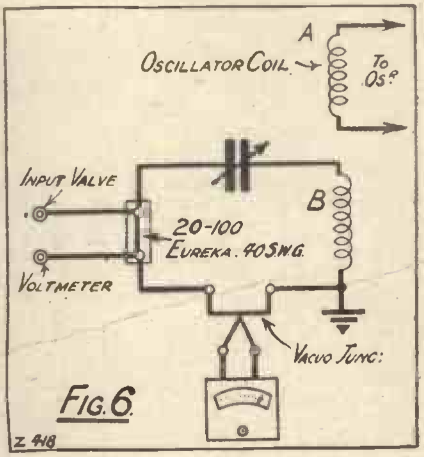
The valve voltmeter will tell you in an unmistakable manner whether any improvement to the aerial or earth has really been a success. Generally it is a series of improvements, undetectable aurally, that add up into one great improvement, making your receiver remarkable for "reaching-out" on a minimum of valves.

The addition of your valve voltmeter across a tuned circuit adds a

A home-made thermo-couple, the holder and vacuo-junction used in the experiments described by Mr. Anson.

capacity of about 15 micro-micro-farads to the circuit, and the tuning condenser will have to be readjusted very slightly to a lower reading.

If your receiver oscillates persistently, your valve voltmeter will detect this. For when no signals are coming through there will be an oscillating voltage across your H.F. anode circuits, or even across the aerial circuit itself. In addition, any parasitical L.F. oscillations in a



resistance-capacity circuit will be made manifest by testing across the resistances. With no signals there should be no H.F. voltages across these coils. It is possible to see if H.F. currents are leaking where they ought not to be—such as on to the grid of the first L.F. valve in a resistance-capacity amplifier. The H.F. choke should stop this; if it does not, your valve voltmeter will detect an H.F. voltage from the grid to earth when the station is standing by between items.

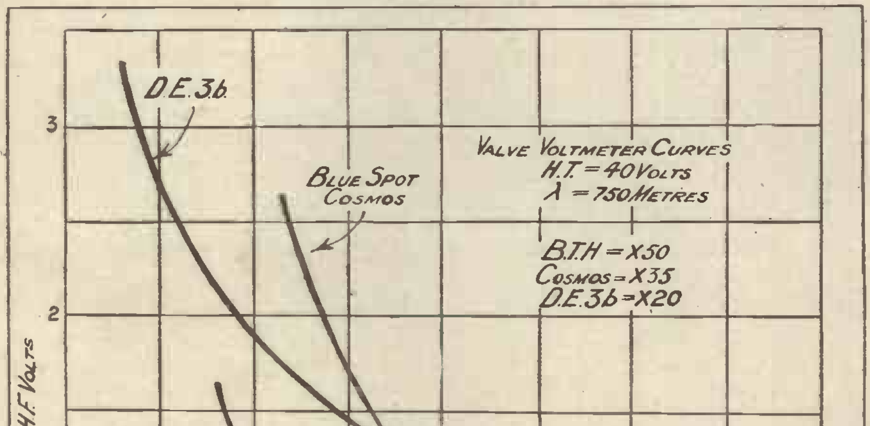
The accompanying four-valve circuit (Fig. 4) shows where measurements and tests can be carried out. It is a simple one—H.F., detector, and two resistance-capacity L.F. valves.

For really quantitative results, such as the measurements of H.F. resistance in coils, the valve voltmeter should be calibrated. It is quite possible to do this at home with a little care and patience. It will be necessary to obtain a vacuo-junction for the purpose from the Cambridge Instrument Co.

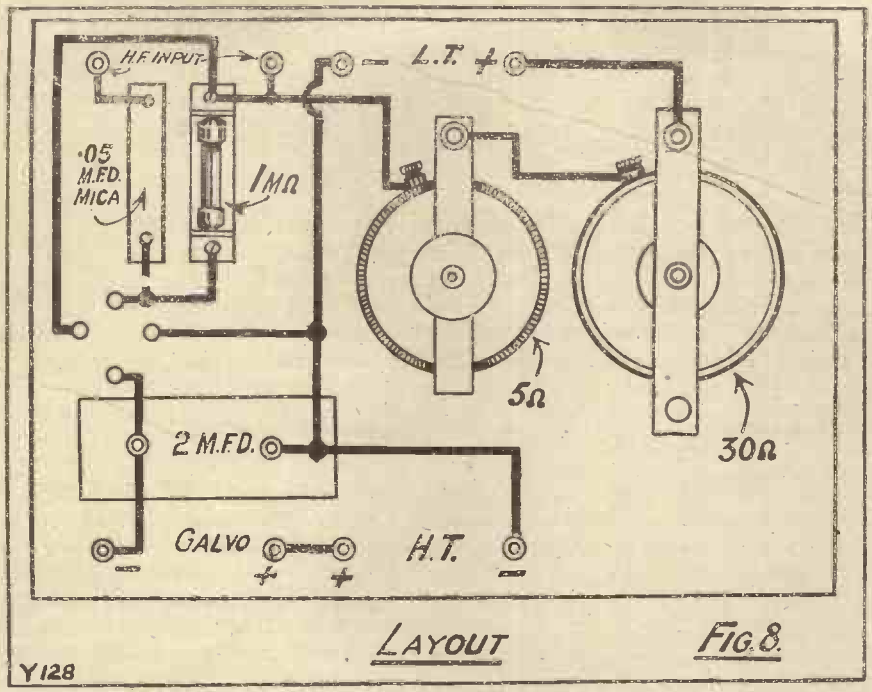
Calibrating the Meter

This vacuo-junction measures H.F. current and, in addition, can be calibrated off D.C. quite simply. Its principle has been explained already. The "Versatile" Cambridge galvanometer used in the valve voltmeter is suitable for use with the vacuo-junction and has a scale on the square-law principle for this purpose.

It is only necessary to pass a known D.C. current through the input terminals of the junction, say 100 milliamps, and note the reading on the thermal scale. All other readings



will be in proportion to this. Or, make the galvo read 100 on the thermal scale by inserting a resistance in series with it (Fig. 5).



The voltmeter calibration on H.F. (it will not work on D.C.) is done by passing a known H.F. current, as measured by the vacuo-junction, through a known resistance made of 40–48 S.W.G. "Eureka" stretched in a straight line between two terminals. The valve voltmeter is connected across this "Eureka" resistance by short leads kept at least two inches apart to avoid capacity shunts.

Further Calibrating Notes

By Ohm's law the voltage drop in the "Eureka" wire will be the current through the "Eureka" multiplied by its resistance. The diagram (Fig. 6) shows the layout for making these measurements. A valve oscillator, A, will be required, capable of injecting some 100 milliamps into another tuned circuit, B, placed nearby, with the "Eureka" resistance connected between the coil and the tuning condenser. This valve oscillator may be either a wavemeter or an oscillating receiver. It will be necessary to use a power valve and between 100 and 150 volts on the plate of the oscillator to obtain sufficient H.F. output.

After everything is connected up, adjust the oscillator to any wave-length; 600 metres upwards is best. The wave-length is really immaterial, but broader tuning will be obtained over 1,000 metres, and, owing to absence of capacity effects, measurements will be easier. Move the oscillator closer or further away until a round number of milliamps flows through the known "Eureka" resistance, which may be anything you like from 20 to 100 ohms. Make out a table showing H.F. current through the "Eureka" in milliamps, and corresponding deflection of valve voltmeter. Then, by multiplying the currents by the resistance of the "Eureka," the corresponding H.F. voltage will be obtained. Suppose the "Eureka" has a resistance of 20 ohms and current through it is 50 milliamps (·05 amps.), then the H.F. voltage is 20 by ·05 = 1 volt. When a series of H.F. voltages have been obtained from ·1 to, say, 2 or 3 volts, a curve should be drawn, H.F. voltage against valve voltmeter reading.

It will look something like one of those in Fig. 7, which were made on the valve voltmeter described, using various valves marked against each curve at 40 volts H.T.

TABLE

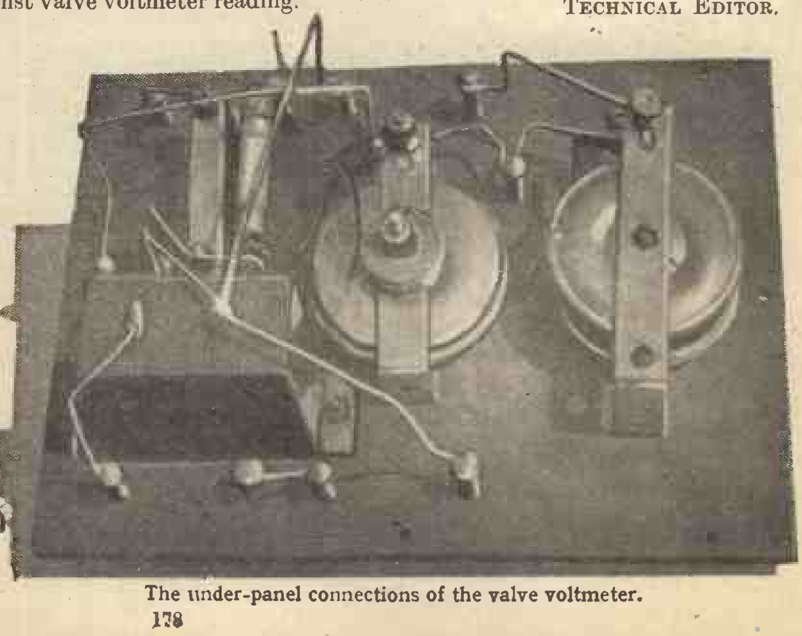
C = Current	R = Eureka Resistance	V = CR	Valve Voltmeter Galvo Deflection
5 m.a.	20 ohms	·1	239
10 ,,	20 ,,	·2	229
20 ,,	20 ,,	·4	204
40 ,,	20 ,,	·8	168

With this calibrated valve voltmeter all sorts of tests may be made. Calculation of earth resistances, coil resistances, and fading tests, by noting fall and rise of voltage across a tuned coil in aerial or anode circuit. Try the latter at sunset and note what sudden changes occur. Do not alter reaction whilst the tests are being made, or you will spoil the results.

NOTE.—The valve voltmeter described in the foregoing article embodies the grid leak and condenser method of rectification. By employing the anode-bend system greater accuracy may be possible, but in this case the instrument tends to become more tricky to handle and less sensitive.

Therefore, in our opinion grid leak and condenser rectification is preferable in a meter designed for general-purpose work of a purely practical nature. It will be appreciated that to the average amateur the values of H.F. measurements are lost if they are not dealt with on comparative bases. Provided any small errors are fairly constant such need not be taken into consideration except by advanced research workers.

TECHNICAL EDITOR.



The under-panel connections of the valve voltmeter.

Distortion in Broadcast Reception

In a great many cases distorted reception is merely the result of overloading one or other of the components in a wireless receiver.

By KEITH D. ROGERS.

As far as I can gather, from correspondence and from talking personally to listeners, the main trouble encountered in wireless sets is distortion, and of the number who are harassed by this particular bogey about seventy-five per cent appear to be overloading their valves.

In the district where I disturb the ether there has recently been an epidemic of distortion, and I have frequently been interrupted in my meditation over some peculiar fault in my own apparatus to discuss those of one or other of my neighbouring listeners. Incidentally, a large number of those who come to me with their troubles are using commercial outfits of "good" make, and it has been my lot lately to examine a few of these sets in endeavours to trace the cause of poor reproduction.

A small speaker should not be expected to deal with a large input without a considerable amount of distortion taking place.

Magnetic Saturation

Usually I found that the L.F. sides of the sets were transformer coupled and contained two stages. Not that two stages of transformer coupling cannot be made to work successfully, but it is, in my humble opinion, simply asking for trouble—and one is not often disappointed in this respect. Unless valves and transformers are very carefully matched there will almost certainly be overloading, to say nothing of a certain amount of distortion due to poor transformer design.

Now there are three main points on the L.F. side where overloading can occur—we can leave the H.F. to itself in this article—namely, the transformer or chokes (if either variety is employed), the loud speaker, and the valves.

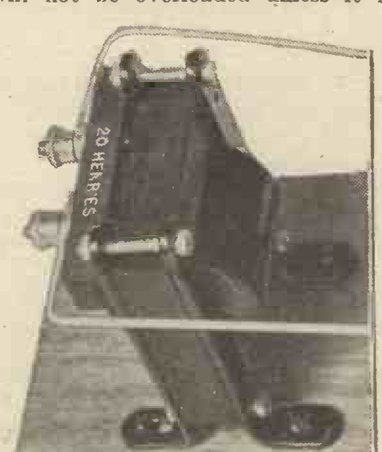
The first-named is not difficult to trace, and its best remedy is prevention by using components that will not overload under normal use. By overloading, in this case, of course, I do not refer to overloading by too strong signals, but by saturation of the iron core of the component so that it can no longer deal with the flux variations due to the signal currents flowing in its windings. This saturation usually makes itself felt when deep notes are being received. If you use components with reasonably large cores and use valves in series with them that take no more milliamps for their plate current than is necessary you will be all right. Some makers will tell you the saturation current of their transformers and chokes, and all constructors should make a point of finding this out.

Thus, a well-known transformer is said to have a saturation value of 3·5 milliamps, but in this case one can be sure of good results if one uses a valve needing less than 3·5 m.a. as plate current in series with the transformer primary. Such a valve would be the P.M.5X, D.E.L.612, and so on, which valves *when properly biased* take less than 3 milliamps and so will not cause the transformer to saturate.

Now you will say, "What happens if this transformer is used in the *second* stage where a P.M.5X would overload?" The answer is simple. *It must not be used* in the second stage if best results are to be obtained, and if loud signals are to be dealt with. In other words, if the signals are too much for valves of the type mentioned, then you must use a "larger" valve, and if you have to use a larger valve (taking more H.T. current) then you must use a "bigger" transformer. These two components *must* work together and be matched up against each other.

Valve Overloading

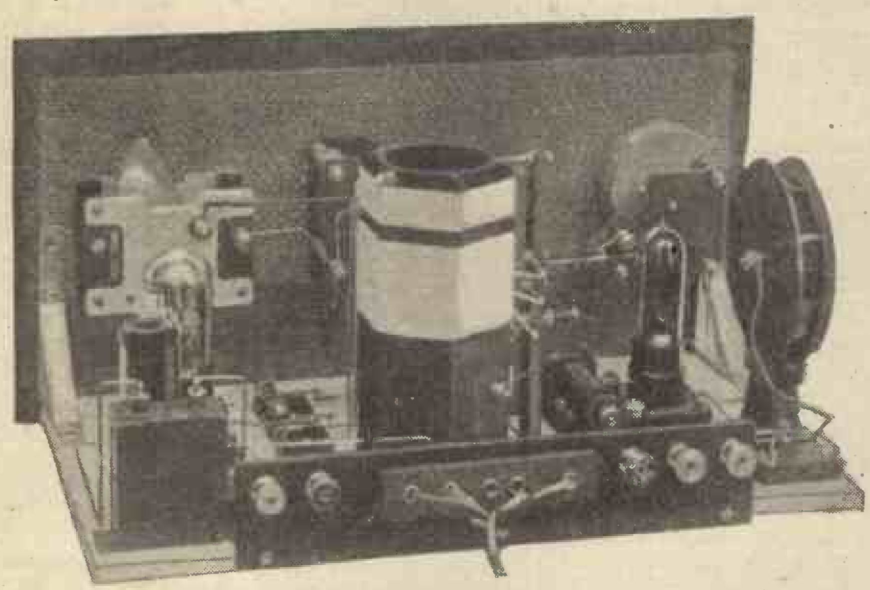
In the case of valve overloading the matter can be easily traced and easily remedied. If on detuning the set when listening to the local transmission the distortion ceases and things become clear, you are overloading either the valves or the loud speaker, or both. The loud speaker will not be overloaded unless it is



Where L.F. chokes are employed they should be of reasonably high impedance, and have ample proportions to obviate magnetic saturation.

of the small type, or is asked to take an absurdly big volume. So it is much more likely to be the valves causing the trouble. (A change over from one loud speaker to a bigger one, which could be borrowed for the occasion, would at once show if the loud speaker were at fault.)

The simplest way to test the valves is by means of a milliammeter. If you have separate H.T. leads to the various stages in the set, the matter is made somewhat easier.



This set has been arranged with a metal panel screen to prevent body-capacity effects —often a cause of trouble and annoyance.

Place the milliammeter in series with the H.T. positive lead going to the last valve, and turn on the set as usual. The milliammeter should remain moderately steady and any "kick" noticed should be very small. Theoretically, it should show no deviation, but short of using large super-power valves, which are more or less outside the scope of the average man, this Utopian state of affairs is rarely obtained.

Milliammeter Test

If separate H.T. leads are available, then the meter should be placed in each in turn, when it will become evident in which stage or stages the distortion is occurring. Alteration of grid bias and H.T. voltage will cure a great deal, if not all, of the distortion, unless really unsuitable valves are being employed.

Should, however, no variation of either grid or H.T. voltages provide a remedy, then the valve or valves concerned will have to be changed, some having less impedance and a larger grid voltage carrying power being substituted.

As a matter of fact, most of the distortion will prove to be in the last stage, and here, if alterations of grid bias do not have the desired effect, the valve will have to be changed, and a power or super-power valve used in its place.

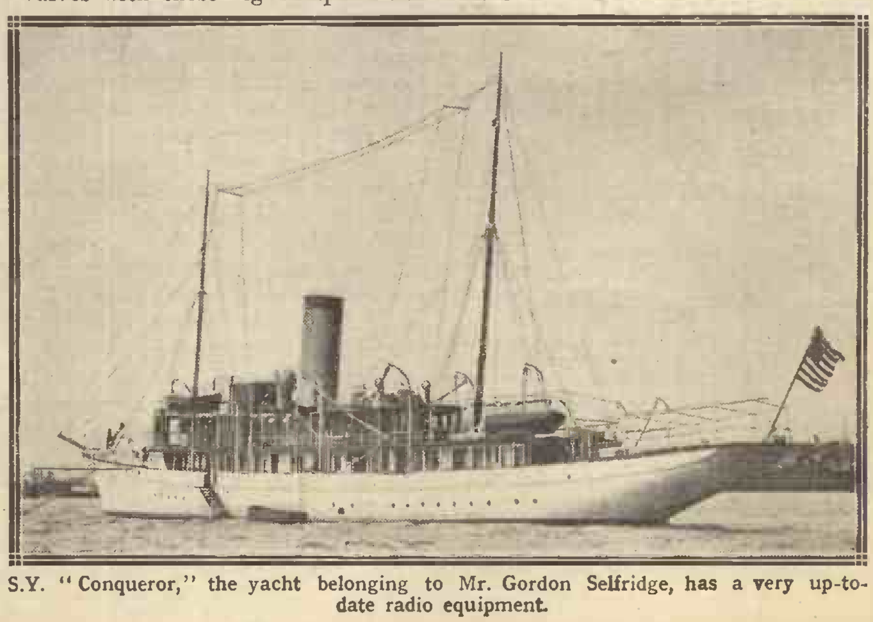
Very often distortion can be cured without this being necessary—a super-power valve takes a lot more H.T. current than the ordinary power type—by means of cutting down amplification in earlier stages, especially if resistance-coupling is being employed. Thus, if you are using a detector or first note-mag. valve having an amplification factor of about 35, try the effect of using one with a magnification of 20 or 25. This will often prevent overloading the following valves, and often greatly improves the tone of reception. As a matter of fact, I am afraid that valves with those high amplification factors often cause more trouble due to overloading than they themselves are really worth, and are likely to give very disappointing results in the hands of the average listener.

Faulty components, especially leaky condensers and bad grid leaks, dry joints, etc., often cause distortion, but usually a loss of signal strength accompanies this kind of fault. However, it is as well to keep an eye on the condensers, especially on the large 1 and 2 mfd. type, as these occasionally cause trouble in this direction. As a rule, however, you may look for the cause of distortion—if you are unlucky enough to experience it—in either the transformers or chokes, the valves, or the loud speaker, and it will usually be due to overloading one or more of these.

New B.T.-H. Valve

By the way, I have just completed my collection of 2-volt valves with the addition of the new B22, made by B.T.-H., Ltd. This is quite a good all-round valve, taking 2 volts L.T., 0·1 amp., and having an amplification factor of 7·5, with an impedance of 14,000 ohms. Thus its efficiency factor or mutual conductance is ·53.

As a detector or first-stage L.F. the valve is quite useful, though it must not be expected to act as a "last-stager" to deal with large inputs. The maximum H.T. advised by the makers is 100 volts, but I find it acts exceedingly well with 120 on the anode and 6 to 8 volts negative grid bias. Whether the extra H.T. will hurt the valve yet remains to be seen, but it certainly improved the operation of the valve I have.



S.Y. "Conqueror," the yacht belonging to Mr. Gordon Selfridge, has a very up-to-date radio equipment.

WHAT READERS THINK

Reception in the West Country

SIR,—Mr. Rogers' adventures in your July issue interested me, because I spent a week in May among the coves and porths between Minehead and Land's End. I took the "Elfin Four" described in your March issue, and set it up once or twice each day on the roadside. The aerial was a thirty-foot length of Electron with a "lucky" stone hitched to the end, by which it was thrown up into trees or along hedges. The ever-useful stair rod formed the earth. In some ways my conclusions were very different from those arrived at by Mr. Rogers, for Daventry was always the best reception by a long way. Radio-Paris often came in well, but I never found Hilversum. On the low waves Cardiff and Plymouth were the best, but I was surprised to find so few other stations audible. Belfast, Stuttgart, Bournemouth, and London were heard weakly, but practically nothing else. My observations were confined to the middle of the day, or else between 5 p.m. and 7 p.m., and, of course, full summer conditions prevailed. There was generally a strong wind blowing, the noise of which made a weak signal difficult to hear. Signals were invariably better on the high uplands and worst in woods and hollows screened by trees. My chief object, however, was to compare the amount of interference with that experienced at my home station in the Wight. The amount of Morse on the low waves was very much less than we get at home, and in no case did its volume rise above the transmission from Cardiff. There was none of that total obliteration by piercing cornet notes which is unfortunately normal to reception in the Wight. Instead of being a blatant foreground the Cornish Morse seemed to be a mild and distant background.

In two places (the high land near St. Colomb and Camelford) I found a curious kind of interference which resembled a proximity to electric trams. It was very broadly tuned, and extended over most of the lower wave. As the Bodmin aerial was in sight I, perhaps hastily, concluded that the short-wave transmitter was the cause. On reflection I have wondered whether the numerous power-conveyor lines feeding the mines in this country may not be the real culprits. I heard no keying on this interference; it was merely a continuous grinding rumble.

As far as Continental reception is concerned, my impressions were that stations are very much more difficult in Cornwall than they are in the Wight. A subsidiary conclusion was that listeners in the happy Midlands do not sufficiently appreciate their solid blessings in immunity from Morse obliteration. And, with slight modification, the same may be said for the County of London.

Faithfully yours,

DONALD STRAKER.

Bembridge, Isle of Wight.

Preventing Direct "Pick-up"

SIR,—In the correspondence columns of your July issue, Mr. H. E. Wright states, "The only reason for screening is to prevent interaction between adjacent circuits." I think this is a very unthoughtful statement, since interaction is only one of two good reasons. I use screening where every coil is concerned, mainly to prevent direct "pick-up." Good spacing can prevent interaction to a large degree, but only screening the coils completely will prevent "the pick-up." The effectiveness can be easily judged with a complete screened receiver up to three miles from a main station. Removal of the screens causes a most unpleasant broadness in the tuning.

Yours faithfully,

H. FOSTER.

Kentish Town,
London, N.W.5.

A Grid Bias-H.T. Danger

SIR,—If grid bias is taken from an H.T. battery it is most important that the negative H.T. lead and positive grid-bias lead are connected to the same cell or battery socket. If this is not done the cells between grid-bias positive tapping and H.T. negative will be short-circuited through the receiver, and result in permanent damage to the intervening cells. This, in the case of a dry battery, may spread through the whole of the cells and ruin the battery.

The best plan when using wet sac Leclanché cells is to have the cells

The apparatus in the Central Telegraph Office, London, which is used to transmit messages via the Beam to Australia.

used for grid bias disconnected from the H.T. battery—in fact, used as a small additional battery with sufficient cells (allowing 1·5 volts per cell) to give the necessary grid-bias voltage. The two sets can, however, be placed in the same tray or cabinet. The No. 1 sac is all that is necessary, due to the fact that no current is taken. The two sets can, however, be placed in the same tray or cabinet.

An examination of the grid-bias circuit in any receiver will show that a short-circuit occurs unless the connecting up is made as we have indicated above, and it is possible that many users of grid bias have inadvertently caused such a short-circuit, with the consequent lowering in the quality of their reception.

Yours faithfully,
M. E. WATES.

Association of Special Libraries and Information Bureaux Directory

SIR,—May I be allowed, through the medium of the Press, to offer my thanks to all those who have kindly responded to my request for information in connection with the preparation of the Directory of Sources of Specialised Information, and at the same time beg those who could assist but have not yet written to me to do so at once, as we are fast approaching the close of our work. I should especially like to be able to include some more collections in the possession of private individuals.

Yours faithfully,
G. F. BARWICK.
(Secretary.)
38, Bloomsbury Square,
London, W.C.1.

Resistance Coupling Problems

SIR,—In the issue of MODERN WIRELESS for April was an article on Resistance Coupling problems which interested me considerably, as I was then experimenting with a three-stage L.F., all resistance coupled, preceded by one stage H.F. The following results may interest other experimenters.

Valves used, to begin with: 1 L.F. and 2 L.F. D.E.5 B, last stage L.F. D.E. 5.

Starting with the 1 L.F., I used grid leak 2 megs. and, seeing so many different values of condensers advised, made up an experimental one out of seven large plates of an old variable condenser.

For 2 L.F., grid leak 2 meg., condenser ·02.

For 3 L.F., grid leak 2 meg., condenser ·02.

This gave very good results on 'phones with either 1 L.F. or 2 L.F. or both together, but as soon as the 3 L.F. was switched on, so far from any increase, the volume of sound was considerably diminished.

Grid leak 5 and condenser ·0005 were then substituted for those in the 3 L.F., with the result that volume was much increased, but distortion was present however much grid bias was adjusted in any of the L.F. stages.

Setting to work again on the 1 L.F. stage, grid leak 5, and condenser ·0005 were substituted here, with the surprising result that nothing whatever could be got out of the valve. That is, a change which worked in the last stage was no use in the first.

Grid leak 2 megs. was therefore replaced and, instead of the extemporised condenser, a ·02 condenser was used. Again no results unless the H.T. was very considerably increased, which made the set very unstable. As a further experiment, before making any other alteration, I exchanged the 1 L.F. valve, which was, as I said, a D.E.5 B, with the valve in use in the H.F. stage—a Louden F.E.R.2.

This has an amplification factor of 12, as against the D.E.5 B's 20, and an impedance of 23,000 against 30,000. Results were astonishing; much better than anything previously obtained, and purity and volume all that could be desired. As a further experiment, Louden F.E.R.1, impedance 12,500, amplification factor 6, was used in place of F.E.R.2, and gave equally good results.

I know nothing of the scientific reason for this, but think it may interest other resistance-coupled experimenters.

I would only add that I have experimented with grid leaks ·5 megs., but could find no value of condenser to go with them to give any result worth having.

The anode resistances I am using are 1 L.F. 80,000, 2 L.F. 100,000, 3 L.F. 80,000.

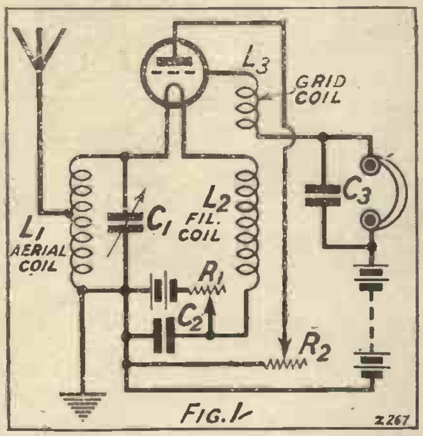
(*Continued on page* 208.)

The wireless "cabin" on one of the latest "tanks." Note the aerial mast and the operator wearing phones.

Further particulars are given in this article of the coils used in the Filadyne One-Valver (described last month), together with some important operating notes.

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

IN concluding my article on the one-valve Filadyne, which appeared in the last issue of MODERN WIRELESS, I promised to give you a few further details in regard to the coils employed in this set. Now, these coils are straightforward enough in themselves, but they play dual rôles in the circuit—at least, two of them do. As you will see by referring again to the theoretical diagram, which is



reproduced on this page, the aerial coil and the filament coil act simultaneously as filament-lead H.F. chokes and as filament tuning coils. In the Filadyne, filament tuning coils correspond with grid-circuit coils in ordinary receivers.

The Two Tuned Coils

As tuned chokes they prevent the H.F. energy passing to earth via the L.T. battery, and one is placed in series with each of the two connections to this accessory. But regarded as an aerial tuning unit these coils are similar in every way to two ordinary coils placed in parallel and tuned by means of a ·0005 mfd. variable condenser, as shown in Fig. 2. And when calculating the sizes that these coils must be for various wave-length bands, the two coils must be treated not separately, but as two paralleled inductances.

When two inductances are connected in parallel the resultant inductance will be less than the inductance of the smaller coil. The necessary formula is similar to that for condensers in series. The reciprocal of the combined inductances will equal the sum of the reciprocals of the two separate inductances. The reciprocal of a value is that value divided into 1. Thus the reciprocal of 4 would be $\frac{1}{4}$.

Slight Capacity Increase

When it happens that the two coils joined in parallel have similar inductances the resultant inductance will be one-half of the inductance of one of the coils. Thus, if two coils each of 200 microhenries inductance were paralleled the result would be a total inductance of 100 microhenries. This is provided that the coils are kept well apart as in the Filadyne, and do not appreciably interact with each other. When they are close together the calculation is, of course, somewhat more complicated.

You will notice that the so-called aerial and filament coils in the Filadyne are of approximately the same size. Therefore, from an aerial tuning circuit point of view the result should be the same as having but one coil of half the size of either. But this is not quite the case, for the addition of the second coil introduces just a little extra capacity into the circuit—its own self-capacity and the capacity of its leads.

All this added together does, as I say, represent but a slight increase in capacity, but it is enough to affect the tuning quite appreciably. It would not be safe to reckon that the two coils together in parallel represented anything much more than one coil of half size. In the case of our 65-turn and 70-turn coils these can be said to equal a coil of about 40 turns—just a bit above the half-size figure, as you will observe.

Reducing Coil Turns

And in winding coils for other wave-bands, you must bear the above in mind. If you reduce the turns of wire on but one coil you will be reducing the wave-band, but you will also be throwing out the balance, as it were. You should endeavour to keep the coils of more or less

The coils in this " Filadyne " one-valver cover the normal broadcast wave-band.

equal sizes, or at least preserve a similar sort of proportion between them that exists in the coils specified in my first article. The reason why the filament coil is a trifle larger is because it has not the advantage of the capacity and inductance of the aerial as has the aerial coil, although, on the other hand, it tends to have increased inductance owing to the proximity of the grid coil, and does not need to be much greater in size than the aerial coil to balance this.

This balancing is not really essential to the success of the circuit, but it is as well to adhere to it in order that one can calculate tuning ranges easily.

For instance, removing five turns from the aerial coil alone will not be quite the same as removing five turns from each of the coils in the effecting of a reduction of the wave-length tuning minimum. And, by the way, removing five turns from each of the coils would not have a similar effect to removing five turns from one coil used in the usual way. You would have to remove about ten turns from each of the coils to arrive at that result.

Decreasing Wave-length Range

Let me give you an example. The present Filadyne coils are of 65 and 70 turns, and these, as I explained before, represent together an aerial tuning coil of about 40 turns. Now, supposing you find that with your aerial you cannot get down to a station operating at, say, 270 metres, even when your variable is at its minimum capacity adjustment. You would probably have to take ten turns off each of the coils, making them 55 and 60 turns, and this would equal one coil of about 35 turns. Note these figures carefully—you will see their significance.

An adjustment of similar proportions is needed when the coils are increased in size. To make the two coils equal in tuning effect to a usual doubling of size the size of both coils must be approximately doubled.

When it comes to a considerable increase in size the effect of added capacities becomes much more marked. For Daventry and similar wave-lengths the coils must be of about 260 turns each. On such long waves the characteristics of the aerial need not be taken into account in respect of the balancing mentioned above.

Coils for Daventry

You should remember that it is just as important that such coils should be of a low ohmic resistance as in the case of smaller coils, as the filament current must pass through them. For Daventry coils a wire of at least 22 S.W.G. is still necessary. And even with this gauge of wire the considerable increase in size will result in a considerable increase in the filament circuit resistance and may, in cases, necessitate the use of a 4-volt accumulator when a 2-volt valve is used. With the B.5 valve, however, no increase in filament battery voltage is needed, as this valve has a very high internal resistance, and the effect of increased external resistance is not so marked. In order to keep Daventry coils reasonable in size, you will find it necessary to wind them in several layers, spacing these with sheets of thin greaseproof paper.

When winding a cylindrical coil in layers you must start each layer at the same end of the former, and must not wind them backwards and forwards.

During the past week or two I have been running through a new collection of valves, and have tried a number in the Filadyne one-valver. I find that the Ediswan D.R.2 makes an excellent Filadyne valve. It will operate quite comfortably with a 2-volt accumulator, and evinces considerable liveliness.

And mentioning "liveliness" reminds me that when you alter the aerial and filament coils you may also find it necessary to alter the size of the grid coil. For Daventry I have found that another 40 turns of 26-gauge wire are necessary, and this must be wound above the original 40 turns.

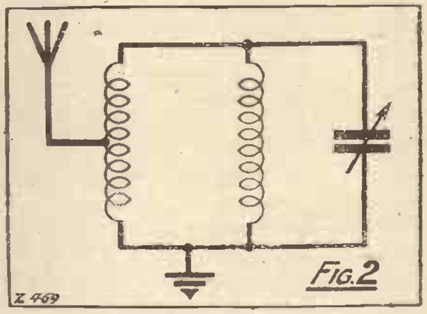


FIG. 2

You will probably notice that I have said nothing about the aerial tapping-point on the aerial coil, but I must make it clear that this should be moved up proportionally to the increase in the size of the aerial coil itself. If this aerial coil (together, of course, with the filament coil) is doubled in size, i.e. increased to 130 turns, then the tapping point should be moved up to the 44th turn, and when the coil is increased to the Daventry size (260 turns) the tapping-point should move up to about the 90th turn.

The Aerial Tapping

This tapping-point is by no means critical. The lower it is on the coil the greater the resulting selectivity, but there may be an appreciable loss in sensitivity accompanying this. If the aerial were taken to the very top of the coil, maximum sensitivity would obtain, but the set might not be selective enough for you. The tapping-points I have indicated appear to me to afford a pleasing compromise. Individual amateurs may, however, vary them just as they desire. If your object is to receive the local station only, then dispense with a tapping-point altogether and join the aerial lead (No. 1) direct to the top of the aerial coil (leads 9 and 10 go to this point).

By this time I expect quite a number of you have Filadyne one-

(Continued on page 207)

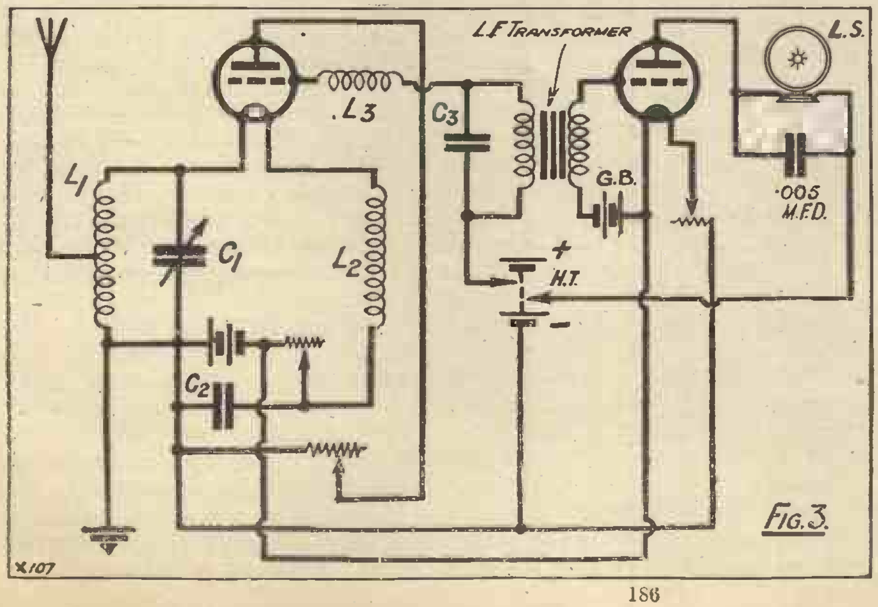


FIG. 3

A DAY OUT WITH A PORTABLE SET

An interesting series of experiments with the two-valve receiver described under the title of "A Self-Contained Portable," in the July "Modern Wireless."

By J. ENGLISH.

In describing recently the construction of a two-valve portable receiver I mentioned some of the novel and interesting experiments that were possible with this type of knockabout set. Such good results were obtained within fifteen miles of 2 L O under normal conditions that in order to test its capabilities to the full I decided to carry out a series of reception tests under the worst conditions that could be found. The programme that I eventually drew up might well be considered a nightmare for any staid " stay-at-home " set, as you will see later ; but the little portable came through it all to the utmost satisfaction.

Now, in case some of you have not read the previous article referred to above, I will describe very briefly the main points of the set used for these tests.

Essentially it consists of a detector with a resistance-coupled L.F. amplifier, the receiver being built into a small case complete with self-contained frame aerial, batteries, and a pair of light-weight 'phones. The whole outfit weighs about nine pounds, and can be put into operation or packed up in a few moments. A particular feature is that the set is designed to work with the case closed, so that the operator can listen-in while walking about with the case in one hand. Anywhere up to ten miles from 2 L O signals are very nearly moderate loud-speaker strength, while its sensitivity is such that faint signals have been received from a few Continental stations—all this without any external aerial.

The Test Commenced

In view of the set's DX capabilities I decided not to rely upon distance tests, but to see what it would do under the conditions of unfavourable surroundings, local interference, noise, and vibration.

So the programme commenced one evening with a reception test on the six-mile train journey to London. Here we have the conditions of vibration and noise in good measure, but the set was not affected in the least. On switching on as the train steamed out of the local station, 2 L O came in loud enough to drown all external noise. In fact, it was too loud for comfortable 'phone audition, so that I had to detune slightly. Although the train shook and bumped a good deal no microphonic valve noises were heard, while the strength of signals remained dead constant.

Consistent Results

On the whole journey signal strength remained consistently loud, increasing slightly on nearing the London terminus, with only slight fading when passing through brick-lined tunnels. The only part of the journey where serious loss of signal strength was observed happened to be where the train ran through a long, but not deep, tunnel before entering the terminus. Here signals faded rapidly to nothing, with occasional traces of speech, and then a final rapid increase to normal as the train came out of the tunnel. This remarkable sequence of fading would appear to be due to many steel girders in the tunnel roof and sides.

However, the results were good enough to demonstrate beyond doubt the possibility of listening to the local station on short train journeys. Maybe the day when we shall listen to an early news bulletin on the way home is not so far off as we think. Just imagine a row of little attaché-cases along the luggage-rack, with their owners wearing headphones. Woe betide the man who oscillates then !

After leaving the terminus, I boarded a 'bus bound for Oxford Street, and installed myself on the rear seat upstairs, choosing this as being most inconspicuous. I believe this is the reason why I had to wait some time for a 'bus with this seat vacant, the occupants in every other case having obviously found conditions just right for two.

Listening on a 'Bus

Donning the 'phones I managed to tune in 2 L O before the 'bus started, and as it was dark I escaped the curious glances of fellow-passengers. Signals now came in well above the roar of the traffic, so that I had no difficulty in distinguishing all that was going on in the London studio. The 'bus was now going at full speed, and, being seated over the rear axle, the set was subjected to remarkably unkind treatment. Although the vibration and jolting were so excessive, still the set gave no trouble, signals remaining unaffected and free

During the day the set was tried in an Underground railway station.

from microphonic valve noises. The absence of the latter was due in part to the spring valve holders and a packing of cotton-wool.

A Peculiar Effect

Now, I had expected signals to increase gradually as we neared the part of Oxford Street in which 2 L O's transmitter is situated, but no marked increase in strength seemed to take place until the beginning of Oxford Street about a mile away. From here onwards the strength of signals became much louder, and on reaching Selfridge's store, on the roof of which is the transmitter, signals were so loud that the second valve was overloaded, giving rise to distortion.

Tuning, moreover, was very broad, signals being heard fifteen degrees either side of the proper setting of the tuning condenser. One would expect this right under the shadow of such a powerful station, but I did not expect to find that the set would not oscillate. This was perhaps due to the overloading of the first valve.

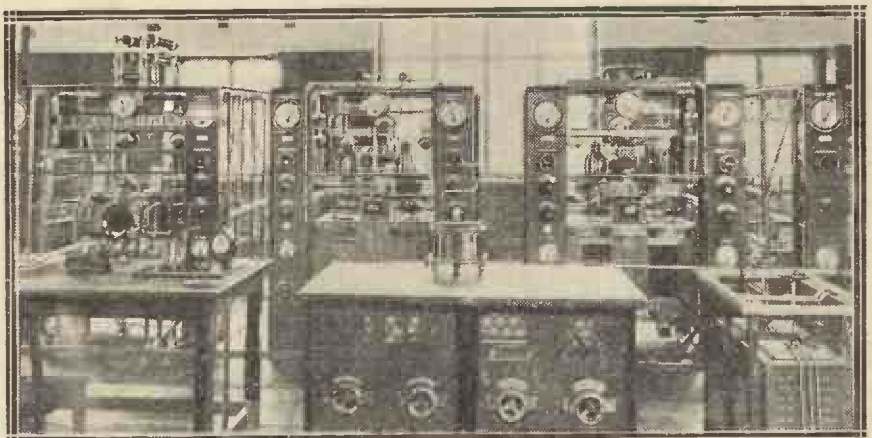
On reaching Marble Arch, just beyond Selfridge's, I packed up the set in a few seconds, alighted from the 'bus, and made for the nearest tube station.

My intention now was to try the set in the tube station, but as this must be at least fifty feet below the street and within a solid tube of steel I had not much hope of hearing a sound. However, choosing a time when no train was passing, I switched on and searched for 2 L O's carrier-wave with the set oscillating. In this condition a valve receiver is extraordinarily sensitive to wireless waves, however faint, manifesting their presence by the well-known heterodyne whistle. I was agreeably surprised to hear the pronounced heterodyne whistle of 2 L O's carrier, but this was not strong enough to be resolved into readable signals. There was a good deal of humming interference, but not so much as one would expect under these conditions.

Further Tests

I next tried the set at Oxford Street tube station, a little further from 2 L O. Here, for some unexplained reason, the carrier was much stronger, and I was able to resolve it into faint readable signals, interference being considerably less on this station. I did not attempt reception in the tube train itself, as the external noise and electrical interference would have swamped any faint signals picked up. On the whole, I was surprised that anything at all should be heard under such formidable conditions. This shows the remarkable penetrating power of wireless waves in spite of the terrific absorption due to the buildings, earth, and steel lining of the tube.

Probably this steel lining acted to some extent as a radiator, for I noticed that stronger signals appeared to be received when the frame was pointed to the wall, although real directional effects were absent. Obviously the waves at this depth were much distorted from their true paths.



The Klipheuvel station, which carries on the Beam service between S. Africa and this country.

Effect of Steel Buildings

This ended the programme of experiments for the day, the results on the whole having shown that it is possible to establish communication under the most unfavourable conditions imaginable.

On another occasion I experienced some very curious results when carrying out tests in a large, modern, steel-framed building in the heart of the City, some three miles from 2 L O. Starting in the lift from the basement, thirty feet below street level, signals were quite good, increasing slightly on reaching ground level. As the lift mounted upwards, signals gradually faded away, due to absorption by the steel framework, and then increased to normal again right at the top. Curiously enough, when I walked about on the roof with the set signals were not much louder than at ground level, in spite of my being some hundred feet up. Another remarkable thing was that when the set was brought near to a large pipe running from a tank on the roof down to an artesian well, signals were much better, while the set oscillated more readily. This may have been due to the frame having a greater capacity to earth at this spot.

Re-radiation Possibility

I noticed in one of the rooms below ground level that there were blind spots where signals were very faint, while the loudest signals were obtained by bringing the case near a particular spot in the wall where a large girder ran upwards through the building. It is hard to explain these curious phenomena except by supposing them to be due to the mass of steel girders in the building. The presence of so much magnetic material may cause reflection and interference between the waves, giving rise to blind spots, while portions may have a natural wavelength near to that of 2 L O, so that re-radiation of energy takes place in their vicinity.

Everywhere the profound influence of steelwork and metallic masses is noticeable, giving rise to the most disturbing conditions in wireless reception. The proximity of large masses of iron and steel gives rise to some freak effects, and in an engineering workshop crammed full of lathes, etc., I have known the set to work better with the plane of the frame horizontal instead of vertical.

The factor of vibration does not count for much with a well-designed portable set in which everything, including the frame, is sufficiently damped to resist shock vibration.

In conclusion, I think the results of the experiments cited above will illustrate the versatility of wireless reception, and the many stunts that can be carried out with a really portable set. The possession of the latter will certainly bring home to you the real fascination of wireless better than any fixed station.

Edison Listens-In

MR. THOMAS EDISON, the world-famous inventor, has created a storm in a teacup lately owing to his very unkind remarks about radio as a means of entertainment. If I remember rightly, he said that the gramophone was very much to be preferred to wireless! Of course, he was very intimately concerned in the invention and original development of the gramophone, whereas he does not seem to have been much associated with the development of wireless, and perhaps it is only natural that his sympathies should be with the former.

Anyway, it is interesting to notice that his attitude towards wireless seems to be changing, for he was one of the most interested of the listeners on the recent occasion of the chain broadcast of "Electric Night" over a large number of stations. The inventor's son, Mr. Charles Edison, spoke into the microphone on the forty-seventh anniversary of the inauguration of the first incandescent electric light system by his famous father.

Radio Cinema Production

The familiar megaphone with which the cinema director has been wont to address his flock is now giving place to a system of wireless loud speakers, which are connected to a central transmission and amplifying system. This has been rendered necessary owing to the very large area covered in some of the modern "super-movies," and to the very considerable numbers of participants. For example, the production of a naval scene in "Old Ironsides" required the co-operation of fifty-two vessels and a distant shore battery. To solve the problem of communication a portable broadcasting set was obtained, with numerous receivers for each group, and the Battle of Tripoli was re-enacted in Catalina Harbour under the control of the director, James Cruze, who held the microphone.

Changing Speed

Dr. Michelson, whose name is so well known in connection with the Michelson and Morley experiments, has now come forward to upset the previously accepted figures with regard to the velocity of light and wireless waves. The figure for wireless waves has been accepted at 299,823,000 metres per second, but according to Dr. Michelson the velocity is really 299,796,000 metres per second. In the case of the longer-wave stations, calculated according to frequency, this will have the effect of taking off about one-tenth of a metre from the wave-length.

Preparing the apparatus for the transmission from the G.P.O. of the first message to Cape Town by the Beam service.

Hand-Capacity Made Useful

Electrostatic capacity effects, which are so important in the operation of a wireless receiving circuit, have been adapted to many purposes entirely outside radio; for one thing, condensers have been used in connection with burglar alarms, the capacity being delicately adjusted so that when a person (in this case, Mr. Burglar) approaches the apparatus the capacity is thrown out of adjustment and the alarm is given. It amounts, in effect, to making practical use of the familiar hand-capacity which is often so troublesome with a wireless set.

Dr. J. H. Dellinger, of the United States Bureau of Standards, has applied a similar effect to a very useful purpose in connection with the landing of an aeroplane. The device which he has produced is fitted into the aeroplane, and when the pilot is perhaps ten or twenty feet from the ground this instrument—by reason of the capacity effect to earth—gives him a clear indication of his height, and thus greatly facilitates the otherwise difficult operation of landing.

Some Condenser!

The Abox Company (U.S.A.) has lately put on the market a very extraordinary filter system for use with "A" eliminators—or, in English, L.T. battery eliminators. This eliminator includes the usual choke coil and condensers, but the remarkable feature is the extraordinarily large capacity of the condensers. The latter are of the electrolytic type, and consist of iron and nickel plates immersed in a strong solution of potassium hydroxide. The high capacity of an electrolytic

(*Continued on page 200.*)

In Our Test Room

"Microstat" Filament Controls

WE recently received samples of the "Microstat" variable fixed filament control for baseboard mounting. The general design is similar in principle to the original "Microstat" filament resistance except that the body of the device is made to revolve for adjustment purposes instead of the screw shaft, which remains fixed. Although, generally speaking, we prefer wire-wound variable resistances, we must say that this new "Microstat" variable resistance is very constant in operation. It provides a wide variation of values and is quite smooth in its adjustment. It has the distinct advantage that it is very small in size and occupies less baseboard area than a grid leak.

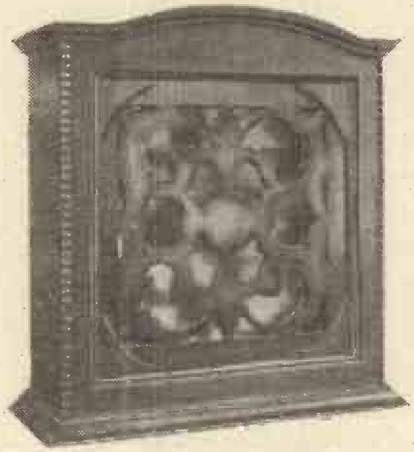
The price of the "Microstat" V.F.R. is 3s.

Amplion Cone Loud Speaker

We recently received an Amplion cone model A.C.7 for test. It is a handsome instrument contained in an oaken cabinet of Jacobean design. The cone itself, which is partially concealed by the cut-away front of the cabinet, is similiar in design to the cones used in all the other models of the Amplion cone range, and appears to be of rather thick material. It is claimed to be quite unaffected by varying atmospheric conditions.

The "Microstat" variable resistor.

Despite its comfortable proportions it does not bring out the bass notes and forget about the higher ones, but deals with the whole range of audio-frequencies very respectably. But it takes a considerable amount of driving. The horned Amplions are generally very sensitive, and it is something of a shock to come up against a speaker bearing that name which needs at least two stages of note-magnification even on the local station to operate it properly.



The A.C. 7. Amplion cone loud speaker.

However, in our opinion the tone is good, and it does not appear to need specially arranged output circuit characteristics in order to register its balance in reproduction.

This particular model costs £6 10s., and it is an instrument capable of enhancing the appearance of a room.

Adhesive Insulating Tape

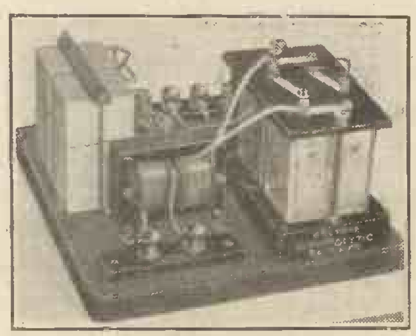
A supply of "Clutch" brand insulating tape was recently forwarded to us by the manufacturers, Messrs. A. H. Hunt, Ltd., Tunstall Rd., Croydon. Such a material is invaluable for tidying up battery leads and other such wiring, and it is useful for all sorts of household purposes as well, and to have in one's garage. The "Clutch" brand appears to be quite good, and is stated to retain its adhesive qualities for very long periods. Rolls are sold in 3d., 6d. and 9d. sizes.

"Goltone" Rectifier Unit

We have recently had a "Goltone" electrolytic rectifying unit under test. Designed for use in H.T. eliminator circuits, it consists of a group of four electrolytic rectifying cells so arranged that full-wave rectification can easily be carried. It can be used on mains of all normal voltages and periodicities, and the necessary transformer, choke, fixed condensers, etc., complete with wiring blue print, are available from the makers, Messrs. Ward & Goldstone, of Manchester, at a very reasonable inclusive figure.

On test the unit functioned very efficiently, and there was little trace of the usual "bubbling" associated with such devices. We should imagine that the electrodes would give out after a fair period of usage, but they seem to be easily replaceable.

Personally, we prefer the valve method of rectification, but the electrolytic method, as exemplified by this



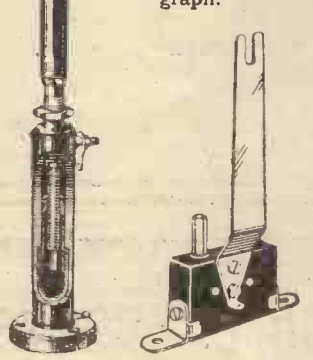
The "Goltone" electrolytic rectifier unit embodied in a complete H.T. eliminator.

Goltone unit, is a simple business, and includes nothing that can bring the user of such up against heavy costs in replacements. Perhaps as an offset against this it calls for just a little more care in maintenence in order to obtain completely satisfactory results, but it can be made, with not much trouble, to give an efficient output free from "hum." By the way, the vent-holes on the Goltone unit are rather on the small side, and could, with advantage, be slightly enlarged.

Two Gambrell Components

Messrs. Gambrell Bros. recently sent us one of their new centre-tapped coil holders. These are designed for

The two Gambrell components mentioned in the accompanying paragraph.



use with Gambrell centre-tapped plug-in coils, and eliminate the necessity for using flexible leads with these.

Also, they greatly facilitate the changing of coils. These holders are similar to the ordinary single-way baseboard-mounting type, but are provided with projecting metal brackets which engage the centre-tap terminal on the coil. The illustration which appears on this page will make the design of the device quite clear. It will be seen that three soldering tags are fitted, and to these are taken the connecting wires.

Constructors who wind their own coils should find this Gambrell device distinctly useful, for not only does it provide an easy means of disposing of a centre-tap connection, but it can be adapted as a holder for coils of the basket and spider-web types. At the price of 1s. 9d. it should prove a popular article.

We also received from the same source a Gambrell Neutrovernia condenser of the latest pattern. It is a considerable improvement on the original model, good though this was, and its improvements are both mechanical and electrical. It is stated that every Neutrovernia is tested on 215 volts over the whole of its capacity range, but that even this represents by no means the maximum pressure the condenser will stand.

It provides an adjustment up to 35 m.mfds. and covers the range smoothly and positively. As will be noticed in the drawing which is reproduced it has a long control handle and is suitable for either baseboard or single-hole panel mounting. The price of the Gambrell Neutrovernia is 5s. 6d.

A Wet H.T. Battery Component

The Wet H.T. Battery Co., 12, Brownlow St., High Holborn, W.C.1, recently sent us samples of their new zincs for use with the small Leclanche-type of wet cell which is becoming increasingly popular for supplying H.T. These zincs are single stampings and are provided each with two holes, one to take a standard wander-plug so that tappings are facilitated, and the other for fixing purposes. They are almost completely tubular, and are undoubtedly an improvement on the more usual rather flimsy, haphazardly produced article.

A High-Resistance Potentiometer

Messrs. Burndept recently sent us one of their new high-resistance potentiometers. In general design the component is similar to their other potentiometers and rheostats and has a similar large dial and substantial knob. But it has the extremely high resistance of 2,000 ohms. Readers will not need to be reminded that this, in very many cases, is a very distinct advantage. It often happens that a potentiometer is used merely as a voltage-applying device and the current that it passes is so much waste.

Despite the high value of its resistance element this Burndept potentiometer is quite robust, and can handle up to 50 milliamps if it is used in a battery-eliminating unit.

The retail price is 8s. Another Burndept potentiometer, having a resistance of 1,200 ohms, is available at 7s.

An Automatic Switching Device

We recently received an "Axuel" programme selector from Pelhams, Ltd., of 5, Banner Street, London, E.C.1. It is a time-switch designed specifically for use with radio receivers. It operates as a "make-and-break" filament switch, and is placed in series with one of the leads running from the L.T. battery to the set. As will be seen from the photograph, it consists of an ordinary clock mounted in the centre of a rather large casing, around which are disposed a number of small holes corresponding with the five-minute intervals of the whole twelve hours.

A number of small pins are provided, and these are placed in the holes in accordance with the desired sequences of switching. The set is switched on at the time denoted by the first pin and switched off at the time indicated by the second, and so on. Thus it will be seen that the whole twelve hours can be mapped out to correspond with any arrangement of desired programme items as closely as to within the nearest five minutes.

It is noteworthy that the switching is purely mechanical and that the various pins are not asked to perform the functions of electrical contacts. And we found the "Axuel" to be

The "Axuel" Programme Selector.

rather more satisfactory than other time controls probably for this reason, and the switching is definite and is not accompanied by the noises such as one gets with slowly operating contacts.

The clock movement appears to be a robust one, and is able to keep good time. An attractive feature is the addition of a switch to the device which enables the set to be turned on or off independently of the internal mechanism, so that one can cut in or out of the programme without upsetting the day's arrangement of pins. The "Axuel" retails at 50s.

Something new in Centre Tapped Coils!

Patent 271384

Two Centre Tapped Coils for B.B.C. and Daventry Ranges have now been added to the famous range of LEWCOS Plug-in Coils. Wound with Litz wire they maintain, in construction and performance, the same high standard of efficiency as the ordinary type Inductance Coil. All wireless dealers stock or can obtain them for you.

No.	Minimum W/L	W/L with ·0005 Condenser	Price each
C.T. 60	188	555	3/6
C.T. 200	595	1,960	5/3

The LONDON ELECTRIC WIRE CO. & SMITHS, LTD.
Playhouse Yard, Golden Lane, London, E.C.1.

LEWCOS

(Registered Trade Mark)

Centre Tapped Plug-in Coils

TRUE TUNING

FORMO
ARTHUR PREEN & CO LTD

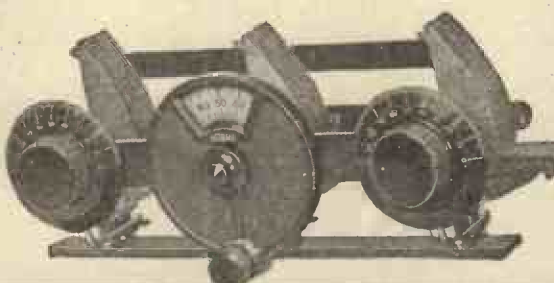
"INDIVIDUAL-GANG" CONTROL CONDENSER

again to the fore!

FIRST we gave our customers a highly efficient and low-priced Variable Condenser and L.F. Transformer. Now we lead in the design of a Gang Control Condenser with individual adjustment which has all the advantages of the ordinary Gang and Single Condensers without ANY of their disadvantages.

CROWN WORKS, Dept. 6,
Cricklewood Lane, N.W. 2.
'Phone: 1787 Hampstead.

Manchester: Mr. J. B. Levee, 23, Hartley St., Levenshulme. 'Phone: Heaton Moor 475.



TWIN GANG £2:12:6
TRIPLE-GANG £3: 3:0

TUNE with the centre dial until you hear your station.
ADJUST with the side dials for maximum signal strength.

IT'S SIMPLE!
IT'S EFFICIENT!!
IT'S GOOD!!!
IT'S FORMO!!!!

Weston Instruments are unvarying in their accuracy and of necessary use in Radio Service

Write for free copy of instructive booklet "Radio Control."

WESTON

STANDARD THE WORLD OVER

Weston Electrical Instrument Co., Ltd., 15, Gt. Saffron Hill, London, E.C.2.

CUT THIS OUT FOR CABINETS

and post to us for FREE *list illustrating Cabinets as shown in "Modern Wireless" etc., etc., and for our additional Bulletin No. 2.*

NAME..

ADDRESS..

....

(Write in block letters, please.)

CAMCO CASEWORK
REGD TRADE MARK

CARRINGTON Mfg. Co. Ltd.,
Camco Works,
Sanderstead Road, South Croydon.
Trade enquiries especially invited.
Telephone: Croydon 0623 (2 lines).

Sources of H.T. Supply

A brief review of the various methods available for the supply of High Tension Current for wireless receivers, particularly with reference to "Wet" batteries.

By "Research."

The progress of wireless reception has resulted to-day in a quality of reproduction that is almost lifelike in its fidelity to the original performance. Unfortunately, the cost at present of the almost perfect instruments is too high for any except the wealthy. There are, however, many extremely good sets now available suitable for home construction that give results falling little short of perfection.

A familiar type of H.T. battery.

A well-constructed receiver and loud speaker to-day are unlikely to require attention, and even the valves are capable of a really long life.

The source of power which the set controls and converts into the sounds we hear is the H.T. supply. The whole of the sounds reproduced in the loud speaker come from this H.T. supply, and the receiver is the instrument controlling it. It is, therefore, in many respects the most important factor of good reception. The object of this article is to examine the requirements of H.T. supply, drawing conclusions as to which is most satisfactory.

"Dry" Batteries

The four present sources of H.T. supply are dry batteries, accumulators, from the mains, and now the wet sac Leclanche type of battery. We will examine each of these in turn.

The *dry cell* is a primary battery developed from the fluid Leclanche battery. The term "dry cell," however, is really a misnomer. No cell can furnish a current if dry. The name is, however, generally understood to cover primary batteries that are portable and relatively dry as compared with fluid Leclanche batteries. The current-giving capacity of a dry cell entirely depends on the size of the elements and depolariser. For currents of 5 milliamps the depolariser used in flashlamp-size cells is suitable; for 10 milliamps double the size, and so on.

If a larger current than this is taken the load is too heavy for the cells, the output is greatly reduced, and the battery will soon become useless. The cells of a dry battery are sealed and carefully insulated from each other. The zinc is the positive end, and the voltage of each cell is 1·5 when new. In service the voltage will drop gradually until it is ·8 volt, and the battery is used up and requires replacement.

The H.T. accumulator is a secondary or storage battery. The battery should be carefully charged at a low current. If an H.T. accumulator is of good quality and particular care is taken to see that the voltage of each cell drops to not less than 1·7, and charging is done properly, it is a good source of supply and can be recommended on sets using heavy H.T. current of 30–60 milliamperes. Before investing in an H.T. accumulator it is a wise precaution to see that the concern dealing with recharging is properly fitted up to supply the small charging current required.

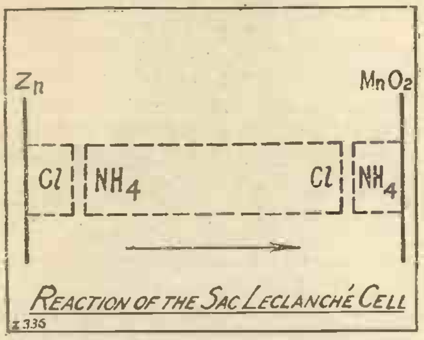
Mains Units

The recent introduction of apparatus for, one might say, "ironing out the creases" in H.T. supply has made it possible to draw *H.T. current from the electric-light mains.* This apparatus consists of chokes to reduce the roughness of the mains current and large fixed condensers to finish off the smoothing process. Non-inductive resistances are also used

A 90-volt battery of Leclanche cells, with tappings provided at every 1½ volts.

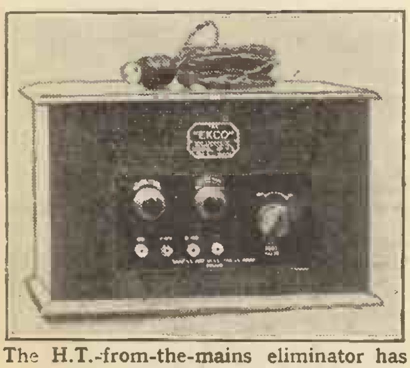
to break down the voltage to suit various valves. With alternating current the apparatus necessary is more expensive.

Success with this apparatus depends on suitable values to the various components. It is also important for the smoothing apparatus to be suitable for the set, and advisable, wherever possible, to ascertain its suitability before purchasing. With sets taking a large current, say 15 milliamps and more, special apparatus will probably have to be made. Where a suitable smoother can be obtained to give dead silent current this form of supply is probably the most satisfactory and economical and can be fully recommended.



Sac Leclanche Batteries

We now deal with the latest form of H.T. supply, *the wet sac Leclanche battery*. As this type of battery has only just come into use, and may not be so generally understood, we will deal with it more exhaustively. It has some advantages over other types of batteries for H.T. supply, and its popularity is assured by reason of its economy in working and the remarkably silent background to reception, due to the smooth and consistent current given.



The H.T.-from-the-mains eliminator has recently come into great prominence.

The original Leclanche battery was introduced by Leclanche in 1868. It has been very popular on bell and telephone circuits ever since. The chemical reaction on passing of current is shown by the diagram above. The cells are constructed from a jar in which a circular zinc surrounds the depolariser or sac; the two elements are in an electrolyte of sal-ammoniac and zinc chloride.

When the cells are giving off current, zinc chloride is formed on the zinc, and the ammonium radicle comes in contact with the manganese dioxide. The ammonium breaks up into hydrogen, which would cause polarisation of the carbon but for the MNO_2, which reduces the hydrogen to water. Polarisation will not occur, provided that the hydrogen can be reduced to water more quickly than it is produced.

Depolarisers

If the hydrogen is produced at a greater rate than it can be converted into water by the manganese dioxide, the gas will tend to polarise the positive element and reduce the current. The original Leclanche cells had a very feeble depolarising quality. The manganese was in large pieces, and carbon was used as the conducting medium. This type of battery is quite satisfactory when used for bells or intermittent telephone work.

For the supply of continuous current, such as that required for H.T. work, it is important that the depolarising agent be as efficient as possible. The porous-pot Leclanche cell is only useful where intermittent work is required. The pot introduces resistance, and gets clogged after a time. The first improvement on this type for heavier work was the agglomerate-block type of depolariser made from blocks of manganese dioxide and carbon made solid by compression.

Sac Elements

This type shows a marked improvement on the porous-pot pattern. Later developments have proved the sac to have a much greater output than either of the two already referred to. The sac pattern is infinitely the best for H.T. work. It is made by compressing hard a mixture of powdered manganese and graphite, etc., round a carbon rod, and then wrapping same tightly with muslin and tying with thin string. This type is suitable for closed-circuit work, and is ideal for giving the small continuous current required for the H.T. supply.

The larger the sac the longer it will last in giving a particular current. The best size to choose for supplying the current for a particular receiver is one that will last from eight to twelve months before the sac element requires renewing. Over this period the sac element will give the greatest economical output. Cells give 1·5 volts each when first used, but as happens with all Leclanche-type cells, whether wet or dry, the voltage at the end of the useful life of the sac is about ·8 per cell.

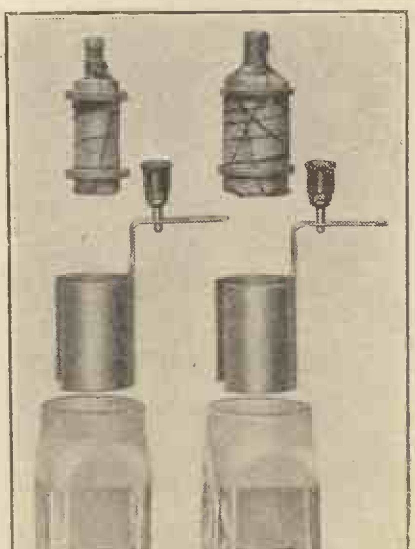

Three Leclanche H.T. cells.

The Post Office usually renew the sac element when the voltage has dropped ·75 volts per cell. Recent developments have resulted in very practical small cells, accessible for renewal and simple in assembly. The best type has a zinc with a hole in the connecting strip for plugging in the standard type of wander-plug. This makes it possible to tap any cell individually. The sac elements have rubber bands to prevent internal short-circuit, and the electrolyte is a solution of sal-ammoniac and zinc chloride. Sal-ammoniac alone does not give very satisfactory results.

Preventing Evaporation

To prevent evaporation it is advisable to pour a little thin mineral oil, such as Prices' "Blancol," on the electrolyte. This also has the effect of minimising creeping of the salts. Creeping of salts is doubly guarded against by waxing the tops of the

(*Continued on page* 202.)


The elements of a wet H.T. battery.

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.

Paris on a Crystal Set

HAVE you noticed how consistently well the long-wave stations have been coming in this summer? Amongst other instances, a Berkshire listener reports having picked up Radio-Paris on an ordinary crystal set. Reception was "quite good" and clear. Can any crystal-set enthusiast who is situated further north beat this, or is it a summer record?

The Wily Man of Borneo

The short-wave wizards have been at it again—this time at Sarawak, North Borneo. A British listener recently picked up Sarawak signals on a Det. and L.F., and he was astonished to learn that the other fellow was using a transmitter only twelve inches high by eight inches across. Visions of some special super valve, capable of tickling up telephones over 6,500 miles away, impelled the listener to ask for details, and what do you think that wily man of Borneo was using?

Highly Surprising Low Power

His transmitting valve was an old Cossor Red Top, his voltage was limited to 220, and the power used was only *seven* watts. Seven watts, mark you, to reach nearly 7,000 miles. (And you know what a wretchedly poor light a *fifty*-watt lamp can throw on a table a yard away, don't you?). No wonder that more and more listeners are building short-wave sets—Sarawak, seven watts, and a Red Top are enough to intrigue anybody!

A 7,000-mile Coincidence

A very curious radio coincidence is reported from Johannesburg. A vocalist there was broadcasting to listeners a certain song when one listener picked up the Eindhoven (Holland) station, relaying 5 X X on short waves. Just as the Johannesburg singer had started, the Daventry vocalist started to sing *the same song*, and they finished the long-distance "duet" almost simultaneously!

Triumph of the "Beam"

Since the last issue of MODERN WIRELESS another link in the Empire chain of radio has been forged, the South African service having completed its seven-days' test. Canada, Australia, and now South Africa are all "on the ether" to England, and it is hoped that very shortly India will follow suit—four fine feathers in the cap of Senatore Marconi.

Community Radio

The idea of a central radio supply, with one powerful set supplying programmes to houses for miles and miles around, seems to be catching on. The first installation of this kind was erected down Southampton way, but the scheme is now being tried with success in many districts. At Lytham-St. Anne's (Lancs) programmes are being provided for two shillings per week, the sum including the cost of the necessary broadcasting licence as well.

(*Continued on page* 198.)

RADIO NOTES AND NEWS OF THE MONTH

—continued from page 196

The Big Noise

American scientists have been tuning-in the world's commercial wireless stations, and measuring the signal strength. And the British P.O. station at Rugby takes the cake for current received. Bordeaux and Ste. Assise (France) come next, and then Nauen, followed by two South American stations.

Rugby's success is all the more noteworthy because the station has an "all-round" range, and was not designed specially for transatlantic work, like some of its rivals.

New French Station

South of England listeners will be interested in the news that a new French station has just started up in Brittany. The tests have been carried out on a wave-length of 320 metres, and the power employed is 500 watts. The name of this station is Rennes, a place about 50 miles from St. Malo, but the regular programmes will be relays from Paris.

Empire Broadcasting

The Postmaster-General has given a new turn to the Empire broadcasting situation by his provisional blessing bestowed upon 2 N M. This latter, as many readers will know, is the call sign of one of Britain's foremost amateur transmitting stations, which at one time or another has been picked up in every part of the globe. The station belongs to Mr. Gerald Marcuse, of Caterham, Surrey, and if all goes well he will have the honour of start- the Empire's preliminary programmes on their way.

2 N M to Start a Service

The present intention is to relay B.B.C. programmes from 2 N M on short waves, 23 metres and 33 metres being favoured for the first tests. In all probability the experimental transmissions will commence on or about August 15th. I hear that Mr. Marcuse himself is confident that the tests from 2 N M will prove that a regular Empire broadcasting service can be carried out successfully and without delay by utilising short waves.

As much of the information given in the columns of this paper concerns the most recent developments in the Radio world, some of the arrangements and specialities described may be the subject of Letters Patent, and the amateur and the trader would be well advised to obtain permission of the patentees to use the patents before doing so.

A FILADYNE FOUR-VALVER

—continued from page 128

carefully followed no difficulty should be experienced. Notice that the leads passing through the baseboard are given the same numbers in Figs. 7 and 8, so that you can easily trace the connections between the wiring on both sides of the baseboard.

The under-baseboard portion of the wiring is best carried out with some form of insulated wire such as Glazite, 1/8 in. holes being drilled in the baseboard at those points where the wiring emerges to the upper side. The insulated wiring need only be carried to a short distance above where it projects through the holes in the baseboard, the wiring on this side being carried out with bare tinned wire as usual.

When mounting the intervalve H.F. transformer it is necessary to cut four small blocks of wood 1 in. high, with a piece cut from the top so that the former can be mounted as shown in Fig. 4b, two of the blocks only being shown in section. These blocks are glued to the baseboard,

(Continued on page 202.)

RADIO ABROAD

—continued from page 190

condenser is due to the very small distance of separation between the electrode and the conducting gas layer against it. In the present case the enormous capacity of ¼ farad, that is 250,000 mfds., is obtained. This condenser is undoubtedly the largest ever made for ordinary radio work, and gives a smoothing effect which is quite unobtainable with condensers of the ordinary size and type.

"Bloopers"

The Sterling Telephone Company, of Minneapolis, has a new way of dealing with the "bloopers" (American for "oscillators"). They have been running an advertisement offering a five-tube tuned radio-frequency set for $60 on which they will allow $17½ for a one-tube regenerative outfit, and correspondingly more for regenerative sets using more than one tube. Says the ad., with respect to tuning-in the old squealer, "Keep the accessories: all we want is your old trouble-making set: All sets turned in will be destroyed."

This idea is very praiseworthy, provided the five-tube sets sold by the Sterling Company on the part-exchange system do not themselves oscillate into the aerial. Note, it is the U.S.A. Sterling Co., not the British.

Changing Wave-Lengths

At a recent meeting of manufacturers and broadcasters in the United States, when the Federal Radio Commission opened a public enquiry into the question of broadcasting wave-lengths, there was considerable opposition to the proposed widening of existing transmission bands, either downward from 200 metres, or upward from 545 metres, the proposal having been made in order to provide room for the 733 broadcasting stations now operating in the United States.

One of the reasons advanced against the proposed widening of the band was that it would entail great expense to the listening public, in that it would tend to render existing receiving sets useless unless a considerable amount of new equipment was designed and sold. Jack Binns (of S.O.S. fame), who is now, by the way, treasurer of the Hazeltine Corporation, objected to the widening of the bands, as he said it would be against the public interest, and would make extra receiving apparatus necessary. The President of the Crosley Radio Corporation said that to expand existing channels would only result in a demand for additional broadcasting licences, and would create an appalling situation in the radio industry. He said listeners would have a wider choice of programmes, but he thought that the public "had no reason to want more than ninety-six different programmes." I wonder what he would have said had he lived in this country?

Short-Wave Experiments

There have been many rumours in broadcast circles that the Westinghouse Pittsburg Station K D K A was using short-wave transmission as part of its technical routine. The experts of this station, however, announce that its short-wave activities are confined exclusively to experimental work. This station "broadcasts" on long waves and "transmits" simultaneously on short waves. At the present time K D K A is broadcasting on 309·1 metres and transmitting experimentally on two lengths of 62·5 and 14 metres. The experiments with short waves have given the K D K A engineers valuable opportunities of perfecting high-frequency and modulation equipment, and at the same time of testing the lower wave-bands for carrying power, losses, and quality.

Development of Television

In the "Proceedings of the Institute of Radio Engineers" current issue is a very interesting paper on "Transmission and Reception of Photo Radiograms," by R. H. Ranger. This paper describes the art of electric picture transmission from its inception (over eighty years ago) to the present day. It is pointed out that the rapid strides that have been made in the art during the past ten years may be attributed to the much larger supply of electrical and mechanical contrivances available.

A pleasure yacht fitted with an ambitious radio outfit.

EXCHANGE DEPT. REOPENED

IF YOU WANT TO BUY NEW PARTS, WE ARE WILLING TO ACCEPT SOME YOU DO NOT REQUIRE IN PART EXCHANGE.

Not more than 4/- in each £ you spend allowed for in old parts. Owing to the thousands of letters received re this department, we are unable to enter into unnecessary correspondence. Please state plainly what you require and what you wish us to take.

Silence polite negative.

IMPORTANT

LEADING DISTRIBUTOR OF LISSEN, G.E.C., BURNDEPT., WEARITE, DUBILIER, EDISON BELL, COSMOS, MULLARD, COSSOR, EDISWAN, B.T.H., MARCONI, STERLING, GAMBRELL, MAGNUM, EVER READY, RESISTON, T.C.C., IGRANIC, FERRANTI, LEWCOS, "J.B." BENJAMIN, LOTUS, NEWEY, PYE, C.E. PRECISION, EUREKA, UTILITY, FORMO, BOWYER-LOWE, COLVERN, R.I., PEERLESS, POLAR, T.C.C., PETO-SCOTT.

STANDARD LINES

Belling-Lee Terminals
Climax H.F. Choke 8/6
Climax Potl. Divider 5/-
Everyman 4 Coils 22/6
Excel Oscillating Detec. 2/9
Formo Twin Gang 52/6
Formo Triple „ 63/-
Formo Vernier Dial 6/-
Geared 2-way 2/11
Hunt's V'meter, D/B, D/R 7/6
Igranic S.W. Coils 10/-
Lewcos Battery leads from 5/6
Precision H.F. Choke 7/-
Sterling Phone Cords 1/6
Silk L.S. Cords, 12 ft. 2/-
Utility Switches.
Uniunic Coils, 5/- Base 2/6
Vernier Dials, 2/11, 3/6, 5/9
Voltmeters D/B, D/R 6/11
Battery Boxes, 63-v. 3/-
Brunet L.F., 3-1, 5-1 7/11
Choke, H.F., Ormond 7/6
Clix stocked.
Coil Sockets, ebonite 1/-
Crystal Sets ... 8/6, 10/6
Dubilier Univane 25/-
Engraved Terminal strips 1/-
Everyman 4 Booklet 1/-
Gambrell C.T. Coil-holders, 1/9
Glazite, 5 colours, 10 ft. 1/2
Grid Bias Clips, pair 8d.
H.T. & L.T. 4-way Leads 2/-
Igranic Preset Res. .. 1/8
Induct. Coils from 1/3
Insulated staples, 50 for 1/-
Junit, 10 feet 1/-
Lotus Remote Control 30/-
Loud Speaker Units 10/9
Micro Bar Amplifier ... 34/-
Microfix Vernier Dial 5/9
Micrometer Detectors 2/-
Oldham 2-v. O.V.D. 5/6
Panel Brackets, pair 1/-
Peerless Coil Formers 1/4
Polar Junior, ·0005-·0003 5/6
Polar R.C. units, 1st, 12/6 2nd, 10/6
Screen and Base, 6-pin 7/6
Siemens 60-v. H.T. ... 9/6
Siemens 100-v. H.T. 15/6
Siemens are the Best.
Simplex Lead-in 1/6
Switches, De Luxe 1/6, 2/-
Switches, Push & Pull 1/6
Switches, Tumbler ... 1/-

ACCUMULATORS. 2-v. 40, 7/11; 2-v. 60, 9/6; 2-v. 80, 12/6; 2-v. 100, 14/6; 4-v. 40, 13/11; 4-v. 60, 17/11; 4-v. 80, 23/6; 6-v. 60, 26/6; 6-v. 80, 35/6. **ALSO** another good make, 1/6 extra on each of above. Post 1/- each.

ASHLEY JACKS & PLUGS Fit panels ⅛ to ⅜ thick, one-hole fixing. **S.C.O.**, 1/3. **S.C.C.**, 1/6. **D.C.**, 1/9. **F.S.C.**, 1/9. **F.D.C.**, 2/3. 'Phone Plugs, 1/6. Valve-holder, 1/3. Ledward Res., 2/6; Base, 1/-.

BEARD & FITCH (Success).—H.F. and L.F. Chokes, each, 10/6. Midget Neut. Condenser, 7/6. "Black" L.F. Transformer, 21/-.

BENJAMIN. — Battery Switch, 1/3. Valve Holder, 2/9; with Grid Leak, 5/3. With Condenser and Leak, 7/-. Rheostat, 2/9.

BOWYER-LOWE.—Dual Var. Condensers, 29/-. Popular ·0005, ·0003, 10/6 each. Neutralising Unit, 9/-. Triple gang, £3/10/0. H.F. Transformers, 9/- ea. Neutralising condenser, 7/-. Valve holder, 3/-.

BRETWOOD.—Grid Leak de Luxe, 3/6; with condenser, 4/6. Anode, 3/6.

BROWNIE No. 2. Latest model, 10/6. Complete with pair of high-class 'phones, 4,000 ohms, value 8/11. Aerial wire, lead-in, Daventry Coil, the lot, 18/11.
2-Valve Amplifier........63/-.
4-way 'Phone Boards, 3/-.
Daventry Coil..................2/9.

BURNDEPT ETHOVERNIER DIAL (with Etholog Station Indicator, 18-1, 9/-.

CARBORUNDUM. Detector only (No. 30), 5/-. Stabilising Detector Unit, with No. 30 Detector, 12/6.

CELESTON Loud Speaker, Oak, 110/-; Do. "A2," 130/-; Do. "A3," 150/-. Mahogany same price; walnut extra.

CLIMAX. — Potential Divider, 5/-. Special Choke, 10/6. Shock Absorbers, 3/- pr. Earth Tubes, 5/-. L.L. Insulators, 1/- pair.

COLVERN SCREENED COILS, &c. Former & Base, 5/-. 6-pin Base, 1/6. Former only, 4/-. Screen and Base, 8/6. S.P.H.F.T., 9/6. S.S. do., 9/6. 2 Monodial, 19/-.

DUBILIER. Duwirohm Wire-wound 20,000 to 100,000 ohm resistances, 5/- each; Base, 1/6; 200,000 ohms, 8/-. Vol Control Unit, 1 H.F., 7/6. Duvarileak, 7/6. Dumetohm Holder, 1/-.

DUBILIER MANSBRIDGE. ·1, 2/6; ·2, 2/8; ·25 to ·3, 3/-; ·4, 3/3; ·5, 3/6; 1 mfd., 4/-; 2 mfd., 5/-; 3 mfd., 8/-.

DUNHAM "ALL-WAVE" TUNER will enable you to dispense finally with troublesome Vernier coil-holders and sets of coils. It is adaptable to any set already made, and covers all wavelengths from 150 to 2,000 metres, and is complete with reaction. **"Allwave" Tuner, 9/6,** *Complete with full instructions and blue prints.*

ELECTONE PROGRAMME SELECTOR. Programme comes on automatically at desired time, 27/6.

EVER - READY H.T. Popular 66-v., 9/6; Do., 108-v., 15/6. Standard 66-v., 12/6; 108-v., 21/-; L.T.3, 7/6 (4½-v.). Flash Lamp, 4·5, 6/- dozen. Grid Bias, 9 Tapped 1½-v., 2/-. USUAL LINES STOCKED.

EXIDE H.T. ACCUMULATORS. 20-v. Unit, 15/- (Not sent by post).

FORMO Individual-Gang Control Condenser. Twin-Gang, £2 12s. 6d.; Triple-Gang, £3 3s. Tune with the centre dial until you hear your station. Adjust with the side dials for maximum signal strength.

GANG Dual ·0005. Ormond, with dial, 32/-. Cyldon, no dial, ... 50/-.
Triple ·0005. Ormond, with dial, 40/-. Cyldon, no dial ... 70/-. Igranic, no dial ... 75/-. Bowyer-Lowe, no dial, 70/-.

GAMBRELL COILS. a/2 4/10. a 4/10. A 5/-. B1 5/3. B 5/6. C 5/9. D 6/3. E1 6/9. E 7/9. F 8/6. 3 10/-. Centre-tapped coils, 6d. extra.

GRAHAM FARISH Bakelite Mica Condensers. Reg. Pat. Design. They mount upright or flat, guaranteed accurate, have S.P.G.L. clip. ·0001 to ·002, 1/-; ·003 to ·006, 1/6; ·007 to ·01, 2/6. Grid Leaks, 1/3; ·0003 and Leak, 2/-.

J.B. CONDENSERS, awarded Certificate (1998) of Merit, "Radio News" of America. We sell them. True tuning, S.L.F. Friction Vernier, ·0005, 16/6; ·00035, 15/6. For Short Waves, ·00015, 15/-. **S.L.F.,** complete with 4-in. Dial, ·0005 mfd., 11/6; ·00035 mfd., 10/6; ·00025 mfd., 10/-. For Short Wave, ·00015 mfd., 10/-.

MULLARD Ever-Rest Wire Wound Anode Resistance (80,000 and 100,000 ohms), 5/-; complete with Holder, 6/6.

MULLARD Grid Leaks and Condensers.

PILOT DIAL. Latest vernier, bakelite shell, 2 calibrations. This is the new model, 4/6.

PRANCO Midget Bal. Condensers. Panel, 3/9; B.B., 4/9, fitted with a cap handle for very fine tuning.

R.I. AERIAL TUNING INDUCTANCE, 39/6. R.I. Permanent Detector, 1-Hole Fixing, 6/6. Multi Ratio L.F., 25/-. Standard Ratio, 25/-. Reactive Anode Unit, 25/-. New H.F. Choke, 9/-.

SFERAVOX LOUD SPEAKER. Speaks for itself. Price, 50/-.

SHAW'S GENUINE HERTZITE. Made from special formula in sealed boxes, with signature. Gold Label, 1/-; White do., 8d.

RADIO MICRO
2-v. ·2, 5/11. Power, 10/-. 3·5-v. ·06, 5/11. Super Power, 12/-. Post 6d. valve.

SUCCESS. Chokes H.F., 10/6; Super, 18/6; Super Tapped, 22/6; L.F., 10/6.

UTILITY SWITCHES. Anti-cap., 2-w., 3/6; 3-w., 4/6; 4-w., 5/-; 6-w., 6/-; Lever Pattern, 2-w., 4/-; 3-w., 5/-; 4-w., 6/6; 6-w., 8/-. **UTILITY** Variable Condensers stocked.

VARLEY. All Chokes and Anodes stocked.

WEARITE, 2-way geared, 5/-. B. of Panel, 7/6. Countryside Four, set of Binocular Coils, 15/-. Rotary o/o Switch, 2/6. M.C.3 Aerial and Transformer Coils, wound on Paxolin formers, ready for use, 3/- pair. Post 6d. M.C.4 Ditto B.B.C., 10/6 set. 5XX, 12/6 set. H.F. Choke, 6/6.

HELLESEN
(post free), 66-v., 12/6; 99-v. 21/-. Grid Bias, 9-v., 2/-; 4½-v., tapped 1½-v., 1/2.

LOTUS. — V. Holders, 2/3; with Terminals, 2/6. 2-way Coil Stand, 7/-, 8/-. 3-way, 10/6, 12/-.

NEUTRALISING. Peto-Scott, 5/-, 6/3, 7/6. Ormond, 4/-. Bowyer-Lowe, 7/-. Magnum, 5/-. McMichael, 4/9. Reaction (Ormond) ·0001, 4/-. J.B., 3/6.

PEERLESS.—6 or 30 ohm Rheostat, 2/6. Fixed Resistors (State Valves), 1/3.

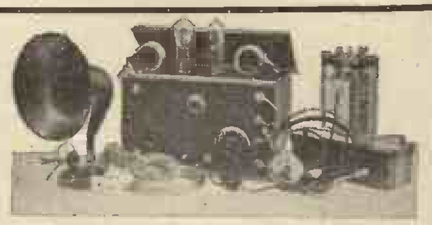
MULLARD VALVES. P.M.1H.F., 2-v., 14/-; *P.M.2, 2-v., 14/-; P.M.2, 2-v., 18/6; P.M.3, 4-v., 14/-; *P.M.3A (R.C.), 4-v., 14/-; P.M.4, 4-v., 18/6; P.M.5X (G.P.), 6-v., 14/-; *P.N.5B (R.C.), 6-v., 14/-; P.M.6, 6-v., 18/6.
Super Power Valve for last L.F. Stage: P.M.253, 4-v., 22/6; P.M.256, 6-v., 22/6.
WE RECOMMEND THEM

BRITISH RADION LATEST VALVES
Type
2-v. 15 H.F. or L.F.
2-v. Power
4-v. 1 H.F. or L.F.
4-v. Power
6-v. Power
5/-
Post 6d. each.

CABINETS. Large stocks of really useful cabinets kept, or made to order. Solid oak. Glass finish. American type, hinged lid, baseboard. Post 1/6 each extra.
8 x 6 x 7 ins. deep ... 6/11
10 x 8 x 8 ins. deep ... 8/11
12 x 8 x 8 ins. deep ... 10/6
14 x 7 x 9 ins. deep ... 13/6
16 x 8 x 9 ins. deep ... 15/11
24 x 7 x 9 ins. deep ... 27/6
Extra quality in Oak or Mahogany, 5/- each extra, worthy of any set.

PANELS. Grade A, cut to size, ¼d. sq. inch, 3/16, or ⅛d. for ¼ in. Reduction Large Sizes.

REVELATION FOUR (*W.M.*, July, '27).
Following parts as specified:—
2 Ormond ·0005 Sq. Law, 14/-; 2 Vern. Dials, 10/-; Coil Stand, 1/9; 6-pin Lewcos S. Trans. for both wavelengths, 10/- each; Base, 2/9; Lewcos Coils, 50, 3/6, 200, 5/6; R.I.H.F. Choke, 9/6; Neutrodyne, 5/-; 4 Vibro V.H. at 2/6 each; 4 Resistors, 2/6 ea.; Ormond Reaction, 4/-; 2 Gd. Leaks, 2-meg. Dub. at 2/6; ·0003 Fixed and Clip Dub., 3/-; ·002 do., 3/6; Igranic 3-pt. Jack, 2/6; 5-pt. 3/-; 2 Plugs at 1/6; Dubilier 250,000 ohm Anode and Holder, 11/-; R.I. Tapped L.F., 25/-; B.-Lee Terminals, 9 for 3/5; Strip Drilled, 10 x 2, 1/-; Glazite, Screws, etc., 2/-.
THE LOT, POST FREE £7:0:0



THREE-VALVE LOUD-SPEAKER SET

NOTE THE WONDERFUL VALUE. TRY ONE OF THESE!
(*The set shown is two-valve.*)
Gets Local, Daventry and many Continental stations.

THIS MAGNIFICENT 3-VALVE SET (D. & L.F.), includes Handsome Polished American-Type Cabinet (all parts enclosed), 3 Dull Emitter Valves, Tuning Coils, H.T. & L.T. Batteries, Aerial Equipment, Leads, Loud Speaker or 'Phones. Tax paid. £ s. d. **5 19 6**
JUST THINK of a 3-Valve Set at £5/19/6! It sounds unbelievable, doesn't it? Car. & P'kg. 7/6

LISSEN PARTS. Variable Grid Leak, 2/6; Lissenstat, 10/6; Major, 7/6; Minor, 3/6; Fixed Leaks, 1/- Valve-holder, 1/-; Mica Condensers, 1/-; ·002 to ·006, 1/6; H.F. Choke, 5/6; Switches, 2-way or key, 1/6; S.P.P. Pull, 2/6; D.P.D.T.P. Pull, 2/6; Rheostats, 7-35 ohms, 2/6 each; Lissenola, 13/6; L.F. Transformers, 8/6.

PETO-SCOTT (Keystone, Copex). Neut. B.B., 5/-; P'l, 6/3; B'ing, 7/6; Midget, 4/6. Special 6-pin Base, 2/9. Copex Screens and Base, 9/6. Coils stocked for all sets.

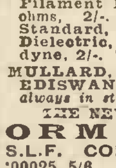
L.F. TRANSFORMERS. Ferranti A.F.3, 25/-; A.F.4, 17/6; Eureka Concert, 25/-; 2nd Stage, 21/-; Baby 1st or 2nd, 15/-; Reflex, 15/-; Formo shrouded, 10/6; Success (Black), 21/-; Royal, 20/-; Ormond, newest model, 15/6; Marconi, "Ideal," all stages, 25/- each; C.A.V., 15/-; Pye, 17/6; Gambrell, 2 stages, 25/6; Ideal Junior, 18/6; R.I., 25/-; Multi-Ratio, 25/-.

ORMOND. Square Law Low-Loss. ·0005, 9/6; ·0003, 8/6; (1/6 each less no vernier); **Friction Geared,** ·0005, 15/-; ·0003, 14/6; ·00025, 13/6. **Straight Line Frequency Friction Geared,** ·0005, 20/-; ·00035, 19/6. **S.L.F.,** ·0005, 12/-; ·00035, 11/-. **SQ. LAW LOW-LOSS DUAL,** ·0005, 16/- each. **Ormond Friction Dial,** 10/-. **Filament Rheostats, Dual,** 2/6; 6 ohms or 30 ohms, 2/-. **Potentiometer,** 400 ohms, 2/6. **Standard,** ·0005, 5/-; ·0001, **Reaction,** 4/-; **Air Dielectric,** 2/-; **Neutralising,** 4/-; **Neutrodyne,** 2/-. **Twin Gang,** ·0005, 32/-; **Triple,** 40/-.

MULLARD, COSMOS, MARCONI, B.T.H., EDISWAN, COSSOR VALVES. *The latest always in stock.*

THE NEW No. 3
ORMOND S.L.F. CONDENSER
·00025, 5/6. ·00035, 5/9. ·0005, 6/-. With 4" Dial. With Friction 55-1 4-in. Dial, 6/- ea. extra.
ORMOND NEW GEARED DIAL 5/-

LOW LOSS SQUARE LAW.



This variable Condenser is simply marvellous value. It cannot be equalled in price or quality.
·0003 .. ·0005 .. **4/11** each
By Post **5/11.**
With VERNIER 1/- extra.

BRITISH HEAD-PHONES.—BROWN'S FEATHERWEIGHT, 20/-. **BROWN'S "A" TYPE** (Reed), 30/-. **B.T.H.,** 15/-. **STERLING,** 20/-, 22/6.

THE NEW FAMILY FOUR. (P. W. Harris.) I have all parts in stock. Perhaps you would like to use up some of your existing parts. In this case, please say what you actually need, and I will give a fixed inclusive price.

FORMO or FINSTON S.L.F. CONDENSERS

With handsome 4" **TRIOLITE** dial and knob .. **7/6**
With Geared Dial, 11/6.

BEFORE YOU PURCHASE ELSEWHERE: CALL AND LET ME QUOTE YOU

LISSEN LATEST 2-WAY CAM VERNIER 4/6

ALL IGRANIC COMPONENTS

LISTS FREE

MAKE OUT YOUR LIST OF REQUIREMENTS. SPECIAL QUOTATIONS OVER 20s.

LOG-MID-LINE
Try our NEW VARIABLE CONDENSERS, made on the Log-Mid-Line principle. ·0005 or ·0003, with a 4-in. Triolite Dial, the best you can buy, for the moderate price of **5/11** each, post free

LISSEN NEW-PROCESS BATTERY
60 volt 7/11
100 ... ... 12/11
Postage Extra.

OPEN
All Day Thursday
All Day Saturday
Hours 9.30—8
Saturday 9.30—8.45
Sunday 11—1
Two shops, one always open.

CALLER'S COLUMN

AERIALS.—100 ft. 7/22 Hard drawn, 1/11. Extra heavy, 2/2. Phosphor 49 strands, 1/-. Electron stocked. Special INDOOR Aerials, phosphor, with ebonite separators and rubber rings (12 ft. x 8 strands), total 100 ft. 4/6. O.V., 2/6. Rubber Lead-in, highest quality, 10 yds. 1/-; 10 yds. 1/3; 10 yds. 1/6. Extra heavy, 2d. and 3d. yd. R. & B. Twin Flex (best), 6 yds. 10d.; 12 yds. 1/6; 36 yds. 4/-. Ins. Hooks, 2 for 1½d. Egg Insulators, 2 for 1½d. Ins. Staples, 4 a 1d. Earth Tubes, Copper, extra value, 2/3. Climax, 5/- (also at 2/6). **EASY FIX AERIALS,** with 2 insulators and lead-in, 1/3. **EBONITE GRADE A.** Stock sizes, 6 x 6 and 7 x 5, 1/3; 8 x 6, 1/6; 9 x 6, 1/9; 10 x 8, 2/9; 12 x 6, 2/9; 12 x 8, 3/6; 12 x 9, 4/-; 14 x 7, 4/6. **ALSO CUT TO SIZE** while you wait at ½d. per sq. inch 3/16th and ¾d. sq. inch for ¼ in. Special cheap panels for Crystal Sets. **TERMINALS.** Nickel W.O. Pillar, 'Phone, 1/- doz. (3 for 4d. with N. and W.); Brass do., 10d. doz., (1d. each with N. and W.), all high quality. Valve-Pins, with nuts, 2 a 1d. Ormond Screws, 6 or 4 B.A., 6d. dozen with nuts, washers 12 a 1d. Red and Black Spades, screw at side, 3½d. pr. Plug and Socket, Red or Black, 3½d. Wander Plugs, Red or Black, 3½d. pr. (Large, good). 'Phone Connectors, 1d. Flush panel sockets and nuts, 4 for 4d., 10d. dozen. Brass Spade Tags, 6 a 1d. Nickel Solder Tags, 4 a 1d. 2 and 4 B.A. Rod, 3d. foot. Nickel Valve Legs and Nuts, 1d.; 8d. dozen. Stop Pins, 2 a 1d. **H.T. BATTERIES.** No cheap and nasty batteries sold here; only highest quality at lowest prices. Adico (Trade test award best given) 60-v., 6/-; 100-v., 11/9. Theria, 60-v., 5/6; 100-v., 10/-. Everready, 66-v., 9/6; 108-v., 15/6. Others from 5/-. 1·5 L.T. Hellesen's, 2/6; Adico, 1/8; B.T.H., 2/-; Flag, 2/-; British, 1/6. **FLASH LAMP.** 4·5 Adico, 4½d., 4/3 doz. British, 6d., 3 for 1/3. **SOLDER,** with Resin, 2d. foot. 1/16 sq. Bus Bar, 2 ft. 1d. Tinned copper, 16 and 18 gauge, round, 9d. per ½-lb. D.C.C., ¼-lb. 20 gauge, 8d.; 22 gauge, 9d.; 24 gauge, 10d.; 26 gauge, 11d.; 28 gauge, 1/-; 30 gauge, 1/2. **MANSBRIDGE CONDENSERS.** "Hydra" 1 mfd., 2/9; 2 mfd., 3/9. 0·1, 1/9; ·25 and ·5, 2/3. **SWITCHES** on Porcelain, D.P.D.T., 1/3; S.P.D.T., 8½d. and 10½d. Sound quality. Panel switches, with Ebonite handle, worth double S.P.D.T., 1/-; D.P.D.T. 1/6. Insulating Tape, 4½d. Copperfoil, 4d. foot (6 in. wide). Grid Bias Clips, 6d. Panel Brackets, 9½d., 1/- pr. Shorting Plug, 3d. **PERMANENT DETECTORS.** Red Diamond (a topper), 2/-. Lion Micro (latest, cannot be equalled), 2/6. Brownie, 3/-. Enclosed Kay Ray, 1/-, 1/3. Service Micrometer, with crystal, 2/9. 4/6. **CRYSTALS.** Superzite, 1/6; Shaw's sealed genuine Hertzite, 8d., 1/-; Wyray, 1/6. **HEAD-PHONE CORDS.** Good, 1/-, 1/3, 1/6. L.S. Cords, 1/6, 1/9. 4-way H.F. and L.T. Leads, 1/9, 2/-. Lewcos Stocked. **COIL PLUGS.** Ebonite on Base, 6½d., 7½d. Lotus, 8d. Burne-Jones, 1/9. Low Loss, 8½d. Panel, 6½d. Various stocked. **GEARED COIL STANDS.** 2-way, 2/3, 2/6, 2/11 up. 3-way, grand value, 5/11. Back of panel from 2/11. All ebonite.

K. RAYMOND
27 & 28a, LISLE St., LONDON, W.C.2

COME TO LEICESTER SQ. TUBE
(Important)
Ask for *back* of Daly's Theatre
This address is opposite.

A FILADYNE FOUR-VALVER

—*continued from page* 198

and the edge of the former then glued to the blocks. This will give a rigid assembly without the use of metal screws.

Fig. 4b also shows the manner of mounting the primary and reaction coils. The first is glued to a thin strip of wood resting on, and also glued to, two of the wooden coil supports.

The reaction-coil former is glued to a second strip of wood, also glued to the top of the former. (Seccotine makes a handy adhesive, but not more than necessary should be used.) The two small formers are both mounted so that the windings are in the same direction as those of the main former. The fine wire ends of the two coils, except one of the reaction leads, are taken down the inside of the coil and then through the space underneath the former to their respective contacts.

Suitable Valves

After construction comes the question of the type of valves to adopt. In the tests of the original set I have used an S.P.18 Blue for the H.F. stage, a D.E.2 L.F. for the Filadyne detector, and an S.P.18G. and S.P.18 R.R. for the first and second L.F. stages. This particular combination of 2-volt valves worked very well.

The H.F. valve should have a high magnification factor but not an excessive impedance, the anode voltage, common also to the third valve, being not less than 80 volts or so. The Short-path type of valve is very useful in that no grid bias is necessary in the H.F. stage.

As regards the Filadyne detector suitable valves in the 2-volt range are the D.E.2L.F., D.E.R., and the Ediswan D.R.2. Notice that the anode-bias positive terminal has a separate lead so that an independent battery supply may be used for the potentiometer. With most valves sufficient variation of potential for working on the upper bend is obtained by connecting this lead to L.T. positive, and in this instance there is no need to disconnect the anode-bias battery when the set is not in use, as this is done automatically when switching off.

In adjusting the Filadyne valve, beware of using too much H.T., as this will not make for easy working. Round about 30 volts is sufficient.

SOURCES OF H.T. SUPPLY

—*continued from page* 195

jars, etc. The advantage of this type of battery is that any required voltage can be built up, including grid bias, and the battery can be maintained permanently, there being no necessity to scrap the zinc or sac element until they are completely used up.

Insulation Important

It is important that the cells be well insulated from each other. The usual method is to have a tray, or trays, with divisions making nests to fit each cell. The size of the battery will depend on the voltage required. The trays for holding the cells should have a sufficient number of divisions for one cell per volt of the total voltage required by set, with a few extra cells for grid bias.

There is no need, in the first place, to obtain the full number of cells, and a good plan will be to work in accordance with the following: Suppose 100 volts are required. Make up a battery of 100 cells, using four for grid bias. Commence by connecting the negative end of battery to the negative end of set with positive terminal to the correct voltage by plugging in the seventy-second cell from negative end. The voltage during the first month or so will be about 100.

When the power of the set has noticeably fallen, due to H.T. voltage dropping, put the plug up to the eighty-second cell, and other plugs, if any, up so that they are at the correct voltage again. When the power of set has again fallen, plug to the ninety-second cell, and again after a further period to the hundredth cell. When the power has finally dropped off, and the battery requires attention—which should be after nine months to a year with a suitably sized battery—it should be overhauled by removing the sac elements and zincs and electrolyte, and washing the jars.

The first seventy-two sac elements should be scrapped. The zinc elements should be examined and replaced with new ones if nearly worn away, but the usual thickness zinc will last at least eighteen months. New sacs should be fitted, and new electrolyte poured in. The sacs following the seventy-two should be left for attention until they have given further service. The battery is then reconnected and used as before.

THE GRIMSBY BEAM STATION

—continued from page 132

The transmitters are each rated at a power of 25 kilowatts. This is the input to the last two valves. The total amount of electrical power consumed by each transmitter—in lighting the filaments of the valves, in high-tension supply, and so on—is about 100 kilowatts. This power is supplied by the Grimsby Corporation, some miles away, and arrives at Tetney at a pressure of 6,300 volts. It is then transformed down to the various values required.

Screened Landline

As one comes up the main road which passes the station one's attention is attracted by the large number of new insulators on the telegraph poles at the side of the road. These are the "pots" supporting the landlines from the Central Telegraph Office in London to the station. Some distance before the station is reached these overhead wires are carried underground. This is in order to avoid the transmission from the nearby aerial being picked up by the landlines and fed back into the transmitters—a pernicious form of reaction!

All the telegraphing is done in London. The staff of about twelve engineers at Tetney is merely there to maintain the transmitter in efficient order. Over the landlines, therefore, come the telegraph currents. They are fed to two valves in parallel. These control two more valves in parallel. The latter are 10-kilowatt oil-cooled valves. The oil used for these is paraffin, while there is also an air-blast directed on the cylinders of the valves. These two valves constitute the first main stage of the transmitter. The stages are:

First stage: Magnifier (as described), coupled to

Second stage: Amplifier. This uses two air-cooled valves in parallel. They take a filament current of 12½ amperes at 17 volts, and a high-tension pressure of 5,000 volts at 150 milliamperes. The keying is done by by-passing the high tension from this stage through an absorbing resistance. This is done by means of two valves in parallel which normally absorb no power. The "spaces" in the signals make their grids positive, however, and they then take a large input. This controls the anode supply to the second stage, which is coupled to

Third stage: Merely a "buffer" circuit, preventing the variations from affecting the even working of the oscillator, which comes next.

Fourth stage: The "drive." An oscillator valve, totally enclosed in a copper box to prevent interaction. The filament supply is 12½ volts 7½ amperes from accumulators, and the H.T. 2,000 volts 85 milliamperes.

The valve in the third stage is of the same type as the oscillator, being air-cooled. Throughout the transmitter great precautions are taken to prevent any variation of frequency, each stage being neutrodyned. The last two stages are coupled to the aerial in the manner shown in Fig. 3. Coils in the anode circuits of stages three and four are coupled to a coil which, in turn, is coupled to the aerial coils. There are two of these in a small box at the bottom of each vertical aerial wire.

In the case of the Indian transmitter there are two sets of stages three and stage four, one for each of the two wave-lengths. When the Australian service changes over from the long route to the short route, or vice versa, it is only necessary to throw over a switch transferring the energy from one aerial to the other on the opposite side of the reflector.

Well Laid Out

The station is admirably laid out. There is one large room housing the machinery—the switchboards, generators, and a bank of sixteen air-cooled rectifier valves. A smaller room is occupied by the two transmitters, one for India and one, already operating, for Australia. They are neatly arranged in panels, one panel for each stage, as outlined above. The Indian transmitter, having two drive and buffer circuits, has an extra panel. In this room there is also a receiving set and a wave-meter. From the loud speaker comes monotonously the stutter of Morse, while engineers listen and watch, taking readings carefully from the numerous meters, slightly adjusting a knob here and there.

Small rooms are occupied by filament and grid-bias batteries, air-blowing plant for cooling the valves, and the by-pass absorbing resistance. The latter is a very dangerous place. The big red notice on the wall giving a "10,000 volts" warning.

The call sign of the Australian set is G B H, while the Indian call will be G B I. Australia replies (to Skegness) with V I Z.

ARE ELECTRONS WAVES?

—continued from page 142

of the optical system includes dimensions which are comparable with the wave-length of light. On the other hand, in solving mechanical problems by means of what is known as the Hamilton-Jacobi method an auxiliary function is used which is exactly the right form to represent the propagation of a disturbance through a medium in accordance with Huyghens' construction.

Mathematical Convenience

It is perfectly true that this auxiliary function is only a mathematical convenience, and is supposed to have no physical significance. When the theory of wave mechanics is applied to it, however, it takes on a very definitely significant aspect indeed. From this point of view the methods of classical mechanics may be said to be analogous to those of geometrical optics.

The irresistible inference is that these methods will assuredly fail when the dimensions of the system are comparable with the wave-lengths of the disturbance; for example, when they are applied to atom dynamics or to the reaction between an electron and a crystal.

Thus it comes about that the "free and discrete electron of measurable charge and mass" is now conceived to be a group of waves rather like the eddies which circle and expand over the surface when a stone is dropped into a quiet pool of water. But there is this difference in the similarity. The group of waves which constitute the electron is limited in all directions, so that actually the whole group does not expand very far or occupy much volume. Mr. Davisson goes back to the language of his predecessors and describes the wave-group moving through an inhomogeneous medium as "a charged particle moving through a field of force."

Further Examination

The experiments in the Bell Laboratories are being diligently pursued. Confident as are the men who have lighted upon this new discovery after many exhaustive tests, it is still felt that every ground for doubt must be removed. For that reason the results of the further tests and experiments will be awaited in the scientific world with avid interest.

DOES THE CRYSTAL DISTORT?

—continued from page 130

20 per cent. If we assume that a single L.F. note is being sent having a frequency of, say, 1,000 cycles, we can imagine that our detector is being supplied with power as indicated in the lower part of Fig. 2. Here the average value of the signal received is 0·8 volt, so that the normal rectified current would be 1·8, as shown at point X.

But when the L.F. note is transmitted the voltage applied to the detector varies as shown, and the rectified current also varies. Under these conditions the L.F. part of the rectified current is a true copy of the input voltages; that is, the detector is rectifying without distortion, for the reason that the modulated portion of the signal is on the straight part of the curve.

Summing up the above explanation, we may say that in the case of a crystal detector:

(1) Amplitude distortion occurs when weak signals are rectified.

(2) Such a rectifier is disproportionately insensitive to weak signals.

(3) Distortionless rectification is obtained when the applied signal is larger than a certain amount, depending on the modulation.

H.F. Amplification

For normal broadcast reception distortionless rectification would be obtained for inputs of above about 0·6 volt. This explains why crystal reception is usually so remarkably "pure," for H.F. voltages of 0·6 are not by any means unusual.

It also explains why the crystal is an unsatisfactory rectifier of weak signals, and it follows that a stage of H.F. amplification before a crystal detector is likely to prove well worth while when good quality is a main consideration.

In practice, a crystal detector is used with an impedance of some sort —it might be a pair of telephones, a simple resistance, or a coupling transformer. Now the effective resistance of a crystal detector depends largely upon the input voltage; for very small inputs its effective resistance is very much larger than for large inputs. From this it follows that for a given load the tendency will be for distortion to be produced with weak inputs, because the effective resistance of the crystal may be much

(*Continued on page* 205.)

DOES THE CRYSTAL DISTORT?

—continued from page 204

higher than anticipated as compared with the impedance of the load. For large inputs the effective resistance of the ordinary galena and perikon detectors is of the order of a few hundred ohms.

Telephones of very high resistance are therefore not required, and when the crystal is to be coupled to an amplifier an L.F. transformer may be used, and distortion will not be produced by it unless the transformer is an extraordinarily bad one; for its impedance at musical frequencies only has to be high compared with that of the crystal. Then, remembering that the impedance of a primary of 5 henries inductance at 50 cycles is 1,575 ohms, we see that the low notes should be well amplified. At the higher frequencies stray capacities reduce the amplification if the ratio is too high.

It is therefore quite practicable to use a ratio of 8 to 1, and a Marconi transformer of this ratio is available.

Is it Worth While?

Finally, is full-wave crystal rectification likely to be worth while? The answer is "No," provided the best working conditions are obtained in each case; for the amount of energy available is fixed, and it is found that either we have to apply half the voltage available to each crystal, or we have to divide the energy available between them. Thus the result is that full-wave rectification will give, under the most favourable conditions, a signal which is only a few per cent. louder.

A practical point is this: Is it essential to connect a condenser across the load joined to the detector? The answer is "Yes, a by-pass condenser must always be used."

THE LOEWE MULTIPLE VALVE

—continued from page 135

should be kept as low as possible. A proof of the correct functioning of the connection is given, if the carrier wave is heard when increasing the reaction condenser and coupling the output plate coil of the long distance valve tight to the input grid circuit of the three-stage valve. Thus the usual interference whistling will be heard. With looser coupling or with the reaction condenser adjusted to smaller values the set will not oscillate.

The output plate of the high-frequency valve is supplied with 50–90 volts; the normal connection is at about 80 volts. The space-charge voltage should not be chosen higher than absolutely necessary for obtaining the desired sensitiveness. Higher voltages are an unnecessary stress to the H.T. battery owing to a greater consumption of current. When using + 7·5 volts of the common battery as H.T. zero potential and connecting the space-charge grid to + 22·5 volts, the space-charge grid current is about 3 milliamperes.

Figs. 4, 8 and 9 show outer and inner view of a finished multi-stage receiving set wired according to Fig. 6, and they give an idea of how to arrange the component parts and to make the shielding arrangements and connections. One should note the three metal protection cases covering the tuning condensers.

Concerning the Layout

The cylindrical sheet covers of the valves are connected to the centre condenser case. The front plate of the case consists of metal. (Of course, vulcanite coated with tinfoil on the inside for avoiding hand capacities may instead be used.) To prevent the two tuning circuits from getting inductively coupled the two coil units are fixed at the maximum distance from each other, viz., at the ends of the case.

The stationary coils belong to the oscillatory circuits, the movable ones are the coupling coils—i.e., on the left there are the coils for the input circuit to the long-distance valve, on the right the ones for the output of same and input to the three-stage valve. The block condenser C (in the porcelain case) which is to short-circuit unwanted high-frequency oscillations, is directly attached to the two soldering plates — H. and An3 of the three-stage valve. Below the middle condenser case there is the small reaction condenser consisting of a fixed and a rotatable vane.

A switch on the left for the three-stage valve, one on the right for the long-distance valve, and two special jacks Ao and Eo at the front plate, permit reception by the three-stage valve only, if a local station is going to be received. A two-way switch below the case of the aerial condenser completes the set. Special rheostats are not provided, since the filaments are adapted for a voltage of 4 volts.

A "COMBINE FIVE" MODIFICATION

—continued from page 163

The next step is to mount an extra small variable condenser on the panel, and one of the Peto-Scott "Midget" variety of ·0001 mfd. is suitable. This can be placed between the second and third tuning condensers, and rather above the centre line. To obtain sufficient space behind the panel the second neutralising condenser can be shifted back slightly.

Now take one of the coils, and observe that there is an unused space on the former below the windings. On this wind 35 turns of No. 34 D.S.C. wire, without troubling about the direction, securing the start and finish by passing the wire through a small hole in the tube and applying a spot of Chatterton. Near the lower edge of the tube, on the side which will be next to the detector valve when the coil is in the third socket, fix a small terminal. Connect one end of the reaction winding to this and the other to the I.S. pin of the coil. Next connect the fixed plates of the reaction condenser to the anode of the detector valve and the moving plates by means of a piece of flex to the new terminal on the coil.

Tune in a station, preferably a weak one, with the reaction condenser at zero, and increase the neutrodyne condensers until the set is in the most sensitive "over-neutralised" condition—i.e. not far off the oscillation-point. Now increase the reaction condenser. The set should come much nearer to self-oscillation and signals should become appreciably louder. If they do not, reverse the connections to the reaction winding. You should now find that it is possible to reduce the capacity of the neutrodyne condensers somewhat, particularly the second one, thus coming back towards the fully neutralised condition, and then bring the set once more to a highly sensitive state by increasing the reaction condenser. For Daventry the reaction winding consists of 90 turns of No. 40 enamelled wire wound over the lower end of the secondary, with three layers of Empire cloth between.

An Acknowledgment

In the July issue of MODERN WIRELESS two photographs of the interior of a modern battery works were published (pages 6 and 16). These photographs were of Messrs. C. A. Vandervell and Co., Ltd.'s works, where, in fact, the well-known C.A.V. accumulators are made.

"A Self-Contained Portable"

This receiver, a description of which was published in the July issue, employs an Igranic Micro-Condenser of ·00004 maximum capacity. It was erroneously described as having a maximum of ·00035.

IN PASSING

—continued from page 172

him sunk in despair, which he varied by spasms of Red Indian frenzy.

"It won't gee!" he yelped, biting a piece out of the book-case. "It's been going off steadily all the week."

"Batteries?" I queried, fumbling for my pocket voltmeter.

"New to-day," he groaned. "Charged to a bright green finish."

"Off Colour"

Certainly the whole outfit was off colour—peevish. I pulled a few knobs and turned a few dials, but without any result of note. The thing seemed to be dead-tired. All my radio experience rose up before me, as a man's sins flash across his mind in some moment of crisis. I thought I knew. I seemed to have felt the same "hunch" when fault-tracing before. I was just about to dash out to the . . . when the nobs began to arrive.

Under the circumstances, I considered that it was only by the mercy of Providence that the fact that the set was a wash-out as a "star" did not trouble the company in the least. In less than fifteen minutes they had divided into two camps, the Resistance-Couplers and the Transformer-Couplers, and were hard at it, ding-dong. Murmuring a few polite words about choke coupling, and setting Mr. Twipe to hand round coffee, I signed to Ambo, and we descended to the garden and hastened to the earthplate.

There it lay, practically on the surface of the garden. *It had been pushed up by the potatoes I had surreptitiously sown there when Ambo and I buried it.*

"Well, I'm——" said Ambo, in tones of amazement. "'Buswiddle's Billiard Balls,'" too. I never handle that variety. How on earth——"

"That's enough of downright lying," I replied. "Let this be a lesson to you to drop these accursed tubers!"

RADIO AND THE ATMOSPHERE

—continued from page 148

effect of magnetic storms on wireless transmission. It has been found that they interfere very seriously with long-distance communication, but, at the same time, when very long waves are used, signals seem to be stronger.

It is thought that it is possible to explain these queer results in terms relative to the Heaviside layer if it is assumed that a magnetic storm increases the electricity in the layer. If this be true, the short waves would have to penetrate the layer in order to be bent back gradually towards the earth, and would be more strongly absorbed because they would return at lower levels, where the friction experienced by the electricity was greater.

And, further, long waves are directly reflected by the layer at its surface, and an increase in the amount of electricity in the layer consequently increases the amount of this reflection.

Peculiar Effects

It would seem that many of the so-called "freak" results obtained by amateurs using low power and short waves are more or less logical if one accepts the results of the recent investigations in connection with the Heaviside layer.

The recent eclipse of the sun was extremely interesting because it provided a means of extending knowledge as to what happens when the sun's rays are suddenly cut off for a period and over only a limited portion of the earth's surface. When a total eclipse was observed in New York in 1925, many wireless observations were made in America and in this country, and certain peculiar effects were observed in England in the reception of signals from New York, which it was thought were directly attributable to the eclipse.

When the Radio Research Board of the Department of Scientific and Industrial Research (which organised a series of special experiments during the recent eclipse) publishes its report, data may be forthcoming showing the effects of the eclipse on the propagation of wireless waves through the atmosphere, and adding further facts to our gradually accumulating knowledge about the behaviour of wireless waves under different atmospheric conditions.

QUESTIONS ANSWERED

—continued from page 154

the transformer. Normally O.S. is connected to the grid of the valve. Remove this lead, and join the grid socket of the valve holder to the arm of the potentiometer, which is usually the centre terminal. In this way it is possible to apply any desired portion of the total voltage across the secondary winding between grid and filament of the valve. A potentiometer with a resistance of about half a megohm is suitable.

SOME FILADYNE NOTES

—continued from page 183

valvers in operation, and I hope I will soon be hearing from some of you. But I will anticipate one of the queries which no doubt some of you will raise by dealing with the addition of amplifiers to this set.

As with most other receivers, it is, of course, rather a difficult business to add H.F. stages to this set, although it is quite easy to design a receiver employing conventional H.F. amplification and a Filadyne detector. Perhaps later on I will give the construction of such an outfit. But a stage of L.F. amplification can be added to this Filadyne one-valver in a very simple manner.

I am giving you the resultant theoretical circuit in Fig 3. You will see that the primary winding of an L.F. transformer takes the place of the 'phones, and that all the other connections are quite straightforward. This transformer should have a ratio of at least 1 : 4, and any standard make can be used.

Grid bias, as indicated, is essential, as is also the use of a power valve in this second position, in order to cope with the very strong signals that develop.

"What Readers' Think."

Owing to readers' complaints that undesirable touting and similar queries have followed the publication of letters addressed to "Modern Wireless," we have decided to discontinue giving the full postal addresses of our correspondents.

Relevant queries arising from such correspondence are always welcomed for publication. We cannot accept any responsibility for the views expressed by readers in their letters.

THE EDITOR

ADVERTISEMENTS

As far as possible all advertisements appearing in "Modern Wireless" are subject to careful scrutiny before publication, but should any reader experience delay or difficulty in getting orders fulfilled, or should the goods supplied not be as advertised, information should be sent to the Advertisement Manager, "Modern Wireless," 4, Ludgate Circus, London, E.C.4.

A CHAT ON CHOKES

—continued from page 144

The damping effect which a choke coil exerts on fluctuating currents is often utilised in loud-speaker work, especially when the loud speaker is working in conjunction with power amplifiers. In the diagram, Fig. 7, is depicted a circuit for the purpose of protecting the more or less delicate windings of a loud speaker. The choke has no effect on the steady anode current of the valve. but it almost entirely prevents the passage of the fluctuating speech currents.

Coupling an L.F. Amplifier

Another use of the L.F. choke coil is for the purpose of coupling an L.F. amplifier, as shown in the diagram Fig. 8. There are other methods of utilising low-frequency iron-cored choke coils in amplifying circuits, but the above is probably the most interesting and straightforward.

The choke control of speech currents in radio transmitters is another interesting application to which the iron-cored choke coil may be put.

Choke Control of a Transmitter

The basic idea of this system will be grasped by a study of the diagram, Fig. 9. Between the control valve of the transmitter and the aerial is placed a choke coil of special construction. Owing to the variations in its degree of impedance under the influence of the varying potentials which flow across it from the control valve, the choke coil modulates the aerial current in accordance with the speech currents set up at the microphone.

In reality, such a choke coil acts as a transformer, but it has no step-up ratio. It behaves, therefore, as a one-to-one ratio transformer.

A SIMPLE CONSTANT COUPLING SYSTEM

—continued from page 160

without affecting in any way the settings for the remaining two condensers, and the advantages of this fact will be at once obvious.

The ideal arrangement is to make the condenser vary its capacity in such a manner that it need not be touched throughout the tuning range. Hence, if we were to choose the value of ·0001 mfd. as being most suitable for 250 metres, then the maximum capacity to keep the same impedance at 550 metres would be:

$$\frac{550}{250} \times \cdot 0001 = \cdot 00022 \text{ mfd.}$$

Intermediate values can be calculated on the same basis, and the exact requisite shape of the condenser plates thus readily ascertained. Including this new feed condenser as a portion of the gang condenser would then result in constancy of feed impedance.

WHAT READERS THINK

—continued from page 183

I have tried transposing these in various ways, but as placed get the best results, although I believe, theoretically, the 100,000-ohm resistance should be in the first L.F. stage.

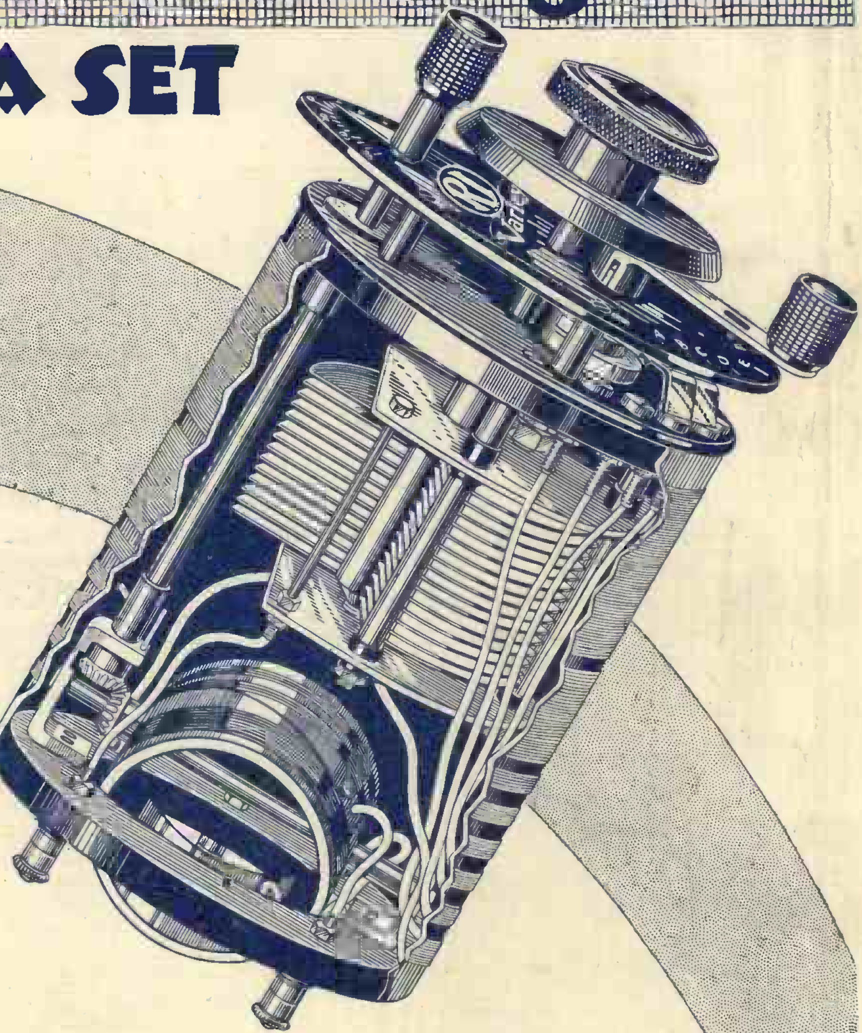
Yours truly,

J. D. P.

Newton Abbot.

P.S.—Probably the result I have already obtained could be still further improved, and if any of your readers can suggest how I shall be grateful.

INDEX TO ADVERTISERS



Printed and published by the Amalgamated Press, Ltd., Fleetway House, Farringdon St., London, E.C.4, on the 1st of each month. Address for advertisements only: John H. Lile, Ltd., 4, Ludgate Circus, E.C.4. Telephone: City 7261. Registered for transmission by Canadian Magazine Post. Subscription rates: Inland and Abroad, 17/- per annum; 8/6 for six months. Sole Agents—Australasia: Gordon & Gotch (Australasia), Ltd.; South Africa: Central News Agency, Ltd.; Canada: Imperial News Co. (Canada), Ltd.—August, 1927. R.R