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German Broadcast Organisation.

If there is one outstanding national characteristic of the German people it is that of ability to organise, and it is therefore of interest to observe how Germany is proceeding to tackle the difficulties with regard to organising a broadcast service.

In this issue we give publication to a description of the methods adopted in introducing such a scheme in Germany, and, whilst there are too many points of difference between conditions there and in this country for the organisations to be considered as parallels, yet the regulations in Germany, particularly at the present time, must be of special interest.

In Germany, as in this country, control over the type of apparatus to be used for broadcasting, and the organisation of the service, is vested in the Post Office. The apparatus manufactured by a number of firms is of uniform design to specifications approved by the Post Office. It appears that, whilst the actual installation in the home is conducted by the firms supplying the apparatus, the final checking of its efficiency is done by a Post Office official, after which the apparatus is officially sealed so that the circuits cannot be tampered with. The apparatus, too, has a wavelength band restricted to the wavelength of the broadcasting station.

In the description of the apparatus, many points of interest will be noticed, whilst a special feature is the employment of the electricity supply to the house for the plate and filament currents for the valves.

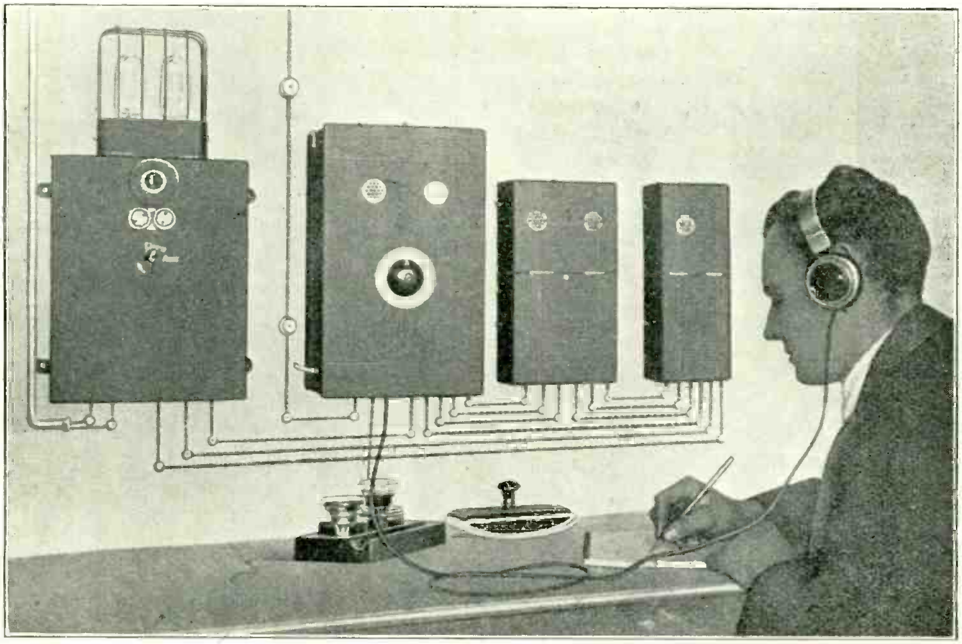
Summer Wireless.

To those who are truly interested in wireless it may seem scarcely believable that summer time should have any effect in detracting from interest in the subject. From many amateur societies, however, there comes the complaint that their members lose interest during the summer months and forsake wireless for other pursuits more strictly associated with outdoor life. Speaking generally, where such a situation arises, the fault is usually to be found with the organisation of the club itself. There should be no difficulty experienced in providing an even greater attraction to the members to attend summer meetings than the winter session lectures. Organised field days with portable wireless apparatus can be made extremely instructive and interesting, and since few societies are without at least one member who has a transmitting licence, it should be an easy matter to obtain the necessary permission from the Post Office for a portable transmitter to be used during the summer months. If societies will only take the trouble to arrange summer meetings there would be no lack of enthusiasm during the summer season.

THE BROADCASTING ORGANISATION IN GERMANY

In view of the manifold difficulties which have presented themselves in the organisation of Broadcasting in this country, in particular with regard to the conditions of licence, broadcast service and the design of the receiving equipment, this article, showing how the problems have been dealt with in Germany, is of special interest.

THE erection of transmitting and receiving stations by civilians is for the time being prohibited in Germany, and therefore one cannot very well speak of a general class of users corresponding to wireless amateurs in other countries. However, the tremendous progress made by wireless amateurs, especially in England and the United States of America, gave the leading wireless companies in Germany the impetus to develop a radio telephone service for the German public. Accordingly, some months ago the leading German radio firms formed a company, the "Rundfunk G.m.b.H." of Berlin, and this undertaking is developing practical amateur receiving sets, and is also planning the erection of eight or nine transmitting stations to be spread all over Germany. Each of these transmitting station districts is to be subdivided into three zones. In the first zone receiving sets will be able to receive without amplification; in the second and third, at a greater distance from the transmitting station, the receivers will be equipped with amplifiers.

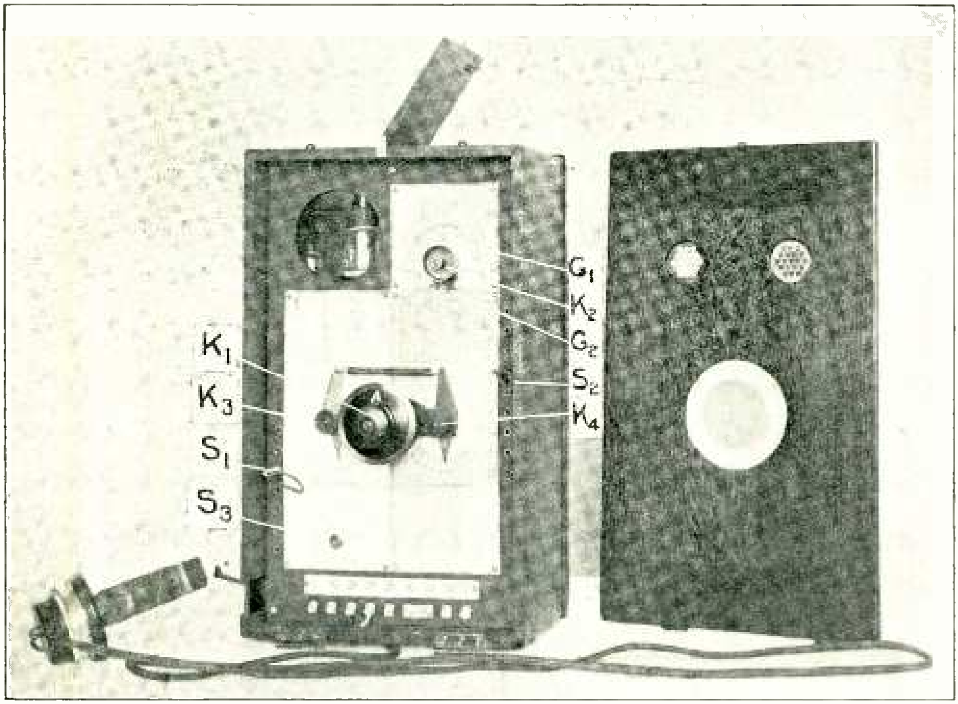


By courtesy Gesellschaft für drahtlose Telegraphie.

Fig. 1. Broadcast Receiving equipment installed by the German Post Office. The instrument on the left produces filament heating and high tension current from the supply mains. The tuner and amplifiers are on the right of the leading-in wire.

It can now be assumed as probable that, thanks to the endeavours of the above-mentioned company, as well as those of the "Radio Club" (a recently founded association of enthusiastic amateurs and experts), the prohibition on the use of wireless by the public will be lifted, at least with only a few necessary restrictions. Such restrictions, in the opinion of Dr. E. Meyer, who is a prominent wireless engineer, are suggested on the following lines :

1. Receiving sets shall be capable of receiving only within a certain wavelength band, to be set apart for broadcasting, the apparatus to be so constructed that the wavelength can be altered only to a limited extent, since the secrecy of the telegraph service ought to be preserved in all circumstances.
2. The sets thus admitted will have to bear the seal of the German Post Office, so that reconstruction for the purpose of wavelength alteration is effectively prevented.
3. Broadcasting by amateurs not allowed.



By courtesy Gesellschaft fur drahtlose Telegraphie.

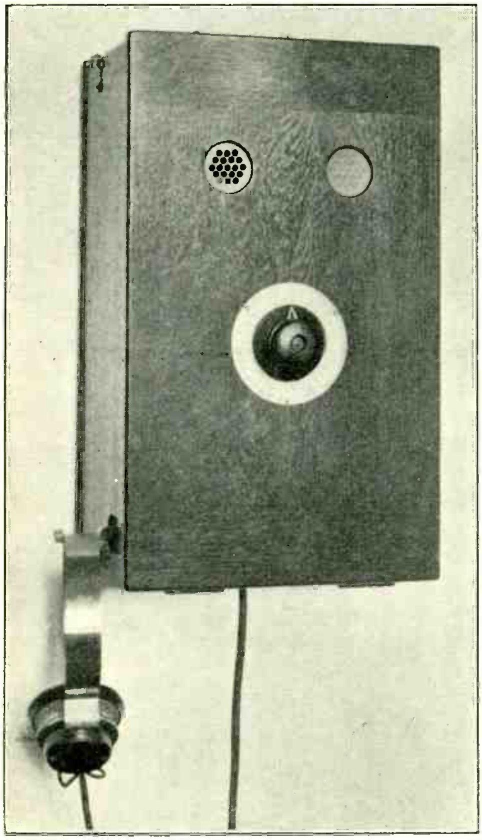
Fig. 2. The Tuner. It is adjusted to the correct wavelength when installed, though limited tuning is permitted and is effected by the single knob seen in the centre.

Judging from the foregoing, the prospects for the German amateurs do not appear to be enviable, still less so when compared with the so much more favourable conditions obtaining in England and the United States.

The first step towards making radiotelephony a public service in Germany was made as far back as 1921 by the German Ministry of Posts, by the introduction of the " German Broadcasting Service." The sets which were installed for this purpose, a description of which will follow, were, on the initiative of the Ministry of the Posts, jointly evolved by the three well-known wireless firms of Telefunken, Huth, and Lorenz, and it seems that this collaboration produced apparatus which combines simplicity of operation with maximum reliability and permanency of service.

The German Broadcasting Service was inaugurated in August, 1922, and was organised in the same manner as the German telephone service. Subscribers, on payment of a certain annual fee, are furnished with the necessary apparatus, the installation and maintenance of which is done by the Post Office. Such maintenance is made considerably easier by feeding the plate and filament circuits directly from supply mains by means of an apparatus especially designed for the purpose instead of using accumulators.

The present subscribers, whose number is approximately 2,000, are recruited chiefly from the ranks of bankers, merchants, big trading concerns, etc. The messages are broadcasted now by the wireless station of Königswusterhausen (one of the most interesting and many-sided stations of the world, fitted with twelve transmitting plants, each single one of them quite an independent unit), with a power of 10 kW., on a wavelength of 4,000 metres, and are chiefly of an economic nature, relating to rates of exchange, exchange quotations of inland and foreign markets, etc. These news items are being collected by the Berlin Telegraph Agency "Eildienst G.m.b.H.," and are then passed on to the Königswusterhausen



By courtesy Gesellschaft für drahtlose Telegraphie.

Fig. 3. Removing the telephone from the switch-hook throws the receiver into operation. One of the gratings can be removed so that the reaction coupling may be increased within limits for the reception of C.W. telegraphy.

transmitting station, whence they are broadcasted.

In the construction of the apparatus the following points were taken into account. The apparatus, whilst as simple as possible, should prove safe in working and easy in operation. Since the operation of the apparatus is not to be done by experts, but, as in the case of the ordinary telephone, used by private individuals, such operation cannot be conditional on more special knowledge than that required for ordinary telephones. To fulfil these conditions, the apparatus is provided with but one external switch, and by an ingenious mechanical device the primary and secondary circuits are tuned simultaneously with it. The apparatus is adapted for use with A.C. or D.C. mains to dispense with accumulators, thus simplifying operation and maintenance.

The Ministry of Posts insisted that the sets should receive only messages destined for the broadcasting service, and that interception of other messages and telegrams should be entirely prevented. This difficult demand was met in such a way that the receiving sets, at the time they are installed, are tuned to the fixed wavelength of the broadcasting service, and sealed so that alteration to other wavelengths is impossible. By means of the simple switch on the outside of the set the tuning can only be altered within the limits of 2 per cent. of the fixed wavelength, so that the subscriber is in a position to adjust his set to give maximum amplification, but is prevented from any alteration of the tuning to a degree which would be necessary for the interception of other messages.

The broadcast receiver, the general appearance of which is illustrated in Fig. 1, consists of three components, as follows :—

1. The tuner with oscillating circuits and detecting valve.
2. The amplifier of 1, 2 or 3 valves, as low frequency magnifiers according to the signal strength required.
3. The mains connecting instrument, *i.e.*, according to the available power, either a direct current or alternating current adapter.

The receiver (Figs. 2, 3 and 4) is a loose coupled circuit valve receiver with reaction coupling, and covers a wavelength band of from 3,000 to 4,500 metres. The apparatus is contained in an oak case 37 cms. high, 22·5 cms. wide, and 16·5 cms. deep, weighing approximately 5 kilogrammes. The box, when the apparatus has been installed, is closed and sealed. The switching arrangement is shown in Fig. 4. When not in use the telephone earpiece is hung up on the hook (1/10), causing the aerial to be earthed. The aerial circuit consists of aerial and earth, condenser (1/10), and aerial inductance (1/9), which is tapped out. The coupling of the aerial and secondary circuits is variable, and is made by the coil (12/13). The secondary circuit consists of this coupling coil (12/13), the coil (25/12), the secondary tapped coil (12/21), and the secondary condenser (11/21). The grid circuit includes the grid condenser (23/11) and grid leak (22/23), of 2 or 3 megohms, connected to the positive end of the filament.

The plate circuit consists of the variable reaction coupling coil (24/25), the fixed reaction coupling coil (25/29), the terminals (29 and 31) which are connected with the H.T. supply, and the primary of the telephone transformer (30/31). The filament circuit has in circuit a 6-volt potential through the terminals (29/22).

The telephone receivers are the usual low resistance type employed by the German Post Office and are, of course, connected in the plate circuit of the valve by means of the telephone transformer (21/32).

The most interesting and original feature of the receiver is the provision for tuning the primary and secondary circuits simultaneously by the operation of a single switch. For this purpose the primary and secondary inductances are each fitted with small movable and self-contained short-circuited coils (34 and 35). By varying the position of these coils, of course, the self induction of the primary and secondary circuits is altered, and hence the tuning of the circuits. These coils carry indicators K3 and K4 (shown in Fig. 2), which are connected with the switch K1 by a mechanism consisting of curved discs and levers in such a manner that turning the switch rotates both the coils (34 and 35) simultaneously and regularly. The tuning, however, can only be altered within the permitted limits, of 2 per cent. of the fixed wavelength.

Special care was taken so that even the process of tuning, before the sealing of the receiving set, should be simplified. The front part of the panel bears a table headed "Secondary Circuit," and this shows the data arrived at experimentally, and gives the adjustment of the secondary coil on different wavelengths. For wavelengths of 3,000 to 4,500 metres, and for steps of 50 metres, plug sockets are provided to allow the most suitable number of turns of the secondary coil to be included. The apparatus, before despatch, is submitted to tests as regards the best coupling between primary and secondary circuits and reaction coupling, so that when installed it is only necessary to tune the primary circuit, which, of course, depends on the values of the aerial.

As it might prove desirable to use the receiver for reception of telegrams as well, the necessary provision has been made. This does not present any difficulties, since all that is necessary is to tighten the reaction coupling. To provide for switching over from the best telephony reaction coupling to the best telegraph reaction coupling, the handle of the

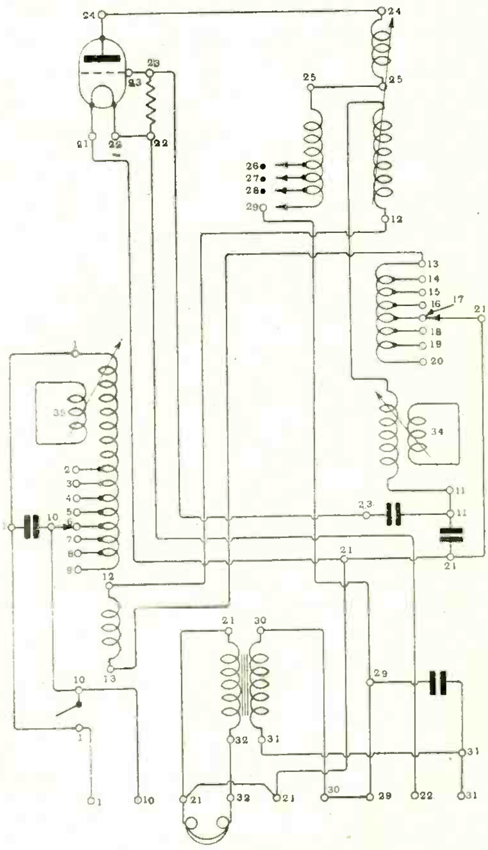


Fig. 4. Circuit of the tuner unit.

reaction coupling coil is fixed to a metal cap (K2, Fig. 2), the movement being limited by stops.

Each receiver is provided with a spare valve. Fig. 2 shows a door in the lid of the box, through which the exchange of valves can be effected without having to resort to an opening of the case itself. The brilliancy of the valve filament can also be seen through the window in the left upper part of the front of the case. (Fig. 3).

In the next issue a description will be given of the Amplifier Units, to be followed by details of the equipment employed for deriving filament heating and high tension currents from D.C. and A.C. Mains.

The Bolitho Circuit

Considerable interest centres on the origin of the receiving principle generally known as the **Super-regenerative Circuit.** Reference has been made in the Correspondence Columns of this Journal to the claims of Armstrong and Bolitho as to priority of invention, and this article deals with the invention by Captain Bolitho as described in his Patent 156330/19.

CONSIDERABLE publicity has recently been given in the technical press to statements which have been advanced from various quarters regarding the origin of what is now generally known as the Armstrong super-regenerative circuit. In particular a definite claim to priority has been advanced by Captain John Bruce Bolitho, the well-known wireless expert and inventor.

A controversy of this nature is one which can probably only be determined in a Court of Law. At the same time the fact that an invention of such outstanding importance as the super-regenerative circuit is in dispute naturally lends a particular interest to any arrangement which claims to have forestalled it.

For this reason, and quite apart from the ultimate issue of the dispute, an account of the Bolitho circuit, as extracted from the covering patent No. 156330 dated October 6th, 1919, will no doubt be welcomed, more especially perhaps by those who have constructed or used the Armstrong receiver.

In the first place super-regenerative amplification as used by Professor Armstrong depends upon a certain critical adjustment of the circuits of a retro-actively coupled valve, whereby the tube is caused to work at or near the threshold of oscillation. In other words the back-coupling is so regulated that the valve is kept upon the very point of oscillating. Simultaneously it is controlled by a rapidly intermittent "quenching" action so that advantage is taken of its extraordinary amplifying powers at this critical "setting," whilst at the same time the whole system is stabilised and prevented from actually boiling over into self-oscillation.

This "quenching" action is obtained in the Armstrong system in either of two ways; but both methods may be used in combination with still more advantageous results. According to the first method, the magnetic linkage across the back-coupling coils is constantly varied so that the valve is first urged towards oscillation and is then immediately afterwards repelled; this effect is secured by altering the value of the plate potential at a suitable frequency. In the other method a similar *result* is obtained in a somewhat different way, namely by periodically varying the "damping" factor of one of the oscillatory circuits, so that the tuning is, in effect, "killed" and "revived" at a corresponding frequency.

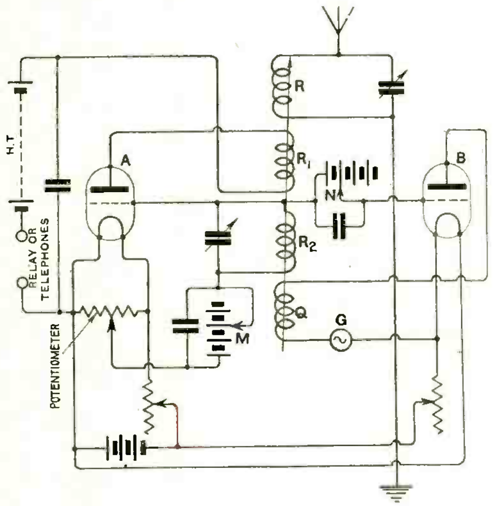
In itself the use of an oscillating valve adjusted or set to the critical "threshold" position is not new. It has in fact been in practical use for some time, more particularly in relay circuits such as those due to L. B. Turner. Again, the necessity for "quenching" in such a circuit is obvious, otherwise the first received impulse would set the whole system into a state of persistent oscillation. Accordingly, the bare problem of quenching or curbing a "triggered" valve is already known to have been met and solved in various ingenious ways.

The fact remains, however, that the mere knowledge of the merits of a "triggered" valve (*i.e.*, one adjusted to the threshold of oscillation), together with means for periodically "quenching" it, although well-known and frequently utilised for special purposes, was not in itself sufficient to produce the extraordinary results obtained by the super-regenerative circuit as used in the Armstrong receiver.

Captain Bolitho's circuit comprises a "triggered" valve A, which is intermittently "quenched" by means of a second valve B, which in turn is excited by a generator G, inserted in its plate circuit. The diagram has been somewhat abbreviated for the sake of clearness, and in order that the operations of the arrangement may be more easily followed.

The plate circuit of the valve A is back-coupled to the tuned grid circuit through the coils R1, R2, the coupling being so adjusted as to set the valve on the threshold or verge of oscillation. The plate circuit of the second valve B contains a reaction coil Q, which is coupled to the coil R2, so as to oppose the magnetic linkage between the coils R1 and R2. The valve B is excited by the generator G at a frequency much lower than that of the received signal. This local generator may consist of a third oscillating valve coupled to a coil in the plate circuit of the tube B.

The grids of the two valves A and B are connected together, the potentiometer and N and M being used to secure the most favourable grid-potential adjustments. The potentiometers M, N, are shunted by condensers so as to by-pass high frequency currents. The aerial coil is shown at R.



An abbreviated diagram of Capt. Bolitho's circuit.

When the valve A is set to the critical point previously mentioned, the first impulse of signal energy through the coil R would in the ordinary course of events be sufficient to set the tube into a state of steady self-oscillation, in which condition it would of course be insensitive to the impact of any further signals.

It is the function of the valve B to prevent this, and to keep the system in a constantly responsive condition.

The action of the generator G throws the plate of the valve B alternatively positive and negative. So long as it is negative, no current can flow in the " reversed " coupling coil Q, and this is therefore, so to speak, out of operation. It has no influence upon the back-coupling between the coils R1 and R2, and the valve A accordingly builds up into self-oscillation.

The next half-cycle of the generator G, however, throws the plate B positive, and a current accordingly flows through the coil Q. As this is coupled in the " reversed " direction it neutralises, in effect, the existing coupling between the coils R1 and R2, and so prevents any energy transfer from taking place between the grid and plate circuits of the valve A. The latter is accordingly " quenched," self-oscillation ceases, and the system again becomes ready to respond to whatever signal energy is then flowing in the aerial coil R. This process is constantly repeated at a rate determined by the frequency of the generator G.

In addition it will be seen that the grid reaction coil R2, is shunted by the grid-filament space of the valve B and is therefore subjected to a variable " damping " effect corresponding to the varying conductivity of the shunt path. This will have the effect of periodically detuning the coil R2, and rendering it ineffective so far as any retroactive transfer of energy is concerned.

It is to be observed that Captain Bolitho illustrates his circuit as applied to operate a relay device, although he states that it is applicable as an amplifier for wireless telegraphy and telephony. The relay T is inserted in the plate circuit of the valve A, and is presumably operated only when and for as long as the valve is set into actual self-oscillation.

To what extent, if any, this arrangement conflicts with or anticipates the super-regenerative circuits disclosed by Professor Armstrong will no doubt provide the basis of considerable discussion and learned argument elsewhere.

The Radio Society of Great Britain.

An ordinary general meeting of the Society was held on Wednesday, May 23rd, at 6 p.m., at the Institution of Electrical Engineers. After the minutes of the previous meeting had been read and confirmed, the President called upon Professor E. W. Marchant, D.Sc., to give his lecture on "Methods of Eliminating Interference in Wireless Receiving Circuits."

At the conclusion of the discussion it was announced that the following had been elected to membership :—

Members : Capt. C. W. Dunn, M.C., The Hon. A. Shaw, M.P., H. MacLane Melville Smith, M.A., A. H. Ninnis, J. J. Honan, H. G. Brown, W. R. Burne, A. H. Macdonald, M.A., W. G. de Winton Mitchell, B.Sc., F.R.A.S., H. H. Hitchcock, P. J. Colohan, T. T. Turner, L. A. E. Tozer, Lieut. A. C. Skinner, P. D. Coates. *Associate Member* : A. G. Bennett.

The following Societies were also accepted for affiliation :—High Wycombe and District Radio Society, The Weston-Super-Mare and District Radio Society, Battersea and District Radio Society, Bournemouth and District Radio and Electrical Society, The Wimbledon Radio Society and the Lyons Radio Society.

The meeting adjourned at 7.20 p.m.

THE WIRELESS WORKSHOP

MAKING THE VALVE HOLDER PANEL

FOR A FOUR-VALVE RECEIVER

By F. H. HAYNES.

Experimenters who are unacquainted with the methods adopted for working in the materials met with in wireless instrument making can derive much benefit from the articles under this heading. The procedure described may not only effect a saving of time in making up apparatus, but will produce instruments of good finish, equal in workmanship to any on the market and incorporating the circuit principles and design favoured by the reader.

THE cutting out and squaring up of the edges of this panel, which measures $13\frac{3}{4}$ ins. by $2\frac{7}{8}$ ins. by $\frac{3}{8}$ in., was dealt with in the previous article under this heading.* The necessary drilling and tapping for the valve legs or holders and for attaching the valve holder panel to the piece of ebonite forming the front of the instrument will now be proceeded with.

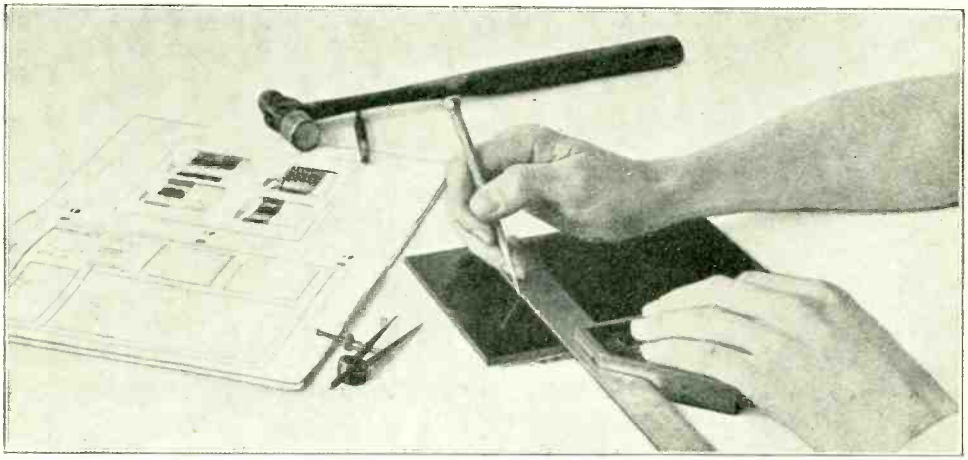


Photo: Radio and Model Engineering

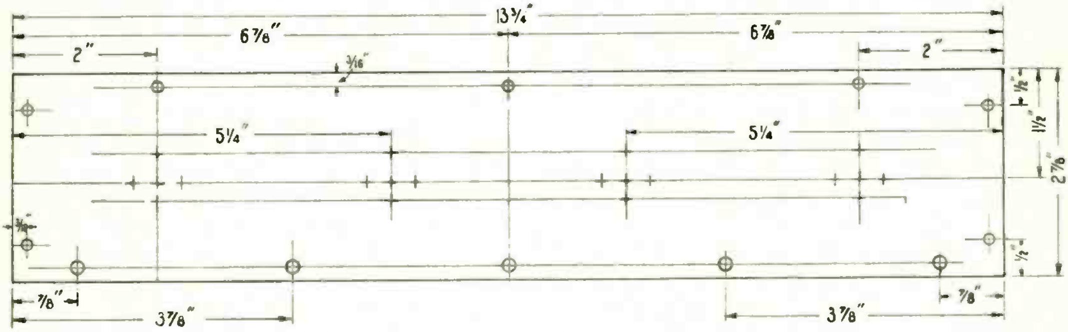
Using a scriber for setting out positions on the face of the panel as measured from one on the edges.

Setting Out For the marking out for the positions of the holes a pair of good spring dividers will be necessary. It is not good enough to lay a steel rule on the work for the purpose of transferring measurements, and particularly does this become important with regard to the position of the holes for the valve legs. A discrepancy of 1/64 in. is very evident in the case of the position of a valve leg when it comes to fitting a valve, and it is extremely difficult to judge distances as measured direct from a rule when by its thickness the divisions are removed about 1/32 in. from the face of the work unless one adopts the inconvenient process of standing the rule edgewise.

As it will be necessary to make scratch lines, the marking out may be done on the under side of the panel. This, however, sometimes causes trouble to the novice who, during drilling, fractures out a small piece of ebonite as the drill comes through on the surface which is to be the outside face. It might be mentioned that with certain classes of work, such as the marking out of the location for blind holes, it becomes necessary to make intersecting scratch lines on the outside face of the work. When this is the case the scratch lines must be so short that in drilling the hole, or countersinking, they are removed. The process of pasting paper to an ebonite panel, so that the marking out can be done with pencil, is not recommended. Pencil lines do not permit of the same precision as scratch lines and when holes are near together the drilling of one detaches and stretches the paper, rendering the location of others inaccurate. Presuming that the marking out is to be done on the outside face, it is as well to roughly mark the positions

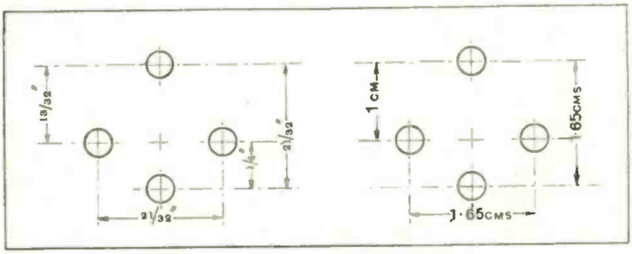
* Page 42, April 14th, 1923.

for holes with pencilled cross lines so that the scratch lines may be made no longer than is absolutely necessary. The distance of the twelve holes round the sides may be measured by setting the dividers to 3/16 in., and making short scratch lines at the approximate positions already marked in pencil with the point of one limb of the dividers just touching the edge. The spacing apart is measured by setting the dividers to the measurements shown on the drawing and stepping them off on the panel. It is customary to take all surface measurements from two edges which are at right angles, but in this case measurements are made from either end of the panel, the reason being that the reader in repeating a given measurement several times, such as the 3-in. steps along the front edge, may repeat a slight error and spoil the symmetry of the work.



Dimensional drawing of panel for four-valve holders.

The exact dimensions are given for the setting out of a valve holder, both in British and metric measure. It will be noticed that various valve makers use slightly different spacing and the measurements given are based upon those first used by the French during the war with slight amendments representing the mean of the dimensions adopted by the valve makers. The two filament sockets are spaced equidistant from the line joining the centres of the grid and plate sockets, the distance being 21/64 in., on either side. The grid socket is ¼ in. below the line joining the filament sockets, whilst the plate socket is exactly 1 centimetre above it, the measurements being so expressed, in British and metric measure, so that they can be easily memorised. The slight discrepancies to be found in stem spacing in valves of different manufacture are small compared with the wide differences met with in certain valve holders, and if the reader intends to make use of made-up valve holders it is as well, unless the particular make is known to him, to scrutinise the spacing as carefully as he can with a steel rule.



The setting out of the valve holders.

Centre Punching

Having marked the positions for all the holes, marks must be made with the point of a sharp centre-punch to prevent the point of the drill from wandering over the work when drilling. When making these centre-punch marks the ebonite should lie flat on a heavy metal surface so that there is not the slightest give or springiness, and a tap of medium lightness will produce a distinct indentation. If pressure is put upon the centre-punch with the left hand while the blow is struck, a deeper mark will be made than if it is held lightly, and, moreover, it will not be permitted to bounce or change its position. A centre-punch mark that is not quite true, as can be readily detected by the eye as not being precisely at the point of intersection of the two scratch lines, can be remedied by tilting the centre-punch sideways and starting another point half-way down the slope of the erroneous one, finishing with another and heavier blow with the punch in a vertical position. For larger errors another punch mark can be started alongside the faulty one, this in itself being out from the correct position and in the opposite direction. Now, with the punch held vertically, there is less resistance on the side of the faulty hole, and when driven home travels into the correct position.

Drilling Valve legs such as are usually purchased are threaded 4 BA., and ous gap. Success lies in making the top edge of the main panel *perfectly* true. Securing the main panel vertically in the vice and placing the valve holder panel carefully in position, the 13/64 in. drill can be put through the holes on the extreme right and left so that its point will produce a mark for drilling the holes which are to be tapped 2 BA. The two end holes may be drilled in the top edge of the main panel with the 5/32 in. drill for a depth of about $\frac{3}{4}$ in.

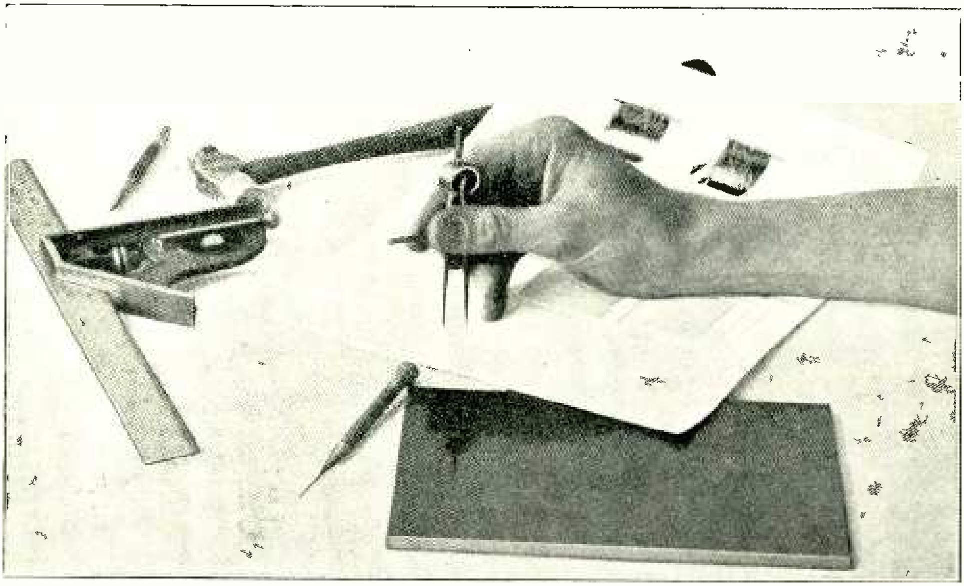


Photo: Radio and Model Engineering.

Transferring measurements from the rule to the panel by means of dividers.

allowing for a slight increase in size of any unthreaded portion, it will be necessary to use a twist drill 5/32 in., to give clearance.

When drilling the holes, a piece of scrap ebonite or hard wood should be clamped in the vice behind the panel to prevent fracture. The utmost care must be taken to ensure that the hand brace is at exact right angles to the face of the work by viewing it in two directions with the assistance of another person. The holes at the end and along one end are made with the same drill. Those along the remaining edge are 13/64 in., to give clearance to 2 BA. screws which are used to secure this panel to the front of the instrument.

Five screws are utilised for this purpose so as to pull the top tightly down, as a bad fit between the edge of the main panel and the valve-holder panel might produce a conspicu-

Tapping With a 2BA. taper tap held in a key tap-holder it is quite simple, with medium pressure, to screw it forward into the hole. After a few turns forward it should be given one complete turn backwards to break up the chips and prevent the tap seizing, which is, however, not likely when tapping such a soft material as ebonite. The tap should be removed when about half-way home and the hole cleared of chips, and the powdered ebonite blown away. A plug tap will be required to finish the thread to the bottom of the hole. It must be remembered that threads produced in ebonite are easily stripped and may not be sufficiently strong unless " full " to lift the tap and holder while the former is being withdrawn. Having thus completed the two end holes, secure the two panels together with two $\frac{3}{4}$ in. by 2BA.

brass screws and mark out the positions for the other three holes with the 13/64 in. drill. Detach the valve panel and drill and tap these holes.

Countersinking As countersunk headed screws will be used for attaching the panels, provision must be made to recess the heads flush with the surface. The easiest way of doing this is to use a twist drill exactly equal in diameter to the head of the screw and carefully working it in just sufficiently far to permit of the head resting level with the face of the panel. The taper of the point of a Morse twist drill is usually more acute than that of the countersunk head of the screw and thus, with this process of countersinking, the screw is supported in position by its top rim. Therefore great care must be taken not to go too far with the countersinking drill or the screw head will sink below the surface. Should one hole happen to be made too deep, bad appearance may be obviated by packing the hole with a few chips of ebonite. Of course, this is not what *should* be done, but the amateur worker with limited time and equipment is bound to have a mishap sometimes. The other holes round the edges will also need countersinking to take the heads of 1 in. by No. 4 brass wood screws.

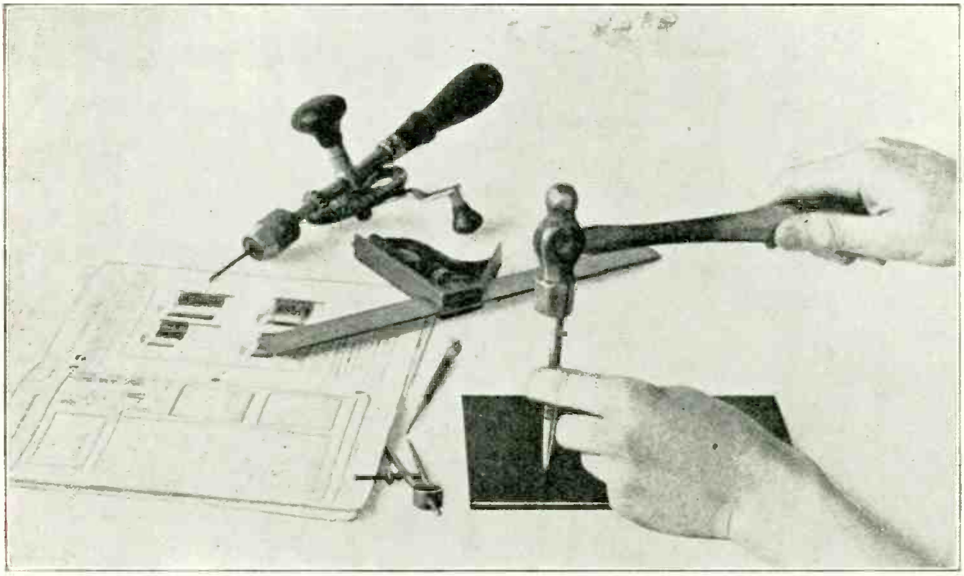


Photo : Radio and Model Engineering

Centre punching the positions for the holes.

Temporarily attach the two panels together and adjust them, filing if necessary so that the join can scarcely be detected. Detach them and test the setting out of the holes for the valve holders but do not proceed with the assembling as there is rubbing down, engraving and lacquering yet to be done.

Articles to look for in the Next Issue.

THE PHENOMENON OF FADING by Capt. P. P. Eckersley.
Chief Engineer of the B.B.C.

THE MEASUREMENT OF THE WAVELENGTH AND CAPACITY OF AERIALS - - - - - By Maurice Child.

CONSTRUCTION OF A THREE-VALVE RECEIVER.

DETAILS OF GERMAN BROADCAST RECEIVERS OPERATING FROM A.C. AND D.C. MAINS.

BUILDING CONDENSERS TO GIVEN CAPACITY.

THE AMATEUR'S EXPERIMENTAL LABORATORY

V.—THE CALIBRATION OF A VARIABLE CONDENSER *(continued)*.

By Philip R. Coursey, B.Sc., F.Inst.P., A.M.I.E.E.

THE method of plotting out the ends of the calibration curve of a variable condenser that was described in the last article is one that is readily susceptible to checking by additional measurements.

In the first place, the method used for obtaining readings at the lower end of the curve may be extended further up the curve, by repeating the measurement for a number of different initial settings of the test condenser. For instance, instead of confining it to 0, 5° and 10° on the scale, it may be repeated for each 10° up the scale until the limit of the calibration curve is reached for the upper reading when the fixed condenser is switched out of circuit. If the measurements have been carefully carried out, all the extra points obtained in this way should, when plotted on the chart, lie exactly on top of the curve that has already been plotted out. If they do not do so it indicates inaccurate work at some stage of the calibration, which should therefore be repeated or rechecked until the necessary agreement is obtained.

In a similar manner the method used at the upper end of the curve may be extended downwards, to meet and overlap the portion checked from the lower end, and once again agreement should be obtained at all points.

Again, the measurements made when determining the upper and lower ends of the calibration curve in the manner described in the last article may be repeated with different values of the fixed condenser C_3, using, of course, the correct capacity of this condenser and not merely its approximate nominal value.

The additional readings so obtained should of course check up with those already plotted, provided that the condenser C_3 is not too small. In the latter case a slight error may be introduced for the reasons already given.

The only advantage of making these additional measurements is to check up those that have already been made, since it is only by a process of repeatedly checking that accuracy can always be assured.

By employing this "step-by-step" method along the straight portion of the characteristic that was first plotted out it becomes possible to make an allowance for the capacity of the switch contacts and of the wires connecting them to the condenser, since by taking a sufficient number of readings in this way with various values of fixed condenser, it becomes possible to determine the value of this "leads capacity" such that when added to each of the fixed condensers in turn it will bring about agreement between all the measurements made with them, and the straight portion of the characteristic curve. It is assumed, of course, in making this statement that sufficient care has been taken in the original determination of the straight portion of the curve in the manner detailed in these articles, for the experimenter to be reasonably certain of its accuracy.

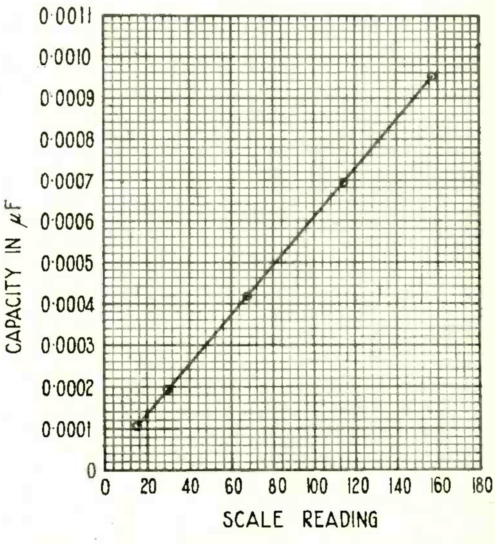


Fig. 1.

This " leads capacity " of the switch contacts and connecting wires should, of course, be quite small—not exceeding a few micro-microfarads—but it may be useful to illustrate here by actual figures how it can be ascertained and allowed for. For this purpose we shall make use of the method last described for taking a step-by-step series of measurements along the characteristic curve. Use will also be made of the straight portion of the calibration curve which was plotted out by the first described method, as by that method any errors due to leads and other stray capacities can be allowed for. This curve is reprinted here as Fig. 1 in order to facilitate reference to it.

In the first place use may be made of a comparison condenser of about 0·0001 microfarad capacity for the fixed condenser C_3 in the diagram of the arrangement given in Fig. 1 in the last article (May 19th issue), and this may be used to step up the calibration curve from point to point.

Thus suppose we assume here that the *exact* value of this comparison condenser is 0·000105 microfarad, as has already been assumed in earlier articles ; and suppose that we commence at 20° on the scale, as with most condensers this is likely to be well on to the straight part of the curve. Then adopting the method described in the last article we find that when the fixed condenser of capacity 0·000105 microfarad is switched off, the setting of the test condenser must be raised from 20° to 40°. Now from our curve we see that the capacity value previously found for 40° is 0·00025, and that for 20° is 0·000135, hence we may conclude that the actual amount that we have added with our fixed condenser is 0·00025—0·000135 = 0·000115 microfarad.

But the true capacity of this condenser is 0·000105, so that the capacity of the wires and switch contacts must amount to 0·000115 —0·000105 = 0·000010 microfarad.

Again, we may obtain a more accurate reading for this capacity by repeating this measurement along the curve. Thus, having arrived at the scale reading of 40° by the measurement just described, the fixed condenser can again be switched in parallel and the oscillator valve adjusted until it is in resonance with the test circuit under these new conditions. The fixed condenser can be switched off and the setting of the test condenser increased until resonance is again obtained, the scale reading being noted. Suppose that we find it to be 59°. The process can be repeated, and a series of points obtained, each being in capacity a simple multiple of the capacity of the fixed condenser, *i.e.*, once, twice, three times, etc., since the capacity of the condenser is repeatedly added on.

These points can be plotted on the squared paper chart, and a line drawn through them, as indicated in Fig. 2 by the line AB. By this means the distance BC can be more readily measured than can the difference between the two curves after one measurement only.

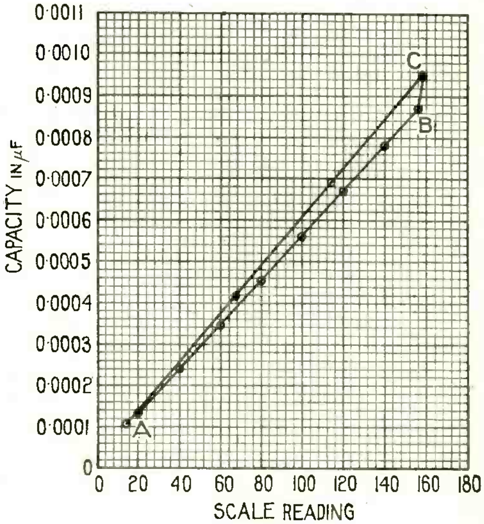


Fig. 2.

Having by this means made a determination of these stray capacities, they can be used to correct the measurements made at the ends of the curve in the manner that has already been described, since these stray capacities should be added to the true capacity of the comparison (fixed) condenser in each case, in order to obtain the true *effective* value of the condenser as used with the switch, etc., in their working positions.

It should be obvious at this stage of the proceedings that if this capacity of the wires, etc., could be neglected it would be possible to plot out the whole of the calibration curve solely by the use of a single fixed condenser of known capacity value. A first reference point on the curve could be obtained by using the method first described with a throw-over switch to substitute the test condenser for the fixed condenser in the test circuit. This point could be checked by interchanging the positions of the test and fixed condensers relative to the switch so as to allow for any difference between the capacities of the connecting wires on the two sides.

Having obtained this one reference point, it could be used as a starting-point for a series of step-by-step measurements by the method just described, thus enabling the curve to be plotted out by a series of equal increments of capacity equal to the capacity of the known fixed condenser. This series would enable the main part of the calibration curve to be plotted in, and this could be used for determinations of the two ends of the curve in the manner that has already been detailed. The calibration curve obtained in this way is liable to be in error, due to the capacity of the leads and switch contacts, and it needs at least two condensers of known capacity value to enable this source of error to be eliminated. The best procedure is to follow in detail the tests that have already been described, as these enable repeated checks of accuracy to be obtained since several reference condensers are employed.

Having obtained a calibration curve in this way it should be carefully drawn in and kept for reference, marking it with a description of the condenser and its number, if it has one, as many uses will be found for this calibration curve in conjunction with the condenser for other measurements which will be described later.

Broadcasting.

Regular Programmes are Broadcast from the following European Stations :—

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Manchester	**2 ZY**	385		
Birmingham	**5 IT**	420		
Cardiff ..	**5 WA**	353		
Newcastle ..	**5 NO**	400		
Glasgow ..	**5 SC**	415		
FRANCE.				
Paris (Eiffel Tower).	**FL**	2,600	Daily 7.40 a.m.	Meteorological Forecast.
			12.15 p.m.	,, Report and Forecast.
			4.30 p.m.	Financial Bulletin (Paris Bourse).
			7.20 p.m.	Meteorological Forecast and Concert.
			11.10 p.m.	Meteorological Report and Forecast.
Levallois-Perret (Radiola)	**SFR**	1,780	Sundays 3-4 p.m.	Concert.
			Weekdays 6.5 p.m.	Financial Bulletin.
			6.15-7.15 p.m.	Instrumental Music.
			9.45 p.m.	Miscellaneous News.
			10.30-11.30 p.m.	Concert.
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Radio-Riviera (Nice).	—	460	Daily 12.0 noon	News and Concert.
			6- 7 p.m.	,, ,,
			10-11 p.m.	,, ,,
Lyons	**YN**	3,100	Weekdays 11.45 a.m. -12.15 p.m.	Gramophone records.

Locality.	Call Sign.	Wave-length.	Times.	Nature of Transmission.
HOLLAND.				
The Hague	**PCGG**	1,050	Sunday 4-6 p.m.	Concert.
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The Hague (Heussen Laboratory).	**PCUU**	1,050	Tuesday 8.45-11 p.m.	,,
			Sunday 10.40-11.40 a.m.	—
The Hague (Velthuyzen).	**PCKK**	1,050	Friday 9.40-10.40 p.m.	Miscellaneous.
Ijmuiden ..	**PCMM**	1,050	Saturday 9.40-10.40 p.m.	Concert.
Amsterdam	**PA5**	1,050	Wednesday 9.10-10.10 p.m.	Concert and News.
BELGIUM.				
Brussels ..	**BAV**	1,100	Working days 1 p.m. ..	Meteorological Bulletin.
			Daily 5.50 p.m. ..	,,
			Sunday 7 p.m. ..	Concert.
			Tuesday and Thursday 10 p.m. ..	Concert.
GERMANY.				
Berlin (Koenigs-wusterhausen) ..	**LP**	2,800	Daily 7-8 a.m. ..	Financial and other news.
			12-1.30 p.m.	,, ,,
			5-6.30 p.m.	,, ,,
CZECHO-SLOVAKIA				
Prague ..	**PRG**	1,800	8 a.m. 12noon and 4 p.m.	Meteorological Bulletin and News.
		4,500	10 a.m., 3 p.m. and 10 p.m.	Concert
SWITZERLAND				
Geneva ..	**HB 1**	1,200	Daily 7-8 p.m. ..	Concert ("Utilitas").
Lausanne	**HB 2**	—	7-8 p.m. ..	,, ,,

INSTRUCTIONAL ARTICLE FOR THE LISTENER-IN AND EXPERIMENTER

WIRELESS THEORY—IX.

It is the purpose of the writer to deal with the principles underlying the action of wireless receivers and transmitters. Those who know *why*, obtain much pleasure which is not experienced by those who have no idea of the action of their wireless set.

The series has been specially designed so that the reader who follows each section as it appears will have obtained a complete wireless education with a minimum of time and trouble, and he will be in a position to successfully design his own wireless equipment.

In previous sections the writer has dealt with the principles of electricity such as the effect of resistance, capacity and inductance. The last two sections deal with alternating current work, the study of which is important to those who desire a clear understanding of wireless.

By W. JAMES.

24.—Inductance and Resistance in Parallel.

SUPPOSE we have a circuit consisting of a resistance in parallel with an inductance as shown in Fig. 52. Such a condition is often met with in practice, when, for example, we have a crystal rectifier or a valve connected across a coil. When an alternating pressure is set up across the ends of the circuit a current flows. The total current is made up of two parts, one part flowing through the resistance,

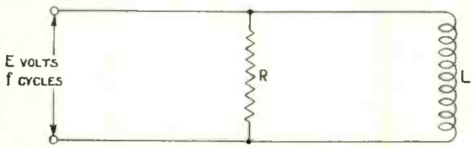


Fig. 52. Circuit consisting of resistance and inductance in parallel.

while the other part flows through the inductance. The current divides according to the *conductance* of the two paths. Conductance, of course, is the reverse of resistance. If a wire has a resistance of 10 ohms it has a conductance of 1/10th *mhos*. It will be noticed the term *mho* is the reverse of *ohm*. The magnitude of the current flowing in the resistance, when a sine wave of pressure is connected, is equal to the pressure divided by the resistance, or, in symbols, $I = \frac{E}{R}$. This current is in phase with the applied pressure E, and the watts lost in heating the resistance is the product of the pressure and current, or $E \times I$. The watts lost may be found in another manner; thus watts $= I^2 R$.

The current flowing through the inductance coil is lagging behind the applied pressure by 90°, and its magnitude is obtained by dividing the applied pressure by the reactance of the coil, $2\pi fL$. The power lost in the coil is zero, because the current and pressure are 90° apart, hence the energy which at one instant is stored in the magnetic field is in the next instant returned to the circuit.

The resultant current cannot be found by simply adding the two currents together. Due regard must be paid to their phases. As the currents are 90° out of phase we may find the resultant, or total current, by the simple vector construction given in Fig. 53. Here the horizontal line represents to scale the current flowing through the resistance. The vertical line represents to the same scale the current flowing through the inductance. The total current is given by OB, that is, the *vector* sum of the two components, and the angle of lag is the angle θ. Instead of constructing the vector diagram the current may be obtained by a simple calculation. From the diagram it is clear the length OB equals $\sqrt{I_1^2 + I_2^2}$ amperes, where I_1 is the current in the resistance, and I_2 the current in the coil.

As a practical example, suppose the coil has an inductance of 1 henry, and the resistance is 200 ohms. What is the total current, the

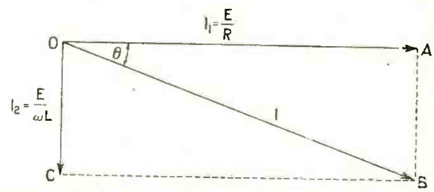


Fig. 53. Vector construction to find the total current I amperes due to the combined currents I_1 amperes through the resistance and I_2 amperes through the inductance.

current in the resistance, and the current in the coil. The pressure applied is 500 volts, 50 cycles. See Fig. 54.

The current in the resistance is equal to the pressure divided by the resistance, or $\frac{500}{200} = 2{\cdot}5$ amperes. The current in the coil is equal to the pressure divided by the reactance of the coil. Reactance $= 2\pi fL$ or $2 \times 3{\cdot}14 \times 50 = 314$ ohms. Therefore the current is $\frac{500}{314} = 1{\cdot}59$ amperes.

The currents, with their proper phase difference (90°) are represented in Fig. 54.

The total current I is given by $\sqrt{I_1^2 + I_2^2}$ where $I_1 = 2{\cdot}5$ amperes and $I_2 = 1{\cdot}59$ amperes. Therefore $I = \sqrt{6{\cdot}25 + 2{\cdot}53}$, or 2·96 amperes. The phase angle between the total current and

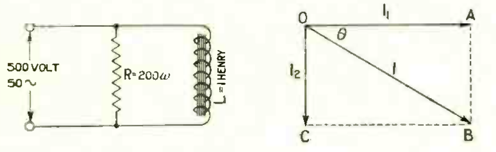


Fig. 54. The total current flowing in this parallel circuit is 2·96 amperes.

applied pressure is represented by the angle θ, which is the angle whose tangent is $\frac{I_2}{I_1}$. In this case θ is the angle whose tangent is 0·604, or 31°. The current lags by this angle.

From the vector construction it is evident that we may write an expression for the resultant current directly. Referring to Fig. 53, the length OA is directly proportional to $\frac{1}{R}$, that is, the *admittance* of the resistance. The length OC is directly proportional to the admittance of the inductance, that is $\frac{1}{\omega L}$. The resultant admittance is therefore given by $\sqrt{\frac{1}{R^2} + \frac{1}{(\omega L)^2}}$. When dealing with Ohm's Law in the ordinary way we find the current by dividing the pressure by the resistance, or $I = \frac{E}{R}$. Since the admittance is the reverse of resistance, that is $\frac{1}{R}$, to find the current we must multiply the pressure by $\frac{1}{R}$. Clearly $\frac{E}{R}$ is the same as $E \times \frac{1}{R}$. In the above case, the current is given by the product of pressure and total admittance, *i.e.*, $E \times \sqrt{\frac{1}{R_2} + \frac{1}{(\omega L)^2}}$.

Rearranging the expression for total admittance we may write the effective impedance

$$Z\ eff = \frac{RL\omega}{\sqrt{R^2 + L^2\omega^2}}.$$

Therefore, the effective impedance of a combination of resistance and inductance in parallel is equal to $\frac{RL\omega}{\sqrt{R^2 + L^2\omega^2}}$ ohms.

The effective resistance of the circuit, that is, that quantity which, when multiplied by the total current squared is equal to the power lost in the circuit, may be expressed as follows:

$$R\ eff = \frac{RL^2\omega^2}{R^2 + L^2\omega^2}$$

Therefore the total current squared, I^2, times $R\ eff$, being the power lost in the circuit, is the same as the current in the resistance squared I_1^2 times the resistance R.

It will be noticed that while a large current may be flowing in the inductance, only a small current is being taken from the mains, depending upon the value of the inductance and the resistance.

25.—Capacity and Resistance in Parallel.

When we have a condenser in parallel with a resistance, as shown in Fig. 55, the currents flowing are found by applying the same principles that were applied in the case of inductance and resistance in parallel.

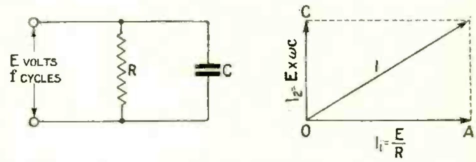


Fig. 55. Circuit consisting of resistance and capacity in parallel.

The current in the resistance is in phase with the pressure, while that in the condenser leads the pressure by 90°. The current in the resistance is given by $\frac{E}{R}$, and that in the condenser by $E \times \omega C$, where ωC is the reactance of the condenser ($\omega = 2\pi f$).

The total current is the vector sum of the two currents. Thus in Fig. 55 OA represents to scale the current in the resistance, and OB represents the phase and magnitude of the condenser current. The resultant,

$$I = \sqrt{I_1^2 + I_2^2} \text{ amperes.}$$

The angle of lead, θ, is the angle whose tangent is ωCR.

The admittance of the circuit is

$$\sqrt{\frac{1}{R^2} + \omega^2 C^2} \text{ mhos.}$$

Therefore the current $I = E \times \sqrt{\frac{1}{R^2} + \omega^2 C^2}$.

The effective impedance of the circuit

$$Z\ eff = \frac{R}{\sqrt{1 + (R^2C^2\omega^2)}},$$

while the effective resistance

$$R\ eff = \frac{R}{1 + (R^2C^2\omega^2)}.$$

The meaning of the above terms have been explained in the last section.

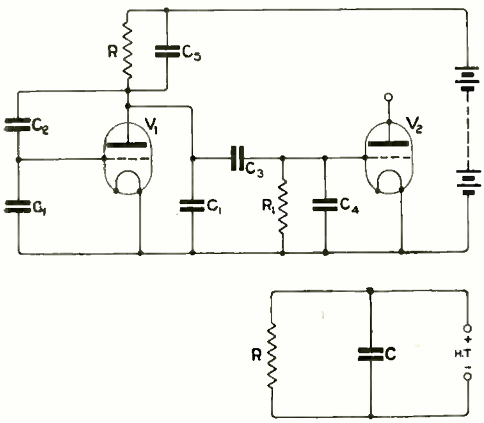


Fig. 56. Diagrammatic arrangement to show the capacities which shunt a resistance used in the anode circuit of a valve.

It is well known that the resistance capacity method of coupling radio-frequency amplifiers is not successful below about 2,000 metres, corresponding to a frequency of 300,000,000/2,000, or 150,000 cycles. Later it will be shown that the amplification obtained from a valve with its associated circuits depends largely upon the ratio of the internal impedance of the valve, and the impedance of the output circuit. In the case of the "R" type valve, the internal or plate to filament impedance under working conditions is of the order of 30,000 ohms. Therefore, to secure high amplification with the resistance capacity method of amplification the anode circuit resistance should be at least 70,000 to 100,000 ohms.

Now a valve with its socket, and the wiring with which it is connected, possesses capacity. The capacity is present between the filament and grid, filament and anode, and grid and anode. The resistance itself may possess capacity. The circuit is given in Fig. 56. Here V represents the amplifying valve, C_1 the anode-filament capacity, C_2 the anode grid capacity, C_3 is the grid condenser with leak R_1, and C_4 represents the grid-filament capacity of the second valve V_2. The whole circuit may, so far as the resistance R is concerned, be represented by a resistance with a capacity of value C across it. The capacity C may be considered as the resultant of the capacities just mentioned.

Now we know the effective impedance of a circuit comprising R and C in parallel is given by $\frac{R}{\sqrt{1 + (R^2C^2\omega^2)}}$ ohms. Let us now work out the value of the effective impedance of the output circuit RC for three wavelengths, namely, 20,000 metres, 2,000 metres, and 300 metres. The corresponding frequencies are 15,000, 150,000 and 1,000,000. An average value of the nett capacity across the resistance R may be in the neighbourhood of 25 micro-microfarads ($\mu\mu$F). Let $R = 100{,}000$ ohms.

Case 1.

Frequency (f) = 15,000. $R = 100{,}000$ ohms.

$C = 25\mu\mu F$ or 25×10^{-12} farads.

$\omega = 2 \times 3{\cdot}14 f$.

$$Z\ eff = \frac{R}{\sqrt{1 + (R^2C^2\omega^2)}} \text{ ohms.}$$

substituting the values,

$$Z\ eff = \frac{100{,}000}{\sqrt{1 + (10^{10} \times 625 \times 10^{-24} \times 887 \times 10^7)}}$$

and $Z\ eff = \frac{100{,}000}{\sqrt{1}}$ or 100,000 ohms.

Case 2.—In this example the frequency is 150,000 cycles.

$$Z\ eff = \frac{100{,}000}{\sqrt{1 + (10^{10} \times 625 \times 10^{-24} \times 887 \times 10^9)}}$$

$$Z\ eff = \frac{100{,}000}{\sqrt{1 + 5{\cdot}5}} = \frac{100{,}000}{\sqrt{6{\cdot}5}}$$

or 40,000 ohms.

C

Case 3.—In this case the frequency is 1,000,000.

$$Z\ eff = \frac{100{,}000}{\sqrt{1+(10^{10}\times 625\times 10^{-21}\times 394\times 10^{11})}}$$

$$= \frac{100{,}000}{\sqrt{1 + 246}}$$

or 6,000 ohms.

In the case of the 20,000 meter signals, the impedance is equal to that of the resistance; in other words, the capacity is negligible. When the 2,000 meter signals are amplified, the capacity has a fairly large effect, the impedance is reduced from 100,000 ohms to 40,000 ohms. When, however, the signal wavelength is reduced to 300 meters, the impedance is reduced from 100,000 ohms to 6,000 ohms. In Fig. 57 is shown the relationship between the amplification obtained and the value of anode resistance (impedance strictly speaking on account of the stray capacity). It will be seen that high amplification is obtained when the conditions are as in Case 1, but low amplification will be obtained when the conditions are as in Case 3. The resistance capacity method of radio-frequency amplification is therefore not satisfactory at low wavelengths. The figure of 2,000 metres,

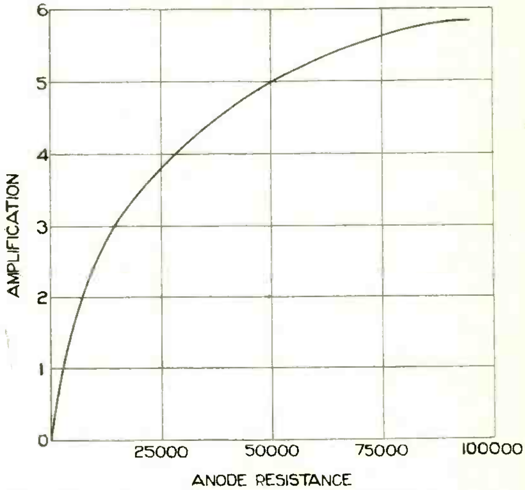


Fig. 57. Curve showing the amplification which may be expected when various anode resistances have various effective values.

below which it is suggested this method of amplification be not employed, represents, therefore, a reasonable value.

(The next instalment under this heading deals with the factors relating to Resonance and the Principles of Tuning.)

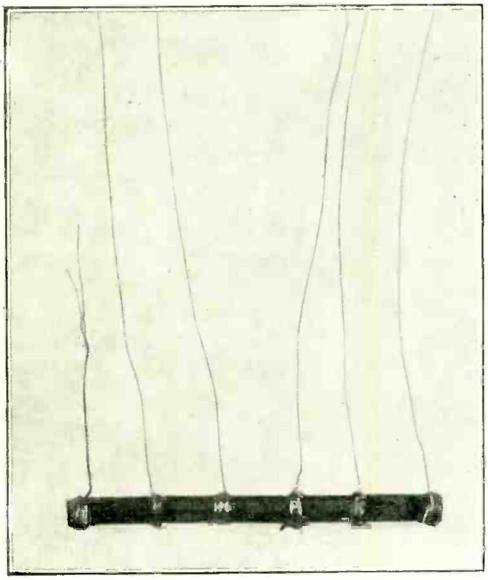
A Variable Non-Inductive Resistance.

By PAUL D. TYERS.

THE photograph on the next page shows a form of tapped resistance which has been used with success for some years. The resistance itself is the familiar graphite deposit on a piece of slate pencil, and calls for no particular attention. In making a resistance of this type it is frequently difficult to obtain an efficient electrical contact between the graphite and some form of metallic clip, but this trouble has been obviated by the following method of construction, which should be quite clear from the illustration.

If a tapped resistance is to be employed the whole length of an ordinary slate pencil with about five tappings is suitable, but if a single resistance is required about a two-inch length will be sufficient. If a lathe or a hand drill clamped in a vice is available it will be found very convenient to put the slate pencil in the chuck since the finished resistance will have a better appearance and also it will be found easier to construct.

The pencil is first made perfectly smooth by rubbing it with very fine sandpaper, taking care to remove all loose dust with a piece of rag. At this stage it is important not to touch the slate with the hand, as a very thin film of grease will be deposited, spoiling the effectiveness of the subsequent operations. The pencil is now marked into five equal parts and at each division a small band of graphite is deposited, about $\frac{3}{8}$ in. wide. For this purpose an HB lead pencil is suitable. The graphite should be forced well into the surface of the slate pencil until the band has a polished appearance. This is very easily accomplished, if the slate pencil is held in a chuck, by placing the point of the lead pencil on one side of the slate and holding a piece of paper behind it. As the slate revolves, the paper and pencil can be gripped tightly by the forefinger and thumb, thus obtaining a good deposit without danger of snapping the slate which is very brittle.



The variable resistance described in this article.

Contact is made with the graphite bands by means of sleeves made from tinned copper wire which are shrunk on. A length of tinned copper wire, about No. 28 S.W.G., is made perfectly clean by scraping it with the edge of a blunt knife, taking care not to make any nicks in the wire which might cause it to break. About five turns of the wire are taken round the first graphite band and the short end of the wire is twisted round the other end which is afterwards taken to a five-point switch. The wire is twisted up tightly with a small pair of pliers until it is friction tight on the slate pencil.

The success of the contact depends upon the final operation, which must be carried out with great care. A soldering iron must be carefully cleaned and well tinned. A small piece of solder is then picked up on the tip of the iron (which must be rather hotter than usual) without the aid of any type of flux. This will be found very easy if everything is quite clean. The twisted ends of the wire are now firmly gripped in the pliers and the far end of the slate pencil is rested on the table so that it is inclined at an angle of about 45 degrees.

The soldering iron is now applied to the turns of the wire. If the wire is quite clean the solder will flow evenly and close up the gaps between the turns, and at the same time the heat will cause the wire to expand, thus making the turns a loose fit on the slate. By exerting a gentle pressure it will be found that the turns will all slip sideways, thus making them a tight fit on the slate once more. As the solder begins to cool the turns will contract, resulting in a very firm connection. It is important to keep everything very still while the solder is setting, and also to remember that no flux must be used. If any flux is present it simply runs between the wires and the slate, resulting in a very inefficient connection.

The process is repeated with the other tappings, which are finally connected to a multi-point switch. The values of the tappings are adjusted by filling the remaining space between the graphite bands with pencil lines until the desired resistances are obtained.

When used as the coupling device in a resistance amplifier the variable tappings will be found of great value, while in other spheres it is equally useful.

Unknown Calls.

Particulars of the locality, etc., of the stations with the following call signs would be of great interest to the many amateurs who have received their transmissions. Any details forwarded we shall be glad to incorporate in our future lists of amateur transmitting stations.

Operators of Experimental Receiving Stations will encourage the holders of transmitting licences to publish up-to-date details as to power, location, etc., by doing them the service of sending reports relating to the experimental transmissions.

The call signs are as follows :—

2 AD	2 XG	5 IS	5 HX
2 AH	2 XT	5 FL	5 RY
2 BN	2 YD	5 LF	5 CG
2 BX	2 YA	5 JW	5 XJ
2 CV	5 AM	5 JM	5 YY
2 DM	5 AC	5 MA	5 NT
2 FS	5 CB	5 MY	5 OG
2 HO	5 DT	5 OH	5 HG
2 LH	5 HW	5 PZ	5 BT
2 OB	5 HK	5 SR	2 IO
2 PK	2 DM	5 VR	6 AJ
2 QX	2 CV	5 ZJ	5 IJ
2 TU	2 OC	5 OC	2 ZJ
2 PW	2 DM	2 AM	5 LS
2 VB	2 XT	2 XB	5 LC
2 VH	5 AR	5 US	5 NZ
2 VR	5 IX	5 CR	

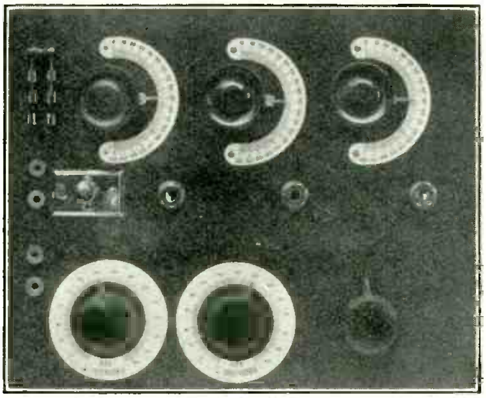
THE NEW

DOUBLE MAGNIFICATION RECEIVER

By W. JAMES.

GREAT interest has been aroused in the circuit of the new double magnification receiver, first described in this country in the issue of May 19th of this journal (page 213, Figs. 9 and 10).

The circuit finally adopted for a practical receiver employs two valves, with a crystal as rectifier. A simple theoretical diagram, with an explanatory diagram, is given in Fig. 1. It will be noticed the aerial circuit is coupled with a closed circuit, which consists of the usual coil and condenser. The H.F. transformers have their secondary windings tuned. A radio-frequency choke coil is connected between one side of the crystal and the first L.F. transformer to prevent any radio-frequency energy which may pass the rectifier returning to the grid circuit of the second valve. A carborundum-steel rectifier is satisfactory when used in conjunction with the potentiometer.



Photograph showing the front view of the new double magnification receiver.

The photograph shows a receiver built by the writer. It will be noticed jacks and switches are provided. The connections, together with constructional details, will be given shortly. A number of refinements are incorporated in the finished instrument.

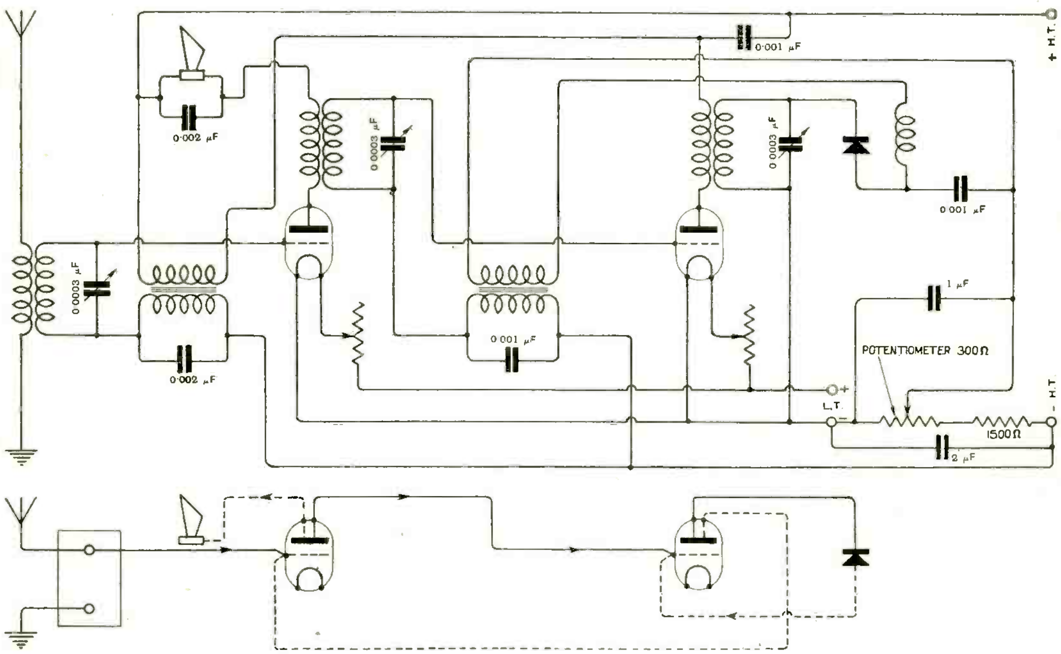


Fig. 1. The figure gives the theoretical connections of the new double magnification receiver. It will be observed that a number of new features are included for the first time. The lower figure shows schematically the circuit arrangement.

Wireless Club Reports.

NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter and worded as concisely as possible, the Editor reserving the right to edit and curtail the reports if necessary. **The Editor will be pleased to consider for publication papers read before Societies. An Asterisk denotes affiliation with the Radio Society of Great Britain.**

Correspondence with Clubs should be addressed to the Secretaries direct in every case unless otherwise stated.

Portsmouth and District Wireless Association*

On May 2nd and 9th, Mr. J. H. C. Harrold, M.I.R.E., spoke on "Ether Waves and Wireless Telegraphy."

The first number of the Association's journal, *The Portsmouth Aether*, has now appeared, and has been well received by the local press.

Hon. Sec., Stanley Hogg, 50, Waverley Road, Southsea.

Windlesham and District Radio Society.*

On May 4th Mr. Kenneth E. Strohmenger delivered an able and informative paper upon "The Principles and Care of the Accumulator."

Hon. Sec., James Baker, Windlesham Schools, Surrey.

North Middlesex Wireless Club.*

A very successful meeting was held at Shaftesbury Hall, Bowes Park, N., on May 2nd, when a lecture was given by Mr. T. Weare on "Workshop Wrinkles." The lecturer took as his text the making of a complete wireless set from raw material.

There was a good gathering of members on May 16th, when the Club's popular President, Mr. A. G. Arthur, delivered an interesting lecture. Mr. Arthur prophesied that within the next year or two many new discoveries would be made in wireless, and said it behoved the members to keep their Club in the forefront of progress.

Particulars of membership can be obtained from the Hon. Sec., H. A. Green, 100 Pellatt Grove, Wood Green, N.22.

Streatham Radio Society.*

At the annual general meeting of the Society, held on May 2nd, the Hon. Treasurer presented a satisfactory balance sheet, in spite of the somewhat heavy expenses of the first year. The following officers were re-elected :—Chairman, Mr. H. Bevan Swift, A.M.I.E.E. Secretary, Mr. S. C. Newton, A.M.I.E.E. ; Treasurer, Mr. A. G. King. The following were elected as Committee :—Messrs. Wood (Asst Secretary), H. T. Swift, Batten, Thomas, Clarke and T. Wartman (Librarian).

A demonstration of members' apparatus was given on May 9th, the exhibits ranging from miniature crystal sets to large multivalve sets and home-made loud speakers. A heterodyne wavemeter has been purchased by the Society. The Society meets at the headquarters, 35, Streatham High Road, upon the second and last Wednesdays in the months during the summer.

Hon. Sec., S. C. Newton, A.M.I.E.E., "Compton," Pendennis Road, S.W.16.

The Radio Society of Highgate.*.

Mr. H. Andrewes, B.Sc., continued his series of lectures on Friday, May 4th, by giving a lecture on "C. W. Transmission." Various examples of British, French and German transmitting valves were exhibited, and their characteristic features explained. The lecturer concluded a highly instructive discourse with a few remarks on the subject of microphones and speech amplifiers.

A lecture and demonstration was given on May 18th by Mr. J. F. Stanley, B.Sc., A.C.G.I., F.R.A., his subject being "Selective Tuning Circuits." A demonstration of a circuit tried out by the lecturer was given ; the London Broadcasting Station was completely eliminated, Manchester being tuned-in while the former station only four miles away was in full blast.

Several specially attractive features are promised in the near future, full particulars of which may be obtained from the Hon. Sec., J. F. Stanley, B.Sc., A.C.G.I., F.R.A., 49, Cholmeley Park, Highgate, N.6.

Wireless and Experimental Association.*

At the Camberwell Central Library, on Wednesday, May 6th, Mr. Voigt outlined a scheme whereby it should be possible, with two small choke coils and two small fixed condensers, to utilise as a twin aerial the two suspended wires feeding the loud speaker at the far end of the hall.

The Dulwich and District Branch of the Association met at the Montessori School, Lordship Lane, on Monday, May 7th, when the following gentlemen were elected as Committee of Management :—Messrs. Faulkner, King, Sinclair, Munday, and Barrett.

Mr. Geo. Sutton, A.M.I.E.E., then delivered an elementary lecture on crystal and valve sets with variometer tuning devices.

Hon. Sec., Geo. Sutton, A.M.I.E.E., 18, Melford Road, S.E.22.

North London Wireless Association.*

Mr. A. G. Hill, on May 7th, gave a paper on "Experiences in Radio Reception," giving some interesting details relating to the earlier days of wireless, when difficulties were experienced in obtaining supplies of material and the data available was sparse.

Mr. F. S. Angel, on May 14th, gave his eighth lecture on the elementary principles of wireless, choosing as his subject "Rectifying and Detecting."

Particulars of membership will be sent by return of post on application to the Hon. Sec., J. C. Lane, Physics Theatre, Northern Polytechnic Institute, Holloway Road, N.

Ilkley and District Wireless Society.*

"Soft Soldering" was the subject of an instructive demonstration on May 7th by Mr. L. L. Lancaster, who gave valuable advice to the members on this important aspect of constructional work.

Hon. Sec., L. E. Overington, 11, Wilmot Road, Ilkley, Yorks.

Smethwick Wireless Society.*

An interesting lecture and demonstration was recently given by Mr. C. Grew, the Society's Technical Adviser, who described his three-valve experimental set, using a special circuit, which he illustrated on the blackboard. All the British broadcasting stations were tuned-in and made audible to the meeting by means of a Western Electric Power Amplifier.

Prospective members should communicate with the Hon. Sec., Ralph H. Parker, F.C.S., Radio House, Wilson Road, Smethwick, Staffs.

Birmingham Experimental Wireless Club.*

"Receivers and Amplifiers for Broadcasting Reception" was the subject of a successful lecture and demonstration given by Mr. Towers recently.

Good results were obtained on the Club's aerial.

Hon. Sec., A. Leslie Lancaster, c/o Lancaster Bros. & Co., Shadwell Street, Birmingham.

The Hon. Sec. will be pleased to forward particulars of the Society to anyone interested.

Hon. Sec., T. H. Mather, 8, Hawkshaw Avenue, Darwen.

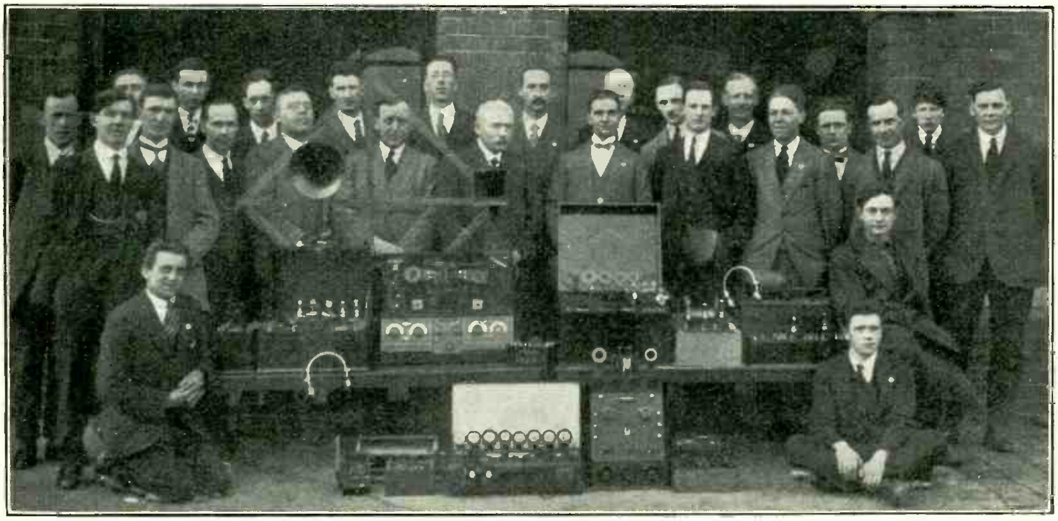
South Shields and District Radio Club.*

On Friday, April 20th, a lecture on "Directive Transmission and Reception and their Value" was delivered by Mr. R. Oliver.

After describing the directional aerial systems of stations such as Leafield and Cairo, Mr. Oliver spent considerable time with frame aerials for reception, and in conclusion spoke of the tremendous value of directional wireless during the war.

The Club's first Annual Exhibition was held from April 24th to 28th, inclusive. Seven trade firms in the district exhibited, and amateur apparatus was a large feature of the exhibition. In the latter section a *19-valve set*, built by the Club's Chairman, attracted considerable attention.

Particulars of membership may be obtained from the Hon. Sec., J. A. Smith, 66, Salmon Street, South Shields.



Our illustration shows the apparatus of the members of the Chesterfield and District Radio Society, exhibited on May 8th.

The Wireless Society of Hull and District.*

On April 27th, a discussion took place on the best and quickest method of obtaining a working knowledge of the Morse alphabet.

Ought a Broadcasting station, or a station for relaying purposes, to be established in the neighbourhood of Hull? This was one of the many topics discussed at an informal meeting of the Society held on May 4th.

Will all members please note that headquarters of the Society are now at the Co-operative Social Institute, Jarratt Street, where meetings are held every Friday evening at 7.30 p.m.

Hon. Sec., H. Nightscales, 47, Wenlock Street, Hull.

Darwen Wireless Society.*

Mr. T. Burton gave an instructive lecture on April 26th entitled "The Construction of Apparatus," illustrating his remarks with many examples.

On May 2nd, Mr. C. Field, B.Sc., gave a very interesting lecture on "Tuning."

Luton Wireless Society.*

The third annual exhibition in connection with the Society was held on Saturday, April 28th, at the Church Street Conference Hall of the adult school. Stands were occupied by Messrs. P. T. King, E. Whitelock, J. Stearn, F. F. Gregory, Borough Engineering Co., H. S. Shoolbred, F. F. Weeks and W. Hammond. The middle of the Hall was occupied by the amateur section and some thirty receiving sets representative of the work of members of the Society were exhibited. A feature of the exhibition was the work of junior members in competition. The first prize for ingenuity was awarded to Master Rayment and the second to Master Prosser.

The good attendance was encouraging, and the funds of the Society were substantially increased.

Hon. Sec., W. F. Neal, Hitchin Road Boys' School, Luton.

Hackney and District Radio Society.*

On Thursday, May 3rd, the usual weekly meeting was suspended on the occasion of a concert and gymnastic display arranged by the Y.M.C.A. boys, at whose request the Society gave a special radio demonstration, the apparatus used belonging to the Vice-President, Mr. E. Cunningham.

On Thursday, May 10th, a special lecture was delivered by Mr. L. L. Robinson, M.Inst.C.E., M.I.E.E., M.I.Mech.E., Chief Electrical Engineer for the Borough of Hackney. The meeting was presided over by the Mayor of Hackney, the President of the Society. Mr. Robinson spoke on "Electric Currents, Minute and Large" treating of the phenomenal and physical principles of the currents used, with special reference to wireless.

A round table conference took place on May 17th, when dissatisfaction was expressed at the fact that the Technical Committee had not completed the Society's set.

Hon. Sec., C. C. Phillips, 247, Evering Road, E.5.

Swansea and District Radio Experimental Society.

"Elementary Principles of Wave Motion" was the subject of an instructive lecture delivered recently by Mr. McNamara, before a large gathering of members.

A further series of elementary lectures for the non-technical man will be given at a future date, and all beginners in wireless theory are cordially invited to attend.

Hon. Sec., Herbert Morgan, 218, Oxford Street, Swansea.

Camberwell and District Wireless Club.

An entire reorganisation of this Club is now being undertaken by a "live" committee, and arrangements are being made for lectures, demonstrations, etc.

All interested should communicate with the Hon. Sec. (pro tem.), René Stone, 3D, Bushey Hill Road, Camberwell, S.E.5.

The Senior Lintonian Radio Society.

The first meeting of the summer session was held on Wednesday, May 2nd, when the Chairman, Mr. J. A. Hardy, announced that Mr. E. L. Booker, B.Sc., had been elected a Vice-President.

Mr. D. G. Bower (5 WF), then delivered the first of an elementary series of lectures to be given by him.

The Society is doing its best to limit the number of "canaries."

Hon. Sec., J. D. Meeke, 14, Avonmore Road, West Kensington, W.14.

The Beckenham and District Radio Society.

An informal chat on the "Evolution of Wireless," was given by Mr. J. F. Butterfield, on May 3rd.

A detailed report on the work of the Society's new set was afterwards submitted by Mr. Langley.

The Society wishes it to be known to all interested that new headquarters have been secured at the premises of the British Legion, High Street, Beckenham. The new headquarters are a great improvement on those vacated.

Hon. Sec., J. F. Butterfield, 10, The Close, Elmers End, Beckenham.

Leeds Y.M.C.A. Wireless Society.

On May 4th and 5th, the Society held its first exhibition, at which almost all the local dealers were represented.

A particularly interesting feature was the display of old and new apparatus, kindly loaned by courtesy of the O.C. 49th W.R. Signals (T.A.), ranging in date from about 1900 to the present time.

On the first evening the chief event was a lecture by Professor R. Whiddington of the Leeds University entitled "The How and Why of Wireless."

The committee wish to tender their thanks to all who assisted them to make the exhibition the undoubted success it was.

Hon. Sec., N. Whiteley, Headquarters Y.M.C.A., Albion Place, Leeds.

Loughborough and District Radio Society.

"The Maintenance of Receiving Apparatus," was the subject of an interesting talk given on Friday, May 4th, by Mr. E. W. Plant, who gave a very clear description of a circuit using dual amplification with a crystal detector. **5 IT** was received very well on a set modified to demonstrate the circuit.

The building of a receiving set is being proceeded with, which will be designed for experimental purposes—testing circuits, etc.

All interested in radio are invited to attend the Society's meetings which are held every Friday, when particulars of membership will gladly be given by the Corresponding Secretary.

Hon. Corresp. Sec., W. J. Tucker, 1, Charnwood Road, Loughborough.

Electron (Junior) Radio Club.

On May 7th, an interesting paper dealing with "The History of Wireless," was read by Mr. W. Cockerton.

Mr. L. A. Brent then described and demonstrated his three-valve receiver, the members enjoying extracts from the programmes of the various broadcasting stations.

Prospective members are cordially invited to attend any of the meetings at the Headquarters, 215, High Street, Lewisham, S.E.13., any Monday evening, or to communicate with the Hon. Sec., James Day, 36, Springrice Road, Hither Green, S.E.13.

The Leyton Wireless Society.

A successful meeting of the Society was held on Monday, May 7th, when a very interesting lecture and demonstration on "Valves" was given by Mr. P. J. Slade.

Meetings are held fortnightly, and the Secretary will be glad to hear from any prospective members.

Hon. Sec., W. G. Peacocke, 73, Frith Road, Leytonstone, E.11.

Notes and News

The erection of a broadcasting station near Dublin is under consideration.

* * * * *

A curfew ordinance for the suppression of raucous loud speakers after 9 p.m. has been suggested at Sierra Madre, California.

* * * * *

Fear is expressed in Paris that the churches may suffer as the result of the popularisation of broadcasting.

* * * * *

A wireless sermon is stated to have converted a man at a distance of 500 miles.

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A plea for midday wireless concerts for industrial workers is being put forward by the Industrial Welfare Society.

* * * * *

Mr. Bernard Shaw thinks that the Society of Authors should appoint a man to listen in permanently to discover whether copyright is being nfringed.

Telephony from Rome (Centocelle).

The times of gramophone transmissions from the above station have now been changed, and are as follows. Daily: 11.15 to 11.45 a.m., 6.30 to 7 p.m. (British Summer Time). It will be remembered that Centocelle transmits on a wavelength of 2,900 metres.

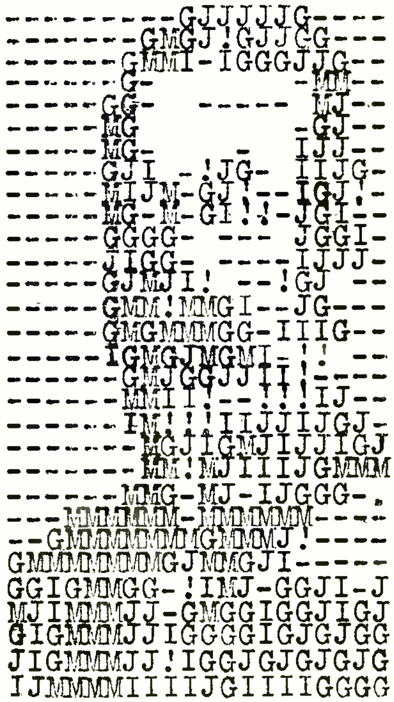
2 LO Enjoyed in Spain.

An encouraging letter has been received by Messrs. Burndept, Limited, the well-known wireless manufacturers, from a gentleman at Salamanca, in Spain. An Ultra IV set (one H.F., detector and two L.F.) was recently installed for this customer, Conde de Alba de Fettes, who writes that he is able to distinguish every word from the London station on the loud speaker. A curious phenomenon, it is stated, is that when tuned in nothing is heard until about 15 minutes after sunset, when telephony suddenly comes in as strong as it will be for the whole evening. Salamanca is some 980 miles distant from London.

Import Duties on Wireless Apparatus.

In the monthly Bulletin of the British Chamber of Commerce in Paris appears the following:—"In view of the numerous inquiries received at this Chamber with regard to the Customs duties payable in England on imported wireless apparatus, we beg to inform interested members that, besides wireless valves, the only parts of wireless receiving sets, as commonly imported into the United Kingdom, that are liable to the Key Industries duty of 33⅓ per cent. are variable condensers and any permanent magnets contained in headphones."

A BROADCAST PORTRAIT.



Above is a portrait of H.M. The King, as it was "dictated" by Doctor Fournier D'Albe during the children's hour at **2 LO** *on May 24th. To obtain the most realistic effect the portrait should be viewed at a distance of several feet.*

Interference at Bournemouth.

A complaint of the abundance of "howlers" in the Bournemouth district is made by Mr. J. P. J. Chapman, who appears to the sporting instinct

NEW BROADCASTING TIME TABLES.

An important broadcasting arrangement, affecting the owners of valve sets, comes into operation on June 1st. On and after that date there will be half-hour intervals in the various broadcasting programmes, allowing listeners-in to tune in other stations. The intervals of closing down at the respective stations will be as follows:—

LONDON	7.30 to 8 p.m.
MANCHESTER and GLASGOW	7.45 to 8.15 p.m.
CARDIFF and NEWCASTLE	8.0 to 8.30 p.m.
BIRMINGHAM	8.15 to 8.45 p.m.

On and after the same date, programmes will begin and finish half-an-hour later.

of certain owners of receiving sets in the neighbourhood. As an experimenter, our correspondent finds it particularly annoying to have his calculations upset by the constant chirps of surrounding sets, and he trusts that, should this notice catch the eye of some of the "howlers," they will give a thought to their fellow listeners-in.

Radio Search for Kidnapped Child.

Of dual interest to wireless enthusiasts is the report of a wireless search for the kidnapped son of Mr. E. F. W. Alexanderson, the eminent American radio scientist.

Verner Alexanderson, six-year-old son of the inventor of the Alexanderson alternator, disappeared suddenly from his home at Schenectady on April 30th. Repeated announcements of the disappearance were made from **WGY**, the General Electric Company broadcasting station, and lantern slide portraits were exhibited in the local cinemas. We have no information regarding the outcome of the search.

The Telephone Manufacturing Co., Ltd.

It has recently come to the notice of Messrs. The Telephone Manufacturing Co., Ltd., that price cutting in the sale of their instruments is taking place. In the event of their learning of any further cases of this kind they will be compelled to take definite action.

A Mistake.

By an unfortunate inadvertency in the compilation of the advertisement of the Wellington Electrical and Radio Engineering Works, Ltd., appearing on page xxxix of the last issue of this Journal, the photograph of the "Ajax" Crystal Valve Detector was inserted upside down.

Book Review

Etudes Elémentaires de Météorologie Pratique, par Albert Baldit, *Ancien chef du Service Météorologique d'un groupe d'Armées de la Commission Météorologique de la Haute-Loire.* 2e édition revue et augmentée. Un volume in-8vo de ix-340 pages, avec 118 figures. (Gauthier-Villars et Cie, éditeurs), 24 fr.

The author of this book is a man of ideals as well as a practical meteorologist. The first part of the book deals very carefully with the planning of a complete National Weather Service, comprising (1) "regional" and (2) "mobile" weather stations. The latter are to be used in conjunction with aeroplanes. Such details as the geographical situation and the disposition of the various buildings in which the recording instruments are to be housed are described in very clear and readable French. We believe the sections on the use of wireless and the land-line telephone and the application of electrical methods to the recording of observations will appeal to the wireless man. The Rothé method of giving the wind at different levels by means of captive balloons by utilising the metallic cable of the balloon for receiving electrical impulses from the recording instruments when in the air, is one of the many devices fully described in the book.

Later chapters discuss the fundamental elements of wind and pressure and the Norwegian theory of Bjerknes in its relation to cyclonic depressions. The book is thoroughly up-to-date, and is, moreover, in some respects a departure from the usual text-books on the subject. We think that the wireless amateur who has become interested in the weather, will find much valuable information in this book and much that is not to be found elsewhere. W.G.W.M.

Correspondence

Referring to the letter from Mr. Gilsen MacCormack, published in last week's issue, it is understood that the organisation of programmes suggested therein has always been the ambition of the B.B.C. The difficulties which have been placed in the way of the company by certain interests have contributed chiefly to the lack of specialised programmes up to the present.—

EDITOR.

Forthcoming Events

FRIDAY, JUNE 1st.

Leeds and District Amateur Wireless Society. Lecture: "Weather Forecasting and Wireless," by Mr. S. Kniveton, F.R.Met.Soc.

Radio Society of Highgate. At 7.45 p.m. At the 1919 Club, South Grove, N.6. Lecture: "Electrostatic Loud Speakers," by Mr. F. H. Haynes.

SATURDAY, JUNE 2nd.

Plymouth College Fête. Wireless Exhibition and Demonstration by various manufacturers (including Messrs. R. L. Brock, Radio Communication Co., Mullard, Graham, McMichael, Igranic Electric Co., Sullivan, Gambrell, Zenith Mfg. Co.).

High Wycombe and District Radio Society. Outdoor meeting on Naphill Common. Special transmission from 2 OD.

MONDAY, JUNE 4th.

The North London Wireless Association. In the Physics Theatre, Northern Polytechnic Institute, Holloway Road, N. Lecture: "Inductance," by Mr. J. Nicol.

TUESDAY, JUNE 5th.

West London Wireless and Experimental Association. At the Acton and Chiswick Polytechnic, Bath Road, W.4. Lecture: "Radio Switching," by Mr. O. S. Puckle.

WEDNESDAY, JUNE 6th.

The Institution of Electrical Engineers (Wireless Section). At 6 p.m. (Light refreshments 5.30 p.m.) At Savoy Place, Victoria Embankment, W.C.2. Lecture: "Wireless Direction Finding in Steel Ships," by Mr. C. E. Horton.

THURSDAY, JUNE 7th.

Kensington Radio Society. Lecture: "Dual Amplification Circuits and Crystal Rectifiers," by Mr. Voigt.

Stoke-on-Trent Wireless and Experimental Society. Lecture: "The Measurement of Electrical Quantities," by Mr. R. W. Steel (Asst. Hon. Sec.).

Historical Notes on Radiotelegraphy and Telephony

By G. G. BLAKE, M.I.E.E., A.Inst.P.

(*Continued from page* 256 *of the previous issue.*)

In 1891 Professor Branley, in a paper in *La Lumière Electrique*, verified Onesti's observations, and also showed the very important further fact that filings could be made to cohere by electric discharge taking place in their vicinity.

With simple apparatus Hertz reproduced all the phenomena of light, including those of reflection and refraction (by means of a pitch prism) in accordance with Maxwell's hypothesis. Maxwell had predicted that their speed would be 186,000 miles per second, the same speed at which light travels, and Hertz supplied the verification. He measured their wavelength, and showed that they could have any length, from a fraction of an inch to many miles. Without all this knowledge wireless telegraphy, as we know it, would have been an impossibility.

It is not to be wondered at that Hertz did not realise the enormous field of usefulness which the production of the waves (called after his name) laid open.

Branley showed that if a small battery was connected across a tube fitted with two metal electrodes with metal filings between them, normally no current passed; but in the presence of electric waves they cohered, or stuck together, and allowed an appreciable current to pass. The little tube is now known as a Branley Coherer—he called it a "radio conductor."

One of the first to recognise the importance of Branley's coherer was Sir Oliver Lodge. He introduced certain improvements, and thus obtained greater sensitiveness. He also devised, in 1894, a mechanical tapper to automatically bring the filings to their normal non-conductive condition again after cohesion had been produced. Lodge exhibited his apparatus before the British Association in 1894, and received signals across a distance of 150 yards, but, strange to relate, the idea did not occur to him then that he had an instrument which might be turned to practical use for long distance radiotelegraphy.

Mr. Rutherford, at Cambridge, in 1896 succeeded in signalling half a mile with Hertzian waves, using a magnetic detector of his own invention.

In the year 1891 Admiral Sir Henry Jackson was greatly perturbed during the naval manœuvres by the difficulty they had of telling friend from foe, and for several years after this he puzzled over the problem of finding some form of secret intercommunication between ships. In 1895, when Bohr described a spring coherer, and knowing also of the work of Hertz, the idea occurred to him that he had within his grasp the elements of secret signalling. He renewed his researches, knowing nothing of the work of Lodge, Hughes, or anyone else, and, in August, 1896, he succeeded in sending telegraphic signals between two ships, using a coherer, and an electric bell acting as a tapper.

On September 1st, 1895, acting under Admiralty orders, he met Marconi at the War Office, and they compared results, which showed that they both had been working on identical lines, but with small differences in the details of the gear they employed. They worked and corresponded together for the next eighteen months, making much progress.

Then the Post Office also joined in. In the 1898 naval manœuvres wireless telegraphy was carried on successfully to a distance of 60 miles. In 1901 Admiral Jackson brought out a system of tuning, and succeeded (for the first time on record) in receiving simultaneously on the same aerial two different printed messages from two ships sending on different wavelengths 30 or 40 miles distant.

In 1904 Admiral Jackson took Marconi on board the battleship *Duncan* for his first long distance wireless telegraph test for ships, and messages from them were easily received at Gibraltar.

On his promotion to the post of First Sea Lord, which he held till 1917, he had much to do with that exceedingly important branch of the service, Wireless Telegraphy, throughout the War. Since that time, as President of Greenwich College, and Chairman of the Radio Research Board, he has been intimately connected with the modern advances in "Wireless."

Chunder Bose of Calcutta made a series of very useful experiments in the production of exceedingly short Hertzian waves at about this time, as did also Professor Righi of Bologna in Italy, and it was under this latter Professor that Marconi first became engaged in the study of wireless telegraphy.

Bose also tested coherence of practically all metals in 1899-1900 and found that while all metals cohered, potassium possessed the property of self decoherence, but had to be used under paraffin oil (or in a vacuum) to avoid oxidisation.

Between 1895 and 1896, Messrs. Popoff, Minchin and others applied the Hertzian method to the study of atmospheric electricity.

Popoff, in 1895, devised a receiver for wireless waves which worked perfectly over short distances.

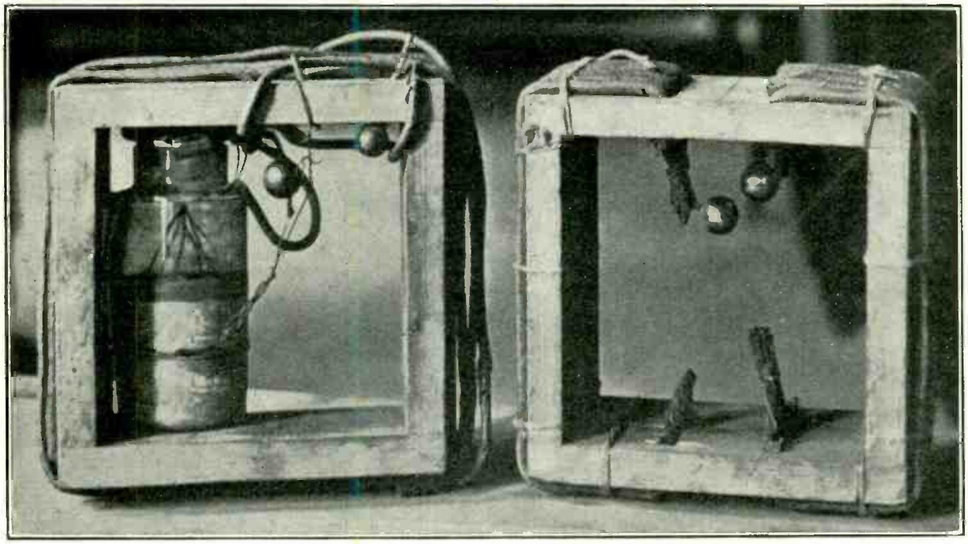
Hertzian-wave wireless had arrived at this stage when Marconi produced the first really reliable detector, using a greatly improved coherer of his own invention.

This little instrument was capable of resisting the comparatively rough usage of everyday work, and from that day successful radiotelegraphy became an established fact, and he set up long distance records one after the other, so fast that he astounded the world with his results. It is interesting to note that as far back as 1892 Sir

William Crookes prophesied the possibility of wireless communication as a serious factor in our lives and suggested that some day the simultaneous interchange of signals might be possible by employment of different wavelengths.

At first Marconi used metallic reflectors behind his transmitter and receiver and focussed the waves so that they travelled in parallel beams between the two places.

(Recently Franklin has been conducting experiments in this same direction).



By courtesy Marconi's Wireless Telegraph Co., Ltd.

Marconi's first short wave tuned Transmitter.

Marconi soon abandoned this arrangement, and used aerials, sometimes using wires attached to kites, like those employed by Loomis and Dolbear, and at other times using wires attached to the towers of high buildings, church steeples, etc. His first trials took place at Bologna. These proving successful, he came to England, and in 1896 was introduced by Mr. Campbell Swinton and the late Sir Wm. Preece, Chief Engineer of the General Post Office. Marconi was then only 22 years of age, and during this year took out his first patent. It is interesting to note that two years previous to the advent of Marconi, Sir Oliver Lodge had already given the first public demonstration of signalling through space by Hertzian waves, at the Royal Institution in 1894 and in 1896 Admiral Jackson had succeeded in signalling between two ships using a coherer and automatic tapper.

Shortly after its introduction to Sir Wm. Preece, the Post Office witnessed a trial, first at the G.P.O., through the walls of several rooms to a distance of 100 yards, and later, on Salisbury Plain, to a distance of two miles.

In 1897, he telegraphed across the Bristol Channel, 8.7 miles, using a 20-in. coil to excite the aerial. In 1899 he conducted a series of experiments, signalling between Dover Town Hall, first to South Foreland lighthouse, four miles distant, and then to the Goodwin lightship, 12 miles further off. Later he telegraphed across the Channel to Wimereux in France, and during these transmissions the signals were picked up also at the Marconi factory at Chelmsford, 85 miles from Wimereux, and later communication was established between these two places.

Marconi also carried out extensive trials in Italy, at the request of the Italian Government, with conspicuous success. Between 1899 and 1900, Dr. Eccles was engaged in development work on Marconi's experimental staff. One of the first things he did was to devise a method of testing coherers, to avoid the necessity of actual testing in reception of signals on an aerial.

The method consisted in plotting the characteristics. He was the first, I believe, to draw detector characteristics, and the first "characteristics" ever published appeared in the *Electrician* of September, 1901.

He also carried out considerable research upon the theory of coupled circuits, and as a result the old conically wound jiggers were superseded by plain solenoids or flat spirals.

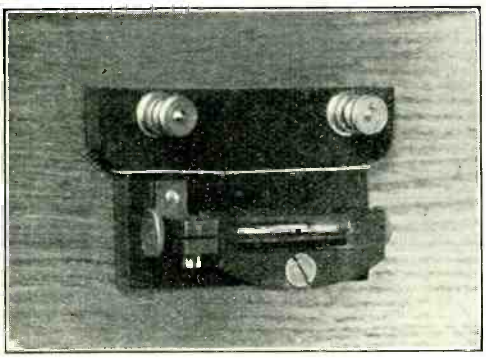
In 1900, he invented a detector in which the expansion of a very fine wire, traversed by signals, caused the alteration of a microphonic contact. This led to the invention of the "thermophone," a small instrument which was actually inserted in the ear, the air waves being produced without the aid of a diaphragm, by the expansion of the air in the aural passages due to the heating of the wire.

These instruments proved troublesome in use, owing to the frequent burning out of the wire by atmospherics.

In 1897, Professor Slaby, who was present during some of Marconi's trials, successfully carried out very similar experiments at Potsdam, and also carried out some investigations regarding the transmission of Hertzian waves through water.

In July, 1897, the Marconi Company was started, and the first long distance trial was made between Bath and Salisbury, 34 miles distant, with complete success. The first permanent station the Company erected was at Alum Bay, Isle of Wight, and was used to transmit to a small steamer which cruised about in the vicinity of Bournemouth.

In 1898, messages were sent between a temporary station installed at St. Thomas' Hospital and the House of Commons. In July, 1899, very extensive trials took place during British Naval manœuvres, the greatest distance at which ships communicated reliably being 60 nautical miles, although signals were clearly read in one direction only to a distance of 74 nautical miles (85 land miles). These results were obtained using Marconi's then newly patented form of induction coil to increase the potential of the received oscillations across the coherer.



By courtesy of the Institution of Electrical Engineers.

Detector used by Marconi to receive the first Transatlantic Signals (type invented by P. Castelli).

In 1899 Marconi apparatus was employed to report the progress of the yacht race between the *Columbia* and the *Shamrock*, after which the American Navy Board put the apparatus to some severe tests, and two ships were arranged to trans mit simultaneously. This had a disastrous result, rendering the received signals unintelligible. It is interesting to note that these tests were made just at the time of the outbreak of the South African War.

(In 1899 the War Office sent out some Marconi instruments to South Africa, but they did not work satisfactorily owing to presence of iron ore in the soil.)

In 1897 another epoch-making device was made by Sir Oliver Lodge, who took out a patent at that date, entitled, "Improvements in syntonised telegraphy without land wires."

Lodge had discovered how to tune circuits to a definite rate of oscillation, for transmission and reception, and it now became possible to have stations working on different wavelengths simultaneously without any interference taking place. At about the same time he produced an automatic method of rapid transmission and reception by means of a syphon recorder, using a disc coherer, which consisted of a steel disc revolving in a thin film of oil above a mercury container. The first wheel coherer was made by Robinson. This system worked perfectly for some time between Elmers End and Aldershot, 34 miles, and between Portland and Portsmouth, 62 miles.

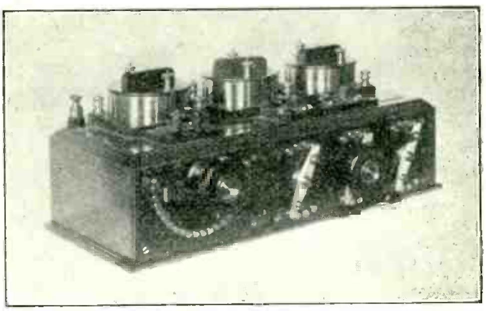
I remember listening in at Richmond to the signals. Sometimes a group of some three Morse letters would be transmitted for hours on end, and it caused us the greatest delight to listen to them. In those days one was glad to hear any station working, when one might listen for hours and find only unbroken silence in the ether. We also used to hear the London Telegraph Training College working with its second station at Mr. Scott's house at Mill Hill Park.

In 1901 the whole world was astonished by the news that Fleming, working in conjunction with Marconi, had transmitted the letter "S" from Poldhu in Cornwall to St. John's Newfoundland, a distance of 1,300 miles across the Atlantic Ocean, and shortly after signals were picked up on board an American liner, *Philadelphia*, fitted with Marconi apparatus, at a distance of 2,099 miles.

A most interesting account of this wonderful achievement appeared in the *Electrician* of June 20th, 1902, in the report of a lecture delivered by Senator Marconi at the Royal Institution. In this lecture he said that for the reception of the first transatlantic signals, he employed a mercury detector of the Italian Navy type. I will quote his own words: "These mercury detectors were used in Newfoundland, where, on a wire elevated by kites, the first signals were received from across the Atlantic."

In 1902, a very interesting patent was taken out under the name of the "Orling-Armstrong System," invented by Orling, a Swedish electrician, and Armstrong, a London engineer. The invention is based on the action of the Lipman capilliary voltmeter.

For transmitting, a constant current is employed between two metal rods driven into the ground and separated as widely as possible. The inventors claimed that with two rods at the transmitting station only 12 feet apart, and those at the receiving station only separated by a similar distance, signals could be transmitted to a distance of 20 miles. Even if this is so, which seems improbable, so many objections to the system exist (interference due to the leakage from electric mains, etc.) that it has not proved practical for ordinary use. A fuller description of this system is given in "The Story of Wireless Telegraphy," by Alfred T. Story also in Dr. Erskine Murray's handbook of Wireless Telegraphy.



By courtesy Marconi's Wireless Telegraph Co., Ltd.

An early Multiple Tuner.

The Johnson-Guyott system was invented in 1903, and tried from a Martelo tower near Pevensey, at about that date. It was impractical so far as distance telegraphy was concerned. It was very similar to that of Dolbear, the secondary of the transmitting coil being connected to earth and to a capacity respectively without the employment of any spark gap. I mention the system as I believe Johnson was the first to suggest the employment of a tuned contact breaker in the primary circuit of his coil for wireless telegraphy; this could be adjusted to vibrate at any desired frequency. Both Helmhaltz and Belo had employed tuned reeds; the former as a contact breaker, and the latter in connection with his early attempts at making a telephone.

The signals were received in a telephone of special design fitted with a reed tuned to the same frequency as the transmitter in the place of the usual diaphragm and could only be heard when the two stations were musically in tune.

In 1900—one year before Marconi's transatlantic achievement—P. Castelli, a signalman in the Italian Navy, invented a self restoring coherer which consisted of a globule of mercury in a glass tube between two polished iron or copper electrodes.

In 1902 the design of this coherer was slightly altered by Solari, who called it the American Navy detector.

Tesla, and many others since the earliest days of wireless, had suggested the employment of wireless as a means of correct time keeping.

In 1902 General Ferrié installed a receiving apparatus at the top of the Eiffel Tower, using a comparatively short aerial and the framework of the tower itself as an earth.

In the same year he installed a small station in a wooden hut on the Champs de Mars connected to an aerial suspended from the top of the tower.

The first experiments for the transmission of time signals from the Eiffel Tower were made by General Ferrié in 1909, and a regular service was announced in 1910.

This was, I believe, the first powerful station to give a regular transmission of time signals.

An American Naval station also transmitted time signals in 1909.

Before the war a German radio station (Norddeutsch) commenced a service of time signals in 1911. During the war, in 1919, Nauen also began a time signal service.

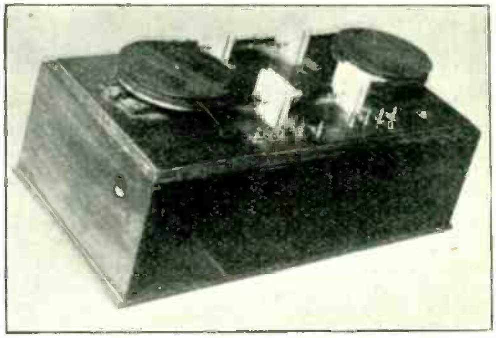
In 1899 General Ferrié invented a coherer, using gold filings, the quantity of which was capable of regulation, afterwards he carried out a series of experiments on the indirect excitation of aerials (loose coupled circuits). He also experimented on the form of the aerial and the influence of its height and capacity on its range. In 1901 he measured the wavelength of the emitted waves by ascertaining the position of nodes and loops on an insulated horizontal wire of variable length, at the base of the aerial. A thermionic amperemeter at the base of the wire indicated the exact length of wire required to give the maximum current.

In 1902 he devised a wavemeter with fixed inductance and variable condenser (one of the first of its kind).

In 1903, Marconi improved on Rutherford's magnetic detector, invented in 1895, and took out patents for the Marconi magnetic detector.

In America, several investigators, to whom much of our present knowledge of wireless is due, were engaged on investigations. Dr. Lee de Forest invented a system which was extensively employed during the Russo-Japanese war, and to his inventive genius the first electrolytic detector is ascribed.

His detector consists of a tube fitted with two metallic electrodes, between which is an electrolysable paste of litharge, glycerine, water, and some metallic filings. A very small constant current passes through this paste, and under the action of this current the well-known crystalline structures are formed, known as lead trees. These tree-like outgrowths are partially destroyed by the incoming current jiggs, and are instantly restored again by the constant current.



By courtesy Marconi's Wireless Telegraph Co., Ltd.

A Magnetic Detector of early Design.

Another form of electrolytic detector was invented shortly after this independently by Ferrié, Fessenden, Schloemilch and Vreeland in 1900. It is interesting to note that the electrolytic break for induction coils was invented by Wehnelt in 1899. This detector takes the form of a miniature Wehnelt break and is called by Fessenden the Barreter. It consists of a fine point of platinum wire, about one-thousandth of an inch in diameter, forming the negative electrode; this dips into a dilute solution of sulphuric or nitric acid, contained in a small lead cup, which forms the positive electrode. The received oscillations momentarily destroy the polarisation of the cell, allowing the passage of a current through the phones. S. G. Brown's detector, consisting of a pellet of peroxide of lead between lead and platinum electrodes, should also be mentioned.

In 1906, Colonel Dunwoody showed that carborundum had the property of rectifying small currents of high frequency and invented the now so well-known carborundum detector. This was quickly followed by Prof. Pierce's molybdenum and copper point detector, Pickard's "Perikon" detector (zincite and copper pyrites), the Silicon detector and many others. I found that iron sulphide and steel or iron had similar properties (particularly so with imperfect samples of home manufacture), made by melting sulphur and iron filings together in a closed crucible. I described my iron sulphide detector in "Electricity," April 24th, 1908. There is another detector of the crystal type which I should mention; this was called the Bronck Cell, and consisted of a contact between tellurium and graphite.

Between 1909 and 1910, Dr. Eccles investigated many kinds of detectors, crystal, electrolytic and magnetic, published characteristic curves, and gave theories of their action.

He discovered that the detector formed by a galena-galena contact, which he was the first to use, could behave like a Dudell arc, and produce oscillations.

In 1909, he invented a regenerative microphonic relay, which also could be used for the production of audible oscillations of small amplitude.

Between this date (1909) and 1912, he carried out a large amount of research work in connection with "atmospherics." and "sunset and sunrise fading," also on the effects of solar eclipses.

In 1908, Walter showed that a tantilum wire resting on mercury made a sensitive form of detector.

In 1897, Bell and Hayes in America, showed that if a circuit containing a battery and a microphone was coupled inductively to a D.C. arc, the arc would audibly reproduce the voice, and they applied this discovery to photophony (the transmission of speech by a beam of light).

In 1901, Simon showed that an arc could be used in place of a microphone.

In 1900, Duddell, carrying further the investigations of Lecher and Peuckert, showed the phenomenon of the musical arc. He showed that if a condenser and inductance were connected in series and were shunted across an arc, electrical oscillations were produced in this shunt circuit; these, in surging to and fro across the arc, would produce audible musical notes.

In 1902, Ruhmer conducted a number of very successful experiments in photophony, using a speaking arc in front of a parabolic reflector as transmitter, and receiving the fluctuating beam of light thus produced on a second reflector at the distant station which brought it to focus on a selenium cell.

In 1903, Koepsel devised a method of wireless telephone transmission; it was a blend of the speaking arc and the Duddell arc coupled to an aerial; this was not found very practical in use as the oscillations across the arc are at a low frequency.

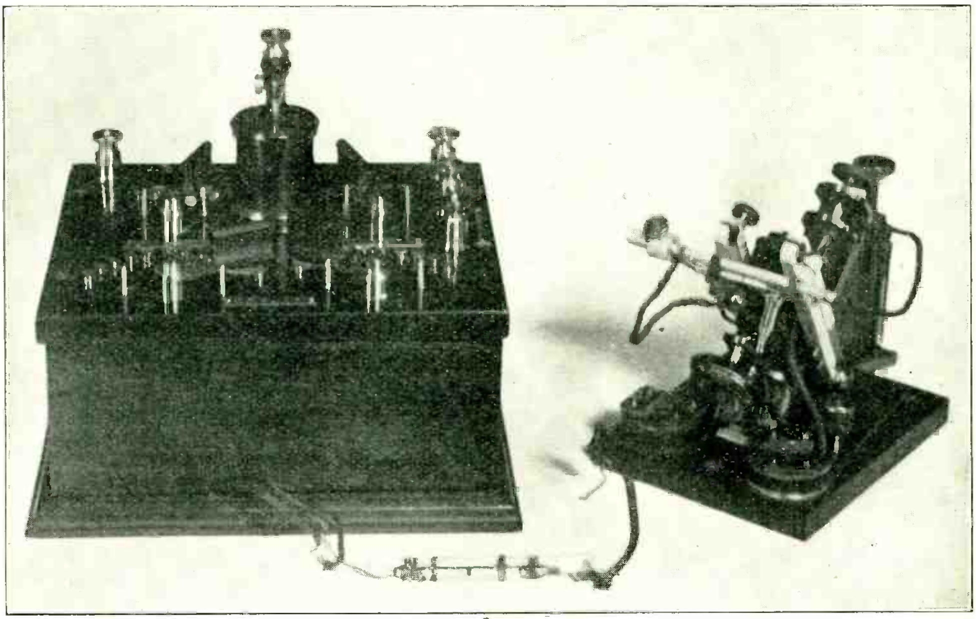
In 1906, The Wireless Telegraph Company of Berlin, by water-cooling the positive electrodes which they constructed in the form of copper tubes, and by using a number of arcs in series (in air), produced high frequency oscillations for wireless telephony.

This method was only capable of dealing with comparatively small currents and the problem of a really workable and efficient arc generator had already been solved.

In 1902, Poulsen took out a Dutch patent, which he quickly followed by patents in other countries.

He had discovered that by placing a Duddell arc in an atmosphere of hydrogen or other gas of high thermal conductivity, and using a water-cooled positive electrode and also placing a magnetic blast across the arc, it became the generator of powerful high frequency oscillations.

It is interesting to note that Elihu Thompson, suggested the use of a magnetic blast at right angles to the spark of his high frequency generator in his 1892 Patent.



By courtesy Mr. Maurice Child.

De Forest Electrolytic Detector and Marconi Coherer.

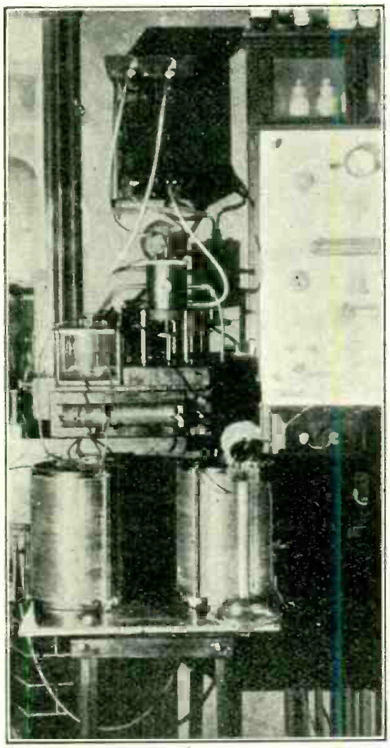
An illustration is given here of a small home-made Poulsen arc I had in use at my station at Richmond in 1913. We used to telephone with this to Mr. Shaw's station at Twickenham, and to the London Telegraph Training College at Earl's Court.

I showed it working at a lecture which I delivered to the London Wireless Society on "The D.C. Arc for Wireless Telegraphy and Telephony" in the following year.

Poulsen invented a method of reception for C.W. signals in which he employed a "tikker."

S. G. Brown introduced a new method of generating C.W. currents for transmission. This works quite reliably on a 200 volt D.C. main, and should prove of utility to the amateur transmitter.

An arc devised by De Forest was very similar to that of Poulsen, the chief difference being that he employs alcohol vapour in place of hydrogen.



The author's home-made Poulsen Arc.

At this point we must not omit to mention the work of Fessenden. Those who have read the account of his lecture, delivered to the American I.E.E. in 1908, will appreciate the enormous amount of work he has done in connection with radiotelephony. As early as 1906 he constructed a high frequency alternator.

Fessenden was the first to use a microphone in the aerial circuit. In 1906, by use of telephone relays of his own design, he demonstrated the possibility of connecting a land telephone line to a radiotelephone station.

I will read the following extract from his lecture before referred to.

"As it was realised that the use of wireless telephony would be seriously curtailed unless it could be operated in conjunction with wire lines, telephone relays were invented, both for receiving and transmitting ends, and were found to operate satisfactorily, speech being transmitted over a wire line to the station at Brant Rock, and retransmitted there wirelessly by a telephone relay, received wirelessly at Plymouth, and there relayed out again on another wire line."

These tests were witnessed on December 11th, 1906, and reported in the *American Telephone Journal.*

In 1907 Fessenden successfully transmitted speech between his station at Brant Rock and Jamaica, Long Island, a distance of 200 miles.

His interference preventor should also be mentioned. This passed severe tests, and was said to be very satisfactory by the American Navy Equipment Dept. in 1905.

Finding that the waves used in wireless travelled more easily over ground having a good electrical conductivity, Fessenden made use of a network of earth wires, which he termed a wave chute.

He was the first to erect an aerial consisting of a steel tube on an insulating foundation, held in position by insulated stays.

A heterodyne method of reception of continuous waves was invented by him.

I cannot do more than mention some of the high frequency alternators and frequency raisers which have been invented since that of Fessenden.

In 1907 Goldschmidt took out patents for an alternator for the direct production of H.F. currents. It was during this year that the Marconi Company opened a public service between Clifden in Ireland and Glace Bay, Nova Scotia.

Then there is the alternator of E.F. Alexanderson, of the General Electric Co., in America, invented in 1908. In 1911 Alexanderson invented a magnetic microphone for which he has since taken out several patents.

C. S. Franklin's improved form of alternator, which he patented in 1913, also that of L. Bouthillon invented in the same year.

Cohen's frequency raiser, described in the *Electrical World* in 1908, also in P. R. Coursey's book, "Telephony Without Wires."

Petersen's frequency raiser, patented in 1912.

Korda's frequency raiser, Vallauri's frequency doubler and several others.

Either of these machines would take a complete lecture to describe so we must pass on to other inventions.

In 1903 Cooper Hewitt took out a patent for the use of a mercury vapour lamp as a generator of H.F. oscillations.

In 1906 Q. Majorana, using his liquid microphone, telephoned wirelessly between Monte Marie and Trapari (Sicily), 313 miles.

It is interesting to note that the first liquid microphone was invented in pre-wireless days by F. Jervis Smith in 1879.

While we are speaking of liquid microphones, we should mention that invented by Chambers in 1910, which is capable of handling a current of some 400 watts.

In 1910, A. F. Collins invented a carbon granule microphone capable of dealing with quite large currents.

In 1912, Varni, employing a Moretti arc, and controlling the radiation with his liquid microphone, telephoned satisfactorily from Cento Celle, near Rome, to Tripoli, a distance of 1,000 km.

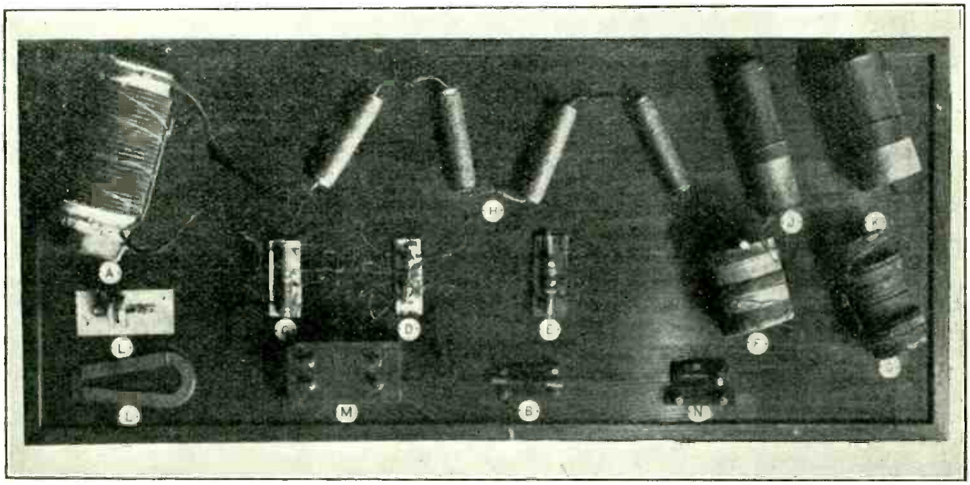
A brief description of Moretti's arc generator may be of interest. It is supplied with a direct current of 500 volts ; the electrodes are of copper and placed vertically. The arc is struck between the negative (which is uppermost, and consists of a solid copper rod), and water which is pumped at a regulated speed, steadily up through the hollow copper positive electrode.

In 1914, Fleming patented an arc generator which would work on a 200 volt D.C. supply. It consisted of a couple of oil-cooled arcs in series, burning in an atmosphere of vapourised oil.

a quenched spark ; this works on a 500 volt D.C. or A.C. supply, the arc is struck between a sheet of delta metal, and a water-cooled disc of copper.

I have used this for radio transmission in days gone by, and still have one in daily use for electro-medical purposes, so I can testify to its reliability.

In 1914, in his Presidential Address to this Society, Mr. Campbell Swinton described a method of recording messages on a moving strip of sensitized paper which photographed the movements of a sensitive manometric flame actuated by the sounds of signals from a telephone receiver, and he showed several wireless messages which he had recorded in this manner. He also showed records from a mirror galvanometer, and mentioned the possibility of recording signals on an ordinary phonograph (records had already been taken in this way). I believe Mr. W. Scott, was one of the first to employ this method). He also showed the



By courtesy of the Institution of Electrical Engineers.

A collection of Historical Marconi Apparatus.

In France, Colin and Jeance invented an arc with carbon discs in an atmosphere of acetylene and hydrogen.

In Japan there is in use a system known as the TYK. They employ a voltage of 500 and the arc (which is said by the inventors to be really a type of quenched spark) is struck between electrodes of magnetite and brass. This system is better adapted to telegraphy than to telephony.

Another Japanese invention is M. Kujirai's frequency raiser.

It is quite impossible for us to go into the various spark systems which have been and are still employed. I may just mention in passing Balsellie's interrupted spark gap, Fessenden's rotary spark, Marconi's disc discharger, Lowenstein's quenched spark, across which a draft of air is blown by an electric fan, the Telefunken quenched spark, Dr. Chaffee's high frequency spark system, which is successfully employed for radiotelephony for distances up to 100 miles, also the De Forest spark system. Then there is the Lepel transmitter, which shares the properties of a hydrogen arc and

use of a syphon recorder and described Poulsen's method of recording signals by means of an Einthoven string galvanometer.

There are various other methods of recording signals, including the Creed method of automatic transmission and reception.

We will now pass on to the invention of the thermionic valve by Professor Fleming. This valve, in improved form, has of late years completely revolutionised the science of radiotelegraphy and telephony.

The Fleming valve is based on an effect noticed by Edison in 1884, when he showed that if a metal plate was placed between the bent filament in an electric lamp, a current (*i.e.*, a stream of electrons) passed from the negative leg of the filament to the plate ; this was detected by a galvanometer connected from the plate to the positive side of the filament battery.

In 1890, Prof. Fleming produced the same effect in air, and in 1904, showed that the valve acted as a rectifier for H.F. oscillations and could be used as a detector for wireless, at which date he took out his original patent in which he termed it a "Thermionic" valve.

The three-electrode valve was invented by De Forest and patented in 1906, and named by him the "Audion" in 1907, at which date, in a U.S. Patent, he spoke of the third electrode as a grid.

In December, 1920, Prof. Fleming described a four-electrode valve in a paper to the London Wireless Society.

Mr. Scott-Taggart has also devised a four-electrode valve which he calls the "Negatron."

Then there is a valve on the market known as the low temperature emission valve. The filament of this valve is coated with a preparation which causes it to emit a vastly increased number of electrons, and it will act as a detector at very low temperatures.

While speaking of valves we must also mention the introduction of the hard valve by Dr. Irving Langmuir and described by him in April, 1915, before the Institute of Radio Engineers under the name of the "Pliotron."

During this same year, 1915, Delanga invented a rather interesting form of Thermal Telephone.

Nor must we close without reference to another American worker, Major E. H. Armstrong, who was the first to employ regenerative circuits (reaction), tuned plate circuits and just recently has developed the super-regenerative circuit.

Innumerable circuits have been devised for the employment of valves, of which I will only mention two, the Turner valve relay and the automatic call device described by Major Binyon to this Society on April 30th, 1920, attributed to the genius of Capt. L. B. Turner and Mr. W. H. Shephard, whose several inventions were combined by Capt. Lea into the complete call device. On June 15th of this same year, 1920, the Marconi Company conducted a radiotelephony test from Chelmsford and Madame Melba's voice was heard in Persia.

I wanted to mention the application of valves to earth current signalling, also the various forms of loud speaking telephones, including that invented by Johnsen and Rahbek, also Leslie Miller's microphonic contact telephone receiver, but I must pass on.

In conclusion, there is much more that should have been added to make this anything like a complete résumé of the history of Wireless. I have not had time to even touch on the wireless control of aircraft, torpedos and even motor-cars, nor on the transmission of photographs by wireless, nor of wireless telewriting; in fact my difficulty all along has been to decide what I could leave out from the enormous amount of work that has been achieved in this most fascinating branch of science. I am therefore well aware of the incompleteness of this lecture, and am extremely sorry that the name and work of so many has had to be omitted; our Society is, however, to be congratulated on the fact that so many of the distinguished scientists I have named to-night are to be found on its roll of membership.

I wish to thank the Marconi Company, the Authorities of the South Kensington Museum, Mr. Campbell Swinton, The Institution of Electrical Engineers, Mr. Maurice Child and others for the loan of historical apparatus and illustrations.

Questions and Answers

"M.D." (Edinburgh) *asks for a diagram of three panels as follows: The first panel to contain a three-coil holder and tuning condensers, with a series-parallel switch, and a stand-by tune switch. The second panel is to contain two high frequency connected valves with switches. They may be cut out of circuit if desired. The third panel is to contain a rectifying valve and two note magnifiers, with switches so that the note magnifiers may be cut out of circuit.*

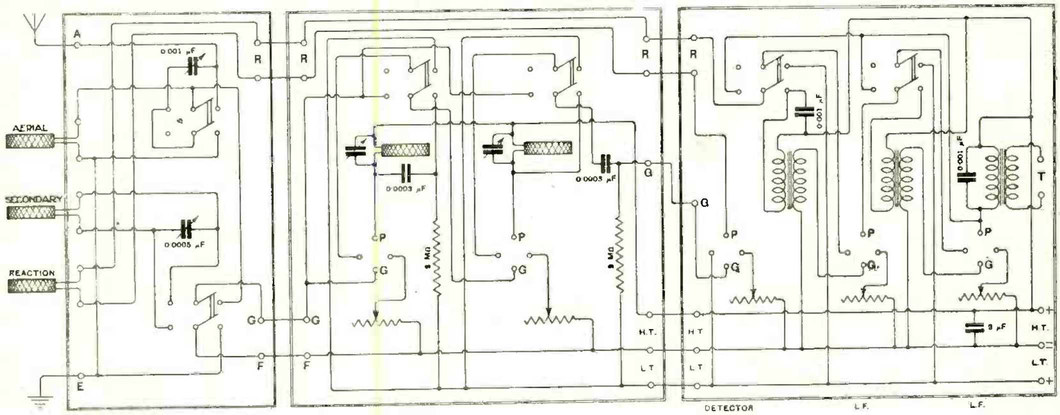


Fig. 1. **"M.D." (Edinburgh).** *The figure gives the connection of three units. (1) Tuner with series-parallel and tune stand-by switches. (2) H.F. panel with two valves coupled with tuned anode coil and grid condensers and leaks, with switches to disconnect them when required. (3) Detector and two L.F. connected valves, with switches to cut out the note magnifiers when required.*

The diagram is given in Fig. 1. The following values will be found satisfactory: Aerial tuning condenser 0.001 mfd., closed circuit condenser 0.0005 mfds., anode tuning condensers 0.0002 mfds., grid condensers 0.0003 mfds., grid leaks, 2 megohms, bypass condensers, 0.001 mfd., condenser across the high tension battery, 2 mfds.

"RADUC" (Nottingham) *asks* (1) *Whether the circuit submitted is correct and will work as required.* (2) *Should the grid of the last valve be given a small negative potential.* (3) *Is it necessary for him to obtain the permission of the Post Office before he can use this receiver, which is different from the receiver, particulars of which were submitted to the Post Office at the time when his licence was granted.*

(1) We have examined the diagram submitted, which is correct, and is similar to many which have been given in this section of the journal during the past few weeks. (2) It may be necessary to apply a small negative potential to the grids of the low frequency connected valves, but with the number of valves in use we think this would hardly be necessary. You could try whether connecting a cell in the lead which joins one end of the secondary winding of the transformer with — L.T. gives better results. (3) We do not think it is necessary for you to inform the Post Office that you propose to use a receiver which is different from the receiver, particulars of which were submitted to the Post Office at the time of applying for the receiving licence.

"W.D.B." (N.B.) *refers to the Armstrong super-regenerative single valve receiver described on pages* 111 *and* 112 *of the April* 28*th issue of this journal, and asks* (1) *Would French "R" valves or Dutch valves prove efficient.* (2) *What would be the best method of increasing the wavelength of a receiver of this description.* (3) *What is a suitable construction for the auto-transformer used across the telephones.*

(1) French "R" type valves may be used, with an anode voltage of 60 to 100, but we do not think you will be successful with a Dutch valve, which is, of course, a soft valve. (2) We suggest you build the receiver precisely as described. The efficiency of this type of receiver increases as the wavelength is decreased, and there would not be much gain through building the receiver to operate on high wavelengths. (3) The auto-transformer may be constructed as follows:—A soft iron wire core is built up to a diameter of 2 in., with a length of 9½ in. Two cheeks 1½ in. in diameter are mounted 1¾ in. apart on the core. The winding consists of No. 40 single silk covered copper wire, which is wound to fill the bobbin. The wire is, of course, insulated from the core, with say, two layers of empire cloth. The ends of the iron core are bent around the bobbin.

"A.P." (Huddersfield) *asks for a diagram of a four-valve receiver, with one H.F. detector, and two L.F. valves, with switching to control the number of valves in circuit, so arranged that a crystal rectifier may be used in place of the valve rectifier.*

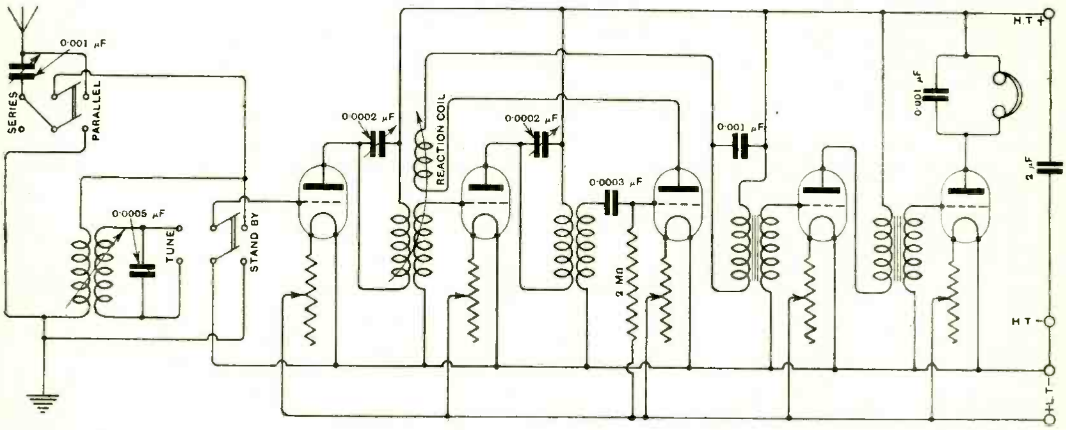


Fig. 2. **"H.J.W.B." (Woolwich).** *A receiver wired according to this diagram is satisfactory for broadcast reception. The first and second valves are coupled with H.F. transformers. The third valve is the rectifier, and the last two are note magnifiers.*

A number of circuits have been given recently in the "Questions and Answers" section of this journal, and in addition we would refer you to circuits Nos. 30, 31, 32, 33 and 34 in Mr. Haynes' book, "The Amateurs' Book of Wireless Circuits."

"D.C.R." (Surrey) *submits diagram and asks* (1) *Why he gets very poor results when he adds* 1 *H.F. variometer coupled valve to the detector and note magnifier, compared with the detector and L.F. valves used alone.* (2) *What is the relative proportion of the aerial and closed circuit coils.* (3) *Are the tuned anode and reaction coils of suitable size for broadcast reception.* (4) *The most suitable position for the by-pass condenser.*

(1) and (3) Your connections are correct for H.F. working, but the windings on your anode variometer are unsuitable. We suggest that you substitute a variometer consisting of a former 4½″ diameter × 2½″ wound with No. 24 D.C.C., and an inner former 3″ diameter × 2″ wound with No. 26 D.C.C. (2) With the aerial condenser in series, the aerial coil may be a little larger than the closed circuit coil, but when the condenser is in

parallel, the closed circuit coil may have twice as many turns as the aerial coil. (4) The by-pass condenser should be connected directly across the H.T. terminals, and should preferably have a value of from 0·5 to 2 microfarads.

you. However, with the most selective form of tuner, you will find it rather difficult to tune out **2 LO** and to receive the other broadcasting stations at your address. In the intervals when **2 LO** is not working you should, however, be able

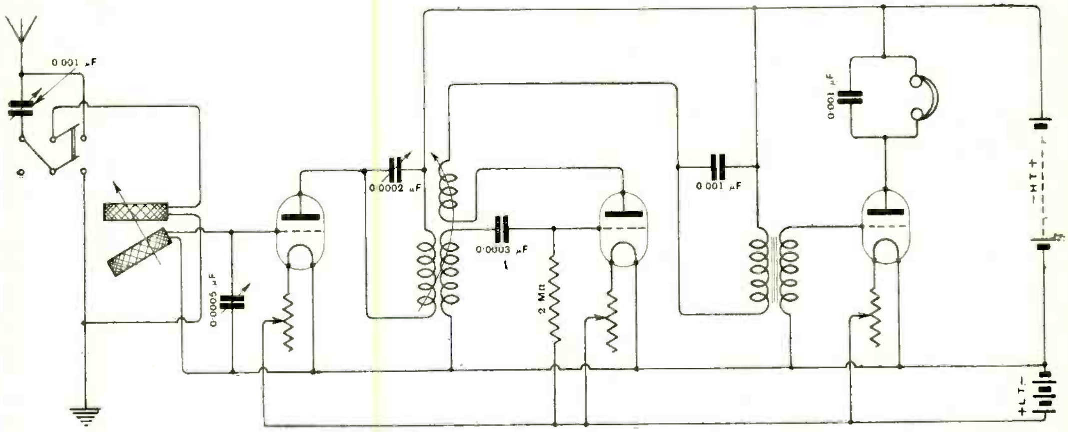


Fig. 3. **"C.J.E." (London, W.C.1.)** *Connections of a three-valve receiver for broadcast reception—H.F., detector and L.F. The reaction coil is coupled with the H.F. transformer.*

to get the other broadcasting stations with the set you describe. No doubt the lead roof is responsible for a certain amount of absorption, and your long aerial lead-in is a disadvantage, but neither of those defects should entirely prevent the reception of signals from the stations you mention. A diagram of a three-valve set is given in Fig. 3. Basket coils would be quite suitable for use in this circuit.

"H.J.W.B." (Woolwich) *asks* (1) *For a diagram of a five-valve receiver, with two H.F. valves, transformer coupled, detector and two L.F., to include variable reaction approved by P.M.G.* (2) *If H.F. transformer coupling is to be preferred to the tuned anode method, and whether a trial of the latter necessitates any appreciable change in the circuit.* (3) *For a method of connecting up a series-parallel and a stand-by tune switch.*

(1) and (3) The diagram is given in Fig. 2, in which is included both the series-parallel and stand-by tune switches asked for in question (3). (2) When properly designed, both methods of H.F. coupling give excellent results. It is possible to include in the circuit a change-over switch, enabling one to use either transformer or tuned anode coupling at will. We would refer you to Fig. 3 on page 161 of May 5th issue.

"STATOR" (Bristol) *submits diagram and particulars of his two-valve set, one H.F. and detector, and complains that while when using the detector valve alone with reaction he gets good results, the results are poor when the H.F. valve is connected.*

Your trouble evidently arises from the coupling of the H.F. valve to the detector valve. We suggest that you use a 0·0002 mfd. variable condenser in parallel with those turns of the anode coil that are in circuit. We also advise you to use a 6-volt accumulator when using the two valves. If the reaction coil is connected to assist the signals when the detector valve alone is used, it may be necessary to reverse the connections when the H.F. valve is connected in circuit.

"C.J.E." (London, W.C.1) *has constructed a three-valve set, particulars of which he gives, and although getting strong signals from* **2 LO** *cannot get signals from any other British broadcasting station.*

(1) As you do not give details of the type of tuner you employ, it is rather difficult for us to advise

"AMATEUR" (Arbroath) *submits diagram of his receiving set, and asks* (1) *Whether the set would be approved by the P.M.G.* (2) *Probable effective range.*

(1) The "Tickler" is an American term for the reaction coil. It is not permissible to use the circuit submitted during the hours of British broadcast transmission. (2) The maximum effective range for the reception of telephony would probably be from 50 to 80 miles.

"J.F.B." (York) *asks* (1) *If tuning may be effected by means of two variometers, one for coarse tuning and the other for fine tuning, and what would be the approximate wavelength range of a variometer.* (2) *For the approximate receptive range of a crystal set with a one-valve note magnifier.* (3) *For the range of the same crystal set with a two-valve note magnifier.*

(1) It would be possible to use two variometers as you suggest, but we do not recommend the arrangement. The usual design of variometer with a stator of not larger diameter than 6″ would probably cover a range of wavelengths up to approximately 900 metres with a 0·0001 fixed condenser in parallel. (2) and (3) The range of a crystal set for the reception of telephony is not increased to any extent by the addition of note magnifier valves. Valves operating as low frequency amplifiers magnify the rectified signal passed through by the rectifying device, whether it

be crystal or valve. The range of a set such as you describe is influenced primarily by the sensitivity of the rectifying device. A crystal is used purely as a rectifier, but when a valve detector is employed the signal may be amplified as well as rectified, and, in addition, reaction effects may be obtained.

valve in the circuit its most suitable potential has been given frequently in recent issues of this journal. We refer you particularly to the diagram on page 702 of our issue of February 24th, 1923. Also see diagram No. 57 of "The Amateurs' Book of Wireless Circuits," by F. H. Haynes.

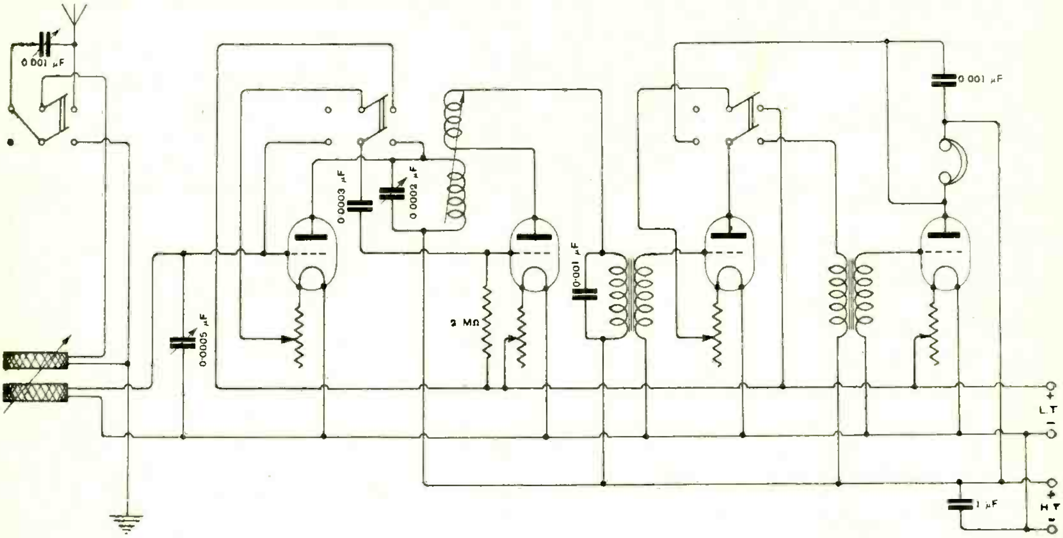


Fig. 4. **"T.A.W." (Chingford).** *This is a diagram of a four-valve receiver with H.F., detector and two stages of note magnification. The H.F. and the last note magnifier may be switched out of circuit when desired. The tuned anode method of H.F. amplification is used and the reaction coil is coupled with this circuit. The circuit is suitable for broadcast reception.*

"T.A.W." (Chingford) *asks for a diagram of a circuit comprising one H.F., detector and two L.F. valves, incorporating various components which he has listed, and having switches to cut out the H.F. valve and one L.F. valve.*

The diagram is given in Fig. 4.

"J.C." (Birmingham) *asks what is the effect of introducing a fixed condenser in series with the aerial circuit.*

The effect of adding the fixed condenser in series with the aerial is to shorten the wavelength of the aerial circuit. In order to satisfactorily receive on low wavelengths it is sometimes necessary to use a series condenser with aerials that have a relatively high self-capacity.

"F.J.W." (Leyton, E.10) *asks* (1) *Whether the circuit diagram given in Fig. 2, page 814, of the issue of March 17th, with his modifications, will give satisfactory results.* (2) *To what wavelength will a coil 4" in diameter × 12" long, wound with No. 28 D.C.C. wire, tune with a 0·0002 mfd. variable condenser in parallel.* (3) *For some means of giving each valve in the circuit its most suitable anode potential.*

(1) The modified circuit will be satisfactory. With reference to (C) it should be remembered that with the aerial condenser short-circuited the series parallel switch must be in the series position. (2) Your anode coil will have a maximum wavelength of 2,500 metres with the 0·0002 mfd. condenser in parallel. (3) The method of giving each

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules:—*(1) *Each question should be numbered and written on a separate sheet on one side of the paper, and addressed "Questions and Answers," Editor,* **The Wireless World and Radio Review, 12/13,** *Henrietta Street, London, W.C.2. Queries should be clear and concise.* (2) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* (3) *Each communication sent in to be accompanied by the "Questions and Answers" coupon to be found in the advertisement columns of the issue current at the time of forwarding the questions.* (4) *The name and address of the querist, which is for reference and not for publication, to appear at the top of every sheet or sheets, and unless typewritten, this should be in block capitals. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume."* (5) *In view of the fact that a large proportion of the circuits and apparatus described in these answers are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.* (6) **Where a reply through the post is required every question sent in must be accompanied by a postal order for the amount of 1s., or 3s. 6d. for a maximum of four questions.** (7) *Four questions is the maximum which may be sent in at one time.*

THE
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An Eventful Day for the Amateur.

By the time this page appears in print, an eventful day in the history of amateur wireless will have passed. The Postmaster-General's Broadcast Committee of Enquiry, which is now sitting three times a week, is hearing evidence from interested parties. Already, amongst others, representatives of several branches of the trade have been before the Committee, and more latterly, Lord Riddell, representing the press. But the eventful day of amateur interest is Thursday, June 7th, when, as previously announced in an earlier issue, Mr. A. A. Campbell Swinton, F.R.S. (a past President of the Radio Society of Great Britain) appears before the Committee to give evidence on behalf of amateurs and experimenters throughout the kingdom, and to uphold their interests in a manner which no one is more fitted than he to do. Mr. Campbell Swinton's name is associated with the earliest efforts to organise amateurs in this country so that there might be one voice in representing the views of experimenters in connection with any representations to the authorities on questions concerning their interests.

Since the proceedings of this Committee are conducted in private, the outcome of Mr. Campbell Swinton's evidence will not be known, but its effect will be borne out in the general recommendations which the Committee will finally make to the Postmaster-General.

As in the case of all other interested parties, we must wait in patience for this time, but we believe that the future is a bright one for the amateur, as everything points to the probability of a large amount of freedom being given to those who are, or who desire to become, students of wireless.

Already we know that the Post Office is dealing with some 30,000 outstanding applications for experimental licences, and, from reports which we hear from all sides, it is apparent that these licences are being granted in every case where the Post Office can satisfy itself that the applicant genuinely wishes to experiment in Wireless Telegraphy. The Post Office has here rather a difficult task, and any assistance which the applicant for a licence can give will naturally hasten a favourable decision by the Post Office, whilst also facilitating their work. One of the best ways of helping is to supply with the application a certificate or letter from the Radio Society of Great Britain or a recognised local wireless society. Numerous instances have been met with where applications for licences, especially transmitting licences, have been turned down by the Post Office for lack of such satisfactory references, and when these have been forthcoming the licence has been issued without further delay.

FADING

With the keen interest that is at present being taken in the problem of fading, the following explanations of observed phenomena, by a wireless engineer, who by virtue of his duties is faced with difficulties attributable to this cause, should prove of great help to the experimenter who is endeavouring to investigate the subject.

By Capt. P. P. Eckersley.

Chief Engineer, British Broadcasting Co.

THE phenomenon of "fading" has been known to wireless engineers for some time, but the advent of broadcasting has brought the subject into great prominence.

There may be those so fortunately situated in relation to one of the broadcasting stations who have never experienced fading, so, at the risk of redundancy, I will try and explain first what I mean by the term.

You are listening to a station 150 miles away when all at once the signals go dead weak. You fly to the reaction handle, but everything you do has no effect, when suddenly without warning the sounds burst out again. The number of people who have conscientiously soldered, tightened and tuned, and scratched a bewildered head must be legion, as the number who write in, having satisfied themselves that *their* end is all right, and complain of the variability of the transmissions, is certainly considerable.

As a matter of fact, the transmissions by the British Broadcasting Co., are *not* variable, and, except where light and shade are desirable in musical items, radiation and modulation are maintained sensibly constant.

The cause of the variability lies, therefore, between the transmitting station and the receiving station.

The question is, then, what is there to influence the attenuation of the waves so markedly and so variably? Why in certain places does London fade while other stations do not? Why is fading only noticeable at night, and why should night time signals be stronger than day time signals in certain places and not in other places? Why should 2 LO only be audible a quarter of an hour after sunset in Salamanca, Spain, and why should the Shetlands get us pretty uniformly, while people in the Victoria district (no! London, not B.C.) experience fading effects which are never noticed, say, in Hampstead? The answer is easy as far as I am concerned, and it simply is, *I don't know!*

But a general theory exists which I will give you, and which probably forms a basis on which to build the explanations of minor variabilities.

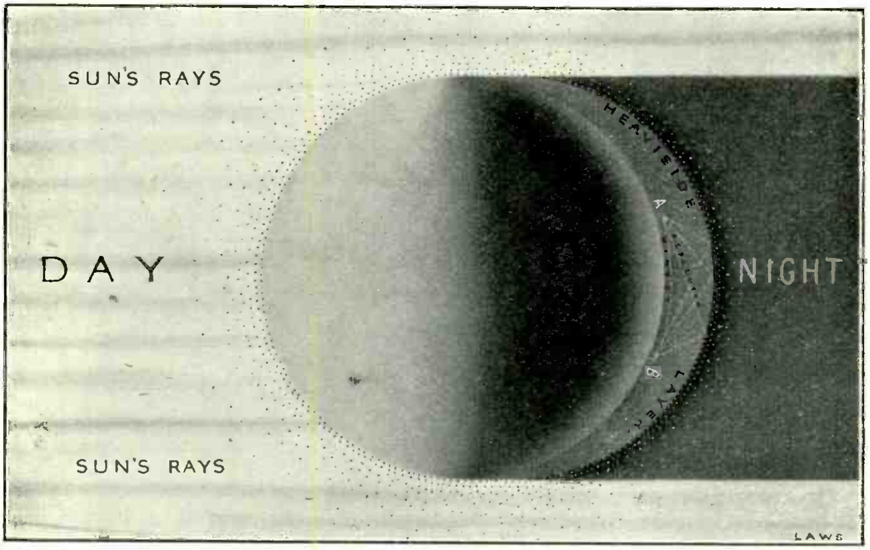
Firstly, in spite of all we have heard about the freedom of the air, wireless waves travel through the æther, which is the postulated medium for the transmission of all electro-magnetic waves. This medium is not in any sense of the word matter, inasmuch as matter is ponderable and can be analysed, weighed, felt and experienced by the human senses, as it were. The æther is perfectly non-conducting to electricity, and to our senses it is nothing. But floating about in the æther are minute particles which in various permutations and combinations form matter—air, water, earth, and so on. Now, if matter is conductive to electricity, it impedes the progress of electro-magnetic waves travelling through the æther which holds matter. Thus, if the air which is suspended in the all-pervading æther is conductive, it impedes wireless waves. It may come as a surprise to many to know that air can be conductive; it is not usually necessary to suspend the filament terminals of your set in a vacuum, but air *can* become quite conductive, and especially does it become so under the influence of sunlight. What happens is that the little particles called molecules in the air are made lively by the sunlight and split up into electrified units, which make possible the conduction of electricity.

Thus, in the accompanying diagram I have drawn a rough sketch of the world with the sun shining full on one side, leaving the other in shadow. On the sunny side what apparently is a swarm of flies is meant to represent electrified particles. On the dark or night side these particles have recombined near the earth, while many others have risen up to a height and are all huddled up together to form a sort of electrified layer, some 20 or 30 miles above the earth's surface. Daylight diffuses the layer which at night time forms above the earth. The layer was first postulated by Heaviside, and is often known as the "Heaviside Layer."

Near the sunrise or sunset region the diffusion is very great, owing to the sunlight being oblique to the air, and gradually towards the night side the air is cleared of particles, while towards the light side uniform diffusion sets in.

Now see what happens between two stations A and B on the night side. Some of the waves go direct, but many of the waves from A to B hit the layer and are reflected from it. The reflected waves are added to the direct rays, and therefore, as the reflective qualities of the layer vary, so the strength of the signal at B varies. It is as though the layer were a great mirror, and that, as it turns and changes and moves uneasily in its sleep, so the signal is reflected more or less, and so fading occurs.

If this theory is true, certain things could be proved as follows experimentally :—



The earth, showing the action of the sun's rays in producing an electrified layer.

(1) There should be no fading in the day time, but the signal should be uniformly weaker.

This is *generally* true.

(2) There should be evidence of rays considerably inclined to the vertical.

In direction-finding work the general principle of determining in the directing of the incident waves is to use a frame, the angle of the vertical plane of which can be varied. When the frame is at right angles to the on-coming waves no signals are heard, *but* this can only be so if the waves are arriving horizontally ; any vertical component will affect the frame equally in any position, and no minimum will be found. This actually happens because a simple frame at night gives no reliable bearings due to the presence of the vertical component.

(3) Using a frame which combines so largely the direct and the vertical ray distortion should occur with speech. This is noticeable more with a frame than with a vertical aerial.

(4) Fading should be more noticeable at great distances from the transmitter than near to. (Obvious from the diagram). This is noticed.

(5) Fading should be more noticeable over land than over sea, owing to the greater attenuation of the direct ray. This has been noticed.

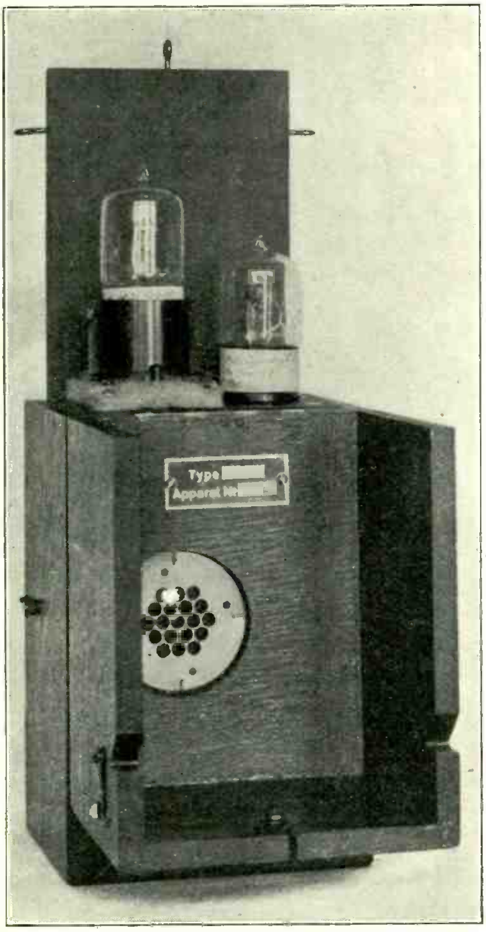
Further than this it is impossible to go, because obviously the whole phenomenon depends so largely upon casual happenings. Undoubtedly, though many of the freak ranges are influenced by casual electrifications forming giant reflectors just in front of the sunset, the extraordinary difference between the power required to drive a signal across the sunset or sunrise band, to that required when this electrified band is removed, is evidence of the justness of the theory, and many of the problems of East and West transmissions are bound up with the same idea.

Local fading (I mentioned that people were getting fading at Victoria, London, from 2 LO) is due to something quite different. Perhaps the telephone service or the electric light mains are influencing factors.

GERMAN BROADCAST RECEIVERS

An article in the previous issue described the organisation of the Broadcast Service in Germany, and the tuning equipment of unique design as installed by the German Post Office. Details of amplifiers for use with the broadcast tuner are given below, together with a description of the apparatus employed for deriving filament and plate current from direct and alternating public supply mains.

AMPLIFICATION is obtained by a one or two-valve low frequency unit. For further amplification a combination of these two sets may be used. It is calculated that, with an available trans-

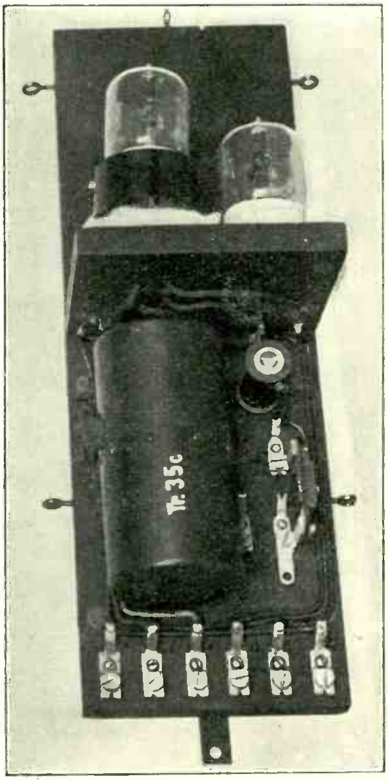


By courtesy, Gesellschaft für drahtlose Telegraphie.

Fig. 5. Single valve amplifier unit with spare valve.

mitting energy of 10 kW, as employed at Königswusterhausen, up to a distance of 100 kilometres, no amplifier is necessary; at distances of 100 to 300 kilometres a one-valve amplifier is required, and above 300 kilometres a two-valve amplifier will be needed to produce signals of a given strength.

The single valve amplifier (Figs. 5, 6 and 7)



By courtesy, Gesellschaft für drahtlose Telegraphie.

Fig. 6. The interior of the single valve unit. The fixed valve filament resistance, the intervalve transformer, and the secondary bridging condenser can be identified.

is placed in a sealed wooden case with a hinged lid and measures 29.6 cm. high, 11 cm. wide, 8.8 cm. deep, weighing 1.5 kilogrammes. The circuit arrangement can be seen in Fig. 7.

To connect the amplifier with the receiver, the primary winding of the telephone transformer is replaced by the primary winding

(45/46) of the input transformer. The secondary winding of the input transformer leads

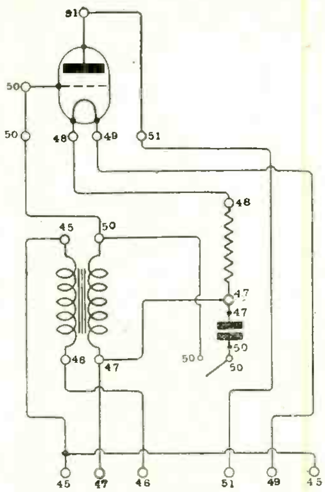
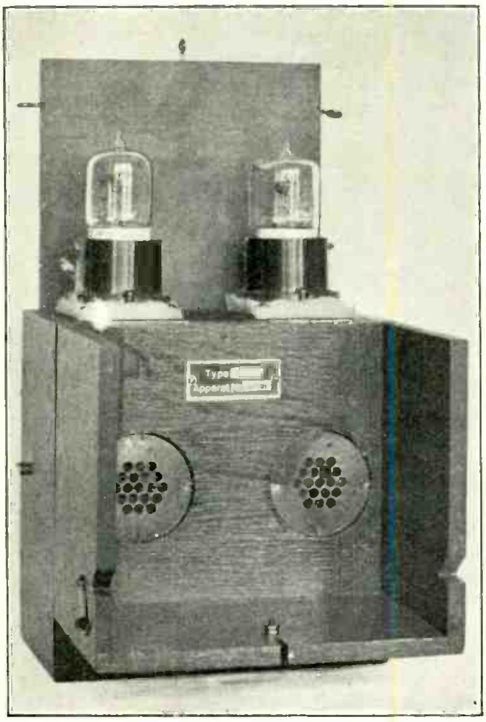


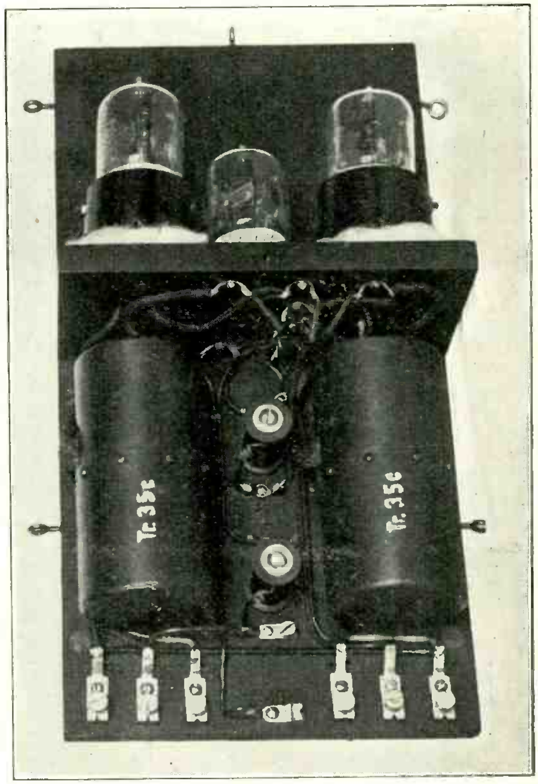
Fig. 7. Circuit of single valve amplifier unit.

to the grid of the amplifier valve, and to a certain point of the filament circuit to pick up a suitable negative potential. This potential is controlled by the resistance (47/48) in the filament circuit.



By courtesy, Gesellschaft für drahtlose Telegraphie.
Fig. 8 Two-valve low-frequency amplifier.

The two-valve amplifier (Figs. 8, 9 and 10) represents really two one-valve amplifiers connected in cascade contained in a sealed case (29.6 cm. in height, 16 cm. wide and



By courtesy, Gesellschaft für drahtlose Telegraphie.
Fig. 9. Interior of the two LF amplifier unit.

8.8 cm. deep) with a hinged lid in its upper part. The weight of the case is 2·5 kilogrammes. The circuit offers no novel feature, and is shown in Fig. 10.

For both types of amplifier one spare valve is supplied. The valves are easily accessible and interchangeable by the lifting of the lid on the top of the case.

Where a one-valve amplifier is to be added to a two-valve amplifier, a condenser is inserted between the grid and the filament of the one-valve set for the purpose of preventing amplifier noises.

Apparatus is installed with the receiving equipment, making it possible to obtain the plate and filament voltages direct from the power system.

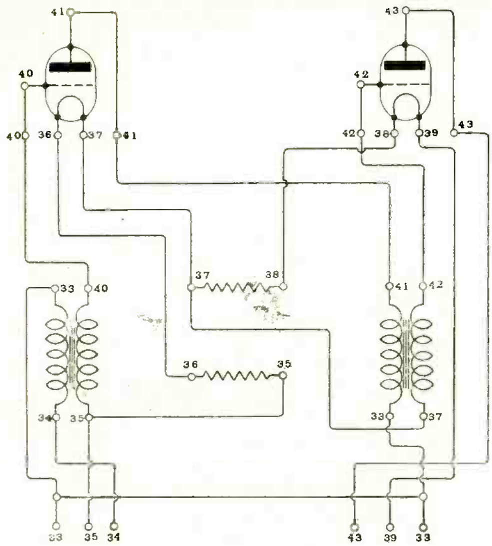
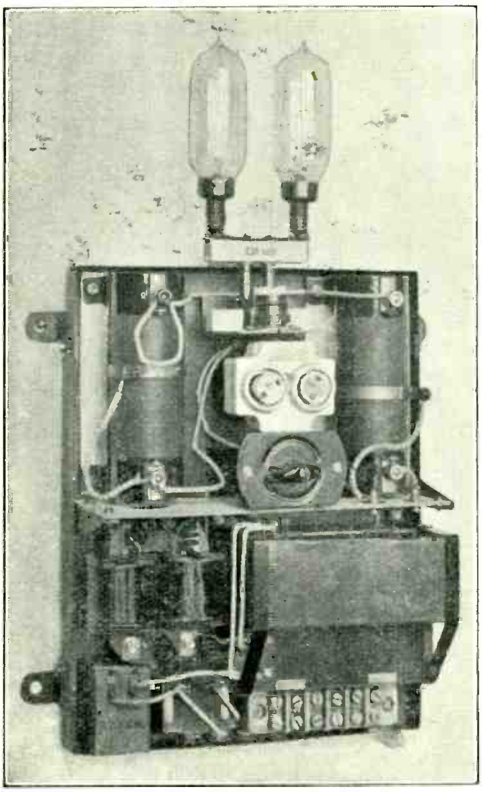


Fig. 10. Circuit of the 2-valve L.F. amplifier unit.



By courtesy, Gesellschaft für drahtlose Telegraphie.

Fig. 11. Apparatus for deriving L.T. and H.T. from direct current mains.

The direct current apparatus (Fig. 11) is protected by an iron box 32 cm. in length, 25 cm. in width, and a depth of 10 cm., weighing 9 kilogrammes.

The circuit is shown in Fig. 12. Both the direct current mains are brought to the apparatus through lamp fuses (F), the negative

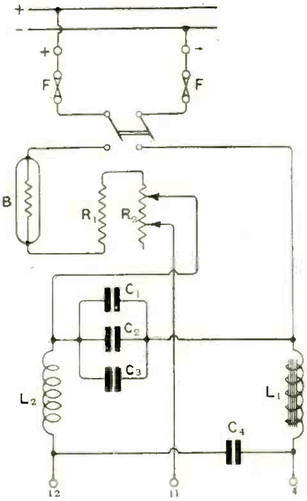


Fig. 12. Circuit arrangement for deriving H.T. and L.T. from D.C. mains.

lead going to the iron cored choke L_1 and on to the common negative terminal 4 for plate and filament circuits. The positive lead goes *via* the barretter resistance tube B to the two resistances R_1 and R_2. Resistance R_2 is provided with two sliding connections which serve to control the filament and plate voltages. The positive filament lead runs to the terminal

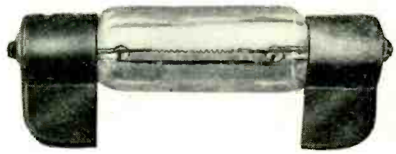


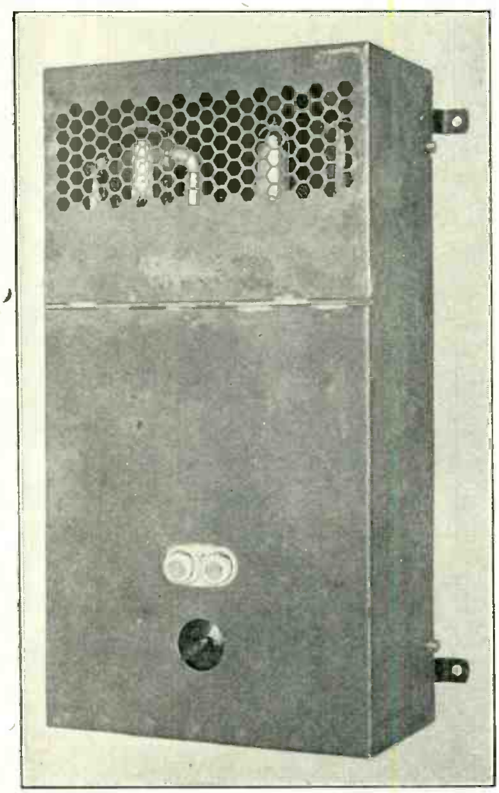
Fig. 13. Barretter tube of the type employed in receiving valve filament circuits for maintaining the current constant.

11 and the positive plate lead to the terminal 12 *via* a high frequency choke L_2. Irregularities in the supply and the disturbing noises in the mains are filtered out through the barretter tube B, condensers and chokes C_1, C_2, C_3, C_4, L_1 and L_2. The barretter tube (Fig. 13) eliminates the irregularities of the direct current mains automatically, being so designed that

the filament current remains stationary at 0·58 amp.

For the purpose of simplifying the circuit, the filaments of the receiver and amplifier valves are arranged in parallel. Suitable barretter t bes are fitted according to the current required. The tubes maintain the current constant with the voltages between 1.7 and 3·1, and eliminate mains irregularities of 25 per cent., which is quite sufficient to remove all likely interference.

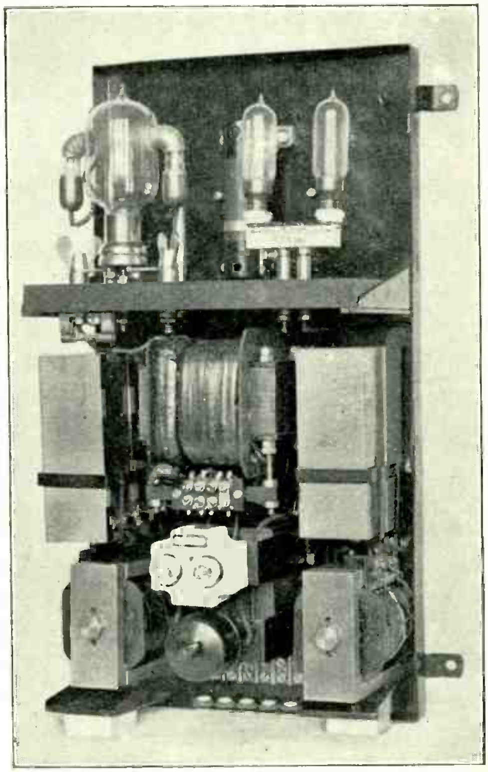
The large type barretter tubes (Fig. 1, upper part), of course, only eliminate the comparatively slow alterations of the direct current supply. To eliminate commutator ripple, the iron core choke L_1 and a bank of three condensers (C_1, C_2 and C) of 8 μF capacity a e used. It is possible that high frequency oscillations may also be present, and since it is imperative to keep these away



By courtesy, Gesellschaft für drahtlose Telegraphie.
Fig. 14. Apparatus for obtaining L.T. and H.T. from A.C. mains.

from the receiving apparatus, a further high frequency choke L_2 and condenser C_4 (2 μF) are employed.

The mains connector for alternating current Figs. 14, 15 and 16) is contained in a sealed zinc box, 52·2 cm. high, 27·5 cm. wide and 15 cm. deep. Its weight is rather considerable, being 23·6 kilogrammes.



By courtesy, Gesellschaft für drahtlose Telegraphie.
Fig. 15. Interior of apparatus for use with A.C. mains.

The Wehnelt rectifier is used, consisting of a glass tube containing a heated cathode and two anodes. A special additional electrode is inserted underneath the cathode, and a resistance is connected in series with it and one of the anodes.

Fig. 16 illustrates the circuit. The A.C. supply is fed through fuses and switches to the primary winding of the transformer, which latter has two secondary windings. One of these windings supplies the filament current for the rectifier cathode. The primary winding of the transformer is subdivided, the section windings being connected by terminals, thus ensuring easy fitting of the transformer on the mains system according to the voltage.

The filament is supplied through a tapped choke (5/13) and another choke (17/18);

whilst the baretter tubes (18/19) serve to maintain the constancy of the current, and thence to the terminal 20. The alternating current component of the direct current feed is eliminated by the bank of condensers (16/17).

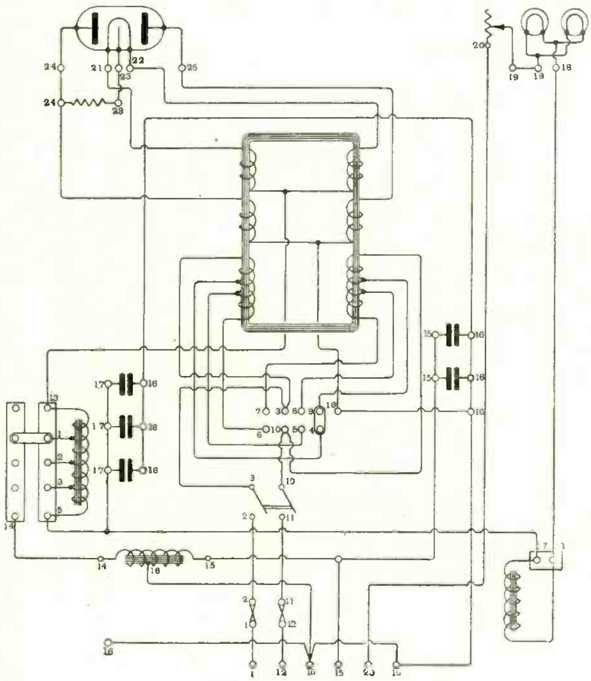


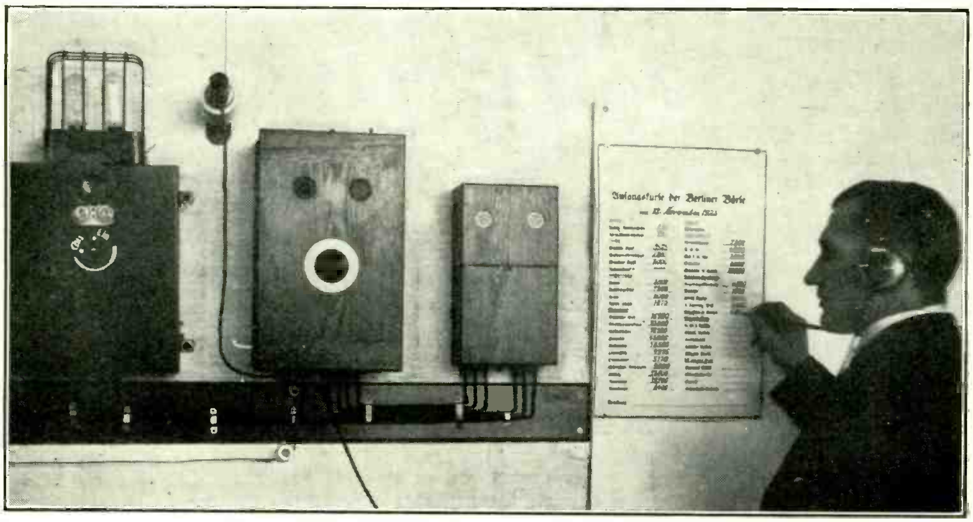
Fig. 16. Circuit of rectifier for supplying filament heating and smooth plate current from A.C. mains.

The plate current is branched off from the filament current choke (13/5), and can be taken to the different valves by means of the sub-divided arrangement (1/5). The plate current chokes (14/15), arranged in series, and the condenser bank (15/16) in parallel with the plate circuit, serve the purpose of filtering the H.T. supply to the plate.

As is well known, it is extremely difficult to transform alternating current by means of a rectifier and obtain direct current as steady as accumulator current. This is especially so if, as in the present case, the receiver tube is provided with a reaction coupling.* The fact that this rectifying apparatus gives good results in use is due firstly to the fact that the Wehnelt rectifier has a coated filament of ample dimensions which maintains a constant temperature in spite of the periodically changing heating current strength. Secondly, and what is possibly still more important, the reaction coupling of the receiver is permanently fixed.

As regards the operation of the broadcast receiver as a whole, this is nearly as simple as the handling of an ordinary telephone. If a message

* See *Wireless World and Radio Review*, 20th January, 1923. "Valve Current from A.C. Mains."



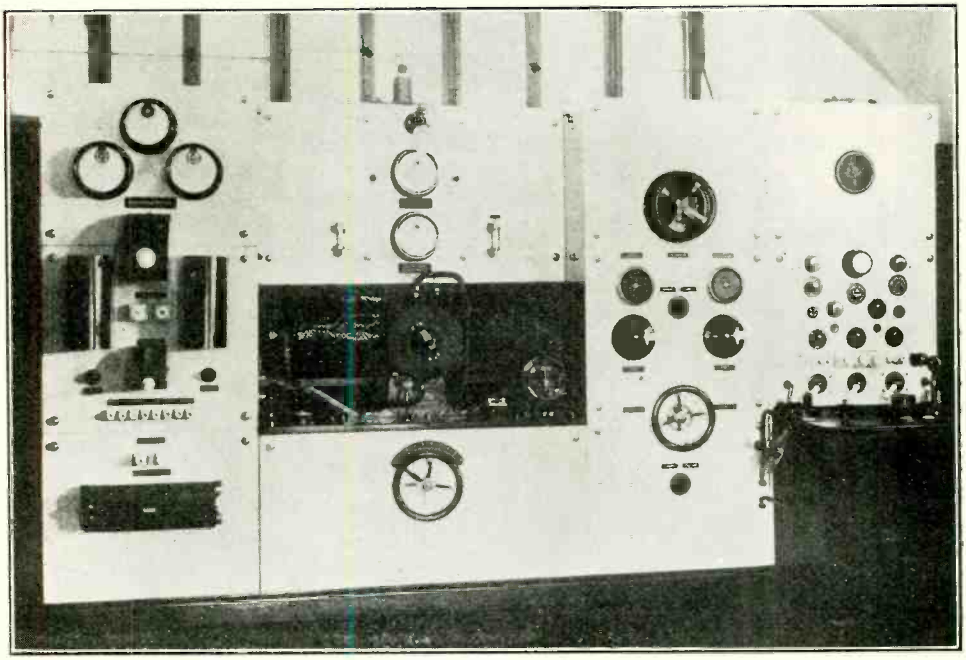
By courtesy, Dr. Albert Neuberger.

Fig. 17. The simplicity of operation is a special feature of the German broadcast receiving equipment.

is to be received, the subscriber simply switches on the mains and takes the telephone earpiece from its hook (Fig. 17). Since the receiver is already tuned to the proper fixed wave-length, searching is not necessary. Small differences in the transmitting wave can be adjusted for by turning the switch to the left or right.

At the conclusion of the message, the subscriber switches the mains off, and replaces the earpiece on to the hook. This earths the antenna automatically.

In order to keep down the necessary number of valves the idea of erecting frame antannæ was given up. If frame antennæ had been employed it would have been hardly possible to employ less than two or three stages of high frequency amplification at some distances.



By courtesy, Dr. Albert Neuberger.

Fig. 18. The transmitting equipment of the German broadcasting station at Königswusterhausen.

Fig. 18 shows the control panel of the broadcasting station at Königswusterhausen. This station is operated by the German Post Office, and is employed essentially for the distribution of news and matters of financial interest. A view of the exterior of the station is shown in Fig. 19.

By courtesy, Dr. Albert Neuberger.

Fig. 19. Exterior view of the broadcasting station, showing the towers.

A Compact Three-Valve Receiver

This article gives the experience of an experimenter in designing a portable and efficient receiver, embodying a variety of circuit arrangements. The use of Dewar switches in the tuning circuits, an error so often made by beginners, is avoided by a simple system of plugs and sockets.

By J. G. W. THOMPSON.

THE following description of a compact three-valve receiver may be of interest to those experimenters who are keen on knowing what the "other fellow's" set is like.

The photograph (Fig. 1) gives a general view of the complete apparatus, less batteries and extra coils.

The factor governing the design of the set is mainly that of portability, as it was desired that the set could be packed up and carried about for outdoor use and so that experiments could be conducted on different aerials. At the same time, it was desired that the set could be adapted by switching arrangements in such a manner that various circuits could be compared.

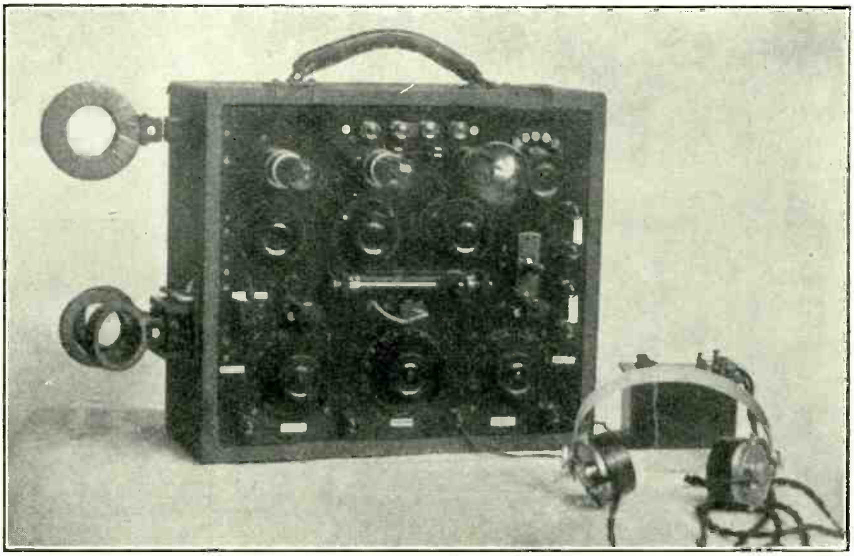


Fig. 1. Portable three-valve receiver, in which provision is made for a number of circuit arrangements.

The amplifying circuit employed (see Fig. 2) is a well known one, being one-valve H.F. (reactance-capacity), one detector and on L.F. The reactance-capacity (or "tuned anode") method of H.F. amplification is, in the writer's opinion, far superior to the transformer method, not only as regards signal strength, but also as regards simplicity, cheapness and ease of working.

The number of change-over switches employed is six, these being in the form of plugs and sockets, thereby making the wiring rather complicated. This tends usually to reduce the efficiency somewhat on short waves, but by careful arrangement of the parts, and by well spacing the wiring, this difficulty can be successfully surmounted.

Dealing with the set in detail, it is mostly constructed from parts of a Mark III* tuner, simply because the writer had these available, though parts available on the market will do equally well. The box of the Mark III* is utilised, the telephone and battery partitions being removed. The two outer condensers each of 0·00055 mfd. capacity, are two secondary condensers from separate Mark III tuners. The middle one (0·0001 mfd.) is home-made. Other Mark III parts are the five-point switch in top right-hand corner, the potentiometer in centre, 10 terminals, grid leak clips, and telephone condenser (inside set).

The tuning circuits utilise home-made honeycomb coils mounted on two-pin plugs. A three-coil holder is used, enabling either direct coupled circuit working, or inductively-coupled circuit working. The change from "tune" to "stand-bi" is effected by the plug and socket switch on the extreme left of the panel, above the left-hand condenser dial. The left-hand condenser is for tuning the

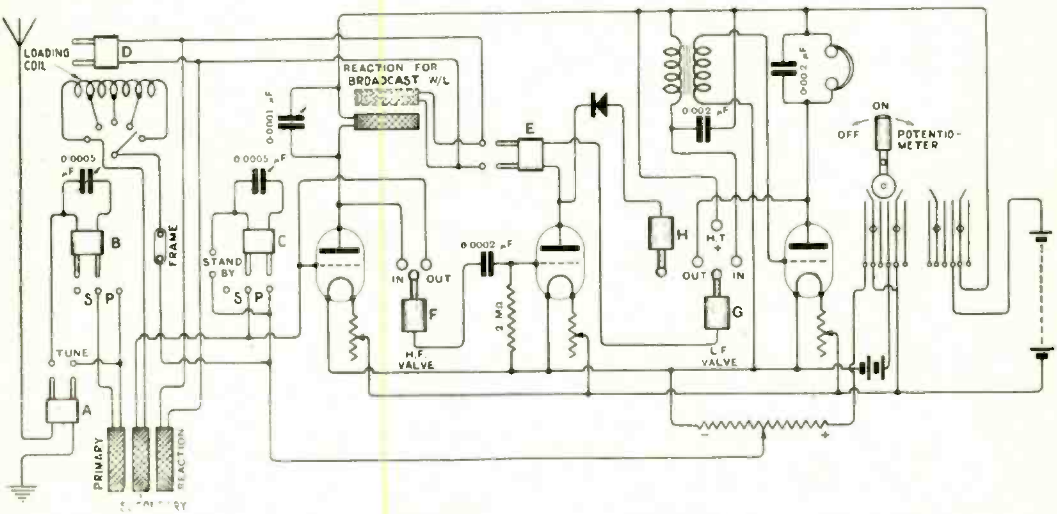


Fig. 2. Circuit showing how plug and socket connectors are provided for giving a variety of tuning systems.

Switching Arrangements.

(1) *One Valve.* Single Circuit. Reaction into Aerial :
A into "Stand-bi" sockets.
F into "Out" socket.
G into "Out" socket.
H.F. and L.F. filament rheostats to "off" position.

(2) *One Valve,* as above, with Note Magnifier :
As above, but G into "in" socket, and switch in L.F. valve by running up filament rheostat.

(3) As above, with addition of H.F. Valve :
Put F into "in" socket, turn up H.F. filament rheostat. Reverse reaction by reversing E in its sockets.

(4) Any of above, Loose-coupled Tuner :
Put A into "Tune" sockets. If oscillation difficult to control put Dewar switch into "potentiometer" position, and move potentiometer slider towards + end of resistance.

(5) Stimulating Self-Oscillation when using Detector Valve only (or followed by Note Magnifier) by tuning Reaction Coil :
Work on stand-bi position, remove primary coil, plug D into "Tune" sockets. Primary condenser is now across reaction coil.

(6) Reaction on Broadcast Wavelengths (only possible when using H.F. and detector valves):
Plug reaction coil into reaction sockets next anode coil, removing reaction coil from the socket next secondary coil.

(7) Frame Aerial on Broadcast Wavelengths :
Remove secondary coil, plug in frame in its place, and work as above (6). Frame must have same inductance as secondary coil used for broadcast wavelengths.

(8) Crystal Detector Circuit (loose-coupled) :
Tune reaction coil by plugging D into "Tune" sockets as in (5). Plug F in "Out" socket. Plug G in "Out" socket and H into "+ H.T." socket. Crystal and telephones are now across reaction coil, which acts as a secondary coil, and secondary coil acts as a primary coil in aerial circuit.

(9) Crystal Circuit, as above, but additional valve as note magnifier :
Switch on note magnifier valve, plug H into "in" socket. Other adjustments as above.

(10) Addition of One-valve H.F. Amplifier :
Above adjustments ; switch in detector valve. Reaction is now introduced into aerial circuit, the crystal and primary of L.F. transformer being across reaction coil.

(11) Second H.F. Valve added :
Above adjustments ; switch on first (H.F.) valve. This circuit gives two H.F. valves, crystal rectification, and 1 L.F. valve.
It may be noted that when L.F. valve is not in use instant reversion from valve and crystal to crystal alone may be made by merely switching off the Dewar switch.

primary coil (when working loose-coupled), and the right-hand one is for tuning the secondary coil. Directly above these condensers may be seen series-parallel switches for the respective condensers. The middle condenser is a seven-plate one (approximately 0·0001 mfd.) for tuning the anode coil of the H.F. valve, which is the upper one fixed on the side of the box. Above this anode condenser is a reaction-reversing switch (necessary when changing the number of valves). Above this is a potentiometer to control reaction, when working loose-coupled, by putting a positive potential on the grid of the H.F. valve. The potentiometer winding is connected across the 6-volt filament battery.

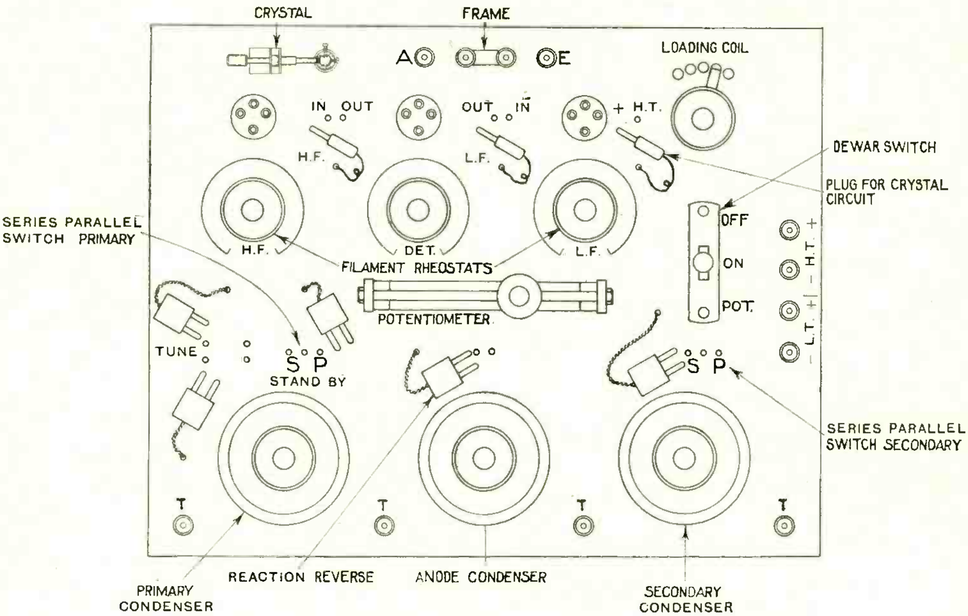


Fig. 3. Lay-out of the components on the face of the panel

To the right of the potentiometer is a switch of the "Dewar" pattern. In the "up" position the H.T. and L.T. are switched off. In the "middle" position the H.T. and L.T. are "on," whilst in the "down" position the potentiometer is switched into circuit.

Below the valves are the filament rheostats, and between the valves may be seen single plugs and sockets for cutting in and out the H.F. and L.F. valves. Any combination of the valves can thus be used.

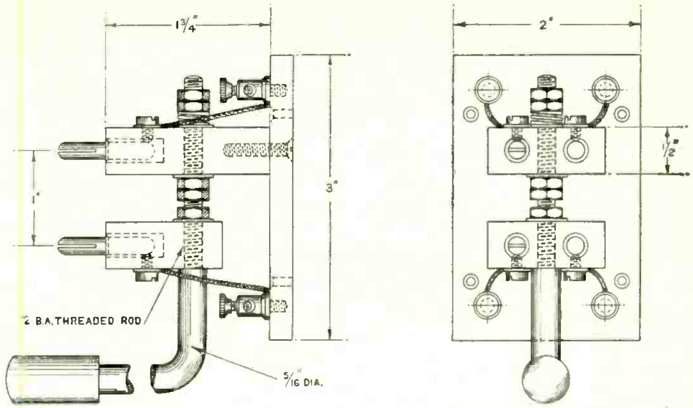
A five-point switch is provided at the top right-hand corner of the panel for tapping off a loading inductance for wavelengths from 8,000 metres to 24,000 metres. This obviates the necessity for using excessively large honeycomb coils, the largest of which (the top one in photo) goes up to about 8,000 metres. The loading coil consists of an old eight-slot H.F. transformer former, wound with 36 gauge D.S.C. in the first three slots, and 42 enamelled in the remaining five. Four actual tappings are brought out to the studs, the first stud being connected to the beginning end of the winding.

A special anode coil (for H.F. valve) was made for wavelengths from 4,000 metres to 24,000 metres and consists of about 2,000 turns of 44 gauge enamelled wire wound in a narrow slot in an ebonite former.

The set is exceptionally quiet, due, partly no doubt, to the fact that every connection is *soldered*.

All the usual high power European stations are received well, most of them being audible all over the room. Quite a number of the American stations are readable, among them being Marion **WSO**, New Brunswick **WII**, Tuckerton **WGG** and Long Island **WQK**. This latter station has been read with phones on table.

Among the telephony stations, Paris, Koenigswusterhausen and the Hague are received well, though the latter is weak. **2 LO** and other broadcast stations have been heard here in Edinburgh with phones on table, when atmospheric conditions are favourable. These results are obtained on a 100-ft. single wire aerial, 35 ft. high. The aerial is very badly screened indeed, being near the bottom of a hill and in the middle of a busy part of Edinburgh. It is also surrounded by tall buildings on all sides, and close to three lines of electric-car overhead wires. The induction effects from sparking at the latter are very troublesome, completely drowning out weak signals at times.



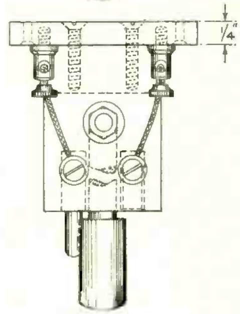


Fig. 4. Constructional details of the two-coil holder.

For the benefit of those who may wish to make up a set on the lines indicated here, a few sketches of some of the parts are given. A rough outline of the external view of the panel is given in Fig. 3, but no measurements are indicated, as experimenters will no doubt prefer to fit their own components, and these vary considerably in size.

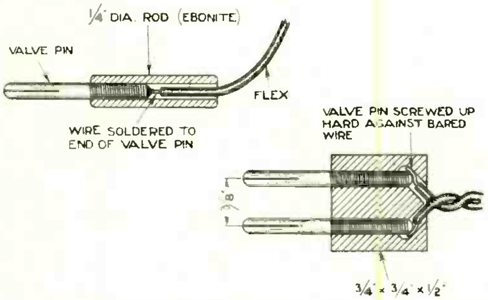


Fig. 5. A simple method of making single and two ended plug connectors.

For those who can make up their own tuning coils, drawing of a useful type of coil holder is given in Fig. 4; The simple two-coil holder is used by the writer for anode and reaction coils.

The writer strongly recommends the plug-in type of switches. They are easy to make, look neat, and have a further advantage in that temporary connections can easily be made to either the plugs or sockets, for the purpose of trying out new circuits, etc. The method of constructing these is shown in Fig. 5.

The writer has his panel hinged top and bottom at the left-hand side, so that the whole panel can swing out like a door. The leads to the coil holders can thus be kept quite short.

CONDENSERS

HOW TO FIND THE CAPACITY OF YOUR CONDENSERS, AND HOW TO BUILD YOUR CONDENSERS TO A GIVEN CAPACITY.

By W. JAMES.

THERE appears to be a lot of misunderstanding concerning the calculation of the capacity of condensers, arising, maybe, through there being several formulæ available, and perhaps with some of the new readers, through the use of the *centimetre* unit.

This note is an attempt to clear away any misunderstanding.

1.—TAKE THE CASE OF VARIABLE CONDENSERS FIRST.

We have a set of fixed plates, and another set of moving plates. The moving plates are mounted upon a spindle which is carried in bearings, so that when rotated, a larger or smaller portion of the moving plates is interleaved with the fixed plates. The capacity of the condenser is determined by the area and number of the plates which interleave, and the distance between them. If a material other than air separates the plates, the capacity is increased accordingly (see "Wireless Theory," page 78, April 21st issue). Instead of referring to the area of the plates which interleave, it may be more clear if one refers to the area of the dielectric which lies between the fixed and moving plates. In the various formulæ which may be used, the area as just defined appears. No allowance need be made for edge effect.

If we express the capacity in micro-micro-farads ($\mu\mu F$), and call the total number of plates N; the radius of the moving plates in centimetres, R; the radius of the centre hole in the fixed plate in centimetres, r; the thickness of the dielectric, that is, the distance between a fixed and a moving plate, in centimetres, t; then the maximum capacity of the variable condenser, that is, when the whole of the area of the moving plates lie between the fixed plates, is as follows :—

$$C\mu\mu F = 0{\cdot}139\,\frac{(N-1)(R^2-r^2)}{t}$$

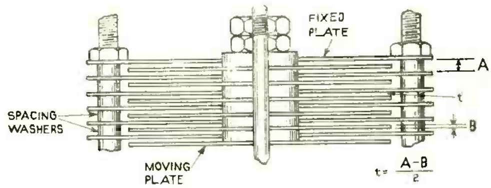
The value of the constant (0·139) is such that instead of having to work out the area of the dielectric covered, the radii (R and r) may be used. The formula gives results accurate to within one-half per cent.

The above quantities are in centimetres, and the formula may be used by those who like this unit, but for those who prefer to use the inch unit the formula may be re-written as follows :—

$$C\mu\mu F = 0{\cdot}353\,\frac{(N-1)(R^2-r^2)}{t}$$

where R, r and t are all in inches.

The distance between the fixed and moving plates t is equal to the thickness of the spacing washer in inches, less the thickness of the plate, the whole divided by 2. Thus, if the



The figure illustrates a portion of a variable condenser. The distance between the fixed and moving plates, t, is obviously given by $\frac{A-B}{2}$ where A is the thickness of a spacing washer and B is the thickness of a moving plate.

spacing washers are $\frac{1}{8}$ in. or 0·125 in., and the moving plates are No. 20 gauge or 0·036 in. thick, the distance between the plates is $\frac{0{\cdot}125-0{\cdot}036}{2}$ ins., or 0·0445 ins.

The formula may be written in other ways. Thus, suppose we have plates of a given size, with spacing washers, and we wish to find how many plates will be required for a certain maximum capacity : then the total number of plates

$$N = \frac{C\mu\mu F \times t}{0{\cdot}353\,(R^2-r^2)} + 1$$

that is, the total number of plates required is obtained by multiplying the capacity and the distance between the fixed and moving plates and dividing the result by the radius of the moving plates squared, less the square of the radius of the hole in the fixed plate, all dimensions being in inches, and the capacity being expressed in $\mu\mu F$. One more plate is added to the number obtained

If we wish to find the distance between the plates permissible when a certain capacity is required, and the plates have a given size,

$$t = 0.353 \frac{(N - 1)(R^2 - r^2)}{C\mu\mu F}$$

The thickness of the spacing washer is then twice this amount added to the thickness of the plates.

The table below is given to enable those who wish to build condensers themselves, the dimensions and number of plates required for various maximum capacities.

As a matter of fact, from a practical point of view, the values calculated and those measured may differ by several per cent., simply on account of the difference in thickness of spacing washers, plates not lying true, etc., and the factor r which appears in the formula may be omitted without risk of serious error. This, however, does not mean that the formula is inaccurate, but that condensers are not ordinarily built with the accuracy which the formula assumes.

Example.—If the moving plates of a condenser have a radius of two inches, the spacing washers are $\frac{1}{8}$ in. thick, and the plates 0·036 in. thick (= No. 20 S.W.G.), what is the maximum capacity of the condenser if there are altogether 45 plates ?

Now $1\mu F = 1{,}000{,}000\ \mu\mu F$.

$$\therefore\ C\mu F = \frac{0.353 \times (N - 1) \times R^2}{t \times 1{,}000{,}000}$$

$$N = 45 \quad \therefore\ (N - 1) = 44$$

$$R = 2'' \quad \therefore\ R^2 = 4$$

$$t = \frac{\text{thickness of spacing washer} - \text{thickness of plates}}{2}$$

$$= \frac{0.125 - 0.036}{2} = 0.0445 \text{ inches.}$$

$$\text{Thus } C\mu F = \frac{0.353 \times 4 \times 44}{0.0445 \times 1{,}000{,}000}$$

$$= 0.0014\ \mu F.$$

From the table the reader will be able to estimate the capacity of his variable condensers by comparing the dimensions of the plates, thickness of the spacing washers and moving plates.

Table showing the total number of plates of various dimensions as obtained from wireless dealers to be used in the construction of variable condensers to give the maximum capacities quoted.

Maximum capacity. mfds.	Diameter of moving plate $2\frac{1}{2}''$. Spacing washer = 0·095″ thick. Moving plate = 0·023″ thick. Total number of plates	Diameter of moving plates = 2 5/16″. Spacing washer = 3/32″ thick. Moving plate = 0·036″ thick. Total number of plates	Diameter of moving plates = 4″. Spacing washer = $\frac{1}{8}''$ thick. Moving plate = 0·036″ thick. Total number of plates	Diameter of moving plate $3\frac{1}{4}''$. Spacing washer = 0·1″ thick. Moving plate 0·023″ thick Total number of plates
0·001	65	65	33	41
0·0005	33	33	17	21
0·0002	13	13	7	9
0·0001	7	7	3	5

2.—How to Deal with Fixed Condensers.

In a fixed condenser we have one or more metal plates (copper foil generally), joined to one terminal, and another set joined to the other terminal, the two sets of plates being held apart with an insulator called a dielectric. The dielectric chosen is generally mica, because mica offers many advantages not possessed by other materials.

Using the centimetre units, the capacity of a condenser in $\mu\mu F$ with N plates, the mica being t cms. thick and having a specific inductive capacity of K (see "Wireless Theory," page 78, April 21st issue), and the metal plates overlapping by A square cms.,

$$C\mu\mu F = \frac{0.0885 KA(N - 1)}{t}$$

Using the inch unit for the dimensions, the formula is as follows :—

$$C\mu\mu F = \frac{0.225 KA(N - 1)}{t}$$

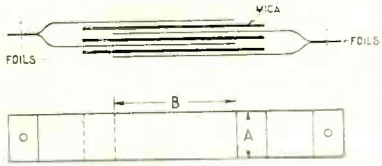
Where K = the dielectric constant of mica (varies from 5 to 8).

A = area of overlap of metal foils in square inches.

N = total number of foils.

t = thickness of mica.

The value of K for mica varies according to the quality of the mica, and how is anyone to know its value when the mica is purchased at a dealer's? In the same way, the dealer may say the mica is 0·002 in. thick, and while some pieces may be, a lot of pieces are not, and are likely enough 50 per cent. out. In



It will be seen that the area of overlap is equal to $A \times B$ where A is the width of one foil and B is the length of foil covered by a plate of opposite polarity.

addition, the formula assumes the space between the metal plates, let us say, is all mica, therefore when the plates are not clamped tightly together, leaving a film of air between the plates, as well as the mica, the nett value of K for the dielectric is lowered immediately

It is quite apparent, therefore, that if you wish to make a fixed condenser which shall have a capacity the same as its calculated capacity, the condenser must be very accurately made, from components of known dimensions and quality.

In the case of mica ordinarily purchased, the value of K may be taken as 5·5, and its thickness as 0·002 in.

The formula may then be simplified considerably. By putting in the above values it becomes

$$C\mu\mu F = 0{\cdot}00062\,A \times (N - 1).$$

Example.—What is the capacity of a fixed condenser built of mica whose dielectric constant is 5·5, and which is 0·002 in. thick; the metal foils have an overlap of 1 square in., and there are a total of three plates.

$$\text{Cmfds.} = 0{\cdot}00062 \times 1 \times 2$$
$$= 0{\cdot}00124 \text{ mfds.}$$

The table below has been worked out from the above formula, and should be helpful.

It will be noticed that if the thickness of the mica is doubled, the capacity is halved, and so on. Also if the area of the metal foils is doubled the capacity is doubled.

Table showing the number of plates and the area of overlap for various fixed condensers. Mica is the dielectric, 0·002″. Its dielectric constant is taken as 5·5.

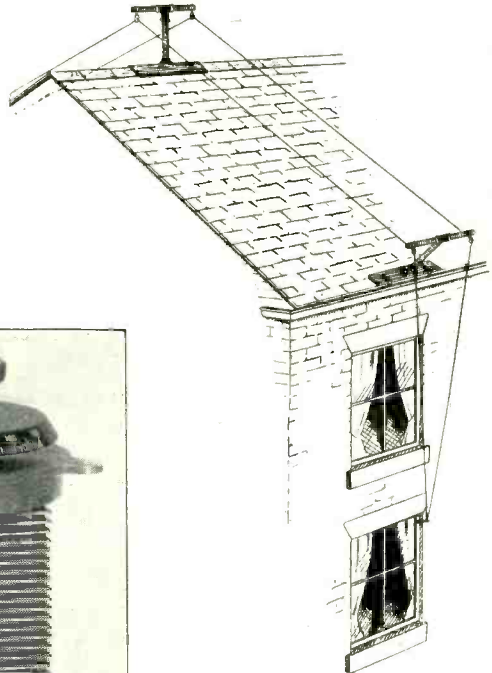
Area in square inches		Capacity in mfds.				
		0·10	0·20	0·30	0·40	0·50
Number of plates.	2	0·000062	0·000124	0·000186	0·00025	0·00031
	3	0·000124	0·000248	0·000372	0·0005	0·00062
	4	0·000186	0·000372	0·000558	0·00075	0·00093
	5	0·000248	0·000496	0·000744	0·001	0·00124
	6	0·000310	0·000620	0·000930	0·00125	0·00155
	7	0·000372	0·000744	0·001116	0·0015	0·00186
	8	0·000434	0·000868	0·001302	0·00175	0·00217
	9	0·000496	0·000992	0·001488	0·0020	0·00248
	10	0·000558	0·001116	0·001674	0·00225	0·00279
	11	0·000620	0·001240	0·00186	0·0025	0·00310
	12	0·000682	0·001364	0·002046	0·00275	0·00341

Area in square inches.		Capacity in mfds.					
		0·60	0·80	1·0	2·0	4·0	6·0
Number of plates.	2	0·000372	0·000496	0·00062	0·00124	0·00248	0·00372
	3	0·000744	0·000992	0·000124	0·00248	0·00496	0·00744
	4	0·001116	0·001488	0·00186	0·00372	0·00744	0·01116
	5	0·001488	0·001984	0·00248	0·00496	0·00992	0·01488
	6	0·001860	0·00248	0·0031	0·00620	0·01240	0·01860
	7	0·002232	0·002976	0·00372	0·00744	0·01488	0·02232
	8	0·002604	0·003472	0·00434	0·00868	0·01736	0·02604
	9	0·002976	0·003968	0·00496	0·00992	0·01984	0·02976
	10	0·003348	0·004064	0·00558	0·01116	0·02232	0·03348
	11	0·00372	0·00496	0·0062	0·0124	0·0248	0·0372
	12	0·004092	0·005456	0·00682	0·01364	0·02728	0·04092

NEW INSTRUMENTS AND DEVICES.

The "Roofaffix" Aerial.

A device for arranging an aerial on a housetop, which is of special interest to the flat dweller, has been introduced by Messrs. B. Byron & Co., of Liverpool. Provision is made by means of brackets for supporting a 2-wire aerial at a distance of a few feet from the walls and roof. The arrangement obviates the risk of damage to property. It is mechanically strong and reasonably easy to fix, and provides an efficient aerial for reception purposes.



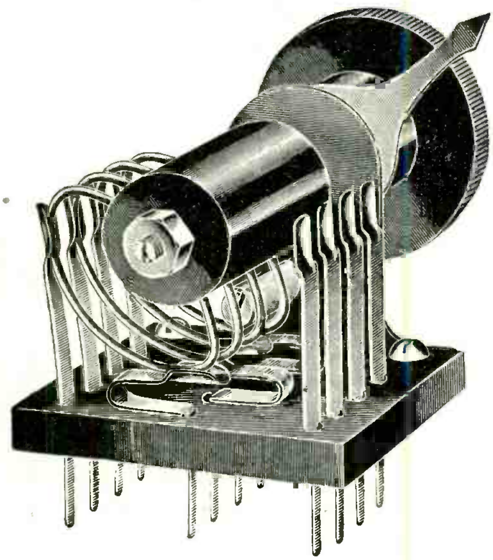
A New Condenser.

A new condenser of substantial design has been introduced by Messrs. J. Lipowski & Co., of 614, Old Ford Road, Bow, E.3. A special feature in the design is a substantial cast aluminium top plate to which the spindles which carry the fixed and moving plates are secured. The strength of this plate overcomes the difficulties which arise when securing the condenser to the instrument panel, for, should the panel be not quite flat, the aluminium top plate of the condenser is not likely to be distorted in consequence.

Above: The "Roofaffix" Aerial.

Centre: Messrs. Lipowsky's New Condenser.

Left: The Efficient Change-over Switch made by Messrs. Wilkins and Wright Ltd.



An end plate of cast aluminium is also a good feature in the construction of this condenser, while to facilitate assembling, the spindle of the moving plates is held in position by means of a spring washer. The capacity of the condenser shown is 0.0015 microfarads.

Change-over Switch for Panel Mounting.

A change-over switch specially designed for use in changing out the circuit arrangements in receiving apparatus is placed on the market at a reasonable price by Messrs. Wilkins & Wright, Ltd., of Birmingham. The design provides for minimum losses, so that the switch can be introduced into high or low frequency circuits. It occupies quite a small space on the face of the panel, and is easily secured by a nut on the spindle and a stop-pin engaging in a hole on the under side of the instrument panel.

With the present extensive use of circuits embodying involved switching arrangements, the introduction of this switch will be appreciated by all experimenters.

A PRACTICAL COURSE IN THE PRINCIPLES OF WIRELESS

EXPERIMENTS FOR THE RADIO AMATEUR

Before useful experimental work can be undertaken it is essential to know the constants of the aerial circuit. Simple methods are described in this instalment for determining the natural wavelength and the capacity of the aerial.

By MAURICE CHILD.
Vice-Chairman of the Radio Society of Great Britain

EXPERIMENT No. 7.

To measure the approximate natural wavelength of the aerial.

Apparatus required :—
- 1 Unshunted or sparking buzzer,
- 1 Dry cell,
- 1 Wavemeter with crystal detector and telephones.

The object of this experiment is to determine the approximate wavelength of the aerial circuit, *i.e.*, the wavelength to which it will most readily respond without the addition of any inductance or condenser in conjunction with it.

It is important for every serious experimenter to know the wavelength to which his aerial, when joined to earth, is most sensitive, and this wavelength is called the natural wavelength. Putting the matter in another form—if the aerial is caused to oscillate, and radiate electric waves, the length of these waves and frequency of the oscillating currents will be governed by the inductance and capacity, and, to a very slight extent, the resistance of the aerial circuit, and these constants therefore determine the natural period.

A precaution should be taken that the aerial is thoroughly well insulated, especially at the free end.

The sparking or unshunted buzzer is joined up to a dry cell, and the aerial joined to either the iron frame or contact pillar of the buzzer, as already indicated in Experiment 4 (see Figs. 5 and 6*).

The earth wire should make a small loop of one or two turns of approximately 4 ins. diameter (Fig. 13). This can be done quite easily by stapling the earth wire to the wall just above the level of the table, and may be permanently left. This loop will be found useful if it is desired now and again to energise the aerial for any purpose.

The wavemeter inductance is brought within an inch or two of this earth loop. The buzzer is now set in operation, and very weak high

* Page 171, May 12th, 1923.

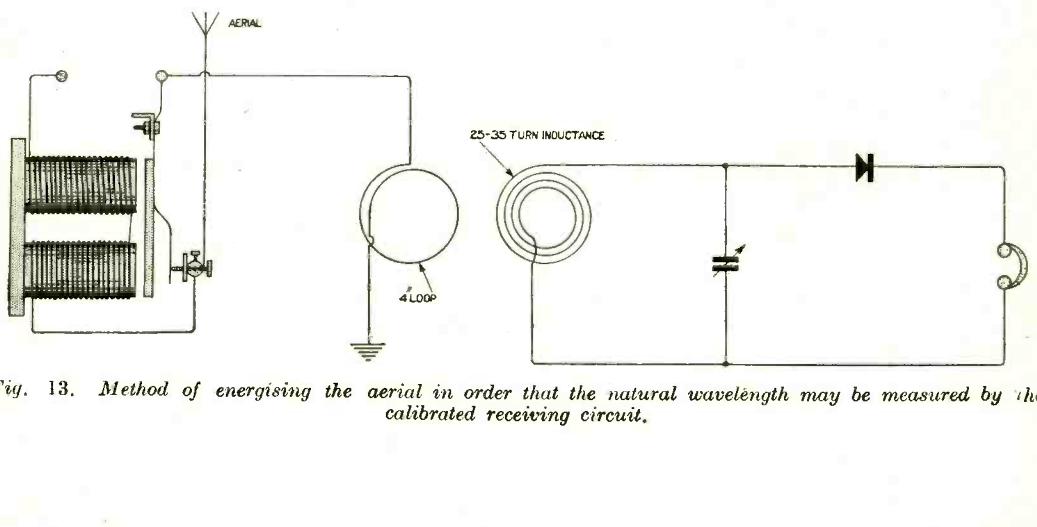


Fig. 13. Method of energising the aerial in order that the natural wavelength may be measured by the calibrated receiving circuit.

frequency oscillations will be generated in the aerial circuit.

The wavemeter must be tuned to give a maximum response in the telephones to these oscillations, and, when this has been done, a reference to the condenser position and the inductance coil employed will give the wavelength on comparison with the chart or curve.

With small aerials, somewhat under the maximum usually licensed by the Post Office, a 25-turn Igranic coil will be found to cover the wavelength range, but with larger aerials, a 35-turn coil will be needed. The wavelength recorded should come within the range of from 150 to 250 metres.

NOTE.—It will be found that the maximum position of the resonance is not very sharp, and, for this reason, care should be taken to keep the wavemeter inductance as far as possible from the earth loop, and also from close proximity to the buzzer itself, as sometimes direct inductive effects from the buzzer magnets may be produced, and make the experiment difficult to perform with accuracy.

EXPERIMENT No. 8.

To measure the approximate capacity of the aerial.

Apparatus required :—

- 1 Shunted buzzer,
- 1 Dry cell,
- A 100-turn inductance coil and mounted holder for same,
- 1 Standard variable condenser,
- 1 Double-pole 2-way switch,
- A tunable receiving circuit, or wavemeter with crystal detector.

The object of this experiment, as already outlined, is to determine the capacity of the aerial. This is useful as, once it is known, the experimenter is able to determine with a very fair degree of accuracy the wavelength which the aerial circuit will respond to when an inductance coil of known value is inserted between the aerial and the earth.

It should be mentioned, however, that in cases where the inserted inductance is a very small amount, the calculated wavelength determinations are not strictly accurate, unless the actual inductance of the aerial itself is known, but in practice, for wavelengths of 200 to 300 metres or so above the natural wavelength of the aerial, the added inductance is of sufficient dimensions to make the calculation accurate enough for all practical purposes. The procedure is as follows :—

The shunted buzzer is connected in series with the dry cell and the 100-turn inductance coil. The inductance coil, in turn, is connected to the middle terminals of a double-pole 2-way throw-over switch. The terminals of the switch marked " A " (Fig. 14), is connected to the aerial and earth, and the terminals marked

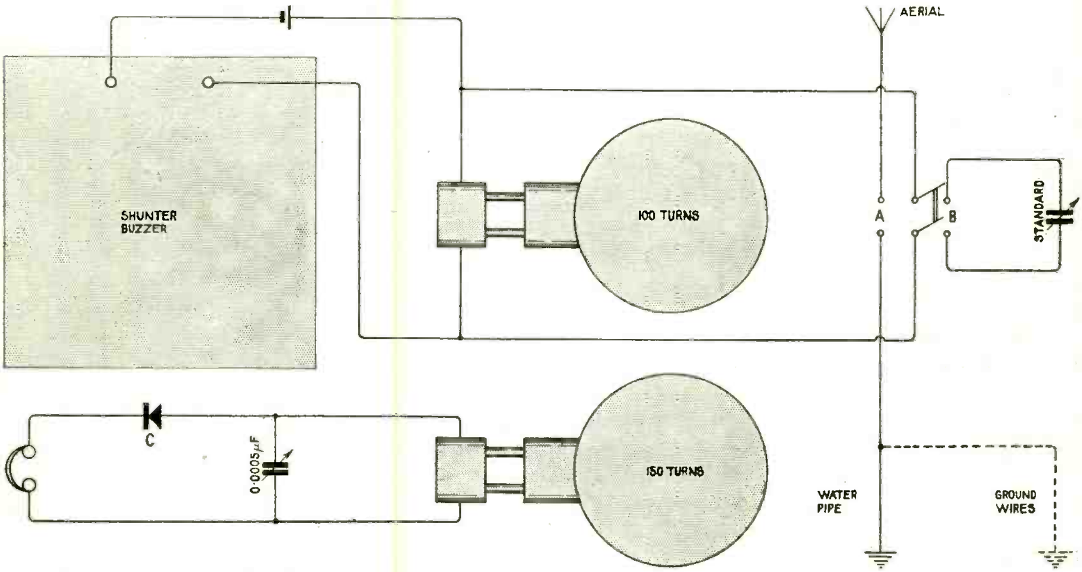


Fig. 14. Circuit arrangements necessary for determining the capacity of the aerial.

"B" to the standard calibrated condenser, the shortest possible connections being used.

A detector circuit consisting of one 150-turn inductance coil and a small variable condenser (say 0.0005 mfds.), should be set up and the two inductances coupled fairly loosely to each other.

On setting the buzzer working, high frequency oscillations will be set up in the aerial circuit when the switch is placed in position "A." Some of this oscillating energy will be induced into the detector circuit "C" when the latter is brought into resonance by means of the 0·0005 variable condenser. This point of resonance should be accurately determined.

The change-over switch is now put into position "B" and the standard condenser swung round to such a position where the maximum signal strength from the buzzer is obtained in the receiving telephones. The circuit "C" must on no account be altered from its original setting when the switch is in the "A" position.

The capacity of the condenser across the terminals "B" is now equal to that of the aerial circuit. It is suggested that the values determined in the previous experiment and this one should be set out on a suitable card or paper, and posted up in some convenient place in the experimenter's laboratory.

A useful extension of the above experiment can be made in some cases. It frequently happens that the experimenter is able to make an alternative earth connection, such as a buried plate, or wires in the ground, as well as the more usual connection to the water main system of the house. In this case the alternative earth connection can be joined as indicated by the dotted line in the diagram (Fig. 14), and the first earth connection removed.

The capacity of the aerial has now to be remeasured, and it will be necessary to alter circuit "C" for maximum signals. A note should also be made as to the difference in strength of the signals when either one or other of the earth connections is used. For this purpose a constant distance between the two inductance coils should be maintained.

A further test can also be made using both connections to earth, and again the variation of signal strength (if any) noted. In general, that earth system which gives maximum signal strength will be found the most useful when the time comes for receiving actual signals. It may be, however, that signals from certain stations will be found better on the water-pipe earth, and, from other stations, on the ground earth; therefore it is convenient to make these two connections easily available.

Review.

ELECTRONS, ELECTRIC WAVES AND WIRELESS TELEPHONY. By J. A. Fleming, M.A., B.Sc., F.R.S.

THIS book* is a reproduction, with some amplification, of the course of Christmas Lectures given by the author at the Royal Institution of Great Britain, London, in December, 1921 and January, 1922.

Professor Fleming, besides being the author of several standard works, is the inventor of the thermionic valve. He is also well known to the readers of this journal through his contributions from time to time, and this book gathers together a number of his articles which have appeared in this journal during the five months, October, 1922, to February, 1923.

The book opens with a discussion on surface waves on liquids, waves in the air, and wave production.

Chapters III and IV deal with the architecture of the atom, the electron theory, electromagnetic fields, forces and radiation.

The remainder of the book is devoted to the practical problems of telephony—the methods of producing and detecting electric waves, the nature of sound waves, the valve oscillator, methods of modulation, valve transmitting and receiving apparatus, and aerials.

Professor Fleming is noted for the remarkable manner in which he is able to explain difficult things simply and clearly, and those who have little knowledge of wireless will find this little book of the greatest assistance.

The book is a standard work, and fills a distinct gap in wireless literature.

* ELECTRONS, ELECTRIC WAVES AND WIRELESS TELEPHONY. By J. A. Fleming, M.A., D.Sc., F.R.S. (London: The Wireless Press, Ltd., 12-13, Henrietta Street, Strand, W.C.2. pp. 326. Price 7/6. Post free, 8s).

INSTRUCTIONAL ARTICLE FOR THE LISTENER-IN AND EXPERIMENTER.

WIRELESS THEORY—X.

It is the purpose of the writer to deal with the principles underlying the action of wireless receivers and transmitters. Those who know *why*, obtain much pleasure which is not experienced by those who have no idea of the action of their wireless set.

The series has been specially designed so that the reader who follows each section as it appears will have obtained a complete wireless education with a minimum of time and trouble, and he will be in a position to successfully design his own wireless equipment.

In previous sections the writer has dealt with the principles of electricity such as the effect of resistance, capacity and inductance. The last two sections deal with alternating current work, the study of which is important to those who desire a clear understanding of wireless.

By W. JAMES.

26.—Time Constant.

IN section 21 we dealt with the relation between current and pressure in a series circuit comprising resistance and capacity. When a condenser without resistance is connected with a battery, assuming the battery and leads have no resistance, the condenser is charged practically instantaneously. When, however, resistance is present, a short time passes before the condenser is fully charged. The higher the value of resistance, the longer the time taken. The quantity RC, that is the product of the resistance in the circuit and the capacity in farads, is called the time constant. Considering Fig. 58, when switch A is closed, at the end of time RC, the condenser will have received 63 per cent. of its charge.

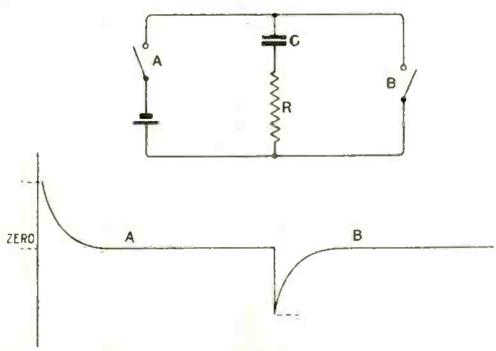


Fig. 58. Curves illustrating the charging and discharging of a condenser in a circuit as shown.

When the switch A is opened and B is closed, in time RC, the condenser will have lost 63 per cent. of its charge. Curves A and B show the charging and discharging currents referred to.*

* Prof. Morecroft.

The current at any instant in the circuit may be calculated thus :—

$$i = \frac{E}{R}(\epsilon^{-t/RC}) \text{ where}$$

E = pressure of battery.
R = resistance in ohms.
C = capacity of condenser in farads.

It will be noticed the shape of the charging and discharging current curves is the same.

If the condenser C has a capacity of 0·001 mfds., and the resistance 500,000 ohms, the time constant of the circuit is 0.0005 seconds.

In the case of a circuit containing resistance and inductance, the quantity $\frac{L}{R}$ is equal to the time constant, that is, in time $\frac{L}{R}$ seconds, the current will have reached 63 per cent. of its final value. The quantity L is the inductance of the circuit in henries, and R the resistance in ohms.

27.—The Series Circuit.

Suppose now we have a circuit consisting of resistance, capacity, and inductance all in series, as shown in Fig. 59. When an alternating pressure is connected to the circuit, a resultant current, which is composed of three currents, will flow. There will be a voltage

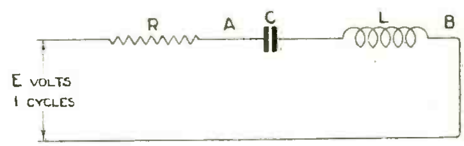


Fig. 59. Series circuit with resistance capacity and inductance.

drop across each portion of the circuit. The voltage drop across the resistance of R ohms is equal to RI volts. This drop is in phase with the current as represented in the vector construction of Fig. 60, where it is represented by OA. The voltage drop across the condenser of capacity C farads is represented by OC in the figure, and its magnitude is given by $\frac{I}{\omega C}$. The condenser current and voltage differ in phase by 90°, the condenser current leading and as the drop across the resistance is represented by the horizontal line OA, the drop across the condenser is represented by the line OC, which is at 90° to OA. The drop across the inductance of inductance L henries is given by $I\omega L$ volts and is represented by OB, which is at right angles to OA, because the current through a choke coil lags behind the pressure by 90°.

It will be noticed the pressure drop across the inductance and capacity are opposite, which means that the magnetic energy associated with the inductance helps to charge up the condenser and *vice versa*. The difference in pressure across the ends of the coil and condenser, AB in Fig. 59, is therefore less than the pressure drop across either the coil or the condenser. The subtraction may be made arithmetically, since the two pressures are exactly in opposition; the total pressure is thus as represented by the right-hand Fig. 60. The magnitude of OD represents the difference between the pressures OB and OC. The resultant pressure E is given by OF, which is the vector sum of OD and OA. From the construction it is seen the capacity reactance predominates over the inductive reactance, therefore the resultant current will lead the applied pressure. The angle of lead is represented by the angle θ in Fig. 60. From the vector construction it is seen that the total pressure E may be written $\sqrt{(OA)^2 + (OD)^2}$

Since $OA = RI$ volts

and $OD = \frac{I}{\omega C} - \omega L I$

or $I\left(\frac{1}{\omega C} - \omega L\right)$

$$E = \sqrt{(IR)^2 + \left(I\left[\frac{1}{\omega C} - \omega L\right]\right)^2} \text{ volts,}$$

$$\text{and } I = \frac{E}{\sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2}} \text{ amperes.}$$

It is plain that when the quantity ωL, which is the inductive reactance, is greater than the capacitative reactance $\frac{1}{\omega C}$, the quantity in the brackets, will be $\left(\omega L - \frac{1}{\omega C}\right)^2$. The smaller is always taken from the greater. The equation just given is Ohm's law of the alternating current circuit, the quantity

$$\sqrt{R^2 + \left(\frac{1}{\omega C} - \omega L\right)^2}$$

being called the impedance. Impedance is comparable with resistance, in so far that each represents the opposition of a circuit

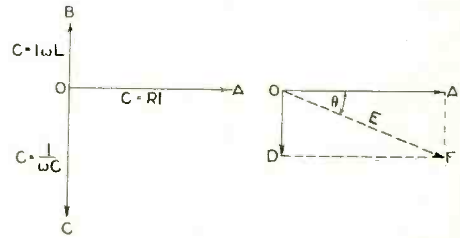


Fig. 60. Vector diagram showing phase relationship in a circuit such as Fig. 59.

to the flow of current. The impedance, like resistance, is expressed in ohms, and is represented by Z.

When the inductive reactance ωL ohms is greater than the capacity reactance, $\frac{1}{\omega C}$ ohms, the resultant current will lag behind the pressure; on the other hand, when the quantity $\frac{1}{\omega C}$ exceeds ωL, the resultant current will lead.

The phase difference (See Fig. 61) is given by

$$\text{Tan } \theta = \frac{\omega L - \frac{1}{\omega C}}{R} \text{ or simply}$$

$$\text{Tan } \theta = \frac{\text{reactance}}{\text{resistance}}.$$

It will be instructive at this stage to take an example which will serve to bring out important points.

Suppose the components have the following values—see Fig. 61. $R = 150$ ohms, $C = 10$ microfarads or 0.00001 farads, $L = 2$ henries, $E = 500$ volts, $f = 50$ cycles.

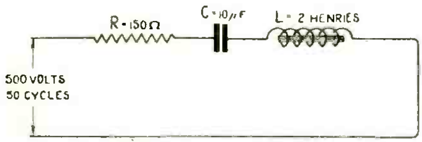
Now $\omega = 2\pi f = 314$
$R^2 = 22{,}500$ ohms | $\frac{1}{\omega C} = 318$ ohms
$\omega L = 628$ ohms

$$Z = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}$$
$$= \sqrt{22{,}500 + 96{,}100}$$
$$= 344.4 \text{ ohms.}$$

The current $I = \frac{E}{Z}$ or $\frac{500}{344.4} = 1.45$ amperes.

The voltage drop across the resistance is equal to RI or $150 \times 1.45 = 217.5$ volts.

The voltage drop across the condenser is equal to $\frac{I}{\omega C}$ or $1.45 \times 318 = 461.1$ volts.



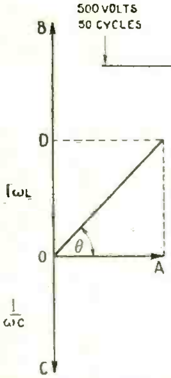


Fig. 61. When the components have the values given, the total current is equal to 1·45 amperes.
The lower diagram shows the vector construction.

The voltage drop across the coil is equal to ωCI or $628 \times 1.45 = 910.6$ volts. *Now it will be noticed the pressure drop across the condenser is practically equal to the applied pressure, while the pressure drop across the coil is nearly twice that of the applied pressure.* As explained before, the condenser and coil pressures are in opposition, and one may be taken from the other. This is shown in the vector diagram of Fig. 61. In the example $\omega CI - \frac{I}{\omega C} = 910.6 - 461.1$ or $449{\cdot}5$ volts.

The vector sum of this pressure, and the voltage drop across the resistance should equal the applied pressure, or

$$\sqrt{(217.5)^2 + (449.5)^2} = 500 \text{ volts.}$$

It may be emphasised here that, as shown in the above example, the pressure across a portion of a series circuit may greatly exceed the applied pressure. The insulation should therefore be carefully seen to.

28.—Series Resonance.

Now it must be quite plain that the capacity and inductance in a series circuit may have such values that their reactances neutralise. When this is the case, the magnitude of the pressure-drop across the coil and condenser is equal, and only ohmic resistance limits the current flow. Thus in the vector diagram, Fig. 61, when OB and OC are equal, they neutralise exactly, and the pressure applied drives a current of magnitude $\frac{E}{R}$ through the circuit. In the example above, the current would be $\frac{500}{150}$ or 3.33 amperes.

Let us suppose the inductance of the coil L in the above example is variable, and find at what inductive value resonance will occur.

Now ωL must be made equal to $\frac{1}{\omega C}$.

Writing $\omega L = \frac{1}{\omega C}$. $L = \frac{1}{\omega^2 C}$ substituting the values given in the example,

$L = \frac{1}{(314)^2 \times 0.00001}$, or just over 1 henry.

Thus, when the inductance has this value, the inductive and capacitative reactances neutralise. The vector diagram is given in Fig. 62

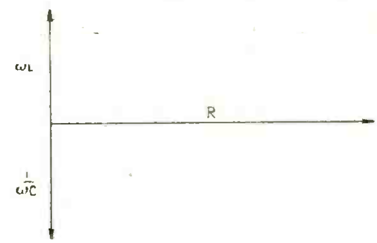


Fig. 62. When ωL is equal to $\frac{1}{\omega C}$, only resistance is effective in the circuit so far as the total current which flows is concerned. We have then electrical resonance.

Now the drop in pressure across the coil is exactly equal to the drop across the condenser, and since the two pressures are acting in opposition, the net pressure is zero. We have then only resistance limiting the flow of current in the circuit.

Instead of writing $\omega L = \frac{1}{\omega C}$ for resonance we may write $\omega^2 = \frac{1}{LC}$ or $\omega = \frac{1}{\sqrt{LC}}$.

Since $\omega = 2\pi f$

$f = \frac{1}{2\pi\sqrt{LC}}$ where L is in henries and C is in farads.

The result is of fundamental importance.

Wireless Club Reports.

NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter and worded as concisely as possible, the Editor reserving the right to edit and curtail the reports if necessary. **The Editor will be pleased to consider for publication papers read before Societies. An Asterisk denotes affiliation with the Radio Society of Great Britain.**

Correspondence with Clubs should be addressed to the Secretaries direct in every case unless otherwise stated.

The West London Wireless and Experimental Association.*

On Tuesday, May 8th, an article from one of the wireless publications dealing with "Crystal Reception," was read by Mr. A. Labram, and questions were then raised and answered by various members.

Full particulars regarding membership of the Association will be gladly sent to all enquirers by the Hon. Sec.

Headquarters: The Acton and Chiswick Polytechnic, Bath Road, Chiswick, W.4.

Hon. Sec., Horace W. Cotton, 19, Bushey Road, Hayes, Middlesex.

The Willesden Wireless Society.*

"Capacity" formed the subject of an extremely interesting lecture delivered by Mr. E. Earnshaw-Wall on May 8th. Much attention was devoted to Leyden jars and particulars of some valuable experiments witnessed by the lecturer.

Applications for membership should be addressed to the Hon. Sec., G. D. Wyatt, 70, Craven Road, Harlesden, N.W.10.

The Kensington Radio Society.*

At the May meeting of the Society, Mr. W. J. Henderson gave a lecture on the various types of "B.B.C." one, two and three-valve receivers, demonstrating the instruments on the Club aerials, and the contrasted results obtained from different combinations were most instructive.

The Hon. Sec., J. Murchie, of 2, Sterndale Road, W.14., will be pleased to answer any enquiries as to membership.

The Stoke-on-Trent Wireless and Experimental Society.*

An interesting discussion on "Reaction," opened by Messrs. F. J. Goodson, B.Sc., and F. T. Jones, took place on May 10th. Mr. Goodson first dealt with re-radiation, what it is and how it is caused, and Mr. Jones dealt with its detection and prevention. A keen discussion followed, in which the subject was thoroughly considered from all aspects.

Hon. Sec., F. J. Goodson, B.Sc., M.I.Mech.E., Tontine Square, Hanley.

Sutton and District Wireless Society.*

An instructive lecture was given by Mr. G. G. Blake on Wednesday, May 9th, entitled "Some Historical Notes on Radiotelephony and Telegraphy."

Meetings are held on the second and fourth Wednesdays in the month, and the Committee hopes to arrange regular lectures of interest on every first meeting in the month, the second meeting taking the form of a practical evening.

Hon. Sec., E. A. Pywell, "Stanley Lodge," Rosebery Road, Cheam, Surrey.

Swansea and District Radio Experimental Society.*

"The Elementary Principles of Wireless Telegraphy" was the title of an interesting lecture delivered on May 9th by Mr. R. G. Isaacs, M.Sc., A.M.I.E.E., of the University College, Swansea. In passing a vote of thanks, the members also expressed their indebtedness to the University authorities.

Hon. Sec., Herbert T. Morgan, 218, Oxford Street, Swansea.

The Lewisham and Catford Radio Society.*

At a well attended meeting held on May 10th, Mr. R. J. Stanley lectured on various types of "Double Magnification Circuits."

The Secretary will be pleased to see any prospective members on any Thursday evening at the Society's new headquarters, Y.M.C.A., 432, High Street, Lewisham.

Hon. Sec., F. A. L. Roberts, 43, Adelaide Road, Brockley, S.E.4.

Paddington Wireless and Scientific Society.*

On Thursday, May 10th, Mr. W. Bursall, A.M.I.E.E., read an instructive paper entitled "Flow Meters," dealing with the measurement of the flow of liquids and steam with the aid of electricity.

Hon. Sec., L. Bland Flagg, 61, Burlington Road, Bayswater, W.2.

The Ilford and District Radio Society.*

On May 3rd, a discussion on "Low Frequency Amplification" was held. Mr. J. F. Payne opened the discussion by enumerating the advantages and disadvantages of this method of amplification. Mr. A. E. Gregory (Hon. Sec.) recommended the use of iron cored choke instead of the customary L.F. intervalve transformers. Mr. J. N. Nickless, A.I.E.E. stated that in his opinion the question of the employment of open cored L.F. transformers had not received sufficient attention.

Hon. Sec., A. E. Gregory, 77, Khedive Road, Forest Gate, E.7.

Wimbledon Radio Society.*

An informative lecture was delivered on Thursday, May 10th, when Mr. C. E. Palmer Jones dealt with "The Construction of Valves." All interested in Radiotelegraphy and kindred sciences in Wimbledon and district are cordially invited to join and applications for new membership will be welcomed by the Hon. Sec., C. G. Stokes, 6, Worple Avenue, Wimbledon, S.W.19.

Eastbourne and District Radio Society.*

On Thursday, May 10th, a very interesting lecture was given by Mr. W. S. Maddock, at the

Technical Institute, the subject being "The Origin of Wireless Telegraphy."

Capt. Adamson then gave a demonstration with a set designed and built by himself; with the loud speaker, reception of speech and music was heard clearly from **2 LO**, both on indoor and outdoor aerials.

The Society has now been in existence for 11 months and the number of members steadily increase, the total now being over 50. Many novel features are in course of preparation in connection with future programmes. Application for membership should be addressed to Hon. Sec., W. F. G. West, "Bridle Gate," Willingdon, Sussex.

The Leeds and District Amateur Wireless Society.*

At the instructional meeting held on May 11th, the President, Mr. A. M. Bage, lectured upon "Aerials—Outdoor, Indoor and Loops," discussing the principles of wave motion through the ether and showing how the energisation of transmitting and receiving aerial systems is brought about.

On May 18th, Mr. A. F. Carter, A.M.I.E.E., lectured upon "Liquid Air and Oxygen," Mr. W. G. Marshall presiding. Thanks to the valued support of Mr. Jakeman, of the British Oxygen Co., Sheffield, the lecturer was enabled to exhibit apparatus and conduct a variety of very instructive experiments using liquid oxygen, which the lecturer dealt with in its relation to valve manufacture and other allied work.

The Hon. Secretary has pleasure in announcing that the subscription for the remainder of the session, which includes twelve lectures, etc., has been declared half the annual subscription.

Hon. Sec., D. E. Pettigrew, 37, Mexborough Avenue, Chapeltown Road, Leeds.

Tottenham Wireless Society.*

On Wednesday, May 16th, Mr. A. G. Tucker lectured on "Radium and the Constitution of Matter."

The lecture was followed by a competition for Novel Crystal Sets, some of which took the form of an inkstand, a book, a matchbox and a paperweight. The prize of £1 went to the owner of a handsome writing case set incorporating special switching arrangements.

On Saturday, May 19th, 14 members visited Croydon Aerodrome by kind permission of the Commanding Officer.

A visit to a Ship Station has been arranged for the near future. Membership to this Society is open to all interested in radio, and particulars will be forwarded on application to the Hon. Sec., S. J. Glyde, 137, Winchelsea Road, Tottenham, N.17.

The Finchley and District Wireless Society.*

At the first monthly summer meeting on May 17th, Mr. Nicholls, Treasurer, resigned his post, but Mr. Wilck kindly volunteered to take on the responsibilities and was duly elected.

Hon. Sec., A. E. Field, 28, Holmwood Gardens, Finchley, N.3.

Plymouth Wireless and Scientific Society.*

A lecture on "Magnetism," was given on May 15th, by Mr. S. G. Monk, B.Sc., who dealt with the subject particularly in its application to inductances. The Society's three-valve set is nearing completion. Full particulars of membership can be obtained from the Hon. Sec., P. M. Fowler, Plymouth Chambers, Old Town Street, Plymouth.

Chesterfield and District Radio Society.

The Society held its first exhibition of members' apparatus on Tuesday, May 8th, at the Central School, Chesterfield. His Worship the Mayor, Alderman G. Clarke (President) was present.

Demonstrations were given during the evening with several of the members' sets and broadcasting was received from the various stations.

Hon. Sec., J. Hambidge, Beetwell Street, Chesterfield.

The Hall Green Radio Society.

Dr. Ratcliffe (**2 OX**) delivered an interesting lecture on May 9th, entitled "The Fundamentals of Wireless Reception." The President, Mr. H. H. Whitfield (**2 LG**), occupied the chair. Experiments and drawings illustrated Dr. Ratcliffe's excellent exposition, which was warmly received.

Mr. F. C. Rushton, Hon. Sec., announced that arrangements had been made for a visit of the members to the Birmingham station of the British Broadcasting Company (**5 IT**) on May 26th.

Anerley Wireless Society.

Several new members were enrolled on May 9th, and at the same meeting it was decided that during the new session special elementary lectures and demonstrations should be given for the benefit of beginners.

All interested and who live in the district should communicate with the Hon. Sec.

Headquarters: 177-179, Maple Road, Penge.

Hon. Sec., F. Bailey, 25, Newlands Park, Penge.

Bexhill and District Radio Society.

An instructive explanation and demonstration of the seven-valve polar set was given by Mr. L. E. Owen, of the Radio Communication Company, on Thursday, May 10th. Very clear reception was obtained from **2 LO**, but atmospherics were annoyingly abundant. The lecturer afterwards gave some useful advice to the members on the building of the Society's three-valve set.

Hon. Sec., A. J. Hill, 15a, Sea Road, Bexhill-on-Sea.

Salisbury and District Radio Society.

An interesting and instructive lecture was given by Capt. Hobbs, of the Tank Corps, Wareham, on May 10th, his subject being "The Practical Application of Theory." Capt. Hobbs described a new single valve circuit of his own design, and also gave the constructional details of a heterodyne wavemeter especially suitable for low wavelengths.

It has been arranged to meet only once a month during the summer, and to spend field days with the Club's set.

There is plenty of room for new members, and prospective members should communicate with the Hon. Sec., H. F. Flutcher, 19, Fisherton Street, Salisbury.

New Society for Doncaster.

At a meeting held in the Technical College, St. George's Gate, Doncaster, on May 10th, it was decided to form a Society under the name of "The

Doncaster and District Radio Society." The officials appointed were as follows:—Chairman, Capt. C. B. Platt, R.E.; Hon. Treas., J. T. Storrow; Hon. Sec., H. Wilson; Assist. Hon. Sec., R. A. Yates. A Committee of three was also elected.

We shall be glad to have the address of the Hon. Secretary.

Liverpool Wireless Society.

"Radio Reception" was the title of a very comprehensive and illuminating talk given on May 10th by Messrs. Pyrah and Atkinson, of the Igranic Electric Co., Ltd.

Mr. Pyrah outlined the development of wireless to the present day. By means of lantern illustrations the members were shown the complicated machinery employed by the Igranic Electrical Company for the manufacture of their honeycomb duolateral and gimball mounted coils.

Mr. Atkinson dealt with the best methods for overcoming the screening of aerials, illustrating his remarks with lantern slides.

The Society would like to record publicly their indebtedness to the Igranic Electric Co., Ltd., and the Western Electric Co., Ltd., for a most instructive and enjoyable evening.

Meetings are held on the second and fourth Thursdays in each month at the Liverpool Royal Institution, Colquitt Street, Liverpool.

Hon. Sec., Geo. H. Miller, 138, Belmont Road, Liverpool.

The Southampton and District Radio Society.

A very interesting discussion on wavemeters took place on Thursday, May 10th, when Dr. McDougall had on view a buzzer wavemeter of his own construction, which he described in detail. Great interest also attached to the Hon. Secretary's exhibit of a Townsend wavemeter and a novel wavemeter of his own construction.

The Hon. Sec. is P. Sawyer, 55, Waterloo Road, Southampton, who would be pleased to hear from local enthusiasts desirous of joining the Society.

Bath Radio Club.

A radio auction and social evening was held at the Red House on May 11th.

Before the auction an important resolution was put to the meeting, and unanimously carried, that the local press be authorised, upon experienced authority, emphatically to contradict recent statements that Bath is a "blind spot." The contrary is evinced by the fact that members of the Club regularly receive all the British and Continental broadcasting—even America has been heard—and moreover, these results are, in many cases, obtained upon the smallest and most inexpensive sets.

Hon. Sec., Geo. J. Barron Curtis, F.S.A.A., F.C.I.S., 6, Pierrepont Street, Bath.

The North-West London Radio Society.

A Society has been formed at Willesden under the above name, with headquarters at "The Willesden Junction Arms" Hotel, near Harlesden Station (Bakerloo Railway).

At the first meeting, held on Wednesday, May 2nd, the following officers were elected:—President, W. E. F. Corsham; Chairman, S. Blake; Hon. Secretary and Treasurer, L. A. Bray; Committee, A. Turner and S. Cook. Subscriptions were fixed at 10s. per year. An interesting programme is being arranged for the summer session, including visits to places of interest. Meetings will be held every Wednesday night at 8 p.m., and the Hon. Sec. will be pleased to receive applications for membership.

Hon. Sec., L. A. Bray, 48, Manor Park Road, Harlesden.

The Radio Association of South Norwood and District.

At the Stanley Halls, South Norwood, on Thursday, May 17th, a lecture was given by Mr. E. A. Saunders, entitled "A Few Considerations of Ether, Electrons and Material Phenomena." The Chair was taken by Mr. S. W. Butters (**5 VU**). The lecturer advocated the study of the ether and electron theories in addition to experimental work, and explained the experiments of great scientists concerning these theories.

It is hoped in the near future to be able to arrange a visit to the Croydon Aerodrome Radio Station.

Hon. Sec., C. H. P. Nutter, 243a, Selhurst Road, South Norwood, S.E.

A NEAT AMATEUR RECEIVER.

Our photo shows the five-valve receiver constructed by Mr. Arthur W. Botten, of "Red Cottage," Bourne End. By means of Dewar type switches, any combination of valves can be obtained. Compactness has been aimed at throughout, and the only visible wires are those to the 'phones or loud speaker.

Notes and News

The first trials with direct wireless communication between Sweden and America will be made at the end of this month.

* * * *

Balmoral Castle, it is understood, will be fitted with wireless before the annual visit of the King and Queen in August.

* * * *

With the idea of diminishing the use of narcotics and sleeping potions, a radio set with 150 pairs of 'phones is being installed in a New York hospital.

* * * *

Evidence on the broadcasting of news and its effect on the Press was given by Lord Riddell before the Postmaster-General's Broadcast Committee on May 29th.

* * * *

Messrs. Reuters, Limited, are taking over new premises to facilitate the handling of news by cable and wireless.

* * * *

Mr. René Stone **(5 FM)**, of 3D, Bushy Hill Road, Camberwell, S.E.5, would be pleased to hear from amateurs who have heard his station working.

* * * *

Birmingham Broadcasting Station.

Birmingham has changed the hour of its day transmissions, which were formerly 11.30 to 12.30 a.m., to 3.30 to 4.30 p.m. It is expected that this alteration will be of great benefit to the trading community and similar changes may be made by other stations.

Our illustration shows a group of successful competitors in a recent wireless competition for schoolboys organised by Messrs. Arding and Hobbs of Clapham Junction. The prizes included apparatus presented by the following firms :—Messrs. Munts. Thames Electric Wireless Co., H. W. Sullivan, Ltd., and the Lithanode Accumulators Co.

Eastcote Fair.

A wireless programme is promised for the annual fair, to be held on June 9th at "The Sigers," Eastcote, Middlesex. The receiving arrangements will be in the hands of the Marconi Company. Eastcote Fair is run in aid of charity, and provides an excellent opportunity of spending an enjoyable afternoon in a good cause.

Radio Between Greenland and Denmark.

In a few months' time regular wireless communication will be established between Denmark and Greenland, states a Copenhagen correspondent. Four stations will be erected for the purpose, and will be fitted with Poulsen Arcs.

8 AE and 8 AÉ.

Apropos of the note in our issue of May 12th regarding the French amateur call signs **8 AE** and **8 AÉ**, we now learn that these signs represent two distinct stations. The former is that of Dr. Pierre Corret, 97, Rue Royale, Versailles (Seine et Oise), and the latter is owned by *La T.S.F. Moderne*, Rue de Suresnes, à Rueil (Seine et Oise).

Wireless and the Blind.

Radio as a hobby appeals very strongly to the blind, and evidence of this is to be found in the "Wireless News and Notes" which appear in that attractive little magazine the "St. Dunstan's Review," published monthly at St. Dunstan's Hostel, Regents Park, N.W.1, price sixpence.

St. Pancras Radio Society.

A club has been formed under the above title to assist enthusiasts in St. Pancras and neighbourhood in all spheres of wireless theory and practice. Will all who desire to learn more of this society please communicate with the Hon. Sec., R. M. Atkins, 7, Eton Villas, Hampstead, N.W.3.

Errata.

Anent the portrait in our issue of May 19th, of Miss Jessie Kenney, it should have been stated that this lady qualified for the P.M.G.'s first class certificate at the North Wales Wireless College, Colwyn Bay.

The special H.F. Resistance with variable Intervalve Reaction, described in the advertisement of Messrs. Radio Instruments, Ltd., in our last issue, has a wavelength range of 200–4,000 metres, and not 250–400, as stated.

Books and Catalogues Received

Instructions as to the Survey of Master's and Crew Spaces. (Issued by the Board of Trade. pp. 32. Price 6d. nett.)

"Sur La Théorie des Surfaces Portantes." By M. M. Roy. (Paris : Gauthier Villars et Cie., 55, Quai des Grands-Augustins. pp. 132. Price 12 francs.)

The Lisenin Wireless Co. An illustrated catalogue entitled "The Home of Wireless," illustrating and describing the *Premierphone* Receiving Sets, for which the Company are the sole concessionaires. Catalogues and agency terms on request from the Company, at 59, Edgware Road, Marble Arch, London. W.C.2.

The Sterling Telephone and Electric Co., Ltd. (210-212, Tottenham Court Road, London, W.1). "The Miracle of Radio : An Introduction to Grand Opera." An illustrated brochure dealing with Sterling Radio Instruments and accessories, and containing portraits of leading artistes of the British National Opera Company, Ltd.

Autoveyors, Limited (84, Victoria Street, London, S.W.1). Temporary "Wireless" Catalogue of Complete Receiving Sets of various makes and of all kinds of components and accessories. Price 3d. post free.

Brown Brothers, Limited (Great Eastern Street, London, E.C.2). Catalogue No. 197, giving particulars of radio instruments, component parts and accessories retailed by this well-known establishment. Also Catalogue No. 197/2, 1923, Nett Wholesale Price List.

A Woman's Radio Club.

By EVA COURSEY, B.Sc.

THE 28th May, 1923, was destined to see another step taken in the development of radio in this country. It was the occasion of a dinner held to inaugurate the "Radio Circle" at the Lyceum Club, Piccadilly. This, which is one of the largest women's clubs, having branches in all the towns of importance throughout Europe, has study circles devoted to topics of special interest to its members, and the formation of a Radio Circle, due to the energy and organising skill of Miss Dicks, brings the educational side of the club into the front rank of progress. The Circle hopes to be affiliated to the Radio Society of Great Britain, and is the first society composed only of women to be devoted to this science.

The chair at the dinner was taken by Mrs. Bigland, better known, perhaps, as Miss Florence Paxbury, who is already a member of the Radio Society of Great Britain. She spoke upon the improvement which may be expected in the quality of singing and speaking now that broadcasting has come to stay, since the radio artist will no longer be able to rely on the attraction of beauty, manner, or clothes, but will stand or fall simply on the merits of the performance.

Among the guests who favoured the company with speeches were included such well-known wireless personalities as Admiral of the Fleet Sir Henry Jackson, Mr. Reith (general manager of the British Broadcasting Company), Mr. Hope-Jones (Chairman of the Radio Society), and Mr. Burrows, the well-beloved "Uncle Arthur" of the children's hour. The last speaker made the encouraging announcement to amateur experimenters that **2 LO** will in future close down for half-an-hour (from 7.30 to 8 p.m.) each evening, so that real experimental work can be carried on at a more convenient hour than is now usually possible, and that the other broadcasting stations will also close down for a similar or longer period.

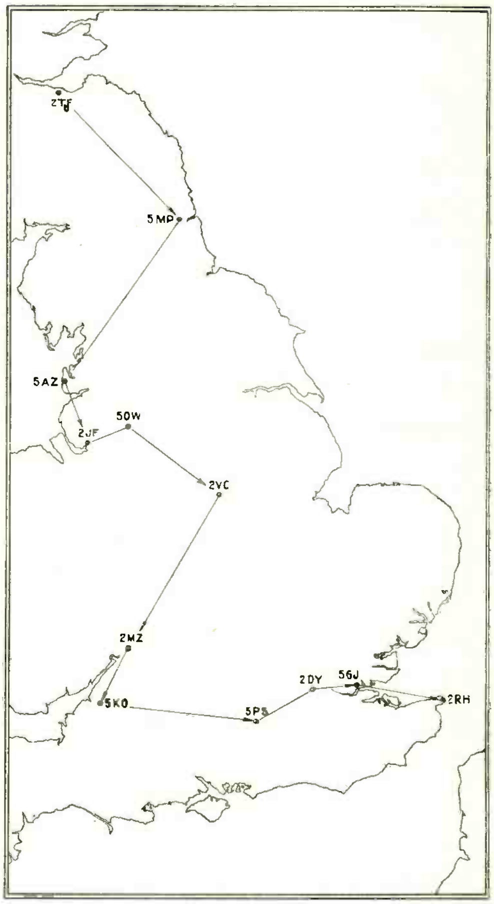
After the dinner Mrs. Bigland gave a few examples of how *not* to speak by wireless, transmitting from **2 BZ** Marble Arch, which station Mr. Basil Davis, also one of the guests, had lent for the occasion. The reception on the loud speaker was somewhat marred by the very poor acoustic properties of the room, but provided a novel and interesting finish to an important event.

TRANSMISSION TEST

TO BE CONDUCTED BY THE BRITISH WIRELESS RELAY LEAGUE.

An official relay test has been arranged for Saturday, June 16th, and the following members are requested to take part—

2TF, 5MP, 5AZ, 2JF, 5OW, 2VC, 2MZ, 5KO, 5PS, 2DY, 5GJ and 2RH. The route indicated on the accompanying sketch map is as follows: Edinburgh, Newcastle-on-Tyne, Blackpool, Liverpool, Manchester, Nottingham, Gloucester, Bristol, Farnborough, London, Stanford le-Hope (Essex), and Broadstairs.



Programme:—2TF will call 5MP from 11.30 to 11.35 p.m., QRK imi QRK K K. 5MP replies and awaits acknowledgment from 2TF and then proceeds to call 5AZ and follow the same procedure as above. Other stations will follow in turn until the communication has been established throughout.

Wavelength, 440 metres throughout, maximum power 10 watts.

The utmost dispatch should be used in getting through and, provided conditions are favourable and sets working efficiently, the last station should be working by 1.30 a.m. Sunday.

All members are requested to listen-in and report on any of these call letters heard, with full particulars as to strength, etc. Will all other amateurs kindly note the times and wavelength, and as far as possible avoid interference with this test.

All reports and logs should be sent addressed to The Traffic Manager, with as little delay as possible.

A further test will be outlined at an early date, and particulars published. All communications to be addressed to the British Wireless Relay League, care of this Journal 12 13, Henrietta Street, W.C.2

Forthcoming Events

FRIDAY, JUNE 8th.

Radio Society of Highgate. At 7.45 p.m. At the 1919 Club, South Grove, N.6. Lecture: "Construction of Amplifiers," by Mr. G. A. V. Sowter, B.Sc.

Leeds and District Wireless Society. Lecture: "Elementary Theory of Transmitting Apparatus," by Mr. D. E. Pettigrew (Hon. Sec.).

Seaforth and District Radio Society. At 8 p.m. At St. Thomas' Parochial Hall, Seaforth Road, Seaforth, Liverpool. Visitors' night.

SATURDAY, JUNE 9th.

Stoke-on-Trent Wireless and Experimental Society. Field day. Visit to Cheadle district.

Mount Pleasant Radio Society. At 21a, John Street, Theobald's Road, W.C.1. First Annual Exhibition and Demonstration.

MONDAY, JUNE 11th.

Prestwich and District Radio Society. Ordinary meeting.

TUESDAY, JUNE 12th.

Winchester Wireless Society. Demonstration by Capt. Young (of Southampton).

WEDNESDAY, JUNE 13th.

Bath Radio Club. At 8 p.m. Lecture: "Aerials and Earths," by Mr. L. E. R. Boxwell.

Clapham Park Wireless Society. At 7.30 p.m. Lecture and demonstration: "My Research Work in Loud Speaker Design," by Mr. J. Grey (member.).

Sutton and District Wireless Society. At 8 p.m. At the Adult School, Benhill Avenue, Sutton. Lecture: "Valves for the Beginner" (illustrated), by Mr. S. H. Naylor.

THURSDAY, JUNE 14th.

Radio Association of South Norwood and District. Lecture: "Wireless: Second Transmission." by Professor P. M. Baker, B.Sc., A.M.I.M.E., A.M.I.E.E.

Broadcasting.

Regular Programmes are Broadcast from the following European Stations :—

Locality.	Call Sign.	Wave-length.	Times.	Nature of Transmission.
GREAT BRITAIN.				
London	2 LO	369	Weekdays 11.30-12.30 a.m.* 5.30 p.m.-11 Sundays 8.30-10.30 p.m.	Regular morning and evening programmes, particulars of which appear in the daily press, are conducted from these stations by the British Broadcasting Company.
Manchester	2 ZY	385		
Birmingham	5 IT	420		
Cardiff	5 WA	353		
Newcastle	5 NO	400		
Glasgow	5 SC	415		
FRANCE.				
Paris (Eiffel Tower).	FL	2,600	Daily 6.40 a.m.	Meteorological Forecast.
			11.15 p.m.	,, Report and Forecast.
			3.30 p.m.	Financial Bulletin (Paris Bourse).
			6.20 p.m.	Meteorological Forecast and Concert.
			10.10 p.m.	Meteorological Report and Forecast.
Levallois-Perret (Radiola)	SFR	1,780	Sundays 2-3 p.m.	Concert.
			Weekdays 5.5 p.m.	Financial Bulletin.
			5.15-6.15 p.m.	Instrumental Music.
			8.45 p.m.	Miscellaneous News.
			9.30-10.30 p.m.	Concert.
Ecole Supérieure des Postes et Télégraphes.	—	450	Tuesday and Thursday 7.45-10.0 p.m.	Concert.
			Saturday 2.30-7.30 p.m.	,,
Radio-Riviera (Nice).	—	460	Daily 11.0 a.m.	News and Concert.
			5-6 p.m.	,, ,,
			9-10 p.m.	,, ,,
Lyons	YN	3,100	Weekdays 10.45 a.m.-11.15 a.m.	Gramophone records.
HOLLAND.				
The Hague	PCGG	1,050	Sunday 3-5 p.m.	Concert.
			Monday and Thursday 8.40-9.40 p.m.	,,
The Hague (Heussen Laboratory).	PCUU	1,050	Tuesday 7.45-10 p.m.	,,
			Sunday 9.40-10.40 a.m.	—
The Hague (Velthuyzen).	PCKK	1,050	Friday 8.40-9.40 p.m.	Miscellaneous.
Ijmuiden	PCMM	1,050	Saturday 8.40-9.40 p.m.	Concert.
Amsterdam	PA5	1,050	Wednesday 8.10-9.10 p.m.	Concert and News.
BELGIUM.				
Brussels	BAV	1,100	Working days 12 noon	Meteorological Bulletin.
			Daily 4.50 p.m.	,,
			Sunday 6 p.m.	Concert.
			Tuesday and Thursday 9 p.m.	Concert.
GERMANY.				
Berlin (Koenigswusterhausen)	LP	2,800	Daily 7-8 a.m.	Financial and other news.
			12-1.30 p.m.	,, ,,
			5-6.30 p.m.	,, ,,
CZECHO-SLOVAKIA				
Prague	PRG	1,800	8 a.m. 12noon and 4 p.m.	Meteorological Bulletin and News.
		4,500	10 a.m., 3 p.m. and 10 p.m.	Concert
SWITZERLAND				
Geneva	HB 1	1,200	Daily 6-7 p.m.	Concert ("Utilitas").
Lausanne	HB 2	—	6-7 p.m.	,, ,,

* 5 IT 3.30-4.30 p.m.

The Elementary Principles of the Valve*

By E. REDPATH.

MY object is to explain as simply as possible the elementary principles of the valve. For the purpose of this little talk I intend to make a very free and easy translation of the words "elementary principles," because I believe that what you wish to know to-night is what the valve is, how it works, and *why it works*. I do not intend to deal with the evolution of the valve, but to come at once to the modern three-electrode valve in almost universal use in wireless receiving sets.

In Fig. 1 is shown a loop (F), the extremities of which are shown connected to the positive and negative terminals of a four-volt battery shown conventionally at B_1. If the wire of which the loop F is made has an appreciable resistance, the passage of the current from the battery will raise the temperature and the wire may become red hot or even incandescent.

In order to control the current flow through the loop, and consequently the heat of the loop, an additional and variable resistance, or rheostat, is introduced between one side of the battery and the loop of wire. When the temperature of the wire is raised sufficiently, minute negative charges of electricity, called electrons, commence to be emitted from the wire. The electrons, normally in a kind of regular planetary movement within the atoms of the wire, are violently agitated by the increased temperature, and are emitted from the surface of the wire.

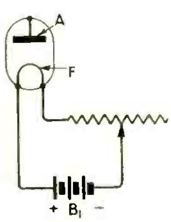


Fig. 1.

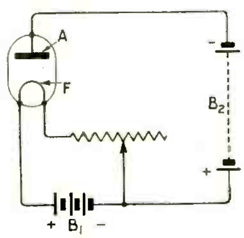


Fig. 2.

In order to obtain a plentiful supply of electrons the wire loop must usually be raised to incandescence, but if this was done in *air*, the wire forming the loop would very rapidly disintegrate. In order to be able to maintain the wire at a high temperature without fear of disintegration, the loop F must be sealed into a closed glass vessel from which all (or very nearly all) the air has been withdrawn. Here, then, we have the first stage in the construction of our valve. A closed glass vessel, exhausted of air and having a filament or loop of platinum, tantalum or tungsten, sealed into the glass, with external connections to which may be attached a battery in order to pass an electric current through the filament and so raise its temperature, and a variable resistance so that the flow of current and consequently the temperature of the filament can be controlled.

*A lecture for Associates arranged by the Radio Society of Great Britain on April 18th, 1923.

Under these conditions electrons emitted from the filament simply drop back into it again, although there will be a certain tendency for electrons emitted from the negative side of the filament (for it should be noted that the extremities of the filament will not be at the same potential), to be attracted to the most positive body near at hand, namely, the positive side of the filament. I should mention here that electrons being negative charges, behave in accordance with the well-known law of electrostatics, namely, they are attracted to positively charged bodies and repelled by those negatively charged. In other words, like charges repel and unlike charges attract.

The next step in the development of our valve is the introduction of a metal plate, which I have lettered "A," and which, in most modern valves, is in the form of an open-ended cylinder surrounding the heated wire or filament.

This plate has a leading out wire sealed in the glass, by means of which connections may be made to an external circuit.

For the moment I will show another battery, B_2, connected so that the negative side of the battery goes to the plate A, and the positive to one side of the heated filament (Fig. 2).

You will see that we now have the plate A negative to the heated filament. Consequently the tendency will be for the plate to repel the negative electron. The plate itself, however, not being heated, does not emit electrons, and under these conditions there will be no flow of electricity through the valve.

Upon reversing the connections of the second battery, however, the plate becomes positively charged, and now attracts the negative electrons emitted by the filament. A heavy flow of electrons takes place between the filament and the plate, the rate of flow depending upon the voltage or electrical pressure supplied to the plate A and the temperature of the filament F.

You should note here that the flow through the valve consists of negative charges, and, contrary to our pre-conceived ideas, the flow is from negative to positive. Any little difficulty in appreciating this change may usually be readily overcome by remembering that an electron flow from right to left is, in effect, precisely the same thing as an electric current flow from left to right.

We saw that if the battery B_2 was connected the other way round, no electron flow occurred. This property of conducting electricity in one direction only is known as unidirectional conductivity, and from it the valve no doubt derives its name. The technical name given to the metal plate is the "anode," meaning *current entering*, whilst the heated filament is termed the "kathode," or *current leaving*, the complete device being known as a two-electrode valve.

Owing to its undirectional conductivity, an alternating or oscillating potential applied between the anode and kathode causes an electron flow at those periods when the anode is made positive to the kathode. When the anode is made negative to the kathode no flow takes place. Consequently the applied alternating E.M.F. becomes changed into a unidirectional pulse, or, in other words, the alternating or oscillatory currents are rectified.

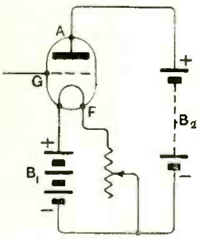


Fig. 3.

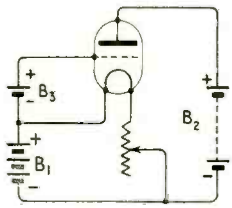


Fig. 4.

Under these circumstances the valve functions in a manner very similar to that of a non-return valve in a water-pipe system. Impulses applied in one direction are allowed to pass, whilst all those applied in the reverse direction are stopped.

The valve in general use to-day is called a three-electrode valve. In addition to the usual filament or kathode and plate or anode, it has a third electrode in the form of an open spiral of wire surrounding the filament, and placed between the filament and the anode. This third electrode is called the *grid* (G), and is represented in Fig. 3 as a dotted line.

The introduction of the grid between the filament and the anode greatly affects the flow of electrons through the valve. If a battery, B_2, is connected between the grid and the filament in such a way as to make the grid *negative* to the filament (Fig. 4), it will tend to drive the emitted electrons back into the filament.

Reversing the connections of the battery so that the grid is now positive to the filament, the grid no longer repels the electrons, but permits them to flow readily through the grid spacing towards the anode.

The particular negative voltage which has to be applied to the grid in order entirely to prevent the flow of electrons depends upon the closeness of the spiral of wire forming the grid and upon the voltage applied to the anode. When the adjustments are such that no electrons are passing from the filament to the anode—the valve is said to be at *extinction* point, that is to say, the electron flow is extinguished. The maximum electron flow through any given valve is determined by the rate at which the heated filament can emit electrons, and when this maximum flow is attained the valve is said to be *saturated*.

Between the two extremes of extinction and saturation the increase in the rate of electron flow is by no means uniform, and, in the practical example of a modern three-electrode valve, the rate of flow is controlled by the potential of the grid.

Very important points, perhaps the most important, concerning the action of the valve are, firstly, that the potential of the grid with respect to the filament controls the flow of electrons through the valve, and secondly, that when a valve is in correct adjustment, a small change of grid potential produces a large change of anode current.

The practical function of valves in connection with wireless receiving apparatus is as amplifiers, high frequency or low frequency, and detectors or rectifiers.

Whatever type of detector is employed in a receiving set, a certain minimum amount of electrical energy must be available before such detector can work properly. Thus, for the reception of long distance telegraphy or telephony signals the incoming oscillatory current must be amplified by means of a valve before being passed along to the detector.

In the diagram (Fig. 5) is shown a typical arrangement in which the valve acts as a high-frequency amplifier, followed by a crystal detector. This particular diagram shows a tuned anode circuit, but, of course, I am not concerned just now with the circuit arrangement so much as with the action of the valve itself. In this particular case we have oscillatory current in the aerial circuit (which, of course, is in resonance with the distant transmitting station), applied to the grid and filament

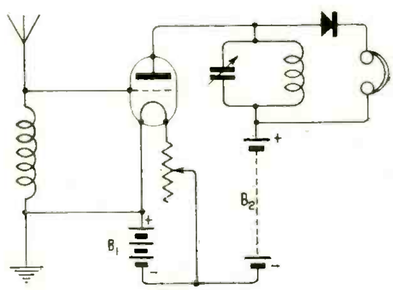


Fig. 5.

of the valve. The oscillatory current, it should be remembered, is at radio-frequency ; that is to say, for a 300-metre wave the frequency is 1,000,000 per second. Now, remembering the two important rules which I mention, namely (1) The potential of the grid controls the flow of electrons through the valve, and (2) when the valve is correctly adjusted a small change of grid potential causes a large change in anode current, it will be seen that oscillatory current of the same frequency, but of greater amplitude, will be set up in the anode circuit which, in this case, is tuned to that frequency. Across the condenser in the tuned anode circuit, therefore, will be set up comparatively high potentials, and these, of course, are available for operating the crystal detector and telephone receivers. As the action in the valve is entirely electrical, that is to say, there are no mechanical moving parts possessing inertia, the valve is able to respond accurately to frequency variations as high as 10,000,000 or more per second.

Next consider the case where signals are received upon a valve or crystal detector, but it is desired to amplify them in order, for instance, to operate a loud speaking telephone.

In this case we are not dealing with oscillatory currents, but with unidirectional impulses after having passed the crystal detector. These unidirectional impulses are applied to the grid and filament of the amplifying valve, and, by a cumulative action, vary in potential with respect to the filament, thus giving rise to amplified impulses of current in the anode circuit, in which circuit are now placed the telephone receivers.

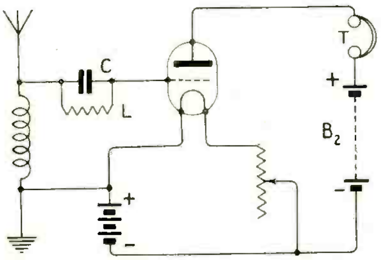


Fig. 6.

I now come to the last of the three functions of the valve which I mentioned earlier, namely rectification. In Fig. 6 is shown a typical detector valve arrangement to assist in the explanation.

I give a simple single circuit receiver with valve detector, and the usual high resistance telephone receivers included in the anode circuit. Here the differences of potentials existing between the ends of the aerial tuning inductance are applied to the grid and filament, the connection to the former being made through a small condenser (C) known as the grid condenser, which in turn is shunted by a high resistance L, or leak, having a value of about 2 megohms (2,000,000 ohms). Note particularly that in this instance the lower end of the aerial tuning inductance is connected to the positive side of the filament. Under these conditions the grid will have a slightly positive potential to the filament, and quite an appreciable steady anode current will be flowing. The grid condenser affords an easy path for oscillatory currents, but any direct current flow from the grid must take place via the two-megohm grid leak. During the arrival of signals, the opposite ends of the aerial tuning inductance are made alternately positive and negative. The grid, therefore, will become alternately positive and negative to the filament. Each time the grid is made positive, it intercepts and collects electrons on their way from the filament to the anode. Each negative half wave produces no effect upon the grid other than to make it momentarily more negative. As the negative charge accumulating upon the grid cannot readily escape owing to the high resistance leak, it follows that the *total effect* of an incoming signal (for instance a group of waves from a spark transmitting station) is to cause one steady reduction of anode-telephone current. In the modern *hard valve* (by hard is meant a valve having a very good vacuum), there is no sharply defined critical point, as in the case of a crystal detector for instance, and it is necessary to employ the grid condenser and

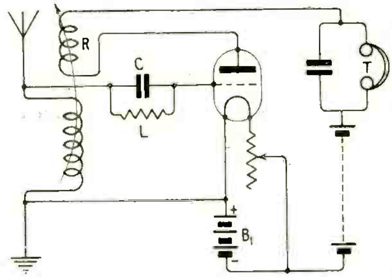


Fig. 7.

leak method of rectification. It is to be noted, however, that when this method is employed, actual signals in the telephone receivers are due to a *reduction* of anode current.

Upon the cessation of incoming signals (say in the interval between wave trains), the negative charge upon the grid leaks away, and the grid resumes its normal average potential in readiness for the arrival of the next signal.

My remarks would be scarcely complete if I did not refer to the well-known circuit arrangement in which the receiving detector valve may be made to act as a feeble generator of continuous oscillations (with disastrous effects upon the tempers of the owners of adjacent receiving stations if employed during broadcast hours).

In the arrangement shown in Fig. 7 the second coil, which is lettered "R," and known as the reaction coil, is included in the anode circuit of the valve, and inductively coupled to the A.T.I. in such a direction that energy from the anode circuit is passed back again into the grid circuit, where it undergoes further amplification.

When the direction of the winding of the respective coils is correct and the coupling is sufficiently tight, the natural loss of energy which occurs in the aerial circuit is more than compensated for by the additional energy from the anode circuit, and the aerial circuit is maintained in a state of continuous oscillation.

Referring to the circuit diagram (Fig. 7), that of a self-oscillating receiver, I need scarcely mention that such an arrangement is not permitted upon the broadcast wavelength during broadcasting hours.

Radio Society of Great Britain.

The next of the series of elementary lectures especially arranged for Associates will be given at 6.30 p.m., on Friday, June 15th, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Mr. J. H. Reeves, M.B.E., will lecture on "Early Mistakes due to lack of appreciation of Capacity Effects."

QUESTIONS AND ANSWERS

"BEGINNER" (Walthamstow) *refers to the issue of May 12th and asks* (1) *With reference to Fig. 4, page 166, would the arrangement be suitable for the reception of broadcast transmissions. If not, would the arrangement given in Fig. 5 be suitable.* (2) *May a vario-coupler be used in a receiver of this description.* (3) *What would be suitable dimensions for the vario-coupler mentioned in question* (2). (4) *What would be suitable dimensions for the low frequency transformer.*

(1) We do not recommend the arrangement given in Fig. 4 for the reception of broadcast transmissions, but we have no hesitation in recommending the arrangement of Fig. 5. (2) and (3) A vario-coupler may certainly be used. The coil L may be one winding and coil L_1 the second winding. Full particulars of these coils are given below the diagram referred to. (4) A low frequency transformer may have a primary winding of 7,000 turns of No. 42 single silk covered wire, and a secondary winding of 21,000 turns of No. 44. The core should be built up to a diameter of ½″ with soft iron wires. The bobbin may be 3″ long.

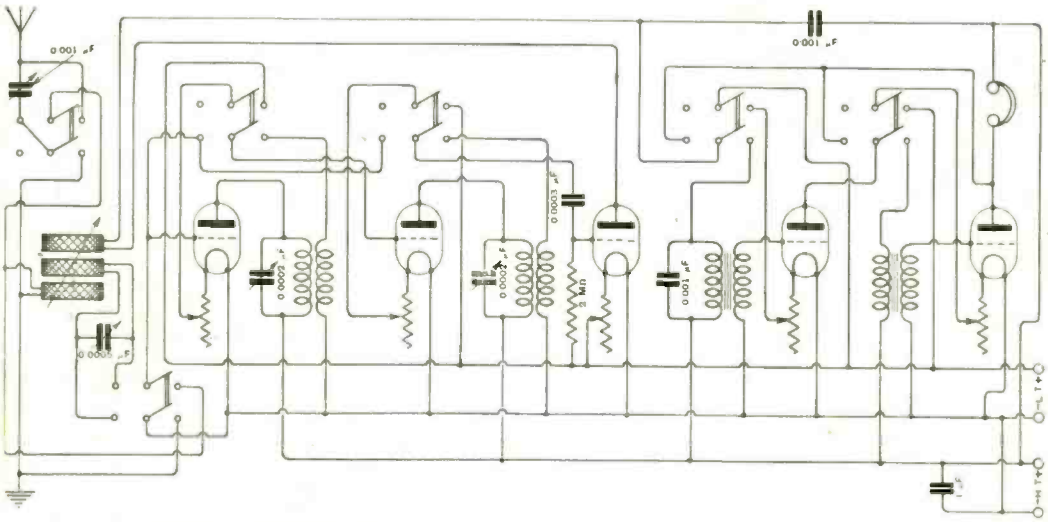


Fig. 1. **"H.P.N." (London, W.14).** *Diagram of a five valve receiver with two H.F., detector and two L.F. stages. Switches are provided to control the number of valves in circuit.*

"H.P.N." (London, W.14) *asks* (1) *For a diagram similar to that given in reply to* **"G.S.E." (Stretford)** *in our issue of April 14th, 1923, but provided with switches for cutting out valves Nos. 1, 2 4, and 5.*

The diagram is given in Fig. 1.

"R.S.B." (E.2) *submits a sketch of his receiver, and asks* (1) *For criticism of the circuit.* (2) *Why, when receiving the Radiola transmissions, he is still able to hear the transmissions of* **2 LO**. (3) *Why is it that although French transmissions may be received on a loud speaker he is not able to receive the transmissions from The Hague.* (4) *What are the hoops of a cage-aerial made of, and are the wires at the end of the aerial soldered together.*

(1) The circuit is correct, although when you are using only the aerial circuit, without a closed circuit, you will not be able to make fine tuning adjustments or eliminate undesired signals. (2) We suggest you use a closed circuit, which may consist of a plug-in coil and a 0·0005 variable condenser. The plug-in coil will couple with the aerial coil. With fine tuning and loose coupling, you may be successful in tuning out the transmissions of **2 LO.** (3) It is difficult to say exactly why you do not hear the transmissions from The Hague, when you are able to operate a loud speaker from the French transmissions, but it may be that you are poorly situated with regard to The Hague, and tuning being very sharp, you may not successfully tune to their wavelength. (4) The free ends of the wires on the cage may be soldered together. The hoops are generally wooden hoops, although sometimes metal hoops are used.

"STATION" (Co. Down) *refers to diagram No. 51 in "The Amateur's Book of Wireless Circuits," by F. H. Haynes, and asks* (1) *For description of the operation of a receiver wired according to this diagram.* (2) *What is the value of the variable condenser connected across the centre tuning coil.*

(1) and (2) The circuit has an aerial coil, with which may be connected in series or parallel the aerial tuning condenser by means of the switch. The closed circuit consists of the centre coil and the variable condenser, which has a capacity of 0·0005 mfds. A switch is connected so that the

aerial or the closed circuit may be connected with the grid and filament of the first valve. In the anode circuit of the first valve is a coil and a tuning condenser. This forms a tuned anode circuit. The second valve has in its anode circuit a transformer and a switch. The purpose of the switch is to connect the reaction coil so that it may be coupled with either the tuned coil or with the secondary coil. With the switch in position A, the reaction coil should be plugged into position A. With the switch over to position B, the reaction coil should be connected at position B, when reaction effects will be obtained in the closed and aerial circuits. The remainder of the receiver consists of an ordinary note magnifier. A potentiometer is connected to control the grid potential of the first and second valves. In the grid circuit of the last two valves, grid cells are connected for the purpose of giving the grids a suitable negative potential to work with the higher anode voltage, which is provided by the tapping from the top of the high tension battery.

"R.G.M." (Lancashire) *refers to the diagram submitted and asks* (1) *With a receiver wired according to the diagram, will it be possible to receive the transmissions from the stations mentioned.* (2) *Will signals be strong enough to operate a loud speaker.* (3) *What will be the correct setting for the inductance coils and variable condensers for the stations mentioned.* (4) *Which would provide the strongest signals—two stages of high frequency amplification, with a detector, or one stage of high frequency, detector, and a note magnifier.*

(1) We have examined the diagram submitted and the connections are not correct. The connections of a receiver with two stages of high frequency amplification and a note magnifier may be obtained from several recent issues of this journal. Also see Fig. 56, "The Amateur's Book of Wireless Circuits," by F. H. Haynes. For a diagram of a three-valve receiver with one H.F., detector, and one L.F. valves, we would refer you to diagram No. 45 in the circuit book referred to. (2) With a receiver correctly wired according to the first diagram, you should receive the transmissions of the stations referred to, although the signals will probably not be of sufficient strength to satisfactorily operate a loud speaker. (3) We cannot give you the exact settings of the variable condensers, but with the aerial tuning condenser in series, the aerial coil should be a No. 75, the closed circuit coil a No. 50, and the anode coil a No. 75. You will then, by varying the tuning condensers, be able to tune in the broadcast transmissions. (4) For the station in Kent we suggest you use a receiver with one H.F., detector, and one L.F. valves.

"J.W." (Somerset) *asks for a diagram of a high frequency panel to be connected with his receiver.*

The diagram in Fig. 2 shows the method of connecting one stage of high frequency amplification to your receiver, which has one H.F., detector, and one L.F. valves.

"R.A.W." (Bradford) *submits a diagram of an unusual circuit and asks whether we have any comments to make.*

The low frequency portion of the receiver is quite standard, but the novelty consists in connecting the frame aerial together with a small coil between the earth and the plate of the first valve. In the grid circuit is the grid condenser and leak and a tuned circuit. We cannot say definitely whether a receiver of this description will give you satisfactory results, because the connections are rather unusual, and although we see no reason at all why it should not give satisfactory results, it is difficult to see whether any advantage is gained through making use of the unusual connections.

"F.B." (Burnley) *submits a diagram of an Armstrong super-regenerative receiver, and asks* (1) *Whether the connections are correct.* (2) *Suitable condenser values.* (3) *Could The Hague concerts be received on a receiver of this description. Should a special low frequency transformer be used.*

(1), (2) and (3) We do not care for the diagram of the receiver which you have submitted. We would refer you to diagram No. 70 in "The Amateur's Book of Wireless Circuits." In the diagram referred to you will find full particulars of capacities and inductances. (4) Any low frequency transformer of reliable make will be found satisfactory.

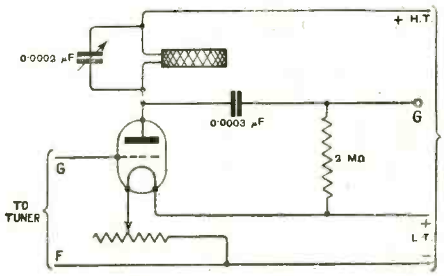


Fig. 2. **"J.W." (Somerset).** *Method of connecting one stage of H.F. amplification with a receiver.*

"MEGOHM" (Leeds) *submits circuit diagram of his receiver and asks* (1) *For criticism.* (2) *If he should be able to receive all British broadcast transmissions on a loud speaker with this circuit, which consists of one H.F. detector and two L.F. valves.*

(1) Your circuit is correct. We suggest, however, that you use a 0·001 mfd. fixed condenser across the primary winding of the first low frequency transformer, and the same value fixed condenser across the telephones. (2) For the reception of all British broadcast transmissions on a loud speaker, you would probably find it necessary to use an additional H.F. amplifying valve.

"F.H.W." (Folkestone) *is having trouble with the H.F. transformer of a H.F. amplifying panel, and asks if there is any simple way of testing a H.F. transformer.*

Your diagram of the H.F. transformer wiring is correct, but you must take care that the two windings are connected up in the right sense in the circuits, *i.e.*, with due regard to the input and output ends of each. The continuity of the windings may be tested with the aid of a battery and a pair of telephones or a galvanometer. The wavelength range of the transformer may be tested by connecting the transformer in circuit, and inducing energy into the transformer from a wavemeter. With the receivers connected in the detector valve circuit, the signal will be loudest when the wavemeter is in tune with the H.F. transformer.

A diagram of a circuit which we recommend is given in Fig. 4. Four valves are used, two H.F. with tuned anode coupling detector, and one L.F. The tuning coils may be plug-in honeycomb type. The reaction coil may be coupled with the anode coil of the first valve.

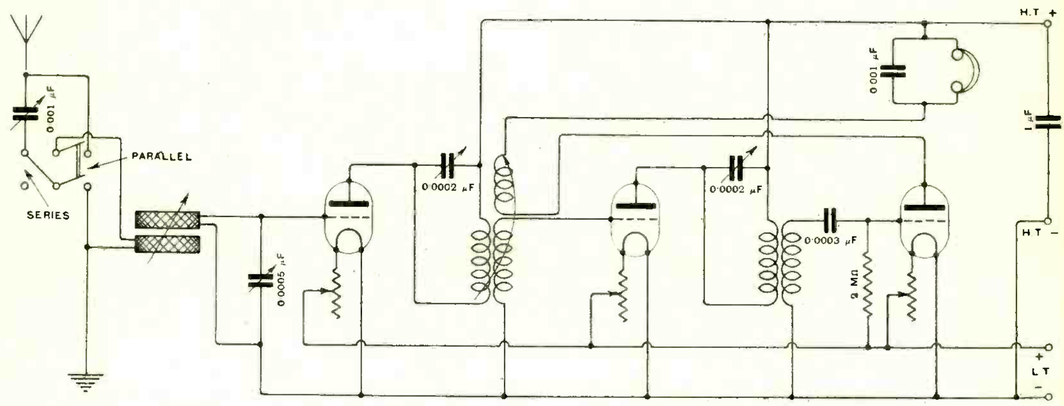


Fig. 3. **"AERIAL" (Rugby).** *Diagram of a three-valve receiver suitable for the reception of broadcast transmissions. There are two H.F. transformer coupled valves and a rectifier. The reaction coil is coupled with the first H.F. transformer.*

"AERIAL" (Rugby) *submits diagram and description of his set; one H.F. valve with crystal rectification, and asks whether with modifications he will be able to receive all the British broadcasting stations clearly.*

We suggest that to receive all the British broadcasting stations clearly, you adopt a circuit employing a type of loose-coupled tuner, and use three valves, two H.F. and detector. A suitable circuit is given in Fig. 3.

"B.G.A." (Guernsey) *asks for particulars and diagram of a selective valve receiving set which will give him good results in Guernsey.*

"ANXIOUS" (Glasgow) *encloses diagram of crystal set, and asks* (1) *If the circuit is suitable for the reception of broadcast transmissions at a distance of three miles.* (2) *and* (3) *Whether a plug-in type coil and a* 0·001 *mfd. tuning condenser may be used.* (4) *Whether a pin may be used to make contact with a galena crystal and if the crystal detector can be wired either way round the circuit.*

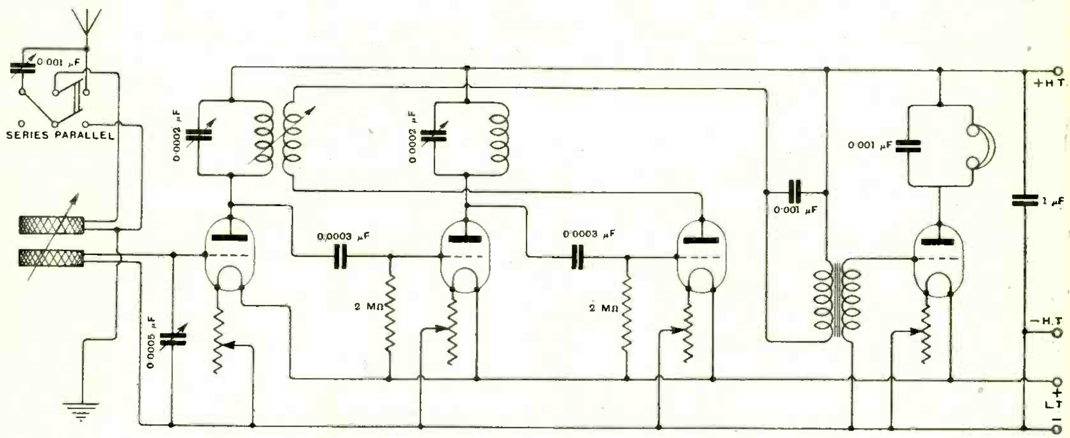


Fig. 4. **"B.G.A." (Guernsey).** *Diagram of a four-valve broadcast receiver with two H.F. (tuned anode), rectifier and one stage of note magnification.*

(1) The circuit submitted is quite correct and suitable for the reception of British broadcast transmissions, but the condenser should be connected in series with the coil. (2) and (3) A plug-in type of coil is quite suitable. We suggest a No. 75. (4) We think you would find the usual

"catswhisker" a more satisfactory contact for use with galena. It is immaterial in which sense the crystal detector is wired up in the circuit, although you should try reversing the connections. mentioned in question (1) will satisfactorily work a loud speaker when receiving British broadcast transmissions and some of the nearer Continental stations.

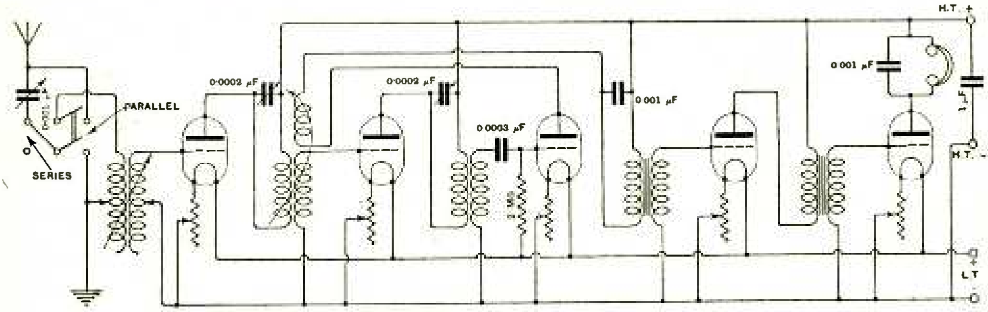


Fig. 5. **"H.H." (Leyton, E.10).** *A five-valve receiver suitable for the reception of broadcast transmissions with two H.F. (transformer coupled), rectifier, and two stages of note magnification.*

"C.A." (Thornton Heath) *submits diagram and particulars of five-valve set, and asks* (1) *For criticism.* (2) *If the volume of sound when using a single detector valve should be greater than when using a crystal as detector.* (3) *If he should be able to operate a loud speaker from the transmissions of* **2 LO** *using detector and two L.F. valves.*

(1) Your circuit diagram is correct except for the series-parallel wiring of the aerial tuning condenser. The correct wiring is given in almost every issue of this journal. (2) The volume of sound when using a single detector valve should be somewhat greater than that obtained from a crystal detector. (3) You should be able to operate a loud speaker satisfactorily from **2 LO** with detector and two L.F. valves.

"H.H." (Leyton, E.10) *asks* (1) *For a diagram of a five-valve receiver using two H.F., detector, and two L.F. valves, with loose coupled tuner, to receive British broadcast transmissions, Paris and the Hague, and to cover a range of wavelengths from* 120 *to* 3,000 *metres.* (2) *Details of H.F. transformers to cover the following wavelengths from* 200 *to* 2,600 *metres.* (3) *Means of calculating wavelengths of signal received.* (4) *If the five-valve receiver mentioned in question* (1) *will satisfactorily operate a loud speaker.*

(1) The diagram is given in Fig. 5. The aerial tuning coil may be a winding of No. 22 D.C.C. copper wire on a former 4″ in diameter × 7″ long with 14 tappings. The secondary coil may be a winding of No. 26 D.C.C. on a former 3½″ × 7″ with 14 tappings. (2) The best values of the windings for these transformers will be found experimentally. Use No. 30 S.S.C. wire wound on bobbins 2½″ diameter with groove ⅝″ deep × ¼″ wide with a primary and secondary winding of 120 turns. This transformer will be suitable for 300-480 metres. Also see page 818, September 23rd issue. (3) If you can determine with some degree of accuracy the values of the inductance and capacity in the closed or secondary circuit of your receiver, you will be able to calculate the wavelength on which you are receiving by means of the formula $\lambda = 1885\sqrt{LC}$ when λ wavelength in metres, L = inductance in microhenries, C = capacity in microfarads. (4) The five-valve receiver mentioned in question (1) will satisfactorily work a loud speaker when receiving British broadcast transmissions and some of the nearer Continental stations.

A good deal depends upon the skill of the person using the receiver. It is possible to spoil a good transmission through poorly adjusted receiving apparatus. The tendency nowadays, it would appear, is to connect the receiver up anyhow, without due regard to the layout of the apparatus and the wiring. Further, it will be found economical in the end to purchase components manufactured by a firm with a good reputation for the excellence of their designs, rather than to purchase inferior apparatus at a more attractive price. A lot of irritation is then avoided.

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules:*—(1) *Each question should be numbered and written on a separate sheet on one side of the paper, and addressed "Questions and Answers," Editor,* **The Wireless World and Radio Review, 12/13,** *Henrietta Street, London, W.C.2. Queries should be clear and concise.* (2) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* (3) *Each communication sent in to be accompanied by the "Questions and Answers" coupon to be found in the advertisement columns of the issue current at the time of forwarding the questions.* (4) *The name and address of the querist, which is for reference and not for publication, to appear at the top of every sheet or sheets, and unless typewritten, this should be in block capitals. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume."* (5) *In view of the fact that a large proportion of the circuits and apparatus described in these answers are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.* (6) **Where a reply through the post is required every question sent in must be accompanied by a postal order for the amount of 1s., or 3s. 6d. for a maximum of four questions.** (7) *Four questions is the maximum which may be sent in at one time.*

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Dual Amplification Circuits.

From time to time in the history of amateur wireless there comes along some new circuit or some new application which finds special favour, and is introduced into the design of the amateur experimental station. These new introductions succeed one another as definite phases of development. For instance, at one time special attention was paid to tuned anode coupling for high frequency circuits, which was brought prominently to the notice of amateurs in this country through a paper read before The Radio Society of Great Britain by C. F. Phillips in February, 1922.

Then again, Mr. Campbell Swinton's paper on "A Universal Amplifier Suitable for all Wavelengths," which was described in *The Wireless World* of June 25th, 1921, attracted special attention to transformer coupled high frequency amplifiers. In December, 1921, and again in May, 1922, articles appeared by P. G. A. H. Voigt on "Dual Amplification Circuits," which also attracted considerable notice at the time.

More latterly we have had what may be described as a "boom" in super-regenerative circuits, which practically every experimenter has tried out in some form or another, not forgetting the Flewelling Circuit, recently described.

At the present moment interest is centred around dual amplification circuits, which have been made especially practical by a rearrangement of the circuit, the principle of which has been described, together with the details of the circuits, in recent issues of this journal. In America this new arrangement of dual amplification circuits is known as the "Grime's" circuit, after the engineer to whom its introduction is attributed. Great possibilities lie in the direction of the development of dual amplification circuits, and it is a subject to which nearly every experimenter is now devoting special attention.

It is of interest to note, also, that dual amplification is at present made use of in more than one standard Broadcast receiver now marketed.

There must be a vast amount of information available on this subject from individual experimental work, and we should very much appreciate the co-operation of readers in supplying their results for publication for the benefit of others.

The Wireless World endeavours to assist the experimenter in every way possible, but this can only be achieved with complete success if the experimenter in his turn will give his results to the journal for publication.

B

AN INTERESTING SEVEN-VALVE RECEIVER

The high-class workmanship and excellent finish of this receiving installation should serve as an incentive to the experimenter to put his very best work into the instruments he may construct. Care taken in instrument-making produces reliable and valuable apparatus, whilst hurried work may give an instrument which functions, but when abandoned for another circuit arrangement can only be scrapped. The circuit principle and constructional details are of special interest.

By MURRAY D. SCOTT.

As the design and construction of this receiver has afforded the writer considerable spare time amusement, and has been of decided educational value, it is thought that a brief description may be of interest to readers of *The Wireless World and Radio Review*.

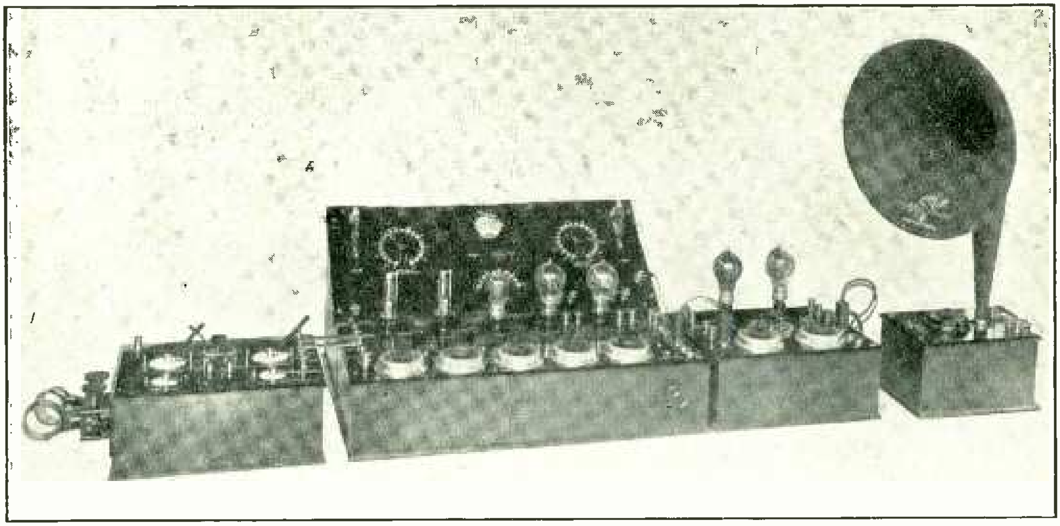


Fig. 1. *The tuning unit is on the left, while the centre instrument comprises two H.F. amplifiers, detector, and two L.F. amplifiers. On the right is the power amplifier followed by the loud speaker.*

The aim in design has been to secure (*a*) Selectivity; (*b*) Long range reception; (*c*) Reception from any two stations transmitting on a wavelength within 80 metres of each other by the movement of a single switch; (*d*) Distortionless reception.

The conditions governing these objectives preclude the attainment of all simultaneously, but the instrument has been designed so that the operator has at his disposal, means of obtaining each with a large measure of success, *i.e.*, for (*a*) and (*b*) the tuning arrangements allow of a high degree of resonance, with consequent low resistance.

For (*d*) the anode, grid and filament control to each valve enables the flat part of the characteristic to be worked, giving clear reception of "upper tones."

The complete receiving set (Figs. 1 and 2), comprises five units as under :—

(1) Tuner; (2) Amplifier and Detector; (3) Power Amplifier with self-contained grid, voltage control for valves six and seven; (4) Self-contained high tension batteries with stud switches, giving separate anode control for the first three and last four valves, and negative grid potential for valves four and five; (5) Low tension battery.

The units are connected together by copper link strips, and all internal connections, with the exception of those in the H.T. battery unit, are made with No. 18 gauge bare copper, and are arranged to reduce unwanted capacity effects. The headphones and loud speaker are connected by jacks and plugs.

The receiver, as at present constructed, presents a neat and finished appearance, but each component has undergone a careful test and comparison in various circuits, arranged

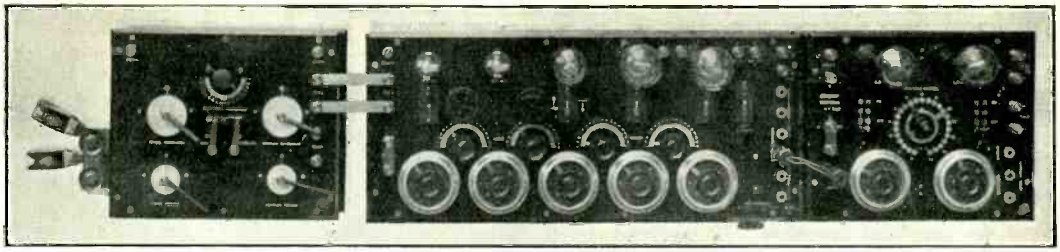


Fig. 2. The tuner, detector and amplifying units.

on a rough deal test board before assembly. The present components, before final assembly, and without the inclusion of the power amplifying unit and loud speaker, at one time occupied a board measuring 6 ft. × 4 ft.

The writer's workshop facilities being limited, the method of construction has been to use standard components wherever possible, and to make such modifications to these as experience has shown to be necessary.

The purchase of a "Magnavox" loud speaker by the time the fifth valve stage was reached necessitated a complete revision in the circuits employed, and stimulated the design and construction of the low frequency transformers, which will be described later. The purchase of this loud speaker and a milliammeter proved of the greatest educational value in the detection and elimination of distortion, and it is the writer's experience that in the majority of cases criticism levelled at a loud speaker should be more rightly addressed to the receiving instrument itself. Provided that the transmitted signals are correctly modulated, and the received signals correctly rectified, the average loud speaker, when not overloaded, will give results approximating to those obtainable with the best headphones.

Tuner Unit.

This unit, which follows generally accepted practice, is mounted in a case 13in. × $10\frac{1}{2}$ in. × $5\frac{1}{4}$ in., and comprises a three-coil holder for the aerial and closed circuit inductances. These inductances are tuned by condensers of 0.001 mfds. with extended handles, whilst fine tuning is obtained by vernier condensers of 0.0001 mfds. connected in parallel.

A two-way switch mounted in the centre of the tuner enables the aerial circuit condenser to be placed in series or in parallel with the aerial circuit inductance, and provision is made for regeneration when required in the anode circuit of the detector valve.

An unusual feature is the fact that both the aerial and closed circuits may be visually tuned. This is done by means of a small milliammeter mounted in the high tension unit. The accumulating negative potential on the grid of any valve is clearly recorded by the reduction in anode current shown on the milliammeter. In addition, the maximum degree of resonance in all the tuned circuits can be "seen" without listening for signals. As, moreover, the inductance coil holder is not graduated to any scale, the value of the condenser readings will vary with the variometer effect for each position of coupling, so that provided the correct value of the inductance is known for various wavelengths it is unnecessary to log condenser settings to obtain quick tuning.

The author finds that much sharper tuning can be obtained in this way than by relying on the ear. Further, tuning can be effected immediately the carrier wave is located, and before signals are actually transmitted.

Amplifier and Detector Unit.

This unit is mounted in a case similar to the tuner, size 25 in. × $10\frac{1}{2}$ in. × $5\frac{1}{4}$ in., and comprises two "V.24" valves for high frequency amplification, a "B" valve for rectification, and two L.S.1 valves for audio frequency amplification.

Switches are connected to give any combination from the detector valve upwards.

The coupling between the high frequency valves and the detector may be by the transformer or tuned anode method, the connections being taken into ordinary four-socket valve holders.

In order to comply with objective (*c*) the primary of the high frequency transformers or the anode inductances are tuned by 0.0002 mfds. condensers, arranged in duplicate. In this way two condensers for each winding are available. A switch throws either pair into operation, and when it is desired to receive from two transmitting stations, the more distant of the two stations is accurately tuned with the A.C.I. and C.C.I. The primaries of the high frequency transformers are then brought into resonance by means of one pair of condensers. To receive from the nearer station, the other pair of condensers is then used to tune the primaries of the high frequency transformers into resonance with the new wavelength, no alteration being made on the tuner unit.

Selectivity is such that, situated ten miles north of London, items from the Glasgow broadcasting station on 415 metres, or Birmingham on 425 metres can be received at will whilst London is transmitting.

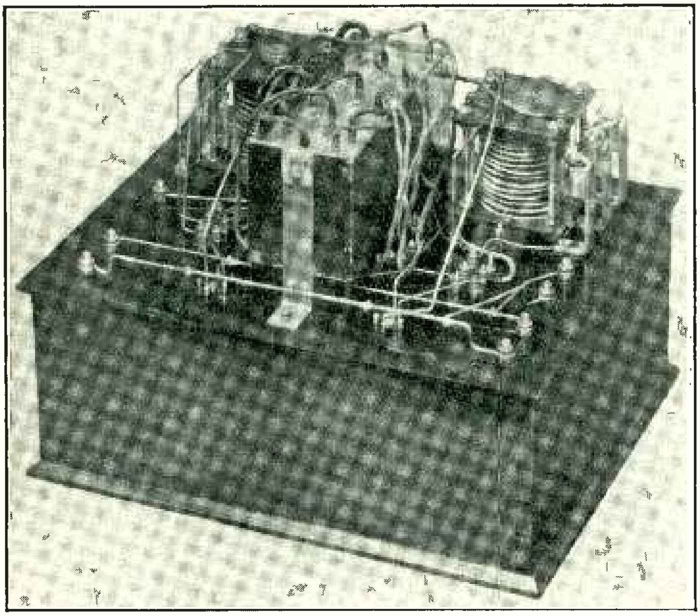


Fig. 3. Interior of the power amplifier. The unique construction of the tranformers is of special interest.

A potentiometer is provided to control the grid potential of the two high frequency valves, and the anode potential is adjustable by a rotating stud switch on the high tension unit.

Rectification is carried out in the usual manner, with a leaky grid circuit of two megohms, connected between the grid and the positive low tension. No potentiometer is used.

Two low frequency amplification stages follow the detector valve. The circuits are conventional, but the selection of a transformer which could be used to couple the valves without producing undesirable distorting influences has been a matter of considerable experiment, and the one at present employed is arranged to obtain voltage amplification in the stage between the detector and the first low frequency valve. A small blocking condenser of 0.001 mfds. is connected across the primary winding to eliminate errors in rectification and a similar condenser of the same value is connected across the secondary to reduce the natural frequency of this winding. This second condenser, while it somewhat reduces the signal strength, has effected a very marked improvement in reception, especially where several further low frequency stages are used, in particular, the percussive effect of the high notes of the piano and the sibilance in speech is markedly reduced.

The second stage of audio frequency amplification is carried out in the valve itself, the transformer being simply a means of coupling. This and the following transformers were wound by the writer and consist of slab coils approximately 2 in. × ⅛ in. with ⅞ in. centre hole, each wound with No. 41 gauge single silk covered wire, to a resistance of approximately 250 ohms. Seven of these coils joined in series form the primary winding, and a similar number of coils with same gauge and resistance for secondary.

The coils are interspaced one primary, one secondary, and are mounted on a soft iron core, each coil being insulated from its fellow by means of two layers of empire cloth. The windings are clamped together with ebonite cleats, which can be seen in the illustration, (Fig. 3). A tight coupling is possible, and using "L.S.1" valves a voltage amplification of five is obtained.

When using the head telephones the impedance in the anode circuit of the last valve is adjusted by plugging the headphones in series or in parallel by means of the jacks provided. It has been found unnecessary to control the normal grid voltage of the first low frequency valve, but a rotating stud switch, allowing a negative potential of from 3 to 40 volts is mounted on the high tension unit to control the grid of the second valve, preventing saturation and excessive " grid current."

The anode voltage of both valves is controlled by another rotating stud switch from 30 to 600 volts.

When the head telephones are employed, the switch controlling the first stage of low frequency automatically connects the telephone to the battery supplying the anode of the high frequency and detector valves. This switch prevents the possibility of the plate on the first three valves being energised at a potential above 100 volts. The connections of this switch are unusual, and are the outcome of a problem which became apparent as soon as separate anode voltages were available for valves. Reference to the diagram (Fig. 4) will show that the telephones or loud speaker can be connected between the positive high tension and the plate of any of the last five valves. Obviously, if each valve has been carefully adjusted as regards filament emission, grid potential, and plate voltage, the movement of the telephone leads from the plate of one valve to the one preceding it will mean that this plate is now charged with the same anode potential as has been applied to the valve following, so that a fresh adjustment of filament emission and possibly grid potential would be necessary ofter the change is effected.

In actual practice the writer employs the same anode voltage for the last four valves, which may be, as previously explained, anything up to 600, but when the first stage of low frequency amplification is cut out, it will result in the telephones being connected between the plate of the detector valve and the high tension positive previously controlling the plate of the first low frequency valve, unless special precautions are taken. In other words, when this switch is moved, both the high frequency and detector valves may be charged to a pressure of 600 volts. The solution of this problem was effected by means of the switch shown in the circuit diagram.

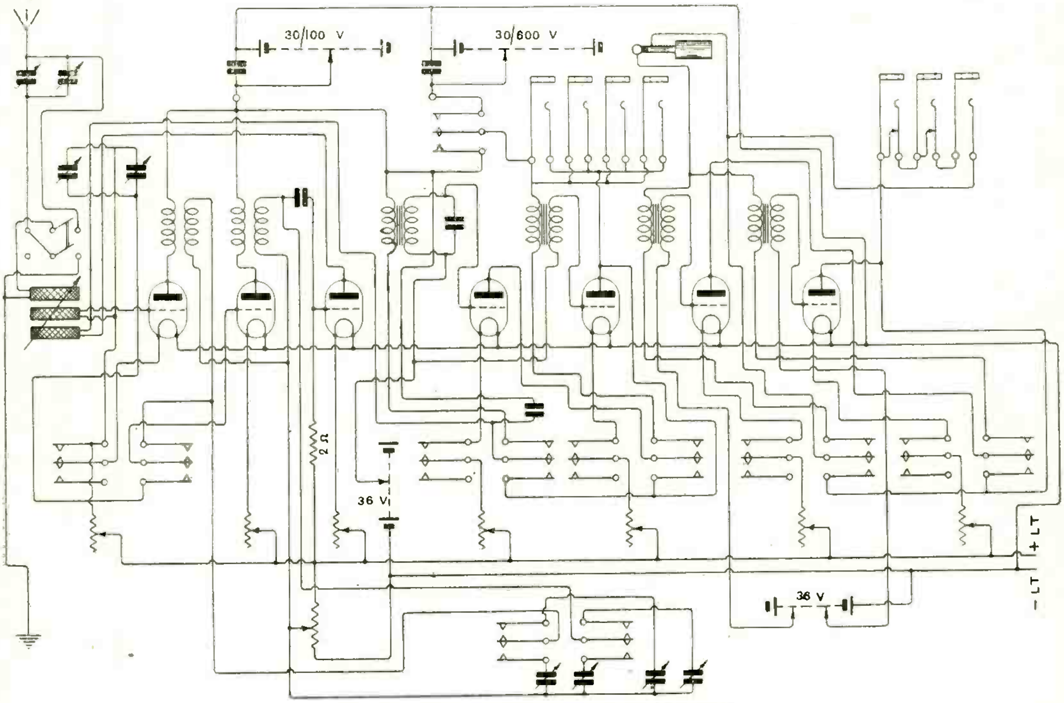


Fig. 4. Circuit of the seven-valve receiver.

It will be noted that each valve has a separate filament resistance, which is mounted on the face of the panel in such a way as to dissipate heat rapidly, and prevent condensation which would otherwise occur in the unit.

Power Amplifier Unit.

The power amplifier unit is self contained in a case 13 ins. by $10\frac{1}{2}$ ins. by $5\frac{1}{4}$ ins, and is arranged for two stages of current amplification, with 1:1 ratio open core transformers as previously described for coupling the two "L.S.2" valves employed.

Dewar switches not being available when this panel was made, small surface double-pole change-over switches were fitted. These switches are an improvement from the point of view of ease of connection, but a slightly larger interval occurs when changing over, and it is possible to get a shock unless carefully manipulated. The self capacity is negligible, and these switches would therefore be admirably suited to H.F. circuits.

The circuit diagram is shown in Fig. 5, and it will be noted that on the left-hand side of the panel are terminals for connecting the low tension supply from the power amplifier to the amplifier and detector panel. Two terminals bridged with a copper link are provided for the attachment of a separate high tension battery. When using the power amplifier with an ordinary standard wireless receiver a jack is used for connecting the anode circuit of the preceding voltage amplifier.

On the right-hand side of the panel are terminals for connection to the low tension battery, terminals for connection to field of the Magnavox loud speaker, and jacks arranged to permit plugging one or more loud speakers or telephones in series or parallel.

A 36-volt dry battery is mounted under the panel, connected to a multi-stud switch, with separately insulated arms operating on the same studs for applying a variable grid potential to either valve. This battery is connected by flexible leads with plug pins to enable a change of battery to be readily made. This rotating switch is extremely convenient to operate, and is a great advance on the employment of a wandering plug, or separate stud switch for each valve.

Loud Speaker.

The loud speaker employed is a standard "Magnavox" junior, except that it has been mounted in a mahogany case to match the receiver, and means have been provided for controlling the natural frequency of the diaphragm or armature by means of :—

(1) Change-over switch fitted in the field circuit, so arranged that the polarity of this field may be reversed.

(2) A rheostat in the field circuit arranged so that the amplitude of the diaphragm oscillation may be controlled.

Normally no adjustment whatever is necessary to the Magnavox as purchased provided that the input to the instrument is undistorted. The modifications described will be found an improvement when it is necessary to clarify signals owing to interference.

High Tension Unit.

The high tension unit shown in Fig. 1 is contained in a case 25 ins. by $10\frac{1}{2}$ ins. by $12\frac{1}{2}$ ins. with a sloping front panel. On the panel are mounted three stud switches, the one on the left controlling the anode potential of the first three valves, and that on the right controlling the anode potential of the last four valves. The right-hand switch, however, is arranged to connect the last four valves to the first battery when it is desired to work the headphones with several stages of low frequency amplification.

Each battery is a separate unit with a common negative, and is shunted with a 2 mfds. condenser, and as an example of the good insulation obtained, it is possible to receive signals from three to five minutes by means of the discharging condensers, and this, twenty-four hours after the high tension supply has been switched off!

In the centre of the panel is mounted a 0-5 milliammeter, and below this is a change-over switch connecting it in series with the plate circuit of either of the first three valves or the plate circuit of either of the last four valves. The use of the milliammeter for tuning-in the oscillatory circuits has already been described, and it is also invaluable for measuring the current modulation on the low frequency stages. Unfortunately, it is of too low a reading for use with more than two stages of low frequency amplification, but with two valves in circuit it records to 2 to $2\frac{1}{2}$ milliamps modulation in the anode circuit. The Paris time signals are invariably recorded visually in this way. Contained in this unit also is a separate battery for supplying negative grid potential to the first two low frequency valves. A seven-stud switch will be seen to control this feature.

Valves.

The selection of a most suitable valve for the function which it is desired to perform is most important, and it is to be regretted that so little information is available from the valve manufacturers in this country. When characteristic curves are obtainable, they are stated to be based on "average" results, and the writer finds it desirable to prepare a characteristic of each valve and to check this from time to time as the valve softens.

The " V.24 " valve is very suitable for high frequency amplification on short wavelengths, but it is extremely critical—a very slight alteration in anode potential or filament emission is quite sufficient to completely interrupt signals. This valve, also, is not very economical.

For rectification the " R.4B " valve has been found most suitable, although the ordinary " R " valve, if moderately soft, gives good results.

For audio-frequency amplification both the " L.S.1 " and " L.S.2 " valves give very good service. They are expensive, but allow a very much higher potential, without saturation and distortion, than any other receiving valve the writer has used.

There are no maker's characteristic curves available with these valves, and the impedance of various specimens varies tremendously. It is, therefore, absolutely essential to have grid voltage control to each valve.

It is most desirable to employ a separate high tension battery for the " high frequency and detector " and the " low frequency stages." Until this battery was separated a considerable amount of distortion arose, due to comparatively large current taken by the power valve, causing a slight drop of voltage on the plate of the high frequency valves. This distortion was brought to light by a milliammeter placed in circuit with the high frequency anode.

The best tuning adjustment when found is recorded visually on the milliammeter. Should it then be desired to switch in a further low frequency stage a very slight drop in filament potential will occur with consequent reduction in the anode current. Unless this is noted and corrected by decreasing the filament resistance of the " V.24 " valves a loss of signal strength will result. With the use of the milliammeter it is a simple matter to increase the filament current until the ammeter needle reaches the previously recorded reading. The writer also uses the milliammeter to ensure that the best portion of the characteristic curve of the detector is being worked on.

The D.C. component on the low frequency valves is practically useless, and until the milliammeter records the minimum steady anode current and maximum modulation, the grid potential can be raised.

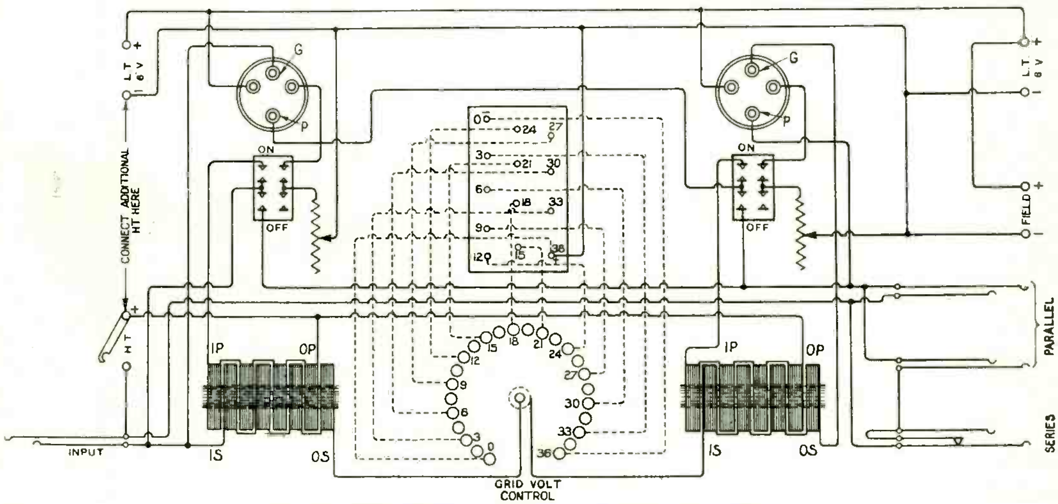


Fig. 5. Circuit diagram of two-valve power amplifier.

It will be noted that both voltage and current amplification is obtainable. The former is preferable with head telephones, and loud speakers constructed on the telephone receiver principle. It has been found that current amplification produces very little increase in sound volume when this type of loud speaker is used.

With the moving field loud speaker further stages of current amplification produce a very noticeable increase in the volume of sound.

Although there are 51 separate controls on this receiver, it is by no means unmanageable. Care is needed with the high frequency amplification stages, and, of course, with the reaction circuit when this is employed. The writer's daughter, aged 6, regularly tunes in and listens to **2 LO**, using the detector valve only.

THE WIRELESS WORKSHOP

MAKING THE INSTRUMENT PANEL

FOR A FOUR-VALVE RECEIVER.

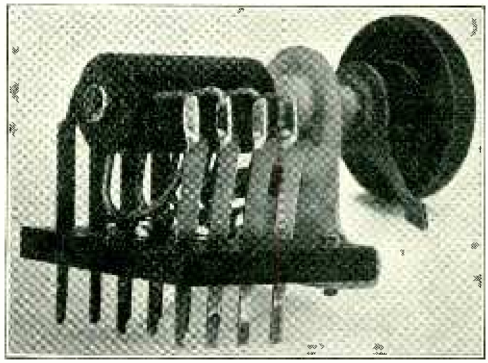
This article deals with the setting out the components of a receiver and preparing the ebonite mounting panel for the engraver. Complete and detailed instructions are given in this and subsequent instalments for making a well designed four-valve receiver.

By F. H. HAYNES.

THE methods by which the ebonite panels are accurately cut to shape, the procedure for transferring the dimensions to the ebonite, and drilling and tapping having been dealt with, it now remains, before describing further workshop processes, to go into the principles of the receiver itself.

Most experimenters will need their receiving apparatus to be capable of operating efficiently on all wavelengths, and thus it becomes necessary for tuning to be effected by means of interchangeable coils. As high frequency amplification is to be embodied and selectivity obtained, no less than five holders for tuning inductances must be provided. A three-coil holder is to be arranged in the aerial circuit, and a two coil holder in the plate circuit of the high frequency valve. To extend the tuning range of the aerial circuit a switch is arranged to connect the aerial tuning condenser either in series or parallel with the aerial tuning inductance. As a closed circuit is employed a switch will be required for introducing the closed circuit inductance after the aerial circuit has been tuned, known as a "stand-by" and "tune" switch. The tuning of the high frequency amplifier circuit introduces manipulating difficulties, and hence, apart from the necessity of producing the desired degree of amplification, it is helpful if a switch is arranged to throw the high frequency amplifier out of circuit. Switches are also introduced for taking out of circuit the two note magnifying valves according to whether head telephones or a loud speaker are used for reception.

Five switches in all will be needed, and these must be of the double-pole two-position type. There are many varieties on the market, possessing various advantages, such as that of occupying small panel space, single spring lever or rotating knob action, contacts that "wipe," and so give reliable electrical connection, minimum capacity between adjacent contacts, and simplicity of mounting. A useful pattern, possessing many of the advantages mentioned, is shown in the adjoining diagram, and is embodied in the design under description, though ample space is allowed on the panel so that any of the many other excellent types may be substituted, according to the tastes of the reader.



One of the many types of multi-contact switch suitable for varying the circuit arrangements of receivers.

Before proceeding with the setting out of the front panel the reader should purchase the components which are to be assembled upon it. These comprise :—

Four circular pattern filament resistances complete with knobs. Good quality resistances should be purchased, which have smooth movement and make positive contact. Three filament resistances of well-known make are illustrated.

Five multi-contact switches as described above.

Three variable condensers, two having a value 0·0003 mfds. for use in the closed and tuned anode circuits and another of 0·0005 mfds. These condensers are to be of solid construction The top plate on which the fixed plates are mounted should be of metal or hard insulating compound, and in the latter case should be provided with a metal bush. An end plate of metal or bushed insulating compound should be employed to form the lower bearing for the spindle. The spindle of the moving plates must be held tightly in the bearings so that it will not slip round when the condenser is mounted edgewise. Alternatively the plates may be balanced. The condensers should be complete with knobs and dials and ready for panel mounting.

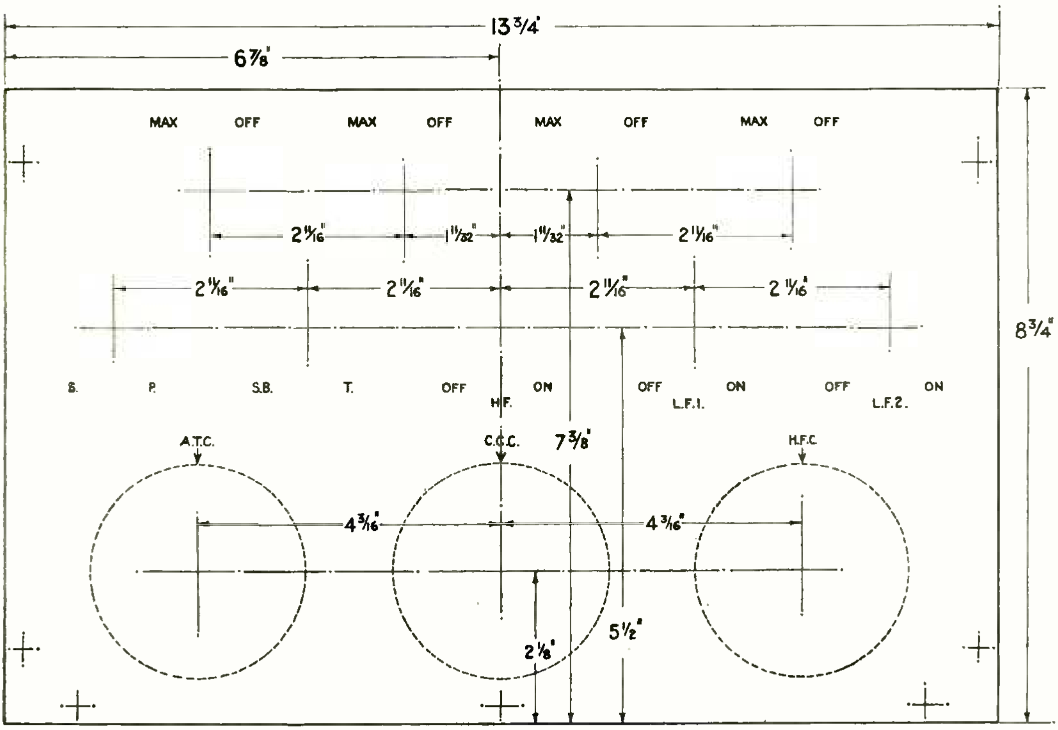
A dimensional drawing of the panel showing the setting out of the centres of the various components is given, and before proceeding with the drilling the reader should look over the parts he has purchased with his rule to make sure that he has not obtained fitments of unusual size, such as would require slight modifications in the setting out given.

The filament resistances will probably need tapped blind holes for securing them to the panel. If their knobs are provided with pointers it is as well to arrange for the "off" and "maximum" positions to be near the top of the panel.

The mounting of the switches is quite simple. A clearance hole is made to take the threaded portion, whilst the point of a $\frac{1}{8}$ in. drill will make a hole to take the small projecting piece of screw which is $\frac{9}{16}''$ below the spindle and projects for the purpose of preventing the switch from turning.

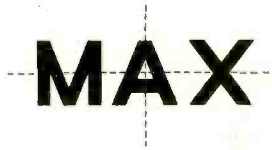
The precise method of mounting the condensers depends on the pattern employed. The reader should aim at avoiding a number of screw heads appearing on the face of the panel, and it is usually less work to tap blind holes from the back of the panel than to make clearance holes, and as a consequence, have to lacquer the heads of the screws appearing on the front.

All apparatus should now be temporarily mounted on the panel, and any defective fit adjusted. When everything is in order, remove the components and proceed to rub down the faces. Eight nails driven into the bench, two at each corner of the panel, will hold it secure, while the polished surface is removed by rubbing with a circular motion with a



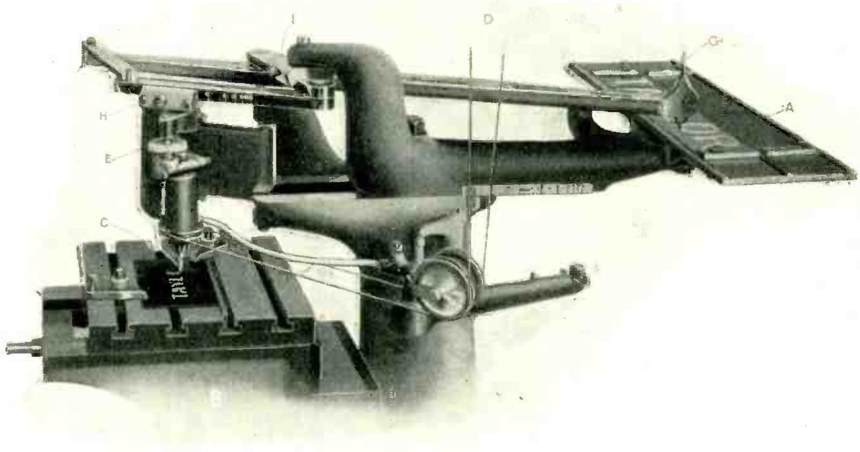
Panel lay-out for supporting the resistances, switches and condensers of a four-valve receiver. Suitable engraving is also indicated. The cross lines represent the centres of the holes for the spindles, the top row being for resistances, the second for the switches and at the bottom the variable condensers.

small block of wood wrapped with a medium grade of emery cloth. This is usually done without any form of lubricant, the use of which tends to give the surface of the panel a somewhat shiny appearance, especially when rubbing down with a cloth to remove the traces of lubricant used. If a little shine is desired, turpentine may be used while rubbing down. A good matt finish should be aimed at, free from predominating scratches, giving an appearance similar to that which would be obtained by sand blasting. It might be mentioned here that ebonite panels should not be cleaned with oil as a patchiness will result. The easiest way of keeping ebonite instrument panels clean is to use a soft brush which will readily remove the dust from parts inaccessible by a duster. Both sides of the panel, as well as those of the valve panel described hitherto, should be treated, and as the area to be covered is by no means small, patience must be exercised.



The centre of the words to be engraved on the panel may be indicated by cross lines.

Engraving may now be considered. With the surface of the panel quite clean, lettering should be put on in pencil in the precise position and exact size as will be required. It is as well to rule lines through each word indicating the centre of the word, as the reader will probably be unacquainted with the spacing of the letters. Machine engraving is carried out by means of a pantograph reducing arrangement with a stylus which travels in recessed type, while a revolving cutter on the surface of the ebonite reproduces the letters with the required degree of reduction. The copy type usually employed in the machine is one inch in height, and a reduction of $\frac{1}{3}$, $\frac{1}{4}$, $\frac{1}{6}$, $\frac{1}{8}$, $\frac{1}{10}$, $\frac{1}{12}$ and $\frac{1}{14}$th can usually be obtained. Thus, it is as well to indicate the size of the lettering required as $\frac{1}{3}$, $\frac{1}{8}$, etc., these being the height of the letters on the ebonite, in inches.



[By courtesy of Messrs. Taylor, Taylor and Hobson, Ltd.]

The mechanism of the Engraving Machine, showing the pantograph action and the revolving cutter.

It has been found necessary to postpone the Transmission Test, arranged by the British Wireless Relay League for June 16th, in consequence of the inability of certain of the transmitting stations from taking part.

The New Meteorology.

PREPARING WEATHER FORECASTS FROM WIRELESS REPORTS.

By W. G. W. MITCHELL, B.Sc., F.R.A.S., F.R.Met.S.

THE reader who has followed the previous articles on the subject of "Wireless and Meteorology," the last of which appeared in this journal on October 14th, has probably realised that the progress of meteorology is entirely dependent upon international co-operation, the weather at any particular place bearing a constantly changing relationship with the weather conditons over at least a whole hemisphere. The chief aim of the local weather forecaster must be to "link up" the changes of weather going on around him with the changes taking place over a much larger surrounding area. To do this he must first of all carry in his mind a mental picture of the movements of high and low pressure areas from a recently prepared synoptic chart, which should be as complete as possible, and extend over a fairly large portion of the northern hemisphere. Then by supplementing his chart with local readings of meteorological elements, the most important being barometric pressure, wind direction and temperature, he will be able to anticipate the direction of motion of these centres of high and low pressure and estimate fairly accurately their time of arrival locally.

The importance of the synoptic chart as the basis of all modern weather forecasting is now firmly established. For obvious reasons it is desirable that the "bird's-eye" view disclosed by the chart should be as recent as possible. The next point to consider is the area to be covered by the chart.

Until recently, that immense area comprising the whole of Europe and North Africa was effectively linked up for meteorological purposes by a network of central W/T issuing stations, which received reports either by W/T or land-line from a number of subsidiary reporting stations or observatories. The position of our own meteorological service was, even under those conditions, one of special difficulty, chiefly by reason of our insular situation at the edge of the European land areas. Although we could receive reports from the south and east, we were dependent upon reports from Atlantic liners for indications of any changes on our Western seaboard. The service of weather reports from ships at sea is a voluntary service, and messages are often relayed through other ships. It is not surprising, therefore, to find that on an average one out of every four or five messages contains errors. Early in 1921 the service was vastly extended and reorganised, the most important improvements being the simplification of the meteorological data asked for and the introduction of a system of "check figures," so that now, although a whole group of the coded figures might be lost before the message was received by the Central Meteorological Office, it is quite possible to replace these with certainty. A further extension of the area covered by the synoptic chart was made by the inclusion of reports by W/T from Iceland, and more recently by the addition of observations from the United States and Canada. The practicability of such a service was demonstrated three years ago when, as a temporary measure, reports were transmitted to us for a short time, in connection with transatlantic flights. The American observations are taken at 0100 G.M.T., and are sent daily to France and incorporated in the International Collective Report issued by the Eiffel Tower at 1005 G.M.T. on a 2,600 m. wave (spark). It has thus become possible for the Meteorological service to have within nine hours of the taking of the observations, a representation of the meteorological situation over the greater part of the Northern Hemisphere, extending from the Pacific Seaboard of America in the west to Russia and Egypt in the east. A specimen synoptic chart prepared from details sent by the Eiffel Tower is illustrated. So that amateurs can pick this message up and decode it, particulars of the transmission are now given.

International Collective Report sent daily from FL at 1005 G.M.T.; wavelength 2,600 m., spark.

Form of Message.

The message commences with ONM (Office National Météorologique), and is divided into four parts.

Part I.—Commences with "Météo Europe" and contains observations of 0100, 0700, 1300 or 1800 G.M.T. from stations in Europe and North Africa.

Code for observations at 0700: I_nI_n BBDDF w_1TTK^1R, and for observations at 0100, 1300 and 1800 (the last two times indicating the previous day's readings) I_nI_n BBDDF w_1TTK^1W.

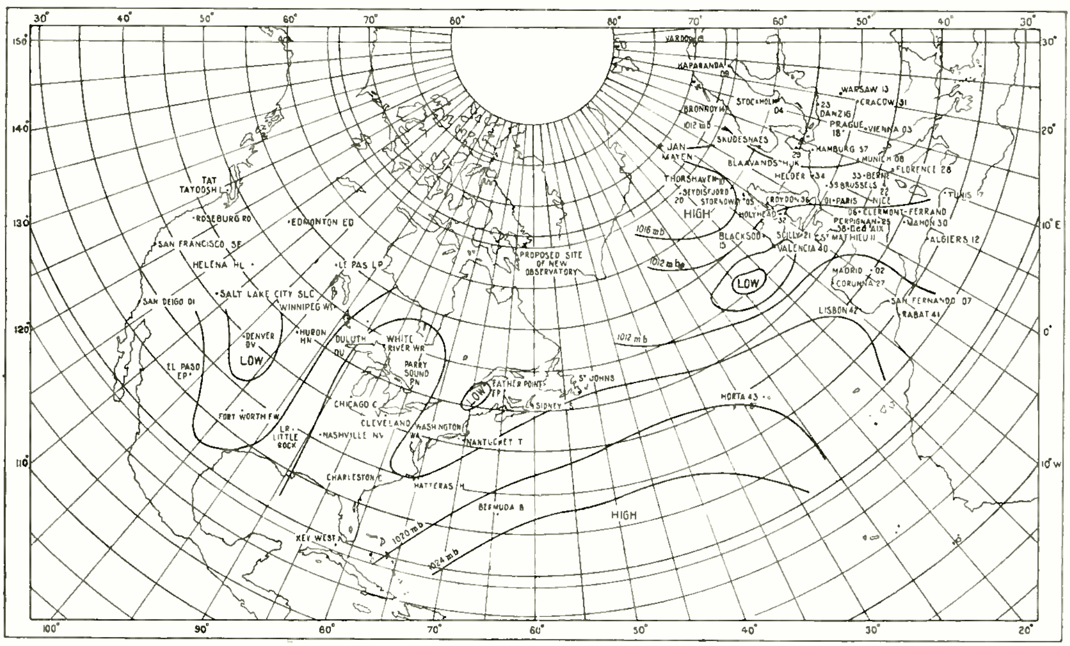
Where w_1 is the initial figure of the present weather code ww (see New International Code, page 821, *The Wireless World and Radio Review*, September 23rd, 1922), and so indicates the general state of the weather, and

K^1 is a single figure indicating the manner in which the barometer is changing (*i.e.*, barometric tendency) as follows :—

Code figure.	Sign of tendency.	Change in last 3 hours in mm. or mb.
0	+	0 to 0·5
1	+	0·5 to 1·5
2	+	1·5 to 3·5
3	+	3·5 to 6·0
4	+	more than 6·0
5	—	0 to 1·5
6	—	1·5 to 3·5
7	—	3·5 to 6·0
8	—	more than 6·0

List of Stations (I_nI_n).

Code.		Code.	
01	Paris	28	Aspio
02	Madrid	29	Helsingfors
03	Vienna	30	Mahon
04	Stockholm	31	Budapest
05	Lerwick	32	Holyhead
06	Lyon	33	Zurich
07	San Fernando	34	De Bilt
08	Munich	35	Rome
09	Haparanda	36	London
10	Thorshavn	37	Hamburg
11	Brest	38	Bordeaux
12	Algiers	39	Brussels
13	Warsaw	40	Valencia
14	Prono	41	Rabat
15	Renfrew	42	Lisbon
16	Bucharest	43	Horta
17	Tunis	44	Messina
18	Prague	45	Reykjavik
19	Ingoy	46	Helwan (Egypt)
20	Seydisfiord	47	Oran
21	Prerov	48	Cassel
22	Nice	49	Malta
23	Lemberg	50	Constantinople
24	Copenhagen	51	Taranto
25	Perpignan	52	Sofia
26	Lister	53	Bizerta
27	Corunna	54	Tripoli



A specimen Synoptic Chart prepared from details transmitted by Eiffel Tower.

Code.		Code.	
55	Agadir	58	Tangier
56	Athens	59	Belgrade
57	Funchal	60	Pertusato

PART II (occasionally) commences with "Navires" and contains observations taken on board ship at sea:

Code: PQLLL lllGG BBDDF

Where P = day of week (1 = Sunday, 2 = Monday, etc., . . . 7 = Saturday).

Part III commences with "Météo Amérique," and contains the observations of 13 stations in the United States and Canada.

Code: PPGG I_n(or I_nI_n or $I_nI_nI_n$) BBDF

This is followed by the positions of the centres of highest and lowest pressure.

Name of station in full BBDF

List of stations (I_n or I_nI_n or $I_nI_nI_n$).

Code letter.	
J	St. John's (Newfoundland).
S	Sydney (Nova Scotia)
FP	Father Point
PN	Parry Sound
WR	White River
WI	Winnipeg
LP	Le Pas
ED	Edmonton
T	Nantucket
WA	Washington
H	Hatteras
C	Charleston
B	Bermuda
K	Key West
LR	Little Rock
NV	Nashville
V	Cleveland
CH	Chicago
DU	Duluth
HN	Huron
SLC	Salt Lake City
HL	Helena
DV	Denver
RO	Roseburg
TAT	Tatoosh
SF	San Francisco
DI	San Diego
FW	Fort Worth
EP	El Paso

PART IV (occasionally) observations by the Amundsen Polar Expedition vessel *Maud.*

Code: "Maud" PQLLL lllGG BBDDF TTTw_2

Where w_2 = state of weather in special code below :—

Code

0 = Clear sky, fine weather.

2 = Cloudy, with intervals of blue sky.

4 = Overcast.

5 = Rain, drizzle or hail.

6 = Snow or sleet.

All the other symbols given have the same meaning as in the New International Code.

Equipment of Local Station.

To enable the local observer to "link up" his weather as outlined in paragraph (1) above, he will need certain equipment. A barometer and thermometer (Fahrenheit or Centigrade) are all that is really necessary. If both these instruments are of the self-recording type, it will be a distinct advantage, although of course the latter are more expensive. The graphical representation given by self-recording instruments enables the eye to gauge the barometric gradient and change, and is also useful at first in checking forecasts by referring subsequently to the past behaviour of local weather. If the thermometer is of the ordinary mercury pattern it should be remembered that it is the temperature of the free air that is required, and the thermometer should therefore be placed in a screened position on the north side of the house.

Let us consider now one typical example of the method of procedure, and we will take the case of a cyclone moving from W. to E. Having beside him the latest available synoptic chart, he notices that the barometer begins to fall quickly, and wind changes most likely occur. These are known by observing the motion of low clouds. Buy's Ballot's Law enables the bearing of the centre of the cyclonic depression to be found, and the chances of its passing north or south of his station. A sudden reversal of wind direction would indicate that the centre of the depression was almost immediately over the local station. He then refers to the charts given in this journal on page 746 of the issue of September 9th last, giving the nature of the weather to be expected from typical arrangements of isobars, and in this connection he may be guided largely by past experience.

THE AMATEUR'S EXPERIMENTAL LABORATORY

VI.—APPLICATIONS OF THE CALIBRATED CONDENSER.

By PHILIP R. COURSEY, B.Sc., F.Inst.P., A.M.I.E.E.

HAVING once obtained a reasonably accurate calibration of a variable condenser, by one of the methods which have been described in the preceding articles, there is no need to follow through that lengthy calibration process if it is desired to calibrate a second condenser. The condenser that has already been calibrated can be employed as a comparison condenser against which other condensers can be measured. For this purpose, probably one of the simplest arrangements to employ is that which was described in Article III in this series.* For convenience in reference, the diagram of that arrangement is reproduced here (Fig. 1). In this diagram

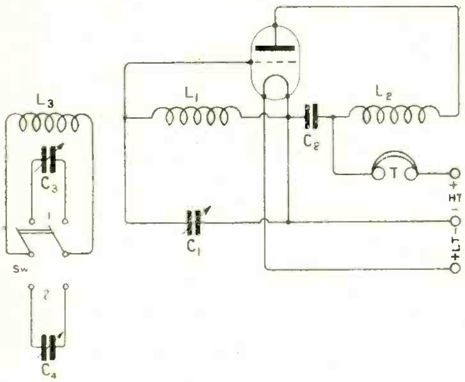


Fig. 1.

both the known condenser C_3 and the new test condenser C_4 are shown as variable condensers, since in this case the *known* condenser C_3 is the variable condenser which has already been calibrated, and for which the calibration curve has already been plotted out. The test condenser C_4 is now the new variable condenser, which it is desired to measure up so that a calibration curve can be plotted.

The procedure for this test is obviously the same as that outlined in the article referred to above, except that in lieu of employing several fixed comparison condensers we now have the calibrated variable. It simplifies the carrying out of the test if a table is drawn up into the columns of which the readings that are taken can be written for subsequent reference and use. The headings required are as indicated in Table I. In these headings, and in subsequent use, the term "test condenser" is understood as meaning the condenser that is being measured or tested, while "standard condenser" is taken as referring to the variable condenser which has already been calibrated, and which is now being used as a comparison standard.

TABLE I.

Scale Reading of Test Condenser.	Corresponding Scale Reading of Standard Condenser.	Capacity of Standard μF.
0°		
10°		
20°		
40°		
60°		
80°		
100°		
120°		
140°		
160°		
170°		
180°		

The figures filled in in the first column are intended to apply to those condensers which have a scale graduated in degrees from 0° to 180°, as is the case with most condensers on the market to-day. If the scale is differently graduated, a different series of intervals can be chosen, but when the scale runs from 0° to 180° it will generally suffice to obtain readings at the points tabulated. It will be noted that these are every 20° with the exception of

*Wireless World, May 5th, 1923, pp. 139-142.

10° and 170° where the interval is made 10° in order to obtain an indication of the curvature of the ends of the scale if there should be any As a matter of fact, for most purposes it will suffice if the interval between readings is made greater than 20° in the centre of the scale where the calibration curve should be a straight line in most cases. Thus, if it is desired to save time or labour in making the calibration, readings could be taken at 0°, 10°, 20°, 60°, 120°, 160°, 170° and 180°, making a total of eight readings instead of twelve.

The procedure to be followed in making this calibration is as follows :—

Set the test condenser at "zero," and adjust the oscillator until it is in resonance with the test circuit, the switch Sw being in contacts (2). Then throw over the switch to contacts (1), and while keeping the oscillator at the same settings, adjust the "standard" condenser C_3 until the circuit is again in resonance with the oscillator. The reading of C_3 at which this condition is obtained (as indicated by the "clicks" in the telephones) should be entered in the second column of the Table I opposite 0° in the first column.

This procedure should be repeated for each of the settings of the test condenser that are tabulated in the first column of Table I, and the corresponding readings of the "standard" condenser filled in the proper places in column 2 of that table.

Having obtained the measurements of the test condenser in terms of the standard condenser in this manner, it remains to translate them into capacity values. This may be done by the help of the characteristic curve of the standard condenser which has already been plotted out (see Fig. 3 on page 203 of Article IV in this series, *The Wireless World and Radio Review*, May 19th issue). Each of the scale readings entered in the second column of Table I, after it has been filled up with the test readings, should be taken in turn, and found on the lower (horizontal) scale of the calibration curve of the standard condenser. The vertical line through this scale reading should be followed upwards until it intersects the plotted curve, whence the horizontal line through this point should be followed along to the left to obtain the corresponding point on the vertical left-hand scale, which is marked in capacities. The capacity values so found should be entered in column 3 of the table, opposite their appropriate scale readings.

The calibration curve of the test condenser can then be plotted out, using the figures in the first and third columns of Table I, setting out the scale readings (column 1) along the horizontal scale, and the corresponding capacities (column 3) along the vertical scale of the chart. The curve drawn through the points so obtained gives the calibration curve of this condenser. It should be marked with the number and description of the condenser so that it can be seen at a glance to which condenser it refers.

It has been assumed in the above that the maximum capacity of the test condenser is less than the maximum of the "standard" comparison condenser, and also that its minimum value is greater than the minimum of the standard condenser. If these conditions should not be complied with it will not prove possible to complete the measurements at both ends of the calibration curve. This difficulty can be overcome by the use of a small auxiliary fixed condenser, the exact capacity value of which need not be known but should preferably be of some value between about 0·00025 and 0·0006 microfarad.

Taking first the difficulty that is the more likely to be met with, viz., the minimum value of the test condenser either being less than that of the standard condenser or so close to it as to render adjustments either difficult or impossible, as much as possible of the calibration curve that comes within the range of the standard condenser should first be measured and plotted out. The test condenser should then be set at some value near the lower end of its scale, such as 30° or 40°, that comes within the limits of the portion of the calibration curve that has already been plotted, and the auxiliary fixed condenser should be connected in parallel with its terminals. Then, with the switch Sw on contacts (2), putting the test condenser into circuit, the oscillator is adjusted to resonance with the test circuit. The switch Sw is changed over to contacts (1), and the standard condenser adjusted until the test circuit is again in resonance with the oscillator. This setting of the standard condenser should be noted—call it "A" for the moment. The test condenser should now be put at 0° on its scale (leaving the auxiliary fixed condenser in parallel), and the oscillator adjusted to resonance with the switch Sw in contacts (2). The switch should be thrown over to contacts (1), keeping the same settings of the oscillator, and the standard condenser adjusted till the test circuit is again brought into tune with the oscillator as indicated by the " clicks " in the telephones. This scale reading of the standard condenser should be noted—call it " B " for reference purposes.

Now, by reference to the calibration curve of the standard condenser, find the capacity corresponding to scale reading (A), and that corresponding to scale reading (B). Subtract the second of these capacity values from the first—the difference is the difference between the capacity of the test condenser at zero and at 30° (or whatever other setting was used for the first reading). But since we know from the portion of the calibration curve that has already been plotted, the capacity of the test condenser corresponding to 30° on its scale (or whatever other initial point was chosen for the first of the above pair of readings), we can by subtraction determine the capacity of the test condenser at the zero of its scale. Similarly, by taking other readings by the same method its capacity at 10° and 20° can also be determined if it has not been possible to measure them by the direct method described at the beginning of this article.

This method enables the lower bend of the calibration curve of the test condenser to be plotted out easily. Should the maximum value of the test condenser, however, exceed the maximum of the standard comparison condenser, it becomes necessary to extend the range of the standard condenser by means of the small auxiliary fixed condenser that was used for the last test.

In this case, the calibration curve of the test condenser should be plotted out as far as possible by direct comparison with the standard condenser, in the manner already described, then placing the standard condenser at 180°, the oscillator should be brought into resonance, with the switch Sw on contacts (1). The auxiliary fixed condenser should then be connected in parallel with the standard, and still not touching the setting of the oscillator, the standard condenser should be adjusted until the test circuit is again in resonance with the oscillator. Call this reading of the standard condenser " D." From the calibration curve of the standard condenser, find its capacity corresponding to scale reading " D," and subtract this capacity from the maximum capacity of the condenser (corresponding to scale reading = 180°). The difference is the effective capacity of the auxiliary fixed condenser.

Now, leaving this auxiliary condenser in parallel with the standard, continue the measurements on the test condenser in the usual way, and fill in the values in the proper places of the table (Table I), making a note of where the extra condenser was added. Then when filling in the capacity values in column 3 of the table, the effective capacity of the auxiliary condenser, as determined above, must be added to the capacity values read off the calibration curve of the standard condenser for all readings taken when the auxiliary condenser was in use.

In this way, by using an appropriate size of fixed condenser, the range of the standard condenser (here assumed to have a maximum value of 0·001 microfarad) can readily be extended to about 0·0017 or 0·0018 microfarad. It can, if desired, by a further application of the same method, be extended to still larger values, but this entails greater care in manipulation, and is seldom required.

In accordance with the instructions laid down in the previous articles, proper care must be taken to ensure that the connecting wires on the two sides of the switch Sw are equal in capacity value. This may be done by interchanging the condensers, in the manner that has already been described in the earlier articles.

TRANSMISSION TEST.

The British Wireless Relay League are holding an official test on Saturday, June 16th, commencing at 11.30 p.m. The following stations are taking part :—**2 TF, 5 MP, 5 AZ, 2 JF, 5 OW, 2 VC, 2 MZ, 5 KO, 5 PS, 2 DY, 5 GJ,** and **2 RH.** A wavelength of 440 metres and a maximum power of 10 watts will be used. All members are requested to listen-in and report on any of the stations heard with full particulars.

The League still requires members for the following districts :—Aberdeen, Glasgow, Berwick-on-Tweed, Carlisle, Lake District, Hartlepool, Scarborough, Hull, York, Lancaster, Sheffield, King's Lynn, Shrewsbury, Birmingham, Northampton, Hertford, Hereford, Aberystwyth, Milford, Swansea, Cardiff, Barnstable, Penzance, Devonport, Exeter, Weymouth, Southampton, Reading, Brighton, Hastings, Dover, Harwich, Cambridge, Brandon, Norwich, and for other places near those mentioned.

All communications to be addressed to the British Wireless Relay League, care of this Journal. 12-13, Henrietta Street, W.C.2.

REGULAR TRANSMISSIONS

Corrected to June

OF METEOROLOGICAL AND OTHER EUROPEAN WIRELESS TELEGRAPHY AND TELEPHONY STAT

Time G.M.T.	Station.	Call Sign.	Wave-length.	System.	Remarks.
0055	Malabar-Java	PKX	8,800	C.W.	Time signals.
0150	Bucharest-Herestrau	BUC	7,500	C.W.	Rumanian synoptic report.
0150	Toulon-Porquerolles	FUQ	3,300	C.W.	Southern France synoptic report.
0200	Air Ministry	GFA	4,100	C.W.	British synoptic report.
0200	Land's End	GLD	600	Spark	Navigational warnings.
0200	Malin Head	GMH	600	Spark	Navigational warnings.
0200	North Foreland	GNF	600	Spark	Navigational warnings.
0200	Wick	GKR	600	Spark	Navigational warnings.
0215	Warsaw	WAR	2,300	Spark	Polish synoptic report.
0220	Paris	FL	7,300	C.W.	French synoptic report.
0255	Annapolis	NSS	17,145	C.W.	Time signal (American scheme).
0255	Washington	NAA	2,500	Spark	Time signal (American scheme).
0300	Ain-el-Turk	FUK	3,500	C.W.	Algerian synoptic report.
0315	Sidi Abdallah	FUA	5,150	C.W.	North African synoptic report.
0328	Le Bourget	FNB	1,680	C.W.	Hourly route report (summer only).
0330	Cullercoats	GCC	600	Spark	Navigational warnings.
0330	Fishguard	GRL	600	Spark	Navigational warnings.
0330	Valencia	GCK	600	Spark	Navigational warnings.
0336	Air Ministry	GFA	1,680	C.W.	Hourly route report (summer only).
0400	Paris	FL	7,300	C.W.	European synoptic report.
0415	St. Inglevert (Calais)	FNG	1,400	C.W.	Hourly route report (summer only).
0422	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report (summer only).
0428	Le Bourget	FNB	1,680	C.W.	Hourly route report (summer only).
0436	Air Ministry	GFA	1,680	C.W.	Hourly route report (summer only).
0444	Soesterberg	STB	1,680	C.W.	Hourly route report (summer only).
0447	Romilly	FNR	1,400	C.W.	Hourly route report (summer only).
0458	Massawa-Eritria	ICX	3,500	Spark	Time signals.
0503	Valenciennes	FNV	1,400	C.W.	Hourly route report (summer only).
0505	Romilly	FNR	1,400	C.W.	Hourly route report.
0508	St. Inglevert (Calais)	FNG	1,400	C.W.	Hourly route report (summer only).
0510	Mayence	LUX	2,200	C.W.	Rhine region synoptic report.
0522	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report (summer only).
0525	Metz	YC	1,450	C.W.	Eastern France synoptic report.
0528	Le Bourget	FNB	1,680	C.W.	Hourly route report.
0530	Pola	IQZ	3,000	Spark	Navigational warnings.
0535	Tours	YG	1,850	C.W.	Western France synoptic report.
0536	Air Ministry	GFA	1,680	C.W.	Hourly report route (summer only).
0544	Soesterberg	STB	1,680	C.W.	Hourly route report (summer only).
0550	Le Bourget	FNB	1,680	C.W.	Repetition of 0100 observations.
0550	Paris	YAQ	2,100	C.W.	Hourly route report.
0600	Air Ministry	GFA	4,100	C.W.	Repetition of British synoptic report transmitted at 0200.
0603	Valenciennes	FNV	1,680	C.W.	Hourly route report.
0605	Romilly	FNR	1,680	C.W.	Hourly route report.
0608	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
0622	Uccle	OPO	1,680	C.W.	Hourly route report.
0625	Metz	YC	1,450	C.W.	Eastern France synoptic report.
0628	Le Bourget	FNB	1,680	C.W.	Hourly route report.
0630	Rome Centocelle	ICD	2,250	Spark	Navigational warnings.
0635	Königswusterhausen	LP	5,700	C.W.	European upper air report.
0636	Air Ministry	GFA	1,680	C.W.	Hourly route report (winter excepted).
0640	Paris	FL	2,600	Telephony	District forecasts (Sundays excepted).
0644	Soesterberg	STB	1,680	C.W.	Hourly route report (summer only).
0650	Königswusterhausen	LP	5,700	C.W.	European synoptic report.
0650	Le Bourget	FNB	1,680	C.W.	Route forecasts for the morning.

Time G.M.T.	Station.	Call Sign.	Wave-length.	System.	Remarks.
1035	Athens	SXG	3,600	Spark	Synoptic report for the Near East.
1036	Air Ministry	GFA	1,680	C.W.	Hourly route report.
1044	Paris	FL	2,600	Spark	Time signal (French scheme).
1044	Soesterberg	STB	1,680	C.W.	Hourly route report.
1045	Swinemünde	KAW	1,000	Spark	Synoptic report.
1050	Le Bourget	FNB	1,680	C.W.	Forecasts for Paris-London-Brussels routes.
1050	Toulon-Porquerolles	FUQ	3,300	C.W.	Southern France synoptic report.
1050	Tours	YG	1,850	C.W.	Western France synoptic report.
1100	Borkum	KAN	1,250	Spark	Synoptic report.
1100	Copenhagen	OXA	600	Spark	Navigational warnings.
1100	Reykiavick	TFA	1,800	Spark	Icelandic synoptic report.
1100	Brussels (Haren Aero.)	—	1,100	—	Weather report.
1103	Valenciennes	FNV	1,680	C.W.	Hourly route report.
1105	Romilly	FNR	1,680	C.W.	Hourly route report.
1108	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
1115	Paris	FL	2,600	Telephony	General inference for 0700 and forecasts for the seaboard. (Sundays excepted.)
1115	Scheveningen	PCH	1,800	Spark	Special report for Mariners.
1116	Cologne	GEK	1,680	C.W.	Hourly route report.
1119	Ostende	OPVO	1,680	C.W.	Hourly route report.
1120	Blaavand	OXB	600	Spark	Navigational warnings.
1122	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
1125	Metz	YC	1,450	C.W.	Eastern France synoptic report.
1128	Le Bourget	FNB	1,680	C.W.	Hourly route report.
1130	Pillau	KAP	600	Spark	Synoptic report and forecast for the Eastern Baltic.
1136	Air Ministry	GFA	1,680	C.W.	Hourly route report and forecasts.
1140	Paris	YAQ	2,100	C.W.	Hourly route report.
1144	Soesterberg	STB	1,680	C.W.	Hourly route report.
1145	Ain-el-Turk	FUK	3,300	C.W.	Algerian synoptic report and forecasts.
1150	Le Bourget	FNB	1,680	C.W.	Route forecasts for the afternoon.
1155	Nauen	POZ	3,100	Spark	Time signal (International scheme).
1155	Nauen	POZ	12,000	C.W.	Time signal (International scheme).
1200	Lausanne	—	1,650	Telephony	Weather report for Switzerland.
1200	Sidi Abdallah (Bizerta)	FUA	1,350	Spark	Algerian synoptic report and forecasts.
1200	Uccle (Brussels)	OPO	1,500	C.W.	General inference and forecast (slow transmission). (Sundays only.)
1203	Valenciennes	FNV	1,680	C.W.	Hourly route report.
1208	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
1210	Vossegat	BE	1,000	Spark	Forecast in Dutch (very slow transmission).
1215	Karlsborg	SAJ	2,500	Spark	Scandinavian synoptic report and coded forecasts.
1216	Cologne	GEK	1,680	C.W.	Hourly route report.
1219	Ostende	OPVO	1,680	C.W.	Hourly route report.
1222	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
1228	Le Bourget	FNB	1,680	C.W.	Hourly route report.
1230	Nantes	UA	2,800	Spark	General inference for 0700 (in French).
1236	Air Ministry	GFA	1,680	C.W.	Hourly route report.
1244	Soesterberg	STB	1,680	C.W.	Hourly route report.
1250	Le Bourget	FNB	1,680	C.W.	Forecasts for Paris-London-Brussels routes.
1300	Manchester	GEM	1,300	C.W.	Hourly route report.
1302	Castle Bromwich	GEC	1,300	C.W.	Hourly route report.
1303	Valenciennes	FNV	1,680	C.W.	Hourly route report.
1305	Renfrew	GER	1,300	C.W.	Synoptic report.
1305	Romilly	FNR	1,680	C.W.	Hourly route report.
1308	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.

Time G.M.T.	Station.	Call Sign.	Wave-length.	System.	Remarks.
1850	Monsanto	CTV	1,000	Spark	Azores synopt
1850	Toulon-Porquerolles	FUQ	3,300	C.W.	Southern Fran
1850	Le Bourget	FNB	1,680	C.W.	Hourly route r
1900	Air Ministry	GFA	4,100	C.W.	British and Ic
1900	Petrograd	RAC	2,000	Spark	Time signal (
1900	Manchester	GEM	1,300	C.W.	Hourly route r
1900	Reykiavick	TFA	1,800	Spark	Icelandic syno
1902	Castle Bromwich	GEC	1,300	C.W.	Hourly route r
1915	Warsaw	WAR	2,300	Spark	Polish synopti
1920	Paris	FL	7,300	C.W.	French synopt
1940	Königswusterhausen	LP	5,700	C.W.	German synop
1940	Vossegat	BE	1,000	Spark	Forecast in Du
1945	Mediouna	CNM	5,000	C.W.	Moroccan syn
1950	Königswusterhausen	LP	5,700	C.W.	European syn
1950	Le Bourget	FNB	1,680	C.W.	Route forecas only).
1955	Bordeaux	LY	23,450	C.W.	U.R.S.I. signa
1955	Sandhamns	OJA	—	—	Finnish synop
1955	San Diego	NPL	9,800	C.W.	Time signals.
2000	Aïn-el-Turk	FUK	3,500	C.W.	Moroccan and
2000	Air Ministry	GFA	4,100	C.W.	General infere and coded
2000	Bordeaux	LY	23,400	C.W.	Scientific Tim
2005	Königswusterhausen	LP	5,700	C.W.	European upp
2000	Lisbon	PQL	1,000	Spark	Portuguese sy
2000	Land's End	GLD	600	Spark	Navigational
2000	Malin Head	GMH	600	Spark	Navigational
2000	North Foreland	GNF	600	Spark	Navigational
2000	Wick	GKR	600	Spark	Navigational
2020	Sidi Abdallah	FUA	5,150	C.W.	North African
2030	Carabanchel	EGC	2,000	Spark	Spanish synop
2030	Pola	IQZ	3,000	Spark	Navigational
2030	Prague	PRG	4,500	C.W.	Czecho-Slovak
2030	Toulon-Porquerolles	FUQ	1,350	Spark	Synoptic repo language (F
2045	Rome	IDO	11,000	C.W.	Italian synopt
2045	Rome Centocelle	ICD	2,250	Spark	Italian synopt
2050	Reval	AZA	2,000	Spark	Esthonian syn
2050	Bergen	LGN	1,850	C.W.	General infere (in code).
2100	Copenhagen	OXA	600	Spark	Navigational
2100	Cullercoats	GCC	600	Spark	Navigational
2100	Fishguard	GRL	600	Spark	Navigational
2100	Nantes	UA	2,800	Spark	Navigational
2100	Paris	FL	7,300	C.W.	European syn
2100	Port Patrick	GPK	600	Spark	Navigational
2100	Valencia	GCK	600	Spark	Navigational
2120	Blaavand	OXB	600	Spark	Navigational
2130	Norddeich	KAV	600	Spark	Synoptic repo Sea.
2135	Monsanto	CTV	2,400	C.W.	Portuguese sy
2145	Swinemunde	KAW	600	Spark	Synoptic repo
2155	Moscow	RAJ	5,000	Spark	Time signal (R
2155	Athens	SXA	1,200	Spark	Time signals.
2200	Paris	FL	2,600	Spark	Scientific time
2210	Moscow	RAJ	5,000	Spark	Russian synop
2210	Paris	FL	2,600	Tele-	General infer

0702	Castle Bromwich	GEC	1,300	C.W.	Hourly route report.
0703	Valenciennes	FNV	1,680	C.W.	Hourly route report.
0705	Athens	SXG	3,600	Spark	Greek synoptic report.
0705	Renfrew	GER	1,300	C.W.	Synoptic report.
0705	Romilly	FNR	1,680	C.W.	Hourly route report.
0708	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
0710	Mayence	LUX	2,200	C.W.	Rhine region synoptic report.
0715	Borkum	KAN	1,250	Spark	Synoptic report.
0715	Cherbourg	FUC	3,300	C.W.	Synoptic report.
0720	Libau	KCB	1,200	Spark	Lettonian synoptic report.
0720	Wilhelmshaven	FUL	1,250	Spark	North Sea synoptic report in plain language.
0722	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
0725	Metz	YC	1,450	C.W.	Eastern France synoptic report.
0725	Rochefort	FUR	3,300	C.W.	S.W. France synoptic report.
0725	Swinemünde	KAW	1,000	Spark	Synoptic report.
0728	Le Bourget	FNB	1,680	C.W.	Hourly route report.
0730	Gibraltar	BWW	4,000	C.W.	Synoptic report.
0730	Malta	BYG	4,500	C.W.	Synoptic report.
0730	Soesterberg	STB	1,900	C.W.	Dutch synoptic report.
0735	Lyngby	OXE	3,650	C.W.	Danish synoptic report.
0735	Tours	YG	1,850	C.W.	Western France synoptic report.
0736	Air Ministry	GFA	1,680	C.W.	Hourly route report.
0740	Belgrade	HFB	4,600	C.W.	Jugo Slavian synoptic report.
0740	Karlsborg	SAJ	4,200	C.W.	Swedish synoptic report.
0740	Reval-Tallin	AZA	1,900	Spark	Esthonian synoptic report.
0744	Soesterberg	STB	1,680	C.W.	Hourly route report.
0745	Air Ministry	GFA	1,400	C.W.	Calibration waves.
0750	Air Ministry	GFA	900	C.W.	Calibration waves.
0750	Christiania	LCH	8,000	C.W.	Norwegian synoptic report.
0750	Le Bourget	FNB	1,680	C.W.	Forecasts for Paris-London-Brussels routes.
0750	Toulon Porquerolles	FUQ	3,300	C.W.	Southern France synoptic report.
0750	Paris	YAQ	2,100	C.W.	Hourly route report.
0800	Air Ministry	GFA	4,100	C.W.	British and Icelandic synoptic report.
0800	Air Ministry	GFA	1,680	C.W.	Calibration waves.
0800	Land's End	GLD	600	Spark	Navigational warnings.
0800	Lisbon	PQL	1,000	Spark	Portuguese synoptic report.
0800	Lyons	YN	15,500	C.W.	Scientific time signals.
0800	Malin Head	GMH	600	Spark	Navigational warnings.
0800	Manchester	GEM	1,300	C.W.	Hourly route report.
0800	Nantes	UA	2,800	Spark	Navigational warnings.
0800	North Foreland	GNF	600	Spark	Navigational warnings.
0800	Ostende	OST	600	Spark	Navigational warnings.
0800	Wick	GKR	600	Spark	Navigational warnings.
0802	Castle Bromwich	GEC	1,300	C.W.	Hourly route report.
0803	Valenciennes	FNV	1,680	C.W.	Hourly route report.
0805	Reval	AZA	2,000	Spark	Esthonian synoptic report.
0808	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
0815	Warsaw	WAR	2,300	Spark	Polish synoptic report.
0819	Ostende	OPVO	1,680	C.W.	Hourly route report.
0820	Deutsch Altenberg (Vienna)	OHD	5,600	C.W.	Austrian synoptic report.
0820	Paris	FL	7,300	C.W.	French synoptic report.
0822	Uccle	OPO	1,680	C.W.	Hourly route report.
0828	Le Bourget	FNB	1,680	C.W.	Hourly route report.
0836	Air Ministry	GFA	1,680	C.W.	Hourly route report and forecasts.
0840	Königswusterhausen	LP	5,700	C.W.	German synoptic report.
0845	Casablanca	CNP	1,800	Spark	Moroccan synoptic report and forecasts.
0845	Mediouna	CNM	5,000	C.W.	Moroccan synoptic report.
0844	Soesterberg	STB	1,680	C.W.	Hourly route report.
0845	Bucharest-Herestrau	BUC	7,500	C.W.	Rumanian synoptic report.
0850	Air Ministry	GFA	4,100	C.W.	European synoptic report.
0850	Königswusterhausen	LP	5,700	C.W.	European synoptic report.
0850	Le Bourget	FNB	1,680	C.W.	Forecasts for Paris-Dijon-Lyons-Paris-Lausanne routes.
0855	Sandhamns	OJA	5,700	C.W.	Finnish synoptic report.
0859	Lyons	YN	15,500	C.W.	Time signal (French scheme).
0900	Aïn-el-Turk	FUK	3,500	C.W.	Moroccan and Algerian synoptic reports.

1315	Cherbourg	FUC	3,300	C.W.	Synoptic report.
1316	Cologne	GEK	1,680	C.W.	Hourly route report.
1319	Ostende	OPVO	1,680	C.W.	Hourly route report.
1320	Wilhelmshaven	FUL	1,250	Spark	North Sea synoptic report in plain language.
1322	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
1325	Metz	YC	1,450	C.W.	Eastern France synoptic report.
1325	Rochefort	FUR	3,300	C.W.	S.W. France synoptic report.
1325	Swinemünde	KAW	1,000	Spark	Synoptic report.
1328	Le Bourget	FNB	1,680	C.W.	Hourly route report.
1330	Belgrade	HFB	4,600	C.W.	Jugo Slavian synoptic report.
1330	Terceira (Faleiras)	PQT	1,000	Spark	Azores synoptic report.
1330	Soesterberg	STB	1,900	C.W.	Dutch synoptic report.
1335	Lyngby	OXE	3,650	C.W.	Danish synoptic report.
1335	Tours	YG	1,850	C.W.	Western France synoptic report.
1336	Air Ministry	GFA	1,680	C.W.	Hourly route report.
1340	Karlsborg	SAJ	4,200	C.W.	Swedish synoptic report.
1344	Soesterberg	STB	1,680	C.W.	Hourly route report.
1350	Bucharest-Herestrau	BUC	7,500	C.W.	Rumanian synoptic report.
1350	Christiania	LCH	8,000	C.W.	Norwegian synoptic report.
1350	Mousanto	CTV	1,000	Spark	Azores synoptic report.
1350	Toulon-Porquerolles	FUQ	3,300	C.W.	Southern France synoptic report.
1355	Sofia	FF	3,500	Spark	Bulgarian synoptic report.
1400	Air Ministry	GFA	4,100	C.W.	British and Icelandic synoptic report.
1400	Land's End	GLD	600	Spark	Navigational warnings.
1400	Malin Head	GMH	600	Spark	Navigational warnings.
1400	North Foreland	GNF	600	Spark	Navigational warnings.
1400	Wick	GKR	600	Spark	Navigational warnings.
1403	Valenciennes	FNV	1,680	C.W.	Hourly route report.
1408	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
1415	Warsaw	WAR	2,300	Spark	Polish synoptic report.
1415	Nantes	UA	9,000	C.W.	U.R.S.I. signal.
1416	Cologne	GEK	1,680	C.W.	Hourly route report.
1419	Ostende	OPVO	1,680	C.W.	Hourly route report.
1420	Paris	FL	7,300	C.W.	French synoptic report.
1422	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
1428	Le Bourget	FNB	1,680	C.W.	Hourly route report.
1430	Mediouna	CNM	5,000	C.W.	Moroccan synoptic report.
1435	Monsanto	CTV	2,400	C.W.	Forecasts for Portugal.
1436	Air Ministry	GFA	1,680	C.W.	Hourly route report and forecast.
1440	Königswusterhausen	LP	5,700	C.W.	German synoptic report.
1445	Aïn-el-Turk	FUK	3,500	C.W.	Moroccan and Algerian synoptic report.
1450	Air Ministry	GFA	4,100	C.W.	European synoptic report.
1450	Königswusterhausen	LP	5,700	C.W.	European synoptic report.
1450	Le Bourget	FNB	1,680	C.W.	Eventual warnings.
1455	Sandhamns	OJA	5,700	C.W.	Finnish synoptic report.
1500	Antwerp	OSA	600	Spark	Navigational warnings.
1503	Valenciennes	FNV	1,680	C.W.	Hourly route report.
1505	Romilly	FNR	1,680	C.W.	Hourly route report.
1505	Königswusterhausen	LP	5,700	C.W.	European upper air report.
1505	Soesterberg	STB	1,900	C.W.	Upper air report.
1508	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
1510	New Holland (Petrograd)	RAC	1,600	Spark	Russian synoptic report.
1515	Casablanca	CNP	1,800	Spark	Moroccan synoptic report and forecasts.
1515	Cologne	GEK	1,680	C.W.	Hourly route report.
1519	Ostende	OPVO	1,680	C.W.	Hourly route report.
1520	Deutsch-Altenberg (Vienna)	OHD	5,600	C.W.	Austrian synoptic report.
1520	Sidi Abdallah	FUA	5,150	C.W.	North African synoptic report.
1522	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
1525	Metz	YC	1,450	C.W.	Eastern France synoptic report.
1528	Le Bourget	FNB	1,680	C.W.	Hourly route report.
1530	Carabanchel	EGC	2,000	Spark	Spanish synoptic report.
1530	Cullercoats	GCC	600	Spark	Navigational warnings.
1530	Fishguard	GRL	600	Spark	Navigational warnings.
1530	Port Patrick	GPK	600	Spark	Navigational warnings
1530	Prague	PRG	4,500	C.W.	Czecho-Slovakian synoptic report.

2315	Scheveningen	PCH	1,800	Spark	Special report for ma…
2355	Nauen	POZ	3,100	Spark	Time signal (Internati…
2355	Nauen	POZ	12,000	C.W.	Time signal (Internati…
2355	Pearl Harbour, Honolulu	NPM	11,500	C.W.	Time signals.

Radiotelephonic communication with aircraft in flight, on a wavelength of 900 … daily from the following stations :—

Brussels	Manchester	Castle Brom…
Ostend	Cologne	Renfrew
Croydon	Rotterdam	Geneva
Schipol (Amsterdam)	Lausanne	St. Inglevert…
Le Bourget	Sœsterberg	Lympne
Abbeville		

The following stations give almost continuous transmissions :—

Carnarvon	MUU	14,000	C.W.	Transatlantic traffic.
Devizes	GKU	2,100	C.W.	Marine traffic.
Stonehaven	GSW	4,600	C.W.	High speed commerc… (Berlin) ; LP replies…
Marion	WSO	11,500	C.W.	Transatlantic traffic.
Tuckerton	WGG	16,100	C.W.	Transatlantic traffic.
New Brunswick	WII	13,600	C.W.	Transatlantic traffic.
Glace Bay	GB	7,850	C.W.	Transatlantic traffic.
Tuckerton	WCI	16,800	C.W.	Transatlantic traffic.
Nauen	POZ	12,600	C.W.	Transatlantic traffic.
Eilvese	OUI	14,400	C.W.	Transatlantic traffic.
Stavanger	LCM	12,000	C.W.	Transatlantic traffic.
Long Island	WQK	16,465	C.W.	Transatlantic traffic.
Long Island	WQL	19,200	C.W.	Transatlantic traffic.
Ongar	GLB	3,800		Working with Paris, U…
Ongar	GLA	2,900		,, ,, Berne, B…
Ongar	GLO	4,350		,, ,, Madrid…
Saint Assise	UFT	15,000		,, Long I…

At the time of going to press, the traffic of Clifden. **MFT.** conducted on 5,7… suspended, owing to the damage done to this station.

BROADCASTING.

Regular Programmes are broadcast from the following European stations :—

Locality.	Call Sign.	Wave-length.	G.M.T.	Nature o…
GREAT BRITAIN.				
London	2 LO	369	Weekdays 1030 to 1130 1630 to 2200 Sundays 1930 to 2130	Regular m… programme… appear in… conducted… by the B… Company.
Manchester	2 ZY	385		
Birmingham	5 IT	420		
Cardiff	5 WA	353		
Newcastle	5 NO	400		
Glasgow	5 SC	415		
FRANCE.				
Paris (Eiffel Tower)	FL	2,600	Daily 0540	Meteorological …
			1015	Meteorological …
			1430	Financial bulle…
			1720	Meteorological …
			2110	Meteorological …
Levallois-Perret (Radiola)	SFR	1,780	Sundays 1300 to 1400	Concert.
			Weekdays 1145 to 1245	News and Conce…
			1605	Financial bullet…
			1615 to 1715	Instrumental m…
			1945	Miscellaneous n…
			2000 to 2130	Concert.
Ecole Supérieure des Postes et Télégraphes	—	450	Tuesday and Thursday 1845 to 2100 Saturday 1530 to 1830	Concert.
Radio-Riviera (Nice)	—	460	Daily 1000	News and conce…
			1600 to 1700	News and conce…

	wich	GEC	1,300	C.W.	Hourly route report.
	es	FNV	1,680	C.W.	Hourly route report.
		SXG	3,600	Spark	Greek synoptic report.
		GER	1,300	C.W.	Synoptic report.
		FNR	1,680	C.W.	Hourly route report.
	rt (Calais)	FNG	1,680	C.W.	Hourly route report.
		LUX	2,200	C.W.	Rhine region synoptic report.
		KAN	1,250	Spark	Synoptic report.
		FUC	3,300	C.W.	Synoptic report.
		KCB	1,200	Spark	Lettonian synoptic report.
	ven	FUL	1,250	Spark	North Sea synoptic report in plain language.
	sels)	OPO	1,680	C.W.	Hourly route report.
		YC	1,450	C.W.	Eastern France synoptic report.
		FUR	3,300	C.W.	S.W. France synoptic report.
	e	KAW	1,000	Spark	Synoptic report.
		FNB	1,680	C.W.	Hourly route report.
		BWW	4,000	C.W.	Synoptic report.
		BYG	4,500	C.W.	Synoptic report.
		STB	1,900	C.W.	Dutch synoptic report.
		OXE	3,650	C.W.	Danish synoptic report.
		YG	1,850	C.W.	Western France synoptic report.
		GFA	1,680	C.W.	Hourly route report.
		HFB	4,600	C.W.	Jugo Slavian synoptic report.
		SAJ	4,200	C.W.	Swedish synoptic report.
		AZA	1,900	Spark	Esthonian synoptic report.
		STB	1,680	C.W.	Hourly route report.
		GFA	1,400	C.W.	Calibration waves.
		GFA	900	C.W.	Calibration waves.
		LCH	8,000	C.W.	Norwegian synoptic report.
		FNB	1,680	C.W.	Forecasts for Paris-London-Brussels routes.
	erolles	FUQ	3,300	C.W.	Southern France synoptic report.
		YAQ	2,100	C.W.	Hourly route report.
		GFA	4,100	C.W.	British and Icelandic synoptic report.
		GFA	1,680	C.W.	Calibration waves.
		GLD	600	Spark	Navigational warnings.
		PQL	1,000	Spark	Portuguese synoptic report.
		YN	15,500	C.W.	Scientific time signals.
		GMH	600	Spark	Navigational warnings.
		GEM	1,300	C.W.	Hourly route report.
		UA	2,800	Spark	Navigational warnings.
		GNF	600	Spark	Navigational warnings.
		OST	600	Spark	Navigational warnings.
		GKR	600	Spark	Navigational warnings.
	ch	GEC	1,300	C.W.	Hourly route report.
		FNV	1,680	C.W.	Hourly route report.
		AZA	2,000	Spark	Esthonian synoptic report.
	Calais)	FNG	1,680	C.W.	Hourly route report.
		WAR	2,300	Spark	Polish synoptic report.
		OPVO	1,680	C.W.	Hourly route report.
	berg	OHD	5,600	C.W.	Austrian synoptic report.
		FL	7,300	C.W.	French synoptic report.
		OPO	1,680	C.W.	Hourly route report.
		FNB	1,680	C.W.	Hourly route report.
		GFA	1,680	C.W.	Hourly route report and forecasts.
	ausen	LP	5,700	C.W.	German synoptic report.
		CNP	1,800	Spark	Moroccan synoptic report and forecasts.
		CNM	5,000	C.W.	Moroccan synoptic report.
		STB	1,680	C.W.	Hourly route report.
	strau	BUC	7,500	C.W.	Rumanian synoptic report.
		GFA	4,100	C.W.	European synoptic report.
	ausen	LP	5,700	C.W.	European synoptic report.
		FNB	1,680	C.W.	Forecasts for Paris-Dijon-Lyons-Paris-Lausanne routes.
		OJA	5,700	C.W.	Finnish synoptic report.
		YN	15,500	C.W.	Time signal (French scheme).
		FUK	3,500	C.W.	Moroccan and Algerian synoptic reports.

1315	Cherbourg	FUC	3,300	C.W.	Synoptic report.
1316	Cologne	GEK	1,680	C.W.	Hourly route report.
1319	Ostende	OPVO	1,680	C.W.	Hourly route report.
1320	Wilhelmshaven	FUL	1,250	Spark	North Sea synoptic report in plain language.
1322	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
1325	Metz	YC	1,450	C.W.	Eastern France synoptic report.
1325	Rochefort	FUR	3,300	C.W.	S.W. France synoptic report.
1325	Swinemünde	KAW	1,000	Spark	Synoptic report.
1328	Le Bourget	FNB	1,680	C.W.	Hourly route report.
1330	Belgrade	HFB	4,600	C.W.	Jugo Slavian synoptic report.
1330	Terceira (Faleiras)	PQT	1,000	Spark	Azores synoptic report.
1330	Soesterberg	STB	1,900	C.W.	Dutch synoptic report.
1335	Lyngby	OXE	3,650	C.W.	Danish synoptic report.
1335	Tours	YG	1,850	C.W.	Western France synoptic report.
1336	Air Ministry	GFA	1,680	C.W.	Hourly route report.
1340	Karlsborg	SAJ	4,200	C.W.	Swedish synoptic report.
1344	Soesterberg	STB	1,680	C.W.	Hourly route report.
1350	Bucharest-Herestrau	BUC	7,500	C.W.	Rumanian synoptic report.
1350	Christiania	LCH	8,000	C.W.	Norwegian synoptic report.
1350	Mousanto	CTV	1,000	Spark	Azores synoptic report.
1350	Toulon-Porquerolles	FUQ	3,300	C.W.	Southern France synoptic report.
1355	Sofia	FF	3,500	Spark	Bulgarian synoptic report.
1400	Air Ministry	GFA	4,100	C.W.	British and Icelandic synoptic report.
1400	Land's End	GLD	600	Spark	Navigational warnings.
1400	Malin Head	GMH	600	Spark	Navigational warnings.
1400	North Foreland	GNF	600	Spark	Navigational warnings.
1400	Wick	GKR	600	Spark	Navigational warnings.
1403	Valenciennes	FNV	1,680	C.W.	Hourly route report.
1408	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
1415	Warsaw	WAR	2,300	Spark	Polish synoptic report.
1415	Nantes	UA	9,000	C.W.	U.R.S.I. signal.
1416	Cologne	GEK	1,680	C.W.	Hourly route report.
1419	Ostende	OPVO	1,680	C.W.	Hourly route report.
1420	Paris	FL	7,300	C.W.	French synoptic report.
1422	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
1428	Le Bourget	FNB	1,680	C.W.	Hourly route report.
1430	Mediouna	CNM	5,000	C.W.	Moroccan synoptic report.
1435	Monsanto	CTV	2,400	C.W.	Forecasts for Portugal.
1436	Air Ministry	GFA	1,680	C.W.	Hourly route report and forecast.
1440	Königswusterhausen	LP	5,700	C.W.	German synoptic report.
1445	Aïn-el-Turk	FUK	3,500	C.W.	Moroccan and Algerian synoptic report.
1450	Air Ministry	GFA	4,100	C.W.	European synoptic report.
1450	Königswusterhausen	LP	5,700	C.W.	European synoptic report.
1450	Le Bourget	FNB	1,680	C.W.	Eventual warnings.
1455	Sandhamns	OJA	5,700	C.W.	Finnish synoptic report.
1500	Antwerp	OSA	600	Spark	Navigational warnings.
1503	Valenciennes	FNV	1,680	C.W.	Hourly route report.
1505	Romilly	FNR	1,680	C.W.	Hourly route report.
1505	Königswusterhausen	LP	5,700	C.W.	European upper air report.
1505	Soesterberg	STB	1,900	C.W.	Upper air report.
1508	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
1510	New Holland (Petrograd)	RAC	1,600	Spark	Russian synoptic report.
1515	Casablanca	CNP	1,800	Spark	Moroccan synoptic report and forecasts.
1515	Cologne	GEK	1,680	C.W.	Hourly route report.
1519	Ostende	OPVO	1,680	C.W.	Hourly route report.
1520	Deutsch-Altenberg (Vienna)	OHD	5,600	C.W.	Austrian synoptic report.
1520	Sidi Abdallah	FUA	5,150	C.W.	North African synoptic report.
1522	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
1525	Metz	YC	1,450	C.W.	Eastern France synoptic report.
1528	Le Bourget	FNB	1,680	C.W.	Hourly route report.
1530	Carabanchel	EGC	2,000	Spark	Spanish synoptic report.
1530	Cullercoats	GCC	600	Spark	Navigational warnings.
1530	Fishguard	GRL	600	Spark	Navigational warnings.
1530	Port Patrick	GPK	600	Spark	Navigational warnings
1530	Prague	PRG	4,500	C.W.	Czecho-Slovakian synoptic report.

2315	Scheveningen	PCH	1,800	Spark	Special report for mariners.
2355	Nauen	POZ	3,100	Spark	Time signal (International scheme).
2355	Nauen	POZ	12,000	C.W.	Time signal (International scheme).
2355	Pearl Harbour, Honolulu	NPM	11,500	C.W.	Time signals.

Radiotelephonic communication with aircraft in flight, on a wavelength of 900 metres, is carried on daily from the following stations :—

Brussels	Manchester	Castle Bromwich
Ostend	Cologne	Renfrew
Croydon	Rotterdam	Geneva
Schipol (Amsterdam)	Lausanne	St. Inglevert (Calais)
Le Bourget	Sœsterberg	Lympne
Abbeville		

The following stations give almost continuous transmissions :—

Carnarvon	**MUU**	14,000	C.W.	Transatlantic traffic.
Devizes	**GKU**	2,100	C.W.	Marine traffic.
Stonehaven	**GSW**	4,600	C.W.	High speed commercial traffic with **LP** (Berlin) ; **LP** replies on 5,250 metres.
Marion	**WSO**	11,500	C.W.	Transatlantic traffic.
Tuckerton	**WGG**	16,100	C.W.	Transatlantic traffic.
New Brunswick	**WII**	13,600	C.W.	Transatlantic traffic.
Glace Bay	**GB**	7,850	C.W.	Transatlantic traffic.
Tuckerton	**WCI**	16,800	C.W.	Transatlantic traffic.
Nauen	**POZ**	12,600	C.W.	Transatlantic traffic.
Eilvese	**OUI**	14,400	C.W.	Transatlantic traffic.
Stavanger	**LCM**	12,000	C.W.	Transatlantic traffic.
Long Island	**WQK**	16,465	C.W.	Transatlantic traffic.
Long Island	**WQL**	19,200	C.W.	Transatlantic traffic.
Ongar	**GLB**	3,800		Transatlantic traffic.
Ongar	**GLA**	2,900		Working with Paris, **UFP** 2,300.
Ongar	**GLO**	4,350		„ „ Berne, **HBB** 3,400.
Saint Assise	**UFT**	15,000		„ „ Madrid, **EAA** 3,600.
				„ .. Long Island, **WQL** 19,200.

At the time of going to press, the traffic of Clifden. **MFT**, conducted on 5,780 metres C.W., is suspended, owing to the damage done to this station.

BROADCASTING.

Regular Programmes are broadcast from the following European stations :—

Locality.	Call Sign.	Wave-length.	G.M.T.	Nature of Transmission.
GREAT BRITAIN.				
London	**2 LO**	369	Weekdays	Regular morning and evening programmes, particulars of which appear in the daily Press, are conducted from these stations by the British Broadcasting Company.
Manchester	**2 ZY**	385	1030 to 1130	
Birmingham	**5 IT**	420	1630 to 2200	
Cardiff	**5 WA**	353	Sundays	
Newcastle	**5 NO**	400	1930 to 2130	
Glasgow	**5 SC**	415		
FRANCE.				
Paris (Eiffel Tower)	**FL**	2,600	Daily	
			0540	Meteorological forecasts.
			1015	Meteorological report and forecast.
			1430	Financial bulletin (Paris Bourse).
			1720	Meteorological forecast and concert.
			2110	Meteorological report and forecast.
Levallois-Perret (Radiola) ..	**SFR**	1,780	Sundays	
			1300 to 1400	Concert.
			Weekdays	
			1145 to 1245	News and Concert.
			1605	Financial bulletin.
			1615 to 1715	Instrumental music.
			1945	Miscellaneous news.
			2000 to 2130	Concert.
Ecole Supérieure des Postes et Télégraphes	—	450	Tuesday and Thursday 1845 to 2100	Concert.
			Saturday 1330 to 1830	
Radio-Riviera (Nice)	—	460	Daily	
			1000	News and concert.
			1600 to 1700	News and concert.

0903	Valenciennes	FNV	1,680	C.W.	Hourly route report.
0905	Königswusterhausen	LP	5,700	C.W.	European upper air report.
0905	Soesterberg	STB	1,900	C.W.	Upper air report.
0905	Romilly	FNR	1,680	C.W.	Hourly rourte report.
0908	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
0910	Csepel (Budapest)	HB	4,400	C.W.	Hungarian synoptic report.
0910	Cullercoats	GCC	600	Spark	Navigational warnings.
0910	Fishguard	GRL	600	Spark	Navigational warnings.
0910	Mayence	LUX	2,200	C.W.	Rhine region synoptic report.
0910	NewHolland(Petrograd)	RAC	2,000	Spark	Russian synoptic report.
0910	Port Patrick	GPK	600	Spark	Navigational warnings.
0910	Valencia	GCK	600	Spark	Navigational warnings.
0915	Air Ministry	GFA	4,100	C.W.	General Inference for 0700 (plain language).
0915	Toulon-Porquerolles	FUQ	1,350	Spark	Synoptic report and forecast in plain language (French).
0916	Cologne	GEK	1,680	C.W.	Hourly route report.
0919	Ostende	OPVO	1,680	C.W.	Hourly route report.
0920	Sidi Abdallah	FUA	5,150	C.W.	North African synoptic report.
0922	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route reportitonal scheme).
0925	Paris	FL	2,600	Spark	Time signal (Interna
0928	Le Bourget	FNB	1,680	C.W.	Hourly route report.
0930	Carabanchel	EGC	2,000	Spark	Spanish synoptic report.
0930	Prague	PRG	4,500	C.W.	Czecho-Slovakian synoptic report.
0930	Rome	ICC	11,000	C.W.	Italian synoptic report.
0930	Rome Centocelle	ICD	2,250	Spark	Italian synoptic report.
0930	Tours	YG	1,850	C.W.	Western France synoptic report
0935	Metz	YC	1,450	C.W.	Eastern France synoptic report.
0936	Air Ministry	GFA	1,680	C.W.	Hourly route report.
0944	Soesterberg	STB	1,680	C.W.	Hourly route report.
0950	Monsanta (Portugal)	CTV	2,400	C.W.	Portuguese synoptic report.
0950	Bergen	LGN	1,850	C.W.	General Inference for 0700 and forecasts in (code).
0955	Balboa (Panama)	NBA	10,100	C.W.	Time signals.
1000	Paris	FL	2,600	Spark	Scientific time signal.
1005	Paris	FL	2,600	Spark	European synoptic report.
1003	Valenciennes	FNV	1,680	C.W.	Hourly route report.
1005	Renfrew	GER	1,300	C.W.	Synoptic report.
1005	Romilly	FNR	1,080	C.W.	Hourly route report.
1008	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
1010	Mayence	LUX	2,200	C.W.	Rhine region synoptic report.
1015	Norddeich	KAV	600	Spark	Synoptic report and forecast for the North Sea.
1016	Cologne	GEK	1,680	C.W.	Hourly route report.
1019	Ostende	OPVO	1,680	C.W.	Hourly route report.
1022	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
1025	Metz	YC	1,450	C.W.	Eastern France synoptic report.
1025	Rochefort	FUR	3,300	C.W.	S.W. France synoptic report.
1028	Le Bourget	FNB	1,680	C.W.	Hourly route report.
1030	Swinemünde	KAW	600	Spark	Synoptic report and forecast for the Baltic.
1035	Paris	FL	2,600	Spark	U.R.S.I. Signals

1530	Valencia	GCK	600	Spark	Navigational warnings.
1536	Air Ministry	GFA	1,680	C.W.	Hourly route report.
1550	Le Bourget	FNB	1,680	C.W.	Eventual warnings.
1550	Brussels (Haren Aero).	—	1,100	—	Weather report.
1600	Ostende	OST	600	Spark	Navigational warnings.
1600	Paris	FL	7,300	C.W.	European synoptic report.
1600	Manchester	GEM	1,300	C.W.	Hourly route report.
1602	Castle Bromwich	GEC	1,300	C.W.	Hourly route report.
1603	Valenciennes	FNV	1,680	C.W.	Hourly route report.
1605	Renfrew	GER	1,300	C.W.	Synoptic report.
1608	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
1619	Ostende	OPVO	1,680	C.W.	Hourly route report.
1622	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
1628	Le Bourget	FNB	1,680	C.W.	Hourly route report.
1636	Air Ministry	GFA	1,680	C.W.	Hourly route report.
1645	Swinemunde	KAW	1,000	Spark	Synoptic report.
1650	Le Bourget	FNB	1,680	C.W.	Eventual warnings.
1655	Washington	NAA	2,500	Spark	Time signal (American scheme).
1655	Annapolis	NSS	17,145	C.W.	Time signal (American scheme).
1700	Manchester	GEM	1,300	C.W.	Hourly route report.
1702	Castle Bromwich	GEC	1,300	C.W.	Hourly route report.
1750	Lausanne	—	1,650	Telephony	Weather report for Switzerland.
1755	Balboa (Panama)	NBA	10,100	C.W.	Time signals.
1800	Manchester	GEM	1,300	C.W.	Hourly route report.
1802	Castle Bromwich	GEC	1,300	C.W.	Hourly route report.
1803	Valenciennes	FNV	1,680	C.W.	Hourly route report.
1805	Renfrew	GER	1,300	C.W.	Synoptic report.
1808	Romilly	FNR	1,680	C.W.	Hourly route report.
1808	St. Inglevert (Calais)	FNG	1,680	C.W.	Hourly route report.
1810	Mayence	LUX	2,200	C.W.	Rhine region synoptic report.
1815	Borkum	KAN	1,250	Spark	Synoptic report.
1815	Cherbourg	FUC	3,300	C.W.	Synoptic report.
1820	Paris	FL	2,600	Telephony	District forecasts (Sundays included).
1820	Wilhelmshaven	FUL	1,250	Spark	North Sea synoptic report in plain language.
1822	Uccle (Brussels)	OPO	1,680	C.W.	Hourly route report.
1825	Metz	YC	1,450	C.W.	Eastern France synoptic report.
1825	Rochefort	FUR	3,300	C.W.	S.W. France synoptic report.
1825	Swinemünde	KAW	1,000	Spark	Synoptic report.
1830	Belgrade	HFB	4,600	C.W.	Jugo Slavian synoptic report.
1830	Terceira (Faleiras)	PQT	1,000	Spark	Azores synoptic report.
1830	Soesterberg	STB	1,900	C.W.	Dutch synoptic report.
1835	Lyngby	OXE	3,650	C.W.	Danish synoptic report.
1835	Tours	YG	1,850	C.W.	Western France synoptic report.
1840	Gibraltar	BWW	4,800	C.W.	Synoptic report.
1840	Karlsborg	SAJ	4,200	C.W.	Swedish synoptic report.
1850	Bucharest-Herestrau	BUC	7,500	C.W.	Rumanian synoptic report.
1850	Christiania	LCH	8,000	C.W.	Norwegian synoptic report.
1850	Malta	BYZ	4,500	C.W.	Synoptic report.

			2000 to 2100 News and concert.
Lyon (La Doua)	YN	3,200	Daily 0945 to 1045 Concert. 1435 Financial Bulletin for Aviators.
HOLLAND.			
The Hague	PCGG	1,050	Sunday 1400 to 1600 Concert. Monday and Thursday 1940 to 2040 Concert.
The Hague (Heussen Laboratory)	PCUU	1,050	Tuesday 1845 to 2100 Concert. Sunday 0840 to 0940 —
The Hague (Velthuyzen)	PCKK	1,050	Friday 1940 to 2040 Miscellaneous.
Ijmuiden	PCMM	1,050	Saturday 1940 to 2040 Concert.
Amsterdam	PA5	1,050	Wednesday 1910 to 2010 Concert and news
BELGIUM.			
Brussels	—	1,100	Working days 1100 Meteorological bu Daily 1550 Meteorological bu Sunday 1700 Concert. Tuesday and Thursday 2000 Concert.
GERMANY.			
Berlin (Koenigswusterhausen)	LP	2,800	Daily 0700 to 0800 Financial and c 1100 to 1230 Financial and c 1600 to 1730 Financial and c Tuesday and Thursday 1830 to 1930 Concert.
Eberswalde	—	2,950	Sunday 1600 to 1900 Lectures, addre
CZECHO-SLOVAKIA.			
Prague	PRG	1,800	0700, 1100 and 1500 Meteorologica
		4,500	0900, 1400 and 2100 Concert.
SWITZERLAND.			
Geneva	HB1	1,200	Daily 1700 to 1800 Concert ("Util
Lausanne	HB 2	—	1700 to 1800 Concert ("Util

NOVEL IDEAS AND INVENTIONS

Abstracted by Philip R. Coursey, B.Sc., F.Inst.P., A.M.I.E.E.

1.—Transmission on Short Wavelengths.

When attempts are made to transmit signals on short wavelengths many experimenters find difficulty either in tuning the aerial to the required wavelength, or in getting sufficient current into the aerial to obtain any useful radiation. Sometimes, too, difficulty is experienced in obtaining oscillations at all from the valve transmitter when attempts are made to work on 200 metre waves, or less. This latter difficulty is one that arises mainly through incorrect proportioning of the various parts of the circuit to one another.

A recent patent taken out by a German radio company may prove helpful in this connection, besides providing another field for experiment.* The main idea of the proposal is that no attempt should be made to get the actual C.W. generator—*i.e.*, the valve—to oscillate down on the short wavelength which it is desired to transmit, but to let it oscillate at somewhere about double or treble this wave. The actual aerial should, of course, be tuned to the wavelength to be transmitted—and up to this point there is no particular novelty in the invention, as it has frequently been proposed to tune the aerial to a harmonic of the generator frequency. The novelty of the idea lies in adding to the aerial circuit another closed circuit which is also tuned to the wavelength of the transmission. This circuit serves to hold the frequency of the aerial constant at that corresponding to the wave to be transmitted, independently of the frequency of the C.W. source.

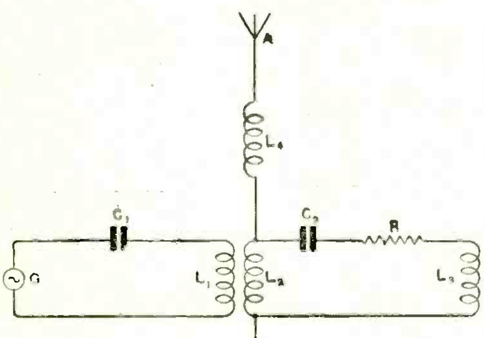


Fig. 1.

An open radiating circuit like an aerial, having capacity and inductance *distributed* along the aerial wires, is much more readily caused to oscillate at a harmonic of the frequency of the source, than is a closed oscillation circuit in which the capacity and inductance are *lumped* into definite parts of the circuit. Hence, even if the aerial is tuned to a harmonic of the oscillator frequency it will have a tendency to radiate at the frequency of the source rather than at its own, but the addition of the closed circuit serves to stabilise matters.

In Fig. 1 the arrangement is sketched. In this diagram the C.W. source is represented diagrammatically by G, and its oscillation circuit—which is tuned to the longer wavelength of about twice that to be transmitted—by L_1 C_1.

The main aerial circuit is A L_4 L_2 E, and this is tuned to the wave to be transmitted. The auxiliary closed circuit is $L_2C_2RL_3$, which also is tuned to the wave to be transmitted, R being a resistance which is preferably made about equal to the effective high-frequency resistance of the aerial itself.

The C.W. source G would, obviously, be the ordinary valve oscillator; but the method would apparently be more useful when applied to an arc transmitter, as there is much greater difficulty in obtaining oscillations of short wavelength from an arc than those of long wavelengths. In any case, however, it would appear to provide a useful field for experiment with short wave valve transmitters.

2.—A New Method of Receiving Radio Signals.

The reception of wireless signals without detectors, valves, telephones, or any of the usual adjuncts of the ordinary radio receiver has become possible by a discovery made by W. F. Einthoven. The string galvanometer bearing his name, in its ordinary form is of use only for physical measurements or for laboratory work on radio signals. It responds only to low frequency currents, or the slow

* British Patent No. 182762, by R. Herzog and the C. Lorenz Co.

current changes obtained by rectifying radio signals by a crystal detector or some similar rectifier. Einthoven has found it possible* to construct a fibre of quartz small enough to tune to the actual radio frequency of the signalling waves, so that when such a fibre is placed in a magnetic field and the received radio-frequency current is passed directly through it, it will vibrate while the signal lasts. By means of a suitable microscope the movements of the fibre can be rendered visible, and projected on to a screen for observation or photographic recording.

With a quartz string 1 millimetre long and one-thousandth of a millimetre in diameter, a tension of 20 milligrams suffices to tune it to a frequency of 300,000 cycles, which corresponds to a wavelength of 1,000 metres.

The actual quartz fibre is enclosed in a vacuum so that air friction is reduced to a negligible quantity, and the damping of the vibrations of the string can then be made very small—much smaller in fact than the damping of any ordinary electrical oscillation circuit. As a result of this the arrangement becomes very much more selective than any ordinary electrical tuning means; although, if required, the damping can be increased sufficiently to enable high speed Morse signals to be received up to several hundred words per minute.

* British Patent No. 187971, by Nederlandsch Indië, assignees of W. F. Einthoven.

3.—Reducing the Resonance Effect in Loud Speaker Horns.

Anyone who possesses, or who has seen a Brown loud speaker with one or more holes drilled in its horn, may have wondered at the reasons therefor. A recent patent issued to S. G. Brown discloses the purpose of such apertures.* By their use the pressure of the air vibrations forming the sound is relieved at points where reflections may occur from the walls. These "nodal" points occur at one-half, one quarter, one eighth, etc., of the length of the horn from its smaller end, and holes may with advantage be made at these points. A purer reproduction of the sounds thus becomes possible, with less resonance effects due to the horn. The construction of a horn with its smaller part of cast metal, and its larger portion or mouth of spun metal is also covered by the same patent.

* British Patent No. 194510, by S. G. Brown.

How to Find the Wavelength of Circuits.

WHEN dealing with radio circuits, it is generally more convenient to deal with wavelength rather than frequency. Since the velocity of electromagnetic waves is 300,000,000 metres per second, and the wavelength is equal to velocity divided by frequency it follows that in place of

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

$$\lambda = 1884\sqrt{LC}$$ where

λ = wavelength in metres,
L = inductance in microhenries (μH),
and C = capacity in microfarads (mfds.).

This is the formula commonly used in wavelength calculations.

From this formula it is easily seen that since the frequency or wavelength depends upon a constant times $\sqrt{LC}$, the quantities L or C may have any value provided their product is unaltered. It is therefore an easy matter to construct a table showing the value of the product of L and C for any wavelength. Such a table is given in Table I. Here the wavelength is in metres, C is in microfarads, and L *is in centimetres.* One microhenry is equal to 1,000 centimetres.

With the aid of the table one is able to find the wavelength to which a coil and condenser will tune without using the wavelength formula at all, or one can find the correct value of capacity and inductance to tune to a given wavelength.

Thus suppose one wishes to tune to 380 metres. Looking at the table, 380 metres corresponds with an $L \times C$ value of 40·7. If one decides to use an Igranic coil, say No. 50, we look up a table for its inductance, which is 134 microhenries or 134,000 centimetres. The capacity which must be used across this coil is then $\frac{40\cdot7}{134{,}000}$ or 0·0003 microfarads, which is well within the range of a variable condenser having a maximum value of 0·0005 mfds.

As another example to make the use of the table quite clear, suppose it has been decided to use a variometer to bring the aerial circuit into resonance with the signal we desire to receive. The capacity of an ordinary aerial may be reckoned as equivalent to a fixed condenser of 0·0003 mfds. A well-known variometer which may be purchased has a minimum inductance value of 54 μH, or 54,000 cms., and a maximum value of 530 μH or 530,000 cms. The product of *LC* in one case is 16·2. Looking up the tables the wavelength most nearly corresponding to this value is 240 metres. This is the minimum wavelength to which the circuit will tune. The maximum wavelength corresponds with the product of 530,000 × 0·0003 or 159 in the tables, and is seen to be 750 metres. The variometer used in conjunction with an aerial will therefore tune to all wavelengths between 240 and 750 metres. W. J.

Showing the wavelength corresponding to various values of capacity and inductance. Capacity is in microfarads and inductance in centimetres. One microhenry is equal to 1,000 cms. of inductance.

λ Wave length metres	*CL* C in μf L in cm	λ Wave length metres	*CL* C in μf L in cm	λ Wave length metres	*CL* C in μf L in cm	λ Wave length metres	*CL* C in μf L in cm	λ Wave length metres	*CL* C in μf L in cm
5	·0057	195	10·71	470	62·3	830	194·0	2000	1126
10	·0282	200	11·26	480	64·8	840	198·5	2050	1183
15	·0635	205	11·83	490	67·6	850	203·4	2100	1241
20	·1129	210	12·41	500	70·4	860	208·2	2150	1301
25	·1755	215	13·01	510	73·3	870	213·2	2200	1362
30	·2530	220	13·62	520	76·0	880	217·9	2250	1425
35	·3446	225	14·25	530	79·0	890	222·9	2300	1489
40	·450	230	14·89	540	82·1	900	228·0	2350	1555
45	·570	235	15·55	550	85·2	910	233·2	2400	1622
50	·704	240	16·22	560	88·4	920	238·1	2450	1690
55	·852	245	16·90	570	91·4	930	243·4	2500	1760
60	1·014	250	17·60	580	94·7	940	248·7	2550	1831
65	1·188	255	18·31	590	98·0	950	254·1	2600	1903
70	1·378	260	19·03	600	101·4	960	259·5	2650	1977
75	1·583	265	19·77	610	104·7	970	264·7	2700	2052
80	1·801	270	20·52	620	108·2	980	270·4	2750	2129
85	2·034	275	21·29	630	111·7	990	275·9	2800	2207
90	2·280	280	22·07	640	115·4	1000	281·6	2850	2287
95	2·541	285	22·87	650	118·8	1050	310·5	2900	2366
100	2·816	290	23·66	660	122·5	1100	340·4	2950	2450
105	3·105	295	24·50	670	126·3	1150	372·1	3000	2533
110	3·404	300	25·33	680	130·2	1200	405	3500	3448
115	3·721	310	27·05	690	134·1	1250	440	4000	4500
120	4·05	320	28·83	700	137·8	1300	476	4500	5700
125	4·40	330	30·66	710	141·9	1350	513	5000	7040
130	4·76	340	32·55	720	145·9	1400	552	5500	8520
135	5·13	350	34·48	730	150·0	1450	592	6000	10140
140	5·52	360	36·48	740	154·0	1500	634	6500	11880
145	5·92	370	38·54	750	158·3	1550	676	7000	13780
150	6·34	380	40·7	760	162·6	1600	720	7500	15830
155	6·76	390	42·8	770	166·8	1650	766	8000	18010
160	7·20	400	45·0	780	171·4	1700	813	9000	22800
165	7.66	410	47·3	790	175·6	1750	862	10000	28160
170	8·13	420	49·7	800	180·1	1800	912	15000	63400
175	8·62	430	52·0	810	184·7	1850	963	20000	112600
180	9·12	440	54·5	820	189·3	1900	1016	25000	176000
185	9·63	450	57·0			1950	1071	30000	253300
190	10·16	460	59·6						

INSTRUCTIONAL ARTICLE FOR THE LISTENER-IN AND EXPERIMENTER.

WIRELESS THEORY—XI.

It is the purpose of the writer to deal with the principles underlying the action of wireless receivers and transmitters. Those who know *why*, obtain much pleasure which is not experienced by those who have no idea of the action of their wireless set.

The series has been specially arranged so that the reader who follows each section as it appears will have obtained a complete wireless education with a minimum of time and trouble, and he will be in a position to successfully design his own wireless equipment.

In previous sections the writer has dealt with the principles of electricity such as the effect of resistance, capacity and inductance. The last sections deal with alternating current work and the properties of resistance, inductance and capacity in series and parallel, the study of which is so important to those who desire a clear understanding of wireless.

By W. JAMES.

29.—Properties of a Series Resonant Circuit.

THE outstanding property of a series circuit which is in resonance with an alternating pressure is that the circuit offers a very low resistance to the flow of current. Although the reactance of the coil and the condenser may be very high, yet only resistance limits the magnitude of the current flow. It is for this reason that a series circuit is sometimes called an *acceptor circuit*.

If we plot a curve showing the relationship between the reactance of an inductance in ohms and the frequency, a straight line is obtained as at A, Fig. 63. The reactance being equal to $2\pi fL$ ohms, when f is zero, the reactance is zero. Increases in frequency cause corresponding increases in reactance, hence a straight line results when reactance and frequency are plotted.

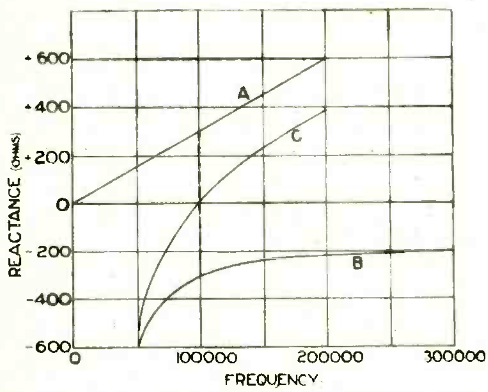


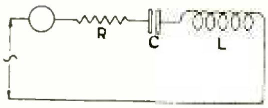
Fig. 63. Curves A and B represent the reactances of a coil and condenser at various frequencies. When both are connected together in a series circuit, the resultant reactance is given by curve C. The point where C crosses the zero reactance line is the resonant frequency of the circuit.

Curve B shows the relationship between capacity reactance and frequency. The reactance of a condenser is equal to $\frac{1}{2\pi fC}$ ohms. When the frequency is zero, the reactance is infinitely great; while when the frequency is very great the reactance is very small. The shape of the curve is determined by the reactance being a fraction of $\frac{1}{f}$. It is plain that for a given change in f, for small values of f the reactance changes considerably, while with a large value of f, the reactance will only change slightly.

The reactance above the horizontal line may be considered positive, and that below negative, since capacitative and inductive reactance tend to neutralise. Adding them together produces curve C. It will be noticed curve C crosses the horizontal line at a frequency of 100,000 cycles. This frequency would be the resonant frequency of the series circuit with a capacity and inductance of the values used in the construction of the curves, the reactance at this point being zero. The current which flows at this frequency is a maximum. For lower frequencies the capacity reactance predominates as shown by curve C lying below the horizontal line; at higher frequencies the inductance is more effective in reducing the current flow.

The Effect of Resistance.

If we have a series circuit, Fig. 64, and apply a pressure with a fixed frequency, a curve may be plotted showing the variation in current with the capacity of the condenser. With small values of capacity the current is small, and as the capacity is increased the current increases, until when the condenser has such a value that together with the coil the circuit is in resonance with the applied pressure, the current is a maximum. This is shown in the resonance curves of Fig. 64. Considering curve A, the maximum value of the current is equal to $I = \frac{E}{R}$ amperes. If the pressure is 10 volts and the resistance 2 ohms, the peak value of the current is 5 amperes. Curve B may be drawn in the same way, but here it is assumed the resistance present



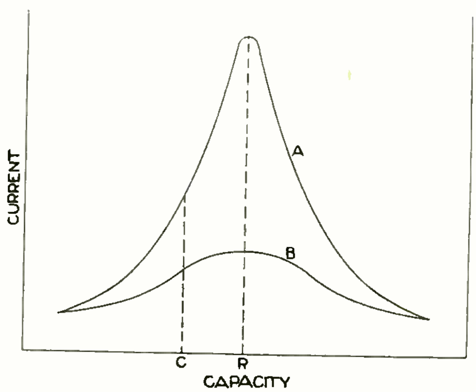


Fig. 64. The curves below show the current which flows in a series circuit when (A) the value of resistance is small, and (B) when the resistance has a higher value. The frequency of the applied pressure remains fixed and the capacity is varied.

in the circuit has a higher value. If it has a value of 10 ohms, the maximum current is 1 ampere. The point to be emphasised is that not only does resistance reduce the current flowing in the circuit at resonance, but the top of the *curve is much flatter*. In other words, a given change in the value of the capacity will make a much smaller relative change in the current. Thus, referring to point C: suppose the capacity is reduced from R mfds. to C mfds., in the case of curve A the current has been reduced to about one-third, while in the case of curve B the current is but slightly reduced.

An example will make this clear.

Case 1. Let $R = 2$ ohms, $E = 10$ volts, $C = 0{\cdot}001\ \mu$F, $L = 2533\ \mu$H. The resonance frequency is 100,000 cycles. At resonance,

$$I = \frac{E}{R} \text{ or } \frac{10}{2} = 5 \text{ amperes.}$$

Suppose the capacity is reduced to $0{\cdot}0008\mu$F.

With the frequency of the applied pressure as before—

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

$$\therefore \quad I = \frac{10}{\sqrt{4 + (1592 - 1990)^2}}$$

$$= \frac{10}{20} \text{ or } 0.5 \text{ amperes nearly.}$$

By reducing the capacity from 0·001 to 0·0008, the current has fallen from 5 amperes to 0·5 amperes. The pressure across the coil at resonance was ωLI or $5 \times 1589 = 7945$ volts. The pressure across the coil when the capacity is reduced is 794·5 volts.

Case 2. Let the values be as before, except that the resistance is 20 ohms. The current at resonance is $\frac{10}{20} = 0{\cdot}5$ ampere.

With the capacity reduced to 0·0008 mfds., the current will be $\frac{10}{\sqrt{400 + (1592 - 1990)^2}}$ or nearly 0·22 amperes.

The pressure drop across the coil at resonance is 794·5 volts. When the capacity is reduced to 0·0008 mfds. the drop is reduced to 349·6 volts. Comparing the two cases; with the circuits in resonance, when the resistance was 2 ohms we had a current of 5 amperes, while with a 20 ohm resistance the resonance current was only 0·5 amperes.

In Case 1, the reduction in the capacity of the condenser caused the current to fall from 5 amperes to 0·5 amperes, or it fell to 1/10th its value. In the second case the current fell from 0·5 amperes to 0·22 amperes, or to about half its peak value.

The effect of resistance is thus shown to be a serious matter. *When a circuit is required which will tune sharply to a given wavelength, the resistance must be kept to as small a value as possible. Then a slight change in the value of the tuning condenser will reduce the current flowing in the circuit by a large amount.* One is then able to closely tune to a station. Signals with a slightly different wavelength will only cause a small current to flow in the circuit compared with the magnitude of the current due to a signal which is exactly in tune with the circuit. When appreciable resistance is present, signals whose wavelengths are close to that of the signal it is desired to receive will produce a current in the circuit with a considerable amplitude compared with the amplitude of the current due to the required signal. It will not be possible to tune out unwanted signals with small variations in the tuning of the circuit.

Effect of Tuning by Varying the Capacity or Inductance.

It is common practice to vary the resonant frequency of circuits by changing the capacity. In the case of a series circuit, if we assume the applied pressure has a constant frequency, the shape of the resonance curve is not symmetrical. It will be seen that this must be so since while the curve A, Fig. 63, representing the reactance of the coil is a straight line, the curve representing capacity reactance B is not a straight line. Therefore the curves of Fig. 64 are not symmetrical; that is, the amplitude of the current for a given change below and above the resonance value is not the same. Referring to Case 1 in the above example, if the capacity was raised from 0·001 to 0·0012, instead of being reduced from 0·001 to 0·0008, the current

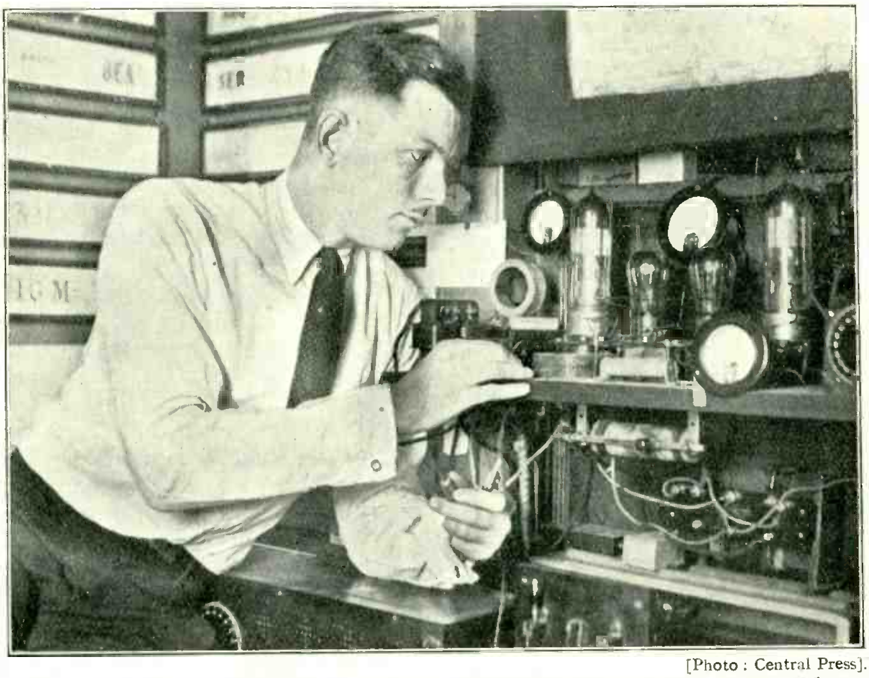
$$I = \frac{10}{\sqrt{4 + (1592 - 1326)^2}}$$

The difference between the inductive and capacitative reactances is now 266 ohms, while in Case 1 the difference is 398 ohms.

The lack of symmetry of the resonance curves through tuning with a variable condenser is not considered to produce any serious ill effect.

When tuning is accomplished through a variation in the inductance, the resonance curve is quite symmetrical, that is, a given change in the inductive value, either increase or decrease from the resonant value, will produce the same reduction in current.

Winner of Highest Award for Amateur Station Working in America.



[Photo : Central Press].

The Hoover Cup, awarded annually to the owner of America's best amateur radio station, this year went to Frederick R. Ostman of 180, Broad Street, Ridgewood, N.J. He operates station 2 OM, and is shown above with his apparatus. The award was made by a committee of three judges selected by Hiram Percy Maxim, President of the American Radio Relay League. This trophy is the highest honour among wireless experimenters in America and is awarded by the Department of Commerce through Secretary Hoover to the best all-round amateur station, the major part of which is home-made.

Wireless Club Reports.

NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter and worded as concisely as possible, the Editor reserving the right to edit and curtail the reports if necessary. **The Editor will be pleased to consider for publication papers read before Societies. An Asterisk denotes affiliation with the Radio Society of Great Britain.**

Correspondence with Clubs should be addressed to the Secretaries direct in every case unless otherwise stated.

The Radio Society of Willesden.*

A successful meeting of the Society took place on May 22nd, when an animated discussion took place regarding the Society's summer programme. As a result it was decided to organise visits, if possible, to places of general interest to radio experimenters The provision of wireless dances is in contemplation.

Hon. Sec., F. H. H. Coote, 183, Carlton Vale, Kilburn, N.W.6.

The Wireless Society of Hull and District.*

A well-sustained and instructive discussion on variometer tuning took place on May 18th.

The Hon. Secretary is at present engaged in drawing up a syllabus for the summer months, and offers of lectures (elementary or otherwise) will be welcomed.

The meetings are now held every Friday at 7.30 p.m., at the Co-operative Social Institute, Jarratt Street. Intending members should communicate with the Hon. Sec., H. Nightscales, 47, Wenlock Street, Hull.

The Ilford and District Radio Society.*

"Ebonite" was the subject of a lecture given by Mr. A. P. Welch on May 17th. The lecturer described the various stages through which the raw rubber passed prior to emerging as finished ebonite. He emphasised the importance of removing the surface of new ebonite before its use for wireless instruments.

Hon. Sec., A. E. Gregory, 77, Khedive Road, Forest Gate, E.7.

Tottenham Wireless Society.*

On Wednesday, May 23rd, Mr. F. Haynes, Assist. Editor of *The Wireless World and Radio Review*, gave a lecture to the above Society on "Electro-Static Loud Speakers." The lecturer dealt with the principles of this class of loud speaking apparatus, and described in detail their construction. The design was distinctly novel and interesting, and operation of the parts was so clearly described that many experimenters may feel tempted to undertake the building up of such an instrument.

The Hon. Secretary will be pleased to forward particulars to anyone desirous of joining the Society.

Hon. Sec., S. J. Glyde, 137, Winchelsea Road, Tottenham, N.17.

Harpenden Radio Society.*

By courtesy of the British Broadcasting Company, Ltd., members were recently enabled to inspect the transmitting apparatus at Marconi House, afterwards visiting the Company's studio at 2, Savoy Hill, where acquaintance was made with Mr. Arthur Burrows in the flesh.

Other activities of the Society, apart from the regular meetings for lectures and practical work, have included an expedition to the London Terminal Air Station at Croydon.

Hon. Sec., P. A. Anscombe, Wellington House, Harpenden.

The Stoke-on-Trent Wireless and Experimental Society.*

Mr. T. R. Clark (Vice-Chairman), on May 24th, gave an interesting lecture on "Adding a Valve to a Crystal Set."

Mr. Clark declared that for the Pottery district, the results of adding a low frequency magnifying valve to a crystal detector were not satisfactory, much better results being obtained by adding a high frequency amplifying valve.

Hon. Sec., F. J. Goodson, B.Sc., G.I.Mech.E., Tontine Square, Hanley.

Newport and District Radio Association.

At the Memorial Institute, Queen's Hill, on May 17th, Mr. J. T. Gray delivered an interesting lecture on "Aerials."

Hon. Sec., H. W. Winslow, 3, Dock Street, Newport.

North London Wireless Association.*

A practical demonstration of valve characteristic curves was given by Mr. V. J. Hinckley on May 28th. The valves used were kindly lent by Messrs. G. Z. Auckland & Son, of Clerkenwell.

Application for membership should be addressed to the Hon. Sec., J. C. Lane, Physics Theatre, Northern Polytechnic Institute, Holloway Road, N.

Dewsbury and District Wireless Society.*

It is proposed to organise a "Direction Finding Committee," with the object of locating those persons who are causing serious interference through oscillating sets. Members are asked to report immediately any case that comes to their notice. It is felt that this step will serve the best interests of both the listener-in and the experimenter.

Hon. Sec., Fred. Gomershall, F.S.A.A., 1, Ashworth Terrace, Dewsbury.

Cheltenham and District Wireless Association.*

The Association is now conducting a series of direction finding experiments with a view to tracing and reporting oscillation offenders, of whom there are a great many in the district. The members are working with a portable D.F. station mounted on a motor car. At a recent meeting the Hon. Secretary announced that Capt. Price **(2 OP)** had offered his assistance with suitable apparatus.

The usual weekly meeting will be suspended during the summer months, reopening in September with a new course of lectures, etc.

All inquiries should be made in writing to the Hon. Sec., H. Dean Poulton, 18, Albion Street, Cheltenham.

Glevum (Gloucester) Radio and Scientific Society.*

Members recently inspected the station of Mr. John Mayall, A.M.I.E.E. **(2 MZ, 2 SD)**, consulting engineer of the Society. In a description by Mr. Chas. Box of his single-valve "super" circuit, he stated that with it he could receive London, Cardiff, and other broadcasting stations on a two-foot frame.

A field day is being arranged and a large attendance is hoped for.

Applications for membership should be addressed to the Hon. Sec., Alec R. E. Jennings, Caer Glowe, Brunswick Road, Gloucester.

THE TRANSATLANTIC TESTS.

The portraits on this page are of Messrs. A. G. Gregory (left) and William Vernon, of Hulme, Manchester, who were among the successful participators in the Transatlantic Tests.

The aerial system employed is shown in the other illustration. Messrs. Gregory and Vernon used three high frequency valves in addition to the detector.

Southampton and District Radio Society.

Following on the resignation of Mr. Stockdale from the Chairmanship, on May 17th, Mr. Holgate was unanimously elected to the office.

A competition for the reception of telephony on crystal sets constructed by members has been instituted. Improvements to the Society's aerial and three-valve set are being carried out.

Headquarters, Y.M.C.A., Ogle Road, Southampton.

Applications for membership will be welcomed by the Hon. Sec., P. Sawyer, 55, Waterloo Road, Southampton.

Redhill and Reigate Radio Society.

On Thursday, May 17th, Mr. H. W. Pope, A.M.I.R.E. gave an extremely interesting lecture on "Telephones and Loud Speakers" to a good attendance of members. Mr. Pope gave his audience several very useful methods of determining polarity of telephones, and emphasised the necessity of having them connected to the correct poles of the battery.

The lecturer described in detail the "Frenophone," a remarkably efficient and unique design of loud speaker about to be put on the market by S. G. Brown & Co., Ltd.

At the close of the meeting five new members were enrolled.

Hon. Sec., C. W. Johnson, 111, Station Road, Redhill.

Fulham and Chelsea Amateur Radio and Social Society.

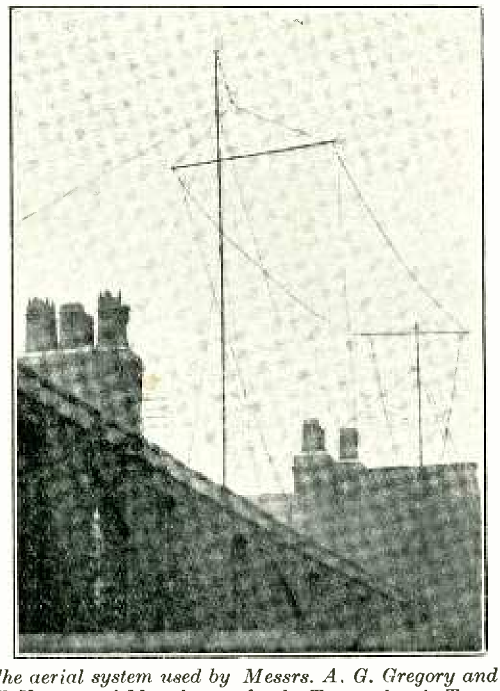
A most interesting lecture and demonstration was given on May 15th by Mr. Tarrant, a member of the Physics Staff of the Chelsea Polytechnic, on the subject of "Electrons." After describing the development of our present knowledge of electrons from the days of Faraday, the lecturer demonstrated the detection, isolation and measurement of separate electron discharges.

Hon. Sec., N. Mickle, 544, Kings Road, Chelsea, S.W.

Mount Pleasant Radio Society.

On Saturday, May 19th, a meeting was held at which the chief item was a demonstration by Mr. Hudson of his three-valve set with loud speaker. The reception of the programme from **2 LO** was excellent.

All particulars regarding membership, etc., may be had from the Hon. Sec., W. R. Fleming, 156, Upton Park Road, Forest Gate, E.7.



The aerial system used by Messrs. A. G. Gregory and W. Vernon, of Manchester, for the Transatlantic Tests.

The Beckenham and District Radio Society.

The formal opening of the new headquarters took place on Thursday, May 17th, the occasion being celebrated by the reception of Grand Opera on a three-valve set with Amplion loud speaker.

The Secretary said that the Society was at last receiving greater recognition in the district and it was hoped that with improved headquarters the membership would rapidly increase.

A vote of censure was passed on local "oscillators."

Hon. Sec., J. F. Butterfield, 10, The Close, Elmers End, Beckenham.

Barnet and District Radio Society.

There was a good attendance at the inaugural meeting of this Society which was held on Thursday May 17th. After an address by the President, Mr. F. W. Watson Buller, the formation of rules was proceeded with, and the enrolment of members. A demonstration of an Armstrong super-regenerative set by Mr. R. Cook afterwards took place, and 2 LO was received satisfactorily with a frame aerial.

Hon. Sec., J. Nokes, Sunnyside, Stapylton Road Barnet.

Sutton and District Wireless Society.

On May 23rd, Mr. J. K. Andrews gave an interesting talk on his experiences in radio work, which commenced in the early days before the war.

Mr. W. H. Norvill then briefly described the new three-electrode variable condenser produced by Messrs. Autoveyors, of Victoria Street. The condenser, he stated, has numerous advantages over the ordinary instrument, the most useful of which is probably its use in a special rejector circuit by which loud stations may be cut out and distant stations received clearly, although the difference in wavelength may be very small.

It was decided at this meeting that regular buzzer practice should be conducted in future as far as circumstances permitted.

Hon. Sec., E. A. Pywell, "Stanley Lodge," Rosebery Road, Cheam, Surrey.

Southampton and District Radio Society.

Final arrangements in connection with the competition for crystal receivers were made on Thursday, May 24th, when it was arranged that there should be two sections—one confined to members only, and one for local amateurs.

Mr. J. Wansbrough, Vice-Chairman, enlightened the members on the circuit in the society's three-valve receiver, and a discussion took place on his suggested improvements, which include high frequency amplification by means of a tuned anode.

Hon. Sec., P. Sawyer, 55, Waterloo Road, Southampton.

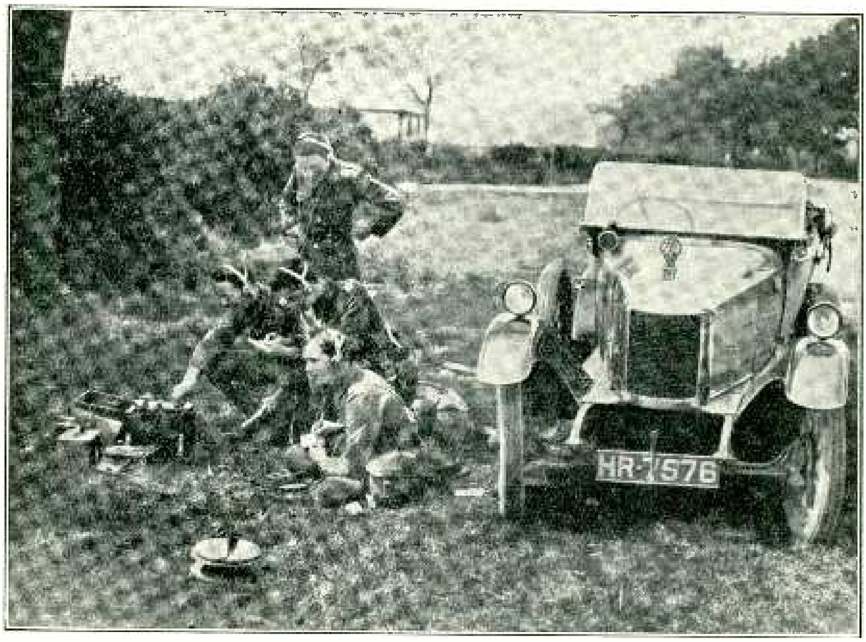


Photo: Photopress.

Wireless played an important part in operations when a massed Field Day was recently held at Bucklersbury Common, Berks, by the combined Officers' Training Corps of Marlborough, Winchester, Wellington, and Bradfield Colleges. Our illustration shows the Marlborough College Wireless Section at work.

The Prestwich and District Radio Society.

On May 28th, in the National Schools Library, Mr. Riley gave some very interesting notes on the interaction of electrically charged bodies with relation to tuning. He showed by experiment, and also blackboard illustrations, some very original and apt analogies to explain the various phenomena.

Hon. Sec., H. A. Wood, Spring Bank, Church Lane, Prestwich.

NEW INSTRUMENTS AND DEVICES.

Intervalve Reaction.

A LARGE increase in signal strength and gain in selectivity may be obtained without distortion when a small amount of intervalve reaction is properly used. A reference to the diagrams which are given in the Questions and Answers section will show that intervalve reaction has been recommended for a long time past, and a number of constructional articles were produced to show suitable constructions.

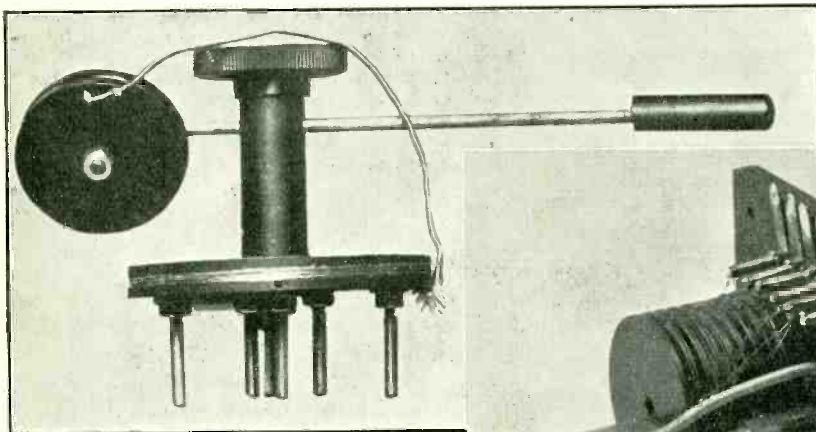


Fig. 1. Plug-in unit consisting of H.F. transformer and reaction coil. (Wellington Electrical and Radio Engineering Works, Ltd.)

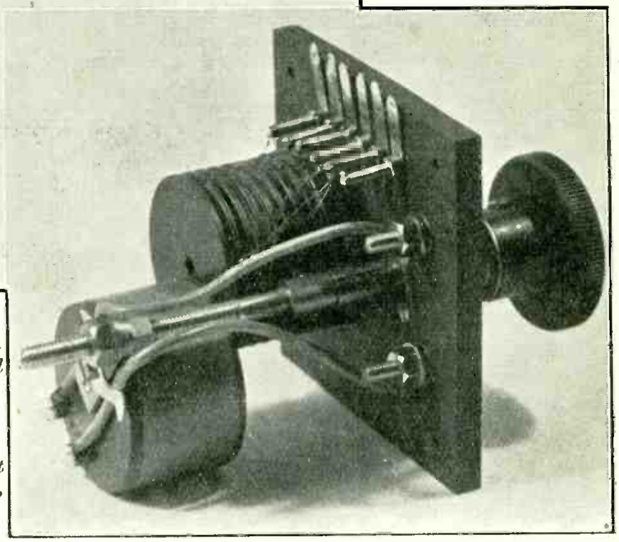


Fig. 2. Variable intervalve reaction unit with anode reactance coil. (Radio Instruments, Ltd.)

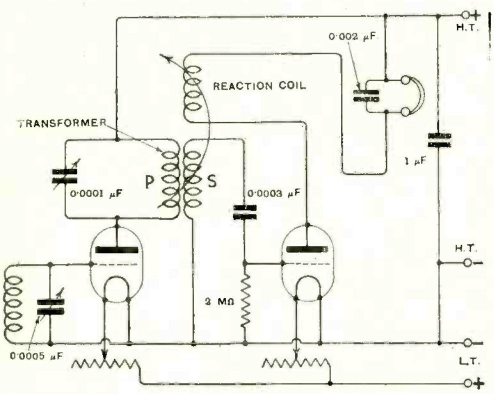


Fig. 3. Method of connecting an H.F. transformer and reaction to provide H.F. amplification.

Reaction effects are obtained, of course, by handing back a little magnified energy so that this small amount may be amplified again. The method of coupling reaction in a receiver with a tuned anode circuit is given in Fig. 4. The photograph, Fig. 2, shows an excellent unit which consists of a tapped anode coil, with a reaction coil. The reaction coil is held on a spindle which may be rotated by turning the knob, providing, it will be observed, variable coupling between the anode coil and reaction coil.

Another form of construction of a unit providing reaction with a transformer is shown in Fig. 1.

The method of connecting an H.F. transformer with reaction is shown in Fig. 3. The reaction coil is the upper coil,

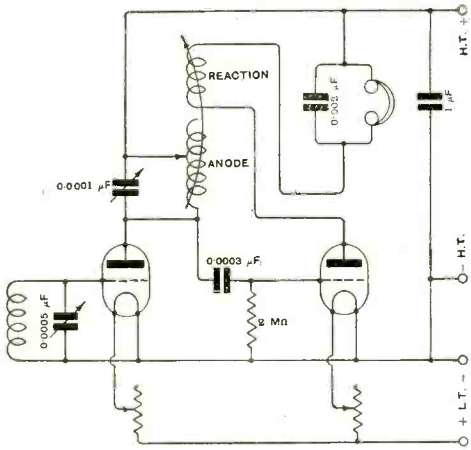
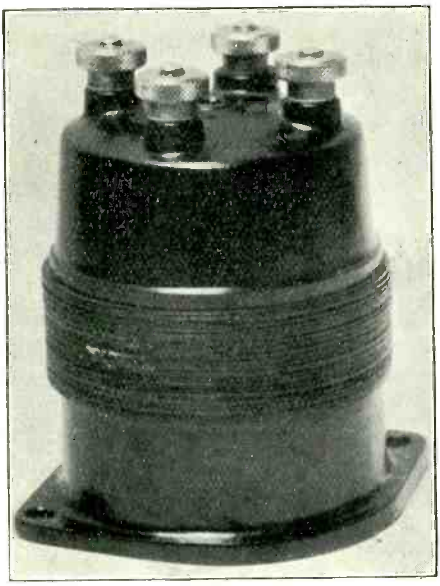


Fig. 4. Method of connecting a receiver using the tuned anode H.F. amplification with reaction coupled to the anode reactance.

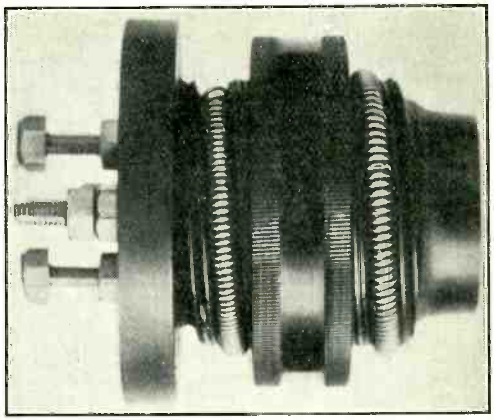
and may be rotated by turning the handle. The four pins are arranged to fit a valve holder, and the two outer pins are connected with the reaction circuit.

Intervalve Transformer.



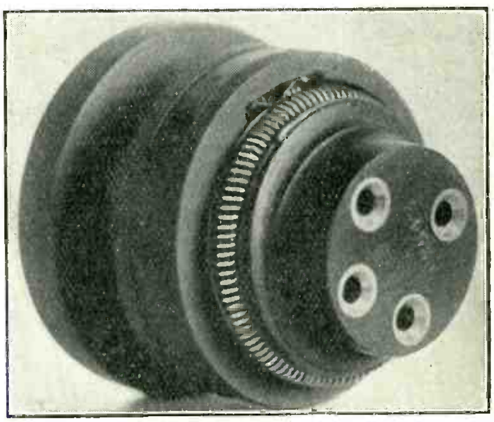
The above illustration shows a Twin-Coil Intervalve Transformer recently put on the market by the M.-L. Magneto Synd., Ltd., of Coventry.

Filament Resistance.



Combined Valve Holder and Resistance manufactured by Messrs. Geo. F. Watts, Son and Co., of Bristol.

This interesting type of valve holder, with which is incorporated the filament resistance, possesses several advantages, such as simplification of instrument wiring and a saving of panel space. It is b ilt entirely of ebonite and is made in three types, viz : (1) With



Another view showing arrangement of adjusting ring, resistance and valve socket.

screwed legs to be fixed in the same way as an ordinary valve holder, (2) with plugs for fitting into the valve holders of sets not fitted with resistances, and (3) a squat type for use in sets where the space is limited. It is apparent from the design that a good deal of skill has been applied to the production of this device.

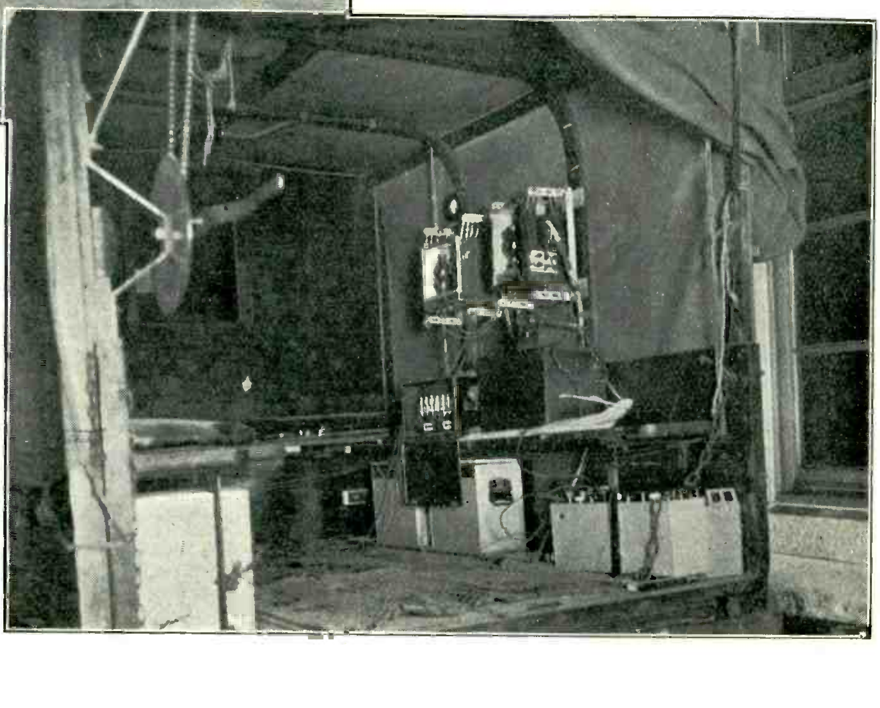
How Wireless Helped in Controlling the Derby Traffic.

THE arrangements for the control of the traffic during the Epsom races were so efficiently organised by the police under the special supervision of Lt.-Col. P. Laurie, Deputy Assistant Commissioner of Police, that it may be interesting to refer to the methods introduced in this organisation, and especially the part which wireless has played in aiding the efforts of the police.

The controlling station was operated from the police headquarters in Scotland Yard, and three other wireless equipments were employed: (1) a fixed station at the race course (2) an aeroplane equipped with wireless for observing the traffic on the road and locating and reporting congested areas, and (3) a motor car equipped with wireless which could proceed to any locality on receipt of instructions from Scotland Yard and keep in touch with police patrols of motor cycles.

This is probably the first occasion on which such an organised effort to control the road traffic has been made, and the success is due to the energy and efficiency of the police organisation, with the co-operation of the Marconi Company on the wireless side. The motor car in use (a photograph of which we reproduce here) is equipped with an aerial system elevated to a considerable height above the car, so that a range of 15 to 20 miles can be obtained with the 100 watt transmitter installed inside the car, a photograph of which appears also on this page.

The aerial arrangement is collapsible, so that where the car has to pass under bridges or trees, the system can be lowered to lie flat along the top of the car. In the development of this equipment experiments have been conducted over a period of some two months, and various forms of aerials have been employed. The wavelength used in transmission by the motor car station was 265 metres, and during some previous trials other wavelengths have been used, but have been found less satisfactory. A very large increase in the range of the station was obtained as the height of the aerial above the top of the car was raised.



Above: The car, showing the aerial arrangement.

Right: Interior: Note the method of suspending the transmitting valves.

Notes and News

Work on the erection of a relay broadcasting station at Sheffield is to be begun immediately.

* * * *

A deposit of £1 has been imposed by the London County Council on each aerial erected by tenants of the Bellingham Housing Estate, near Catford.

* * * *

One of the bandstands in Sefton Park, Liverpool, has been fitted with loud-speaking equipment, and wireless concerts are to be given twice weekly.

Photo : Photopress.

Bradfield College Portable Wireless Section in operation at the recent massed Field Day of Marlborough, Winchester, Wellington, and Bradfield Colleges.

A regular trade, it is stated, is going on in the manufacture of illicit B.B.C. stamps. These are manufactured abroad and disposed of in this country.

* * * *

A central listening-in station is being installed at 2LO in order that officials there may judge the quality of reception from distant broadcasting stations.

* * * *

Ninety Miles Telephony Transmission with "R" Valve.

An amateur transmitter (**5 DC**) at St. Annes-on-Sea (Lancs.) has recently been conducting low power tests with local receivers, and a correspondent at Holyhead (N. Wales) informs us that he has received these transmissions with remarkable clarity, using four valves (1 H.F., detector and 2 L.F.). In one particular instance **5 DC** employed 50 volts on the anode of a Marconi "R" valve, with a power of 0.18 watts. His astonishment was great to receive a faithful report of his transmission from Holyhead, 90 miles distant. Is this a record ?

Broadcasting in Australia.

A resolution has been passed, as a result of a broadcasting conference in Melbourne, permitting the decentralisation of broadcasting services. Each station will be allotted a different wavelength, licensed receivers in the surrounding area using the same wavelength. Preference will be given to Australian and British apparatus. Bona fide experimenters will be allowed reasonable freedom to carry out work not interfering with broadcasting. It is expected that broadcasting developments will be proceeded with immediately.

Have you Heard Telephony from Denmark ?

Programmes of speech and music are frequently broadcast from Lingby, near Copenhagen, and a correspondent from the latter city asks whether these transmissions have been picked up in this country. Last autumn, he states, a Danish ship off the north of Scotland was able to receive music from Lingby. Reception with a good valve set should not, therefore, be impossible in Great Britain. The hours of working are generally 1930 to 2030, and sometimes 1600 to 1630. Lingby is an arc station, and transmits on wavelengths of 2,200, 2,500, 2,700 and 3,200 metres.

Improper Use of Call Sign.

In a recent issue we published a complaint by Mr. T. Hesketh (**2 RS**), of Folkestone, regarding the regular use of his call sign by someone in the district. The call sign was erroneously given as **2 SR.**

Wireless on the Road.

A charabanc journey from London to Oxford has been performed to the accompaniment of broadcast music. The vehicle, which belongs to the City of Oxford Motor Bus Company, was installed with a Western Electric high frequency three-valve set and loud speaker. It is stated that the opera "Aida" was reproduced with great clarity, and the travellers kept in touch with London throughout the ride.

Continental Amateurs Heard in Northumberland.

French and Dutch experimenters owning stations with the undermentioned calls may be interested to learn that they have been heard by a listener-in situated in the north of England. Mr. W. B. Parker, of Monkseaton, Northumberland, has heard the following, using a three-valve set (H.F., D. and L.F.) :—

French.

8 AA	8 AQ	8 CF
8 AB	8 BF	8 CH
8 ARA	8 BM	
8 AS	8 BV	

Dutch.

OYB	OMX	OAA	ONY

All of the above stations, states our correspondent, were heard sending C.W. or unrectified A.C., with the exception of **8 BF**, who has been heard on telephony as well as C.W.

Free Wireless Consultations for Mariners.

The Norwegian and Swedish Governments have inaugurated a system of medical advice by wireless for use in cases of sickness or accident on board ship. In future the master of a ship will be able to communicate (in Norwegian, Danish, Swedish, German, English or French) with the Bergen or Gothen radio stations, giving a brief report of the patient's symptoms. The details will then be transmitted to the Bergen Municipal Hospital or the Almanna och Sahlgrenska Hospital at Gothenberg, when doctors at these hospitals will dispatch advice on the case, no charge being made either for telegrams or advice.

Unknown Call Signs.

Particulars of the locality, etc., of stations using the following call signs would be of interest to the experimenters who have heard them working :—

2 XQ	5 DT	5 QM
5 TT	5 FQ	6 IM
5 UQ	5 QL	5 HW

New Tumbler Switches.

The use of tumbler switches greatly facilitates the manipulation of experimental apparatus and in their "Duplex" and "Pivot" Switches, Messrs. A. P. Lundberg and Son (Pioneer Electrical Works, Liverpool Road, N.7.) have produced valuable accessories for the management of batteries. Particulars of circuit connections will be furnished on application to the firm.

Amateur Transmitters Heard in Newcastle.

From May 3rd to May 20th, states Mr. F. P. Mills, of Newcastle, he has heard the following amateur transmitters, using two valves :

2 OM	2 NF	2 OD	8 BF	3 AB
8 CF	5 QM	2 DF	0 MX	2 JX
5 KO	8 AQ	5 RD	2 AW	2 ON
8 AB	8 BM	8 CF	5 FS	2 NM
2 KF	2 TC	7 JS	5 RB	

Reception in China and Japan.

The development of radio in the Far East falls far short of Western progress. We have received an interesting account of wireless experiences from a gentleman operating a Dutch ship station, in Eastern waters. There is not a single D.F. station, he states, between Singapore and Vladivostock, which, in view of the dense fogs common to these seas, is rather deplorable.

Our correspondent has some excellent long-range reception to his credit. Using a single valve he is able to read the Nauen press almost daily. **PCG** (Kootwijk-Sambeek, Holland) has been heard in Manchuria, with the 'phones on the table, two valves being employed. With regard to telephony and music, our correspondent states that the principal transmissions of this kind are made from Shanghai, by the Radio Corporation of China and by the "Radio Circle." There are two radio-telephonic stations at Kobe in Japan, and two of very low power at Tokyo.

Errata.

In the report of Mr. G. G. Blake's "Historical Notes on Radiotelegraphy and Telephony," appearing in our issue of June 2nd, the following corrections should be made :—On page 287, col. 1, line 19, for "and" read "to"; on page 289, col. 1, line 11, for "Belo" read "Bell"; on page 293, col. 1, line 23, for "Delanga" read "Delange."

Books and Catalogues Received

Radio Simplified : What it is, How to Build and Operate the Apparatus. By Lewis F. Kendall, Jr., and Robert Philip Koehler. (London : Stanley Paul & Co., 31, Essex Street, Strand, W.C.2. Pp. 271. Price 5s.)

"Radio" (Incorporating Sea, Land and Air). A new magazine dealing with wireless in Australia and New Zealand. (Price 9d. Obtainable from the Wireless Press, Ltd., 12 & 13, Henrietta Street, Strand, W.C.2.)

A. J. Dew & Co., 21-25, Endell Street, London, W.C.2. A 440-page illustrated motor accessories catalogue with comprehensive supplement relating to wireless sets and components (wholesale only). A copy will be posted to any bona fide Motor Agent or Wireless Dealer on application.

Bell Battery and Accessory Co., Ltd. (39, Wilson Street, E.C.). Leaflet illustrating the new "Seddon" High Tension Battery Box, shortly to be placed on the market. The object of the device is to enable exhausted sections of high tension batteries to be replaced, thus giving longer life to the complete unit.

Gambrell Bros., Ltd. (Merton Road, Southfields, S.W.18). A cover containing illustrated descriptions of the wide range of wireless apparatus, including sets and components, manufactured by the Company.

Wicken's Wireless Message Recorder and Radio Amateur Economics. (London: Compilogues, Ltd., 268, Kennington Road, S.E. Pp. 116. Price 2s. 6d.)

Forthcoming Events

FRIDAY, JUNE 15th.

Radio Society of Great Britain. At 6.30 p.m. At the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. Lecture for Associates: "Early Mistakes Due to Lack of Appreciation of Capacity Effects" (with demonstration), by Mr. J. H. Reeves, M.B.E.

Leeds and District Amateur Wireless Society. Lecture: "Some Experiences with Non-radiating Receiving Circuits," by Mr. H. F. Yardley, M.I.R.E.

SATURDAY, JUNE 16th.

Tottenham Wireless Society. Visit to a ship station.

MONDAY, JUNE 18th.

Sydenham and Forest Hill Radio Society. At 8 p.m. Lecture: "Elementary Electricity," by Mr. W. V. Pegden.

WEDNESDAY, JUNE 20th.

Tottenham Wireless Society. At 7.30 p.m. Buzzer Practice. At 8.30 p.m. Lecture: "Making and Testing of Field Condensers, Grid Leaks, Coils, etc.," by Mr. T. Vickery.

THURSDAY, JUNE 21st.

Finchley and District Wireless Society. At St. Mary's Schools. Lecture and Demonstration.

Derby Wireless Club. At 7.30 p.m. At the Shaftesbury Restaurant. Lecture: "Experiments with Two H.F. Valves." By Mr. H. J. Kirk.

Broadcasting.

Regular Programmes are Broadcast from the following European Stations:—

Locality.	Call Sign.	Wave-length.	Times.	Nature of Transmission.
GREAT BRITAIN.				
London ..	**2 LO**	369	Weekdays 11.30-12.30 a.m.* 5.30-11p.m. Sundays 8.30-10.30 p.m.	Regular morning and evening programmes, particulars of which appear in the daily press, are conducted from these stations by the British Broadcasting Company.
Manchester	**2 ZY**	385		
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			11.15 p.m. ..	,, Report and Forecast.
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Levallois-Perret (Radiola)	**SFR**	1,780	Sundays 2-3 p.m. ..	Concert.
			Weekdays 5.5 p.m. ..	Financial Bulletin.
			5.15-6.15 p.m.	Instrumental Music.
			8.45 p.m. ..	Miscellaneous News.
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Locality.	Call Sign.	Wave-length.	Times.	Nature of Transmission.
HOLLAND.				
The Hague	**PCGG**	1,050	Sunday 3-5 p.m. ..	Concert.
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The Hague (Heussen Laboratory).	**PCUU**	1,050	Tuesday 7.45-10 p.m.	,,
			Sunday 9.40-10.40 a.m.	—
The Hague (Velthuyzen).	**PCKK**	1,050	Friday 8.40-9.40 p.m.	Miscellaneous.
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BELGIUM.				
Brussels ..	**BAV**	1,100	Working days 12 noon ..	Meteorological Bulletin.
			Daily 4.50 p.m. ..	,, ,,
			Sunday 6 p.m. ..	Concert.
			Tuesday and Thursday 9 p.m. ..	,,
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		4,500	10a.m,,3p.m. and 10 p.m.	Concert.
SWITZERLAND.				
Geneva ..	**HB 1**	1,200	Daily 6-7 p.m. ..	Concert ("Utilitas").
Lausanne ..	**HB 2**	—	6-7 p.m. ..	,, ,,

QUESTIONS AND ANSWERS

"QUERY" (Sussex) *asks* (1) *If a receiving set having two high frequency amplifying valves, crystal detector, two low frequency amplifying valves, and employing reaction, would give satisfactory reception of British broadcast transmissions with a frame aerial at a distance of* 40 *miles.* (2) *For a circuit diagram of a set similar to that mentioned in Question* (1), *employing carborundum crystal.* (3) *If the receiving set mentioned in Question* (1) *would not satisfactorily operate a small loud speaker under the circumstances given, or* (4) *to suggest a circuit which will do so.*

(1) We think that a receiving set constructed on the lines mentioned in Question (1) will give you satisfactory reception of British broadcast transmissions at a distance of 40 miles. (2) A suitable diagram is given in Fig. 1. (3) and (4) We consider that you will have no difficulty in operating a small loud speaker under the circumstances mentioned.

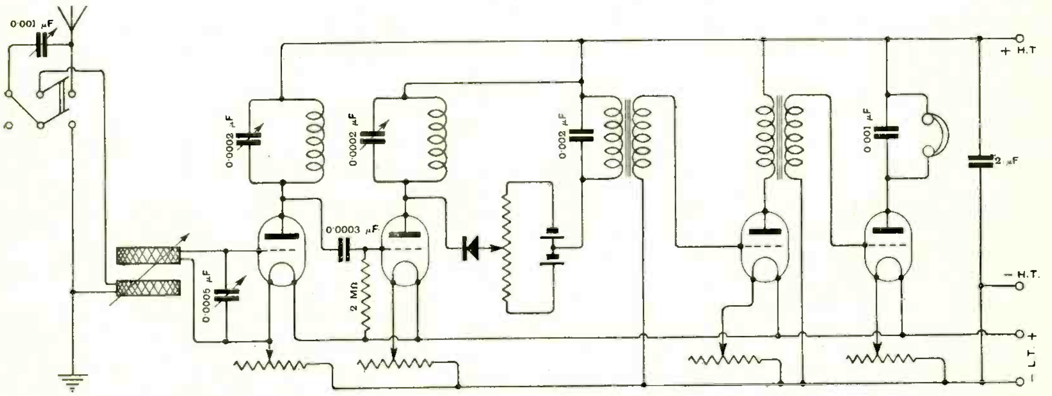

Fig. 1. **"QUERY" (Sussex).** *Diagram of connections for* 2 *H.F. valves crystal detector and* 2 *L.F. valves.*

"J.P.2" (Hove) *submits a circuit diagram, and asks* (1) *For particulars of coils suitable for use in the aerial, secondary, anode and reactance circuits, when receiving British broadcast transmissions.*

(1) We suggest that you wind four coils as follows: Aerial tuning inductance, 2½″ diameter wound with 65 turns of No. 20 D.C.C. copper wire. Secondary inductance, 2½″ diameter wound with 50 turns of No. 24 D.C.C. copper wire. Anode inductance, 2½″ diameter wound with 75 turns of No. 28 S.W.G., D.C.C. copper wire. Reaction inductance, 2½″ diameter, wound with 50 turns of No. 28 S.W.G., D.C.C. copper wire.

"H.M.K." (Kensington, W.14) *asks* (1) *If a variable condenser of* 0.0003 *mfd. capacity will be suitable for tuning the anode coil described in the reply to* **"E.H." (Sweden)** *page* 844 *of our issue of March* 24*th.* (2) *If the reaction coil described for use with the set mentioned in Question* (1) *should be tuned by a condenser.* (3) *Why a diminution of signal strength should take place when a small capacity variable condenser is placed across the primary winding of a plug-in high frequency transformer having* 90 *turns on each winding.* (4) *The reason for an appreciable increase in signal strength, and valve oscillation, when the hand is held on the high frequency transformer.*

(1) A variable condenser of the capacity suggested is suitable for tuning the anode coil. (2) The reaction coil does not, as a rule, require a tuning condenser, but for accurate tuning on weak signals it is frequently an advantage. The condenser should have a maximum capacity of 0.0001 mfds. (3) A variable condenser of 0.0003 mfds. maximum capacity may be used, although it is rather large. The natural wavelength of the transformer is probably roughly that of the signals received. When a small tuning condenser is connected, the wavelength of the tuned transformer is raised above that of the signal. The number of turns in the transformer should be slightly reduced. Try 75 turns instead of 90 turns. (4) This effect will disappear when the transformer is properly tuned. Placing the hand close to the transformer alters the tuning a little.

"J.B.G." (Cheshire) *submits four samples of insulated copper wire, and asks us to identify them.*

No. 1 is 36 S.W.G., S.S.C.; No. 2 is No. 26 S.W.G., S.C.C.; No. 3 is No. 36 S.W G., D.S.C.; No. 4 is No. 46 S.W.G., S.S.C.

"E.F.E." (Cheshire) *submits particulars and diagram of a two-valve set and asks* (1) *For the approximate number of turns required on the aerial tuning inductance and anode tuning inductance to tune up to* 2,600 *metres.* (2) *For suggestions why the circuit should be unstable, and the means of remedying the defect.* (3) *Why satisfactory results*

***should** be obtained using an anode reactance coil of* **36** ***turns**, whereas we usually advise* 100 *turns.* (4) *The theoretical reason for using an insulated earth wire.*

(1) With the full 120 turns of the aerial tuning coil in circuit, and the 0.001 mfd. variable condenser in parallel, the set should just tune up to 2,600 metres. (2) and (3) We think that there may be some characteristics peculiar to your circuit which causes the normal size of reactance coil to be unsatisfactory. (4) The reason for using an insulated earth wire is to retain the natural characteristics of the aerial circuit as constant as possible The use of a bare wire is liable to make its characteristics an unstable quantity through making intermittent contact with earth along its length.

"DUAL" (Durham) "HENDON," and others *ask: With reference to a much advertised two-valve circuit, is the arrangement an ordinary single-valve double magnification circuit with crystal rectifier and a single-valve note magnifier, as described many times before in the* WIRELESS WORLD *and American journals.*

The circuit referred to, which is reproduced in Fig. 2., consists of a single valve operating as a double magnifier with a crystal rectifier, to which is added a note magnifying valve. Fig. 3 shows the circuit redrawn to conform to the usual practice of this journal in representing circuit diagrams, while Fig. 4 is a schematic diagram showing more clearly the operation.

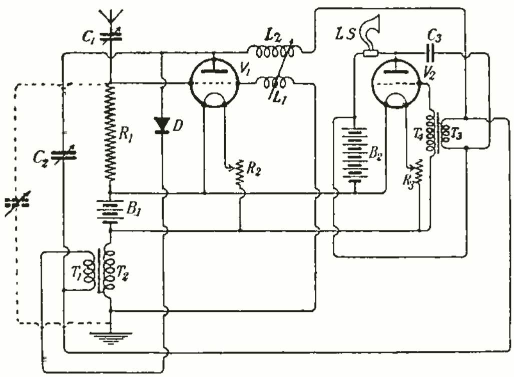

Fig. 2.

"YAMSI" (Stamford Hill, N.6) *submits a diagram of a two-valve set and asks* (1) *For criticism.* (2) *If the anode coil should be variable for different wavelengths, and if the plug-in slab type of coil would suit this purpose.* (3) *The capacity of the variable condenser to tune the anode coil.*

(1) The circuit diagram submitted is correct. The grid leak should, however, preferably be connected from the grid of the detector valve to positive L.T. (2) It will be necessary to have a number of separate anode inductances, if it is desired to receive over a large range of wavelengths. Plug-in slab type coils would be quite suitable for this purpose. (3) A variable condenser of 0.0002 mfds. maximum capacity is suitable for tuning the anode inductance.

"HOTSPUR" (Alnwick) *asks* (1) *The wavelength range of a coil of* 120 *turns wound on a former* 3¼″ *diameter with No.* 29 *S.W.G., D.C.C. copper wire, using a* 0.001 *mfd. variable condenser in series*

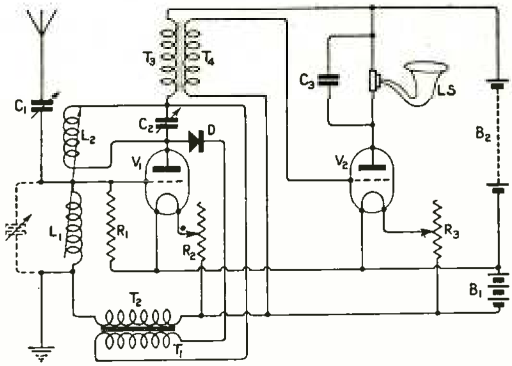

Fig. 3.

or parallel. (2) *The winding most suitable for a reaction coil wound with No.* 36 *S.W.G., to use with the aerial tuning inductance mentioned in Question* (1). (3) *The name of a firm that stocks soft Dutch valves.* (4) *The probable range of the Flewelling single valve circuit.*

(1) With the aerial condenser in series, the minimum wavelength of your coil would be approximately 150 metres, and with the aerial condenser in parallel, a maximum of approximately 2,000 metres. (2) We suggest that you wind 80 turns of No. 36 S.W.G. copper wire on a former 26″ diameter to slide inside the aerial tuning inductance and take four tappings. (3) We think that if you look carefully through the advertisement pages of almost any issue of this journal, you will find the address you require. (4) The results obtainable in the operation of the Flewelling circuit depend very largely upon the skill with which it is handled, and no definite figures can be given.

"F.J.F." (West Bromwich) *asks* (1) *If fixed reaction coupled to the aerial inductance is permitted for the reception of British broadcast transmissions.* (2) *If there is any theory to explain the rectifying properties of crystals, taking into account the geological structure of the crystal and the electron theory*

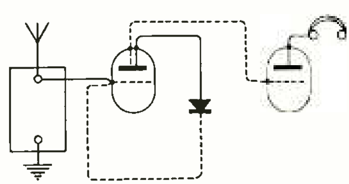

Fig. 4.

of matter. (3) *For the identity of* **2 MV** *and* **5 FI.** (4) *For the windings of two coils required to tune up to* 500 *and* 1,000 *metres respectively, using No.* 21 *S.W.G. wire wound on a former* 1½″ *diameter.*

(1) The employment of a reaction coil coupled directly or inductively to the aerial tuning induc-

E

tance during the hours of British broadcast transmissions is not permitted by the P.M.G. when receiving on the range of wavelengths from 300 to 500 metres. (2) The subject receives a little attention in most wireless books. In particular see a paper entitled "Carborundum and its Rectification Effect," by H. M. Dowsett, M.I.E.E., F.Inst.P., in *The Radio Review*, November, 1921. (3) We have no information concerning these

(1) A suitable diagram is given in Fig. 5. A reaction coil is arranged to couple with the high frequency transformer. (2) Several diagrams of the method of taking separate H.T. positive tappings for the anode of each valve, have been given in recent issues of this journal. In particular we would refer you to page 702 of the issue of 24th February, 1923. (3) A suita le diagram is given in Fig. 6.

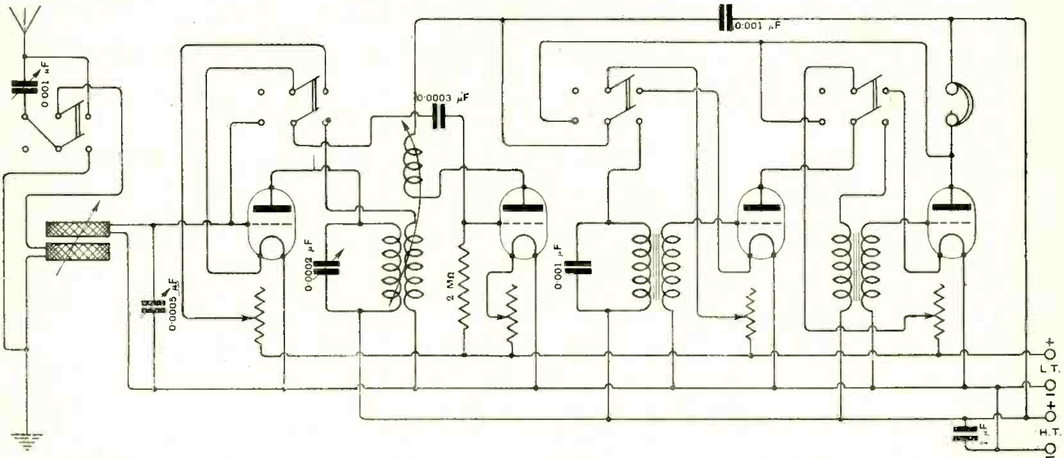

Fig. 5. "**SIRKIT**" **(Lancs.).** *Connections of a four-valve receiver with H.F., rectifier and two note magnifiers. Switches are connected to cut out valves when required.*

stations, but as soon as we obtain particulars of new transmitting stations, details are published in this journal. (4) We suggest that you wind the coils with 75 and 150 turns respectively, honeycomb fashion.

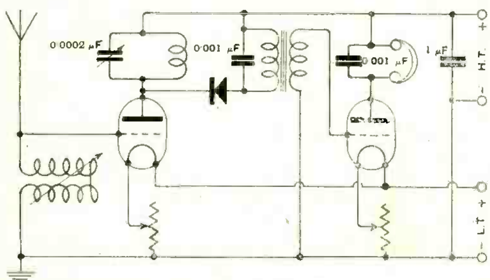

Fig. 6. "**SIRKIT**" **(Lancs.).** *The first valve operates as a H.F. amplifier, the crystal rectifies and the second valve is a note magnifier.*

"**SIRKIT**" **(Lancs.)** *asks* (1) *For a diagram of a circuit employing one high frequency, detector and two low frequency valves, transformer coupling for H.F. valve, variable reaction, and switches for cutti g out all but the detector valve.* (2) *For a method of giving each valve in the circuit its most suitable anode potential.* (3) *For a circuit diagram, in which the tuning is effected b means of a variometer, and using one high frequency connected valve, crystal detector, and one low frequency amplifier.*

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules :—*(1) *Each question should be numbered and written on a separate sheet on one side of the paper, and addressed "Questions and Answers," Editor,* **The Wireless World and Radio Review,** 12/13, *Henrietta Street, London, W.C.2. Queries should be clear and concise.* (2) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* (3) *Each communication sent in to be accompanied by the "Questions and Answers" coupon to be found in the advertisement columns of the issue current at the time of forwarding the questions.* (4) *The name and address of the querist, which is for reference and not for publication, to appear at the top of every sheet or sheets, and unless typewritten, this should be in block capitals. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume."* (5) *In view of the fact that a large proportion of the circuits and apparatus described in these answers are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.* (6) **Where a reply through the post is required every question sent in must be accompanied by a postal order for the amount of 1s., or 3s. 6d. for a maximum of four questions.** (7) *Four questions is the maximum which may be sent in at one time.*

THE
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In this Issue.

Our first article this week relates to the design of a five-valve set, and is contributed by Mr. A. J. Bull, who to all but new readers is already known as the author of earlier articles on apparatus design. The particular set described this time has been produced with the idea of providing a conveniently portable set capable of use either with or without an outside aerial. That is to say that the provision of two stages of high frequency amplification enables the set to be used with very satisfactory results with a portable frame aerial. Many novel features are introduced without complicating the construction, and one can readily recommend that this set should be made up by anyone who wants a really efficient receiver.

Another contribution, which is the first of a number which will appear under the name of Mr. Richard Twelvetrees, will be found of special interest to those who make up their own apparatus and conduct experimental work. Mr. Twelvetrees is already familiar probably to most of our readers in connection with his talks from 2LO on motoring subjects. His articles will be found to be essentially practical and will contain a great amount of information applicable to workshop practice.

Aerials.

Among wireless enthusiasts travelling by road or rail, conversation usually turns upon a criticism of the many aerials to be seen along the route, and the wireless skill of the owners is judged by the design of their aerials. On the whole, amateur aerials reflect credit on those responsible for their erection, as the conditions ruling the design usually make the setting up of an ideal aerial difficult. One does, however, occasionally see glaring errors. In particular might be mentioned the practice of leading in at a distance of a foot or more from the end of the aerial. It is obvious that such an arrangement is equivalent to two aerials of uneven lengths connected together, and, although satisfactory results may be obtained, they in no way compare with what would be obtained with a properly designed aerial system. An aerial of this sort at once condemns the ability of the owner of the station in the eyes of an expert. Other points often criticised are, uneven lengths of wire in multi-wire aerials, arranging the leading-in wires so that they take up a position running beneath the aerial, single wire aerials which, after running in one direction, make a bend and lead-in to the instruments in a direction parallel to the free end of the aerial. The extreme efficiency of the valve receiver is probably responsible for the adoption of these undesirable arrangements, for, as most of us are aware, it is usually possible to get quite a good range without an aerial at all.

PORTABLE FIVE-VALVE RECEIVER

THE CHOICE OF DESIGN AND THE CIRCUIT TO EMPLOY.

By A. J. BULL.

IT is surely safe to suggest that among the great number of people who recently listened in to the operas produced at Covent Garden Theatre and broadcast from **2LO**, there were many who wished that they possessed receiving apparatus of their own. Others possessing crystal or single valve sets, sighed for more powerful apparatus in order that they could press into service many pairs of telephones, or operate loud speakers so that their friends could also participate in the joy of listening to good singing and instrumental music.

Complete practical details for

MAKING AN EFFICIENT RECEIVER

for the reception of broadcasting & transmissions on other wavelengths, are given in this article.

The design adopted does not involve an unnecessary amount of work as is the case when assembling a number of components on an ebonite panel, whilst the arrangement is a marked improvement on the method of simply securing the parts to a base board. The receiver is easily portable, and built in such a manner that it cannot be readily damaged in transit. For this reason it will serve as an ideal outdoor equipment during the summer weather for Clubs, and open-air use generally.

The Author is well known to readers of "THE WIRELESS WORLD" as a writer of a number of practical articles, among which in particular will be remembered the design given for a three-valve receiver published in August of last year just prior to the general introduction of broadcasting. The number of letters of appreciation received indicated that the instrument must have been made up by an enormous number of wireless enthusiasts.

In this article it is presumed that the reader is able to understand an ordinary circuit diagram, and also able to recognise component parts of wireless apparatus at sight. Such constructional details as the size of screws, etc., to employ are not given in every instance, the choice of same being left to the good judgment of the experimenter. The design of the instrument shown in the photographs was decided upon after consideration of the following points:—

Cost, simplicity, flexibility, portability, space, and the problem of interference.

Dealing with the last mentioned consideration first, it may perhaps be useful to consider the reason for the employment of the circuit shown in diagram Fig. 1.

In the early days of spark telegraphy, the circuit employed for the reception of Morse signals was as shown in Fig. 2.

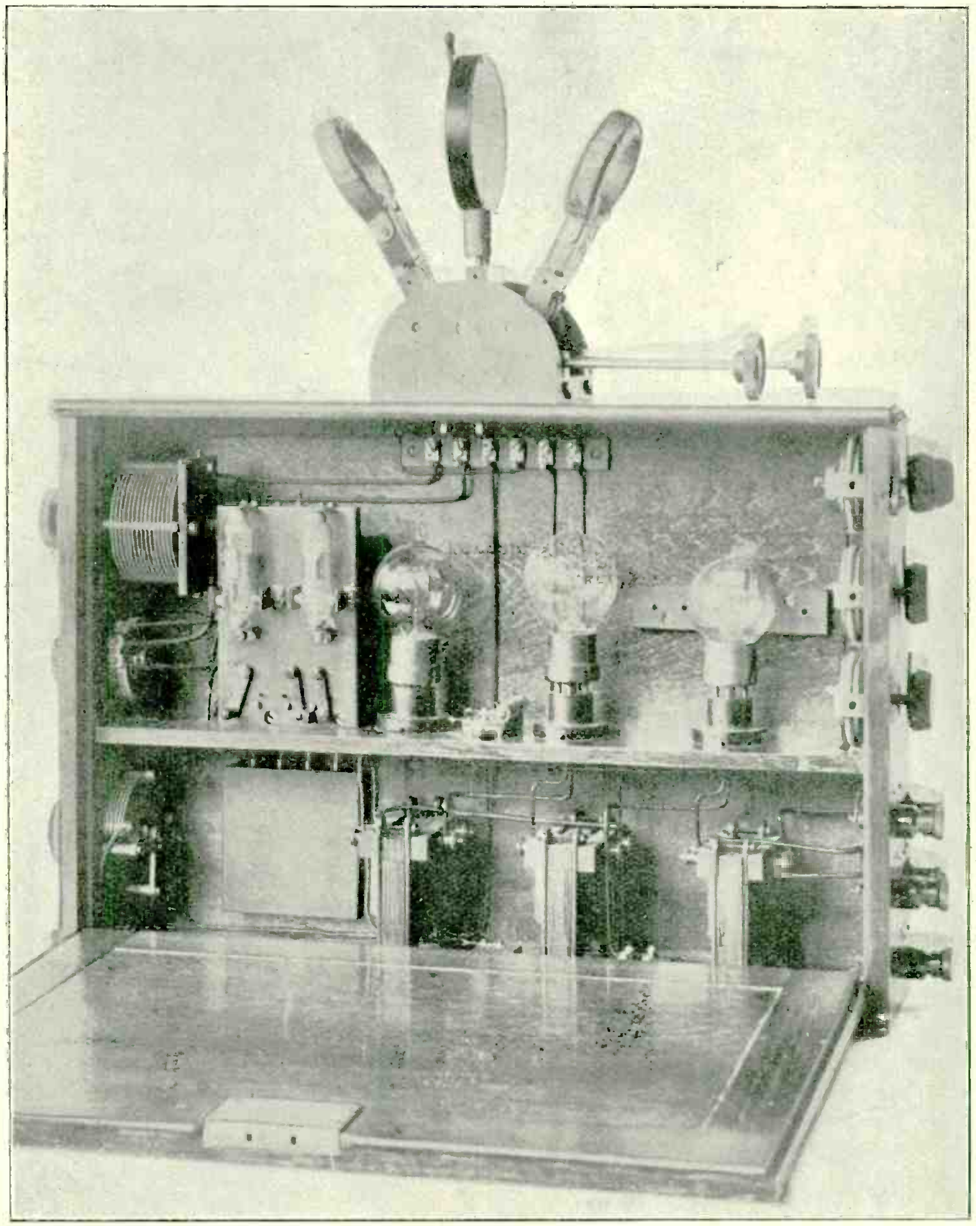
As the number of transmitting stations gradually increased it was found that this circuit, although tuned to a particular frequency, was not sufficiently selective, inasmuch as it is responsive to a less degree to frequencies near the frequency to which it is tuned, and so circuit Fig. 3 was introduced.

This improved matters considerably, because although signals of different wavelength might affect the aerial and cause currents of different amplitude through coil "A," Fig. 3, yet by varying the coupling, or in other words the position of coil "A" relative to "B," and tuning this second circuit to the desired wavelength by means of condenser "C1," the interfering signals are by virtue of the coupling eliminated or partly eliminated, depending upon the strength and tuning of the interfering signal and degree of coupling employed.

To the newly fledged experimenter it may be thought that, owing to the transference of energy from coil "A" to coil "B," the strength of the desired signal must in consequence necessarily suffer. That is not always so, unless the coupling is made very loose, because the detector, whether crystal or valve, is a pressure operated device, and therefore if some means is provided for raising the potential of the feeble current (which is caused to flow in the aerial and coil "A" by the ether wave) before being applied to the detector, and thus an improvement in signal strength is to be expected.

In order to produce the "step-up" in potential, coil "B" is wound with many more turns of wire than "A," and possesses a larger

The complete receiver, consisting of two high frequency and two low frequency amplifiers, with valve detector, described in the accompanying article.



Aerial circuit tuning is accomplished by variable condenser and plug-in coil. A closed circuit is arranged for selective tuning. The high frequency valves can be taken out of circuit by a switch and wander plug. Interchangeable transformers are used in the high frequency amplifying circuits. The low frequency valves are transformer coupled.

inductive value. Since wavelength expressed mathematically is equal to $1885\sqrt{LC}$, where L is the inductance measured in microhenries and C the capacity measured in mfds., it follows that having made " B " of large inductive value (many turns) the condenser " C1 " will be of small capacity for a given wavelength. has been tuned in, selectivity can also be gained by slightly decreasing the value of " B " and increasing " C1," the result being that the voltage applied to the detector both from the *desired* and *undesired* waves, will now be slightly less. The variation will be found useful when the desired signal is very *strong*,

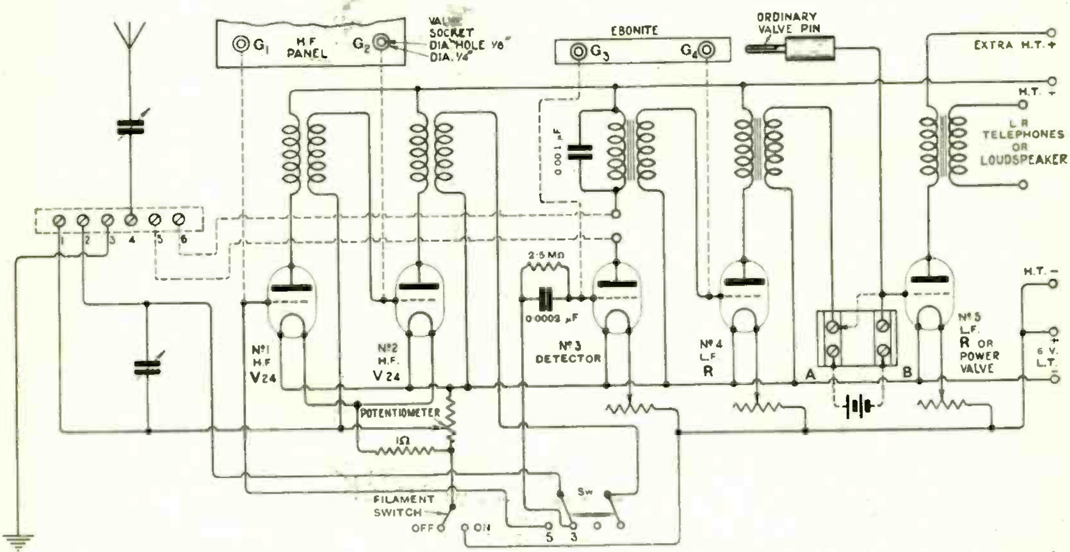


Fig. 1. Circuit diagram of the Receiver, which should be carefully studied in order that the principles may be thoroughly understood, before commencing to adjust and tune-in.

Such an arrangement will give maximum signal strength because the resonance voltage across the capacity " C1" to be applied to the detector will be as high as possible owing to the voltage step up obtained at coils " A " and " B," and the large value of inductance and small value of capacity. In practice, however,

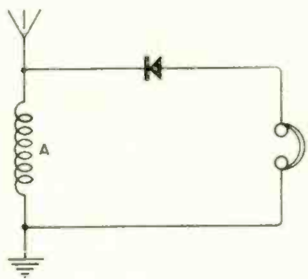


Fig. 2. A simple receiving circuit, which does not permit of selective tuning.

it is a good plan to arrange for the winding on coil " B " to be variable. If this is done it will be found that after the desired signal and consequently one could afford to cut it down, if by doing so the interfering signal is partly or totally eliminated.

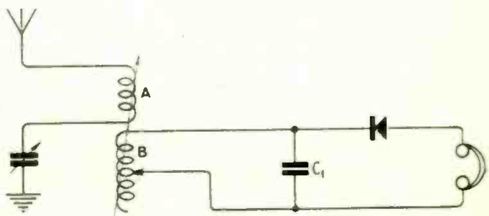


Fig. 3. Selective circuit, not liable to give rise to interference by jamming from stations operating on nearly similar wavelengths.

A more selective circuit still is sometimes employed as shown in Fig. 4.

Where interference is experienced from one particular station, the circuit shown in Fig. 5 is very useful

There have been numerous circuits designed for reducing interference, the majority of which, as is the case with those already mentioned, are based on the ordinary theory of alternating

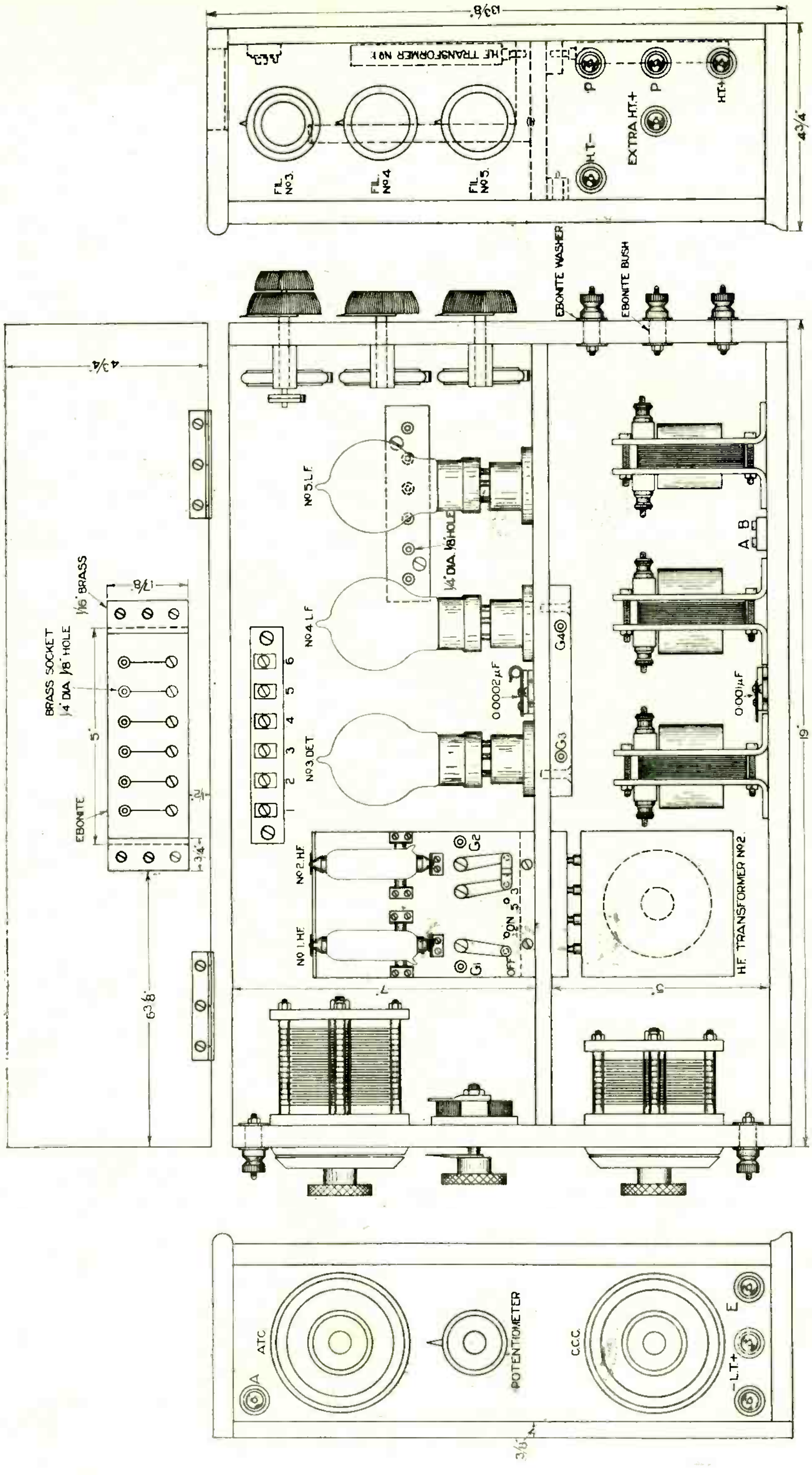


Fig. 6. Scale drawing from which the general dimensions and lay-out of the components can be obtained.

currents, that is they are designed to deal with regularly occurring feeble alternating currents of different frequency produced in the aerial by the ether wave. When, however, we erect our receiving station very close to a powerful transmitting station, these selective circuits do not give satisfactory results, because by absolute shock excitation the transmitter excites the receiving aerial and sets it oscillating at whatever frequency it happens to be tuned.

Strangely enough, probably owing to many simple manipulations, many experimenters living near the coast are employing circuit diagram Fig. 1 for the reception of broadcast music, and of course experience interference from ship stations.

Referring to Fig. 1, it will be noticed that when employing three or more valves (two H.F. and one detecting), there are three tuned circuits in addition to the aerial, which circuits help to make for selectivity, viz., the coupled closed circuit and the two H.F. transformers.

For extreme selectivity, the primary and secondary of the transformers must be well spaced, and wound with copper wire.

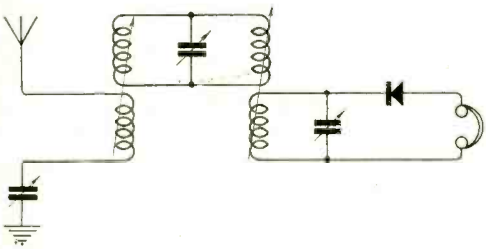


Fig. 4. A circuit providing great selectivity.

Further details will be given later in this article.

Dealing with the question of the general arrangement of the instrument shown in the photograph and Fig. 6, it will be noticed that simplicity is the keynote of the design. Upon opening the front of the cabinet, everything is exposed to view, and is get-at-able, thus enabling faults to be easily traced.

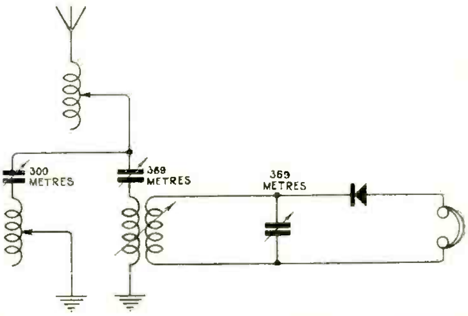


Fig. 5. A circuit arranged to eliminate interference by a particular transmitter.

Elaborate switching arrangements have been avoided, but at the same time, any number of valves from one to five can be instantly brought in and out of service by means of the wander plug. For transport purposes, and for economy of space, the coil holder is fitted with six pins so that it can be plugged to a position inside the cabinet when the apparatus is out of use, the valves first being removed, as indeed, they should be for safety in carriage. When the front and top of the cabinet is closed, the whole becomes easily portable and comparatively dustproof. Having determined the number of valves it is desired to employ for a particular occasion, the instrument can be operated in a closed position, as all the adjustments are situated at the ends of the cabinet, with the exception of plug and the two switches seen immediately below the two "V.24" valves.

The left-hand switch cuts the two H.F. valves in or out of service, and the right-hand one connects the closed circuit to the grid of valve No. 1 or 3 as required.

(*To be concluded*).

An Aperiodic Amplifying System.

By ANDRE BLONDEL and M. TOULY.

THE authors of the present note were particularly interested in the article contributed by Mr. Coursey, which appeared in *The Wireless World and Radio Review* under the title of "On the Amplification of High Frequency Currents,"* and were pleased to note his reference to our circuits,† but the modifications suggested were not very new, since they had been patented in France and already described.§

In the following note it is proposed to refer to some of the modifications which have been made to these circuits.

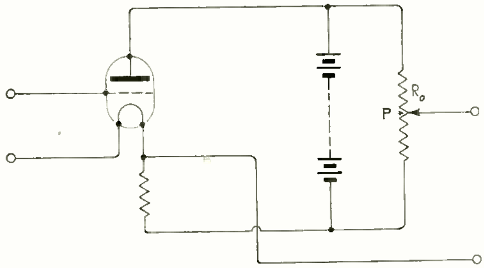


Fig. 1.

Referring to the circuit of Fig. 1, the principle will be seen. Instead of finding a point P with a resistance R_0, at the same potential as the filament, we obtain it from a direct connection to the battery. In the case where a fraction of the voltage of a cell is required, this particular cell is shunted by a potentiometer of suitable value.

This arrangement is shown in Fig. 2, where the battery is divided into two sections, P_1 and P_2. The section P_2 being introduced directly in series with resistance R, P_2 and R can be included without interfering in any way with the remainder of the circuit. This gives us the connections shown in Fig. 3, and with this it will be seen that if one desires to employ several stages of amplification in cascade, it is possible not only to make use of a filament battery common to all valves, but also to supply all the stages by the batteries P_1 and P_2.

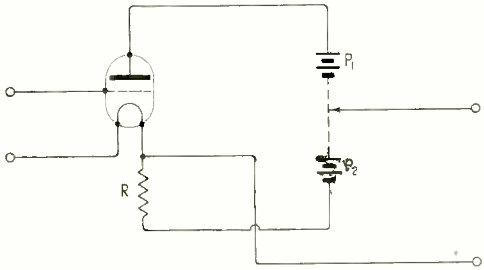


Fig. 2.

Fig. 4 illustrates a two-valve amplifier connected in this manner. The principle of back coupling can easily be applied to our circuits with the well-known advantage that greater amplification is obtainable. Instead of applying the current to be amplified between the filament and the grid of the first valve, a portion of the energy obtained after amplification is applied here. The introduction of an E.M.F. on the grid of the first valve, Fig. 4,

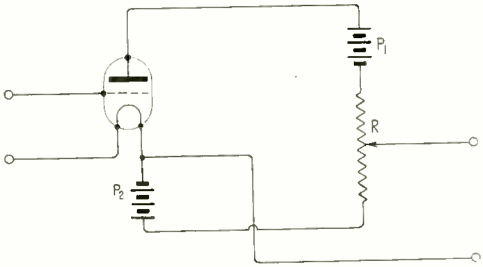


Fig. 3.

serves to vary the current I_1 in the resistance R_1, the potential V_a at the point A in respect to the potential V_f being given by the simple relation $V_a - V_f = EP_2 - R_1I_1$ (EP_2 being the potential of the battery P_2) which will vary in proportion to the value of I_1. The same applies in the case of point B. It is observed that at this point B the variation in potential with respect to the filament is strongest, and that in the absence of E.M.F. on the grid of

* *The Wireless World and Radio Review*, No. 24, Vol. X.

† Figs. 7 to 10.

§ *Compte Rendu de l'Aid des Sciences*, tome 169, page 557. R.G.E. Sur de nouveaux dispositifs amplificateurs potentiometriques de Blondel et Touly, tome VI, page 427. Voir aussi au sujet de l'emploi des amplificateurs pour le Revue Générale d'Electricité, 9 Aôut, 1919, tome VI, pages 163-179.

the first valve, the potential is small or zero with respect to the filament. If we introduce between this point B and the filament, a high resistance R_0 (Fig. 5), the return to the grid of the first valve will be made at a point C, suitably chosen on the resistance R_0. The voltages between the point B and the filament will be allocated in proportion to this resistance,

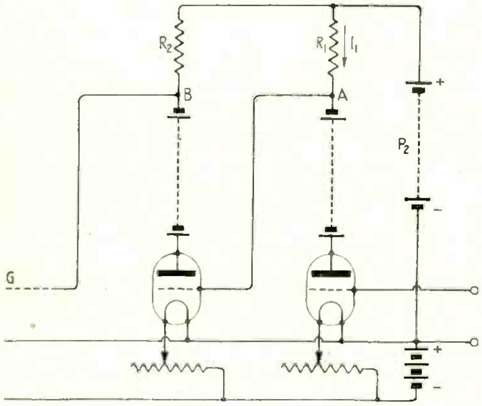


Fig. 4.

i.e., fractions greater or less than the amplified E.M.F. The potentiometer so arranged therefore provides an easy control of back coupling, and therefore to amplification. It is known, moreover, that an alteration in the coupling introduces instability into the circuit. If one requires a sensible proportional amplification, the grids should be made negative with respect to the filament in order to prevent the grid currents from shunting the plate resistances and upsetting the amplification. In addition the plate potentials must be so chosen that the valves work on the straight part of the characteristic curve.

Of course the circuit can be rendered symmetrical by introducing the potentiometer into the first valve. In addition, back coupling may be employed with a multi-valve circuit, provided it is introduced between the two units separated by an even number of valves. If care is taken that the apparatus is constructed with non-inductive resistances having no self-capacity, it is possible to provide a circuit which is practically aperiodic, and where distortion of amplified signals is reduced to a minimum. In particular it is possible to obtain reaction with low frequency oscillations without appreciable distortion. With this arrangement also, the time taken to put the circuit into operation is reduced to a minimum; in fact, only the resistances and the capacities of the valves or batteries come into consideration, and in most cases these can be regarded as non-existent.

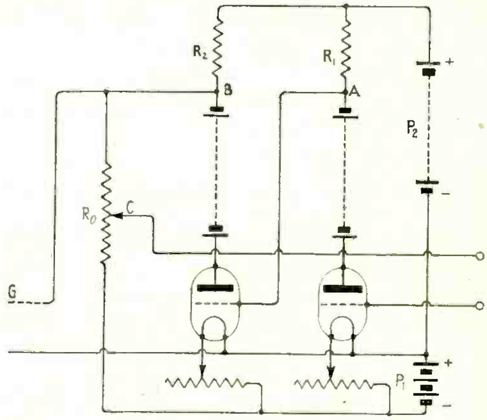
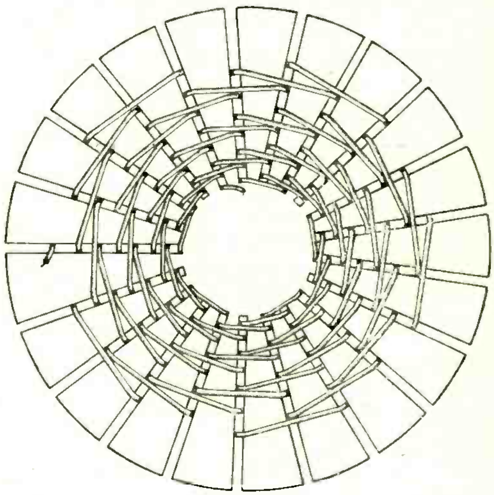


Fig. 5.

In order to eliminate the effect of self-induction, it is well to introduce a further stage for the output; for example, in Fig. 5, G represents the grid of the output stage whose plate and filament circuits can also be supplied from the main batteries, P_1 and P_2.

A Duolateral Basket Coil.



The accompanying sketch illustrates a novel method of winding a basket coil. As usual, an odd number of pegs or slots is used, but the wire is passed round two pegs at a time. The result is a basket coil of duolateral formation which possibly still further reduces the self-capacity. E.J.H.

MATERIALS USED IN WIRELESS CONSTRUCTION

NOTES ON THEIR SELECTION, USE AND PRESERVATION.

Of an essentially practical nature, this article will serve as a useful guide to the beginner in wireless instrument making. Many readers are probably already acquainted with the name of the author, Captain Twelvetrees, a well-known writer on motor and general engineering matters. In particular, his much appreciated weekly talks from the London Broadcasting Station on practical topics related to motoring renders any further introduction to the listener-in unnecessary.

By RICHARD TWELVETREES, A.M.I.Mech.E.

BEFORE any real progress can be made in producing scientific instruments, a good deal of forethought with reference to the selection and purchase of suitable materials is required, and in offering a few hints on the subject the writer hopes to render some assistance to wireless constructors who, whilst thoroughly conversant with production methods, may not have occupied themselves with the most efficient and economical means of stocking their workshops.

Hints on Purchasing Materials.

It will be assumed, of course, that the reader has definitely decided upon the class of constructive work he intends to take up, and has prepared a list in advance, detailing the various materials required for his particular purpose. Provided with such information, he is in the position of acquiring his stock with the minimum of delay and expense, and is well advised to devote the necessary time in making the purchases personally, rather than to risk disappointment and delay in ordering them directly through local supplies.

There are many suppliers in large towns who carry sufficient stocks of the various classes of material required by wireless constructors, so before starting out on a purchasing expedition, it is preferable to decide upon a firm capable of dealing with all the requirements at one time.

In addition to starting out with the list already mentioned, the equipment for a shopping expedition should include a 2-ft. rule, a pocket standard wire gauge used for measuring sheet metals as well as wire, a sliding calliper gauge, and if possible a one-inch micrometer gauge. Apart from its actual use, the latter has a very salutary effect upon counter assistants, for the fact that a customer is armed with such an instrument impresses them that he is unlikely to be satisfied with anything but his exact requirements. The purchaser must also be prepared to detect defects or blemishes in the materials offered, although the stocks of reputable firms can generally be accepted without question. Orders given in bulk invariably receive more detailed attention than those of a piecemeal character, and firms will readily deliver orders too large to be carried away by the purchaser, without delays in transit. For the benefit of readers who have decided upon the above-mentioned methods of purchasing, we will now consider the most useful forms in which the materials of construction may be bought.

Brass as a Material of Construction.

Brass is supplied commercially in various forms and by reason of its special qualities is extremely valuable as a material of construction. When annealed it is very malleable and easy to work both for bending and cutting, whilst its composition enables one to finish off parts with a high degree of polish if such is required. As a conductor of electricity it ranks very high, for taking silver as the unit of conductivity at 100, pure copper comes next at 94·1. The small percentage of zinc used with copper in the composition of brass has very little effect on reducing the electrical conductivity, whilst providing the necessary toughness of the material.

Brass rolled into the form of sheets is extremely useful in the wireless workshops, two useful gauges being No. 20 S.W.G., corresponding with $\frac{1}{32}$ in., and No. 10 corresponding with $\frac{1}{8}$ in. In selecting rolled brass, care should be exercised to see that "shortness" does not exist, a defect sometimes present. "Shortness" is a trade expression denoting that the material is brittle, and can be detected by an over crystalline appearance of the edges, the presence of which will cause a great deal of trouble when attempts are made to work the metal into the required shapes.

Sheet brass showing scratches on the surface, particularly at the edges, should be carefully inspected, as these blemishes may indicate cracks extending nearly through the metal. It is desirable, too, to select only sheets which are perfectly flat, as irregularities may result from " short " patches that cannot be properly removed by annealing.

When one is working to drawings giving definite dimensions, a good deal of time and energy can be saved by purchasing brass of the required thickness in the form of flat strip, which is obtainable in convenient lengths varying in thickness from $\frac{1}{32}$ in. up to $\frac{1}{2}$ in., and in widths from $\frac{1}{8}$ in. to 1 in. in the smaller sizes and from $\frac{3}{8}$ in. to 3 ins. in the larger. The convenience of working with this form of brass will be appreciated by those to whom economy of time is an important factor.

A carefully graded selection of angle and tee section brass will prove of value to the experimenter as obviating bending operations connected with the production of certain components, the rigidity of rolled angle pieces being far greater than those bent into shape from sheet material, as the unavoidable stretching of metallic fibres at the bends weakens the material to an appreciable degree.

Brass foil measuring from 0·001 in. up to 0·010 in. will be found useful for a variety of purposes, and a few sheets should be included in the stock.

Even if one happens to own a lathe, the sizes of round brass need to be selected with care in order to avoid the work of reducing the bars or rods to the required dimensions. Extended brass rods have very uniform sections and are correct to diameter within a few thousandths of an inch, so that parts of components requiring no turning on the outside can be finished off accurately by the use of emery cloth. Those who use lathes for making their own components generally limit the largest diameter of their brass stock to correspond with the internal bore of the lathe spindle, which greatly facilitates production methods. Extended brass can be purchased in all sizes down to 1/16th in. so that the selection of the most convenient sizes for our purposes is not difficult.

Though very few amateurs take the trouble to make the nuts they require, except those of special sizes, the value of stocking a certain amount of hexagon brass should not be overlooked. Bushings for such components as switch, variometer and condenser spindles which are secured to panels by back nuts should be turned from hexagon stock, the drawn hexagon being used for the nut portion without further machining or filing operations, and if one has a few odd moments to spare in the workshop these can be usefully employed in making nuts for stock. If one sets up a lathe for the purpose, when it is not otherwise occupied, such components can be turned out in readiness for use by a younger brother or a son, who will welcome the opportunity of being really useful in the shop and of improving his knowledge in the use of tools. Such possibilities should not be overlooked by the enthusiastic and unselfish wireless amateur.

Round and square tube, and solid square brass are other very useful items of stock, whilst a few packets of rivets of the same material will come in for a variety of purposes for which small nuts and bolts are generally employed.

Copper, aluminium and tin are other metals which should be stocked in sheet form of selected gauges, and a few convenient sized coils of plain and insulated copper wire will complete the stock of raw materials needed by the amateur.

Care of Materials.

In conclusion a few words on the care and arrangement of materials may not be amiss, for unless due precautions are observed, these may become misplaced, damaged or even lost. Bar material should be kept in racks arranged to support long and short pieces according to dimensions, in such a position that the required piece can be seen and reached without disturbing the rest of the stock. Metals liable to suffer from corrosion should be stored in places where they are unexposed to the action of acid or corrosive vapours, and all steel material is best preserved if stored in a flat position, but as this often prevents the easy identification of the piece needed, suitable racks made for the purpose occupy but very little space along one wall of the workshop.

Finally it may be remarked that the benefits of holding a useful stock of materials are often impaired if such stock is not arranged in an orderly and systematic manner.

Radio Society of Great Britain.

The next meeting of the Society will take place on Wednesday, June 27th, at 6 p.m. (Tea at 5.30), at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2, when Mr. R. Watson Watt will deliver a lecture entitled: "Atmospherics" (with experimental demonstration).

INSTRUCTIONAL ARTICLE FOR THE LISTENER-IN AND EXPERIMENTER.

WIRELESS THEORY—XII.

It is the purpose of the writer to deal with the principles underlying the action of wireless receivers and transmitters. Those who know *why*, obtain much pleasure which is not experienced by those who have no idea of the action of their wireless set.

The series has been specially arranged so that the reader who follows each section as it appears will have obtained a complete wireless education with a minimum of time and trouble, and he will be in a position to successfully design his own wireless equipment.

In previous sections the writer has dealt with the principles of electricity such as the effect of resistance, capacity and inductance. The last sections deal with alternating current work and the properties of resistance, inductance and capacity in series and parallel, the study of which is so important to those who desire a clear understanding of wireless.

By W. James.

The Best Ratio of Inductance to Capacity.

(1) *To obtain greatest selectivity.*

A circuit in resonance with an alternating pressure may have either its capacity or inductance changed, provided their product LC remains the same. The aim in building the resonant circuit is to so construct it that currents of the resonant frequency flow very easily, while pressures with a frequency differing from that of resonance will produce a minimum current flow. The best circuit will therefore have the smallest resistance possible, and the value of inductance and capacity should be such that a minimum current will flow when a pressure is applied with a frequency only slightly different from the resonant frequency. *The result is obtained through making the ratio of L to C as high as convenient.* Unfortunately, an increase in the value of L causes a corresponding increase in resistance, through the longer length of wire required and other coil losses due to insulation, the coil former, etc.

That the selectivity of a series circuit is increased by making the ratio L to C greater is readily proved from a consideration of the formula for the circuit.

The current which flows is

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}} \text{ amperes.}$$

at the resonant frequency

$$I = \frac{E}{R} \text{ amperes.}$$

At different frequencies the current is reduced, due to a difference in ωL and $\frac{1}{\omega C}$. Since so long as LC remains constant, the resonant frequency is not changed, if L is large and C is small, ωL will be large, and $\frac{1}{\omega C}$ will also be large. The difference between ωL and $\frac{1}{\omega C}$ is also large, therefore for the given pressure the current will be small.

Example. Suppose we have a circuit with a resonant frequency of 100,000 cycles. The correct value of LC is the 2533. Let $R = 10$ ohms, and the pressure 20 volts. Let us find the current in the circuit at resonance, and when the frequency of the pressure is 99,000 cycles in the following cases.

Case 1. Let the capacity be 0·002 μF, when the inductance will be 1266·5 μH for resonance at 100,000 cycles. The current at resonance $I = \frac{20}{10} = 2$ amperes. The current at 99,000 cycles

$$I = \frac{E}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega C}\right)^2}}$$

$$R = 10 \quad \therefore R^2 = 100$$

$$\omega L = 2 \times 3{\cdot}14 \times 99{,}000 \times 1266{\cdot}5 \times 10^{-6} = 787 \text{ ohms.}$$

$$\frac{1}{\omega C} = \frac{10^6}{2 \times 3{\cdot}14 \times 99{,}000 \times 0{\cdot}002} = 804 \text{ ohms.}$$

$$\text{Then } \frac{1}{\omega C} - \omega L = 804 - 787 = 17 \text{ ohms.}$$

$$\therefore 17^2 = 289$$

$$\therefore I = \frac{20}{\sqrt{100 + 289}} = 1 \text{ ampere nearly.}$$

When the applied voltage was at the resonant frequency, 100,000 cycles, the current flowing was 2 amperes. By reducing the frequency to 99,000 cycles, the current has fallen to 1 ampere, which is quite considerable.

Case 2. Let us now work out the current which will flow at 99,000 cycles when the capacity is 0·0005 μF and the inductance is 5066μH. Notice the product of L and C is as before.

The current at resonance is 2 amperes.

$$R = 10 \qquad \therefore \; R^2 = 100$$

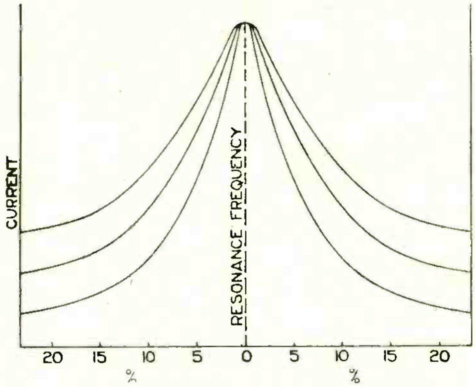
$$\omega L = 2 \times 3{\cdot}14 \times 99{,}000 \times 5{,}066 \times 10^{-6} = 3{,}148 \text{ ohms.}$$

$$\frac{1}{\omega C} = \frac{10^6}{2 \times 3{\cdot}14 \times 99{,}000 \times 0{\cdot}0005} = 3{,}216 \text{ ohms.}$$

Then $\frac{1}{\omega C} - \omega L = 3{,}216 - 3{,}148 = 68$ ohms, and $68^2 = 4{,}624$.

$$\therefore I = \frac{20}{\sqrt{100 + 4{,}624}} = \text{nearly } 0{\cdot}3 \text{ ampere.}$$

When the applied voltage was at the resonant frequency, 100,000 cycles, 2 amperes was flowing. By reducing the frequency to 99,000 cycles, the current is reduced to 0·3 ampere. In Case 1 above, the current was only reduced to 1 ampere. These two cases illustrate that to obtain selective tuning, it is essential to provide a maximum of inductance with a minimum of capacity. This can be carried too far, however, as will be shown later.



The figure illustrates a number of resonance curves showing how the selectivity of a circuit is improved with a high ratio of inductance to capacity. The upper curve corresponds with a low ratio of L to C, and the lower curve with a high ratio of L to C. It will be noticed, that for a given % change in the frequency, the amplitude of the current is reduced most in the lower curve—which corresponds with the circuit having the largest ratio of L to C.

(2) *To obtain maximum voltage at resonance*

The valves and most crystals used in wireless receivers are potential operated devices. It is therefore desirable that the potential applied to either the valve or crystal be as high as possible.

When the resistance in the circuit is small, at resonance the current $I = E\sqrt{\frac{C}{L}}$ where C and L represent the capacity in μF and the inductance in μL in the series circuit respectively. The energy stored in the condenser is given by $\frac{CE^2}{2}$. The energy stored in the inductance is $\frac{LI^2}{2}$. Since the energy which is stored at one instant in the condenser is a little later stored in the inductance,

$$\frac{CE^2}{2} = \frac{LI^2}{2}$$

$$\text{or } E = I\sqrt{\frac{L}{C}}$$

$$\text{and } I = E\sqrt{\frac{C}{L}}$$

The voltage across the coil or condenser at resonance is then seen to be proportional to the ratio of L to C. The higher the ratio the higher the pressure.

In the last example, Case 1, the pressure across either coil or condenser is ωLI or 1,590 volts.

Using the above formula

$$E = I\sqrt{\frac{L}{C}}$$

$$E = 2 \times \sqrt{\frac{1266{\cdot}5}{0{\cdot}002}} = 2 \times 796$$

or 1,590 volts.

In Case 2 the pressure

$$E = 2\sqrt{\frac{5{,}066}{0{\cdot}0005}} = 6{,}360 \text{ volts.}$$

These examples clearly show that to obtain the greatest pressure across the coil, the ratio L to C should be as large as possible.

To summarise the properties of a *series or acceptor circuit* :—

(1) When the applied pressure is in resonance with the circuit, the current flow is only limited by ohmic resistance.

(2) The larger the ratio of L to C in the circuit, the smaller will be the current flow for a given frequency change from resonance.

(3) The resonance curve is sharper the smaller the resistance. Resistance in the circuit broadens the peak of the resonance curve.

(4) The greater the ratio of L to C, the larger is the pressure generated across the coil or condenser.

(5) The resonance curve will be symmetrical when tuning is obtained through variation of inductance.

(6) The resonance curve will not be symmetrical when tuning is obtained by varying the capacity.

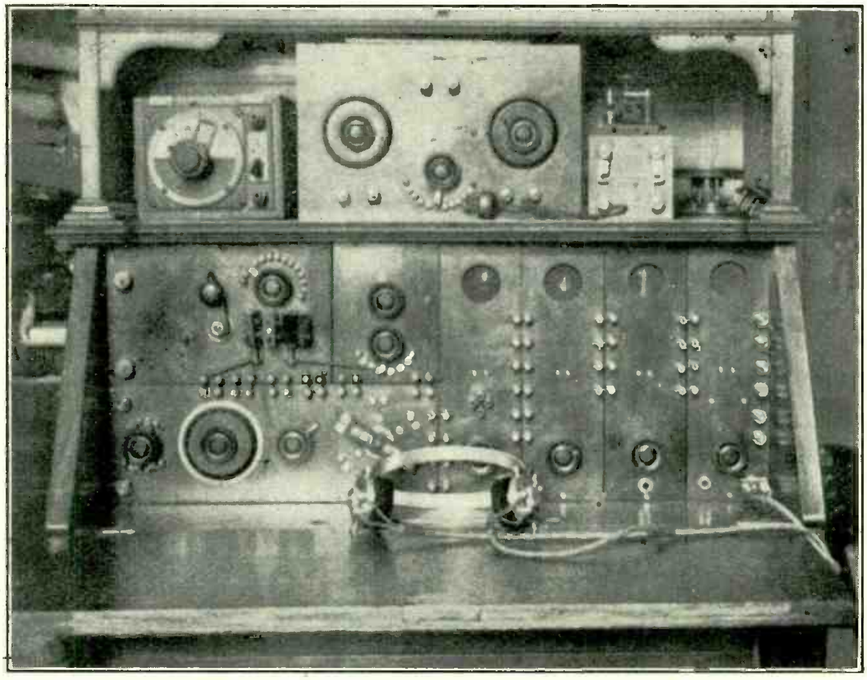
AN EXPERIMENTAL UNIT SET.

By F. C. LISTER.

THE set was commenced in January 1922, but the whole design was not set out until May, when the switch described below was published in *The Wireless World*.

Commencing on the left, the upper rectangular panel contains two tuners—one, a single circuit solenoid with ball type reaction, covering 600 to 4,000 metres, added to which not used, and one coupled with the tuned anode coil, immediately above set, is employed.

Any of these tuners may be coupled to the amplifier by simply moving the switch arm, seen immediately below the short wave tuner. This switch was described in the May 13th issue of *The Wireless World*, and automatically connects the condensers (main and vernier) to the tuner to be used. In the left-hand



The Experimental unit described in this article.

is a plug coil arrangement. Next to this panel is the short wave tuner built similarly to the larger solenoid, but covering wavelengths of 200 to 900 metres. Ball type reaction is provided, but during forbidden hours this is bottom corner is the series-parallel switch used when the single circuit tuning is in use.

Each of the valve panels is identical in size, the valve on each being mounted on a small bracket behind the panel with a gauze-covered window cut into the panel to observe the filament brightness, etc.

The first valve is a high frequency magnifier and to provide coupling with the next valve (the detector) the necessary leads are brought to the four-valve leg sockets, into which may be plugged either resistance transformer or tuned anode couplings.

The detector panel is quite standard, grid condenser and leak being used.

The last two valves are L.F. transformer coupled, and the "Elwell" jacking system provides for employing only the amount of amplification required. Thus, the plug to which the 'phones are attached may be placed in the plate circuit of the detector valve or third or last valve at will.

The whole of the panel terminals are of the screw-down type, and are lettered. This is done by cutting discs from a rod of ivory of the size of the terminal heads. These are engraved H.T.+, etc., and are filled in black and look very neat.

The whole set is mounted in an oak bureau, and is of panel construction, the advantages of which are obvious, as, when the tuner and detector panels are finished, the set is ready for work and additional panels may be built as time and money allow.

As regards results, the author claims nothing exceptional, though WOR was picked up using three-valves on the only morning he attempted to listen for American broadcast. All the English and European telephony has been logged. Of the B.B.C. stations, London and Glasgow, the most distant, are best, while Manchester, the nearest (80 miles away) is not so good.

The advantages of the above set are first its flexibility without sacrificing neatness (not a loose wire is showing normally), and the ease with which one can make comparisons of different tuners and coils and high frequency couplings, etc.

The author is indebted to a fellow club member (Mr. Grimshaw) for the photograph.

All the apparatus, with the exception of the transformers, and of course terminals and knobs, is home made.

LATEST AMERICAN MICROPHONE.

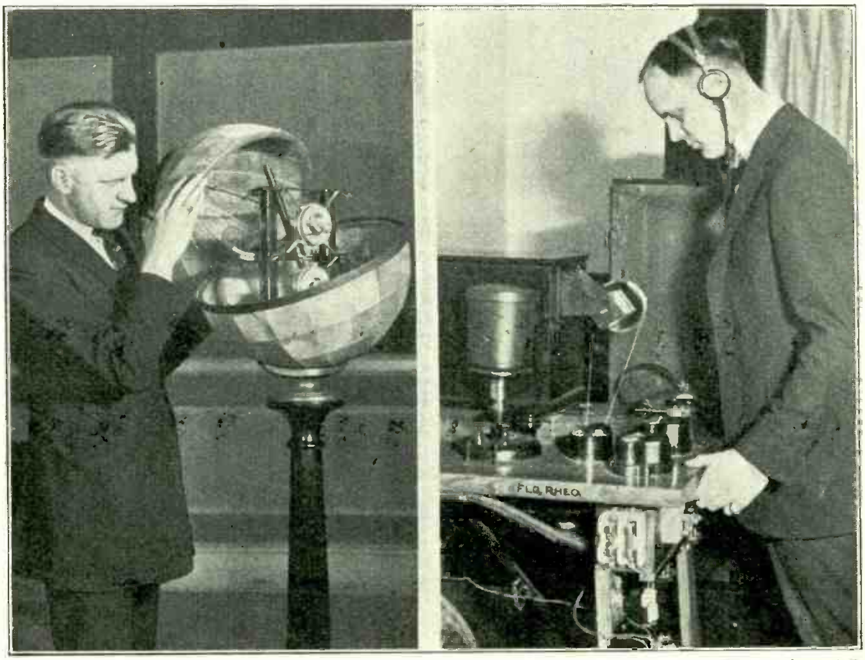


Photo: Central Press.

This new microphone, shown on the left, is arranged to operate the two stations **WJZ** *and* **WJY**. *The right-hand illustration is a device for visibly indicating the degree and quality of the modulation.*

A PRACTICAL COURSE IN THE PRINCIPLES OF WIRELESS

EXPERIMENTS FOR THE RADIO AMATEUR

The author having explained in previous instalments simple methods for the determination of wavelength and capacity of the aerial, he now describes the procedure for setting up a crystal receiver, arranged in a manner which will demonstrate the principles of tuning.

By MAURICE CHILD.
Vice-Chairman of the Radio Society of Great Britain.

EXPERIMENT No. 9.

To arrange and adjust a simple and efficient circuit for the reception of morse and telephony transmissions :—

The apparatus required is as follows :—

- Triple Contact Tuner.
- Carborundum Crystal Detector (mounted).
- Potentiometer and Battery of four small dry cells.
- Telephone Transformer, together with 120 ohm Telephones.
- 0.001 mfds. Fixed Condenser.
- 0.001 mfds. Variable Condenser.
- 0.0005 mfds. Variable Condenser.
- Single-pole Switch.
- Buzzer Wavemeter.
- Unshunted Buzzer.

The above list of apparatus will no doubt appear somewhat formidable, but the experimenter who has carried out the previous experiments will find that he has already a considerable number of the parts required for this one. By the term "triple contact tuner," the author has in mind a simple inductance coil provided with three contacts which can be moved over the surface of the coil, the insulation of which has been removed for the purpose of allowing contact to be made.

The gauge of wire with which the inductance is wound should not be less than No. 20 S.W.G., and the overall length of the coil 12 ins. to 15 ins. by 4 ins. to 6 ins. diameter.

In radio work it is important to use insulating materials for building inductances that will give small dielectric losses. Shellac varnish should, as far as possible, be avoided in coils which have to carry high frequency oscillations. If a damp-proof covering is ever required, use paraffin wax sparingly.

In a few types of sliding contact tuners it will be found that the brass rods on which the moving contacts work are not insulated from the wooden end supports. It is better for the rods to be held by some ebonite bushing in order to increase the insulation.

To ensure reliable contact between the sliders and rods, a few strands of fine copper wire may be soldered directly to the sliders, the other end of the wires being soldered to the rods. At the same time, if the contacts are tipped with small pieces of silver neatly rounded off, an advantage will be gained.

A simple tuner of the above character is of great use to the experimenter, not only for the particular experiment which is about to be carried out, but also for future work.

The author recommends the experimenter to use a carborundum crystal for general reception work until such time as he feels inclined to employ a thermionic valve in lieu thereof.

Carborundum possesses many advantages over any other type of detector of a similar character, the chief among which are robustness, reliability, and sensitiveness. A firm steel contact pressing on the carborundum crystal serves the purpose of maintaining a constant adjustment which is not easily upset unless a very violent shock occurs to displace the crystal itself. Provided the experimenter obtains a good piece of carborundum, he will find little to be desired as regards sensitiveness, in comparison with the many other well-known types. There are certain crystals which may be more sensitive and can be operated without the use of a potentiometer and battery, but in general they are less stable.

The potentiometer should be of the sliding contact type, provided with a battery of four small dry cells. The resistance of the winding should be from 400 to 750 ohms, but the exact value is not very material. Many of these can be purchased in quite good condition second-hand, and some of the ex-Army types are fitted with a single pole switch, in which case the experimenter will not require to purchase this item.

The telephone transformer should be purchased with great care, as it will be required for many other experiments, and should therefore be of the highest possible efficiency. In this particular instance it is important that a fair price should be paid for a really good article. The points to be looked for in these instruments are as follows :—

There should be a very substantial laminated iron core which should completely fill the centre of the bobbin. The core should be of a large number of fine stalloy stampings tightly clamped together. The primary winding in this particular case is that which has to carry a large number of turns. The resistance of the secondary winding should be about 40 to 50 ohms.

With regard to the rest of the apparatus tabulated, as these items have already been described, it is not necessary to do so again.

The various parts should be connected up as shown in Fig. 15.

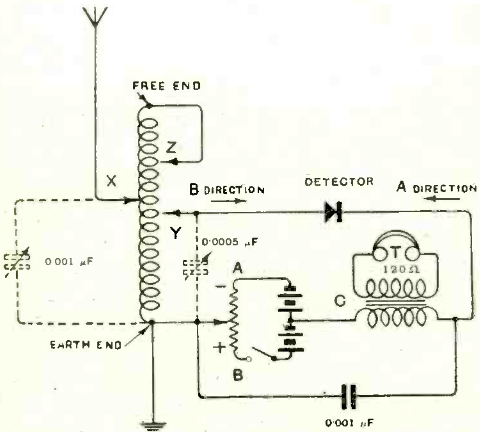


Fig. 15. Experimental Crystal Receiving Circuit.

It is important that the point marked " Y " goes direct to one side of the detector which is called the " high potential " side, and that the potentiometer " AB " and telephone transformer " C " be connected on the other side of the detector which is called the " low potential " or " earth " side.

The variable condensers shown with their connections dotted in will only be required when it is desired to receive wavelengths over 1,000 metres, or thereabouts.

To adjust the apparatus for sensitiveness, the experimenter should first of all obtain the maximum results from his detector by means of a sparking buzzer placed close to it. (See Experiment 4.*) The only adjustments for this which will have to be made are firstly, that between the crystal and the contact point or strip placed on it, and secondly, the sliding contact of the potentiometer. It will be found that there is a critical position for this slider when the signal from the buzzer will increase in strength very considerably, and the sound in the telephones will be much sharper, or more aggressive. The diagram indicates the direction in which the current from the battery, joined to the potentiometer, flows through the crystal circuit when the sliding contact is placed either in the " A " or " B " position. If the slider is placed exactly on the middle point, no current flows through the detector at all.

Having obtained the sensitive adjustment on the detector itself, the shunted buzzer can be joined up to the calibrated circuit comprising the wavemeter, and this circuit should be brought within a foot or so of the earth end of the tuner.

The point " Y " can be fixed roughly half-way down the coil if it is desired to receive short wavelengths, *i.e.*, waves between 300 and 1,000 metres, or at the free end of the coil if it is desired to receive longer wavelengths.

The contact " Z " should be placed at the free end of the coil. The contact " X " is now moved up from the earth end to a position where the signals from the wavemeter are of maximum strength. The contact " Y " should now be brought down as close to " X " as possible without losing strength of signal. A final critical adjustment of " X " can then be made.

If there are signals being transmitted from any station on the particular wavelength to which the wavemeter has been set, and they are of sufficient strength, they will be heard in the telephones.

The experimenter has now scientifically adjusted his apparatus, and the author hopes

* Page 171, May 12th, 1923.

that, having done so, he will speedily be rewarded for his trouble, and have the satisfaction of knowing from the results obtained that he is working on the right lines.

With regard to the contact "Z," this may be of considerable utility if it is desired to use this tuner for the reception of wavelengths 200 to 400 metres or thereabouts. In this case the contact "X" will come very close to the earth, probably only six or eight turns being required. The contact "Y" will likewise be somewhere near "X," although usually there will be two or three times as many turns between "Y" and the earth than between "X" and the earth. This *ratio* of turns becomes less as the wavelength received increases.

The contact "Z" should be employed purely as a final adjustment.

A position may be found for it where the signals received will increase very much in strength. This is due to the fact that oscillations in the lower portion of the coil are no longer dissipating some of their energy in producing wasteful currents in the upper portion.

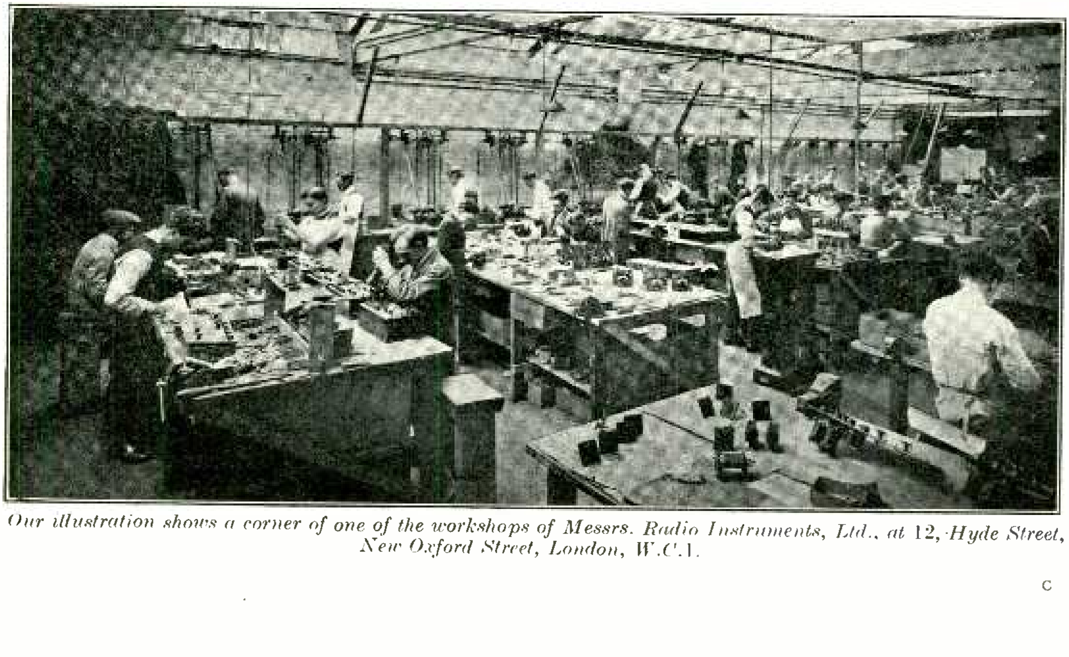
For long wave reception the contact "X" of course will be placed much nearer the free end, and it will be found an advantage generally to use a variable condenser of 0·001 mfds. between "X" and earth. In this way it is not neccessary to employ so much inductance, and the tuning of the aerial circuit will be more efficient and selective.

For long waves the contact "Y" can be placed right up to the free end of the coil and final tuning obtained with the condenser 0·0005 mfds. The condensers dotted in Fig. 12 need only be employed for wavelengths over 1,000 metres.

If greater selectivity is required, the contact "Y" should be brought down towards the earth end of the coil, and as each small adjustment is made in this direction, the variable condenser between "Y" and earth should be increased in capacity. This will have the effect of maintaining the strength, and, in many cases, increasing it. The further "Y" is brought to the earth end with any given position of "X," the looser is the coupling between the aerial circuit and the detector circuit, and even on short wavelengths, if a high degree of selectivity is required, the variable condensers *can* be used to assist in obtaining this result.

The whole receiver is an interesting apparatus for the experimenter to work on, and it will be possible to use the various parts employed subsequently for further work.

It is strongly urged that as much use should be made of the wavemeter as possible, as in this way greater certainty is assured of obtaining the required signals.



Our illustration shows a corner of one of the workshops of Messrs. Radio Instruments, Ltd., at 12, Hyde Street, New Oxford Street, London, W.C.1.

PREVENTION OF INTERFERENCE.

HINTS FOR BETTER BROADCAST RECEPTION.

THOSE who operate a powerful receiver located near a broadcast station, often experience difficulty in tuning out the local transmissions in favour of the transmissions of other broadcast stations. A good many prefer to use a single circuit tuner as in Fig. 1, on account of the simplicity of tuning. That is about its only recommendation. It will be found, in general, selectivity is better when the tuning condenser is in series with the tuning coil.

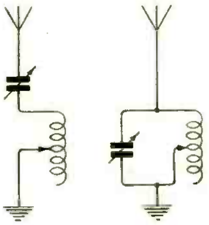


Fig. 1. A simple aerial tuning circuit. For broadcast wavelength work, the condenser may have a capacity of 0·0005 mfds. The coil may be 4 ins. in diameter and 4 ins. long wound with No. 20 D.C.C. with 12 or 14 taps, the more the better.

The first step towards better tuning is to employ a coupled circuit. Many use a coil holder to accommodate an aerial and a closed circuit coils. While the arrangement has some favourable points, with the ordinary type of coil holder, where one coil may be simply rotated away from the other in one plane, it is not ordinarily possible to obtain that fine adjustment of coupling which is desirable. Better results are obtained when the cylindrical coil combination is used, one coil sliding within the other. A further improvement consists in placing the secondary coil so that it has no coupling with the aerial coil. Coupling is obtained by connecting a few turns in series with the secondary and coupling them with the aerial coil (see Fig. 2). A switch is essential for connecting either the aerial circuit or the closed circuit with the remainder of the receiver. Now we may " search " with the aerial circuit connected, and afterwards with the secondary circuit coupled, and sharply tune to the wavelength of the signal.

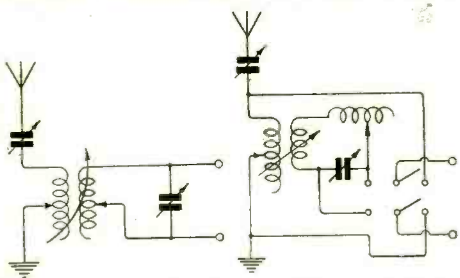
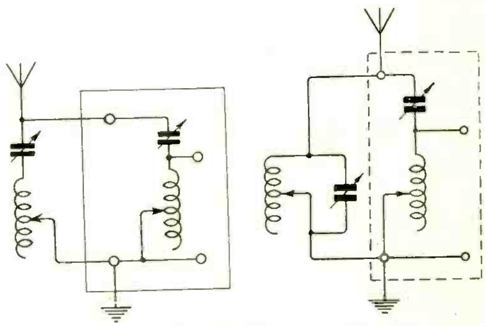


Fig. 2. A coupled circuit. Better selectivity is obtained by splitting the secondary coil. The coil which couples with the aerial circuit may be 3 ins. in diameter, with 10 turns. The other secondary coil may be 4 ins. in diameter and 3 ins. long of No. 22 D.C.C. with 10 taps.

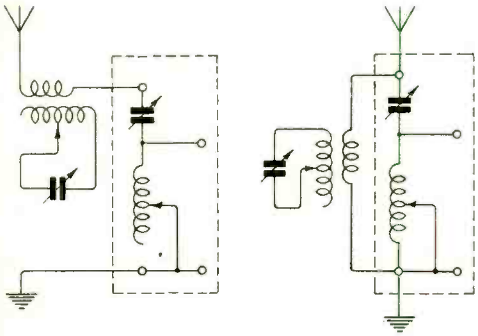
Even with this refinement it is not always possible to cut out interfering signals which differ only by a matter of a few metres. It will be found that great assistance may be obtained through the use of filters.

A filter consists essentially of a coil and condenser. The simplest connection is shown in Fig. 3. Here the filter inductance and capacity are connected in series, and the whole is joined across the aerial and earth terminals of the receiver. The filter inductance should be placed so that it has no coupling with other portions of the receiver. The efficiency of a filter of this description depends entirely upon the losses of the coils and condensers. The coil should be made so that its losses are a minimum. Any good condenser is satisfactory. A cylindrical coil will be best for short wavelength work. Of course, the reaction coil may be coupled with the filter coil to make good the



Figs. 3 and 4. Simple filter circuits joined with the receiver. The condenser may have a maximum value of 0·0005 mfds.

losses, but this is a refinement which will only be used by a few. The filter may consist of an inductance of 50 turns of No. 22 D.C.C. with four or five taps, wound upon a former 3 ins. in diameter, and a 0·0005 mfd. variable condenser for use over the broadcast band of wavelengths. The former upon which the wire is wound may be of ebonite, the thinner the wall the better. Keep wax and shellac off the wire, although if it is thought the wire insulation may become damp, dry the coil first, and then apply a little shellac to keep the moisture out, not to hold the turns together.



Figs. 5 and 6. Here the filter circuits are coupled with the aerial circuit. The coupling coil in the aerial circuit (Fig. 5) may have 5 to 10 turns. The coil across aerial and earth (Fig. 6) should be 3 ins. in diameter with 50 turns of No. 22 D.C.C. with a few taps.

The impedance of a series circuit at resonance is almost zero when the resistance is small. Therefore, if the filter circuit is tuned to the wavelength of the interfering signals, there will be very little of it pass through the receiver.

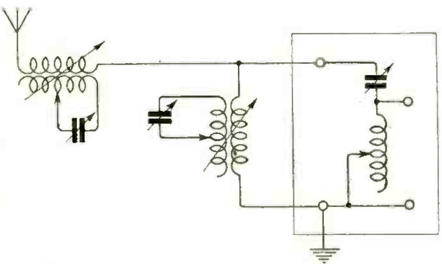


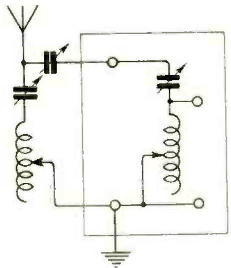
Fig. 7. This is a combination of Figs. 5 and 6.

Another method of connecting the filter is shown in Fig. 4. Here the filter consists of an inductance and condenser in parallel. The filter is tuned to the wavelength of the interfering signal.

A better arrangement consists in coupling the filter circuit with the aerial circuit as shown in Figs. 5 and 6. Either arrangement will prove satisfactory in cutting out the transmissions of the local broadcast station. In each case the filter circuit is tuned to the wavelength of the offending signal. In the case of Fig. 6, it is necessary to retune the receiver when adjustments of the filter are made.

Another arrangement, which is a combination of the circuits of Figs. 5 and 6, is shown in Fig. 7, while in Fig. 8 is shown another satisfactory combination.

Perhaps the filter circuit which gives best results of all is that given in Fig. 9. The switches A and B are opened, and the condenser C, and coils L_1, L_2, and L_3 are tuned to resonance. The closed circuit coil is L_5. Now the switches A and B are closed, and the condensers C_2 and C_3 are adjusted until interfering signals are eliminated. It will be necessary to retune the aerial circuit by varying C_1. This



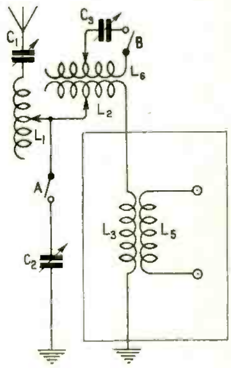


Fig. 8. This arrangement is often satisfactory, and is not so complicated as that of Fig. 7.

Fig. 9. The filter circuit shown here is the best of all. Coils L_2 and L_3 may each be about 10 turns of No. 22. Coil L_1 should be 50 turns, all wound on formers 4 ins. in diameter. Coil L_5, which is the ordinary closed circuit coil, and L_6 may both be a winding 3 ins. in diameter of No. 22 D.C.C. 4 ins. long with several taps.

arrangement looks complicated, but after a little practice is easily operated. The results are worth while to those who live " on top " of a broadcast station.

W.J.

Wireless Club Reports.

NOTE.—Under this heading the Editor will be pleased to give publication to reports of the meetings of Wireless Clubs and Societies. Such reports should be submitted without covering letter and worded as concisely as possible, the Editor reserving the right to edit and curtail the reports if necessary. **The Editor will be pleased to consider for publication papers read before Societies. An Asterisk denotes affiliation with the Radio Society of Great Britain.**

Correspondence with Clubs should be addressed to the Secretaries direct in every case unless otherwise stated.

The West London Wireless and Experimental Association.*

A lecture on "Radio Switching and Control" was delivered by Mr. O. S. Puckle on Tuesday, June 5th. The lecturer dealt with low tension, high frequency, detector and low frequency circuits, and also with the various forms of coupling.

The Hon. Sec. will be pleased to receive applications for membership.

Headquarters: The Acton and Chiswick Polytechnic, Bath Road, Chiswick.

Hon. Sec.: Horace W. Cotton, 19, Bushey Road, Hayes, Middlesex.

The Willesden Wireless Society.*

The efficiency of his three-valve receiver was demonstrated by Mr. A. G. Greene on June 5th, a novel circuit being employed.

By courtesy of the authorities at the Croydon Wireless Station, the Society will shortly visit the aerodrome, and members wishing to join the party are requested to communicate with the Hon. Sec. at once.

Particulars regarding membership of the Society will be furnished by the Hon. Sec., F. H. H. Coote, 183, Carlton Vale, Kilburn, N.W.6.

The Wireless and Experimental Association.*

A well-sustained discussion on low temperature emission valves took place on May 30th, the subject being introduced by Mr. Voigt. After the discussion Mr. Green described the construction and uses of the hydrometer, and later, Messrs. Joughin and Voigt addressed the meeting on the subject of loud speakers.

The Assistant Hon. Sec., Mr. G. H. H. Horwood, has offered a prize of one guinea for the best substantiated record of the longest distance reception by any member.

Hon. Sec., Geo. Sutton, 18, Melford Road, S.E.22.

Ilkley and District Wireless Society.*

At the Regent Café on May 28th a communication was read from the Radio Research Board (forwarded by the Radio Society of Great Britain), dealing with the fading of signals and "blind spots." Several members have taken up research work in connection with these phenomena.

All interested are invited to attend the meetings and particulars of membership, etc., can be obtained from the Hon. Sec., L. E. Overington, 11, Wilmot Road, Ilkley.

Tottenham Wireless Society.*

A debate took place on Wednesday, May 30th, when the subjects of High and Low Frequency Amplification were discussed. The Chairman opened the debate, and Mr. Ellis and other members contributed. Application for membership will be received by the Hon. Sec., S. J. Glyde, 137, Winchelsea Road, Bruce Grove, Tottenham, N.17.

The Radio Society of Willesden.*

The Society is feeling keenly the loss of its President, Mr. T. H. Illingworth, J.P., whose death has just taken place. Mr. Illingworth was greatly esteemed for the ceaseless interest he manifested in all the activities of the Society.

On May 29th Messrs. Picker and Blunden conducted satisfactory experiments with a view to the organisation of wireless dances by the Society. The membership of the Society is now approximately fifty, but there is still plenty of room for new members. Full particulars of membership can be obtained from the Hon. Sec., F. H. H. Coote, 183, Carlton Vale, Kilburn, N.W.6.

Hackney and District Radio Society.*

At the Y.M.C.A., Mare Street, on Thursday, May 24th, several "waistcoat-pocket lecturettes" were delivered by members of the Society. Mr. O. Elman asked why a horse-shoe magnet held near a valve, appreciably increased signal strength, a question which provoked discussion. Mr. Bell spoke on the elucidation of circuit diagrams, and Mr. Jenkins described, with blackboard illustrations, an experimental two-valve panel of his own construction. The evening concluded with a short lecture by Mr. A. H. Phillips, who spoke on "Seeing by Wireless."

Prior to the formal business of the meeting held on May 31st, the Chairman presented an illuminated testimonial to Mr. E. R. Walker, the Society's first Hon. Sec., who resigned from that position at the end of last year.

Mr. Cunningham reported the success of the Society's demonstration in connection with the National Cycling Union at Woodford.

Mr. Epton concluded the meeting with a comparison of four different makes of L.F. transformers, using a loud speaker for the purpose.

The Hon. Sec. issues an invitation to all Hackney residents interested in radio to attend the meetings, which are held on Thursday evenings at the Y.M.C.A., Mare Street, E.8. Particulars of membership can be obtained from the Hon. Sec., C. C. Phillips, 247, Evering Road, E.5.

Wembley Wireless Society.*

A highly successful exhibition, organised by the Society, was held on Thursday, May 31st. About 100 exhibits were on view, and it is estimated that the number of visitors approached 500. The apparatus was tastefully displayed, the tables being decorated by the lady members of the Society.

A fine collection of high frequency apparatus was displayed by the President, and his wireless clock tuner, which evoked considerable interest, was demonstrated by Mr. H. W. Gregory, who showed a rectifier and model electric train in operation. All types of apparatus were shown, varying from simple crystal sets to elaborate valve models. A number of visitors applied for membership of the Society.

The exhibition was organised by Mr. W. E. Meldrum, assisted by the Hon. Sec., Mr. W. R. Mickelright, of 10, Westbury Avenue, Alperton, Wembley, Middlesex, to whom application for membership should be made.

Leeds and District Amateur Wireless Society.*

"The Electron Theory" was the subject of an instructional lecture delivered by Mr. T. Brown Thomson, on May 25th. In the course of his remarks the lecturer emphasised the importance to the experimenter of a sound knowledge of the electron theory, urging that only with such a knowledge could wireless really be understood.

On June 1st, Mr. S. Kniveton, F.R.Met.Soc., delivered an instructive lecture on "Wireless and Weather Forecasting," illustrated with lantern slides. Mr. Kniveton gave some instructive details of the methods of collection and distribution of meteorological data, and showed how the work was facilitated by the use of radio communication.

Hon. Sec., D. E. Pettigrew, 37, Mexborough Avenue, Chapeltown Road, Leeds.

Seaforth and District Radio Society.

A highly interesting lecture on inductance, capacity and valves was given by Mr. R. Roberts on May 25th.

Several members produced their sets which would not work, but after the attention of a few of the more experienced members the unruly sets were carried away in triumph, in perfect condition.

One or two members are experimenting on various inductance couplings, and if anything matures, it is hoped to publish the results.

Hon. Sec., R. Roberts, 237-9, Crosby Road, Seaforth.

Raymald Wireless Club.

"Inductance and its Relationship to Wavelength" was the title of a lucid lecture given on Thursday, May 17th, by Mr. J. Ayres, who kindly gave his services at short notice in place of Mr. F. Boulden, who was to have lectured on the Club's portable receivers.

Particulars of membership may be obtained from the Hon. Sec., F. E. Baker, 28a, Estella Avenue, New Malden.

The Sydenham and Forest Hill Radio Society.

On May 7th a lecture on "Elementary Electricity" was delivered by Mr. W. V. Pegden (Chairman). Appreciation of the lecture was evinced by the proposal that the Chairman should deliver a similar lecture each month throughout the year.

Hon. Sec., M. E. Hampshire, 139, Sydenham Road, S.E.26.

Winchester Wireless Society.

The Society continues to meet on Tuesdays and excellent progress is being made with constructional work. A four-valve set is being built, and a special terminal panel will be employed so as to allow for easy change of circuits.

A special campaign against re-radiation is being organised by the Society, and non-members are being asked to adopt circuits which will give good results without the objections now existing.

Hon. Sec., A. Parsons, 65, Cromwell Road, Winchester.

Uxbridge and District Radio and Experimental Society.

On June 1st Mr. Bailey demonstrated with a compact and efficient pocket two-valve set, the Radiola Concert being well received from Paris. By kind permission of the Marconi Company Mr. Piper exhibited different types of valves, including a 1½ kilowatt transmitting valve and a rectifying valve of the kind used at the London Broadcasting Station. Mr. Bailey then gave a lucid explanation of his seven-valve amplifier.

Hon. Sec., J. R. M. Day, 10, Cowley Road, Uxbridge.

The Beckenham and District Radio Society.

The Society held a successful meeting on Thursday, May 31st, the first part of the evening being devoted to the construction of their new set. Later a paper was read by Mr. Hugget on "Comparisons of American, German and English Broadcasting."

Before the conclusion of the meeting the Chairman stated that he had pleasure in announcing that the local "broadcast spoiler" had been traced and the meeting agreed that the matter should be reported to the General Post Office.

Hon. Sec., J. F. Butterfield, 10, The Close, Elmers End, Beckenham.

South Dorset Radio Club.

The above is the name of a new Club, formed at the Guildhall, Weymouth, on April 27th. The Club is fortunate in having as its President, His Worship the Mayor of Weymouth (Councillor W. J. Gregory).

Weekly Morse classes are being held and lectures have been arranged for early dates.

A hearty welcome to membership is extended to all in the district who are interested in wireless or allied subjects, and particulars can be obtained from the Hon. Sec., E. B. Cartwright, 18, Newberry Terrace, Rodwell, Weymouth.

The Southampton and District Radio Society.

The Society's new aerial is now in use, and on May 31st Dr. McDougall gave a successful demonstration with his five-valve experimental panel and loud speaker, constructed by himself. The set comprised two H.F. (tuned anode), one rectifying and two L.F. valves.

Six new members were elected, which is indicative of the growing enthusiasm of the local amateurs.

Headquarters, Y.M.C.A., Ogle Road, Southampton.

Hon. Sec., P. Sawyer, 55, Waterloo Road, Southampton.

Ashton-under-Lyne and District Radio Society.

The Society's meetings during June are being devoted to general discussions and experiments, and members with faulty sets are being given an opportunity to have them examined and adjusted by competent members of the Committee.

A field day during the summer months has been suggested.

Hon. Sec., James Hy. Marshall, 22, Warrington Street, Ashton-under-Lyne.

Notes and News

A broadcast programme from Glasgow has been enjoyed 330 feet below ground at Dykehead Colliery, Larkhall, 15 miles distant. A four-valve set was used.

* * * *

Radio chess as a pastime for passengers has been inaugurated by the steamers *Western World* and *American Legion* in the South American service.

* * * *

The South Carnarvonshire Village Club Association is proposing to install wireless apparatus in several village halls for the coming autumn.

* * * *

Regular communication by means of radiotelegraphy has been established between Bulgaria and Russia (Moscow).

* * * *

The Postmaster-General is considering, in conjunction with the British Broadcasting Company, arrangements for providing broadcasting facilities at or in the neighbourhood of Plymouth.

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Senatore Marconi's Experiments.

On June 14th Senatore Marconi arrived at Southampton on his yacht *Electra* after two months' experimenting at Funchal and Cape Verde. It is understood that his researches have been devoted to directional wireless telegraphy and the elimination of interference.

Scientific Jubilee of M. Branly.

An interesting festival took place at the Trocadero, Paris, on June 7th, when the jubilee of M. Branly's entry into scientific research was celebrated. M. Branly had an enthusiastic reception from the distinguished company present, which included eminent personages in politics, science, art and literature. The illustrious inventor, whose name is so closely associated with development of the coherer, delivered a lecture on the scientific wonders to which wireless would pave the way.

Tributes of praise were paid by M. Berthelot, M. Laffont (Under-Secretary of State for Posts and Telegraphs), and M. Berard (Minister of Instruction).

French Amateurs Heard in Berkshire.

Mr. Vyvyan A. G. Brown **(6 JZ)**, of Reading, reports that he has heard the following French experimenters :—

8 AY	**8 BF**	**8 BM**
8 AQ	**8 AS**	**8 BN**
8 BQ	**8 ZZ**	**8 AB**

The Dutch amateurs **0 MX, 0 BQ, 0 RX** and **0 DV** have also been heard, besides the Copenhagen transmitter **7 JS.**

Suggestions for 2 LO.

Suggestions regarding broadcasting were incorporated in a letter to **2 LO** which the Hon. Sec. of the Wireless and Experimental Association was requested to send on June 6th.

The following four questions were addressed to the British Broadcasting Company : (1) Would it be possible, when **2 LO** is closing down for one minute or more, to switch off the carrier wave ? (2) Would the Company consider the broadcasting of a suggestion to licensed amateurs that they should refrain from transmitting during the " close down " half-hour ? (3) Could the call sign of the Broadcasting station always be used before and after each item ? (4) Would necessary Sunday testing be kept down to a minimum ?

The Secretary was instructed to assure the B.B.C. that the communication was not sent in a censorious spirit, but with the desire of arriving at harmonious working.

King of Spain's Wireless Wager.

The progress of wireless on aircraft was illustrated by an amusing incident which occurred during recent military manœuvres at Seville. His Majesty the King of Spain is well informed in most military matters, but on this occasion he expressed some doubt as to the efficiency of wireless communication between aircraft in flight and ground stations. He made a sporting bet with a member of his household that intelligible speech would be impossible, and took charge of the Marconi ground station. Speech came through remarkably clearly, however, and he expressed delight that he had lost his bet.

H.M. The King of Spain listening to speech from an aeroplane in flight.

B.B.C.'s New Assistant Chief Engineer.

Captain A. G. D. West, B.A., B.Sc., has been appointed Assistant Chief Engineer of the British Broadcasting Company. During the war Captain West was wireless experimental officer in the Royal Air Force, and conducted research in short wave direction finders. At Cambridge he secured first-class honours in mathematical tripos, parts I and II, and in October, 1922, he obtained first class honours in B.Sc. (London). He is now investigating the possibilities of a relay broadcasting station in the Sheffield area.

Royal Air Force Aerial Pageant.

Stirring incidents in which wireless will feature, are to take place at the Royal Air Force Pageant on Saturday, June 30th, at the London Aerodrome, Hendon. The outstanding event will be a thrilling rescue of a beleagured garrison by air, based on an actual occurrence which took place last year at Iraq. The incident will centre round the holding of an important railway bridge which is protected by a small military post. Hostile troops attack strongly, and a wireless message for assistance is therefore sent to the R.A.F. headquarters. While the garrison is being evacuated, fighting aircraft attack the enemy, successfully covering the retreat, and permitting the demolition of the bridge.

Tickets for the pageant can be purchased from the leading agencies and libraries. Boxes for six cost £4, £5 and £7, and tickets are available at 5s. and 10s. Tickets for the 2s. enclosures are obtainable only at the Aerodrome on the day of the pageant.

Birmingham Broadcasting Heard in U.S.

An instance of long distance daylight broadcasting has been verified by the B.B.C. On April 12th a Mr. Harry New, of 1,419 East Hewson Street, Philadelphia, picked up an orchestral selection at 7 a.m. On seeing a London newspaper for that date, Mr. New surmised that the item emanated from Witton, which would at that time be giving its midday transmission. His conjecture has been confirmed by the Birmingham Station authorities.

New P.M.G. on Wireless.

Referring to pressing problems to be tackled, Sir Laming Worthington-Evans (Postmaster-General) speaking at Exeter recently, mentioned "the present and future of that young and lusty national interest, broadcasting, and the question of Imperial wireless communications." Where so much was at stake, said Sir Laming regarding both these important questions, decisions would not be taken without mature reflection, and he would devote himself to finding solutions that would satisfy everybody concerned.

FORTHCOMING EVENTS

FRIDAY, JUNE 22nd.

Leeds and District Amateur Wireless Society. Lecture by Mr. A. M. Bage (President).

Radio Society of Highgate. At 7.45 p.m. At the 1919 Club, South Grove, N.6. Lecture: "Why Oscillatory Circuits Oscillate," by Mr. J. F. Stanley, B.Sc.

Bath Radio Club. At 8 p.m. Lecture: "Batteries, H.T. & L.T.," by Mr. L. E. R. Boxwell.

SATURDAY, JUNE 23rd.

Grimsby and District Radio Society. "Radio Tea" and Outing at Ashby (particulars from M. M. Bennett, Wellowgate, Grimsby).

MONDAY, JUNE 25th.

Sydenham and Forest Hill Radio Society. At 8 p.m. Lecture: 'The Thermionic Valve," by Mr. C. A. Percival (of Ediswan's).

North London Wireless Association. At 8.30 p.m. Lecture: "Armstrong Supersonic Heterodyne," by Mr. E. H. Robinson.

WEDNESDAY, JUNE 27th.

The Radio Society of Great Britain. At 6 p.m. (tea at 5.30). At the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, W.C.2. General meeting. Lecture: "Atmospherics" (with Experimental Demonstration), by Mr. R. Watson Watt.

Clapham Park Wireless Society. At 7.30 p.m. Popular lecture: "Lightning Discharges" (lantern illustrations and demonstrations with model buildings), by Mr. Alfred Hands, F.R.Met.S. (authority in lightning protective systems).

Swansea and District Radio Experimental Society. Lecture by Mr. Benson, A.M.I.E.E., A.M.I.Mech.E.

Portsmouth and District Wireless Association. Lecture: "Choosing a Set," by Mr. J. H. C. Harrold, M.I.R.E.

Wolverhampton and District Wireless Society. Visit to Birmingham Broadcasting Station.

THURSDAY, JUNE 28th.

Newport and District Radio Association. Lecture: "Humours of Listening-in." By Mr. G. L. Betts.

St. Pancras Radio Society. At 7.30. At the Working Men's College, Crowndale Road, N.W.1. Inaugural Meeting.

Luton Wireless Society. At 8 p.m. At the Hitchin Road Boy's School. Lecture and Demonstration: "The Flewelling Circuit," By Mr. E. Plater.

Wireless Health Hints.

Public health information has now been regularly broadcast in the United States for twelve months. The service is under the control of the Public Health Department, and it is estimated that, directly or indirectly, the information has reached 27,000,000 people in the United States alone. These messages are translated in various languages by the Foreign Language Information Service, and correspondence on the subjects dealt with has been received from as far away as Czecho-Slovakia.

H.P.R. Wireless, Ltd.

This Company, formerly of Carlton House, Great Queen Street, W.C.2, has now removed to 10, Lancaster Place, Strand, W.C.2.

Messrs. The Clayton Rubber Co.

The address of the above is Croft Street, Clayton, Manchester, and not Crofton Street, as erroneously stated in the Company's advertisement appearing on page xvi of the issue of this Journal for June 9th.

British Wireless Relay League.

In order that a complete record of amateur transmissions may be secured, the members are requested to keep a regular log showing times, wavelength, etc., of all such transmissions. Extracts from these logs should be sent to the Traffic Manager in the manner suggested by the following example:—

B.W.R.L. Station **2 ZZ.**

Stations heard.

May 1st	**2 PQ**	440	C.W. and Tel.
,, ...	**5 MH**	250	C.W.
,, ...	**5 LT**	440	C.W.
,, ...	**6 HH**	435	C.W.

May 5th	**2 AL**	440	Tel.
,, ...	**2 PT**	180	Tel.
,, ...	**2 HF**	200	C.W. and T.T.
,, ...	**5 CR**	185	C.W. and Tel.

Stations Worked.

May 1st	**2 PQ**	C.W. and Telephony.
May 7th	**2 HQ**	Telephony.

General Remarks—

Following any special tests, notes on abnormal atmospheric conditions, with general data on fading, etc., will be welcomed, and extracts will be published for general information, or issued for members' perusal only. Foreign amateurs' calls should also be recorded with short and concise remarks on the quality of reception.

Circuit diagrams will only be published by permission of the members submitting them, such consent being notified on the diagrams. If it is desired that a description of the station should be published, this should be outlined as briefly as possible, and accompanied by one or two photographs or circuit diagrams.

Questions should be addressed to the Hon. Secretary, Offices of *The Wireless World and Radio Review*, who will arrange for the replies to be published or answered by post as convenient.

Members wishing to carry out special distance tests should apply to the Traffic Manager, giving the approximate range of transmission, whether C.W. or Telephony, and the most convenient time. These tests will be arranged by post, and any special results will be reported in the League Section.

Attention is called to the P.M.G. regulations regarding amateur transmissions, and any serious breach should be reported to the Hon. Secretary.

The co-operation of the League in reducing interference during broadcasting hours will be appreciated by the authorities, and every effort should be made to assist novices in the matter of radiating receiving sets. In return for this slight service we may rest assured that the interests of the amateur will not be overlooked.

In conclusion, members are informed that this Journal will record all activities of the League, of which it is the official organ.

Y. W. P. EVANS, *Traffic Manager.*

Broadcasting.

Regular Programmes are Broadcast from the following European Stations :—

Locality.	Call Sign.	Wave-length.	Times.	Nature of Transmission.
GREAT BRITAIN.				
London ..	**2 LO**	369	Weekdays 11.30-12.30 a.m.* 5.30-11p.m. Sundays 8.30-10.30 p.m.	Regular morning and evening programmes, particulars of which appear in the daily press, are conducted from these stations by the British Broadcasting Company.
Manchester	**2 ZY**	385		
Birmingham	**5 IT**	420		
Cardiff ..	**5 WA**	353		
Newcastle ..	**5 NO**	400		
Glasgow ..	**5 SC**	415		
		*5 IT	3.30-4.30 p.m.	
FRANCE.				
			Daily	
Paris (Eiffel Tower).	**FL**	2,600	6.40 a.m. ..	Meteorological Forecast.
			11.15 p.m. ..	,, Report and Forecast.
			3.30 p.m. ..	Financial Bulletin (Paris Bourse).
			6.20 p.m. ..	Meteorological Forecast and Concert.
			10.10 p.m.	Meteorological Report and Forecast.
			Sundays	
Levallois-Perret (Radiola).	**SFR**	1,780	2-3 p.m. ..	Concert.
			Weekdays	
			5.5 p.m. ..	Financial Bulletin.
			5.15-6.15 p.m.	Instrumental Music.
			8.45 p.m. ..	Miscellaneous News.
			9.30-10.30 p.m.	Concert.
Ecole Supérieure des Postes et Télégraphes.	—	450	Tuesday and Thursday 7.45-10.0 p.m.	Concert.
			Saturday 2.30-7.30 p.m.	,,
			Daily	
Lyons ..	**YN**	3,100	Weekdays 10.45-11.15 a.m.	Gramophone records.

Locality.	Call Sign.	Wave-length.	Times.	Nature of Transmission.
HOLLAND.				
			Sunday	
The Hague	**PCGG**	1,050	3-5 p.m. ..	Concert.
			Monday and Thursday 8.40-9.40 p.m.	,,
			Tuesday	
The Hague (Heussen Laboratory).	**PCUU**	1,050	7.45-10 p.m.	,,
			Sunday 9.40-10.40 a.m.	—
			Friday	
The Hague (Velthuyzen).	**PCKK**	1,050	8.40-9.40 p.m.	Miscellaneous.
			Saturday	
Ijmuiden ..	**PCMM**	1,050	8.40-9.40 p.m.	Concert.
			Wednesday	
Amsterdam	**PA5**	1,050	8.10-9.10 p.m.	Concert and News.
BELGIUM.				
			Working days	
Brussels ..	**BAV**	1,100	12 noon ..	Meteorological Bulletin.
			Daily 4.50 p.m. ..	,, ,,
			Sunday 6 p.m. ..	Concert.
			Tuesday and Thursday 9 p.m. ..	,,
GERMANY.				
			Daily	
Berlin (Koenigs-wusterhausen) ..	**LP**	2,800	7-8 a.m. ..	Financial & other news.
			12-1.30 p.m.	,, ,,
			5-6.30 p.m.	,, ,,
CZECHO-SLOVAKIA.				
Prague ..	**PRG**	1,800	8a.m.12noon and 4 p.m.	Meterological Bulletin and News.
		4,500	10a.m..3p.m. and 10 p.m.	Concert.
SWITZERLAND.				
			Daily	
Geneva ..	**HB 1**	1,200	6-7 p.m. ..	Concert (" Utilitas ").
Lausanne ..	**HB 2**	—	6-7 p.m. ..	,, ,,

PITFALLS FOR BEGINNERS*

By Percy W. Harris.

In choosing as my subject "Pitfalls for Beginners," I hope the word "pitfall" will not be interpreted too literally. Of course, properly used, the word "pitfall" means a hole in the ground carefully dug by a hunter, lightly covered over at the top with brushwood, leaves and grass so as to appear like the ordinary ground. With the hunter hidden near by, the unsuspecting animal walks on to the grass and brushwood, whereupon the whole lot collapses, the animal falls to the bottom, and is thereupon safely captured.

Of course, the kind of pitfalls we find in wireless are not exactly of this variety, but many of them let us down rather badly and cost both time and money before we get out. It occurred to me that the associate members might like to hear of a few of the pitfalls which are not generally mentioned in text-books, but which come the way of practically every serious experimenter sooner or later. Of these the most difficult and dangerous are the mental pitfalls.

Before long almost every broadcast listener wants to know something of the way in which his apparatus works, and fortunately he has available both books and societies from which he can learn the rudiments of the art. A little later he will, perhaps, desire to build his own apparatus, and here again he will find the information he requires readily available.

In every one of us there lives what Edgar Allen Poe has called the "Imp of the Perverse." It is more than likely that the beginner will want to vary some point of the design which has been recommended to him, and here he will be treading on the brushwood round the hole. He may not like the position of one of the components, and will forthwith place it on the opposite side of the box. Having done this, he will perhaps introduce a Dewar switch to cut off one of the valves, and then, having spent a little more than he originally intended, he will perhaps attempt to economise on the ebonite. The net result will be that when the set is connected up it will either refuse to work or else give out a glorious howl which will be the envy of every dog for miles.

This perverseness of human nature, and the tendency to alter things, is not in itself a habit that can be blamed. Without it there would be little progress made. But the advice I would give to every beginner who is making his own set for the first time is to follow carefully, even slavishly, the design chosen until he has once made it work in the way described by the author. When he has done this there is little harm in experimenting, for he will have obtained the results for which the set was designed, and may be able to find an improvement. The more thought one gives to a set the better, as few improvements are the result of blind chopping and changing. If you have reasons for thinking something may be improved by changing it, by all means try.

There is one very important pitfall of which every beginner should beware. Do not be put off your experiments by people who will give you a hundred and fifty reasons why your proposed scheme will not work. Six times out of seven they will be right, but the seventh is the time when you will score. If you want to know whether a thing will work, do not ask the other fellow, but if you possibly can, try for yourself.

In the course of an interesting paper on the history of wireless, delivered at the last meeting of this Society by Mr. G. G. Blake, reference was made to the work of Hughes, who very nearly discovered wireless years before Marconi or even Hertz. I would like, with your permission, to give a few extracts from a letter written by Hughes describing his work.

Hughes' Experiments.

In 1899 Mr. J. J. Fahie was engaged in the preparation of a history of wireless telegraphy from 1838 to 1899. Sir Wm. Crookes had told him that he (Crookes) had seen some experiments by Hughes many years before in which he signalled from one part of the house to another without the aid of wires. Mr. Fahie accordingly wrote to Hughes and pressed him to publish his results. In reply, Hughes wrote this letter, which I take the liberty of quoting, as it shows in a remarkable way the danger of allowing oneself to be dissuaded from experimenting by others who appear to know a great deal about the subject but who are not themselves experimentally inclined. The letter runs to some 1,500 words, and describes in detail the experiments Hughes had carried out.

Here, for example, is a portion of the letter which shows how close Hughes came to discovering how to propagate free electric waves at least six years before Hertz published his monumental work. "Further researches," says Hughes, "proved that an interrupted current, in any coil, through which an electric current was sent, gave out at each interruption of the primary current such intense extra currents that the whole atmosphere of the room (or in several rooms distant), would have a momentary invisible charge, which became evident if a microphone joint was used as a receiver to a telephone. This led me to experiment upon the best form of receiver for these invisible electric waves, which evidently permeated great distances, and through all apparent obstacles, such as walls, etc." He then describes a number of forms of receiver. Later he says, "I will not describe the numerous forms of transmitter and receiver that I made in 1879, all of which I wrote down in several volumes of manuscripts in 1879 (but these have never been published) most of which can be seen here at my residence at any time, but I will confine myself now to a few salient points. I found that very sudden electric impulses, whether given out to the atmosphere through an extra current from a

* Lecture delivered at the Radio Society of Great Britain to Associate Members on Monday evening, May 14th, 1923.

coil, or from a frictional electric machine, equally affected the microphone joint, the effect depending more on the sudden high potential effect than any prolonged action. Thus a spark obtained by rubbing a piece of sealing wax was equally as effective as a discharge from a Leyden jar battery of the same potential. The rubbed sealing-wax or charged Leyden jar, had no effect until they were discharged by a spark, and it was evident that this spark, however feeble, acted upon the whole surrounding atmosphere in the form of waves or invisible rays, of which I could not at the time determine. Hertz, however, by a series of original and masterly experiments, proved in 1887-9, that they were real waves similar to light, but of a lower frequency, though the same velocity." He then describes further interesting experiments.

"In December, 1879," continued Hughes, "I invited several persons to see the results obtained. Among others who called on me and saw my results were Mr. W. H. Preece, F.R.S., Sir William Crookes, F.R.S. (this was the visit to which Crookes referred when writing to Fahie), Sir W. Robert Austin, F.R.S., Professor W. Gryll Adams, F.R.S., Mr. W. Groves . . . They all saw my experiments on aerial transmission, as already described, by means of the extra current produced from a small coil and received upon a semi-metallic microphone, the results being heard upon a telephone in connection with the receiving microphone. The transmitter and receiver were in different rooms, about 60 feet apart. After trying successfully all distances allowed in my residence in Great Portland Street, my usual method was to put the transmitter in operation and walk up and down Great Portland Street with the receiver in my hand, with the telephone to the ear.

"The sounds seem to slightly increase for a distance of 60 yards, then gradually diminish until at 500 yards I could no longer with certainty hear the transmitted signals. What struck me as remarkable was that opposite certain houses I could hear better whilst at others the signals could hardly be perceived . . . .

"The President of the Royal Society, Mr. Spottiswoode, together with the two Hon. Secretaries, Prof. Huxley and Prof. G. Stokes, called upon me on February 20th, 1880, to see my experiments upon aerial transmission of signals. The experiments shown were most successful, and at first they seemed astonished at the results, but towards the close of three hours' experiments, Professor Stokes said that all the results could be explained by known electromagnetic induction effects, and therefore he could not accept my view of actual aerial waves unknown up to that time, but thought I had quite enough original matter to form a paper on the subject to be read at the Royal Society.

"I was so discouraged at being unable to convince them of the truth of these aerial electric waves, that I actually refused to write a paper on the subject until I was better prepared to demonstrate the existence of these waves; and I continued my experiments for some years in hopes of arriving at a perfect scientific demonstration of the existence of aerial electric waves . . . . The triumphant demonstration of these waves was reserved to Professor Hertz, who by his masterly researches upon the subject in 1887-9, completely demonstrating not only their existence, but their identity with ordinary light . . . . Hertz's experiments were far more conclusive than mine, although he used a much less effective receiver than the microphone or coherer. I then thought it was now too late to bring forward my previous experiments, and through not publishing my results, and means employed, I have been forced to see others remake discoveries I had previously made as to the sensitiveness of the microphone contact, and its useful employment as a receiver for aerial electric waves."

The extracts I have read to you are taken from the full letter which has been preserved by Sir Oliver Lodge in the later editions of his book, "Signalling Through Space without Wires." To me they seem to carry a very important lesson to every wireless experimenter. If we feel we are working along the right lines and are obtaining results which have not hitherto been published, we should carefully record them, not allow ourselves to be dissuaded from the work by others who fail to grasp their significance. I know it is hard to keep on working when others with much more experience make little of what we are doing, but there are many glorious examples to follow. Take Marconi himself. He was little more than a boy when he produced his first working wireless telegraph, and many superior scientific personages endeavoured to persuade him he was wrong. His attempts to span the Atlantic with wireless signals were looked upon as particularly good evidence of his ignorance of fundamental principles, for it was obvious that the curvatures of the earth would effectively prevent any such passage of the waves.

The same scientific worthies were not greatly worried when Marconi did succeed. They soon provided adequate theories to account for his success, as they will always provide theories when the work is already done. As a third example, take the case of Armstrong, the young American student. Reaction, as you know, was practically simultaneously invented in England and America. In America, Armstrong is officially recognised as the inventor of reaction. When he discovered the new principle, Armstrong was still a college student, and realising that he had really discovered something of importance, he endeavoured to persuade his father to lend him the money to take out a patent. His father, however, could not agree to such waste of money. He probably adduced all the arguments brought out at such times—Armstrong's youth, his lack of knowledge of the world, the fact that scientists much older than he, and who had been studying the subject before he was born, had not yet discovered it, showed it could not be much use, and so forth. Yet Armstrong still kept his faith, and a friend suggested to him that it might be useful to write out a description of the invention, with drawings, and have it dated and witnessed before a notary public, or whatever the corresponding official is called in America, so that his priority of invention might be proved. Several years later, when the question was brought into the courts, this signed and witnessed document proved all-important, and the Judge decided that the date on the document could be taken as the date of the invention.

It is quite a mistaken idea to think that no inventions of importance can be produced unless the inventor has spent years in studying the subject.

Of course a good groundwork of principles is required, but after that originality of thought is the prime requisite. We all need to cultivate a divine curiosity, a habit of always asking ourselves " why?" and a fear of taking too much for granted. And at this point I should like to say a few words on the subject of theory and practice, and the pitfalls that lie in that direction.

There is a tendency among some people to look upon what is generally broadly entitled " theory " as something absolute, something which is the final arbiter in all things. There is presumed to be some mysterious source of information from which all can draw, and of which, when one has enough of it, it is possible to predict what may happen—indeed what *will* happen, in any given set of circumstances. Indeed, from the way some people talk, one would gather that there is no need for experimental work at all, as they can always tell you beforehand what is going to occur in your experiments.

If we take all the facts we can gather regarding a particular subject, arrange these facts in order and in kind, we shall soon see that from the facts we have we can deduce certain principles or laws. If, for example, every man we saw in the Strand one afternoon had red hair, we might fairly assume that all the male inhabitants of London were red-haired. We should deduce this law from the facts available to us. And of course, seeing only those people who passed down one thoroughfare in one afternoon, we should be judging on only a very small proportion of London's population.

This, of course, is rather an absurd instance, but it illustrates the point I want to make. Let us take something more closely related to wireless. Take single-circuit tuners, of the kind that are found in most Broadcast receivers.

Now, judging from the facts available, single circuit tuners are the reverse of selective. With them it is not possible to cut out the local broadcasting station while listening to one of the others. By local I mean within four or five miles. But because the existing instruments with single circuits are non-selective, we must not necessarily assume that single circuit tuners will never be selective. All we can say is that the present ones are not very satisfactory.

A well-known wireless experimenter and expert, Dr. McLachlan has recently brought out a very remarkable relay working on a new principle. Briefly, it consists of an iron drum with windings and on this drum runs an iron shoe. When current is passed through the windings the drum becomes a magnet, whereupon the iron shoe is attracted and sticks, being pulled forward instead of allowing the drum to run under it as it does when no current is flowing. Nothing very wonderful in this, you say ? Nothing except that the pull exerted by this magnetic grip is many times greater than is theoretically calculable. It is just one more example of the danger of accepting too readily what we are told. The theory available has obviously been based on too few facts.

Just to show how readily we accept what we are told, take the case of the plug and socket fitted to the well-known multi-layer coils. It was, I believe, first brought out by de Forest, and is now a standard fitting on all duolateral, honeycomb, lattice and similar interchangeable coils. This plug is often termed a " non-reversible " plug, as the coil cannot be fitted the wrong way round. It is thought that if the plug carried two equal pins and the socket two equal sized holes, the coil would often be connected the wrong way round. What we all overlooked until recently was that if we pull out the coil, turn it round, and insert it once more in the socket, we shall not only have reversed the connections, but the turning of the coil will have altered the direction of the magnetic field to compensate, so that the polarity will be precisely the same again ! This may not be very clear without a diagram, but you will understand it if you think of the analogy of the commutator of a dynamo.

The real trouble in wireless is that there is so much work to do, so much new work, that we are often glad to accept incomplete theories to help us on our way. But these theories are often good walking sticks and bad crutches. They need constantly revising in the light of later discoveries and new facts.

I am afraid I have been laying too much stress upon this aspect of the subject. Let us take some further pitfalls likely to give trouble.

One of the most amusing points about the average amateur installation is the pains taken by the installer to use thick wire (sometimes very heavy rubber-covered cable) for his lead-in, while in the tuner attached to this the aerial tuning inductance is perhaps wound with No. 26 wire. In the circumstances he might as well use No. 26 wire for the lead-in. While this is not exactly a pitfall, it illustrates the need for clear thinking about every point in our installation. It is quite useless trying to make our lead-in wire of low resistance if the tuner itself is of a resistance much higher. I am inclined to think that the resistance of receiving tuners is a matter which might receive the attention of experimenters, as the use of reaction does not truly compensate for the losses so occasioned.

There are a large number of pitfalls in the way of the beginner when we come to deal with the subject of valves. At present we have on the market a number of different makes, and of different varieties of the same make. Each make and each type has its partisans. One often hears a member of a wireless society praising one kind and heavily condemning another, when neither his praise nor his condemnation are justified.

Receiving valves are used for several purposes. We can, for example, use them for high frequency amplification, low frequency amplification, detection or oscillation. Some valves are excellent as detectors, but very poor as amplifiers. The little Dutch valve now generally obtainable is an example. Some make very good note magnifiers, but are useless as high frequency amplifiers, and so on. Some valves are good for all-round work, such as the " R," the " Ora," and the Ediswan " AR."

Now without attempting to discuss the relative merits of different makes of valve, let us take two popular makes of valve, the " R " and the " Ora," and interchange them. The " Ora " works on a comparatively low plate voltage. Let us assume we have three " Ora " valves in a set with, say, 36 volts on the plates. We will assume that good results are being obtained. Now let us substitute three " R " valves, leaving the plate voltage the same. What happens ? The results obtained with the "R" valves are very poor indeed. From this the beginner might be inclined to think that the "Ora" was by far and away the better valve.

Now let us take another three-valve set with three "R" valves, with 60 or 70 volts on the plate, this being the figure at which these valves work very satisfactorily. We will again assume good results are being obtained. Now substitute for the "R" valves three "Ora" valves. What is the result? The results may be poor. This might lead us to think that the "R" is much better than the "Ora," whereas the last experiment suggested the reverse. If you think the matter over, you will see that unless we use a valve with the plate voltage suitable for it, we shall not get the best results with any make. I have often heard different makes wrongly condemned for no other reason.

Mixing valves in a multivalve set is often the cause of trouble. In most amateur and professionally built apparatus one high tension battery serves for high frequency, detecting and low frequency valves, and the beginner, hearing, for example, that the Dutch valve is good for detecting, and the "R" for high frequency, places these valves in their respective sockets, and runs them off a 60-volt battery. Now 60 volts is much too high a plate voltage for the soft Dutch valves, and anything much less is too low for the "R" type so it is quite useless mixing these two kinds if one high tension battery is to be used for both.

There are a number of special pitfalls when we come to consider loud speakers. Contrary to the general belief, most loud speakers do not greatly distort speech and music. The distortion usually attributed to them is, in nine cases out of ten, due to the note-magnifiers used with them. My present loud speaker has been highly praised by visitors, who often say how different it is from the "ordinary" loud speakers which sound so "tinny." It is, of course, a good instrument, but I have often heard it condemned by others when used on other sets. However good the loud speaker, it cannot possibly correct distortion due to faultily designed note magnifiers.

If we want to get the best out of a loud speaker we must first of all provide it with distortionless speech and music, and, secondly, we must avoid overloading it. No matter how good the design of the receiving instrument, we shall get distortion if we use too many valves for the distance at which we are situated from the broadcasting station. To use a seven-valve set on a full-sized outdoor aerial for the reception of London at, say, Hampstead, is not merely asking for trouble—it is a perfect guarantee of getting it.

As a fairly safe rule we may reckon that two more valves than are necessary for good reception in the telephones, are needed to work a loud speaker. Within a dozen miles of a broadcasting station a detector valve with two note magnifiers is quite sufficient to work a loud speaker in a good-sized room. A crystal detector and two note magnifiers are also a good combination for this distance. As things are at present, and unless we use one of the specially designed power amplifiers, we cannot work more than two note magnifiers without getting distortion, at least that is my experience.

For this reason if two note magnifiers do not give sufficient strength when added to a detector valve, it is best to bring up the strength by adding high frequency valves. This will enable magnification to be obtained with a minimum of distortion.

With the exception of the special loud speakers made for filling very large halls, there is a limit to the power a loud speaker will handle without distortion. Most of them are really specially designed telephones with magnets and diaphragms similar to the earpiece type of telephones. If signals are too strong, the diaphragm will be overstressed and bad distortion will occur. Overloaded loud speakers are too often heard nowadays, especially in demonstrations in public halls, organised by those who do not understand how to make the best of the apparatus. If great volume is required, it is wise either to use a special electrodynamic loud speaker, or else a number of ordinary loud speakers in parallel. This latter method is very satisfactory, but very expensive.

There are many pitfalls connected with the use of ebonite. This substance, when pure, is a remarkably good insulator, but even with the best qualities the surface is frequently a poor insulator. To obtain the high gloss so frequently seen on the surface of ebonite, it is sometimes rolled hot between sheets of tinfoil. A very minute and invisible layer of this tinfoil (of course a conductor) is sometimes left on the surface of the ebonite, and of course makes a conducting path. In all cases the surface of the ebonite should be removed by rubbing with fine emery paper, using a circular motion.

At the present time there is a lot of black rubbish on the market masquerading as ebonite. Several sets made up from designs for which I have been responsible have been brought to me in the last few months for an explanation of why they would not work. The builder had found that on listening in the telephones, he has heard nothing but a continuous rushing and frying noise. In each case I have traced the trouble to poor ebonite, and when it has been taken out and a new panel substituted, the set has worked very satisfactorily and without further trouble.

Good ebonite is expensive stuff, and for this reason it is surprising that the average amateur uses such great quantities of it in his set. It is particularly absurd to buy a large sheet of ebonite for, say, an Armstrong Super-regenerative receiver, drill it out and mount the component parts, and thereupon cover practically the whole of the back of the panel with copper or tin foil to avoid hand capacity effects. In such a case it would be cheaper to make a metal panel and fit it with insulating bushings where necessary.

It is surprising how much ebonite you can dispense with in a wireless receiver without losing efficiency, and I recommend every home builder of apparatus who wants to make a good set with the minimum of expense to review his design carefully to see whether he can dispense with at least three quarters of the ebonite originally allowed for. It should not be difficult to do so.

There are also many pitfalls in connection with soldering. I know it is the custom to recommend beginners to avoid using any of the soldering pastes which are so largely advertised, but my own experience is that none of them is harmful if carefully applied in minimum quantities. The most important point in connection with soldering is to use everything in a clean condition—soldering bolt, solder and the object to be soldered. The last should be filed clean before the hot bolt is applied. If an excess of flux is used, it will melt and run over the ebonite or other insulating substance used, forming a high resistance leak and occasioning loss of signal strength.

Contrary to what might be expected, I have always found that a large and heavy soldering bit is easier to use in instrument making than the small and light bolts now sold for the purpose. The small bolts hold very little heat, and almost as soon as the bolt is applied to the screw or wire to be soldered, it has cooled down below a useful temperature. The large bolts, on the other hand, hold the heat for a considerable time and enable one to proceed with one's work at leisure. Very frequently it is necessary to solder a wire to the end of a screw which passes through ebonite and generally the screw is held tight with a nut. It is unfortunate that if we heat this screw it will almost always loosen in the ebonite, and for this reason all nuts should be retightened after the soldering operation is over. It is very disheartening to finish a carefully made set and find that after it is fixed in its cabinet work several of the terminals are loose in the ebonite.

These then are a few of the pitfalls which the beginner may encounter in wandering through the woods of wireless. I am afraid that in this paper they have been dealt with in rather a jumbled way, without indicating their relative importance. It is possible, however, that these few scrappy notes may save some of our newer members from making the mistakes which the older members have learned to avoid by expensive experience.

QUESTIONS AND ANSWERS

"RADIO" (Mon.) *asks* (1) *For a diagram of a six-valve set with two high frequency, detector, and three low frequency valves, using components which he has listed.* (2) *For the maximum and minimum wavelengths of a variable H.F. transformer having eight slots.* (3) *Suggestions why he receives no telephony using the circuit given in Fig. 5 in our issue of October 21st.* (4) *Using H.F. transformers with a stated band of wavelengths when tuned with a* 0·00025 *mfd. variable condenser, what would be their maximum and minimum wavelengths when tuned with a* 0·0005 *mfd. variable condenser.*

(1) The diagram is given in Fig. 1. (2) The particulars you give of this transformer are not sufficiently detailed for us to give you an approximate figure for its maximum and minimum wavelengths, but we suggest as a probable range 150-1,500 metres. (3) The aerial tuning inductance requires a variable condenser in parallel with it in this circuit, and the primary windings of each of the H.F. transformers should preferably be tuned with a variable condenser of 0·0002 mfd. maximum capacity. In your list of components you do not show that you possess these essential items. (4) In practice we think you will find that a condenser of 0·00025 capacity is the most suitable value for use across the primary winding of a H.F. transformer. For reception on higher wavelengths another H.F. transformer with windings designed for that wavelength will be found necessary. When using the 0·0005 mfd. condenser, the minimum wavelength may be raised a little, and the maximum wavelength will be raised by 1·4 times.

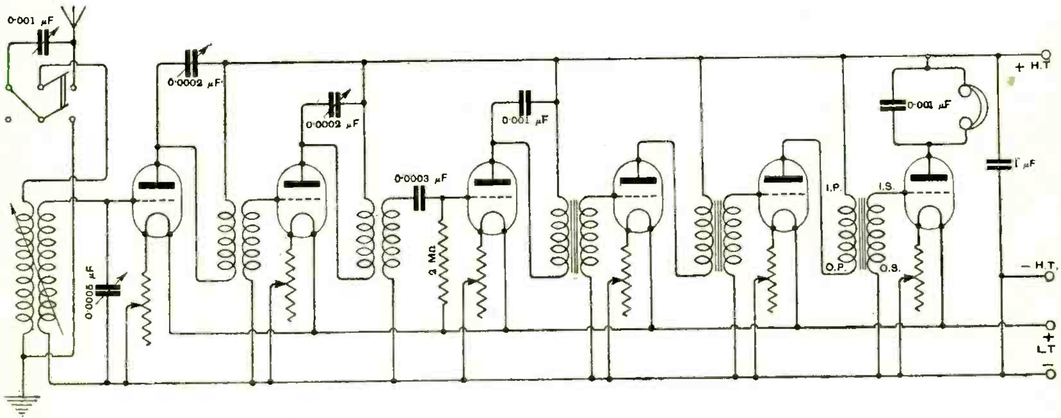

Fig. 1. **"RADIO" (Mon.).** *The diagram gives the connections of a six-valve receiver with two H.F., rectifier and three L.F. valves. Tuned transformers are employed to couple the H.F. valves. No reaction is provided, and the circuit is suitable for the reception of broadcast transmissions.*

"H.E.N." (Ladbroke Grove, W.10) *asks* (1) *For particulars of a coil suitable for use as the secondary of a loose coupled tuner, of which the primary is a former* 4" *diameter wound with* 110 *turns of No.* 26 *S.W.G., D.C.C. copper wire.* (2) *The approximate wavelength range of the tuner mentioned in Question* (1). (3) *If it is possible when using this tuner in a circuit comprising one high frequency* *amplifying valve, crystal detector, and one low frequency amplifier, to tune out* **2 LO** *and receive the Birmingham broadcast transmissions.*

(1) On a former 3½″ diameter, wind 200 turns of No. 28 D.C.C. copper wire, and use a 0.0005 mfd. variable condenser in parallel. (2) The approximate wavelength range of the tuner is from 150 to 2,000 metres. (3) With careful tuning you may receive the Birmingham broadcast transmissions.

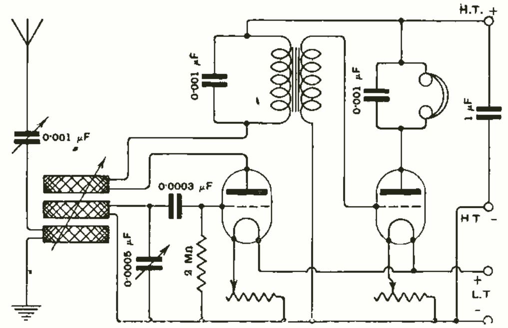

Fig. 2. **" A.C.P." (Bruton).** *A two-valve receiver —rectifier and note magnifier.*

" A.C.P." (Bruton) *asks* (1) *For a diagram of a two-valve receiver comprising one detector and one L.F. valve.* (2) *Is it likely that the signal strength will be reduced through using leads 30′ long between the instrument and the loud speaker.*

(1) A diagram of a two-valve receiver with switch to cut out the L.F. amplifying valve is given in Fig. 2. (2) We do not think you need fear a reduction in the signal strength through using leads 30′ long.

" G.H." (Canterbury) *submits a circuit diagram of a two-valve set, one high frequency amplifier and detector, and asks* (1) *How to connect a switch for cutting out the high frequency valve.* (2) *If three variable condensers are essential.*

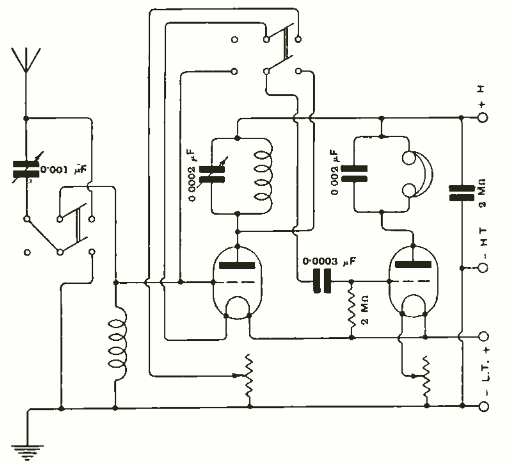

Fig. 3. **" G.H." (Canterbury).** *Diagram of a two-valve receiver with H.F. and rectifier. A switch is connected to cut out the H.F. valve when required.*

(1) The method of connecting a switch is given in Fig. 3. You should examine the diagrams which are given in replies to queries for the method of connecting switches in various circuits. (2) By using a single tuning coil as indicated in the diagram, only two tuning condensers are required, but it is much better to employ a coupled circuit tuner.

" C.C." (Surrey) *asks for a diagram of a tuner employing reaction, with values of components, to receive on wavelengths from 300 to 3,000 metres.*

A suitable diagram is given in Fig. 4. A series-parallel, and a stand-by tune switch are connected.

" A.J.W." (Ilford) *submits a sketch of his aerial and lead-in arrangements, and asks* (1) *If the aerial is suitable. It is desired to receive telephony with a crystal set nine miles from the London Broadcasting Station.* (2) *If the effective height of the aerial would be measured by the average distance of the wires from the roof, above which it is situated.* (3) *If it would be desirable to move the aerial to a position where it would be slightly lower, but would not be above any roofs.*

(1) The aerial as sketched is satisfactory, and you should receive the London transmissions, using a crystal receiver. (2) and (3) The consideration which largely influences the efficiency of an aerial is the extent to which it is screened by surrounding trees or buildings. The fact that it is close to the roof, means a lowering in effective height.

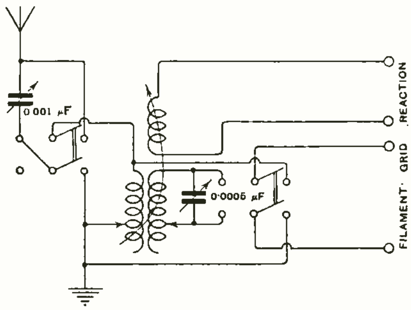

Fig. 4. **" C.C." (Surrey).** *Showing the connections of a series-parallel, and a tune stand-by switch.*

" J.C." (Liverpool) *asks* (1) *For suitable windings of a set of basket coils to use in a three-coil holder to tune from* (*a*) *300-500 metres* (*b*) *1,000-2,000 metres, using No. 26 S.S.C. wire, and a former 1½″ diameter.* (2) *If an aerial erected in accordance with the sketch submitted would be satisfactory.* (3) *For the number of turns of No. 40 D.S.C. wire required for high frequency transformers to tune from* (*a*) *300-500 metres,* (*b*) *1,000-2,000 metres, using a former 2½″ diameter with 3/32″ grooves, ¼″ deep.* (4) *For a diagram showing the connections of a grid leak and condenser used in conjunction with the detector valve in a circuit employing H.F. amplification.*

(1) For tuning to 300-500 metres we suggest you wind the following coils for use in the primary, secondary and reaction circuits respectively:

75 turns, 60 turns, 45 turns. For 1,000-2,000 metres, we suggest you wind four or five coils of 75 turns each, and use combinations of the coils in series for each circuit. A 0.001 mfd. variable condenser is recommended for tuning the aerial circuit, and a 0.0005 mfd. variable condenser for tuning the closed circuit. The aerial condenser should be in series for short wavelengths and in parallel for long wavelengths. (2) We think you would find an aerial erected according to your sketch quite satisfactory. (3) For full details regarding the construction of high frequency transformers we would refer you to the issues of this journal of September 2nd and 16th, 1922. (4) The connections for the grid leak and condenser are shown in all issues of this journal.

Also see diagrams 80 and 81, "The Amateurs' Book of Wireless Circuits," by F. H. Haynes.

"W.H.S." (Ottery St. Mary) *submits a diagram of a three-valve set and asks for criticism.*

The circuit submitted is correct. A receiver wired from the diagram will be satisfactory for the reception of a wide range of wavelengths. If you wish to obtain greater selectivity, use a closed circuit consisting of a coil and 0.0005 mfd. maximum variable condenser coupled with the aerial circuit. The input of the first valve is then joined with the closed circuit.

"T.G." (Hay) *submits a sample of insulated copper wire and asks (1) If it is suitable for the construction of a frame aerial. (2) For the number of turns and spacing required for a frame aerial to use with a receiving set which tunes from 200 to 800 metres.*

(1) The sample of wire submitted is suitable for a frame aerial. (2) Using a frame with 2′ 6″ sides, wind eight turns, spacing to be ½″.

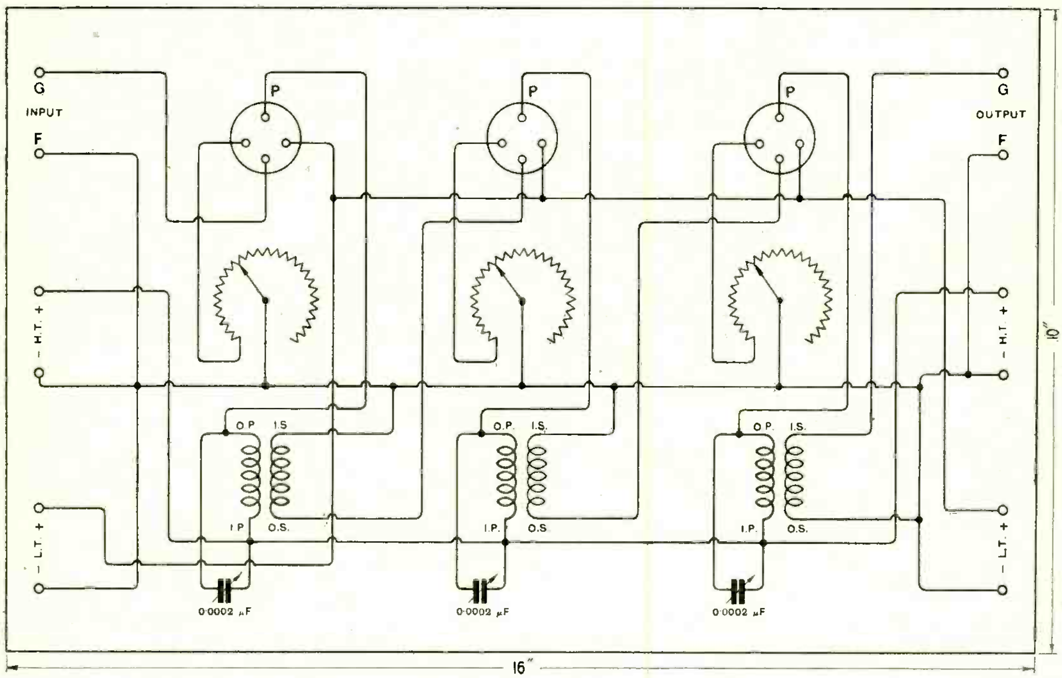

Fig. 5. **"P.R.B." (Godalming).** *Panel with three H.F. valves.*

"P.R.B." (Godalming) *asks (1) For a diagram of an amplifying panel with three high frequency valves, using transformers. (2) For the names of the newspapers in which are published the daily programmes of the Manchester broadcast transmissions. (3) For particulars of a simple Morse recorder.*

(1) A suitable diagram with values and suggested panel dimensions is given in Fig. 5. (2) We would refer you to the various daily newspapers which are published in the Manchester district, for details of the transmissions from the Manchester broadcasting station. (3) For full information on the recording of wireless signals, we would refer you to the Discussion before the Wireless Society of London, recorded in the issues of this journal of October 29th, 1921, and November 26th, 1921.

"K.H." (S. Devon) *asks (1) For a diagram of a circuit comprising one high frequency amplifying valve, detector and one low frequency amplifier. The tuned anode method of high frequency coupling to be employed and stand-by tune and series-parallel switches to be included. (2) For the dimensions and windings of suitable pancake coils to use in the set mentioned in Question (1) for the reception of British broadcast transmissions, and Continental telephony. (3) For the approximate range of the set.*

(1) A suitable diagram is given in Fig. 6. (2) On a former of 2″ diameter, wind with No. 24 D.C.C. copper wire, a number of coils of 50 and 35 turns each. For the reception of British broadcast transmissions, we suggest that you employ for the aerial, secondary, anode and reaction inductances respectively coils of the following numbers of turns 50, 35, 50 and 50; the aerial condenser to be in series with the aerial inductance. For reception on the higher wavelengths employed by Continental telephony stations, use combinations of the coils in series, in approximately the same proportions. (3) The approximate range of the set for the reception of telephony would be about 400 miles.

gauge given. (2) It is not possible to provide a single-valve circuit employing the tuner, and using reaction in an approved form. A single-valve circuit in which this tuner is employed, with one winding utilised as a reaction coil, is given in Fig. 4, page 11 of the book. (3) When H.R. telephones are connected in a valve circuit, the windings may burn out, or the insulation be broken down. When a transformer and L.R. telephones are connected, the steady anode current flows through the transformer primary winding, and the telephones are protected. With a single valve receiver use H.R. telephones.

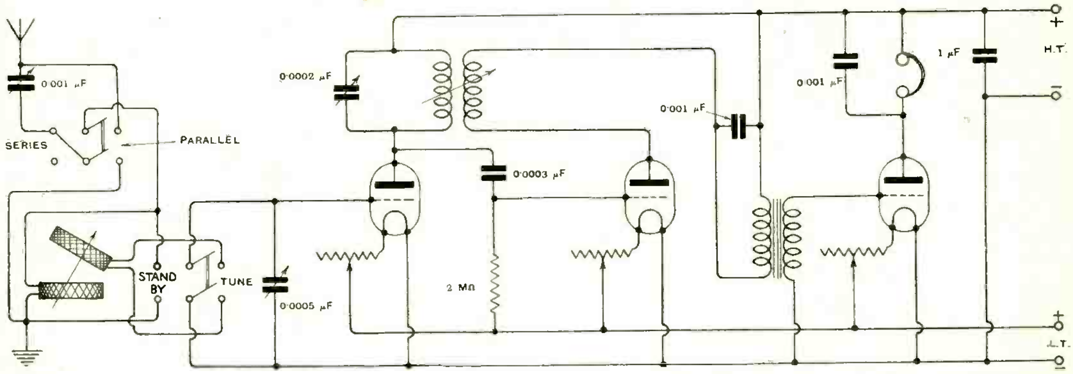

Fig. 6. **"K.H." (S. Devon).** *This is a diagram of a three-valve Broadcast receiver using one H.F., rectifier, and one L.F. valves. All values are given. The reaction coil is coupled with the tuned anode coil.*

"A.N.P." (Bristol) *asks for the wiring of a series-parallel switch of a type as indicated on sketch submitted.*

The wiring diagram for this switch is given in Fig. 7.

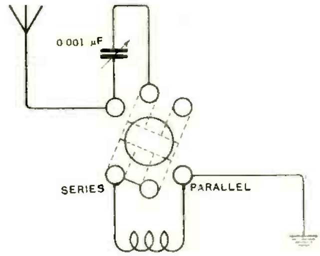

Fig. 7. **"A.N.P." (Bristol).** *Method of connecting a switch to join the aerial condenser in series or parallel.*

"L.R.S." (East Finchley) *asks* (1) *With reference to the loose-coupler described in "The Construction of Amateur Valve Stations," what would be the quantities of wire required.* (2) *For a circuit diagram of a one-valve set incorporating the tuner mentioned in Question* (1). (3) *If it is better and cheaper to use high resistance 'phones than a transformer and low resistance 'phones.* (4) *If "ORA" type valves are more satisfactory rectifiers than "R" type valves.*

(1) For the primary winding purchase ¼ lb. of wire, and for the secondary winding 2 ozs. of the

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules:—(1) Each question should be numbered and written on a separate sheet on one side of the paper, and addressed "Questions and Answers," Editor,* **The Wireless World and Radio Review**, 12/13, *Henrietta Street, London, W.C.2. Queries should be clear and concise. (2) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. (3) Each communication sent in to be accompanied by the "Questions and Answers" coupon to be found in the advertisement columns of the issue current at the time of forwarding the questions. (4) The name and address of the querist, which is for reference and not for publication, to appear at the top of every sheet or sheets, and unless typewritten, this should be in block capitals. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume." (5) In view of the fact that a large proportion of the circuits and apparatus described in these answers are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.* (6) **Where a reply through the post is required every question sent in must be accompanied by a postal order for the amount of 1s., or 3s. 6d. for a maximum of four questions.** (7) *Four questions is the maximum which may be sent in at one time.*

THE WIRELESS WORLD AND RADIO REVIEW

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Preparing for the Winter Programme.

It has already been mentioned in the Editorial page of an earlier issue the tendency which exists to allow other pursuits to take the place, to some extent, of wireless during the summer months.

The object of our Editorial this week is to draw the attention of British amateurs to the work which lies before them for the winter months, and to remind them that there is much to be done in the way of preparation if we are to retain the position which has already been won in respect of transatlantic amateur communications.

In this connection readers will be interested to read on page 425 quotations from a letter received from the Headquarters of the American Radio Relay League, with which organisation, it will be remembered, the British amateurs have co-operated in transatlantic amateur tests in the past.

To be forewarned is to be forearmed, and we know now what is expected of us this autumn. What we ourselves have to consider is—*are we quite ready for all that has got to be done?* We know that there are at least some British amateurs who, since last winter's tests, have thought of little else but preparation for the next attempt, and have been busy with the installation of apparatus worthy of their high expectations. Many amateurs too have been concentrating on improving transmission on 200 metres, and it would certainly be a great score if we were successful in getting across on this wavelength, as, although in the last tests certain stations succeeded in transmitting to America, it was on wavelengths round about 400 metres, and probably in this respect we had the advantage over American amateur stations transmitting on their shorter wavelengths of 200 and below.

It is not a bit too soon to get busy with our preparations, and we cordially invite any readers to send in suggestions which they may have to make with regard to the organisation of the next attempts, whilst we, on our side, will be pleased to give any information which may be of service to those who wish to take part.

Let us all start now to prepare seriously for what is before us, in order that we may be ready when the time comes.

INDOOR WIRELESS WORK BENCHES

By RICHARD TWELVETREES, A.M.I.Mech.E., M.S.A.E., M.Soc.Ing.Civ. (France).

A GOOD many wireless enthusiasts, who live in suburban dwellings, regard with envy the accomplishments of their friends in the direction of constructional work, but hesitate to commence making their own sets on account of their own lack of workshop facilities.

Nevertheless quite a valuable amount of scientific research has been performed under the most unfavourable conditions, although everyone does not possess the ability to turn out good work in adverse circumstances.

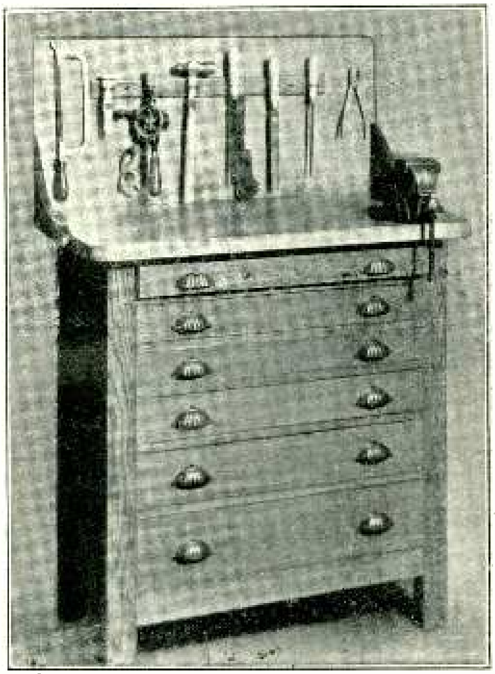
Many potential amateur constructors are hindered from exercising their natural bent, not because the first cost of purchasing suitable equipment constitutes any difficulty, but simply by reason of space restrictions in their residences. If in the ordinary way a kitchen or back room is commandeered by the amateur, his expanding ideas with resultant occupation of further domestic territory soon render his activities somewhat unwelcome to the domestic authorities, and this article is intended to offer a solution of his difficulties.

A Self-Contained Work Cabinet.

The activities of the indoor worker must naturally be restricted to the construction of apparatus built up largely of bought components, but this condition need not necessarily compel the amateur to develop his experimental research along stereotyped lines. It is only by following one's own initiative that real progress can be made, and so whilst being unable to make certain parts by means of more elaborate equipment than can be accommodated indoors, one can economise space and time by arranging the tool outfit according to the available facilities.

The indoor work cabinet must be absolutely self-contained, and should, if possible, be made to harmonise in appearance with the furniture of the room it occupies. If, for example, the kitchen is to be used as a wireless workshop at the end of the day when culinary operations have ceased, the most autocratic of cooks would not object to using a kitchen table which fulfilled the duties of a work bench in its leisure hours. But of course, as the ordinary kitchen table is unsuitable, it must be substituted by a carefully camouflaged work cabinet, which, when closed up, serves in its stead.

Some amateurs prefer to use an ordinary tool-chest equipped with tools suitable for their purpose, but even the most skilfully arranged tool-chest is only a tool-chest after all or a mere accessory in the workroom, wherein bench accommodation must be found.



A beginner's cabinet with drawers for material.

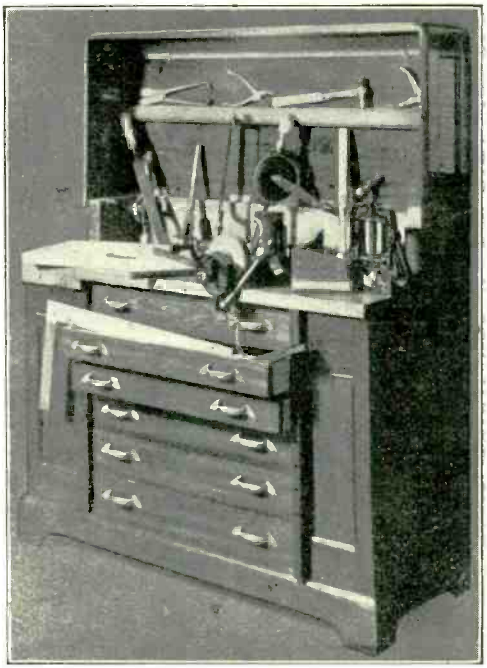
Assuming that it is not convenient to use the kitchen as a temporary workshop, and one of the living rooms has to be requisitioned, the work cabinet must be of a little more elaborate nature, or at least, should possess sufficient decorative features so as not to appear incongruous.

Dual-Purpose Tool Cabinets.

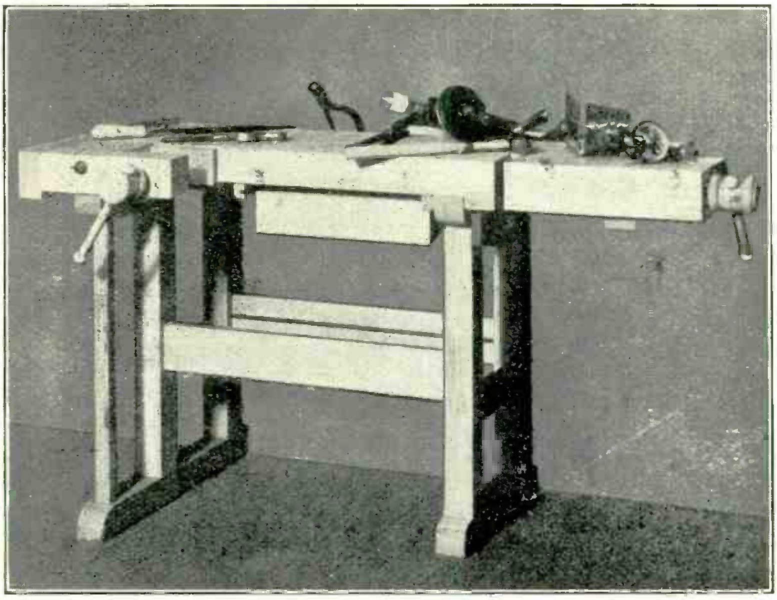
During his investigations connected with tool equipment for wireless amateurs, the writer has inspected a number of useful tool cabinets made by well-known suppliers of tools, but as none of these appear to be designed specially for the peculiar needs of the wireless amateur, his cabinet should be either ordered specially from firms specialising in this particular line of business or constructed locally to his instructions. For example, it may be desirable that the cabinet when closed should conform with the dimensions of the kitchen table it is to supplant. The cabinet when filled with tools will be fairly heavy, and this will prove a hindrance when the kitchen floor needs scrubbing (apologies for introducing unavoidable domestic details), but by the adoption of disappearing castors the objection can be ruled out.

In determining the height of the cabinet its dual purpose should be remembered, and due provision will be needed to exclude water from the interior when it is in the closed position. This only calls for careful workmanship and the selection of seasoned wood more or less impervious to moisture.

The actual arrangement of the tool racks should be deferred until the character of the tool kit has been determined, but these can be added after the cabinet is built. The woodworker's vice should be incorporated with the bench portion, but as the fitting of a metal vice may interfere with the closing of the lid, this should be of the movable pattern. A square hole measuring $1\frac{1}{2}$ ins. across the flats, cut right through the bench near one end, will serve to support a stake or anvil used for hammering metal sheets into shape, the position of the hole being arranged where the bench is most rigid, *i.e.*, over the legs.



A fully equipped work cabinet. When not in use the back rack of this cabinet is arranged to close down over the table.



A strong and simple bench for the workroom.

Although the space beneath the bench could be conveniently allocated for shelves and cupboards, it will be advisable not to elaborate in the latter direction, or the whole cabinet will become too cumbersome when merely used as a table. It may be found convenient, however, to provide terminals in some handy place upon the bench, for connecting with the aerial and earth when experiments with sets are in progress.

The Tool Cabinet as a Piece of Furniture.

The tool cabinet shown on the previous page is of massive construction and has a tool-rack lid which closes down over the bench when not in use. Designed for use in one of the less artistic of the living rooms, this piece of furniture need not be so mobile as the other, but should be arranged far enough away from the walls to permit of sweeping the surrounding flooring. Whilst the main features of this cabinet correspond with those of the less pretentious one, the accommodation beneath the bench can be usefully employed for the storage of raw materials, component parts, and pieces of apparatus in course of construction.

If at any future time the building of a separate workshop is contemplated, either of the cabinets described can be usefully employed for storage purposes in the workshop so that their usefulness is not limited to indoor operations alone.

Open Pattern Work Bench.

Where first cost is of more importance than the considerations mentioned above, the type of bench illustrated at the foot of the previous page will be very desirable, but it cannot be used except in spare rooms where the space is not required for other purposes, or where the tools can be left more or less exposed without the risk of loss or damage. In the smaller bench the working space is somewhat restricted, but as it will be used in a spare room, some other form of bench or table will probably be available to counteract the limitations of the bench.

* * * *

Before discussing the various tools required by the wireless amateur the writer proposes to offer a few suggestions concerning the lay-out and construction of small workshops, suitable for erection on suburban garden plots, and afterwards the subject of tool selection will be dealt with, the classification being arranged in relation to the uses of various types of tools.

"2 LO Testing."

By Capt. C. C. J. FROST (of the B.B.C.)

A GREAT deal of interest is being taken by "listeners-in" in the many tests which take place from time to time from the London station of the British Broadcasting Company.

Quite a number of people are on the look out for the call "2 LO testing" and write to the Company giving much valuable information on their reception of the testing.

Some people, however, have an erroneous idea that the object of the tests in which radiation occurs simultaneously from all of the broadcasting stations, is to have one central station from which a programme may be carried out, the remaining broadcasting stations radiating that same programme. This scheme would, of course, destroy local colour, as a singer in London would hardly be as much appreciated in Lancashire as a Lancashire singer would be. Items, however, such as the opera from Covent Garden Theatre, and notable singers who may sing from time to time from one of the broadcasting stations would be highly appreciated by listeners-in, no matter where they might be. The object of recent tests has therefore been to ascertain the possibility of radiation from all stations simultaneously of any special features or items which would appeal to the whole of the listeners-in in the United Kingdom, and possibly outside of our small island.

The first simultaneous test transmission was carried out Sunday, May 13th. Doubtless many *Wireless World* readers heard this transmission, and are among the many who wrote to the B.B.C., sending valuable reports.

It may be of interest to readers to know the way in which the voice of the speaker in the studio of the London station was conveyed to the various broadcasting stations from which radiation occurred. The whole of the broadcasting stations were linked up by land line to "2LO" and several factors have to be considered in transmission over land lines. The impedance of the lines is, of course, dependent on the type of line over which transmission is taking place, and its length, and on this the amount of current sent over the line has to depend. Therefore a separate and minute check has to be kept on each of the lines running outwards from the London station throughout the whole time occupied by the simultaneous broadcast. For some considerable time prior to the actual simultaneous radiation, the lines have to be carefully checked and watched—the actual data of amps, ohms, and volts being calculated and tested before any attempt can be made to radiate. This applies equally to one line as it does to five lines. In addition to these, independent speech lines are generally used, by which medium complete synchrony and control is maintained. I have assumed that the lines are all in order and everything is going happily, and that transmission from 2 LO to the various broadcasting stations can be carried on without fear of any misadventure. But this is not always, and I might say, very rarely the case. A great number of technical difficulties arise which require surmounting. Many of my readers have doubtless listened to the "tests" and have felt that "*now* we shall be able to have items relayed from any broadcasting station, and I shall be able to benefit straight away now from the opera from London and in the immediate future from any special items performed in the provincial towns." Now that is a very natural conclusion, but I would urge that such a very, very great number of technical difficulties have to be overcome before the best and nothing but the best can be given in this way over land lines. So that the watchword should be "patience"—think of the great deal that has already been achieved—but it needed days and nights of experiment and tests innumerable, and *it takes time*.

We carried out a further test on Thursday, May 17th, after the cessation of the ordinary broadcasting programme from the London station. On this occasion, music as well as speech was transmitted and radiated from several of the broadcasting stations; the object of this test being to experiment—and to improve, if possible, the transmission over the lines. A small current was used on the lines communicating with the broadcasting stations—amplification occurring at the stations themselves before radiation. Accordingly, a further test was carried out on May 30th, in which the final act of the Covent Garden Opera, "Hansel and Gretel" was broadcast from all stations simultaneously. Many of my readers doubtless heard this transmission, and have their own opinion regarding it. The reports received from the Provinces have, so far, been highly satisfactory.

I may say that the idea of special items being simultaneously broadcasted should appeal strongly to the crystal set user situated in the areas served by other broadcasting stations than London. This would mean that London, which is the acknowledged centre of real good entertainments and of star artistes, could supply the provisional broadcasting stations with items which would ordinarily be out of the reach of the owner of crystal and small valve sets situated at great distances from the metropolis. London would relay by land lines the music or special item to, shall we say, Glasgow, and the crystal set user in and round Glasgow could obtain the full enjoyment from the star performance. This method of transmission is by no means perfect, and can only be regarded as being in its experimental stage, but I think that it can quite be realised that transmission of this nature should open up realms of immense interest and possibility in the future.

One point may be worth mentioning in connection with the test which occurred on Sunday afternoon, May 13th. That was that such a number of people wrote regarding the large amount of echo (and blanketing) of the voice which was apparent during the test. I think that these reports illustrate quite well the real use of the draping as it exists in the new studio of the London station. The voices which were speaking during the early part of the afternoon were speaking from an undraped room with the resultant echo (and blanketing) and as some people described it, "hollowness of speech." When speech occurred from the studio itself, the echo ceased and normal conditions were more or less restored. The new studio draping is an attempt to render speech conditions as nearly similar as is possible to speech in the open air.

A High-Wavelength Tuner for a Frame.

With the advent of super-regenerative and other highly sensitive receiving circuits, the use of a frame aerial for long distance reception is becoming more and more common. The advantages of the frame aerial, its portability and directional properties, are too well known to need repetition, whilst the construction of frame aerials has been dealt with in previous articles in *The Wireless World and Radio Review*.

WHEN receiving on short wavelengths, a frame of the usual size is readily tuned with an ordinary variable condenser, but when it is desired to receive on the higher wavelengths with a small frame, this method becomes cumbersome and expensive owing to the large size of condenser required, and the use of fixed condensers becomes necessary in conjunction with the variable condenser. The object of this article is to describe a tuner by means of which an ordinary sized frame may be tuned over a large wavelength range with the use of a minimum number of condensers.

A circuit diagram of the tuner is given in Fig. 1, and from this it will be seen that one variable condenser and four fixed condensers are used.

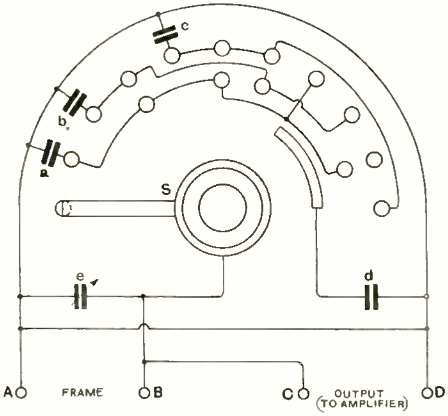


Fig. 1. Circuit arrangement for providing a wide range variable condenser.

The frame aerial is connected to the terminals A and B, the variable condenser being connected across these terminals. One terminal of each of the four fixed condensers, a, b, c, and d, is connected to the terminal A, and the switch arm S is used to give a combination of these capacities to cover the required wavelength range. The construction of the switch arm S is shown in Fig. 2, and it will be seen that three contact springs are provided, for making contact with the two concentric rows of contact studs and with the sector strip respectively.

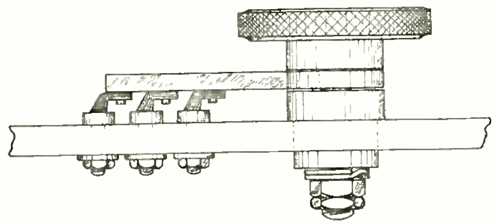


Fig. 2. Details of the switch arm.

The tuner may be contained in a box approximately 5 ins. square by 5 ins. deep, the variable condenser being mounted vertically with the knob projecting through the top, and the switch arm and studs being mounted on the front. A sketch of a suitable arrangement is given in Fig. 3, the top and front of the box being of $\frac{1}{4}$-in. ebonite.

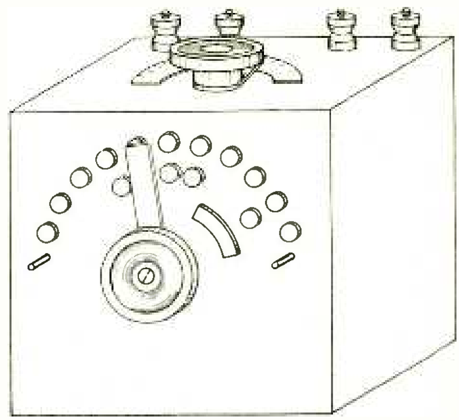


Fig. 3. Method of assembling switch and variable condenser.

The capacities of the condensers are given below :—

e Variable condenser, air dielectric, maximum capacity - 0·0006 mfd.
a Fixed condenser, mica dielectric, capacity - - - 0·0005 mfd.
b Fixed condenser, mica dielectric capacity - - 0·001 mfd.
c Fixed condenser, mica dielectric, capacity - - - 0·002 mfd.
d Fixed condenser, mica dielectric, capacity - - - 0·003 mfd.

With these values, the ranges of capacity connected across the frame with the different positions of the switch arm are as follows :—

Position of Switch arm.	Condensers in parallel.	Range of Capacity.
1	e	Minimum of Variable Condenser — 0·0006
2	e+a	0·0005 — 0·0011
3	e+b	0·001 — 0·0016
4	e+a+b	0·0015 — 0·0021
5	e+c	0·002 — 0·0026
6	e+a+c	0·0025 — 0·0031
7	e+b+c	0·0030 — 0·0036
8	e+d+a	0·0035 — 0·0041
9	e+d+b	0·004 — 0·0046
10	e+d+a+b	0·0045 — 0·0051
11	e+d+c	0·005 — 0·0056

It will be seen from the above that the ranges obtained with consecutive positions of the switch arm overlap, so that a continuous variation of shunted capacity from almost zero up to 0·0056 mfd. is obtained with the use of only one variable and four fixed condensers. Using a frame three feet square with 80 turns, the range of wavelengths covered with the tuner is approximately 2,400-17,000 metres.

Of course, greater efficiency would be obtained by the use of a much larger frame, but this is not always convenient, and the use of such a tuning capacity then becomes necessary if the higher wavelengths are to be reached.

As regards constructional details, the building of both fixed and variable condensers has been described in previous numbers of *The Wireless World and Radio Review*. The containing box is quite ordinary except that the front should be of ebonite, and the only uncommon feature is the switch arm itself with its three contact springs. This is, however, quite straightforward in construction. The spindle may be of screwed brass 3/16 in. in diameter, having a knob screwed on at the top, and secured behind the panel by means of a washer and two locked nuts. The actual switch arm should be of brass, 2 ins. long by 3/8 in. wide and 1/8 in. thick, the three springs being attached each by two small screws. The contact studs are each secured by a nut as shown in Fig. 2. The outer row consists of eleven equidistant studs on a circle of 2 ins. radius. The distance between two rows of studs and between the inner row and the sector is 3/8 in., there being four studs in the inner row. Instead of the sector strip, a row of four studs connected together behind the panel may be used, and will, in fact, generally be more convenient. An ordinary variable condenser mounted in a box can easily be adapted by mounting the switch arm and studs on a piece of ebonite screwed to the front, the box being drilled where necessary for the passage of the connections. The fixed condensers may be screwed to the bottom or sides of the box. If the tuning condenser is in the same cabinet with the receiver, the switch arm and studs may be mounted on the front of the cabinet.

E. J. W.

INSTRUCTIONAL ARTICLE FOR THE LISTENER-IN AND EXPERIMENTER.

WIRELESS THEORY—XIII.

It is the purpose of the writer to deal with the principles underlying the action of wireless receivers and transmitters. Those who know *why*, obtain much pleasure which is not experienced by those who have no idea of the action of their wireless set.

The series has been specially arranged so that the reader who follows each section as it appears will have obtained a complete wireless education with a minimum of time and trouble, and he will be in a position to successfully design his own wireless equipment.

In previous sections the writer has dealt with the principles of electricity such as the effect of resistance, capacity and inductance. The last sections deal with alternating current work and the properties of resistance, inductance and capacity in series and parallel and in particular series resonance, the study of which is so important to those who desire a clear understanding of wireless.

By W. James.

Parallel Resonance.

In a series circuit the current is the same at each point of the circuit. In a parallel circuit, as the same voltage is applied across the circuit, the current in each branch will be different, depending upon the impedance of the branches. The current which flows in the inductance I_L Fig. 65 is given by $\frac{E}{\omega L}$ amperes and lags the applied pressure E volts by 90°. The condenser current I_C leads the pressure by 90°, and its magnitude is ωCE amperes. The currents only have the above magnitude and phase when the condenser and inductance have no resistance. Since the two currents are 180° out of phase with each other the resultant current is given by $I_L - I_C$. If a resistance R ohms is connected across the circuit as well, the current I_R in the resistance will be given by $\frac{E}{R}$ amperes, and the resultant will be the vector sum of I_R and $I_L - I_C$. Fig. 66. The total current is then, from the figure,

$$I = \sqrt{I_R^2 + (I_L - I_C)^2}$$

$$= E\sqrt{\frac{1}{R^2} + \left(\frac{1}{\omega L} - \omega C\right)^2}$$

Since $I = \frac{E}{Z}$ where Z is the impedance of the whole circuit; $Z = \frac{E}{I}$ and

$$\frac{E}{I} = \frac{1}{\sqrt{\frac{1}{R^2} + \left(\frac{1}{\omega L} - \omega C\right)^2}}$$

$$\text{or } Z = \frac{1}{\sqrt{\frac{1}{R^2} + \left(\frac{1}{\omega L} - \omega C\right)^2}}$$

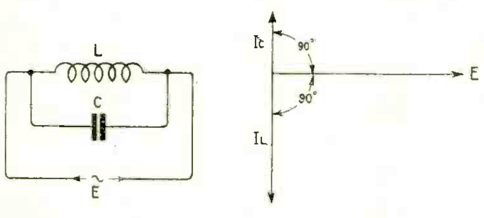


Fig. 65. A circuit with a condenser of capacity C farads in parallel with an inductance of L henries. The phase relationship is shown in the vector construction.

When the coil has resistance (Fig. 67), the current flowing through the coil

$$I_L = \frac{E}{\sqrt{R^2 + (\omega L)^2}}.$$

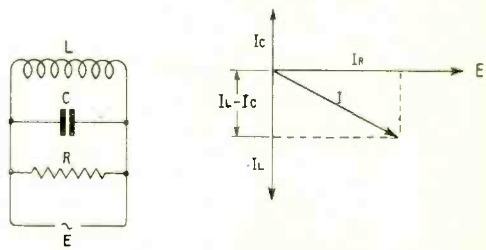


Fig. 66. Inductance capacity and resistance of R ohms in parallel. The vector relationship is shown. The current I is the total current from the supply.

The current will then lag, not by 90°, but by a smaller angle θ whose tangent $= \frac{\omega L}{R}$. The resultant current is now

$$I = E\left(\frac{1}{\sqrt{R^2 + (\omega L)^2}} - \omega C\right) \text{ amperes.}$$

If we neglect all resistances,

$$I = E\left(\frac{1}{\omega L} - \omega C\right) \text{ as before.}$$

If now the frequency of the applied pressure is gradually raised, the quantity $\frac{1}{\omega L}$ will gradually decrease, and ωC will increase. At some frequency their difference will be zero

$$\text{or } \frac{1}{\omega L} = \omega C \text{ and } f = \frac{1}{2\pi\sqrt{LC}}.$$

This is the natural frequency of the circuit, and the current taken from the mains is zero.

It will be noticed that although the current from the mains may be zero, the circulating current, that is the current flowing in the coil and condenser, may be large.

As before $I_C = \omega CE$ and $\omega = \dfrac{1}{\sqrt{LC}}$

Then substituting $I_C = \dfrac{CE}{\sqrt{LC}}$

$$I_C = E\sqrt{\frac{C}{L}} \text{ amperes,}$$

$$\text{and } E = I_C\sqrt{\frac{L}{C}} \text{ volts.}$$

This means that when the circuit is in resonance with the applied pressure, the circulating current, $E\sqrt{\frac{C}{L}}$ is larger the greater the ratio of capacity to inductance.

For a given circulating current the voltage across the resonant circuit is greater the larger L compared with C.

These points are better brought out with an example.

Case 1.—Suppose the inductance is 2533μH, and the capacity $0{\cdot}001\mu F$

$$f = \frac{1}{2\pi\sqrt{LC}} \text{ and in this case } = 100{,}000.$$

Suppose the applied pressure is 10 volts.

$$I_C = 10 \times \sqrt{\frac{C}{L}} \text{ where } C = 0{\cdot}001 \times 10^{-6} \text{ farads.}$$

$$L = 2{,}533 \times 10^{-6} \text{ henries.}$$

$$\text{Then } I_C = 10 \times \sqrt{\frac{0.001}{2{,}533}} = 10 \times 0{\cdot}00063 \text{ or } 0{\cdot}0063 \text{ ampere.}$$

Case 2.—Suppose now the capacity is $0{\cdot}1\mu F$ and the inductance $25{\cdot}33\ \mu H$. Note the product LC remains the same as before, therefore the natural frequency is as before.

$$I_C = 10 \times \sqrt{\frac{0{\cdot}1}{25{\cdot}33}} = 10 \times 0{\cdot}063 \text{ or } 0{\cdot}63 \text{ ampere.}$$

These two examples show clearly the effect of using different ratios of capacity to inductance

If we assume the circulating current is 1 ampere, in Case 1 the pressure across the circuit $E = I_C\sqrt{\frac{L}{C}}$

$$\text{or } 1 \times \sqrt{\frac{2{,}533}{0{\cdot}001}} \text{ or } 1{,}591 \text{ volts.}$$

In Case 2 the pressure is equal to

$$1 \times \sqrt{\frac{25{\cdot}33}{0{\cdot}1}} = 15{\cdot}9 \text{ volts.}$$

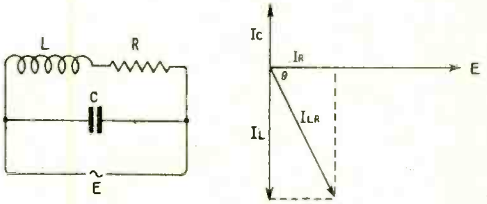


Fig. 67. A coil with inductance L henries and resistance R ohms in parallel with a condenser. The vector diagram shows the phases of the currents. The current I_{LR} is the current which flows through the resistance and inductance in series. The current from the mains is obtained by the method of Fig. 66.

The ratio of inductance to capacity also determines the current which will flow *through* the circuit when a pressure of frequency a little different to the resonant frequency of the circuit is applied. The current referred to is that current which flows from the source of pressure. When the applied pressure is resonant with the circuit this current is zero. Let us suppose the frequency is 95,000 cycles instead of 100,000 cycles as in the above examples. With the other values as before in Case 1,

$$I_C = \omega CE$$

$$\omega = 2 \times 3{\cdot}14 \times 95{,}000$$

$$\text{and } I_C = 2 \times 3{\cdot}14 \times 95{,}000 \times 0{\cdot}001 \times 10^{-6} \times 10 = 0{\cdot}00597 \text{ ampere.}$$

$$I_L = \frac{E}{\omega L}$$

$$I_L = \frac{10 \times 10^6}{2 \times 3{\cdot}14 \times 95{,}000 \times 2{,}533} = 0{\cdot}0066 \text{ ampere.}$$

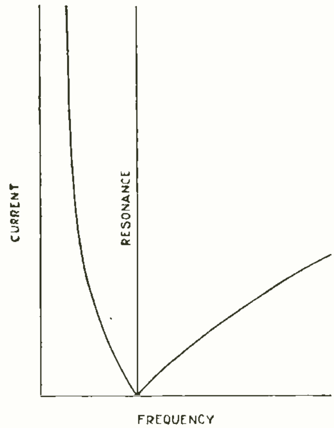
The line current is then the difference between I_L and I_C or $0{\cdot}0006$ ampere.

Case 2.

I_C is now 100 times its value in Case 1 or $0{\cdot}597$ ampere.

and I_L is now $0{\cdot}66$ ampere.

The difference is $0{\cdot}063$ ampere, which is considerable. From the point of view of interference therefore, it is better to use as large an inductance and as small a value of capacity as possible.



The curve shows the variation in current taken from the supply when the applied frequency is varied. At resonance the current is negligible, that is the circuit has a high impedance. To the left of the resonance point a larger portion of current flows through the inductance; to the right the condenser carries a larger current.

When the resistance of the coil is small compared with its inductance,

$$I = \frac{ER}{\omega^2 L^2} \text{ amperes.}$$

The condenser current and coil current are not quite the same, the difference being smaller the smaller the resistance of the coil. The impedance of the whole combination is $\frac{L}{CR}$ ohms.

It will be noticed a parallel circuit at resonance behaves quite different to a series resonant circuit. The impedance of a parallel circuit is very high, while a series circuit is low. It is for this reason that a parallel circuit is called a *rejector* circuit.

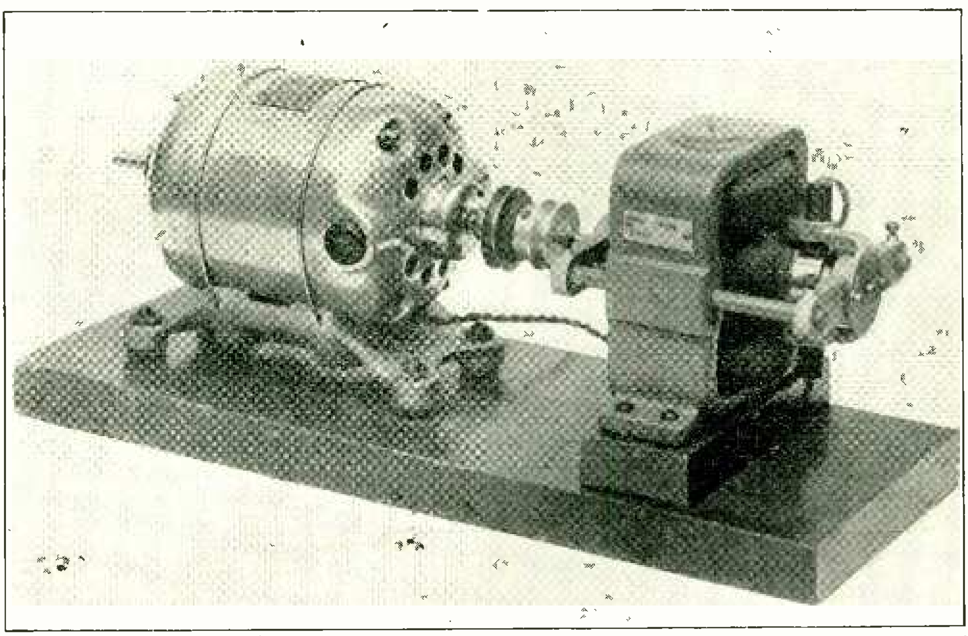
The properties of a rejector circuit are as follows :—

(1) At the resonant frequency, when resistance is negligible, the impedance of the circuit is infinitely great. No current flows from the source of pressure. When resistance is present a current will flow, depending upon the value of the resistance.

(2) The selectivity of the circuit is greater the larger the ratio of inductance to capacity.

(3) For a given circulating current, the pressure across the circuit is greater the larger the ratio of inductance to capacity.

(4) Resistance should be made as small as possible to obtain better selectivity, and higher pressure across the circuit for a given current.



An efficient charging outfit made by Messrs. Serjeant & Rose of Bath Road, Hounslow, for small accumulators such as are used with receiving sets on A.C. or D.C. supply. The substantial motor on the left is driven from the house mains, and the dynamo on the right delivers charging current. It is fitted with ball race bearings and designed for long runs.

A NEW LOUD-SPEAKING DEVICE

A NEW loud-speaking device of novel design and having some features of special interest, has lately been devised by Mr. S. G. Brown, and whilst the instrument has not, up to the present, gone beyond the stage of experimental models, it has nevertheless been recently demonstrated at the Royal Institution, and, through the courtesy of Mr. S. G. Brown, the author has had an opportunity of inspecting the instrument and hearing its performance.

The apparatus serves not only as a loud speaking reproducer, but at the same time also acts as an amplifier and provides for a very considerable degree of amplification.

The operation is entirely mechanical in principle, and depends for its functioning on friction between a revolving glass disc and a shoe, the under side of which carries a thin layer of cork which makes rubbing contact with the glass disc. The shoe is connected to the reed of a Brown telephone ear-piece of the usual pattern, and the movement of the reed, controlled by incoming signals, serves to vary the pressure of the shoe on the revolving glass disc, thereby varying the friction between the shoe and the disc.

The shoe is connected mechanically to the centre of the diaphragm of a sound box of gramophone or similar pattern.

The arrangement of the instrument recalls somewhat the Johnsen-Rahbek loud speaker, except that in the latter case the friction between the shoe and the rotating disc or cylinder is controlled electrostatically, whereas in the new instrument this friction is controlled entirely by mechanical means.

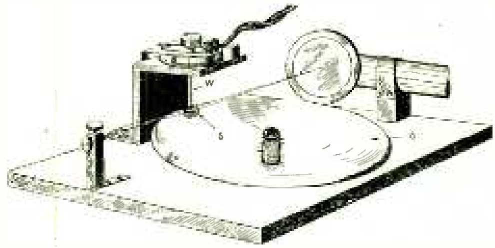
The accompanying illustrations will give some idea of the arrangement of the parts.

The rotating glass disc " G " must of course be very carefully ground and polished to ensure the utmost evenness of surface.

The speed at which this disc is rotated is somewhere in the neighbourhood of 70 revolutions per minute, so that the usual gramophone motor can be suitably employed for the purpose. The diameter of the disc in the model which has been exhibited is about 7 ins.

The shoe " S " is a steel disc about half an inch in diameter, which is rigidly attached by means of a steel wire "W" to the reed of the diaphragm. This wire is about 1 in. in length.

On the under side of the shoe which makes contact with the glass disc is secured a thin disc of cork such as is used for tipping cigarettes. The telephone earpiece must, of course, be very accurately adjusted above the revolving disc, and the shoe should be arranged so that it barely touches the revolving disc; any movement of the reed will bring it into closer contact and produce a rubbing friction.



The " Frenophone " Mechanical Amplifier and Loud Speaker.

A spiral spring is provided to maintain the tension of the cords on which the metal shoe is slung and connected to the sound-box diaphragm.

It is essential that the glass disc should be kept free from dust or any tendency to stickiness, and it is therefore advisable to provide a cover to enclose that part of the apparatus.

As to the performance of the instrument, the quality of reproduction is surprisingly good, and it would not be an exaggeration to say that it threatens to rival any loud-speaking device at present on the market.

As to its efficiency as an amplifier, the degree of amplification might be estimated as approximately equal to two stages of low frequency amplification. Speech from 2 LO which, with a receiver having a detector valve and one stage of low frequency amplification, giving signals in the telephones which were just audible at 2 feet from the telephones, when passed into the loud speaker gave a volume of sound with an almost entire absence of distortion, sufficient to fill a large room.

One might have expected that the varying pressure of the shoe on the rotating disc of glass would have produced a damping effect on the telephone reed as would have produced distortion, but in practice there appears to be no suspicion of any such trouble.

THE AMATEUR'S EXPERIMENTAL LABORATORY

VII.—FURTHER APPLICATIONS OF THE CALIBRATED CONDENSER.

By PHILIP R. COURSEY, B.Sc., F.Inst.P., A.M.I.E.E.

THE need for a simple, readily accessible and easily used method of measuring the capacity of any condenser is soon felt by anyone who is carrying out much experimental radio work.

Not only is it desirable to have available calibration curves of all variable condensers that may be used from time to time in various experimental circuits, which calibrations can be obtained by the methods which have been set out in previous articles, or by other similar ways which will be dealt with later, but it is also convenient to be able readily to measure the capacity of any fixed condenser that may be used or constructed.

For this purpose a special arrangement may with advantage be fitted up, so that a capacity can be measured at any moment. It is not necessary for this purpose to use the variable condenser which was first calibrated by the methods which have been described, and which has been referred to as the comparison "standard," but any other convenient condenser may be employed provided that its calibration curve is known, or has been plotted out. For general purposes it suffices to employ a comparison variable condenser, having a maximum capacity of about 0·001 microfarad, but a rather more useful arrangement is obtained with a larger condenser — say one of 0·0015 microfarad maximum capacity, or thereabouts.

To carry out such measurements on the lines of the capacity comparisons that have already been described, it is necessary to reserve for this use a complete oscillator valve, with associated circuits such as have been sketched in diagrams published in earlier articles in this series, and also to build up another auxiliary circuit consisting of a suitable inductance, the calibrated variable condenser and two test terminals to which the condenser to be measured may be joined. The arrangement of this auxiliary measuring circuit is sketched diagrammatically in Fig. 1. In this diagram the position of the oscillation circuit of the oscillator valve is indicated by L_1 C_1, as in earlier diagrams, the whole of this circuit being exactly the same as used in earlier measurements. The measuring circuit in this case consists merely of the coil L_3, in parallel with which is connected the calibrated variable condenser C_3. The "test" terminals T_1 T_3 are provided so that the condenser to be measured can conveniently be connected to them without disturbing the remainder of the circuit. The coil L_3 must be chosen of such a size that the circuit L_3 C_3, without any additional condenser, can be tuned to be in resonance with the oscillator valve circuit L_1 C_1, resonance being indicated by the double-click method which has already been described.

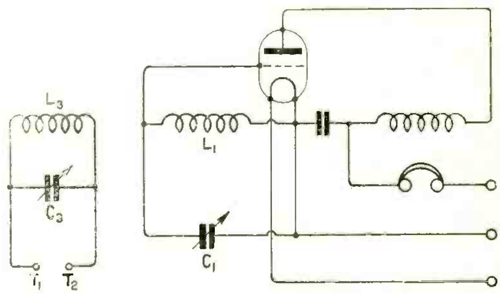


Fig. 1. Arrangement of test circuit for the measurement of the capacity of a condenser.

For convenience in use the whole apparatus may with advantage be set out on a baseboard. If the oscillator valve and its associated circuits have already been mounted on such a board in the manner described in an earlier article, the complete oscillator may, if desired, be attached to a larger board allowing sufficient space to accommodate the new measuring circuit, or if preferred, an entirely new oscillator may be built up and kept for the purpose of such measurements as are here under discussion. In any case the coils L_3 and L_1 should be held rigidly so that their relative position is not changed once the best position has been found for obtaining clearly defined clicks in the telephones attached to the oscillator valve circuits. The two terminals T_1 T_2 should be mounted on an insulating strip, such as of ebonite, or on two insulating pillars, and wired up with stiff wires to the terminals of the condenser C_3, these leads being kept as short as conveniently possible.

To carry out a measurement with this apparatus, the comparison condenser C_3 should be set at somewhere near the maximum end of its scale, with no additional condenser connected to T_1 T_2, and the oscillator valve should be brought into resonance with the measuring circuit by adjusting the tuning condenser C_1—resonance being indicated by the "double-click" method. Next the condenser to be measured should be connected on to the test terminals without touching the setting of the oscillator, and the comparison condenser C_3 altered until the circuit is again brought into resonance with the oscillator. The amount by which the setting of the condenser C_3 must be reduced to re-establish resonance is a measure of the capacity of the condenser under test. This value can obviously be found by reading off from its calibration curve the capacities of the condenser C_3 corresponding to the two scale settings just found, and subtracting the second from the first.

For greater convenience in use a special calibration curve can be plotted out for use in such measurements, this special curve being deduced from the ordinary calibration curve which has already been obtained. Thus, suppose the condenser C_3 is set at 170° on its scale before commencing the measurement, and the oscillator circuit is brought into resonance under these conditions, then 170° becomes our new "zero" for these tests, and a curve can be plotted out from which, at a glance, can be read off the difference between the capacity of the condenser at any scale reading and its value at 170°. The form of such a special calibration curve is sketched in Fig. 2. The capacity values that have been plotted in this diagram were deduced from the calibration curve which was printed as Fig. 3 on page 203, in article IV of this series, which was printed in the May 19th issue of *The Wireless World and Radio Review*. A scale setting of 170° has been assumed as the "zero" to which the apparatus is adjusted when no test condenser is connected.

To make use of this curve for a measurement of this type, it is merely necessary to switch on the oscillator valve, leave the apparatus for a few minutes for the oscillations to become steady, verify that the oscillator is in tune with the test circuit when C_3 is at 170°, connect on the condenser to be measured, readjust C_3 to resonance, read off the scale setting, and by reference to the special calibration curve plotted out like Fig. 2, read off directly the capacity corresponding to this scale setting of the condenser C_3. This capacity is the required capacity of the condenser to be measured.

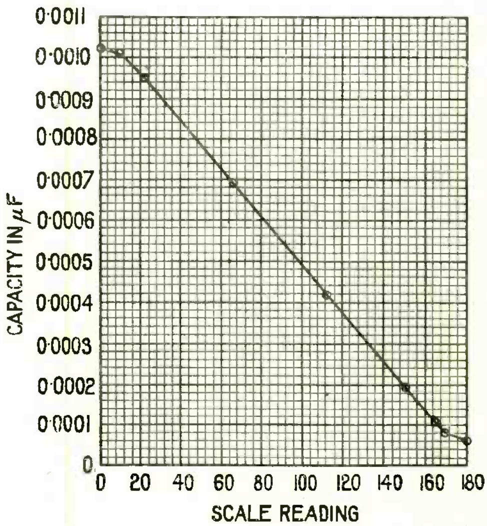


Fig. 2. Calibration curve of standard condenser, arranged so that differences of readings can be read off direct for the determination of values of condensers connected across the terminals of the standard.

Such an arrangement is, of course, limited to the measurement of capacities of smaller value than the maximum value of the comparison condenser C_3—*i.e.*, to capacities less than about 0·00095 in the case of a comparison condenser of 0·001 maximum value or to less than about 0·0014 in the case of a comparison condenser having a maximum value of about 0·0015 microfarad.

The illustrative special calibration curve that has been sketched here in Fig. 2 is drawn out for a 0·001 microfarad condenser, but the same method and procedure can be applied if this condenser has a maximum value of 0·0015 such as is more desirable for the reasons that have already been stated.

PORTABLE FIVE-VALVE RECEIVER

THE CHOICE OF DESIGN AND THE CIRCUIT TO EMPLOY.

By A. J. Bull.

(*Concluded from p. 372 of previous issue.*)

Continuing the description of the general arrangement of the instrument (see Fig. 6, p. 371, of previous issue) it will be noticed that to the left of the last transformer can be seen two terminals marked A and B which are normally short circuited by a piece of wire. These terminals will be found very useful when it is required to place a negative potential on the grid of the last valve for loud speaker working, this negative potential being necessary when extra voltage is given to the plate of the last valve, in order that the valve shall function about the centre of its characteristic.

By connecting a wandering lead to "B" and plugging its other end to either of the sockets "G1," "G2," "G3," and "G4," the number of valves in service can be varied. For example, if only a single (detecting) valve is required, the switch "Sw" is moved to the right, the plug inserted in socket "G 3" and valve No. 5 only switched on. It is of course unnecessary to utilise the plug

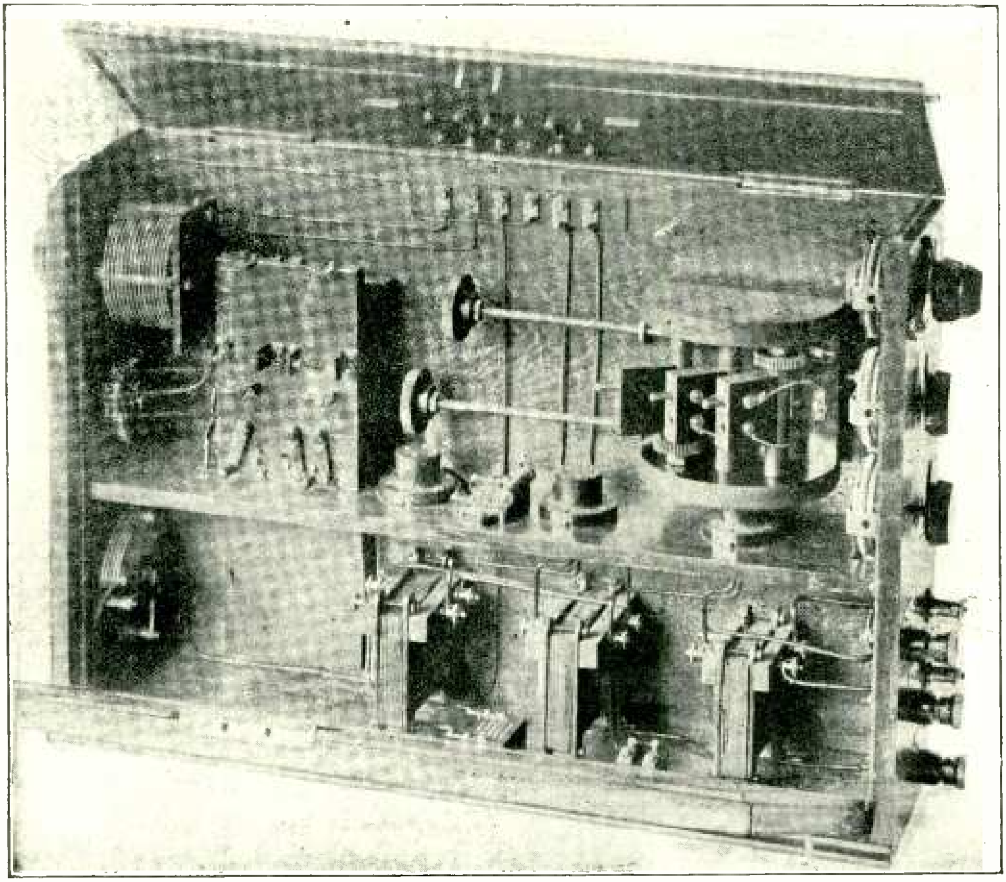


Fig. 7. The Receiver with valves removed and coil holder transferred to the interior for portability.

when transferring from five to three valves and *vice versa*, as those changes can be made by means of switch " Sw."

It should be noted that the wander plug and sockets are not shown in the photograph, but are included in the Figs. 1, 6, and 10. Two of the sockets marked " G3 " and " G4," are shown immediately below valves Nos. 3 and 4, and " G1 " and " G2 " are situated on the ebonite panel carrying the H.F. valves.

In addition to the constructional information given in the drawings and photographs, it is mentioned that by means of worm and worm wheels (which can be purchased at 1s. 6d. per pair) arranged so as to permit of a friction slip, vernier and coarse adjustment of the tuning coils are available (Fig. 8). The vernier adjustment by means of the long handles, and the coarse adjustment by grasping the coils by hand and moving them to the position required. (Full particulars for constructing this coil holder were given by the writer in *The Wireless World and Radio Review* for Nov. 25th last, page 255).

six valve sockets are held in the rectangular piece of ebonite in the lid by threads specially cut on the outside of them, the usual threaded portion having been previously cut off, thus reducing by half the total length of the socket.

The rectangular piece of ebonite is recessed in the lid and held in position by brass strips

Fig. 9. Valve and pin for wander plug and coil holder bracket.

at each end, as shown in the drawings. Flexible wire connections are made from the lid to screw terminals numbered 1 to 6 and situated immediately above valves 3 and 4, these six terminals being in turn connected by means of No. 20 tinned copper wire (insulated by coloured sleeving) to the closed circuit, aerial circuit, and reaction respectively.

As regards the cabinet, which measures when closed 1 ft. 7 in. × 1 ft. 1⅜ in. × 4¾ in., it should be constructed of hard wood to match

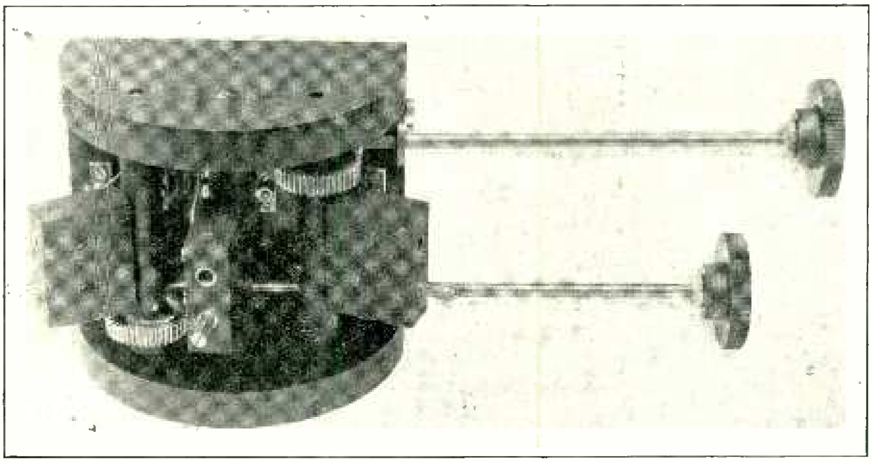


Fig. 8. Coil holder arranged with gearing to provide critical adjustment. The two wheels seen in the photograph are secured to the coil holder spindles by means of spring washers so that while sufficient grip is obtained for the wheels to turn the coils, the coils may be moved to any position without propelling by the pinions.

Connections between the coil holder and lid of cabinet are made by means of six valve sockets and pins, or valve legs as they are sometimes termed, see Fig. 9 showing pin and socket as purchased. The split pins are screwed into the ebonite base of the coil holder, and flexible wire connections made between them and the three standard coil plugs. The

the furniture in the room where it is likely to see longest service. If house-room is a consideration, the cabinet can be placed on a small bracket fastened to the wall, and the H.T. and L.T. batteries accommodated on the floor immediately below it. Such component parts as the closed circuit condenser, potentiometer, and terminals, etc., should not be in direct contact with the wood of which the cabinet is constructed. They should be insulated by ebonite bushing and washers. This is easily done (see terminals Fig. 7) in most cases by obtaining a piece of ebonite rod of suitable diameter and cutting it into pieces ½ in. long, *viz.*, to the thickness of the ends of the cabinet.

Holes are bored in the cabinet to the diameter of the rod and the bushes glued in them.

When the glue is set, the ebonite bushes are drilled to receive the components. Washers 1/16th in. thick are prepared from ebonite rod of a larger diameter than the bushes. These can be cut by means of a tenon saw.

the two "V24" valves (Fig. 10), and transformer No. 2 below it. The six sockets seen at the back of the fifth valve are to receive the coil-holder for transport purposes. The top right-hand filament rheostat controls filament current of valve No. 3, and is fitted with vernier adjustment, reaction being available with this valve if required. The two rheostats below it control valves Nos. 4 and 5 respectively.

For reasons to be given below, if the experimenter is out for maximum amplification and selectivity, he is recommended to construct his own radio frequency transformers. H.F. transformers, as is well-known, are usually designed to pass a particular band of wavelengths.

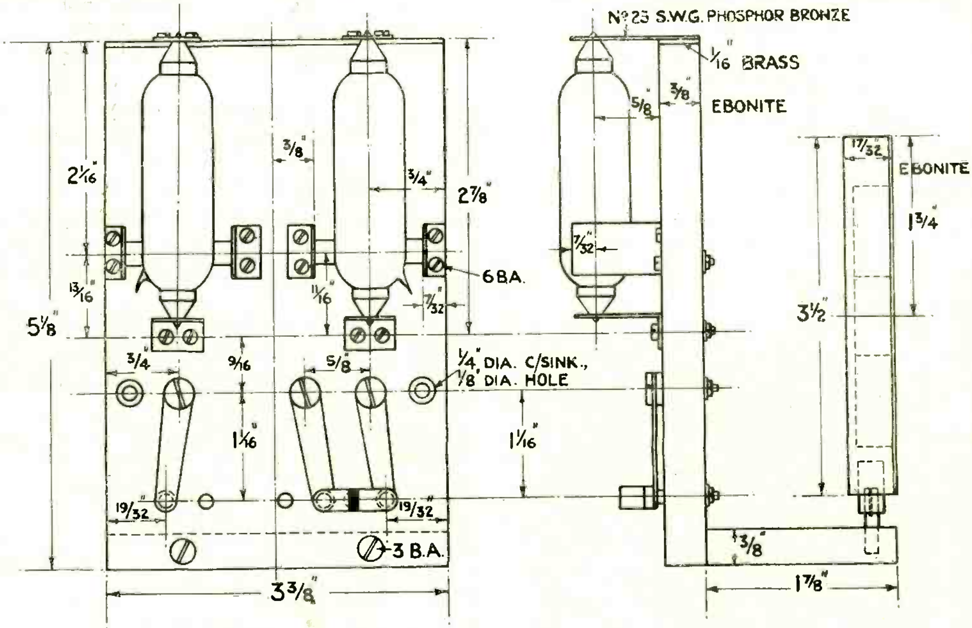


Fig. 10. Dimensions for setting out the H.F. valve panel.

Before passing to the construction of the H.F. transformers, the position in the cabinet of some of the component parts of which the instrument is made up will be indicated to the reader. Referring to the photograph in the previous instalment, the centre coil in the coil-holder is a basket coil wound for the broadcast band, enclosed in ebonite and tapped, so that it will function equally well on short or long aerials.

The variable condenser in the bottom left-hand corner is the closed circuit condenser, and the one above it the aerial tuning condenser. Situated between them is the potentiometer, which to a certain extent controls the H.F. valves. H.F. transformer No. 1 is located behind the panel carrying

Within certain limits nearly equal amplification can be obtained over the whole band, or, on the other hand, they can be designed so that *maximum* amplification is obtained with the *centre* (or optimum as it is termed) wavelength of the band, and decreasing amplification on either side of the optimum, until a point is reached where amplification ceases.

For example, maximum amplification might be arranged for on 369 metres, and then at points 20, 30 or 40 per cent., etc., on either side of 369 metres amplification to cease. It follows then that the smaller the band is made the more selective will the transformer and hence the complete instrument be. In order to limit the band, the primary and secondary windings should be spaced from each other, and copper wire of not smaller gauge than about No. 44 D.S.C. employed. The closer the coils are placed together and the higher the resistance of the wire, the broader will be the tuning band.

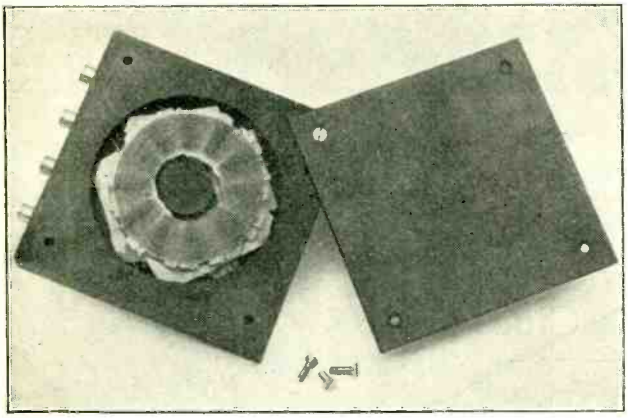


Fig. 11. One of the H.F. Transformers.

The transformers (Fig. 11) seen in the instrument were designed for an optimum of 369 metres (**2 LO** wave) and 20 per cent. either side. They consist of two basket coils spaced 3/16 ins. apart, each coil having a diameter of 2 ins., and wound with No. 44 D.S.C. copper wire.

The spider on which the coils were wound consists of a centre or hub measuring $\frac{7}{8}$ in. diameter by $\frac{3}{8}$ ins. thick, and is fitted with eleven spokes each $\frac{1}{8}$ in. diameter. The centre can be either of brass or ebonite threaded to receive the metal spokes. Having made the basket coils to the dimensions given, the circuit shown in Fig. 12 should be arranged on a board in order to test the coils for wavelength.

If the experimenter resides within a dozen miles or so of the broadcast station, a frame aerial will be found very useful for the tests. A temporary frame can be made of two pieces of dry wood, each piece measuring 1 in square by 3 ft. 10 ins. long, and halved together to form a cross. A cup-hook is screwed into one end of the cross, so that it can be suspended from a piece of string stretched conveniently across a room. On one side of each of the four legs of the cross 14 saw cuts should be made at a slight angle and spaced $\frac{3}{8}$ in. apart, the first cuts being made $\frac{3}{4}$ in. from the ends. On this frame, 14 complete turns of D.C.C. (gauge from 20 to 28) wire are wound in saw cuts.

It is assumed that the experimenter does not possess a wavemeter, so the next step is to connect the frame across the 0·0005 variable condenser, insert the "V.24" valve only, and the telephones between "P1" and "P2," and pick up signals from the nearest broadcasting station.

Having done this and *noted* the condenser reading, transfer the telephones to valve No. 2 and insert a transformer to be tested at No. 1, as shown by dotted lines connected to "P1" and "P2" and "S1" and "S2."

If signals are heard from the broadcasting station, raise the primary about $\frac{1}{4}$ in. above the secondary by means of a piece of insulating material and note if signal strength is improved. If this is the case, gradually increase the distance separating the coils until maximum signal strength is obtained. A point may be reached where signals become a maximum, and then the set immediately breaks into oscillation. This can be accepted as an indication that the transformer is of the correct value.

Should maximum results be obtained with the coils spaced several inches apart, they can be brought closer together (and thus economise space) by removing wire from the primary by one turn at a time and testing as before.

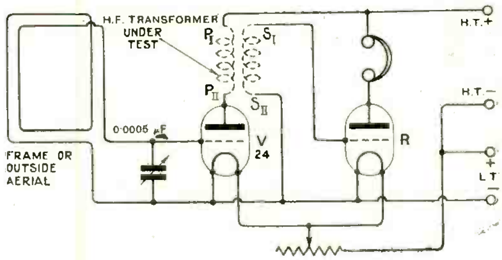


Fig. 12. Circuit with frame aerial for testing the H.F. Transformers.

How close the coils are arranged depends upon to what degree the experimenter wishes to limit the band (as previously explained), and must be decided by him.

Reverting to the point where the two valves were switched on, it may happen that no signal is heard; if so, the 0·0005 mfd. condenser should be varied until a click is heard in the phones or the set oscillates. An increase in value of the condenser signifies that the coils under test are too large, a decrease, too small.

As regards the sensitivity of the completed instrument, the set shown in the photograph, employing five valves and only the closed circuit coil, was operated 23 miles from London, and excellent loud speech was received from 2 LO, this without aerial or earth and no reaction coil.

This example is not quoted as an extraordinary performance, but only as a guide to the experimenter as to what is to be expected, providing the utmost care is exercised in the construction of the H.F. transformers.

In conclusion the writer would point out that time devoted to the problem of interference is time well spent, and although much can be done at the receiving end, yet co-operation must also come from the transmitting end in the form of reduced power and sharper defined waves.

[*Correction: The double switch in Fig. 1, p. 370 of the previous issue, should have a lead connecting stud 3 to the stud on the immediate right of it*].

Wireless Club Reports.

Contributions to this section are welcomed. Reports should be as concise as possible and should record the most interesting features of each meeting. The Editor reserves the right to edit the reports when necessary. **Papers read before Societies will receive special consideration with a view to publication.**

An Asterisk denotes affiliation with the Radio Society of Great Britain.

High Wycombe and District Radio Society.*

The first summer meeting of the Society was held on Saturday, June 2nd, at "Polmark," Naphill, the station of a member (Mr. E. H. Milner), and proved an unqualified success.

2 OD (Mr. E. J. Simmonds, Gerrards Cross) kindly provided a transmission, and the Scientific Department of the Royal Grammar School, under Mr. J. Hurn, demonstrated transmission and reception on the O. T. C. Mark III trench set. An extensive equipment was made available by Mr. Milner, the lofty mast being much admired, and amongst other apparatus exhibited by members the miniature crystal set of Mr. Westlake afforded considerable interest by its excellent reception of **2 LO** when heterodyned by a valve set.

Forthcoming events include visits to the Leafield and Northolt stations of the G.P.O.

A cordial invitation is extended to prospective members.

Hon. Sec., A. C. Yates, 30, High Street, High Wycombe, Bucks.

Walthamstow Amateur Radio Society.*

The Hon. Secretaryship of the Society has now changed hands, the Hon. Sec. now being H. J. Sarson, Belle Vue House, Beacontree Avenue, Walthamstow, E.17.

Wireless and Experimental Association (Dulwich Branch).*

A profitable discussion on the relative merits of crystal and valve detection took place on June 4th. At the same meeting Mr. Sinclair was unanimously elected Assistant and Corresponding Secretary.

Hon. Sec., Geo. Sutton, A.M.I.E.E., 18, Melford Road, S.E.22.

Grimsby and District Radio Society.*

At a general meeting, held on May 31st, the election of new officers took place, a new Chairman and new Secretary being appointed. A Morse class has been inaugurated under the guidance of Mr. N. Chivers, an ex-naval operator.

Club room: Wellowgate, Grimsby.

Hon. Sec., M. M. Bennett, at above address.

Portsmouth and District Wireless Association.*

On Wednesday, June 6th, Mr. A. G. Priest continued his lecture on "Crystal and Valve Circuits," which he illustrated with several good circuits on the blackboard. The lecturer emphasised the importance of close attention to details, and observed that the use of a good earth connection was often neglected.

Mr. G. J. Claret, on June 13th, described the construction of a four-valve unit set, and experimented with a novel valve panel of wood, using condensers consisting of postcards and tinfoil. At the conclusion of the lecture Canon I. J. T. Kuner gave some valuable hints on hard soldering.

The number of amateurs in and around Portsmouth who continue to allow their valves to oscillate are earnestly requested to join the Society and mend their ways.

Hon. Sec., Stanley G. Hogg, 50, Waverley Road, Southsea.

Hackney and District Radio Society.*

A debate on "Seeing by Wireless" took place on June 9th, and was opened by Mr. A. H. Phillips, who was sceptical as to its possibility for many years to come. A number of members, however, warmly contested the point.

It was announced that on account of his forthcoming marriage, the Hon. Secretary, Mr. C. C. Phillips, would be absent for several weeks, and hope was expressed that the rival attraction would not in any way clash with his earlier attraction, viz., Radio!

At the meeting on June 16th, the Chairman, Mr. H. A. Epton, expressed the thanks of the Society to the Vice-Chairman for his very handsome gift of an Amplion loud speaker.

The Society's library is slowly but surely growing, the latest addition being Prof. Fleming's famous book "Electrons, Electric Waves and Wireless Telephony." The library books are in great demand, as well as the Society's Lokap winder, which is lent to each member for one week free of charge.

Until further notice, all enquiries respecting membership should be addressed to the Chairman, Mr. H. A. Epton, 17, Chatsworth Road, Clapton Park, E.5.

North London Wireless Association.*

Of great interest was a lecture on "Inductance," given on June 4th by Mr. J. Nicol, B.A., B.Sc., who illustrated his remarks with the aid of special apparatus.

A successful experiment was made on June 11th, when the members held a general discussion, questions being asked and answered. It has been decided to hold similar meetings on regular dates, so that members may have an opportunity for the exchange of views and the solution of problems.

Applications for membership should be addressed to the Hon. Sec., J. C. Lane, Physics Theatre, Northern Polytechnic Institute, Holloway Road, N.

Radio Society of Highgate.*

An interesting lecture on "Electro-Static Loud Speakers" was given by Mr. F. H. Haynes on June 1st. The working principles of these instruments were carefully explained and some useful constructive hints were given. The lecturer then demonstrated a Johnsen and Rahbek loud speaker, made by himself, and the results, in spite of the lack of sufficient amplification, clearly showed the possibilities of the new instrument under normal conditions.

On June 8th, Mr. G. A. Y. Sowter, B.Sc., gave the first of his lectures on "Amplification," confining his remarks to high frequency amplification. Some interesting figures were given by the lecturer showing the importance of avoiding stray capacity effects in radio-frequency circuits.

Hon. Sec., J. F. Stanley, B.Sc., A.C.G.I., 49, Cholmeley Park, Highgate, N.6.

The Radio Society of Willesden.*

An animated discussion on summer outings, etc., took place on June 12th. Provisional arrangements have been made for visits to the wireless stations at Croydon and Northolt by courtesy of the authorities concerned. Any member desirous of joining the respective parties should communicate at once with the Hon. Secretary.

Applications respecting membership should be addressed to the Hon. Sec., F. H. H. Coote, 183, Carlton Vale, Kilburn, N.W.6.

Wolverhampton and District Wireless Society.*

A lecture entitled "Ether Waves—A Material or a Force?" was recently delivered by Mr. A. H. Watkins, A.I.A.E., and proved of great interest. The lecturer handled the subject from many points of view and an animated discussion followed.

Hon. Sec., J. A. H. Devey, 232, Great Brickkiln Street, Wolverhampton.

Liverpool Wireless Society.*

A most interesting lecture entitled "Reason in Radio Reception" was delivered on Wednesday, June 13th, by the Society's Vice-President, Dr. S. S. Richardson, A.R.C.Sc.

The lecturer first dealt with the many differences between experimental and broadcasting sets. Broadcasting arrangements, he said, had followed too closely on well advertised "freak" receptions, with the result that the public were clamouring for sets capable of freak results by the mere turning of a knob. This demand was unreasonable, and the lecturer's sympathies were entirely with the designers of B.B.C. sets, who were called upon to produce extraordinary apparatus.

The lecturer developed diagrammatically a circuit which had given excellent results, and for the convenience of beginners he commenced with a one-valve receiving circuit, proceeding with a dual amplifier, the first valve acting as both H.F. and L.F. amplifier.

Messrs. Downes and Davies later gave a remarkably good demonstration of a G.R.C. set (one H.F. and four L.F. stages).

Hon. Sec., Geo. H. Miller, 138, Belmont Road, Liverpool.

Tottenham Wireless Society.*

A demonstration of members' apparatus was given on Wednesday, June 13th. A wide assortment of sets was on view, ranging from a one-valve to a five-valve R.I. set, and the Society's instrument. Interesting results were obtained with the Flewelling circuit and with an interference eliminator. Arrangements are being made for further displays, to be held monthly.

All interested in wireless will be welcomed to the membership, and particulars will be furnished on application to the Hon. Sec., S. J. Glyde, 137, Winchelsea Road, Bruce Grove, Tottenham, N.17.

The Thornton Heath Radio Society.

A Radio Society for the Thornton Heath district was founded at a successful meeting held on June 5th, when officers were elected and a committee appointed.

Mr. J. J. Dearden exhibited his three-valve set, and broadcasting was received satisfactorily being made generally audible with a Junior loud speaker.

Efforts are being made to secure a garage to be equipped as a workshop.

Meetings will be held fortnightly, and membership is open to all ladies and gentlemen interested. All communications should be addressed to the Hon. Sec., R. S. Keeler, 72, Bensham Manor Road, Thornton Heath.

Newcastle and District Amateur Radio Society.

On Thursday, June 7th, the Chairman (Dr. R. H. Smallwood) read a comprehensive paper on "Waves and Wave-Motion," in which he dealt with waves in gases, liquids, and solids, and electro-magnetic waves in ether. Refraction and reflection of all kinds were also referred to.

Hon. Sec., Colin Bain, 51, Grainger Street, Newcastle-on-Tyne.

The Sydenham and Forest Hill Wireless Society.

An amusing lecture on a beginner's experience was recently given by Mr. Leonard Dowling, who used his artificial leg (of tubular fibre) as a loud speaker.

Mr. Dowling devoted some of his remarks to the evils of the misuse of reaction, there being a considerable amount of "howling" in the Sydenham district.

Hon. Sec., M. E. Hampshire, 139, Sydenham Road, S.E.26.

The Wandsworth and Battersea Wireless Societies.*

At the kind invitation of the Management of the Electric Pavilion, Lavender Hill, Battersea, a large number of members and friends of the Wandsworth and Battersea Wireless Societies were able, on June 3rd, to attend an interesting cinematograph exhibition of pictures on wireless subjects.

Eight films were shown, lent by the kindness of Messrs. The Ideal Film Co., Gaumont Film Co., Goldwyn Film Co., Marconi's Wireless Telegraph Co., and Pathé Frères, Ltd. The subjects dealt with included Broadcasting, Postal Telegraphy, Wireless and the Fire Brigade, Direction Finding, and the largest wireless station in the world (St. Assise).

At the conclusion of the performance those who wished to were enabled to inspect the transmitting and receiving apparatus of the Electric Pavilion station.

Stratford-on-Avon and District Radio Society.

On Tuesday, June 5th, "The Beggar's Opera," broadcast by **2 LO** from the Lyric Theatre, Hammersmith, was received with great strength and purity in the loud speaker. An exhibition of apparatus by members will be held on July 2nd.

Hon. Sec., E. W. Knight, 17, Park Road, Stratford-on-Avon.

The North West London Radio Society.

By the kind permission of the Post Office authorities, members of the Society recently han an opportunity of visiting the Research statiod at Dollis Hill. They were conducted over the station by members of the staff, who carefully demonstrated and explained the various objects of interest.

"The Club Set" formed the subject of discussion at the weekly meeting held on June 6th, and it was decided to build a three-valve instrument with two H.F. valves and detector.

The Hon. Sec. will be pleased to welcome new members at any of the Society's meetings, which are held every Wednesday at 8 p.m.

Headquarters: The Junction Arms Hotel, Acton Lane, Willesden.

Hon. Sec., L. A. Bray, 48, Manor Park Road, Harlesden, N.W.10.

Owing to pressure on our space we have been compelled to hold over a number of Club Reports.—Editor.

Correspondence

To the Editor of THE WIRELESS WORLD AND RADIO REVIEW.

REFERENCE "BLIND SPOTS" AND "FADING OF SIGNALS."

SIR,—It is pleasing to note that the matter of fading is to be investigated by a central authority with the assistance of organised amateurs throughout the country.

The Club of which I have the honour to be Secretary has conducted some small tests, and as a result of our experience we would suggest that the central authority announce definite stations and times for the tests and thereby save itself much trouble in collating the information it seeks. This could, of course, be in addition to any casual tests indulged in.

The method of reporting results set out in the article in your paper for May 12th suggests that the whole of the trouble is in the receiving of the signals, whereas some amateurs hold the opinion that the transmitting apparatus is not entirely blameless.

The fixing of definite times and stations for a national test would go far to settle this point. It is quite obvious that weather conditions in the south may be different from those in the north, and, with the geological nature of the country being known in each case, should the times and degrees of fading north and south coincide, the cause of the phenomenon would then be looked for in some direction other than that of bad weather and geological conditions.

No doubt you would publish in your widely read Review a programme of a week's tests if such was decided upon.

PERCIVAL SAWYER.

Hon. Sec., Southampton and District Radio Society.

To the Editor of THE WIRELESS WORLD AND RADIO REVIEW.

SIR,—In a back issue of *The Wireless World and Radio Review* I read a discussion of some more practical method of communication than the Morse code. Transmission on a slightly varying wavelength, producing different tones when heterodyned, was especially referred to. I would like to call your attention to the fact that in receiving weak signals it is quite important to adjust the tone of the incoming signal to a certain value, evidently the tone to which the receivers or the operator's ears are the most sensitive.

Some of our American amateur C.W. stations have a varying tone which probably is produced by using a horizontal key with a contact on each side or a Vibroflex, putting the key in some part of the oscillating circuit, and putting a very small inductance in series with the contact on one side. Thus the signals produced by touching one contact are of a slightly different wavelength than those produced by touching the other, and a different tone is produced at the receiving station. I have supposed that operators of such transmitters had arranged the set in this manner to give the station a distinctive sound that it may be recognised whenever heard, but it is possible that the result has been accidental, and is not known by the operator. Stations with two tones, although the difference may be very small, are very difficult to read.

VICTOR ANDREW.

(Radio **8 BPP**).

SHORT-WAVE DIRECTIVE TRANSMISSION*

CONSTRUCTIONAL DETAILS OF THE TRANSMITTING AND RECEIVING EQUIPMENTS.

THE experiments here described make use of directive aerials for transmission. It is also possible to use aerials of marked directional characteristics for reception, and thus to reduce interference in reception caused by undesired transmitting stations. This is the next logical step in the development of a directional system of communication. Since the waves are reflected and radiated in one direction, a less powerful generating set is required to cover a given distance than when a non-directive antenna is used.

Another serious difficulty in radio communication is due to "strays," which are stray waves caused by atmospheric electric disturbances. It is general experience that atmospherics are less severe on short wavelengths than on long wavelengths, and at such short wavelengths as 10 metres it has been found that strong atmospherics are not ordinarily encountered. Atmospherics usually come from a particular direction and can be practically eliminated by the use in reception of an aerial having marked directional characteristics.

The possibilities of short-wave transmission, both directive and non-directive, are so great that the value of further research along these lines is apparent. It is hoped that the results of this article may encourage further investigation.

THE GENERATING CIRCUIT.

Various three-electrode valves were tested, a 50-watt valve of the coated-filament type being finally selected for these experiments, since it functioned at higher frequencies than any other valve tested.

The arrangement of the transmitting apparatus is shown in Fig. 1 and the circuit in Fig. 2. Coil "A" consists of a single turn 17 cms. in diameter in the plate circuit, and coil "C" is a similar coil for grid coupling. The capacity between the elements of the valve, together with these coils, forms the oscillatory circuit. It is this internal capacity which determines the upper limit of the frequencies obtainable with a given valve.

* Extracted from Bureau of Standards Pamphlet, No. 469.

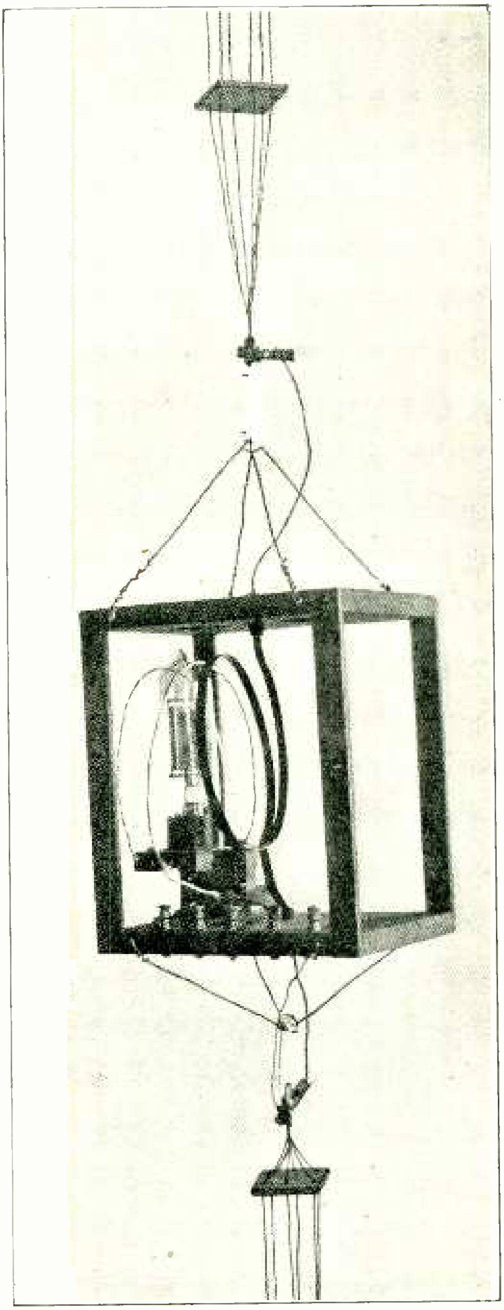


Fig. 1. The transmitting apparatus.

The radiating system "D" is coupled to the generating circuit by means of coil "B," which is similar to coils "A" and "C." The antenna "D" consists of two sets of six parallel wires arranged in a circle, as shown at "E" (Fig. 2). These wires are spaced about 3 cms. apart and 1.8 metres in length.

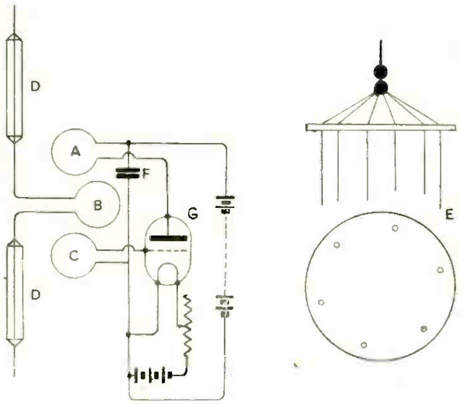


Fig. 2. Circuit of transmitter and arrangement of aerial.

In connecting up it is obvious that all leads should be kept as short as possible, since at these high frequencies the leads may form an appreciable part of the total inductance in the circuit.

THE REFLECTING SYSTEM.

The most effective method of obtaining directive transmission for short wavelengths consists of the use of a reflector with a radiation somewhat similar to a parallel beam of light which has passed through a slit in an opaque screen.

Figs. 3 and 4 illustrate the construction of the reflector. It is made by suspending 40 wires from a frame constructed in the form of a parabola. Each of these wires is tuned to 10 metres and spaced 1 foot apart. The frame is suspended from a rope stretched between two poles, so that the reflector may be rotated. The suspended wires are insulated from the frame and from each other. The focal distance should be made one-quarter of a wavelength; that is, 2.5 metres.

In Fig. 5 the valve oscillator is shown at the focus "G" at a distance of one-fourth of a wavelength from the vertex "B." The curve "C B A" is parabolic. Each wire along "C B A" reradiates the energy received from "G" by virtue of the fact that it is tuned to "G." Since any distance "G K O" or "G P L" is equal to "G B" plus "B G," it is evident that the reradiation from all the wires along "C B A" will reach the aperture "C A" in phase with each other. It is evident, therefore, that reinforcement takes place in the direction "G M" and interference in the direction "G B." Except for leakage, as shown at "G W," practically all the energy is reflected over a small angle in the direction "G M." By extending the parabola, as shown at "S" and "R" (increasing the aperture), this side leakage is reduced, thus giving a narrower beam.

RECEIVING APPARATUS.

In order to study the radiation characteristics of the transmitting system at short distances, the apparatus shown in Fig. 6 was employed. This consists of a single loop of wire about 31 ins. in diameter, and a two-plate tuning condenser having a maximum capacity of approximately 20 micromicrofarads inserted in series with this loop. The terminals of

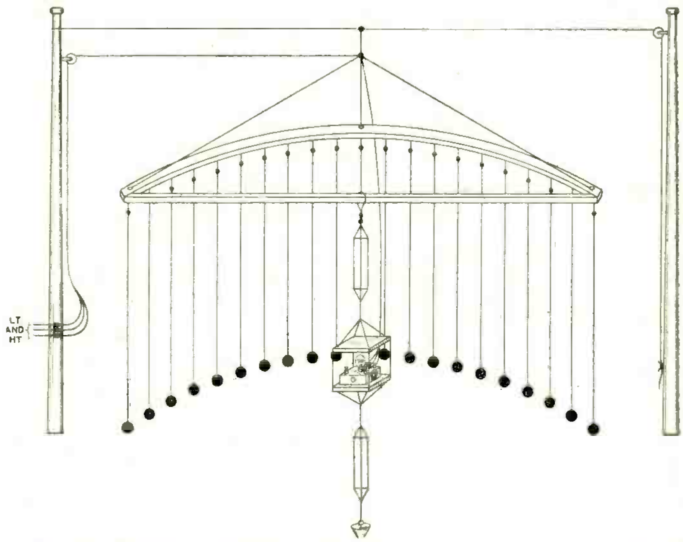


Fig. 3. Practical details of the reflector and suspension of transmitting apparatus and aerial.

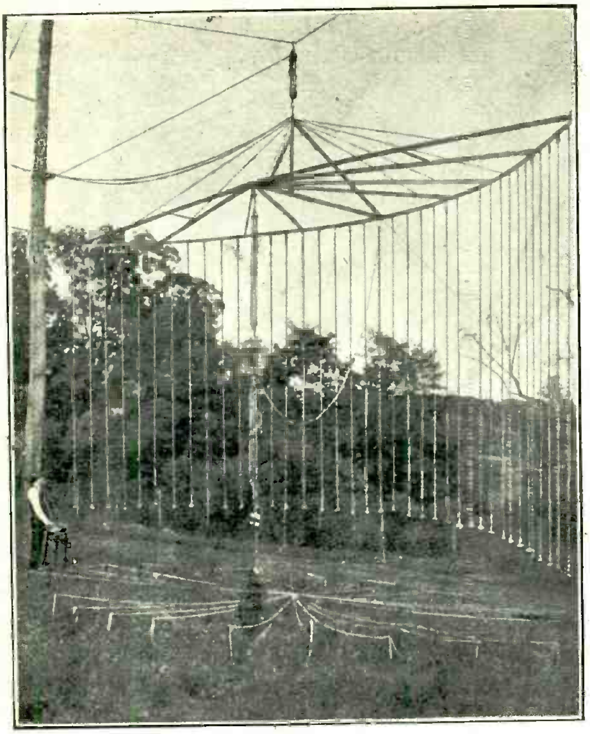


Fig. 4. The reflector and transmitter.

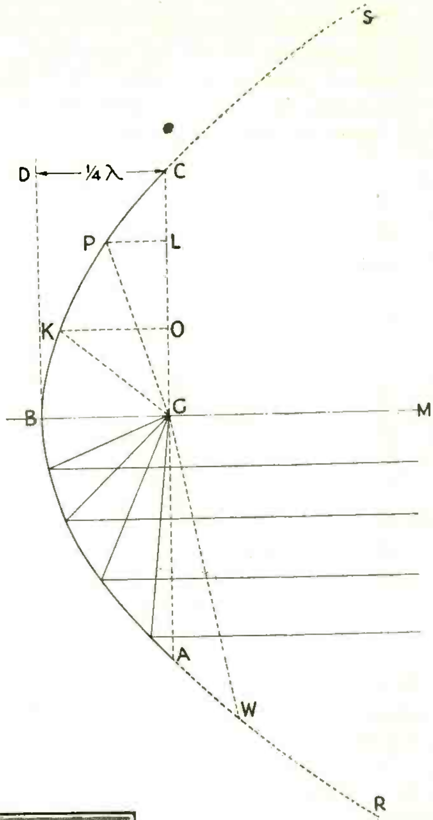


Fig. 5. The transmitter is located at the principal focus, which is arranged to be one quarter of the wavelength employed.

the loop are connected to a 5-ohm thermocouple, the output of the couple being connected to a galvanometer having a 0 to 100 micro-ampere scale. At distances up to 52 metres from the reflector a full scale deflection on this galvanometer can be obtained when the apparatus is adjusted for maximum radiation.

For receiving signals at greater distances than 46 metres a receiving set consisting of a detector and two stages of audio-frequency amplification should be used with an external heterodyne when receiving continuous wave signals. This apparatus is shown in Fig. 7.

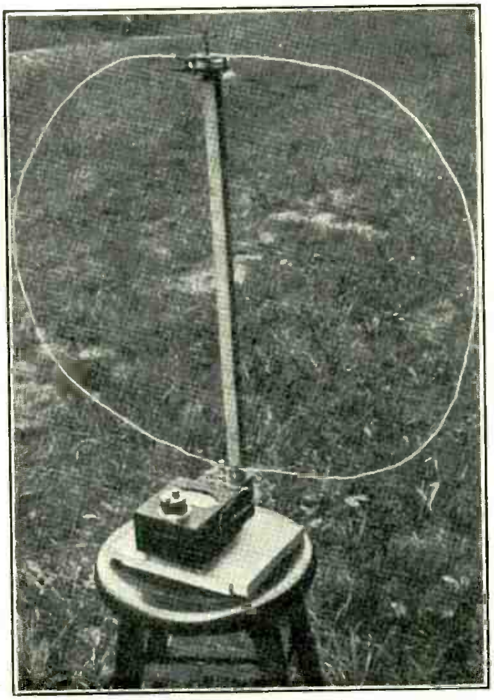


Fig. 6. Apparatus for determining radiation characteristic at short distances.

The secondary of the receiving set, which consists of a single loop of wire 12 ins. in diameter, is connected to the grid and filament of the detector valve. A 0.00005 microfarad vernier condenser is shunted across this loop for tuning purposes.

The grid lead must be made as short as possible, thus reducing to a minimum the capacity between it and other parts of the circuit. The two stages of low frequency amplification are of the usual type.

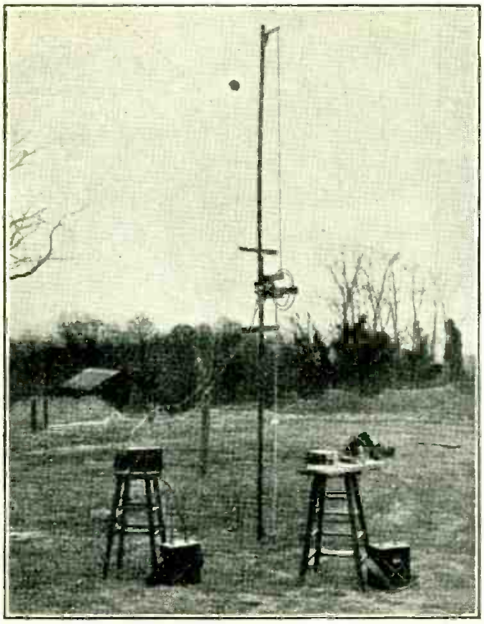


Fig. 7. Short wave receiving equipment.

TELEPHONY.

In order to facilitate tests at a distance, a modulator circuit may be attached, so that

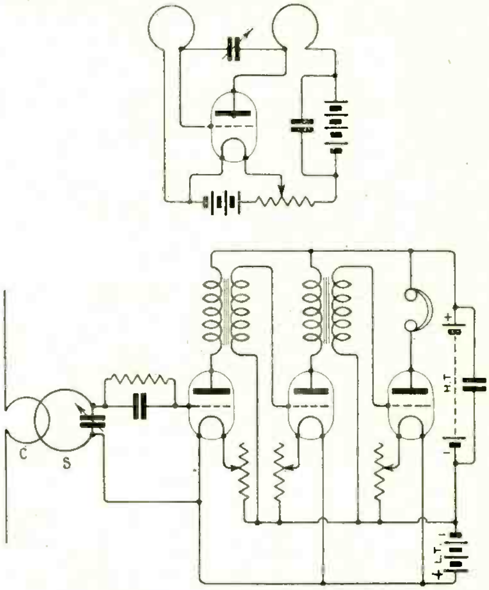


Fig. 8. Circuit of short wave receiver.

The aerial (see Fig. 7) used in picking up the energy at the receiving apparatus is a single wire tuned to the incoming wave frequency and coupled at its centre by means of coil " C " to the secondary coil " S " of the receiving set (Fig. 8). The total length of wire in the aerial, including the single turn 1 foot in diameter, is 4·37 metres. This aerial was made from a single piece of No. 14 S.W.G. copper wire.

telephony is possible. As the reflector is rotated its angular position can be read to the receiving operator. The circuit is shown in Fig. 9.

In conclusion it may be said that directive wireless communication on short wavelengths, employing the type of apparatus described, has been found to be practicable and to merit much more comprehensive investigation and use.

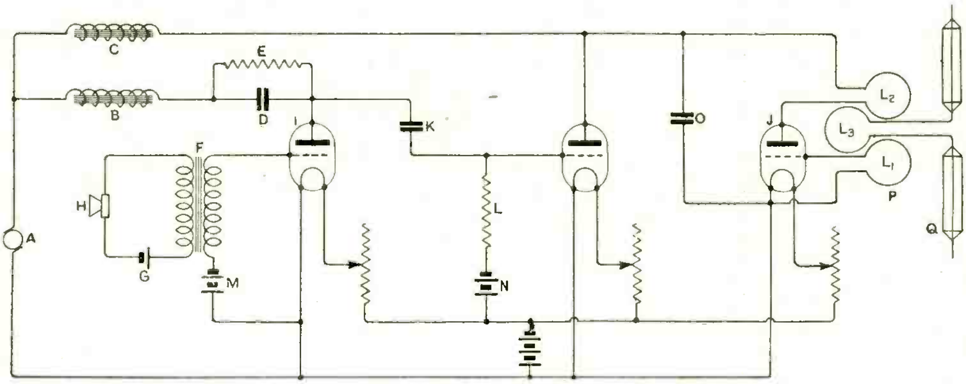


Fig. 9. Circuit of modulator for telephony for use with 10-metre wavelength directional transmitter.

Notes and News

Scotland Yard now possesses a wireless wagon which can communicate by telephony when travelling at a speed of 40 miles per hour.

* * * *

Distant control by radio has been used to manœuvre the old battleship *Agamemnon*, which provided a target for the Atlantic Fleet at gun practice.

* * * *

The Broadcasting Enquiry Committee, it is stated, hopes to complete its report by the end of July.

* * * *

Eight hundred acres of land, it is stated, have been acquired by the Government at Hillmorton, Rugby, for the erection of a wireless station in connection with the Imperial Wireless Scheme.

* * * *

The B.B.C. announces that in future a concert will be broadcast from the London Station (2 LO), on Sunday afternoons, commencing at 3 p.m.

Our illustration shows one of the Stands at a Radio Exhibition in Japan, held at the Industrial Institute, Tokyo, during April. Great enthusiasm was shown by the public.

Complaint is made in Bombay of the inefficiency of the wireless service from Leafield, *via* Cairo, Aden and Karachi. Since June 1st, the service has been suspended owing to atmospherics.

* * * *

A Radio Exhibition in Japan.

The Industrial Institute of Tokyo was, on April 15th and the nine days following, the scene of the city's first wireless exhibition, which was conducted by the following officers :—Mr. Keijiro Inouye, President (Ex-Director of Tokyo Electric Bureau), Mr. Teijiro Koto, Technical Adviser, and Mr. Aquila Kajima, General Manager (Proprietor and Editor of *Radio Times*, and Musen News Agency).

Among the exhibitors were the Government Departments of Communications, Army and Navy, the Tokyo Electric Bureau, Waseda University and 52 other representative concerns, public and private.

An interesting programme of entertainments was given during the exhibition, and included music, radio experiments, and a cinematograph display of scientific theories.

In connection with the two leading newspapers, *Kokumin* and *Hochi*, "Radio Day" was observed on April 12th, when a cinematograph lecture was given in Hibiya Park, attracting a crowd of 30,000.

The object of the exhibition and demonstration was to pave the way for radio broadcasting, which is to begin in July.

Loud Speaker causes Obstruction.

An unusual prosecution, involving the use of a loud-speaker for advertising purposes, took place on Friday, June 22nd, when the City Accumulator Company, of Mark Lane, E.C., were summoned at Bow Street, for causing an obstruction outside their Rupert Street, W., branch. A police sergeant said that between 50 and 60 people collected to hear a wireless loud-speaker. On the understanding that a smaller instrument would be used, the magistrate dismissed the summons on payment of 2s. costs.

Ship's Master Fined for Wireless Negligence.

An unusual case, said to be the first of its kind to arise in an English court, was heard at Liverpool a few days ago, when John Owen Evans, Master of the Hain Steamship Company's vessel *Tredenhamo* (8,435 tons) was charged with failing to maintain a continuous wireless watch at sea.

In the defence it was admitted that on two occasions a continuous watch was not kept in Australian waters, as backward apprentices were being given lessons in navigation and seamanship.

A fine of £10 was imposed.

Time Signals from Annapolis (NSS).

It is announced that, until October 15th of this year, the high power station at Annapolis, Chesapeak Bay (NSS), will transmit a special time signal daily on C.W. at 0855 G.M.T. using full power and a wavelength of 17,145 metres.

A Civil Servants' Radio Society.

It has been proposed that the Civil Service Clerical Association should include a Radio Society, which might be affiliated with the Radio Society of Great Britain. Civil Servants interested should communicate with the Secretary of the Association, Admiralty Branch No. 1 (Mr. E. B. Wood), Room 72, Prince's House, Kingsway, London, W.C.2.

The B.B.C. and the Experimenter.

In our last issue we gave publicity to four questions addressed by the Wireless Experimental Association to the B.B.C. authorities at 2 LO, containing proposals for harmonious working between the Company and experimenters. The Secretary of the Association states that he has received a business-like and courteous reply from the Chief Engineer, Capt. Eckersley, dealing carefully with every point raised. The letter concludes as follows :—" *You will realise, however, that our work, too, is largely experimental, and sometimes we have to do tests on a Sunday which we have no opportunity of doing at any other time. We will seriously try and use this time to the best of our ability and not jam the ether unnecessarily, and we would like to take this opportunity of thanking amateurs throughout the Kingdom generally for the sporting way in which they have treated the Broadcasting Company.*"

The Broadcast Band.

Public discontent continues to grow regarding the limited range of wavelengths allotted to the Broadcasting stations. In defence it is urged that manufacturers should provide more selective apparatus, but in reply to this attitude it is argued that selective apparatus requires expert handling. Col. Moore Brabazon points out that listening-in in many coastal towns is, frankly speaking, impossible, owing to interference from ship stations.

The solution to the trouble, as stated in the *Times*, by Captain Eckersley, Chief Engineer of the Broadcasting Company, is the employment of modern apparatus on ships, capable of transmitting on a given wavelength and no other. At present a great laxity exists in the transmission of ships' messages on 600 metres, some ships using a lower or higher wavelength and effectively jamming the ether on both sides of the stipulated wavelength.

Aeroplane Telephony over 400 Miles.

A new record for long-distance wireless telephony from aircraft is stated to have been established by Captain W. R. Hinchcliffe, whilst piloting a Daimler air express over Bremen, in Germany. From this distance, he was able to converse with the London Air Station, 400 miles away. The feat is the more remarkable in view of the fact that the full power of the Marconi wireless set fitted to the Daimler expresses is only 100 watts, and that the pilot was sitting within a couple of feet of a 450 horse-power engine.

FORTHCOMING EVENTS.

FRIDAY, JUNE 29th.

The Radio Society of Highgate. At 7.45 p.m. At the 1919 Club, South Grove. Exhibition and demonstration of loud speakers.

Leeds and District Amateur Wireless Society. Lecture : " Signalling—Ancient and Modern," by R. E. Timms (Hon. Treasurer).

SATURDAY, JUNE 30th.

High Wycombe and District Radio Society. Visit to Leafield (G.P.O.) Radio Station. Leaving High Wycombe at 2 p.m.

MONDAY, JULY 2nd.

The North London Wireless Association. At 8.30 p.m. Lecture : " Trigger Valve Circuits," by Mr. V. J. Hinkley.

Stratford-on-Avon and District Radio Society. Exhibition of Members' apparatus.

Ipswich and District Radio Society. At 55, Fonnereau Road. Lecture by Mr. Berry.

Hornsey and District Wireless Society. Lecture : " Construction of Valve and Crystal Receivers," by Mr. H. Davy.

THURSDAY. JULY 5th.

Dewsbury and District Wireless Society. General Meeting.

Erratum.

Readers will have observed a slight error in Mr. James' Theory article appearing in our issue of June 16th. In the paragraph immediately following the equation in the right-hand column of page 353, the current should be stated as 0·025 amperes, not 0·5 amperes, and the pressure 39·7 volts.

Books and Catalogues Received

" Radio : Télégraphie-Téléphonie-Concert." by E. Reynaud-Bonin (Paris : Gauthier-Villars et Cie., 55, Quai des Grands-Augustin. 178 pages. 88 figures. Price 10 francs.)

J. W. Barnard & Haynes, Ltd. (4, Great Winchester Street, E.C.2.). Special Wireless Price List relating to J.W.B. Accumulators.

Radiax, Limited (4, Percy Street, W.1.). An illustrated catalogue dealing with " Radiax " Wireless Receivers, Units and Components sold by the firm.

C. L. Malone, Radio Engineer (17, Piccadilly Arcade, London, S.W.1.). Catalogue of Malone Crystal and Valve Apparatus. Leaflet describing the " Alva " Self-charging Accumulator.

Sterling Telephone and Electric Co., Ltd. (210-212, Tottenham Court Road, W.1.) Publications No. 350 and 357, describing respectively the Sterling Combined Crystal and Valve Set, and a novel Multiple Connector for Radio Telephones.

General Electric Co., Ltd. (Magnet House, Kingsway, W.C.2). Booklet No. B.C.2984, illustrating the wide range of "Gecophone" Wireless Accessories.

Abbey Industries, Limited. (Abbey Wood, S.E.2). Abbiphone Wireless Catalogue dealing with "Abbiphone" Receiving Sets, Amplifiers, Accumulators, etc.

The Chloride Electrical Storage Co., Ltd. (Clifton Junction, Nr. Manchester). A highly attractive and artistic brochure describing the works and manufactures of the Company.

Amateur Transatlantic Transmissions.

The following are extracts from a letter received by the Editor of this journal from the headquarters of the American Radio Relay League, and should be read in conjunction with this week's Editorial on page 399.

"Our sole interest in life is the furtherance of the idea of two-way short wave amateur telegraphic communication, and now that we have almost completely mastered any distance within the United States, it is but natural that the thoughts of our amateurs turn to the other great English-speaking country . . . . We confidently await the day when your amateurs and our amateurs may communicate with each other with at least the ease and frequency with which we now work over the distance from this coast to the Mississippi River. We feel that our end of the Relay is fairly well equipped to do this now, and we know that your fellows are 'there' on receiving."

The letter continues :—

"It would please us more than we can tell to see an expanding interest in 200 metre telegraphic transmission in your country with the use of power having a decent chance of getting over in good weather. Naturally the chances of doing very much are small during the summer weather, but winter will find you with more transmitters than before, and if only your men are on the air at the same time ours are, some communication is almost inevitable.

"Our fellows seem generally to be desirous of having another go at listening for European amateurs some time late this year, and our Traffic Manager is now evolving some ideas in his mind. . . . The co-operation of *The Wireless World and Radio Review* through its affiliation with the Radio Society of Great Britain and the British Wireless Relay League, will be quite indispensable."

BROADCASTING.

Regular Programmes are Broadcast from the following European Stations :—

GREAT BRITAIN.

LONDON 2 LO, 369 metres ; **MANCHESTER, 2 ZY,** 385 metres ; **BIRMINGHAM, 5 IT,** 420 metres ; **CARDIFF, 5 WA,** 353 metres ; **NEWCASTLE, 5 NO,** 400 metres ; **GLASGOW, 5 SC,** 415 metres. Regular morning and evening programmes, particulars of which appear in the daily press, are conducted from these stations by the British Broadcasting Company. The usual times of transmission are:—Weekdays, 11.30 a.m. to 12.30 p.m., 3.30 to 4.30 p.m. (**5 IT** only), 5.30 to 11 p.m. Sundays, 3 p.m. (**2 LO** only), 8.30 to 10.30 p.m.

FRANCE.

PARIS (Eiffel Tower), **FL,** 2.600 metres. Daily, 7.40 a.m.. Meteorological Forecast ; 12.15 p.m., Meteorological Report and Forecast ; 3.30 p.m., Financial Bulletin (Paris Bourse) ; 6.10 p.m., Concert and Meteorological Forecast ; 11.15 p.m., Meteorological Report and Forecast. Sundays, 6.10 p.m., Concert and Meteorological Report.

LEVALLOIS-PERRET (Radiola), SFR, 1,780 metres. Sundays, 2 to 3 p.m., 9 to 10.30 p.m., Concert. Weekdays, 12.40 p.m., Concert, 5.5 p.m., Financial Bulletin ; 5.15 to 6.15 p.m., Instrumental Music ; 8.45 p.m.. Miscellaneous News ; 9 to 10 p.m., Concert. Thursdays, 9.45 p.m. to 10.30 p.m., Dance Music.

ECOLE SUPÉRIEURE des Postes et Télégraphes, 450 metres. Tuesday and Thursday, 8.30 p.m., Concert. Saturday, 2.30 to 7.30 p.m., Concert.

LYONS, YN, 3,100 metres. Weekdays, 10.45 to 11.15 a.m., Gramophone records.

HOLLAND.

THE HAGUE, PCGG, 1,050 metres. Sunday, 3 to 5 p.m. Concert. Monday and Thursday, 8.40 to 9.40 p.m., Concert.

THE HAGUE (Heussen Laboratory), PCUU, 1.050 metres, Tuesday, 7.45 to 10 p.m.. Concert. Sunday, 9.40 to 10.40 a.m., Concert.

THE HAGUE (Velthuyzen), PCKK, 1,050 metres. Friday, 8.40 to 9.40 p.m., Miscellaneous.

IJMUIDEN, PCMM, 1,050 metres. Saturday, 8.40 to 9.40 p.m., Concert.

AMSTERDAM, PA 5, 1,050 metres. Wednesday, 8.10 to 9.10 p.m., Concert and News.

BELGIUM.

BRUSSELS, BAV, 1,100 metres. Working days, 12 noon, Meteorological Bulletin. Daily, 4.50 p.m., Meteorological Bulletin. Tuesday and Thursday, 9 p.m., Concert. Sunday, 6 p.m., Concert.

GERMANY.

BERLIN (Kœnigswusterhausen), LP, 2,800 metres. Daily, 7 to 8 a.m., Financial and other news ; 12 to 1.30 p.m.. Financial and other news ; 5 to 6.30 p.m., Financial and other news.

CZECHO-SLOVAKIA.

PRAGUE, PRG, 1,800 metres, 8 a.m., 12 noon and 4 p.m., Meteorological Bulletin and News. 4,500 metres, 10 a.m., 3 p.m. and 10 p.m., Concert.

SWITZERLAND.

GENEVA, HB 1, 1,200 metres. Daily, 6 to 7 p.m., Concert ("Utilitas").

LAUSANNE, HB 2. Daily, 6 to 7 p.m., Concert ("Utilitas").

Methods of Reducing Interference in Wireless Receiving Sets.*

By Prof. E. W. Marchant.

WHEN Dr. Eccles asked me to give a lecture to your Society, it seemed to me that we in Liverpool were well fitted to discuss the subject of interference, because as he has said, the interference produced in Liverpool by ships and the G.P.O. station at Seaforth is serious, and it has been found very difficult indeed to get rid of it. I am not going to confine myself, however, entirely to discussing the circuits which we have tried out in Liverpool in order to get rid of interference. I propose to deal with the subject rather more generally, and to discuss in the first place the three different kinds of disturbance which one is likely to suffer from in a wireless receiving circuit.

Disturbances may be classified into three groups :—

(1) Interference due to what are commonly known as "atmospherics" or "strays" and other similar disturbances. Among these "similar disturbances," some of the most troublesome we have met with have been due to tramcars, and to tramcar points particularly. When an electrically controlled tramcar point is altered, it is moved by an electro-magnet which gives a spark when the current through it is broken and causes a very strong "atmospheric." There are some places close to tram routes which are very badly disturbed from this cause, and the "wave shape" of the disturbance must be very much like the wave shapes that have recently been described by Dr. Appleton and Mr. Watt.†

(2) Interference due to signals from other stations, and

(3) Interference due to locally induced currents. Unfortunately, we are working in a laboratory with a large amount of machinery and a great many commutators and other sources of rapidly fluctuating currents ; these give a great deal of trouble in receiving circuits, and the getting rid of them is one of the greatest, if not the greatest problem which has had to be dealt with.

Dealing first of all with atmospherics and other similar discharges, I had intended to describe in some detail the results that Dr. Appleton and Mr. Watt have recently published before the Royal Society, but I understand that Mr. Watt is coming here next month to talk about these results. Therefore, I will cut short what I was going to say about their work. At the same time, I should like to mention some of the results, because I think they are of very great interest. They are the first results that have been obtained of the actual wave shape—if one can call it that—of an atmospheric discharge. The general opinion that one has had of atmospherics, up to this paper, has been that they gave rise to high frequency oscillating currents, and I think most people thought that the atmospheric that one received on an antenna consisted of such a high frequency oscillation. Dr. Appleton and Mr. Watt have found that only about half of the disturbances that are received on an antenna are oscillatory, and that nearly half the total number of atmospherics are aperiodic. Fig. 1 shows some atmospherics that were observed a good many years ago now in Liverpool.

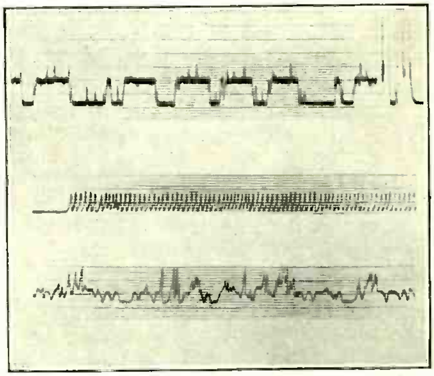


Fig. 1. Top : Signal from Brussels showing atmospheric. Middle : Paris signal. Low frequency spark. Bottom : Atmospherics superimposed on Clifden signals.

The bottom curve is the most interesting. That was a record taken on an Einthoven galvanometer of currents received from Clifden without any particular precautions being taken to get rid of atmospherics. It will be noticed that the signals are almost completely masked by a continuous succession of them. In the paper of Dr. Appleton and Mr. Watt to which I have already referred, the number of atmospherics observed was 590 in 10 days, but I think one would have had many times that number in an hour from the Clifden record, because, with these long waves, atmospherics are almost continuous.

Fig. 2 shows curves taken from the paper by Dr. Appleton and Mr. Watt, representing the wave shape of atmospherics, *i.e.*, the curves giving the relation between the voltage per metre on the antenna, and time. I must say a word or two about them because they are a little difficult to understand without some explanation. In getting the curves, a cathode ray oscillograph was used. A cathode ray oscillograph consists essentially of a heated

* A paper read before the Radio Society of Great Britain on Wednesday, May 23rd, 1923.

† Proc. Royal Society A, vol. 103 (1923), p. 84.

filament in an exhausted glass bulb which gives rise to a discharge of electrons, and just in front of the filament are two pairs of plates at right angles to each other, as shown in Fig. 3. The cathode beam comes from the heated filament and falls on the fluorescent screen. The pair of plates *nn* is connected to an oscillating

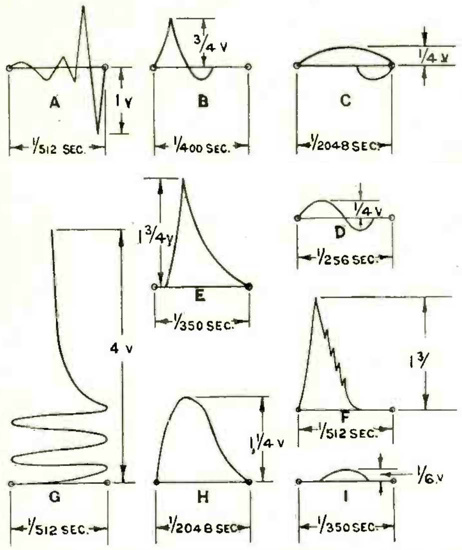


Fig. 2. Curves representing the wave shape of atmospherics.

circuit which gives an oscillating potential difference between them. That causes the fluorescent spot to be deflected horizontally with an ordinary harmonic motion. The two plates *mm* are connected to a resistance in the antenna circuit and give a record of the voltage on the antenna. They are connected either directly or through amplifiers, and that gives a vertical motion. If the atmospheric lasts longer than the time taken for the beam to execute one half vibration horizontally there will be apparently two values of the antenna voltage at any given time. There are two main types of atmospheric shown in Fig. 2, one of rounded form and the other "cusp" shape. In (*c*) Fig. 2 the spot has begun to go back before the atmospheric discharge ends, and apparently there is a double value. In (*g*) Fig. 2 there appear to be many values at any given time; the whole time taken by the atmospheric is roughly five times the time

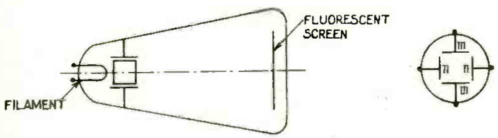


Fig. 3. The production of the Cathode beam used in the Cathode ray oscillograph.

for one half oscillation horizontally or 1/100th second. These curves show that the discharges that have to be dealt with in atmospherics are very similar to those which are produced by a spark from a tramcar point or anything of that kind, and the methods to be adopted, therefore, for getting rid of them are very similar.

The comparatively long time that an atmospheric lasts is evident from the curves in Fig. 2. One cannot say that the wave has a definite period because it is aperiodic in nearly half the cases. The time for which a wave lasts is of the order of 1/500th of a second; therefore, if one puts it in terms of wavelength for a complete oscillation, it means that the length of the waves produced are of the order of 600,000 metres. When there are periodic disturbances as shown in (*f*) Fig. 2, the rate of oscillation is very much more rapid, and the wavelength is of the order of 10,000, 50,000 or 100,000 metres, which are comparable, of course, with the wavelengths that are used for long distance commercial transmission. These disturbances, therefore, cause much more trouble on long distance long wave transmissions. Fortunately for those who are listening in with broadcasting receiving sets, the trouble from atmospheric disturbances is nothing like so serious as it is when one is working on long waves. Short waves are so different in wavelength from these disturbances that the disturbances do not cause a great deal of interference in short wave sets. Dr. Eccles can tell you a great deal more about this subject than I can, because he has records of strays taken over a number of years. I should like to mention one rather interesting fact which is stated in one of his papers, and that is, that atmospherics appear to decrease just before sunrise. In one case he mentions they were rather strong during the night, but, just before sunrise they completely disappeared and after sunrise they increased again. I do not know whether there is any explanation of this fact. I have never seen it, but it is a very curious record.

There are one or two other interesting facts about atmospherics which have been observed recently which, perhaps, might be mentioned. Stoye in Strasburg noted that when a particular condition of the sky occurs, *viz.*, what he calls "curls" appear (I suppose he means those little wisps of cloud one sometimes sees in the sky), preceding a barometric depression, atmospherics are troublesome. Another observer has stated that atmospherics are greatest when the vapour pressure is a maximum. Atmospherics are a minimum during times of dry fog, low temperature and high atmospheric pressure. I should think the weather here recently has been favourable as far as atmospherics are concerned; I mean the recent weather seems to have corresponded fairly well with the conditions for fewer atmospherics. I have not specially observed atmospherics recently, but I should think they have not been so bad this year as in some previous years at this season.

Methods of Reducing Interference due to Atmospherics.

Now I come to methods for getting rid of the disturbance caused by atmospherics. A very large number of methods have been tried and I am only going to refer to some of those which appear to have been most successful. A method was suggested many years ago which consisted in connecting the aerial through a special form of crystal contact to earth, which was said to have the effect of diverting the atmospheric from the aerial and preventing it from going through the receiving coil of the antenna.

The principle which underlay the action of this contact was that it offered a low resistance to the heavy discharges produced by atmospherics and a high resistance to weaker signals, so that when a bad atmospheric struck the aerial, the atmospheric current was deflected through the crystal contact.

There was another suggestion made and, I believe, tried by Marconi, although I do not think it has been used to any great extent, and that was to tune the aerial, not to the fundamental wavelength, but so that it was set in harmonic oscillation by the received wave.

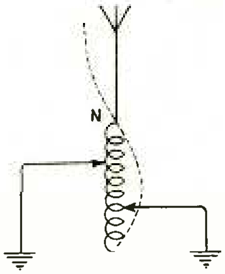


Fig. 4. Potential nodes in aerial system.

If we put an earth leak at the potential node N of the wave received on an aerial as shown in Fig. 4, the result is nil as far as the received wave is concerned; the earth connection will do nothing because it is at a node of potential, but when waves of other wavelength are received, the earth connection acts as a by-pass and the atmospheric or other wave goes to ground. I have had no practical experience with this arrangement.

Fig. 5 shows a diagram of a circuit which has been tried; which on paper looks well, for getting rid of atmospherics. There are two primary coils in series with the antenna, each having a secondary circuit coupled to it. These two secondary circuits are connected, as shown, with two valves, but they might be connected to any other kind of

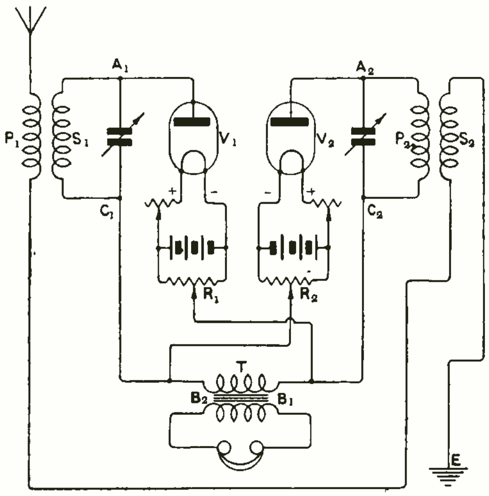


Fig. 5. Circuit arranged to eliminate interference.

detector. One valve V_1, acts as receiver for the signal that is produced in the one circuit, and the connection to it is made between the points A_1 and B_1. The received current goes through the valve and through the transformer T, to B_2 and thence to C_1. The other circuit produces a current in the opposite direction through T, so that the signals received by the two circuits balance each other if the currents that are produced in the two receiving circuits are the same. If both circuits are tuned to the frequency of the received signal, there will not be any signal at all, but if one of these circuits is detuned slightly, it will not have so strong a current induced in it as that in the circuit that is tuned for the signal it is desired to receive, and therefore there will be a current through the transformer, and a signal will be heard in the telephone. If, however, an atmospheric strikes the antenna, the effect that will be produced in both these circuits will be very nearly the same. The difference in tune will not make any difference in the strength of the signal, and therefore the atmospheric will not be heard at all. That looks very well on paper, but the trouble with the

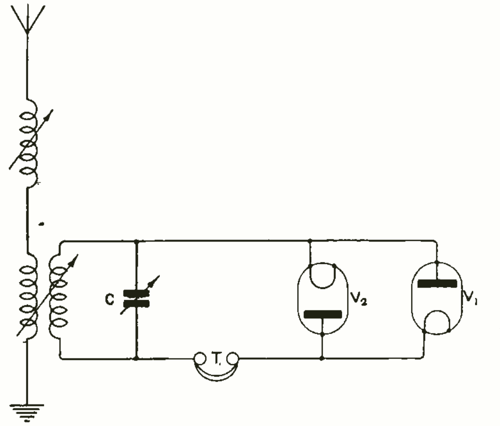


Fig. 6. Balanced valve circuit.

arrangement is that when a very powerful atmospheric strikes the antenna, the antenna starts in oscillation at its natural frequency, and when there is an oscillation of the natural frequency of the antenna, the arrangement is useless; and I do not think the method has been used to any great extent. I have described the arrangement, however, because, with a slight modification, it could, I believe, be used successfully. If a resistance were put in the antenna circuit, of such a value as to make the antenna aperiodic, the apparatus should work quite well. The trouble is that the amount of resistance that would be required for an ordinary P.M.G. aerial is large. The actual value comes out to about 800 ohms, and consequently the signal strength will be very much reduced. With strong signals, however, this arrangement should prove very useful.

Another circuit which has been used a great deal is the balanced valve or balanced crystal circuit. This is shown in Fig. 6.

The two valves are run at different filament temperatures, one is bright and the other is dull. If a weak signal comes in, then valve V_2, rectifies the current and gives a signal on the telephone. When a strong signal comes in, it passes equally well through both valves, *i.e.*, there is as much positive as there is negative current through the two valves and the disturbance is eliminated to a certain extent and the effect produced by the atmospheric in the telephone is limited. I think the circuit, with balanced crystals, is probably the most successful of the anti-atmospheric devices in operation to-day; it is used largely in the tropics.

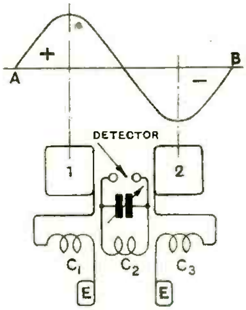


Fig. 7. Principle of the Weagant arrangement.

A very ingenious arrangement has been devised by Mr. Weagant of New York. It is a device which has been applied to long waves with considerable success. Weagant uses two aerials. Fig. 7 illustrates the principle.

There are two aerials or two frames. These are arranged half a wavelength apart. If one is working on a 5,000 metre wave, they would be 2,500 metres apart. A positive current is produced in one loop of the aerial and a negative current in the other loop. These currents go through C_1 and C_3, and the circuits are so arranged that they produce opposite E.M.F's in the coil C_2, so that if the waves produce positive current in one aerial and a negative current in the other aerial there will be a signal in the detector. If the waves strike the two coils simultaneously, they will produce two equal currents. These two equal currents produce opposite effects in the receiving circuit and balance each other out. Fig. 8 is taken from a paper read by Mr. Weagant and shows the actual arrangement.

The two loop antennæ are both tuned for the wave it is desired to receive. They are connected up to the two coils C_1 and C_2 inside which is a rotating coil which is coupled to both. This rotating coil can be moved so as to obtain equality of E.M.F. from the two receiving circuits, the circuit coupled to the rotating coil being also tuned to the received wavelength. This arrangement cuts out all disturbances that strike the two loops at the same time. Mr. Weagant found that a large number of atmospherics appeared to come from a vertical direction and struck both antennæ simultaneously. These atmospherics he called "grinders" because of the noise they made in the telephones. Grinders were got rid of altogether by this arrangement, but it was not effective in getting rid of a second type of disturbance which he called "clicks." "Grinders" were supposed to be due to thunderstorms occurring in the upper regions of the atmosphere and "clicks" to thunderstorms and lightning discharges near the surface of the ground, and, of course, a thunderstorm near the surface of the ground produces a wave which would not necessarily strike the two coil aerials at the same instant.

A very ingenious arrangement was devised for an improved apparatus, using what Mr. Weagant called a static tank. Fig. 9 illustrates the working of the static tank.

The two aerials with their receiving circuits C_1 and C_2 are coupled to the rotating centre coil circuit C_3 in such a way that the signal produces

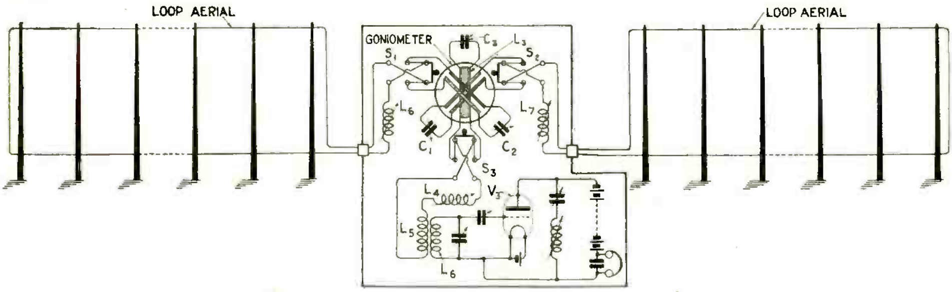


Fig. 8. The Weagant receiving system for eliminating interference.

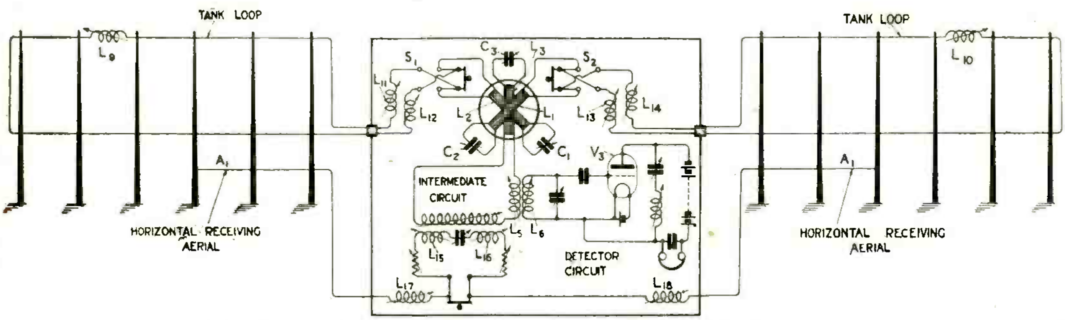


Fig. 9. Another and improved arrangement devised by Weagant.

no effect. The only effect produced in the rotating coil circuit is due to the statics striking the two aerials. In addition, there is a small horizontal antenna shown at A_1 and A_2 in Fig. 9, which is coupled up through another circuit C_4, and which also influences the receiving circuit C_3. By adjusting the coupling between the "tank" circuit and the receiving circuit, the atmospheric effect which is produced by the loops can be made exactly equal and opposite to the effect that is produced by statics in the horizontal antenna. The signal produces no effect on the "tank" circuits. It *does* produce an effect on the horizontal antenna, and that effect is recorded as a signal. So far as I know, this arrangement has not been used on short waves, but in cases of serious disturbance it is a method which might well be tried.

Interference from other Transmitting Stations.

Getting rid of signals from other stations is a very much easier problem to solve than getting rid of atmospherics, because the wavelength of the interfering signal is known, and, as a rule, the signals are due to continuous waves. The most effective way of eliminating the influence of other stations is, of course, by accurate tuning. There are two methods of tuning which are important. One can get accurate tuning (selectivity) by using a number of circuits. That was the old way.

Take the case of a receiving circuit which is accurately tuned (see Fig. 10). Suppose there is an aerial A, and a secondary circuit B tuned to it. Now assume that all these are tuned for waves of 100 metres, and that there are also waves of say 99 metres wavelength striking it. With a

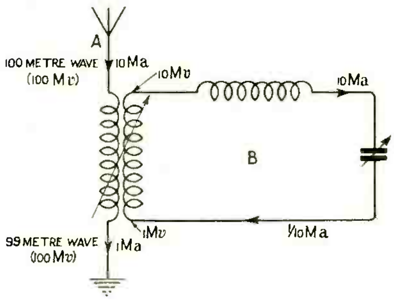


Fig. 10. Distribution of current and potential in receiving oscillatory circuits.

sharply tuned circuit one can make the current in the antenna circuit about one-tenth (or even less) as strong for the 99 metre wave as for the 100 metre wave, so that if one supposes that two waves are reaching the aerial A simultaneously, of 99 metres and 100 metres wavelength respectively, the current in the antenna be will one-tenth as strong for the 99 metre wave as for the 100 metre wave. If the circuit B is also tuned for 100 metres let us assume that, when it has a certain E.M.F. applied, corresponding with a wavelength of 100 metres, there is, say, 1 milliampere flowing, but that the same E.M.F. of a frequency corresponding to 99 metres will give 1/10th of a milliampere. If one compares the effect of two waves of the same amplitude reaching A, one of 100 metres wavelength and the other of 99 metres wavelength, there will be a current of 10 milliamperes in the

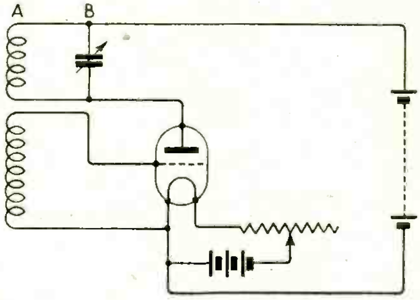


Fig. 11. Reacting valve for reducing the effective resistance of the grid circuit.

aerial A and an E.M.F. of say 10 millivolts in the circuit B, due to the 100 metre wave, as compared with a current of 1 milliampere in the aerial A, and an E.M.F. of 1 millivolt in the circuit B, due to the 99 metre wave. Since the circuit B is tuned for the 100 metre wave, there will be a current round it of say 10 milliamperes due to the 100 metre wave, as compared with 1/10th of a milliampere due to the 99 metre wave.

Theoretically, the more circuits there are, the sharper the tuning, but one cannot go on increasing the number indefinitely because every time there is a transformation or coupling, there is loss of energy, and it is not practicable to use more than four or five circuits. This principle was made use of many years ago in the Marconi Multiple Tuner. The thing that has improved sharpness of tuning most, during recent years, has been the use of reaction. If reaction is used in the receiving circuit, the effective resistance of the receiving circuit may be reduced to zero. With an ordinary detector valve, the plate circuit of the valve may be made to react on the grid circuit in the ordinary way (see Fig. 11), with the result that the effective resistance of the grid circuit = 0. The "steepness" of the tuning curve for an oscillating circuit depends upon the resistance in the circuit. If there is a large resistance the resonance curve is flat and relatively broad, whereas if there is a very small resistance, the resonance curve becomes steeper, and the tuning is very sharp. Therefore, if one uses reaction one can get a much sharper tuning than is possible without it, and the use of reaction has done probably as much as multiple circuits did, to improve the sharpness of tuning. Anyone who has had experience of the use of reaction knows how much the sharpness of tuning is improved by its use. Of course, one must not use reaction in the aerial circuit, but one can use it in the other circuits. We have not found reaction completely effective, however, as far as getting rid of disturbance from ships is concerned, and we have been making a good many experiments lately on the tuned circuits which I think were described in the first number of *Modern Wireless*. For convenience one may call them the Hinton rejector circuits, though I am not sure that Mr. Hinton was the first person to use them.

The circuit which we have found most satisfactory from the point of view of reducing disturbance is shown in Fig. 12. A shunt is connected across the tuned secondary circuit (see Fig. 12) consisting of a condenser and inductance with reaction coupled back on to the plate circuit of the detector valve, both the

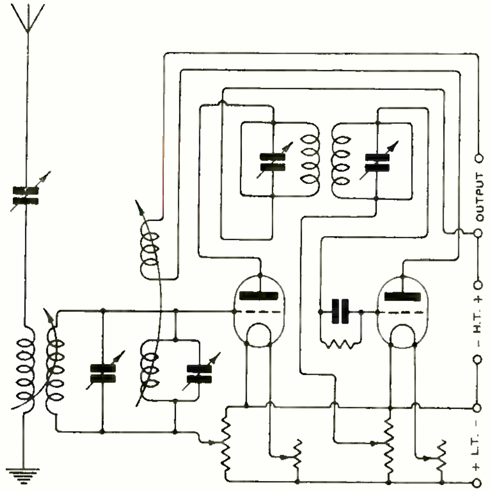


Fig. 12. *Receiver with absorption circuit coupled to the reaction inductance for reducing interference.*

secondary circuit and the shunt circuit being tuned for the received wavelength. Now in such a circuit, if one calls $L\omega$ the reactance of the coil, then the impedance across the circuit for currents of the frequency for which it is tuned is $\frac{L\omega^2}{R}$ R being the sum of the resistances of the condenser and the coil. Therefore, one can make this circuit of practically infinite impedance for signal currents that it is desired to receive, and one can make the circuit of relatively low impedance for such signals as it is desired to eliminate; one can design the coil within limits, to give very high selectivity. We have found this circuit extremely good. The signal comes in and produces a current in the antenna, and is received on the tuned circuit coupled to the antenna, but if anything comes in that is not of the right frequency it goes through the rejector circuit. If it is of the right frequency, it goes on to the grid of the valve and then through the transformer and so on to the next rectifying valve which is coupled to it through a transformer in the ordinary way.

Another circuit which is very good is the tuned anode circuit with which I expect most people are now familiar. We have also experimented with this circuit as shown in Fig. 13, the rejector circuit being used also, but without reaction. The "tuned anode" circuit seems to give stronger signals than the tuned transformer circuit, with the rejector circuit

With these circuits we can get Birmingham and Glasgow separately and clearly. We also get London and Manchester without any mutual interference. We also get Cardiff without any appreciable interference. I do not claim that as anything very remarkable, but it is something that we find is possible to do with these circuits. The arrangement we have had most experience with is the Hinton rejector circuit, and with that we have almost got rid of ships, but not completely. Seaforth station is a very difficult station to eliminate because it uses a rapidly damped spark. Such stations are more difficult to cut out than those using continuous waves.

The last thing I want to speak about is disturbance due to direct induction. That is, of course, very troublesome and particularly with us, because we are working in a laboratory where there are a great many varying currents which cause induced E.M.F.'s. The method we have tried to get rid of these disturbances has been to put the receiving circuits in metal cases. That is not completely effective. Another method that can be used if there is an alternating current disturbance, is a "resonance" shunt on the antenna. That is a shunt which is tuned for the frequency of the disturbance that it is wished to get rid of. Another method which I have not actually tried but which does almost as well (so I was told by one of my old

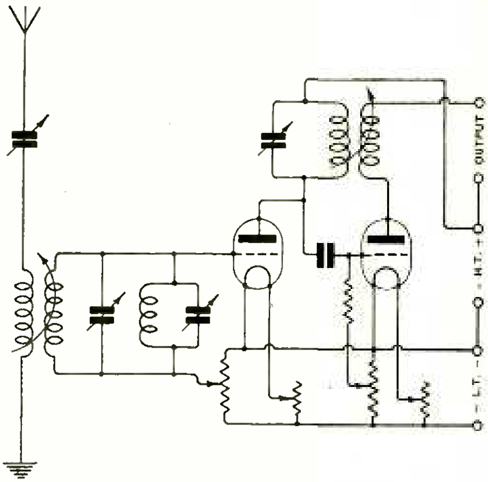


Fig. 13. *Another circuit with rejector.*

students who has an alternating current lighting supply) is simply to screen the valve. I do not know whether this would be effective in all cases. I rather doubt it, but in his case the unpleasant hum that is produced by alternating current induction almost entirely disappeared.

I have only touched on a few of the methods that have been tried for getting rid of these disturbances, and if I have said anything to interest you or to promote a discussion of other devices which other people have tried with equal or greater success, I shal feel that my lecture has not been in vain.

[*The discussion which followed the reading of the paper will appear in the next issue.*]

QUESTIONS AND ANSWERS

"J.F.F." (Swansea) *submits a diagram of a four-valve receiving set which he proposes to build, and asks for criticism.*

We have examined the diagram and particulars submitted. The circuit is correct. We suggest, however, that you increase the number of turns on your anode coil to cover a length of approximately 4". The proposed coils should then enable you to receive satisfactorily on wavelengths up to 1,200 metres.

"J.M." (Manchester) *asks* (1) *For a diagram of a set employing crystal rectification and a single valve H.F. amplifier.* (2) *Which is the most selective type of tuner to employ.* (3) *For the best crystal or combination of crystals for use in the above set.* (4) *If it is possible to radiate energy from an aerial when using this set.*

(1) A circuit is given in Fig. 1. (2) A loose-coupled tuner is satisfactory. (3) A number of types may be used, but for stability we recommend a carborundum crystal with a small battery and potentiometer, as indicated in the diagram. (4) It is possible, but if care is taken you need not fear that oscillating energy will be generated in the aerial circuit.

"NUTTY" (Sheffield) *asks* (1) *For the names of purchasers of burnt-out valves and the prices given.* (2) *For the cost of replacing burnt-out filaments in "Mullard" valves, and the names of firms undertaking this work.* (3) *For a three-valve receiving circuit employing detector and two L.F. valves, using transformer coupling and two variable condensers, circuit to be of a type approved by P.M.G.* (4) *Why a circuit comprising detector and two L.F. valves will not tune down below* 350 *metres when a No.* 35 *De Forest coil is used with an aerial* 40′ *long, single wire, and a* 0·0005 *condenser in series.*

(1) E. McDay & Co., 16, City Chambers, Broad Street, Birmingham. Prices would be furnished on application. (2) From 6s. to 8s. The Leeds Flint Glass Co., Ltd., Aire Bank Lamp Works, Hunslet, Leeds. See advertisement pages of this journal. (3) In Fig. 2 a circuit is given using

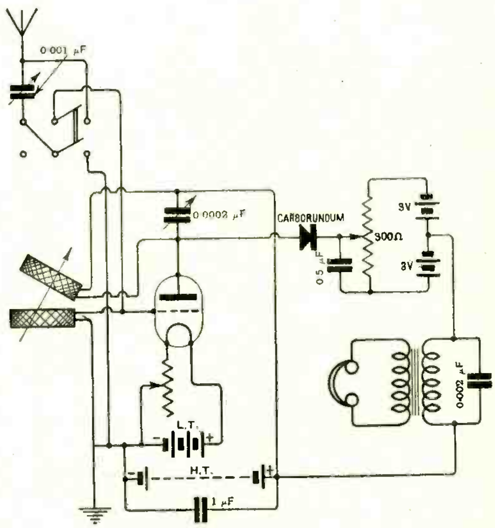


Fig. 1. **"J.M." (Manchester).** *Diagram of a receiver with the valve operating as a high-frequency amplifier and the crystal as rectifier.*

valves as suggested with a two-coil tuner. This circuit is non-radiating. (4) We think you have made a mistake in your wiring. A No. 35 De Forest coil has a natural wavelength of 85 metres,

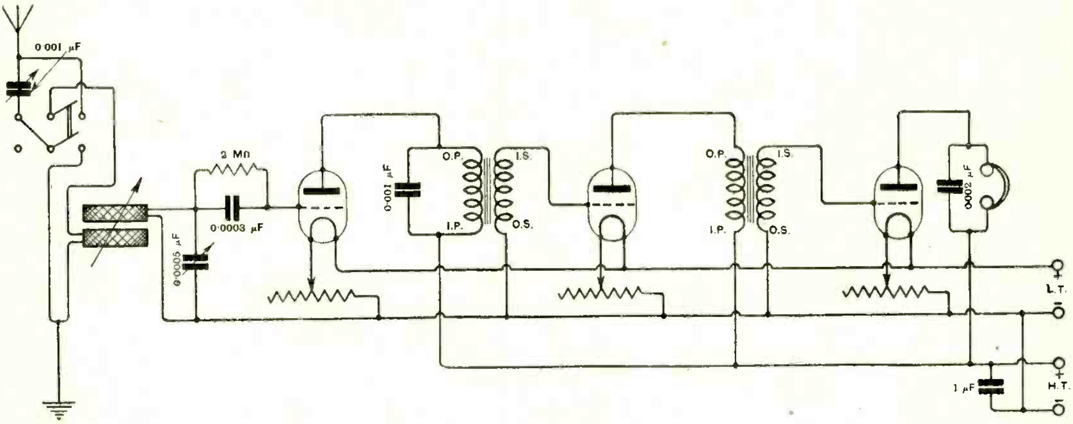


Fig. 2. **"Nutty" (Sheffield).** *Here we have a three-valve receiver—the first valve operates as a rectifier, and the others as note magnifiers.*

which may be increased to 471 metres with a 0·001 mf. condenser in shunt with it.

"S.M.W." (London, N.20) *asks for particulars of instructional classes in Wireless theory and practice.*

We would advise you to look through the advertisement pages of recent numbers of this Journal, where you will find the desired information.

"W.H." (Sutton) *submits wiring diagram of two-valve receiver, and asks* (1) *Is wiring correct.* (2) *Whether two 2-volt accumulators would be used for this set, and their length of service on one charge.* (3) *The number of turns for a set of basket coils to* one of these coils of 50 turns should be sufficient. (4) When one pair of telephones is in use, the two outside terminals are employed. For two pairs, one tag of each pair of telephones is inserted in the middle terminal. The other two are inserted in the two outside terminals.

"S.A.M." (Doncaster) *gives a diagram and description of his two-valve set, and after describing symptoms arising during operation, asks for advice on the continued falling off in signal strength.*

The falling off in signal strength is probably due to the pressure of the H.T. battery falling after a little use.

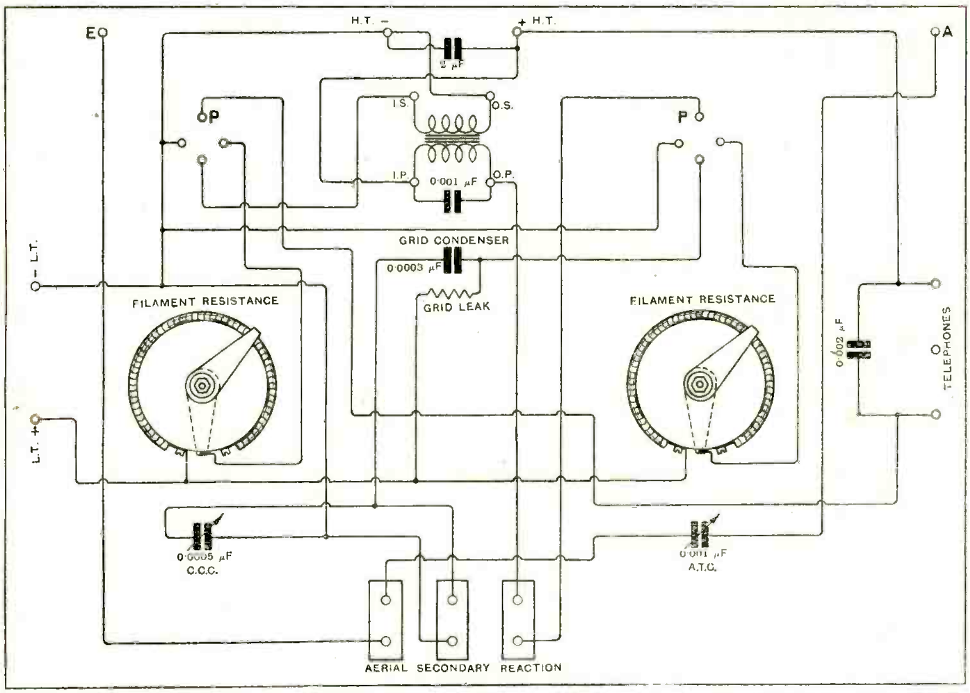


Fig. 3. **"W. H." (Sutton).** *Wiring diagram of a two-valve receiver. The first valve operates as a rectifier and the second as a note magnifier.*

receive the Hague concerts. (4) *The reason for the three telephone terminals.*

(1) Your wiring diagram is not correct. We suggest that you rewire your set according to the diagram given in Fig. 3. (2) The two 2-volt accumulators coupled in series will give you a 4-volt unit, but as you do not state the ampere hour capacity of each accumulator, we cannot advise you what service you will obtain from them on one charge. (3) On a 2″ diameter former wind a number of coils of 80 turns each with No. 28 D.S.C. wire. Use two of these in series with two tappings taken from each coil, for the aerial tuning inductance; a 0·001 variable condenser should be used in parallel with this coil. For the secondary, three of these coils will be required in series, with two tappings from each coil, and a 0·0005 variable condenser in parallel. For the reaction coil,

"J.T.S." (Glasgow) *asks if it is practicable to use the city electric supply mains* (250 *volts D.C.*) *as a high tension supply for a six-valve receiver.*

It is practicable to use the D.C. public supply mains for the H.T. supply, and we suggest that you adopt the arrangement given in Fig. 4. The choke coils would each consist of a winding of

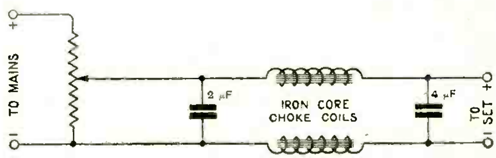


Fig. 4. **"J.T.S." (Glasgow).** *Method of taking H.T. supply for valves from the direct current mains.*

5,000 turns of No. 34 S.S.C. copper wire on an iron wire core ½" in diameter. We would also refer you to Fig. 90 in "The Amateurs' Book of Wireless Circuits" (F. H. Haynes).

"ARIO" (Keighley) *asks* (1) *If it would be practicable to use a lead in taken from either end of a 100 ft. single wire aerial.* (2) *If there is any objection to using a* 0·0005 *mfd. variable condenser across the anode tuning coil instead of the* 0·0003 *mfd. condenser which we advise.* (3) *Whether a three-plate condenser could be connected to give better tuning.*

(1) It would be quite practicable to use a lead in at either end of a single wire aerial, providing, of course, that the end of the lead in which was not in use, be kept properly insulated. (2) The objections to the use of the 0·0005 mfd. condenser are that when the moving vanes are in the zero position, the condenser still has appreciable capacity, which is a disadvantage when tuning in to a wavelength closely approaching the natural minimum of the anode coil, also a large value condenser reduces the sharpness of tone and the voltage across the coil. (3) When a 0·001 mfd. variable condenser is used in the aerial circuit, it will be found of great assistance in fine tuning to bridge the terminals of the 0·001 mfd. condenser with another variable condenser of the size you suggest.

"A.K." (Charlton) *asks with reference to the diagram given in reply to* **"T.A.T." (Acton, W.),** *in the issue of April 7th, how should he arrange*

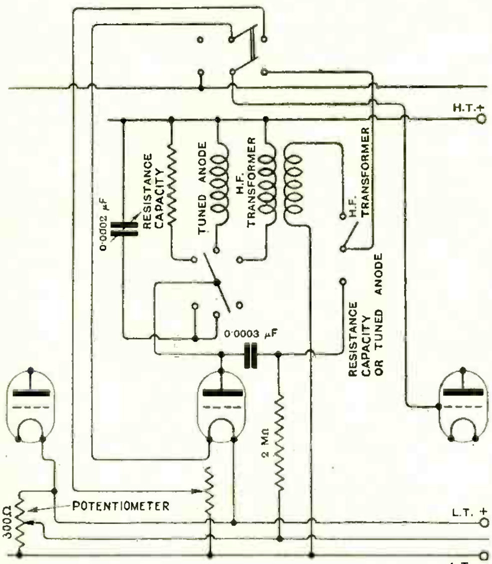


Fig. 5. **"A. K." (Charlton).** *Method of connecting a switch so that the resistance-capacity, tuned anode, or transformer method of coupling may be used.*

the switching in order to employ any of the following methods of H.F. intervalve coupling: resistance capacity, tuned anode, or H.F. transformer.

A diagram of the switching arrangement is given in Fig. 5.

"F.E.C." (Herts) *asks for advice on a method of connecting a reaction coil to his three-valve set, in which the valve combination is one H.F. amplifying valve, detector and one L.F. amplifier.*

To include a reaction coil in your set it will be necessary to break the lead which connects the primary of the L.F. transformer with the anode of the detector valve. In this lead include a coil which couples magnetically to the H.F. transformer. You are then employing reaction in the most convenient way. The arrangement is shown diagrammatically in Fig. 6.

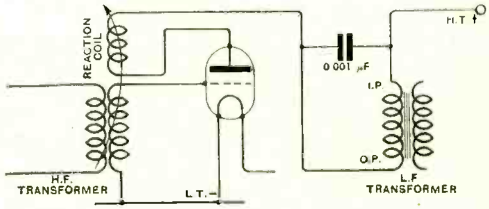


Fig. 6. **"F.E.C." (Herts).** *Method of connecting a reaction coil.*

"H.V." (Wisbech) *asks whether he will be able to receive* **PCGG** *using the valve and crystal receiver described on page* 724, *March 3rd issue.*

The receiver is designed for short wavelengths only. To receive longer wavelength signals, coils may be added. Try three more coils connected in the aerial circuit and four more joined in the anode circuit.

NOTE.—*This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules:*—(1) *Each question should be numbered and written on a separate sheet on one side of the paper, and addressed "Questions and Answers," Editor,* **The Wireless World and Radio Review,** 12/13, *Henrietta Street, London, W.C.2. Queries should be clear and concise.* (2) *Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before.* (3) *Each communication sent in to be accompanied by the "Questions and Answers" coupon to be found in the advertisement columns of the issue current at the time of forwarding the questions.* (4) *The name and address of the querist, which is for reference and not for publication, to appear at the top of every sheet or sheets, and unless typewritten, this should be in block capitals. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume."* (5) *In view of the fact that a large proportion of the circuits and apparatus described in these answers are covered by patents, readers are advised, before making use of them, to satisfy themselves that they would not be infringing patents.* (6) **Where a reply through the post is required every question sent in must be accompanied by a postal order for the amount of 1s., or 3s. 6d. for a maximum of four questions.** (7) *Four questions is the maximum which may be sent in at one time.*