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Wireless Weekly

Vol. 6. No. 22.

A VISIT TO THE G.E.C. RESEARCH LABORATORIES

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A Short-Wave Problem

THE experiences reported by some of our readers who are preparing receivers for the tests from NKF serve to emphasise the importance of a problem which seems to be receiving too little attention from the experimenter upon short waves. When a short-wave receiver has been finished, quite a difficult problem is presented by its calibration, and the difficulty does not end here; in the Reinartz circuit (which provides one of the easiest methods of constructing an effective receiver for frequencies in the neighbourhood of 14,991 kc.), the calibration of the circuit depends to a noticeable extent on the setting of the reaction condenser and the number of turns in use upon the reaction winding, and it often happens that some change being made in the aerial system completely alters the reaction demands of the circuit, and when this has been corrected the calibration is found to be upset.

Considerable pains are usually devoted in special short-wave receivers to the reduction of all stray capacities, and when the set is operated at small condenser readings the inter-electrode capacities of the valve play a quite important part, and it is therefore within the bounds of possibility that the calibration which has been laboriously obtained may be lost by a mere change of valve.

Bearing these points in mind, and also the fact that the space occupied upon the dial of a condenser of convenient size by the signals of any one station upon the shorter waves is exceedingly small, it is evident that a wavemeter of some sort is practically essential if a great deal of time is not to be wasted in searching. Probably many experimenters feel that the calibration of any wavemeter which they may construct is a matter of prohibitive difficulty, but a little consideration of this point will show that the difficulty is, in reality, not a very serious one.

All that is required is a calibration of quite approximate accuracy, but of dependable constancy. There are at the present time a sufficient number of stations transmitting on accurately measured wavelengths which frequently announce the frequency or wavelength which they are at the moment using, and it is therefore a fairly simple matter to secure a calibration of sufficient accuracy for the ordinary purposes of searching.

The actual design and construction of a wavemeter for use upon these higher frequencies, however, is a matter which requires a good deal of experimental work, since the normal types of wavemeter become exceedingly inconvenient to use on such high frequencies. The buzzer wavemeter is, of course, practically ruled out in its conventional form for any really accurate work, while the heterodyne wavemeter becomes subject to many annoying defects upon such high frequencies as those equivalent to the 20-metre wavelength.

(*Concluded on page 713.*)

CONTENTS.

Director of Research:
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The G.E.C. Research Laboratories

In view of the recent articles by Mr. Harris on the various research laboratories he visited during his tour of America, this description of a visit to an English research laboratory will be of particular interest. The article has been specially written by Mr. J. H. Reyner, B.Sc. (Hons.), A.C.G.I., D.I.C., of the Radio Press staff.

A recent portrait of Mr. C. C. Paterson, O.B.E., the Director of the G.E.C. Laboratories.

FEW people realise the part which is played by research in the development of any new product. The valve as used to-day in all its multitudinious applications is, perhaps, one of the most striking recent examples of this.

From the point of view of the outside public the story is simple and somewhat uninteresting. In the early days of wireless broadcasting, immediately after the war, the only valves in use were bright emitters of the R type. There were one or two different types of valve, it is true, but very little was known about the design of valves to fulfil any given conditions, and, in addition, the price was 26s.

Dull-emitter Valves

Then, after some years, the dull-emitter valve makes its appearance, and the principle employed is, in itself, so simple that the public asks why it was not thought of long before.

As a matter of fact, the dull-emitter valve was only made a practical proposition by the perfecting of the processes employed for the exhaustion of the bulb, and this work occupied several years of concentrated research.

The ultimate result is that these methods are applied to the manufacture of other classes of valves, and further improvements are made from time to time, with the result that the price of *all* valves is periodically reduced, and it is now possible to buy for 16s. 6d. a valve of the most expensive dull-emitting type (the 60 milliampere class), which does the same work as the 26s. bright emitter of a few years ago.

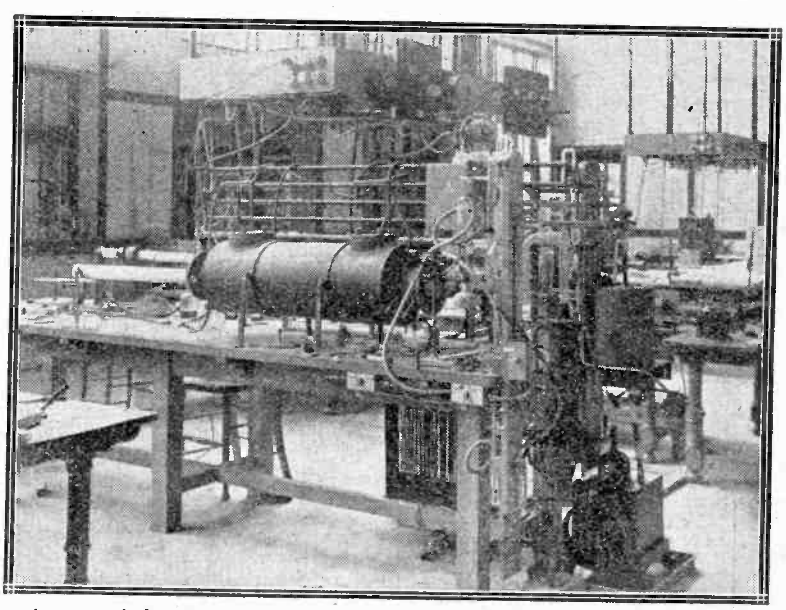
All this is the result of a few years' quiet but persistent research upon methods of valve manufacture, about which the general public heard nothing. This work, of course, was going on in all the chief works in the country, one of the most important being the General Electric Company, who have erected a large laboratory at North Wembley for research in lamp and valve manufacture, and other subjects of interest to that company.

Glass Bubbles

Through the courtesy of Mr. C. C. Paterson, O.B.E., the director of the Laboratories, we are able to give a very interesting account of the work which is being conducted at this establishment.

One of the most important factors in the manufacture of lamps and valves is the glass which is used for the bulbs themselves. The physical properties of the various types of glass are therefore the subject of experiments, of which the following is one rather interesting example.

At one time in the past the occurrence of numerous bubbles in the glass tubing used in lamps and valves was a disturbing factor, since the bubbles, in addition to being unsightly, occasionally caused a breakdown of the glass and allowed air to enter the finished lamp or valve.



A view of the electric furnace used for annealing samples of metal. The long tube on the left, with the coil sliding over it, is used to introduce the samples at a point some distance from the furnace itself, as described in the article.

In order to obtain information on this point, therefore, a saturated solution of sugar is employed, which is mixed to have the same viscosity as the molten glass will have in the process under consideration. It is found, for instance, that for each value of viscosity there is a critical slope in the pouring process above which bubbles are obtained in the glass. The value of this slope and other relevant information can be obtained by a study of the appropriate sugar solution.

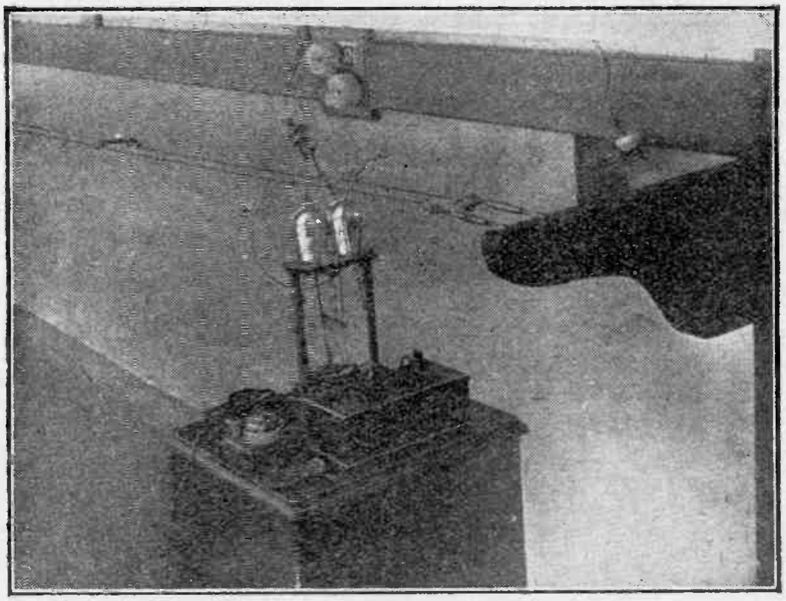
Annealing in a Vacuum or in Hydrogen.

Another very interesting process was that of the annealing of electrodes of valves or other specimens of metal in a vacuum or in an atmosphere of hydrogen. In the case of the larger valves the extraction of all the occluded gases in the anode and grid occupies some considerable time after the bulb itself has been exhausted.

Occluded Gases

In order to save time, therefore, these electrodes are often *annealed* before being inserted in the valve. The annealing process consists in heating the electrode in a suitable atmosphere, when the occluded gases are driven off by the heat, and may be extracted by the usual pumping methods.

An electric resistance furnace is used for this purpose. The furnace consists of a long tube, around one end of which is a coil of wire carrying an alternating current. The material to be annealed is placed inside the tube and is heated by radiation from the heat generated by the currents flowing through the coil.

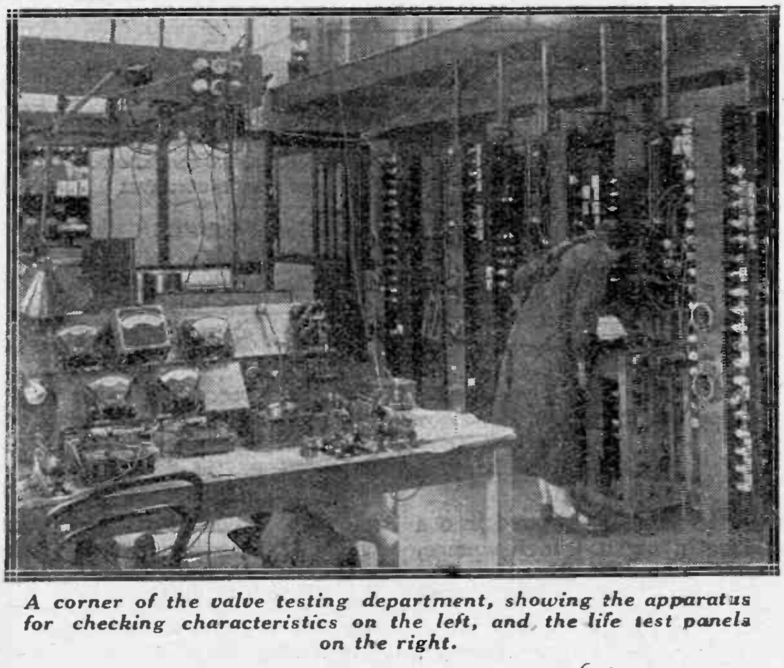


The 150,000 kilocycle oscillator, coupled to a Lecher wire on which standing waves of 2-metre wavelength are produced. The test lamp can be seen lit up at the first current node.

Method of Introducing the Material

The material, when annealed, must be cooled down before being taken out of the furnace, and this takes some time if it is left in the hot part of the furnace. The tube, therefore, is made long, as previously stated, and the material is introduced in a special boat of nickel to which a small piece of iron is attached. This boat is introduced at the cool end of the tube, which is then sealed up (to enable the air to be exhausted later in the proceedings), and the boat is moved into the hot end of the tube by means of a moving coil sliding over the tube. This exerts a magnetic effect on the piece of iron attached to the boat, and enables it to be drawn into any desired position.

A similar method is employed for removing the charge.

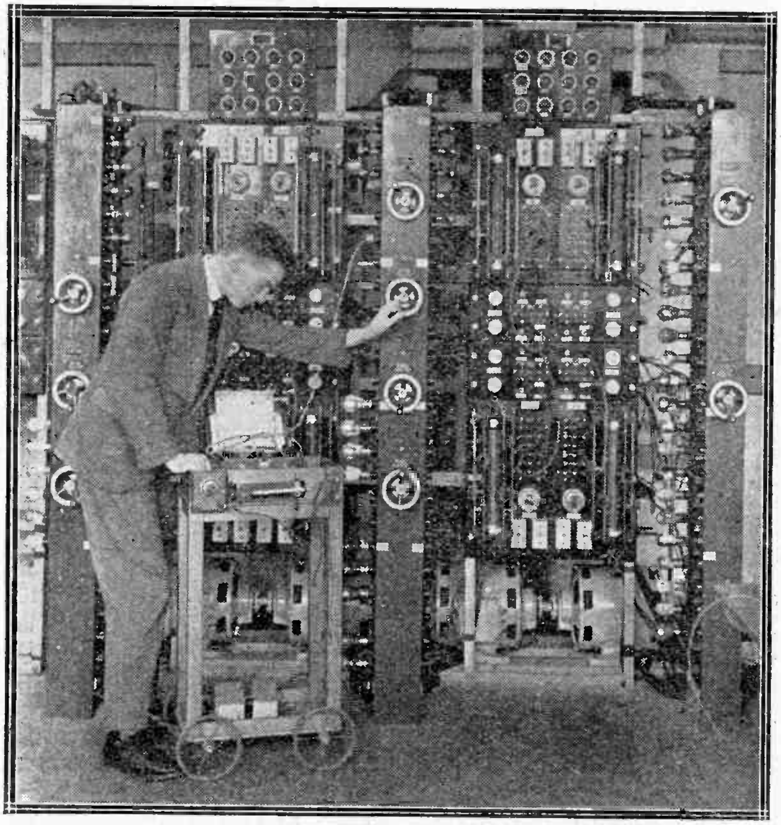


A corner of the valve testing department, showing the apparatus for checking characteristics on the left, and the life test panels on the right.

Tests for Vacuum

The method of measuring the vacuum inside a lamp or valve is of interest. It consists in sealing or otherwise connecting to the bulb under test a small bulb containing a filament of wire (an ordinary unmounted tungsten filament lamp serves for the purpose). The resistance of the filament is then measured, and it is found to vary with the amount of gas in the bulb. This is due to the difference in the convection of heat away from the filament by the molecules of gas, the more gas present the greater being the cooling, and thus the less the resistance. This device is known as a Pirani gauge.

These gauges are used to test



Some of the life test panels in the valve department. A key to this photograph is given in Fig. 1 below.

all the metal valves during construction. The most critical part of the manufacture is the sealing of the glass end on to the copper anode, and it is obviously uneconomical to continue with the manufacture of the valve if this part is faulty. Hence each valve, as it reaches this stage, is sealed on to a Pirani gauge and partially exhausted. The vacuum is then tested every day for a considerable period. If the resistance of the gauge remains constant throughout the test, then the glass-to-metal seal is considered sound.

Filaments

Another very interesting example of the persistent research into minor points which makes all the difference between success and failure was found in the photomicrograph department.

Experiments have been conducted now for a considerable period into the structure of filaments used in the manufacture of lamps and valves. The ideal filament, from the point of view of mechanical rigidity, is one which is composed of a single long, fine crystal.

Various methods of manufacture and treatment have been tried, and some results remarkably near the ideal have been attained. To examine the filament, the wire is dropped into a small bath, about ¼ inch square, containing molten glass. The glass is then rubbed down with emery cloth until the filament is exposed to the required depth, when the whole is placed under a microscope and examined. Photographs of suitable specimens are taken for record purposes.

Life Tests

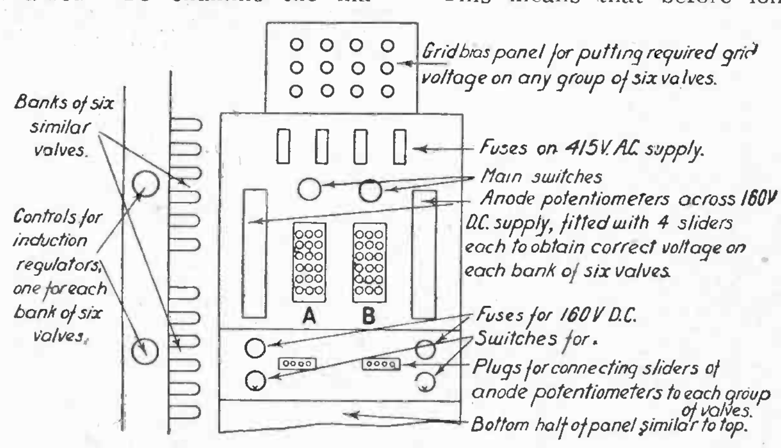
There is a remarkably comprehensive valve-testing department, two views of which accompany this article. Here the new valves are tested for characteristics and performance, and tests are made to see that existing valves are up to standard.

One of the most interesting features is the life test panel, in which valves of any type or make may be put on life test. Facilities are available for placing the requisite high-tension and grid-bias voltages on to the valves so that the tests shall be as fair as possible.

A.C. for Filaments

It is interesting to note that the filaments are lit with alternating current on this panel. The reason for this is as follows:—If the filaments are lit with D.C. and the current is regulated with a resistance in series, then, if one of the valves burns out, the voltage on the remainder rises, because the current taken is less, and so the voltage drop in the resistance is less.

This means that before long another valve may burn out, which still further increases the voltage on the remainder, so that the effect is cumulative. It was not an uncommon experience to find a whole bank of six or more



Panels A and B are the tappings from the filament transformer secondaries (see fig. 2). The plugs give 0, 2, 3, 4, 7 and 10 volts. Any intermediate voltage is obtained with the induction regulator.

Fig. 1.—Key to the valve test panel illustrated above.

valves burnt out during the night from this cause.

Induction Regulator

The method now adopted, therefore, is to use alternating current with an *induction regulator* to control the voltage.

This instrument is a species of variometer, and may be considered as a transformer with a variable transformation ratio (see Fig. 2). When the coils are helping one another the ratio is a maximum, while as the rotor is rotated relative to the stator, so the ratio decreases to a minimum.

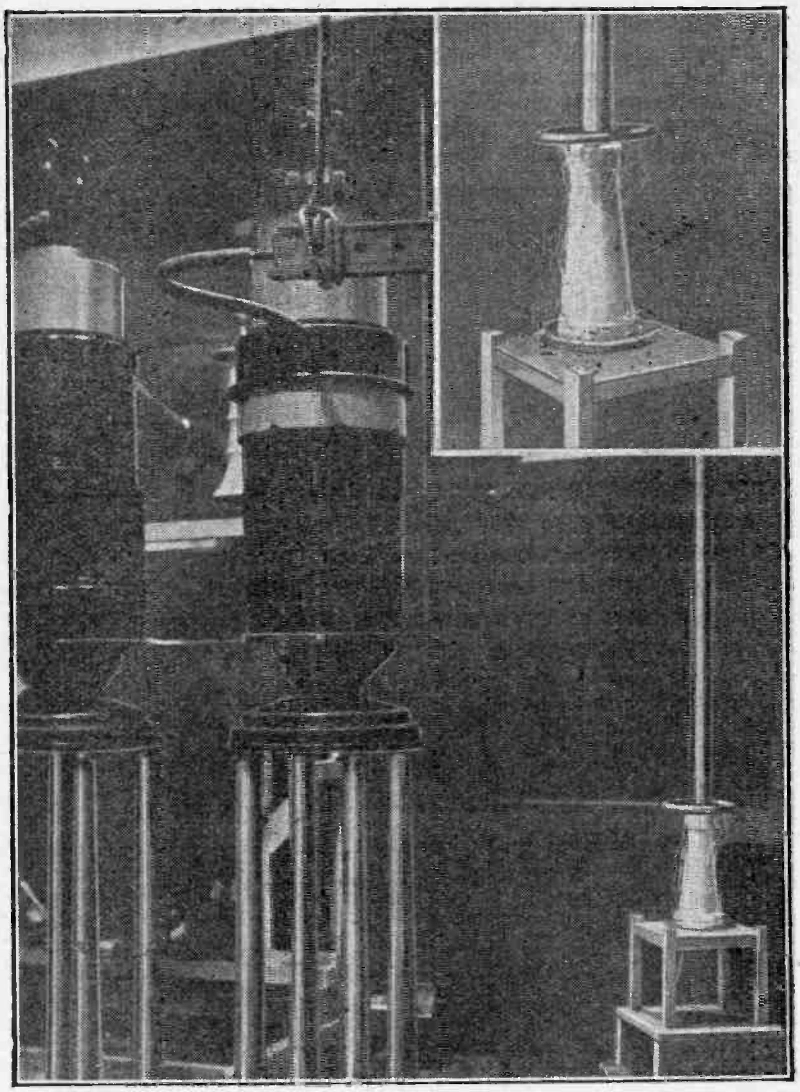
In this manner a continuous variation of voltage is obtained, and this voltage is independent of the current taken by the load, *i.e.*, the number of valves in circuit.

The grid bias is obtained from nickel-iron cells giving a voltage of 1.25 each instead of 2 with lead cells, so obtaining a finer control.

Exhausting Processes

A walk through the exhausting room showed the usual forms of exhausting plant. The valves during exhaustion are subjected to heat in order to drive off all the gases occluded in the glass of the bulb and the electrodes themselves.

A photograph is appended showing a large metal valve undergoing exhaustion just after the glass has been sealed to the copper.



A view of the high-tension testing apparatus, showing a flashover test on an insulator. Inset: A close-up view taken during the actual flash at 110,000 volts.

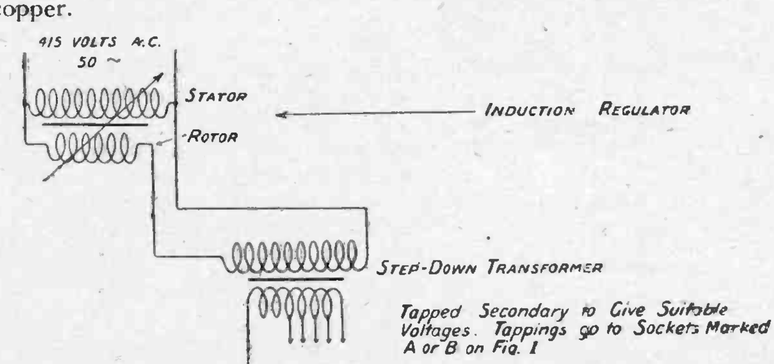


Fig. 2.—Illustrating the use of an induction regulator to control the voltage on the valve filame s.

This valve will then be tested for vacuum as previously mentioned, after which the top will be cut open and the grid and filament inserted. The whole is then sealed up again and finally exhausted. This time the oven is lowered over the valve, which is then raised to a fairly high temperature during the exhaustion. Current is also passed through the valve from filament to anode, which makes the anode red hot. This power is absorbed in the resistance mat, which can be seen on the left.

150,000 Kilocycle Oscillator

The radio department has several interesting instruments for carrying out the usual types of routine test, such as the measurement of the amplification per stage of a low-frequency amplifier.

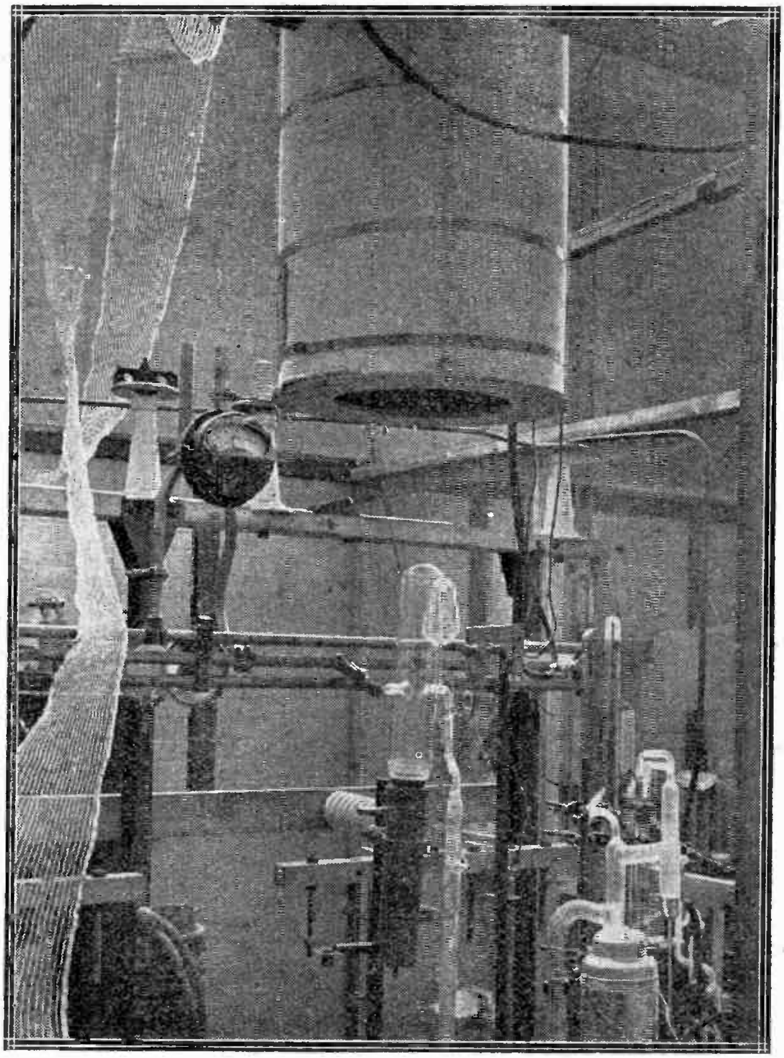
An interesting feature of this section was the 150,000-kilocycle oscillator, of which a photograph is shown. The tuning coils of this oscillator are simply short lengths of straight wire, bridged across, and can be seen in the photograph on the second page.

The four spirals underneath the valves are high-frequency chokes in the filament leads.

This oscillator was coupled to a long "Lecher wire," which consists of two parallel wires connected at one end to a loop, magnetically coupled to the oscillator.

The high-frequency oscillations set up "standing" waves on the Lecher wire of the corresponding wavelength, in this case 2 metres.

Current nodes are obtained every half wave, and a small pocket lamp bulb placed across the wires at these points lit up quite brilliantly. This lamp can be seen alight in the photograph, at the first node, one metre along the wire.



A metal valve undergoing its first exhaustion to test the glass to metal seal prior to the insertion of the grid and filament. The resistance mat and the heating oven used in the final exhaustion can clearly be seen.

High-tension Tests

A recent addition to the equipment is that of a high-tension testing plant for testing insulating materials. Thisplant, which is capable of producing voltages of 150,000 volts above earth potential, enables valuable information to be obtained concerning the breakdown voltages of insulators, etc.

It was demonstrated in a flashover test on a porcelain insulator of the type used for supporting bodies at high potentials. As the voltage was increased the insulator commenced to glow, indicating the presence of "brush" discharge, and finally flashed over with a roaring noise at the breakdown potential of 110,000 volts.

Design of Transformers

The transformers used are interesting in one respect. In a high-potential arrangement like this the trouble is to maintain adequate insulation between the windings and the core, which is at earth potential. In these instruments, which were designed by Messrs. Haefely Bros., the transformers are insulated from earth by being mounted on wooden legs, so that the cores are themselves at a high potential, and the insulation required on the windings is much reduced. One of the photographs shows these transformers, and also gives a close-up view of the insulator flashing over.

A Well-organised Library

Finally a visit was paid to the library, which is beautifully organised. In addition to books of reference, the leading periodicals are available, and a very complete card index system is in force enabling information on almost any subject to be obtained with a minimum of delay.

These are only some of the impressions gained during a comparatively short visit. The spirit of the laboratories was one of quiet enthusiasm, and I came away feeling that the position of English research is a great deal stronger than is popularly supposed.

A NEW LOUD-SPEAKER CIRCUIT

By G. C. BEDDINGTON (Trinity College, Cambs.).

This article describes an ingenious method of obtaining a trigger effect in low-frequency amplifiers which provides considerable experimental interest.

THE method of amplification described in this article has been lying dormant and semi-incubated in various patent specifications for years, but it is only lately that any practical application of the principle has been developed. There are two principal patents which are concerned in this method. The first of these is due to G. W. Pierce (British Patent No. 15,681 of 1914). The essence of Pierce's arrangement is shown in Fig. 1. The second valve has a battery connected in the grid circuit, the circuit of this battery being completed through the anode-filament path of the first valve. Consequently the actual potential applied to the grid of the second valve depends upon the conductivity of the first valve. Thus as signals are impressed upon the grid of the valve V1, so the voltage applied to the grid of the valve V2 is correspondingly varied, and this produces changes of current in the telephones in the anode circuit.

This would at first sight appear to be a rather cumbersome method of coupling two valves in cascade, but it will be seen later that, provided certain conditions are fulfilled, a "trigger" action can be obtained.

Gill's Limiting Device

The second patent concerned is due to E. W. B. Gill (British Patent No. 155,742 of 1921). The arrangement described in this patent is shown in Fig. 2, and will be seen to be similar generally to the previous patent except that the battery in the grid circuit of the second valve has been removed.

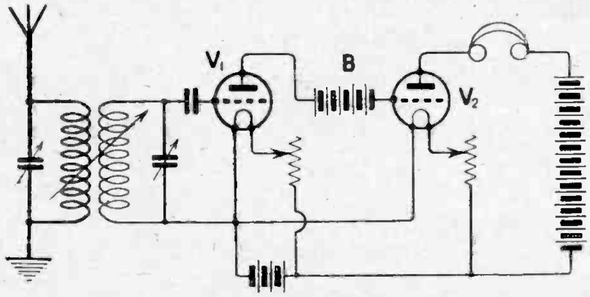


Fig. 1.—Under certain conditions this method of coupling (due to G. W. Pierce) will provide a "trigger" action.

If the current in the anode circuit of the valve V2 is plotted against the voltage applied to the valve V1, a curve of the nature shown in Fig. 3 is obtained. The exact effect will be described shortly, but the point to be noted is that the anode current of V2 decreases as the voltage on the grid V1 is increased. The curve only has an appreciable slope over a limited portion, so that a strong signal would be limited if passed through an arrangement of this sort. This was the advantage of the arrangement that was claimed by Gill in the particular patent specification referred to.

Prince's Modification

Major C. E. Prince, of the Marconi Company, suggested to the author a circuit which is a development of the principles underlying the two

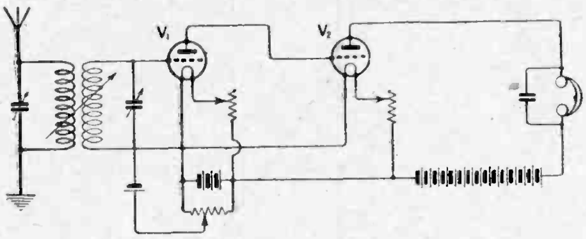


Fig. 2.—The circuit of E. W. B. Gill's limiting device.

previous circuits, but which takes advantage of the trigger action which can be obtained. Consider the circuit shown in Fig. 5, and assume that the voltage on the grid of the valve V1 is sufficiently negative to render the valve non-conductive.

Then to all intents and purposes the grid of the second valve is "free." This grid, therefore, will take up some fairly high negative potential, the value of which will depend upon the characteristics of the valve.

This is the normal condition, and the anode current under these circumstances will be termed the "normal current."

Theory of Operation

If now the valve V1 is made conductive, then the positive end of the grid battery B will be connected to the filament through the resistance of the anode-filament path of the first valve. The effect of this will be to apply a large negative potential to the grid of the second valve in excess of whatever negative potential may already be in existence. This will cause a further reduction in the anode current of the second valve.

It will be seen that the circuit is almost identical with that of G. W. Pierce. The action, however, is different, in that, with the present arrangement, the valve V1 is normally operated at a point Z on the characteristic (see Fig. 4 (a)), such that the valve is non-conducting.

The normal working position of the valve V2 will be at some point such as X on Fig. 4 (b). It follows, therefore, that if the grid battery B has a voltage equal to, or greater than, Y in Fig. 4 (b), the anode current of the second valve will be reduced to zero when the first valve becomes conducting.

Trigger Action

The trigger action is due to the fact that with the normal currents carried by V1, the resistance of the anode-to-filament path of the valve is comparatively low, compared with the resistance of the grid-filament path of the valve V2. Consequently as soon as the valve V1 becomes conducting, practically the full voltage of the battery B is applied across the grid and filament of the valve V2, and the anode current of this valve is reduced to zero. By this means, therefore, a considerable reduction in anode current can be arranged, such reduction being many times greater than the change in anode current, which

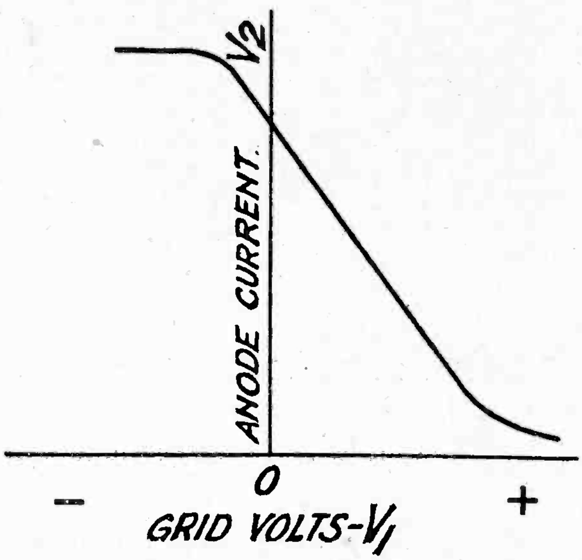


Fig. 3.—The type of curve obtained with the Fig. 2 circuit.

would result if the original voltage were applied direct across the grid and filament of the valve V2.

Working Points on Characteristics

It follows, therefore, that in order to obtain the best results the valve should be operated so that the " normal current " of the valve V2 is fairly large. Thus when the voltages are applied to the grid of the valve V1 a fairly large reduction in the anode current of V2 is possible.

Moreover, at the end of each signal the grid will have been made excessively negative, and must recover its potential in time for the next signal. That is to say, the charge which has accumulated on the grid of valve must be allowed to leak away.

It is thus necessary to insert a suitable leak between the grid and the filament. A circuit incorporating this is shown in Fig. 5, and this circuit has been used on telephony with considerable success.

Use of Soft Valves

It will be obvious that the " trigger " effect depends upon a somewhat sharp change from the non-conducting to the conducting state in the valve V1. This demands a characteristic with a very sharp bend at the point where the anode current falls to zero, and this condition is best obtained with a soft valve. Consequently the best arrangement is to use a soft valve for V1 and a power valve for V2 in order that the current

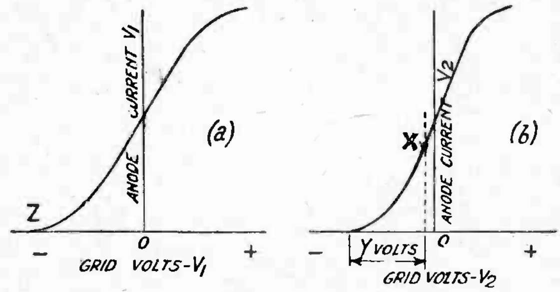


Fig. 4.—The curves referred to in the discussion of the Fig. 5 circuit.

controlled by the trigger valve may be as large as possible.

In the circuit shown in Fig. 5 a Phillips' soft valve was used for V1 and an L.S.2 used for V2. The valve V1 was provided with an anode voltage of about 36 volts, and was operated at about 2.5 volts negative potential on the grid.

Strength of Incoming Signals

Provided the incoming signals are of sufficient strength to work the " trigger," practically the only limitation of the amplification obtainable is that of the high-tension voltage available and the type of power valve used.

If the signals are so strong that the power valve keeps on becoming paralysed (so that a speaker at the transmitting end seems to choke at every word), then the filament of the detector should be dimmed slightly, or else a smaller value of grid-leak should be tried. Grid-leaks of the interchangeable type are extremely useful for this purpose, and with the values shown in Fig. 5 about 5 megohms will generally be suitable.

Practical Notes

It should be remembered that the first valve in this circuit must be arranged to work on or very near to the point of origin of its grid-voltage

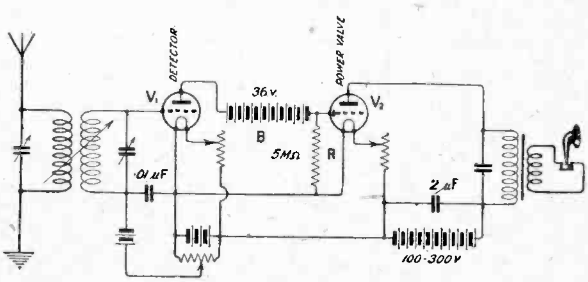


Fig. 5.—The circuit suggested to the author, and used on telephony with considerable success.

anode-current curve. To bring it to this point no amount of negative potential applied to its grid, if the latter be a fairly open one, is as effective as a smaller negative potential applied to a fairly fine-meshed grid.

As has been stated a soft Phillips valve gives very good results. A Q valve, having a much finer meshed grid, if used in this circuit with a 36-volt anode battery, will give excellent results, and requires only half a volt negative or even less on its grid.

Quality of Reproduction

The thing that first strikes one most on hearing this circuit on good telephony is the extraordinary amount of energy handled by a single stage of amplification following the detector. The second surprising thing is the almost uncanny absence of distortion. The latter is often blamed to a great extent on to loud speakers, but if a really good loud-speaker is used this circuit will reveal how little it actually does distort.

This lack of distortion is chiefly due to the absence of any iron circuits in the amplifier, apart from the loud-speaker itself and the step-down transformer, if one is used with the loud-speaker.

Signal Strength Required

A rough idea of the strength of telephony necessary to "trigger" this new circuit satisfactorily may be given by the following approximate gauges, which, however, are rated rather conservatively.

If loud and strong telephony comes in on a good crystal detector without amplification then only the detector will be needed in front of the power valve, and the circuit of Fig. 5 will be suitable.

If signals are of such a strength that speech is received just loud enough to be heard clearly and distinctly without any strain on the hearing with the crystal set, then one stage of high-frequency amplification should be added in front of the detector, and the circuit of Fig. 6 will be suitable.

If speech on the crystal set is barely audible, then two stages of high-frequency amplification should be added.

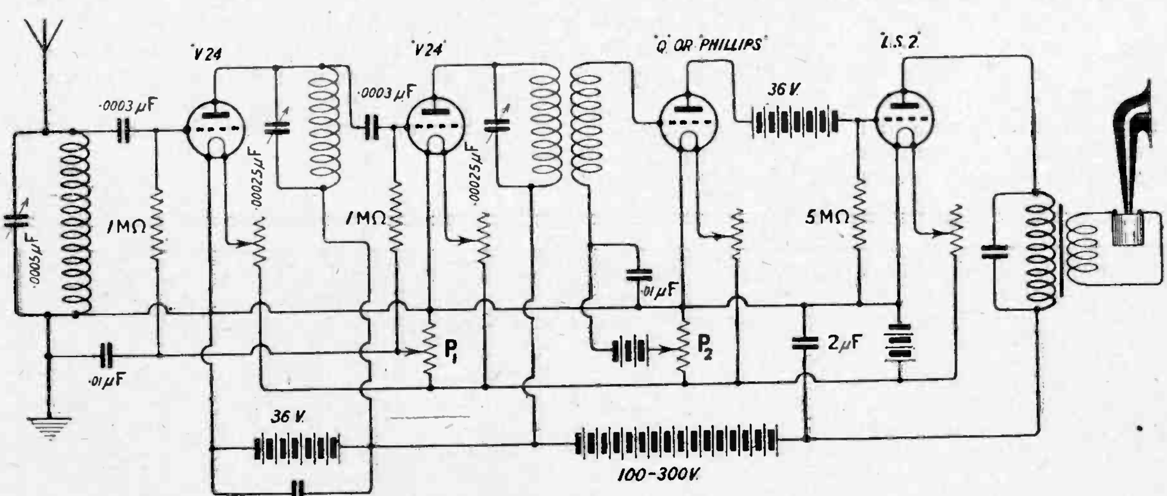


Fig. 7.—A circuit used with success by the author for full loud-speaker reception of stations which are barely audible on a crystal set.

A Practical Circuit

In Fig. 7 is shown the circuit, with all values, of a set designed by the writer after considerable experimenting, which gives excellent results.

The unit used in front of the trigger circuit set consists of an aerial tuning coil tuned by a condenser followed by two stages of tuned-anode H.F. amplification. The set was designed for the reception of long-wave Continental broadcasting, especially before the opening of 5XX.

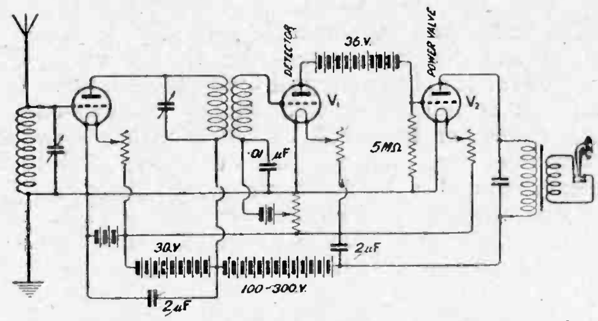


Fig. 6.—A circuit suitable for loud-speaker work, when signals are normally heard clearly on a crystal set.

Self-oscillation Tendencies

The tendency to break into self-oscillation is extremely small owing to the use of V24 valves, which have comparatively little inherent grid to plate capacity; also in the designing of the set strong capacities and couplings have been most carefully avoided. Whatever slight tendency to instability there may be is very easily and smoothly controllable by means of the potentiometer P1.

Though the arrangement of a grid-condenser and leak in front of the first high-frequency valve is somewhat unorthodox, the writer has found that with it the potentiometer control is made infinitely easier and far less critical than when applied in the more usual way to stabilise two high-frequency stages, one or both of which employs tuned-anode coupling.

Results

With this trigger circuit, using only one valve following the detector, signals can be produced ideally free from distortion, which can be heard a hundred yards or more away from the loud-speaker, as a modulated output of as much as 7 milliamps. or more can be obtained.

The writer has experimented for the past year to find out the best values for the circuit in practice for telephony purposes. Once found these need not be altered, and the circuit has proved itself stable and foolproof. Publication has been delayed for two reasons, one connected with patents on further developments not yet disclosed, and the other that with the opening of 5XX at Daventry it is now possible to get the very best results from the circuit.

Short Wavelengths

On short waves the circuit suffers to a certain extent from the fact that the inherent grid to earth capacity of the power valve, as well as stray capacities from the 36-volt battery to earth, tend to bring about paralysation of the power valve before full advantage can be taken of the cumulative effect.

One word of warning should be given to all who propose to make up this circuit. That is that as soon as the circuit is connected up, if one is used to ordinary circuits, it seems so utterly dead that one feels there must be a wrong connection somewhere. But the way the circuit jumps to life as soon as the right combination of adjustments is found is apt to be startling.

Values of Components

For tuning-in purposes, to begin with, it is advisable to use head 'phones, and in place of the power valve an ordinary receiving valve with about 100 volts on its anode. A slight re-adjustment of the potentiometer will then be necessary when the power valve is put in instead.

Other values of components than those specified will work if correctly combined. The ones given in this article will not necessarily prove the best with all types of valves; in each individual case the best values should be found by experiment.

The writer will be most interested to hear from anyone using this circuit, and, through this journal, to give any help that he can. In conclusion he would like to add that he considers that the great advantage of the circuit is not so much range as unsurpassed quality.

FOR SHORT-WAVE ENTHUSIASTS

It may be of interest to those engaged in short-wave reception to learn that the following message has been sent out recently :—

"CQ de RDW. We have an experimental transmission from 0100 to 0200 from 1220 to 1320 and from 2225 to 2325 GMT. Pse QSL to following address, Russia, Nijni Novgorod, Radio Laboratory."

This message was sent out in English, French, German and Esperanto. The wavelength used was in the neighbourhood of 30 metres (9994 kc.), I.C.W. being employed. On 2 valves (V-1) on an indoor aerial in the N.W. part of London, this station was received at R4-R8, there being a slight amount of swinging.

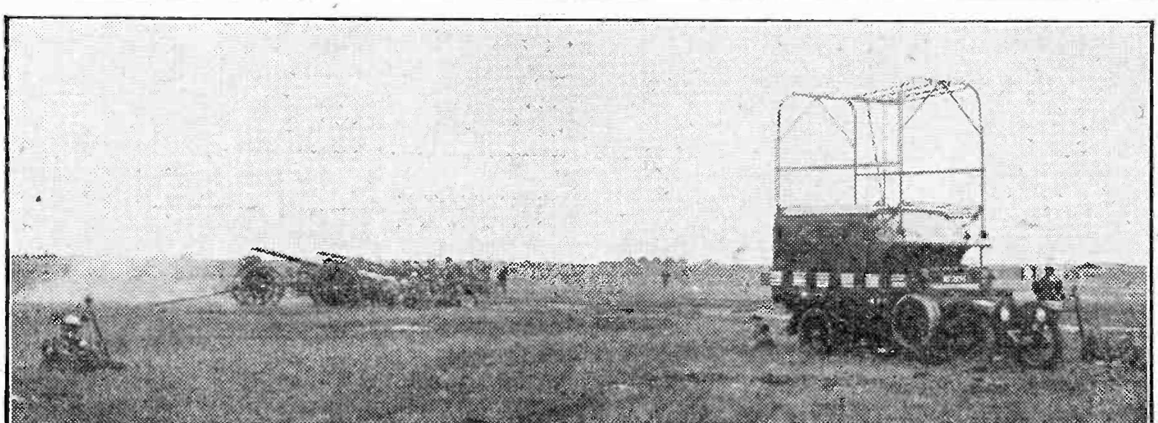
Other stations heard in the region of 25-30 metres are WQN and WIZ, both heard calling ABC, and sending V's.

Americans on 20 Metres

Although the 20-metre wave is not supposed to carry well at night, U1II was strongly received recently on 2 valves at 11 p.m. G.M.T. He gave his wavelength as 20.8 m. (14414 kc.) and power 90 watts. His strength was R5-R7 on an indoor aerial.

When an American amateur gives a number before signing off this is his wavelength. The A.R.R.L. have established a number of official stations which send on certain wavelengths with an accuracy of a few per cent. This is a useful fact to remember when calibrating a short-wave receiver.

C. P. A.

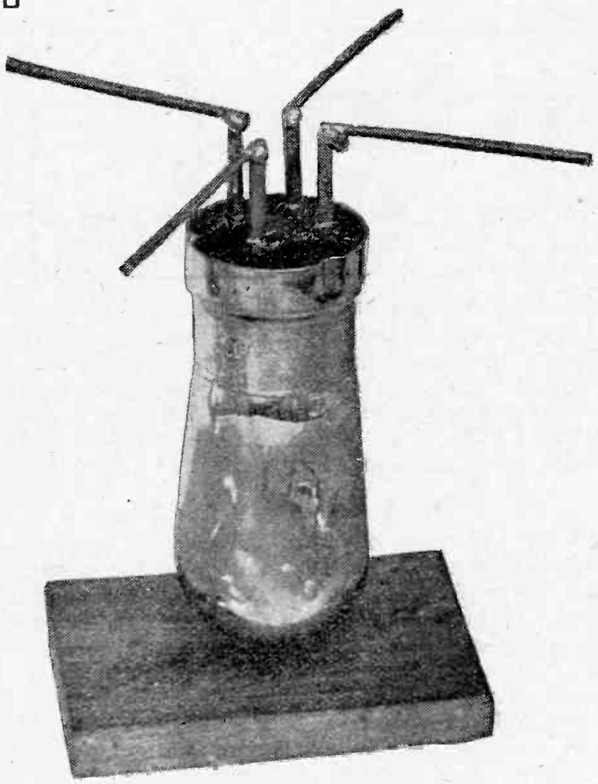


A big concentration of troops is now taking place on Salisbury Plain in preparation for the forthcoming manœuvres. A battery of the R.G.A. is shown in action, directed by a travelling wireless station.

Mounting Valves for Short-Wave Experiments

By A. V. D. HORT, B.A.

Some suggested methods of mounting four-pin valves for experimental work in circuits where the reduction of casual capacities to a minimum is desired.



Here the valve is supported in the receiver by the wires soldered direct to its legs.

THE use of standard four-pin valves for reception on wavelengths around 100 metres (2,998 kc.) has for some time been known to be quite satisfactory. Even on the shorter waves, below 20 metres (14,991 kc.) or so, these valves will function well, provided that suitable precautions are taken in designing the receiver, as has been demonstrated by Stanley G. Rattee, M.I.R.E., in *Wireless Weekly*, Vol. 6, No. 12.

Whenever it is desired to reach the highest frequencies, it is essential to avoid unnecessary stray capacities in the receiver, and to reduce to a minimum those which cannot be altogether eliminated. Such experiments in this direction as are likely to lead to greater efficiency are well worth a trial.

Valve-holder Capacities

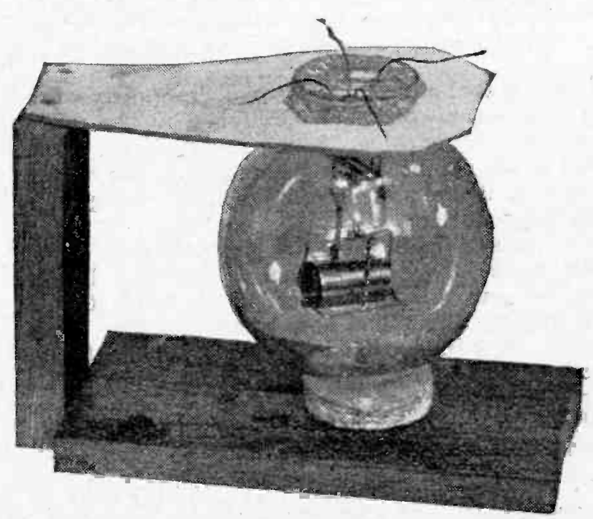
Any valve-holder for four-pin valves, however it is constructed, must add a certain amount of capacity to that already present between the legs of the valve itself. Even if the shortest and thinnest possible tubular sockets are used, their thickness will have the effect of bringing the leads from the electrodes closer together, and so increasing the capacity between them.

By soldering leads direct to the valve legs the holder can be dispensed with altogether, and an inappreciable amount of extra capacity will be introduced. This is illustrated in the photograph at the top of this page. A short length of stiff copper wire is soldered to each leg; the valve can then most conveniently be mounted inverted as shown, a hole drilled in a piece of wood accommodating the "pip" and keeping it steady. Alternatively, the pip may rest on a piece of sponge rubber. Connections are soldered to the outer ends of the stiff wires in the ordinary way.

Valves with Base Removed

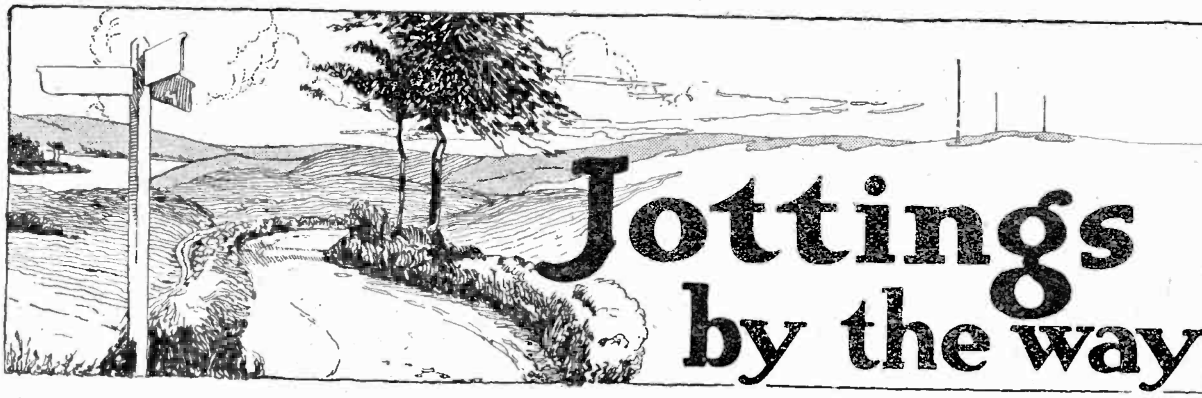
In order to reduce still further the capacity between the leads from the electrodes, the base of the valve may be removed, as described in last week's issue. When this has been done, the problem presents itself of mounting the valve for use. A suggested method of accomplishing this is given here, the photograph showing clearly the construction of the necessary supports.

This method of mounting, which is applicable either to bulbous or to tubular four-pin valves, is to invert the valve with its pip resting on a piece of sponge rubber glued to the baseboard of the receiver. A wooden upright, slightly shorter than the valve, has screwed to its upper end a piece of fairly stout cardboard about 3 ins. long. In this a hole is cut, so that it can be placed round the "neck" of the valve. The wooden upright should be made of such



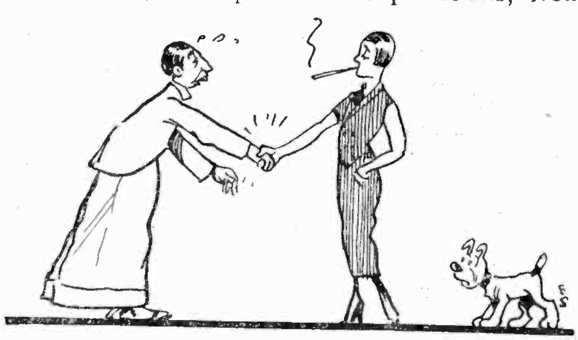
Care should be taken to see that the electrode leads are not crossed in the base of the bulb.

height that the cardboard arm presses the valve downwards slightly, and so keeps it steady. At the same time the springiness of the cardboard and the sponge rubber will help to insulate the valve from mechanical vibration.



The Latest

I EXPECT that you were properly thrilled when you read in the correspondence columns of a morning paper of the horrid accusation that a lady has levelled against wireless. You and I know, of course, that wireless is responsible for most of the ills that assail humanity, from Bolshevism to bunions, from hay fever to hurricanes, from earthquakes to entertainers, from thunderstorms to taxes, from typhoons to typhoid, from shipwrecks to sea sickness, from plumbers to politicians, from floods to foot and mouth disease, from dirty work at the cross-roads to droughts. The most eminent authorities have assured us, too, that it has the best of influences upon the young, and that it undoubtedly blights their young lives from the outset.


. . . Effeminate men and mannish women . . .

All these things, then, are perfectly clear to us. But there is one thing that I think we hardly realise, and this the writer of the letter that I am talking about has now brought home. In a word, she asserts that it is entirely owing to the devastating effects of wireless that men at the present time are growing more and more effeminate, whereas women are becoming daily more mannish.

Decadence

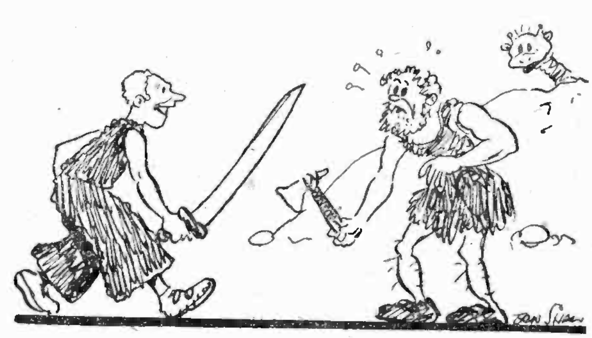
The way in which the thing is done, the writer tells us, is perfectly simple. Each human being—that, of course, includes you and me—has really two personalities, a male and a female. In the ordinary way in the he-man the male side predominates, whilst the female element is subconscious. But now mark what terrible things may happen. The etheric disturbances of wireless draw out and develop the subconscious part of the mind at the expense of the conscious. Thus it is that the he-man is transformed imperceptibly into a she-man who wears Oxford trousers, whereas the she-woman becomes a he-woman, who, if we are to believe the dear old ladies, goes on simply anyhow.

A Precaution

I am going to leave woman to take care of herself first of all, because, so far as I can see, she is perfectly capable of doing so, and, secondly, because my better half usually reads these notes. But I propose here and now to strike a blow or two in defence of poor maligned man. There can be no doubt that for years and years and years we have been going to the bow-wows. Dear old Horace (I am talking now of the Latin poet, and not of Gubbsworthy) said so nearly a couple of thousand years ago, and ever since his time other fellows have been pointing it out to the world as fast as they jolly well can.

Snaggsby Agrees

Having been myself educated at Eton, Harrow, Oxford and Cambridge, I can claim to speak with some authority upon all that appertains to masculine correctness. I am not saying that the greater public schools and the old universities are alone entitled to a voice in the matter. That would be simply snobbish. Snaggsby, for example, who was at Borstal and Dartmoor, both reputable seats of learning of the newer kind, has very sound views indeed. I find that he is quite in agreement with myself that the young man of the present day is neither more nor less degenerate than he was ten thousand years ago.


. . . Armed with a bronze gizzard-slitter . . .

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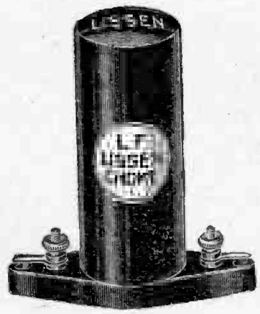

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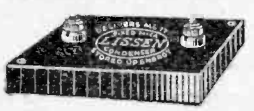

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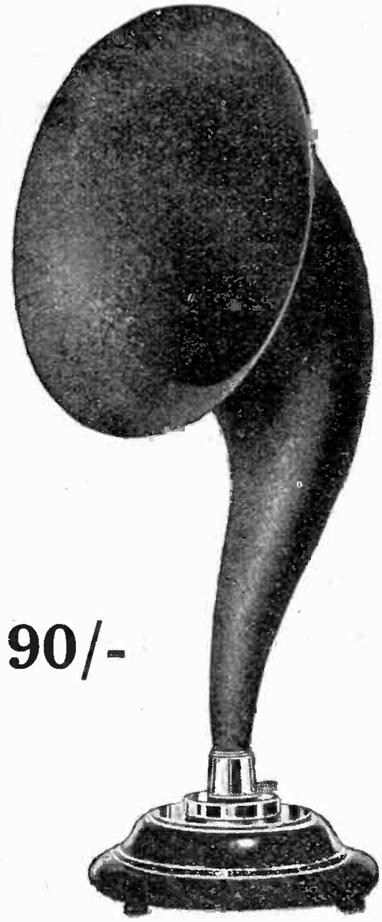

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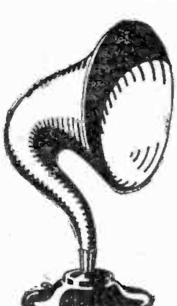

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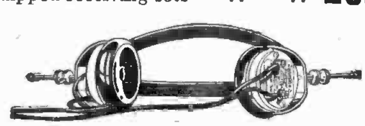

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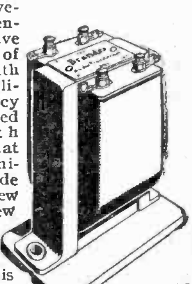


17/6

Degeneracy in the Stone Age

I feel quite sure that when the first young gent appeared in a natty suiting of woad, all the old fellows of the tribe wagged their beards in horror and told one another, and the world in general, that things were not like that in their time, and that they did not know what was coming over the young men of the day. Imagine, too, the feelings of a Stone Age die-hard who found himself confronted in battle by an ultra-modern youngster armed with a bronze gizzard-slitter. Stone had been good enough for him and for his grandfather, and the use of that nasty sharp stuff in battle was nothing more nor less than taking a mean advantage, which just showed the degeneracy of the age.

Bags

Somehow I had never before connected the Oxford trouser with wireless in a general way. But on thinking it over I believe that I can now see the connection between the Oxford trouser and wireless. It is all a question of wavelengths. In no nether garment do you get such beautiful sine waves as you do in the Oxford trouser as the wearer moves. But why should they call this habiliment effeminate? For the life of me I cannot say. So far as I can see, it is thoroughly masculine. Have not our noble Jack-tars worn Oxford trousers ever since the great days of Nelson? Possibly they have not, but I feel that you will not be any more definite on the point than I am. Anyhow, there can be no better example of the he-man than the sailor.

A Great Help

Though I beg leave to doubt whether wireless is really responsible for the Oxford trouser, I can prove to you very simply that, in my case at

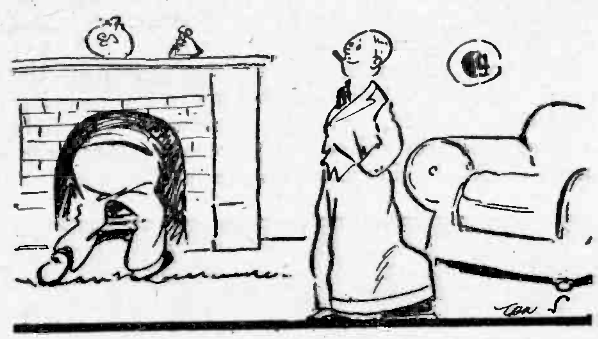
. . Have not our Jack-tars worn Oxford trousers since the days of Nelson? . .

any rate, the Oxford trouser is responsible for wireless. At the present moment my household is rejoicing in the reproduction of broadcasting given by a glorious five-valve set, which I owe entirely to the Oxford trouser. In days gone by I have been able to borrow here a valve, there a transformer, here a rheostat, there a condenser; but until these voluminous bags came along, that was really as far as I could go, as people usually discovered far too soon that borrowing had taken place.

But now, thanks to the Oxford trouser, things are very much better. The other day I was paying a visit to Admiral Whiskerton Cuttle, who desired to demonstrate the marvellous powers of the five-valve set which he had just constructed. As a rule, I am shown upon arrival into his drawing-room, which contains no wireless apparatus. A new maid, however, ushered me into his wireless den. There upon the table was the new set, which I promptly transferred to the floor, and covered with the flowing folds of my nether garments. Presently the Admiral entered.

Rough on the Admiral

"My dear fellow," he said, "I am delighted to see you. I just want you to hear what my new set can do, so that you may get some idea of what a thoroughly efficient five-valver should be like." He moved across to the table.



. . . He made a thorough search . . .

"Hullo!" he said, "where have I put that set? I thought that it was here." He made a thorough search of the room and then went out to his workshop. Coming back, he reported that he could not find the set anywhere. "I quite understand," I said, "these wireless things are always getting lost. Only yesterday I mislaid a gridleak and could not put my hand on it for hours and hours." He searched and searched without success, looking simply everywhere for the missing set. Eventually he rigged up a three-valver and gave me a demonstration with that. I was quite polite about it, saying that it was not half bad, but if he wanted to hear results he had better come round the next evening to see what my five-valver could do.

A He-Man Feat

Thanks to the Oxford trouser and to a little skilful manœuvring, I was able to get away with it in the end, and I can assure you that we have simply revelled in broadcasting ever since. When the Admiral came to see me I gave him a jolly good demonstration. Naturally, I had taken the precaution to give the panel a coat of green paint and to effect certain alterations in the cabinet. He told me that it was rather queer that I should have produced identically the same design as his own, but I explained this away by talking quite a lot about telepathy and great minds thinking alike. If anybody wants to talk about the Oxford trouser being effeminate, just you send him round (provided that he is reasonably small) to see me. Personally, I think that it is the hall-mark of he-mannishness.

WIRELESS WAYFARER.

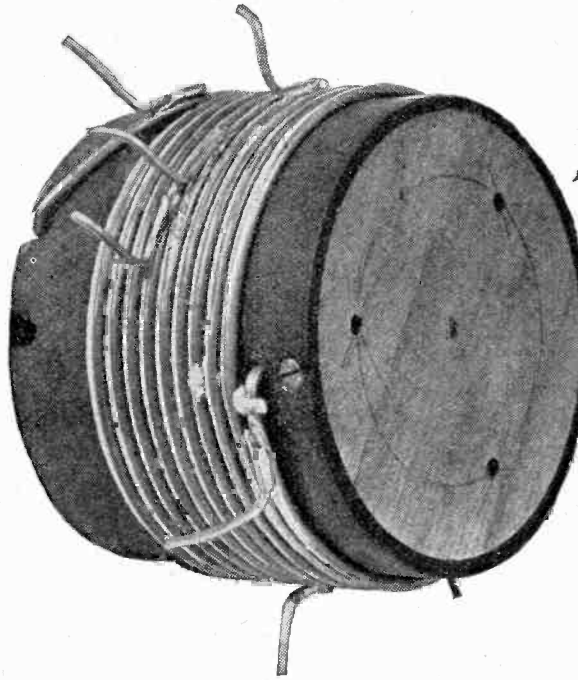
An Easily Made Thick-wire Inductance

Heavy-gauge wire is sometimes found troublesome to handle in coil winding, and these notes describe how coils of this type may be simply constructed and mounted.

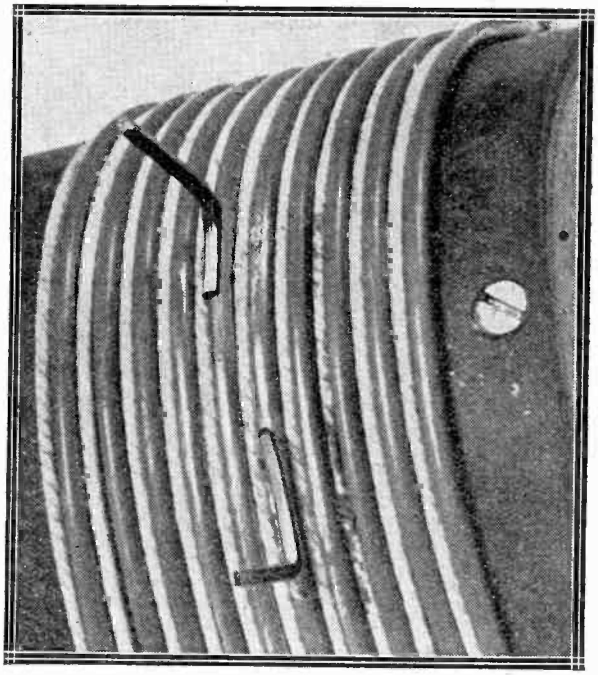
IT is not always an easy matter to construct a rigid and robust coil of thick wire, especially if bare wire is used, for then the turns must be spaced so as to prevent adjacent turns touching.

The coil shown in the photograph has the merit not only of being quickly made, but of being absolutely rigid, evenly spaced and easily mounted where desired. A piece of ebonite tube, about 4 in. in diameter, was used. A piece of wood was cut with a washer cutter to fit tightly into this, three holes being drilled through the wooden disc to allow of mounting the complete inductance. If a washer cutter is not at hand a piece of wood about an inch wide and half an inch thick may be cut with rounded ends so as to fit, the tube being held in position, as is the disc, by means of wood screws passed through the ebonite tube.

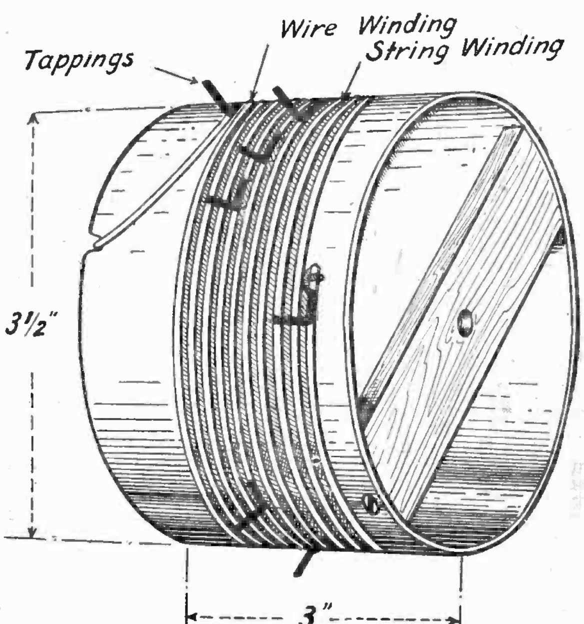
A hole is drilled near the edge of the tube and one end of the wire put through it, and the wire is then wound on together with some string of medium thickness to space it. The end of the winding is then dropped into a slot cut in the other edge of the former, and bent over with a pair of pliers to fix it firmly in position. The end of the string is fastened by drilling two small holes, threading it through and tying it. Short lengths of square wire to serve as tapping points may be soldered at convenient places, as shown in the photographs. C. P. A.



A disc of wood fitted into the end of the former is used to mount the coil.



Showing how tappings may be taken from the completed winding.



Instead of the disc shown above, a strip of wood may be held in position by screws at one end of the former.

Constancy in Wavemeter Coils

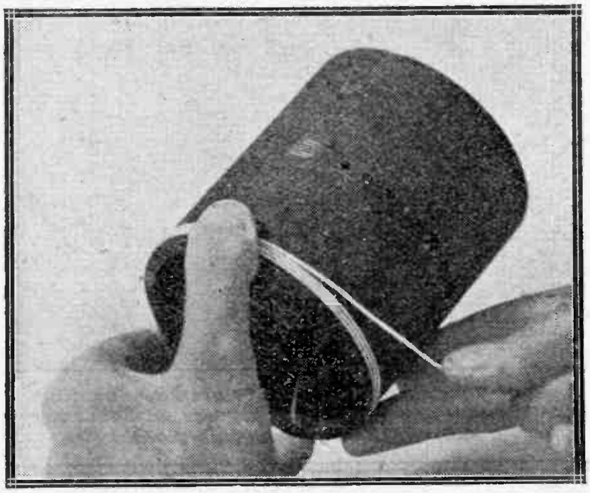
By G. P. KENDALL, B.Sc., Staff Editor.

A much-neglected part of the average wavemeter is the coil, and this article shows that large variations in calibration may result from such lack of attention.

MOST experimenters who feel themselves capable of building an effective wavemeter probably realise clearly the importance of securing the greatest possible constancy of calibration in the finished instrument, and it is usual to see due attention devoted to such points as the choice of a good and well-constructed variable condenser, the maintenance of uniform conditions for the oscillating valve, and so on.

Observation seems to show, however, that many people do not realise that although all these other points may have been attended to with great care, yet if the design and construction of the coil is not given equal consideration the result may be an instrument of quite hopeless unreliability. I have recently been carrying out some experiments with a view to determining just what factors in the coil and its design give rise to changes in the calibration of a wavemeter in the course of time, and it would appear that in everyday use these are as follow:—

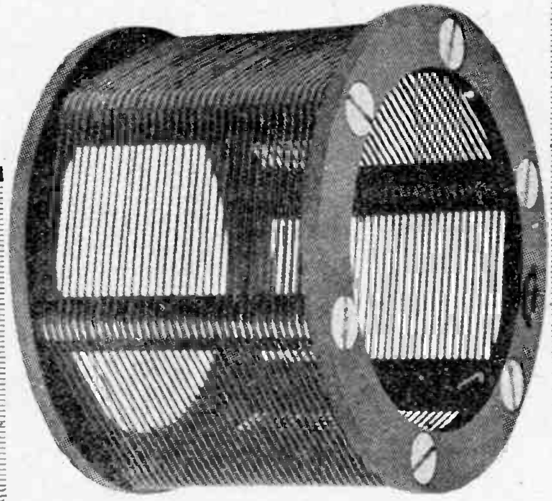
(1) Deformation of the coil as a result of the release of the natural springiness of the turns.



Putting a winding on the type of ebonite former described. Cotton covered wire was used here so that it would show up clearly, though in practice enamelled wire is to be preferred.

(2) The deposition of moisture in the covering of the wire or the former upon which the coil is wound.

(3) Chemical changes in the material used to impregnate the coil.



Coils of this type can be used in wavemeters if the turns are firmly secured.

A consideration of each of these points in turn should assist those who intend to design their own wavemeters to produce an instrument which can be depended upon to maintain something like a constant calibration.

Coil Deformation

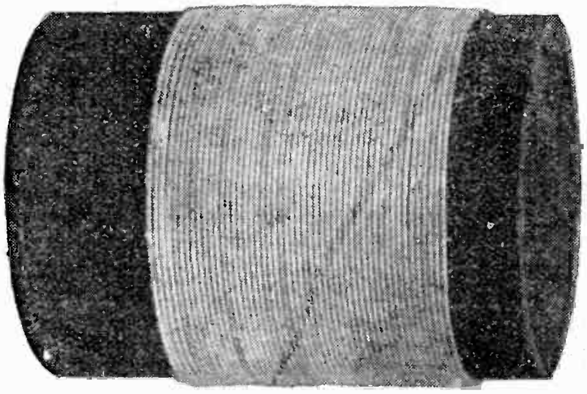
Certain types of coils are, I find, apt to produce quite surprisingly large variations in a given tuning adjustment, as a result of actual changes of shape taking place in their turns. In coils where the turns have been put on with considerable tension and no very definite means has been provided for securing them in position, the natural springiness of the wire will often lead to quite perceptible changes of shape after the coil has been mounted in the wavemeter. In a basket coil, for example, which had been merely tied up with string, and not impregnated with varnish, I recently observed a change in dial reading from this cause of one and a-half degrees on a .0003 μF condenser on a wavelength of 400 metres.

Single-layer Coils

It is evident, then, that we must regard certain coils as being quite unsuitable for wavemeter use, and in general, we should make a point of employing some variety in which the turns are either very firmly secured in some way, or else are so arranged that they cannot spring out after winding. For example, a single layer coil whose ends are firmly secured is practically immune from such troubles. Since at the present time most of us are interested very largely in wavemeters for the broadcast wavelengths, I think it is safe to say that by far the best procedure is to decide upon a single layer inductance, whatever type of circuit is used. Reasonable precautions in winding will then ensure that the coil will be fairly constant as far as any changes in dimensions are concerned.

The Effect of Moisture

It may be remembered that I recently described in *Wireless Weekly* (Vol. 6, No. 6) the results of some experiments upon



Coils of double cotton covered wire are best impregnated with a damp-resisting medium.

the effect of moisture in a variety of different types of tuning inductances, from the point of view of signal strength rather than constancy of calibration. The results I obtained, however, will serve our present purpose quite well. It was shown that in all types of coils where wire with an absorbent covering such as silk or cotton was used, and in which the various turns press fairly tightly upon one another, the effect of moisture in such amounts as are met with in actual practice might be extremely serious. In some cases signal strength was affected to a very considerable extent, and the tuning adjustment of a station upon the broadcast band might be altered to seven or eight degrees on the dial of a .00075 μF condenser in series in the aerial circuit.

Cotton-covered Wire

Such variations are, of course, entirely prohibitive in such coils as those in wavemeter circuits, but it is to be noted that in the case of single layer inductances the effect was much less noticeable than in true multi-layer coils. The effect upon signal strength of quite a considerable amount of moisture was in many cases only slight in such coils, although the alteration in tuning produced was such, again, as must not be allowed to occur in a wavemeter. No type of coil which I tested and which was wound with unprotected cotton-covered wire, was sufficiently impervious to the effect of moisture to be used in a wavemeter unless it could be enclosed in a hermetically sealed box, and it will therefore appear that when such wire is used some form of damp-proofing impregnation is essential.

Shellac Dangers

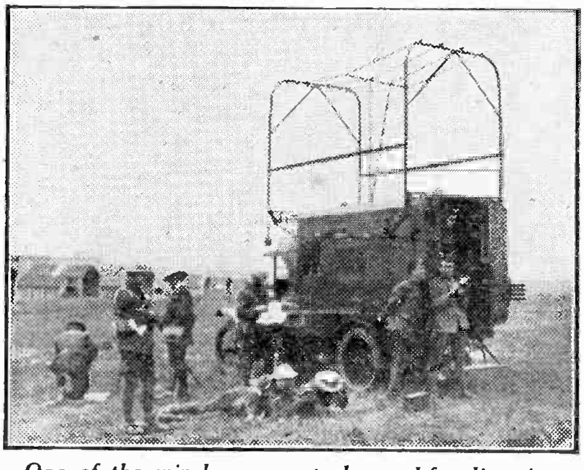
Experiments carried out at the same time upon shellac varnish impregnated coils were somewhat surprising in their results, since I found that the customarily recommended treatment with extremely dilute varnish was of very little service in preventing the absorption of moisture to a degree capable of considerably altering a tuning adjustment, and it would seem that in wavemeter coils the impregnation with varnish should be quite heavy, and usually extremely thorough baking is undoubtedly very important.

So far as constancy is concerned, I have obtained very much better results by means of a paraffin-wax protection, and this seems a desirable method to adopt. When a good grade of paraffin wax is used, it appears that the resulting coil becomes remarkably constant in its characteristics, and can be depended upon to be entirely trustworthy within the ordinary limits of amateur experimental work.

Value of Paraffin Wax

From a practical point of view, such impregnation must be carried out at a reasonably high temperature in order that all moisture contained in the coil may be expelled, and it is imperative that a really good grade of wax should be employed. Paraffin wax as an impregnating agent, when used with due discretion in this way, is particularly valuable, since it enables us to use a cheap and convenient cardboard former for wavemeter purposes, which is otherwise a procedure strongly to be deprecated.

If shellac varnish is to be used, probably it is safest to make it a definite rule that only a good ebonite former should be used for the coil, since shellac-protected cardboard has proved in my experiments to be an extremely risky material.



One of the wireless vans to be used for directing the gunners in the Army manœuvres on Salisbury Plain, which commence this month.

Use of Enamelled Wire

An alternative method of overcoming the moisture difficulty is to use either bare or enamelled wire so arranged that adjacent turns do not touch, and I have succeeded in constructing an exceedingly constant coil in this way. This coil is wound upon a threaded ebonite tube with enamelled wire, the former in question being obtained by stripping off the Litzendraht winding of a Mark III* coil. It will be remembered that these coils are obtainable from one of the Army crystal receivers, and they can be obtained from the majority of dealers who still have any Disposals Board stock in hand.

A photograph was specially taken to illustrate the use of one of these formers, and this appears in the second photograph in this article, where the operation of winding wire on to such a former is illustrated. For the purpose of the photograph cotton-covered wire was used, in order that its whiteness might show up clearly upon the former and show how the turns are spaced apart and held firmly in position by the thread cut in the tube. In practice, of course, enamelled wire is to be preferred, or bare wire if desired.

Skeleton Formers

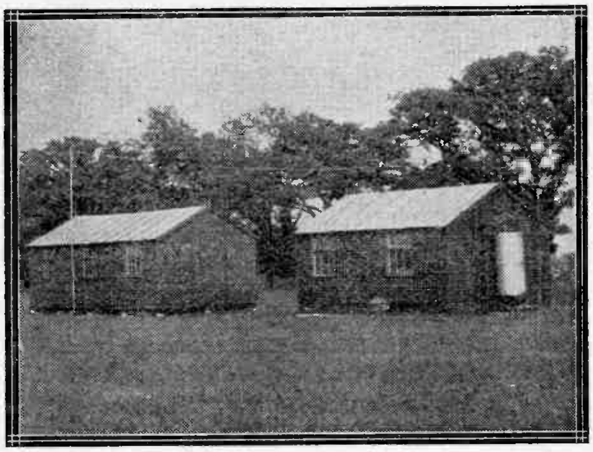
Another method of using enamelled or bare wire to produce a very dependable type of coil is to employ one of the Collinson skeleton formers which are now often used for supporting low-loss windings, and I have obtained quite good results in this way. The main difficulty consists in so winding the coil that all the turns are kept fairly well under tension, none being left slack. A certain amount of trouble is involved in doing this, and probably the easiest thing to do is to wind on the wire without very much regard to this point, and then go over the finished coil with a little really thick and tacky shellac varnish, running the varnish brush down each of the rods supporting the windings, so that each turn is properly stuck in position when the varnish has been baked.

Chemical Changes

A little-suspected cause of variation in calibration was discovered accidentally in the use of some supposedly pure paraffin wax of doubtful origin. A coil had been impregnated with this material, and it was found that there was a progressive change in the dial reading of the tested wavelength, which led to the dissection of the coil. On scraping down into the impregnated cotton covering it was found that there was a distinct greenish tint developing in the wax, and it is therefore surmised that the material in question must have contained some animal fat, whose fatty acid content had attacked the copper. This should put the reader on his guard against any impregnating material except paraffin wax of the most dependable quality. Similarly, if shellac varnish is used, again only that supplied by reputable electrical firms should be used, since there are a number of disconcerting possibilities associated with the employment of the so-called shellac varnish which may be obtained from an ordinary paint and colour merchant.

Conclusions

To summarise the results of the simple tests which I have been making, it seems to me that it should be decided that the single layer coil is to be regarded as a standard for the type of wavemeter which we are using for the broadcast band, that where possible enamelled wire should be used, so supported that the turns are relatively immovable, but that where this is not practicable, double cotton-covered wire impregnated with the highest quality paraffin wax may be substituted. Avoid all coils in which the turns are not firmly secured in position, beware of poor-quality paraffin wax or shellac varnish, and unless the paraffin-wax method of impregnation is used, choose a former for the coil which is known to be relatively impervious to the effects of moisture, such as a piece of ebonite tube.



The receiving station at Hayes, erected by the B.B.C. for the purpose of picking up foreign stations to be re-broadcast.

A Short-Wave Problem

(Concluded from page 697)

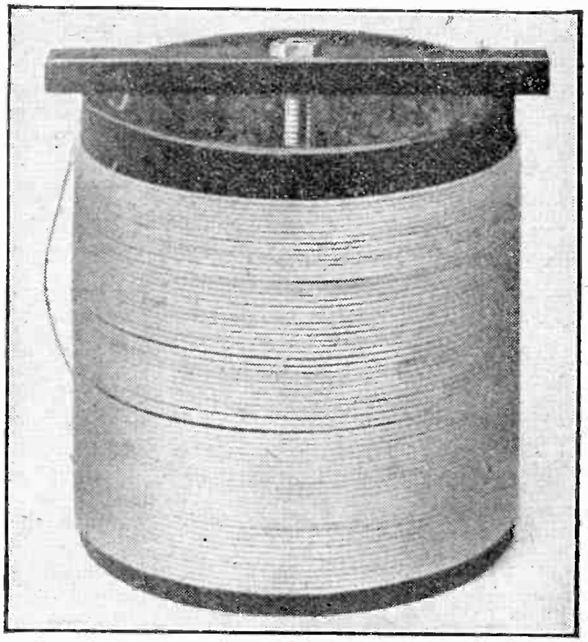
Probably the easiest wavemeter to use and the most promising from the point of view of experimental development, is the simple absorption type, consisting merely of a coil and condenser arranged to tune over the desired band of frequencies, and placed somewhere in the neighbourhood of the oscillating receiver. The familiar phenomenon of clicks denoting stopping and starting of oscillation indicate resonance between the wavemeter circuit and the receiver, and a quite useful effect can be obtained in this way.

Before such wavemeters can be really effective, however, one must overcome the difficulty of the strong "interlocking" effect of tuned circuits in close proximity, which becomes troublesome at these higher frequencies, since it is often found that a considerable variation will be observed in the reading of the wavemeter dial, depending upon the direction in which the reading is approached. A partial screening of the wavemeter coil is sometimes found helpful, and here there is an exceedingly promising field for research, requiring only simple apparatus.

Mounting Some Types of Home-made Coils

By C. P. ALLINSON (6YF).

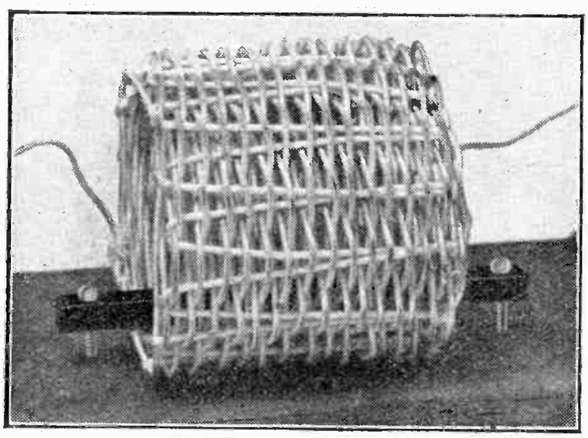
Much of the advantage obtainable by using home-made coils may be lost by unsuitable methods of mounting them. This article describes some practical ways of treating coils of this type.



The screwed rod passes through the coil into the panel or baseboard.

MANY constructors are building receivers which are designed with a view to covering only a certain fixed waveband, so that instead of plug-in coils being used one inductance only is sufficient.

Such an inductance may be a home-made single-layer solenoid, a basket weave or a spider-web. Whatever its form it will probably need to be mounted in some position, and methods suited to each type of coil are here indicated.

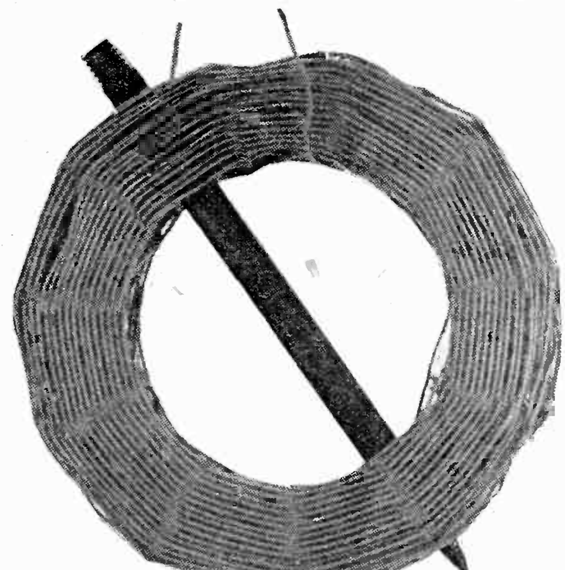


A simple and secure method of mounting a basket-weave coil.

The first illustration shows a convenient method of securing a single-layer coil wound on an ebonite tube to either a panel or a baseboard. A flat strip of ebonite has a hole drilled through the centre, through which a piece of screwed rod is inserted, which is then either screwed into the panel or the baseboard, according to circumstances. A nut and washer serve to clamp the strip against the coil, and thus the coil is held tightly in the desired position.

Other Types of Coils

The illustration on the right shows the spider-web coil mounted by means of a small ebonite rod slipped through the spaces in the coil. The rod

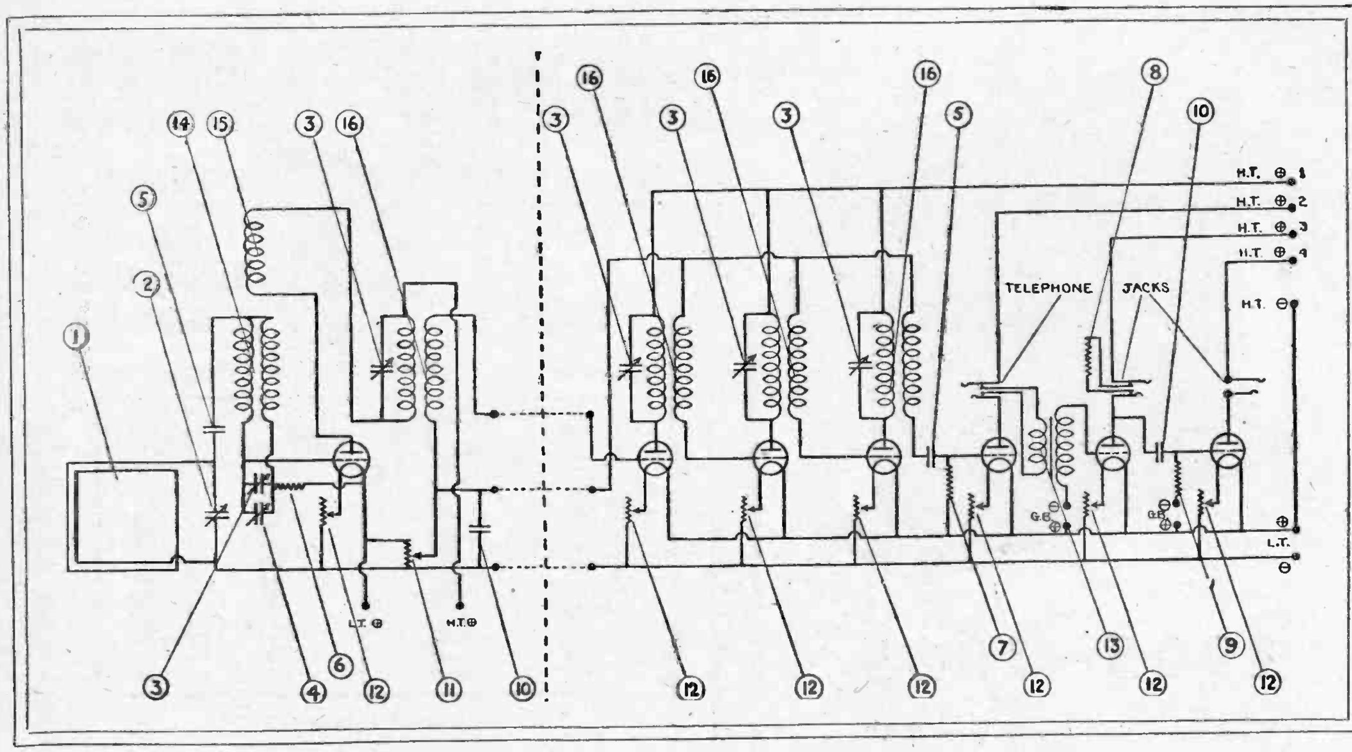


An ebonite rod pushed through the windings of a spider-web coil can be screwed or plugged into a hole in the panel or a conventional plug-in coil mount.

is inserted in a hole drilled in the baseboard or panel, and firmly supports the inductance.

Lastly, the basket-weave coil may be mounted as shown. A slip of ebonite has a couple of holes drilled in each end, 4 B.A. clear being a suitable size. The coil can then be fixed either against the panel or baseboard as is convenient by means of a couple of screws through these holes. If desired, a second strip of ebonite may be used underneath the coil when the inductance is mounted on a baseboard, so as to lift the coil clear of it.

It is always advisable to remember when mounting coils to fix them so that metallic objects such as L.F. transformers or variable condensers do not come within the magnetic field of the coil.



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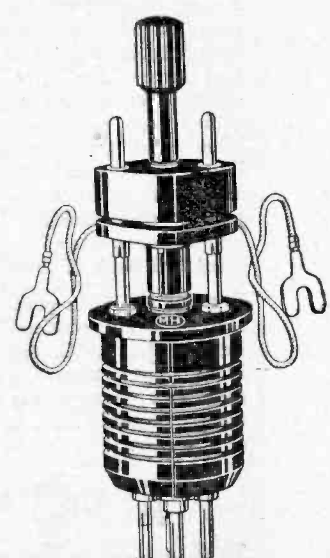

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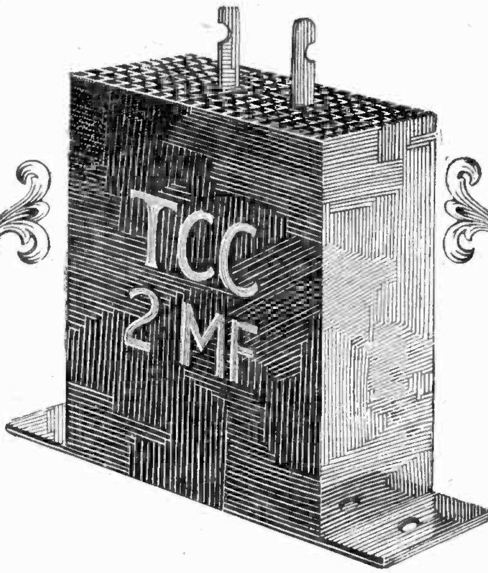

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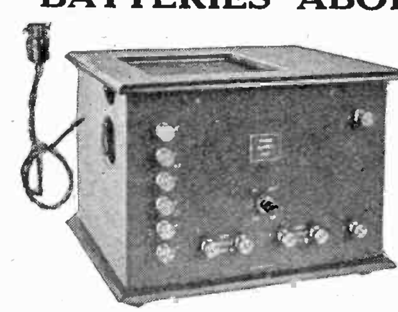

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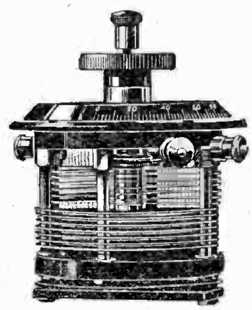

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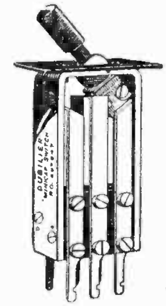

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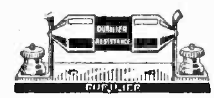

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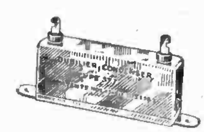

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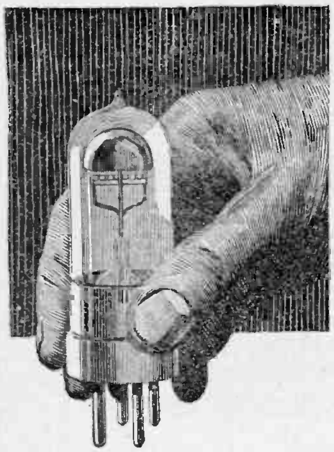

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Wireless News in Brief.

Empire Wireless. A great wireless development is expected in India as a result of the new work undertaken by the Indian Radio Telegraph Company. A licence was recently granted to this company to erect a beam station for direct communication between India and Britain. The British Post Office has sanctioned the erection of a reciprocal station here.

The transmitting station for India will be in the cantonment of Kirkee, near Poona, on the site of the old Marconi station, long begun but never completed. The receiving station will be at Dhond on the G.I.P. Railway. Land has been acquired and buildings are about to commence, and it is expected that the station will be ready for work by the middle of 1926.

* * *

The Polish Government intends to develop radio broadcasting, and stations will be erected at Krakow, Lwow, Poznani, and Warsaw.

* * *

Amateur Radio in India. We are informed that a Radio Relay League of India is being formed primarily for the mutual benefit of amateur transmitters. Wireless has developed very largely in India, and the Radio Clubs of Bombay, Calcutta, Madras, Poona, Baroda and Indore are co-operating very well, with the result that there is very little clashing of transmissions, and people can easily get into touch over the 2,000 miles that sometimes separate the stations and the receiving sets. The Madras Radio Club is quite amateurish, but its members are very enthusiastic. It has a very simple transmitting set, roughly assembled on a wooden bench, and although the input is no more than ten watts, the transmissions have been tuned in as far away as two hundred miles.

An amateur in Poona has succeeded in logging three or four short-wave amateurs in his attempt at securing KDKA's short-wave transmissions.

Another enthusiast succeeded in tuning in to the Calcutta and Bombay programmes from Madras, a distance of over 1,200 miles, on a four-valve straight circuit.

* * *

A new wireless service to Japan has been inaugurated by Marconi's Wireless Telegraph Company, Ltd., and is now available to the public.

* * *

World Radio Conference. The State Department in Washington has sent invitations to 42 foreign Governments to attend a Radio Conference next spring.

The main purpose will be to discuss the revision of the International Radio Telegraph Convention of 1912, and measures for the increased supervision of broadcasting, the handling of Press messages, radio telephony, and the elimination of interference.

* * *

New facilities for intercommunication between islands in the Faroe group have been provided by the installation of two small power duplex wireless telephone sets on the islands of Thorshaven and Nols. Each set, which is of the Marconi XP1a type, comprises a small power valve transmitter and valve receiver, worked entirely from batteries, thus obviating the necessity for a dynamo. With the aerial supported by masts 70 ft. in height, communication over a distance of 20 miles can be maintained.

* * *

Wireless telegraph and telephone installations are being fitted by Marconi's Wireless Telegraph Company, Ltd., for the Northern Lighthouse Board, on the Sule, Skerry and Monach Lighthouses, and also at Stromness. A third group of Trinity House Stations, based on Yarmouth, is being equipped also with telephone apparatus. A total of thirty-one British lightships, lightvessels and harbour authority offices will then be fitted with Marconi wireless telephone equipment.

* * *

Despite the unsettled condition of the country, broadcasting is making considerable progress in China. The principal broadcasting station is at Shanghai, and a full programme of news, talks, and concerts is sent out daily.

* * *

Investigations are being renewed by the London Midland and Scottish Railway into the possibility of establishing communication to and from moving trains by wireless telephony. Successful experiments with wireless telegraphy were made many years ago, but as a wireless telegraph service for trains had no particular practical value the matter was not proceeded with.

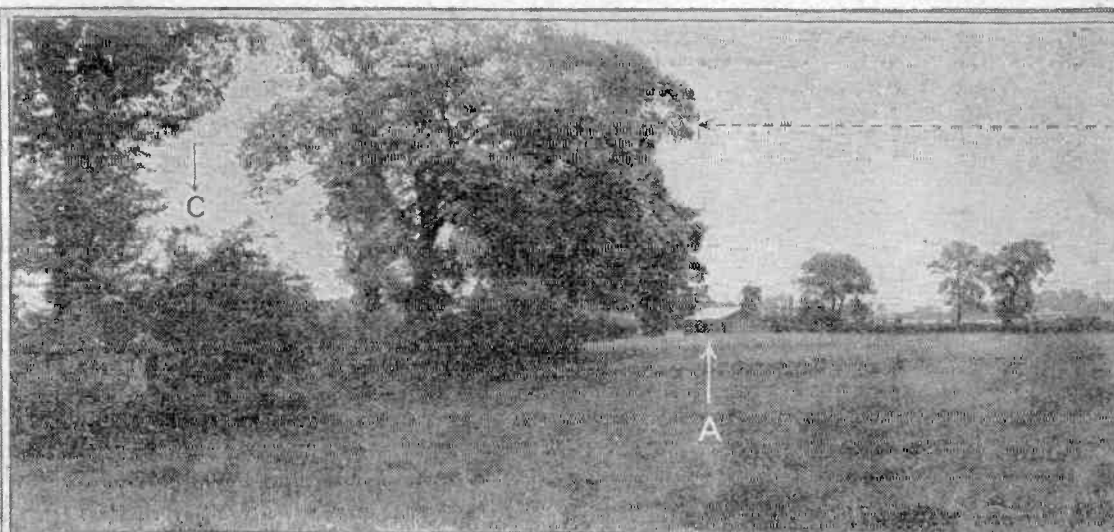
* * *

New Call Sign. The call sign 5VR has been allotted to the Edison Swan Electric Co., Ltd. Experimental transmissions will shortly commence on wavelengths of 23, 45 and 90 metres. The company intimates that reports of the reception will be greatly appreciated and acknowledged, and times of special tests will be sent to anyone on request.

* * *

Re-Broadcasting WAP. A recent experimental attempt to re-broadcast on 322 metres the 40-metre transmissions of music and Eskimo songs from the Macmillan Expedition in the

(*Continued on page 722.*)



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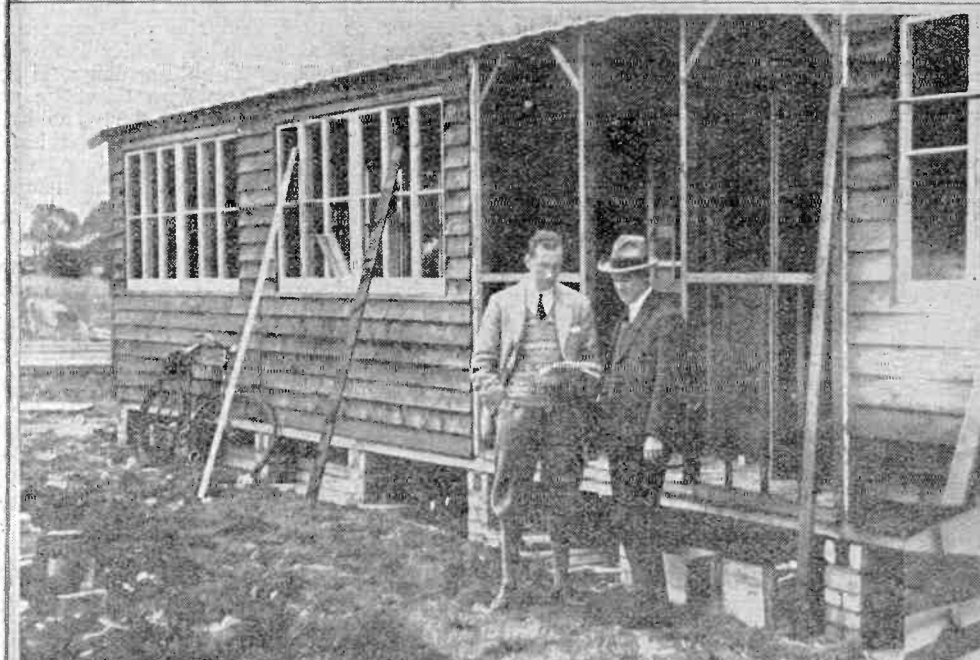
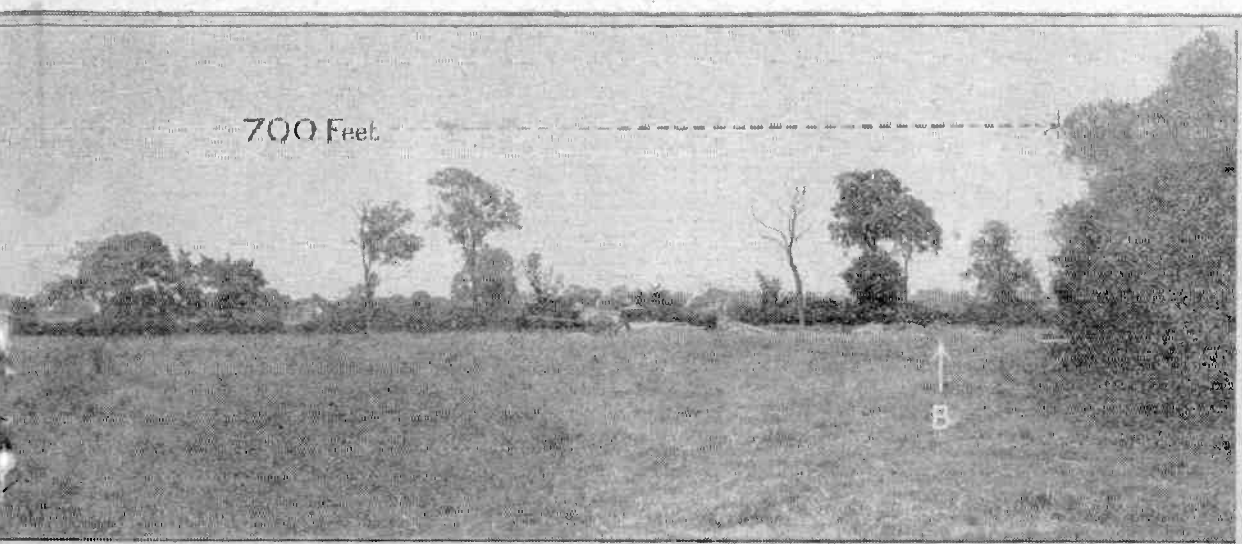


No time is being lost in pushing forward the development of the first stage of the erection and organisation of the Radio Press laboratories at Elstree, and the photograph which heads these pages will convey some idea of the scale of the operations.

This first stage consists in the erection of a number of temporary buildings in order that the work of the laboratories may be unhindered by building delays, and the photographs show this work of construction at its commencement: considerable progress has been made since they were taken.

The upper view shows the piece of land which is being used for the initial developments, and it will be seen



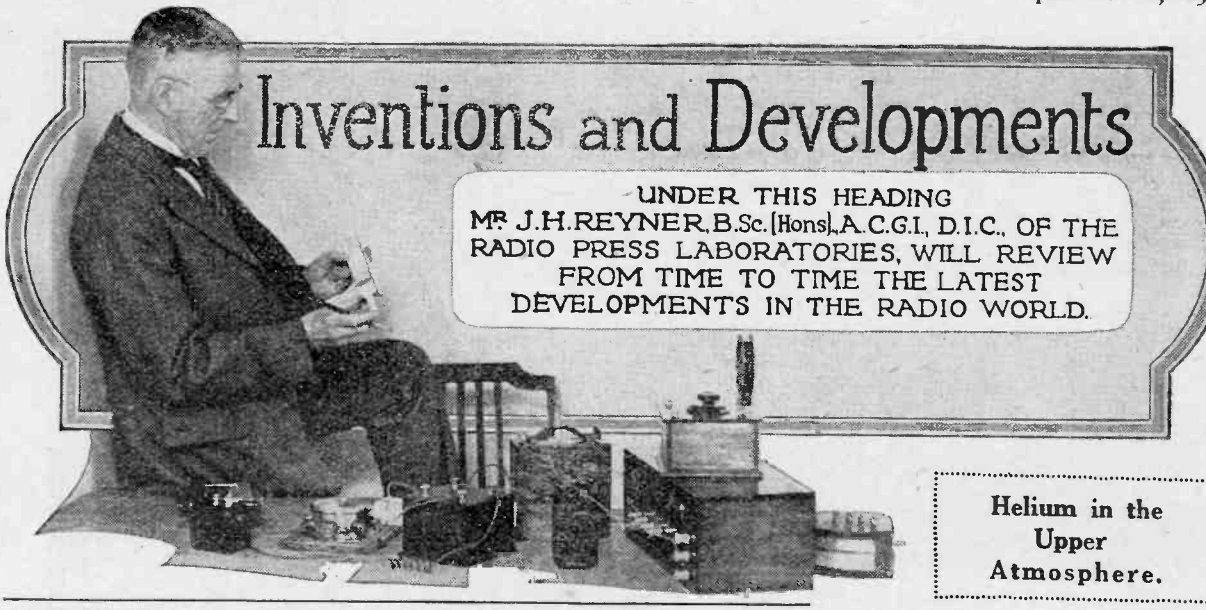
GRESS
AT
TREE

dio Press laboratories may be as possible, a number of are being erected, and there es the first photographs to be e work in its initial stages.

that it has a road frontage of seven hundred feet. A total of seven acres is available, and in addition to the area visible there are two further sites of considerable extent, one on the left at "C," and the other on the right.

The first building to be completed was the one intended for the Service Department, and this may be seen at "A," close to the road. When the photograph was taken the concrete foundations of the next building had just been finished, and these are at "B."

In two of the views Mr. Scott-Taggart (holding papers in the left-hand photograph) and Dr. Robinson may be seen discussing the arrangements.



Helium in the Upper Atmosphere.

SOME of the most important information which we possess concerning the composition of astronomical bodies, and the upper atmosphere, is obtained from an examination, by means of a spectroscope, of the light which is emitted by these bodies. If, under certain conditions, white light is passed through a prism, the light is split up into its several components—red, orange, yellow, green, blue, indigo, and violet, and if the light from the prism is thrown on to a suitable screen, a continuous band of light is obtained, changing its colour from red to violet. This band of light is termed the spectrum.

Nature of Spectrum

Now this complete spectrum containing all the colours previously mentioned is only obtained from what is generally termed white light. If some element is raised to incandescence and emits light in consequence, the spectrum of this light will not be found to contain all the colours, but only certain definite bands.

For example, the spectrum obtained from incandescent sodium consists simply of two bright yellow lines close together, the remainder of the spectrum being absolutely black.

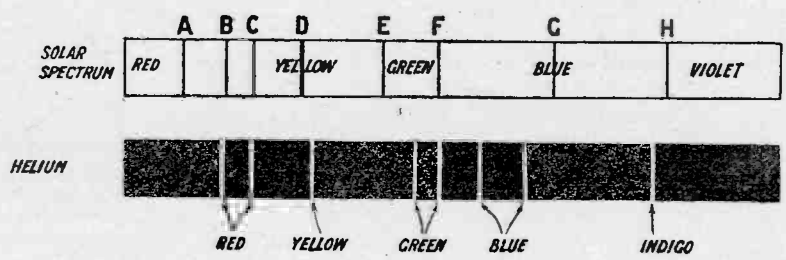
Black Lines

Again, if white light is passed through the vapour of some such element on its way to the prism, the light which would normally be emitted by the particular element is under certain conditions absorbed from the white light, with the result that the spectrum is lacking in these particular colours. This manifests itself as black lines in the appropriate portions of the spectrum.

If, therefore, we obtain the spectrum of the light from some particular star, and we find that it contains black lines in certain parts, then by examining exactly where these lines occur, we can say that the light in its journey from the star to the earth has passed through certain vapours which can be determined exactly from the position of the black lines in the spectrum.

The Aurora Borealis

By this means scientists are able to say with considerable certainty exactly what elements are present in the upper atmosphere. It has been found, however, that when examining the light from the Aurora Borealis, there were certain green lines which were unexplainable. There are in this spectrum several bands of black lines, which indicate that nitrogen and certain other elements were present in the atmosphere, but the green lines could not be produced artificially by any known means, and did not correspond with any known elements.



The positions of the main black lines in the solar spectrum are shown in the top drawing, while the line spectrum of helium is shown below.

Another peculiarity of the green lines was that they could be obtained from any cloudless sky during the night, irrespective of the direction from which the light was obtained.

Professor McLennan, however, has now discovered the origin of these green lines, and has shown that they originate in highly rarefied oxygen, the brilliance of the lines being considerably intensified if helium is added to the oxygen. By making quantitative experiments, Prof. McLennan estimates that the light from the Aurora comes from regions some 60 to 100 miles above the earth, and his experiments also indicate that at this height the atmosphere contains 20 to 30 times as much helium as oxygen.

(Concluded on page 722)

Broadcasting Below 300 Metres

By D. J. S. HARTT, B.Sc.

There is much of interest to be heard below 300 metres, which was formerly considered the lower limit of the usual "broadcast" band. Some suggestions for adapting sets which do not already tune below this wavelength are given in this article.

UNTIL more recently, when we spoke of the "broadcast band" of wavelengths, we were accustomed to think of the 300- to 500-metre (1,000 to 600 kc.) band, since the majority of stations were then operating within these limits. Now, however, we find that the band has been somewhat extended on the lower range, particularly between 250 and 300 metres (1,200 and 1,000 kc.). There are, for instance, about six Continental stations operating in this band which are frequently heard very well in this country.

Higher Frequencies for Broadcasting

Now, if the positions of the European stations, including, of course, the British stations, are in the future allotted in the broadcast band uniformly on a frequency separation basis between, say, 1,200 and 600 kilo-cycles (250 to 500 metres), it is obvious that we shall have more stations operating between 250 and 300 metres. Thus the tendency will be for the frequencies to be increased, that is to say for the wavelengths of the stations to be lowered.

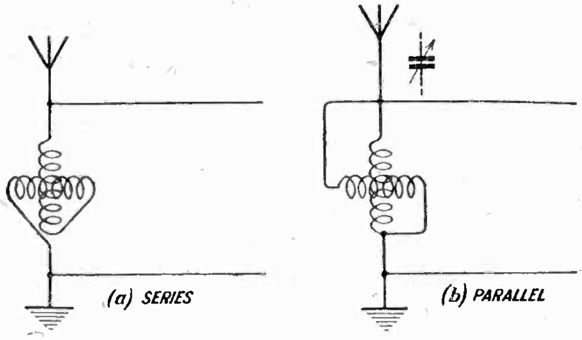


Fig. 1.—In variometer tuned sets a lower minimum wavelength will be obtained by connecting the windings of the variometer in parallel as at (b).

Practical Difficulties

It has even been suggested that all broadcasting should be done on frequencies above 1,500 kc. (wavelengths below 200 metres), but there are obvious practical difficulties, apart from any other influences, which render this out of the question, for some time to come, at any rate.

Another instance of this tendency to broadcast on higher frequencies is given by the recent tests carried out by the Eiffel Tower station on 200 metres (1,500 kc.) and 64 metres (4,685 kc.). All are familiar, of course, with the broadcasting from KDKA, Pittsburgh, on about 68 metres (4,409 kc.). In addition, there is a fair amount of amateur telephony transmission on 200 metres (1,500 kc.).

Tuning Range Limitations

Thus there is plenty of speech and music to be heard below what used to be considered the lower wavelength limit of the broadcast band. The question of the design of receivers to include these transmissions naturally arises. Apart from special home-constructed sets, it may be asked how many commercial receivers can be used or adapted to tune successfully down to these wavelengths?

Inquiries as to the lower limits of wavelength to which some commercial receivers would tune showed that a few of these had serious limitations in this respect. In some tuning was carried out with fixed coils and variable condensers; in others, variometers and fixed anode tuning units were used, in most cases with loading devices for extending the tuning ranges on the upper limit to include the high-power stations.

Effect of Casual Capacities

In a few cases, however, the obvious advantages of interchangeable tuning units had been neglected, and it would not have been possible to tune down below 300 metres (1,000 kc.) without partially rewiring the set and the substitution of new inductances. It is in the question of tuning ranges, particularly on the lower ranges, that casual capacities are an important factor. Those who have read my article in *Wireless Weekly*, Vol. 6, No. 20, will have realised how seriously a total stray capacity of 50 to 100 $\mu\mu$F in parallel with the main tuning condenser can restrict the range at the lower end.

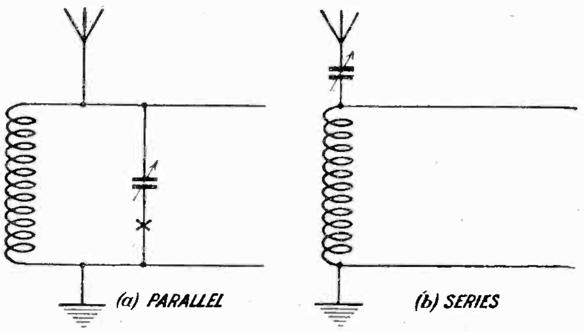


Fig. 2.—To obtain a lower minimum wavelength the tuning condenser may be used in series by breaking the connection at X and attaching the aerial to the condenser.

Designing Suitable Receivers

There are two solutions to this problem in designing receivers which are intended to cover a wide tuning range. The first is to disregard these stray capacities and employ a number of interchangeable tuning units, and, secondly, where a number of such units is not desired—as, for instance, in a complete and totally enclosed set—to make every effort to reduce such casual capacities to a minimum, and so enjoy the benefit of a larger tuning range.

This latter method will, no doubt, result in a greater measure of efficiency all round, and, for this reason, is the more desirable.

At some future date I propose to give some practical details and figures to show just how large a range it is conveniently possible to cover using only one tuning unit.

Adapting Existing Receivers

The most convenient method, however, of adapting an existing set to tune below 300 metres (1,000 kc.) will naturally depend largely on the type of tuning already incorporated. If the aerial is variometer tuned a slight alteration in connecting up the windings of the variometer in parallel, as in Fig. 1 (b), will often enable the receiver to be tuned down to about 250 metres (1,200 kc.), where the normal minimum was, say, 300 metres (1,000 kc.). If this is not possible. a series condenser connected in the aerial lead outside the set will give further assistance.

Series or Parallel Aerial Tuning Condenser

Where the set employs a fixed coil with variable condenser in parallel the desired decrease in the minimum wavelength may be effected by breaking that connection from the condenser to the earthed end of the coil, and attaching the aerial to the condenser at this point, thus putting it in series, as shown in Fig. 2.

It is claimed by the operator, Mr. N. R. Wimer, that this station, situated at Los Angeles, California, is the smallest amateur transmitting station in the world.

Where a fixed coil is used in a tuned anode, practically nothing can be done except to tap off a portion of the coil or substitute another for it. If high-frequency amplification is employed, and it is desired to convert the set for use on the short waves, say, 60 to 100 metres (4,997 to 2,998 kc.), it is recommended that the H.F. valves be completely cut out of circuit by withdrawing them and taking a lead from the grid socket of the first to the side of the grid condenser remote from the grid of the detector valve. If plug-in coils are used the further necessary changes can be made by winding a special auto-coupled coil or using a semi-aperiodic aerial circuit.

Mr. Collins, of Cedar Rapids, Iowa, recently picked up messages transmitted on a 16-metre wavelength from the Macmillan Arctic Expedition at Etah, in Greenland.

For more complete information as to how to effect these changes, the reader is referred to the article on "Adapting Your Receiver for KDKA," by G. P. Kendall, B.Sc., in the June, 1925, issue of *Modern Wireless.*

Sufficient has been said, however, to indicate that in many cases a modification of design is necessary to enable the tuning range to be extended, at any rate, down to about 250 or 200 metres (1,200 or 1,500 kc.).

Random Technicalities

By PERCY W. HARRIS, M.I.R.E.
Assistant Editor.

Some Notes of Interest to the Experimenter and Home Constructor.

ONE thing which has impressed itself upon me very strongly since my return from the United States is the poor quality and general inefficiency of the average British condenser dial. Note that I say *average*, for there are one or two good ones. The average dial is too small, the knob is uncomfortable to hold, the degrees are badly marked, a lot of them stand away from the panel so far that the reading depends upon the angle at which you look at it, and, just to round off their other qualities, many of them wobble on the shaft. In any case, I think it time we gave up the old-fashioned three-inch dial marked as if it were graduated in 180 degrees, but actually divided into half that number, sometimes reading in one direction and sometimes in the other. What is the use of developing low-loss sharply-tuned circuits if we cannot control them with a good dial?

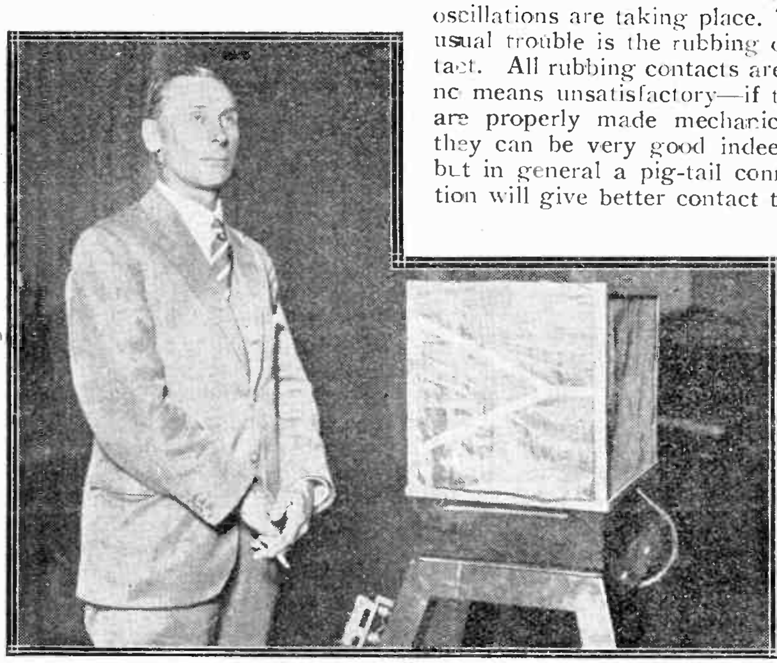
I have lost count of the number of radio sets I used in the United States, but I do not think that at any time I used a dial as small as three inches, or a knob as uncomfortable as the conventional knob we use here. A four-inch dial with a nice large knob, bevelled at a comfortable angle, is a joy to use, and can be adjusted more accurately than many of the single-plate vernier arrangements which are so rarely satisfactory.

* * *

I do not think that the losses in condensers are anything like so great as many people would have us believe, but I do know that far too many condensers have imperfect contact in them, which make them very noisy when used in a circuit where continuous oscillations are taking place. The usual trouble is the rubbing contact. All rubbing contacts are by no means unsatisfactory—if they are properly made mechanically they can be very good indeed—but in general a pig-tail connection will give better contact than the ordinary frictional arrangement. Even the pig-tail scheme needs to be well carried out, and particularly on short waves can be very noisy if two parts of the coiled spring touch one another intermittently. When the central shaft is drilled, and a vernier shaft passed through it, and when we have still another frictional contact in parallel with the first, we are asking for trouble, and frequently get it. If the vernier shaft is sufficiently free it is often wobbly, and, on the other hand, if it is too tight, as usually happens, the main shaft and the vernier shaft will not move independently of one another.

* * *

There is an inherent disadvantage in the single-plate vernier arrangement, which is not generally realised. I heard of the fact that on a low setting of the main part of the condenser the increase of capacity due to introducing the single plate is very appreciable, whereas when we are using a good part of the main condenser the effect of the vernier is not so noticeable. For this reason, I am inclined to think that vernier dials are a much better solution of the problem of fine tuning. On the one hand we avoid electrical difficulties such as may arise from additional rubbing contacts, and on the other the condenser is easier to calibrate. There is room for a great deal of ingenuity in the designing of vernier dials, and there is no reason why they should not be as neat-looking as the non-vernier dials, for it is possible to conceal the vernier mechanism beneath the knob, and between this and the dial itself, as is done in several American patterns. I cherish



Jack Hobbs recently broadcast a talk from 2LO after scoring his record number of centuries in first-class cricket.

particularly pleasant memories of a super-heterodyne I used in my room in the Pennsylvania Hotel in New York. This had two vernier dials with a three or four to one ratio between the knob movement and the dial movement. There was no arrangement for changing from vernier to full motion, nor did there seem to be any need for one, and although the instrument was exceedingly sharp in its tuning—far sharper than any other super-heterodyne I have used—there was no difficulty whatever in stopping exactly where one wanted to stop, on either of the dials concerned.

* * *

In constructing a vernier dial the greatest care must be taken to avoid back-lash, for neither comfort nor accuracy can be obtained if one has to turn the dial a degree or so in either direction before the condenser moves. Quite a number of the American vernier dials are defective in this respect, and there are only three or four which really satisfied me in this regard. I hope British manufacturers get out a good vernier dial quickly, for this is a type of component which can be imported without restriction from the States, and, in fact, is imported already.

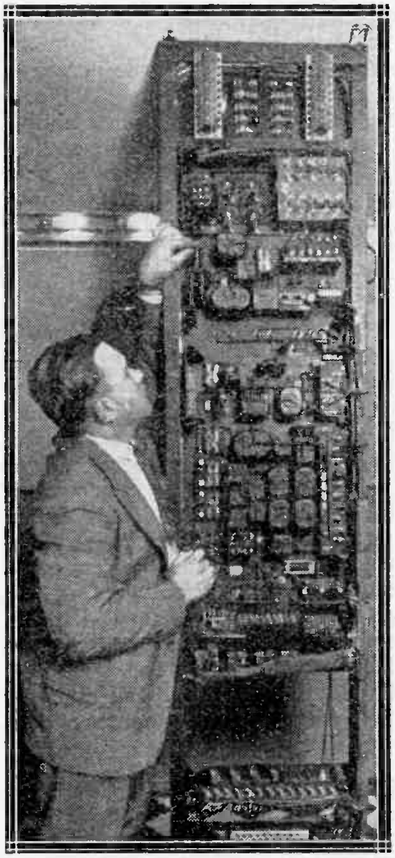
* * *

I was very pleased to find that we have nothing to learn from the Americans in regard to audio-frequency transformers. The average American transformer is by no means a high-grade instrument, and now good modulation is obtainable from a number of their stations, the American public are beginning to wake up to the fact. It is quite surprising to find a number of otherwise excellent sets fitted with quite inferior audio-frequency transformers. I found about three really good instruments on sale as components, and one or two more which are not sold apart from the set. Our transatlantic friends are just beginning to realise that we know something here about the audio-frequency side, and British loud-speakers are very popular. I have before me as I write a pamphlet issued by a Chicago firm to popularise a particular circuit with their set of components. They go out of their way to refer to the Amplion as being particularly suitable for this set.

* * *

Speaking of audio-frequency matters reminds me that the British Broadcasting Company is by no means careful to keep its modulation up to a high standard these days. 2LO in particular varies a great deal. The difference in quality may not be noticeable on badly-designed sets, but is very annoying when one has taken trouble to get out a really good receiver for high-quality reproduction.

It may be fancy on my part, but I am under the impression that there has been an improvement in the reproduction of the Savoy Band in the last few weeks, possibly due to an alteration of the microphone.



This compact switchboard at WRNY, the "Radio News" Station in New York, is used in controlling outside broadcasts.

Wireless News in Brief

(Concluded from page 715)

Arctic was successfully carried out by WJAZ, the Zenith station in Chicago, in conjunction with the Zenith Arctic Experimental Station 9XN. The test of relaying the broadcast was not contemplated and was attempted as an eleventh hour conclusion with makeshift emergency connections. The success of the tests assured the officials and engineers present that the relaying was practical, and it was decided to make further attempts while the expedition is still in the Arctic.

* * *

Test transmissions from European broadcasting stations, in connection with the re-allotment of wavelengths suggested by the International Conference at Geneva, are to be carried out to-night and on September 4, 7, 9 and 14, between the hours of midnight and 2 a.m. British Summer Time. Listeners are requested by the B.B.C. to take note of any interference between stations which they may observe, and to send in reports to the B.B.C. Headquarters, 2, Savoy Hill, W.C.2, on the day following the test.

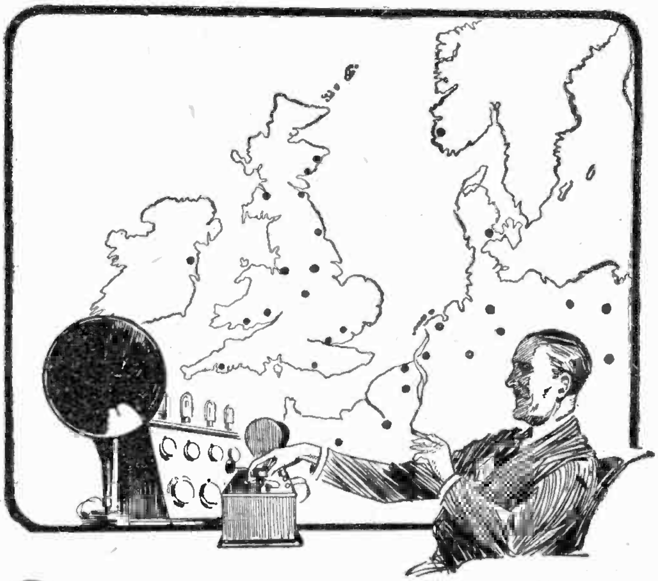
Everybody will, of course, appreciate the fact that the success of these transmissions in furnishing information about interference between the various broadcasting stations depends to a large extent on the listening public who are earnestly asked by the B.B.C. to refrain from oscillation.

INVENTIONS AND DEVELOPMENTS

(Concluded from page 718)

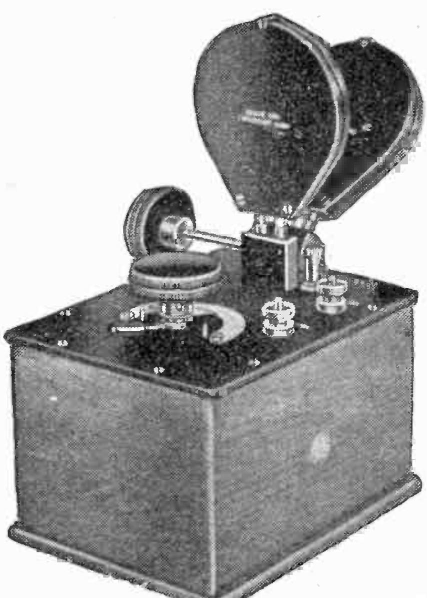
The Heaviside Layer

This discovery has considerable bearing upon the question of wireless transmission round the earth. As is well known, the theory of the Heaviside Layer has been somewhat severely tried of recent years, and there are those who suggest that this layer, if existent at all, has no appreciable effect upon wireless transmission. This proof, however, of the existence of a fairly concentrated atmosphere of helium at this height above the earth, certainly lends support to the existence of the Heaviside Layer, and it is probable that further researches will be forthcoming which will do much to clear up this point.



Bring in the D.X. stations thro' the local!

IF you would separate Radio Paris from 5XX, 2LO from Cardiff and so on up and down the scale . . . if your local station is too "high-brow" this evening or too "low-brow" as the case may be . . . you want an Ericsson WAVE TRAP.



By a careful combination of circuits skilfully arranged you can easily reach out to your heart's content. It simply means 50% extra selectivity for your set. Minimises trouble from electric mains, local disturbances like trams, electric trains, etc. You can easily get distant stations on the loud-speaker you never could try for before . . . all through having an Ericsson WAVE TRAP in your aerial lead.

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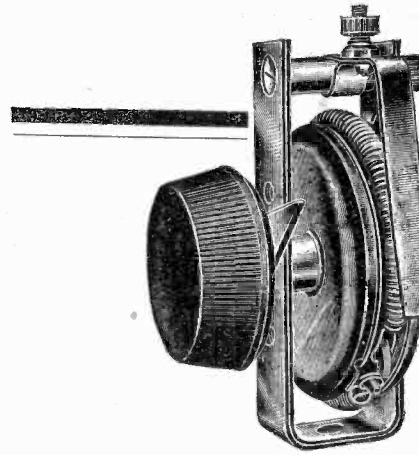

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Experiment with wireless but not with components

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Igranic Rheostats, remarkable for their extremely smooth action, critical control of filament current and absolute reliability, are particularly valuable components for the wireless enthusiast engaging in experimental work.

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The Igranic D.E. type Filament Rheostat is suitable for controlling all types of Dull Emitter valves. It is smoothly and evenly variable over its whole resistance range and permits of very fine adjustment.

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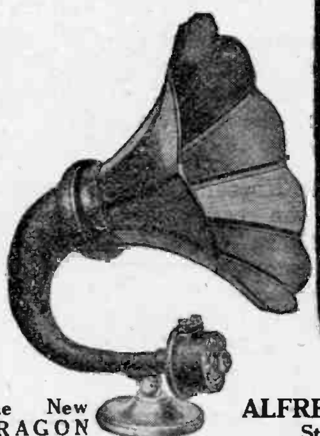
The reason why the AMPLION is undeniably the finest Radio Loud Speaker and recognised as the World's Standard.

It will be seen that the AMPLION is not merely produced to meet a sudden demand, but is the result of years of experience in Loud-Speaker design and construction.

Thirty-eight years ago . . .

In 1887	Mr. Alfred Graham demonstrated the first practical Loud Speaker.
In 1893	GRAHAM Loud Speakers placed upon the market.
In 1894	First used in the British Navy. Transmitters applied to Phonographs for Loud Speaker reproduction. Demonstrations by Prof. McKendrick at the Royal Society.
In 1896	Naval Telephones developed and adopted by the Admiralty.
In 1898	Watertight Loud Speakers Patented. Fitted on board many warships and mercantile vessels. Telephonic Submarine Signalling System devised.
In 1902	Complete Loud Speaker installations on central battery plan erected on warships as sole means of communication.
In 1906	The most extensive naval installation to date, including exchange system fitted to H.M.S. "Dreadnought."
Onwards	Graham Loud Speakers applied to all sorts and conditions of service at home and abroad, ashore and afloat.
To 1919	No less than 12,000 ship installations carried out.
In 1920	AMPLION Loud Speakers produced for Wireless, and "AMPLION" Trade Mark Registered.
In 1922	AMPLION standardised by leading manufacturers of radio apparatus.
In 1924	*At Home* AMPLION sales exceed those of all other makes put together.
	Abroad AMPLION companies formed, and agents appointed in all countries where Broadcasting is in operation, ensuring world-wide distribution.



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REWOUND to any RESISTANCE & MADE EQUAL to NEW. PRICE QUOTED ON RECEIPT OF INSTRUMENTS.

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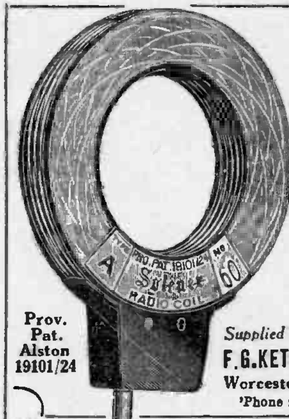
2/6 QUERY COUPON 2/6

WIRELESS WEEKLY. Vol. 6. No. 22. September 2, 1925.

This coupon must be accompanied by a postal order of 2/6 for each question, and a stamped addressed envelope.



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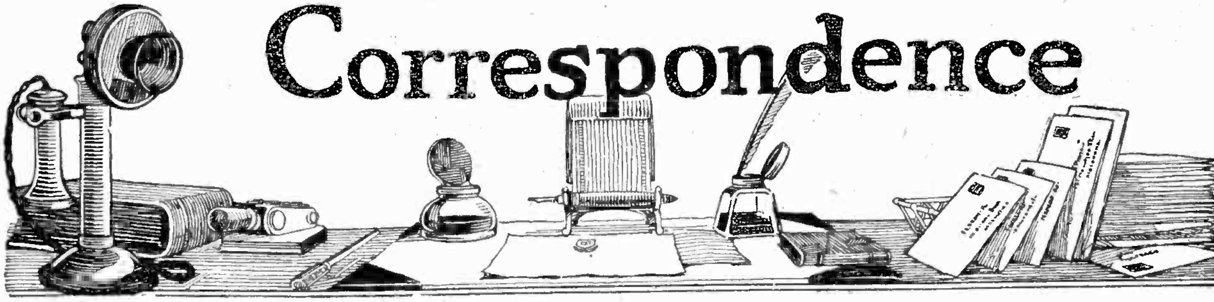
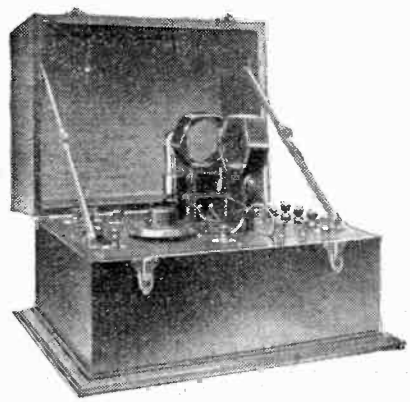


ENVELOPE NO. 9

Sir,—I herewith beg to enclose a photograph of the Single-Valve Receiver (Radio Press Envelope, No. 9), which I have made throughout, including the cabinet, having no previous knowledge of wireless valve sets. I am very pleased with results obtained. I have used a .06 dull-emitter valve (Mullard) with dry batteries. I have also included the two-phone arrangement given in *The Wireless Constructor* for August (page 892).



The Single-Valve Receiver built by Mr. Woodward from Radio Press Envelope No. 9.

I can get Daventry as strong as Birmingham with two pairs of 'phones; these stations are very strong. I have also received at fair crystal strength on one pair of 'phones :—Manchester, London, Bournemouth, Stoke and Notts, and two French stations come in on two pairs of 'phones strongly.—Yours faithfully,

EDWIN WOODWARD.

Rotton Park, Birmingham.

AN APPRECIATION FROM MALTA

Sir,—I thought it might perhaps interest you to know my results with the "Family" Four-Valve Set. Although I have read numerous reports about this wonderful instrument, I think that another one added to the list will not be out of place.

I wish to congratulate Mr. Percy W. Harris for the wonderful circuits and the clear instructions he gives in Radio Press Envelope No. 2. The results obtained are as follows: Rome, Radio Toulouse, Breslau, 5XX, Radio Paris, all at full loud-speaker strength; Rome could sometimes be received on an indoor aerial; Zurich, Petit-Parisien, London, Bournemouth, Vienna, Madrid and two unknown stations at very good telephone strength. I use Cossor valves and basket coils for low wavelengths. My aerial is 80 ft. long, 20 ft. lead-in and 15 ft. high on roof.

I also beg to state that your journals are very popular in Malta, and you will find them in the hands of every wireless amateur.

The best point about this set is the clarity of reproduction, and I consider that it is the best all-round four-valve set.

All my wireless knowledge had been gained after reading your papers, and I have also constructed many other three and four-valve sets described in your journals from time to time. I am only 18 years old, and began radio a year ago, but I now find no difficulty in building any set described in your papers.

Finally, I once more wish to congratulate Mr. Percy W. Harris on this wonderful circuit, and to wish further success to your excellent three journals, of which I am a regular reader.—Yours faithfully,

ANTHONY PELLA.

Sliema, Malta.

A JUNIOR READER'S EXPERIENCE

Sir,—I have recently completed the "All-Concert de Luxe" receiver, as described in Envelope No. 4 by Mr. Percy W. Harris. I am only 15, but thanks to your diagrams and instructions the construction was easy.

I have had all the B.B.C. main stations; also 2LO, 5IT, 5SC, 6BM, 2ZY, and 5NO on the L.S.; 5XX (Daventry) comes through very strongly. There is little difference in the strength on two valves. Daventry is strong on 'phones with no aerial or earth.

I have so far received all the relays except Plymouth and Dundee. 5NG is very loud on the L.S.

I have had two U.S.A. stations—WBZ and WEAF. From the Continent I get Lyons, Toulouse, Radio Paris, Ecole Superieure, Petit-Parisien, Hilversum, Munster, Hamburg (and relays), Voxhaus, Rome, Madrid and Koenigswusterhausen.

Hoping this may be of interest to you.—Yours faithfully,

T. C. HART.

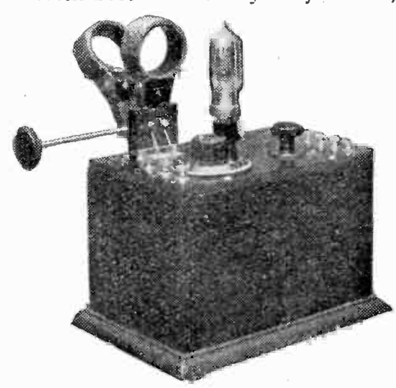
Broughton, Kettering.

A "SINGLE-VALVE RECEIVER FOR BRIGHT OR DULL EMITTER VALVES"

Sir,—I have constructed the "Single-Valve Receiver for Bright or Dull Emitter Valves" exactly to the design in *Wireless Weekly*, October 15, 1924, by Mr. Stanley G. Rattee, M.I.R.E.

With this set I have up to the present received the following stations: Bournemouth, London and 5XX, the latter being at excellent strength. The valve in use is an Ediswan A.R.D.E.

With best wishes to your journals, of which I have been a regular reader.—Yours faithfully,



Mr. Bate's Single-Valve Receiver, with which satisfactory results have been obtained.

A. C. BATE.

Hove, Sussex.

RECEPTION OF NKF

Sir,—With reference to your articles *re* short-wave signals from NKF, I am enclosing herewith particulars of reception from that station. I would like here to remark that the listening amateur, as distinct from the transmitting amateur, is rather badly placed with regard to reporting reception of signals. He patiently searches the ether for hours, and particularly in the "small" hours, and jots down call signs, wavelengths, QRM's, etc., and, where possible, he writes out detailed reports and forwards them to the experimenters who require them. The only reward he seeks is a QSL card or short letter to show that his work is appreciated, but even these are seldom forthcoming. Months ago, when NKF first asked for reports on their signals of different frequencies, I received a very complimentary letter from Dr. Hoyt Taylor. With this as an incentive I was continually watching for his signals and forwarding reports. When the 20-metre transmissions commenced I was one of the first in the British Isles to "log" them from NKF, and from four or five American amateurs.

As a contrast to the indifference shown by some transmitting amateurs I feel I must mention the different attitude of the officials at the Radio Laboratory. Nijni-Novgorod, Russia (call sign RDW). I sent them reports last March on their 100-metre transmissions. In return they were almost lavish in their letters of thanks. When they have special transmissions they notify me through the post-office by telegram. At present they are transmitting on wavelengths varying from 20 metres to 30 metres, from 0100 to 0200 hours, from 2225 to 2325 hours and from 1220 to 1320 hours, G.M.T. I have received their 30-metre signals on 15 metres, using a badly screened indoor aerial in conjunction with three valves in daylight. I do not know a word of Russian, and all my reports are in English.

The amateur transmitter may reply "via the ether" when necessary and know that his reports have "got there," but we who are not amongst the lucky ones must play a patient game and plod along doing our best in our own small way. Let the English-speaking experimenters awaken to the fact that many of us amateurs are without transmitting gear, not because we lack enthusiasm, knowledge or initiative, but for other divers insurmountable reasons. When reports are wanted common courtesy demands an acknowledgment of receipt. Realisation of these facts will bear fruit by bringing information galore to those who require it.

I enclose tabulated details of my reception of NKF on various dates. The transmissions on 71 metres are always of good strength and need no comment, as they can be received at any time during the night and for long after complete daylight in the mornings.—Yours faithfully,

PAUL MARSHALL.

Dublin.

SHORT-WAVE SIGNALS FROM NKF.

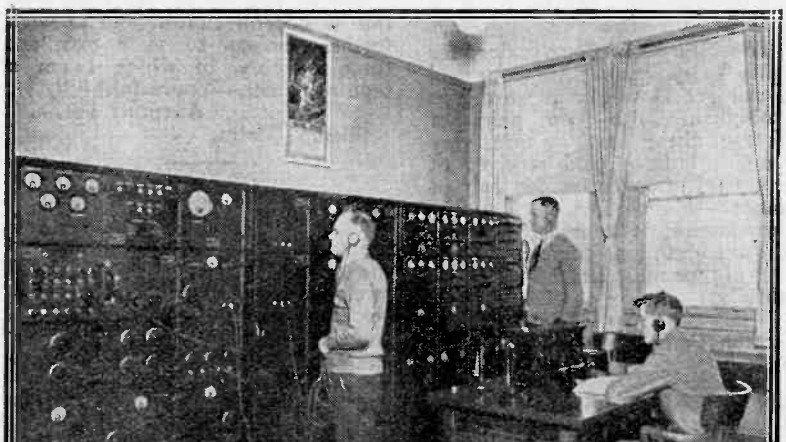
Date.	Time, G.M.T.	Wave-length.	Nature of transmission.	Strength of signals.	"Fading."	Remarks.
19/3/25	0200	41 m.	4 DU U NKF	R3-4	Slow "fading"	—
1/4/25	1745	20.8 m.	5 LF U NKF (clearing traffic)	R5-6	No "fading"	—
28/7/25	0100	41 m.	WNP de NKF (Copies of messages are in my possession)	R5	Slow "fading"	No reply heard from WNP as about 10 amateurs in U.S. were calling him and "jamming" was bad.
16/8/25	0110	20.8 m.	WAP U NKF (giving WAP "K")	R7.9	Irregular "fading"	Signals generally unsteady and tending to wobble. Unusual for NKF.

Details of Mr. Paul Marshall's recent reception from NKF on various wavelengths.

A PORTABLE RECEIVER IN CORNWALL

From Earl Russell.

SIR,—Your readers may be interested in my experience in Cornwall with a three-valve (O-V-2) travelling set. The aerial was 100 ft. of electron wire, and its height above the ground was only 8 ft., and not more than 80 ft. of it was effectually in use. My earth was a connection on a water-pipe, but merely a loose rubbing one, and my position was almost at Land's End. I received 5XX regularly and steadily at about R5, but could not get either Bournemouth or Cardiff sufficiently loud to identify them, only catching a word here and there. The results were, of course, poor, but in view of the supposed badness of Cornwall for reception, the very poor aerial I was using, and the faulty contacts of my coil-holders, I thought they might be worth while recording. Since the set returned home, having travelled 600 miles in a motor-car, it has been receiving 5XX at full loud-speaker strength, having suffered no damage by the journey. I am quite clear that with a proper aerial I could have received Bournemouth at about R4.—Yours faithfully, RUSSELL.



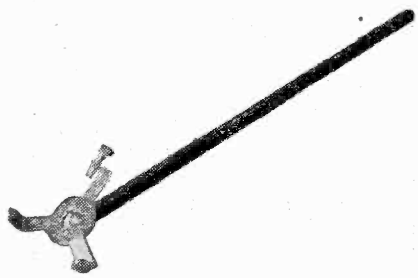
In the control room of the General Electric Company's station KGO at Oaklands, California. The operator on the right is listening on 600 metres for distress signals at sea.

Apparatus we have tested

Conducted by A. D. COWPER, M.Sc., Staff Editor.

An Anti-Capacity Handle.

A useful anti-capacity handle, suitable for applying to any knob of the standard type and readily moved from one tuning-point to another, is that sent to us for comment by Messrs. Burwood Electrical Supplies Company (1924). This is an insulated handle some 6½ ins. long, and at the end of this a metal star fitting with hooked ends and a set-screw for applying to the common pattern of 1½-in. diameter ebonite knob. On trial it was found to fit securely on the standard knob for fine adjustment of a tuning condenser or variometer, and it could be applied or removed in a couple of seconds. The long handle facilitated fine tuning up to the point determined by the shake in the control spindle, and practically eliminated the risk of hand-capacity effects. For application to an existing receiver, where provision has not been already made for fine tuning, this accessory can be recommended.



The "anti-capacity" handle supplied by Messrs. Burwood Electrical Supplies.

H.T. and L.T. Supply Unit

The claims for the Dynamergy Mains Supply Unit, which has been submitted for test by Messrs. Dynamergy Mains Supply, of Teddington, are that it enables both H.T. and L.T. batteries to be dispensed with where D.C. house mains are available. A maximum L.T. current of .5 amps. is supplied, while the model submitted for test gave a single H.T. supply of 80 volts. The L.T. current is provided by means of a suitable resistance, such as a lamp, being placed in series with the mains, and in series with this is a special cell, the terminals of which go to the L.T. terminals on the unit. No acid is used with it, distilled water only being needed with which to fill it up from time to time.

The complete H.T. & L.T. Supply Unit.

The H.T. supply is obtained by means of a form of potential divider and will supply sufficient current to work a multi-valve set. Chokes and condensers assist in eliminating any hum and reducing current variations.

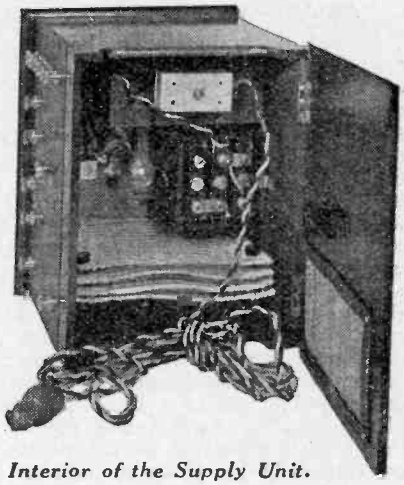
The unit was used with a four-valve set, 2 H.F., detector and 1 L.F., headphones being worn so that any hum present would easily be detected. Three .06 and one .12 ampere valves were used in the set, taking a total current of .4 amps., which is well within the capacity of the instrument. The unit was found to be exceedingly silent in operation, the amount of hum noticeable being no more than that usually experienced owing to induction from the house mains. Since the unit is designed for 3-volt valves, such as those in use, filament resistances are not really required and, further, whether one or four valves (or more if the .06 type are in use throughout) are employed, each will burn at the correct temperature, so that if three of four valves are turned off, no difference in the brilliance of the remaining valve can be detected.

80 volts is, of course, a little high to use on H.F. as well as detector and L.F., and a certain amount of reaction backlash was noticed. It is understood, however, that another model giving three H.T. voltages is available.

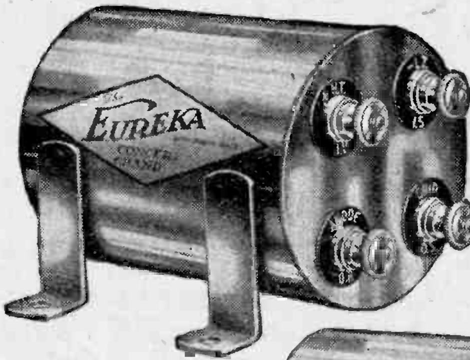
Terminals are provided on the unit to which the aerial and earth leads are affixed, two other terminals being connected to the aerial and earth terminals of the set. This protects the mains from accidentally being earthed and so blowing a main fuse and perhaps damaging valves. The output may similarly be connected to special terminals so as to isolate the 'phones from the H.T. supply proper, thus obviating any possible risk of shock to the user.

This unit was also tried on a three-valve set, using Wuncell valves, which take from .18 to .2 amps. each, and it was found to give sufficient current to run these, notwithstanding that it was slightly in excess of the rated output. Altogether the unit can be recommended as being quiet in action and delivering its rated current, while the fullest protection against any possible damage to valves or house wiring is provided.

C. P. A.



Interior of the Supply Unit.



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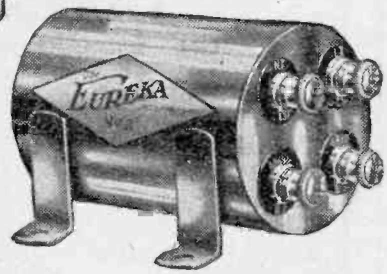

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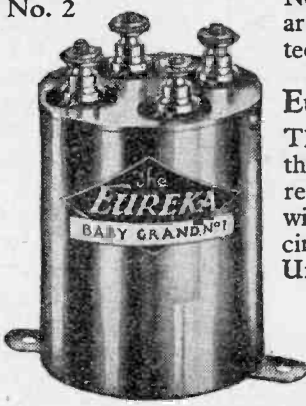

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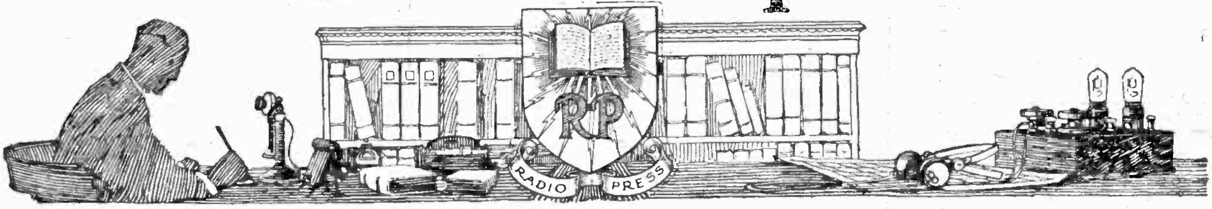
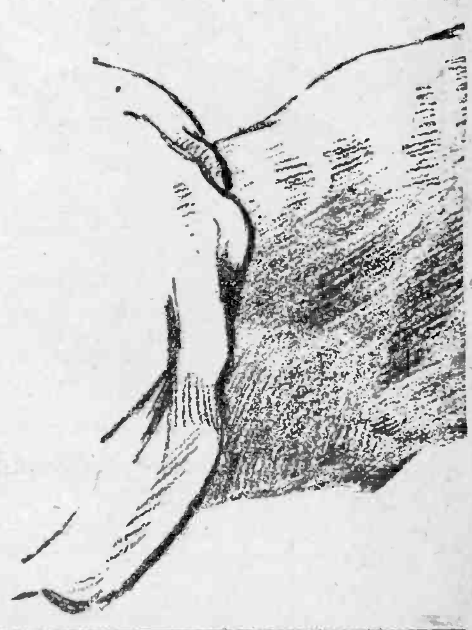


E. A. H. (NOTTINGHAM) has been experimenting with various sizes of condensers connected in parallel with his loud speaker for "tone control" purposes, and asks us for an explanation as to the manner in which they alter the quality of the received signals.

The theoretical reason for the quality being changed when a condenser is placed across the loud-speaker winding is fairly evident when certain underlying principles are grasped. The impedance offered by an inductance increases with frequency whilst that of the condenser varies inversely; that is, the higher the frequency the lower will be the impedance of the latter. It follows therefore that where the high notes tend to be accentuated this tendency may be counteracted if a condenser of suitable value is placed in parallel with the loud-speaker windings, due to the fact that the higher musical frequencies will then tend to pass through the condenser and not affect the loud-speaker. By this means apparently more uniform reproduction is obtained. The value of the tone control condenser will generally be found to lie between .001 μF and .01 μF. The greater the value of this condenser the more "mellow" will be the tone, until a point is reached where this becomes "woolly" and "fluffy" in nature, which is as much to be avoided as the over-emphasis of the higher frequencies, resulting in "tinniness." In some cases no "tone control" condenser is necessary, whilst in others one even above .01 μF will improve quality.

D. A. V. (SWANSEA) has constructed the Single-Valve Reflex receiver described in Radio Press Envelope No. 8, and states that the crystal detector is to all intents and purposes a "passenger," since he can lift the catswhisker from the crystal and still receive signals.

With Reflex receivers employing crystal rectification the trouble our correspondent is experiencing is by no means unusual, and in extreme cases it may often be found that the set will not work satisfactorily unless the catswhisker is raised. All that is wrong is that the dual valve is working on the part of its characteristic curve which gives rise to rectification effects, instead of working on the correct straight portion for amplification at high and low frequencies. Increasing the applied high tension and very carefully adjusting grid bias will almost always remedy this trouble. When doing this it is necessary to make certain that a sensitive spot has been found on the crystal.



JOHN SCOTT-TAGGART, M.C.,
F.Inst.P., A.M.I.E.E.
(Editor-in-Chief of all Radio Press Publications.)

"WIRE

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(A New ST.100 Receiver.)
Major James Robinson, D.Sc., Ph.D., F.Inst.P.
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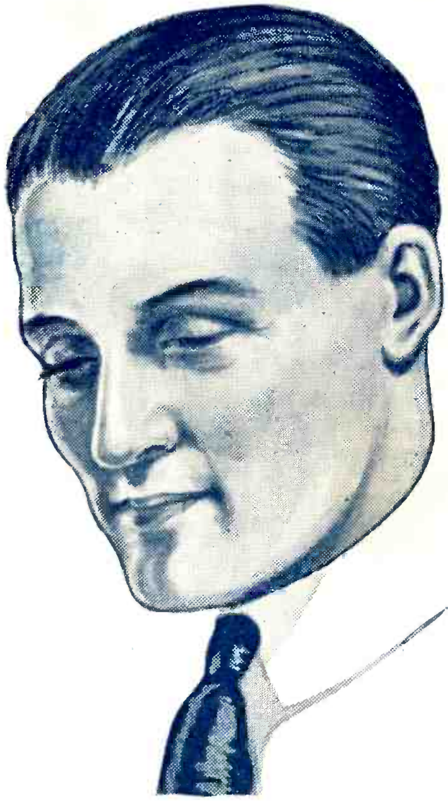

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- „ **The "America Three" Receiver.** By Stanley G. Rattee, M.I.R.E.
- „ **A Single Valve Reflex Set.** By A. Johnson-Randall.
- „ **A Simple Crystal Receiver.** By D. J. S. Hartt, B.Sc.

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Wireless Weekly, 6d. Net. Wednesday September 9th, 1925

Wireless Weekly

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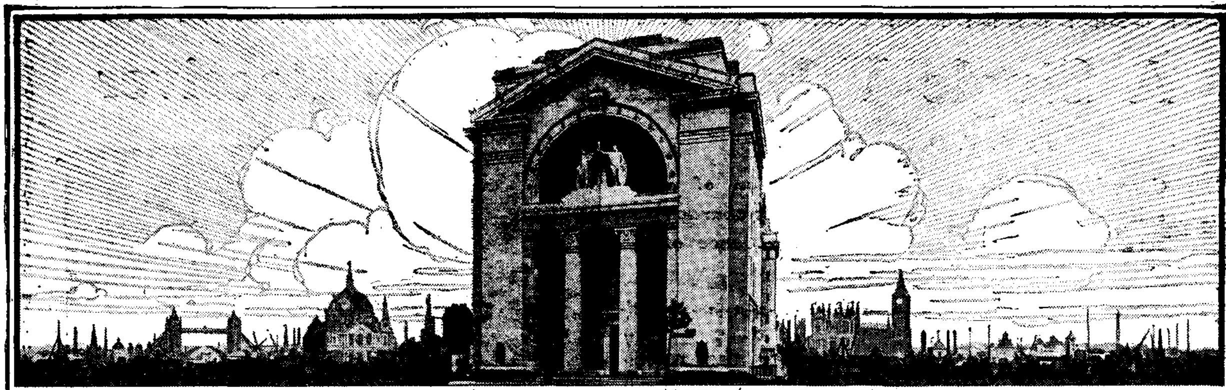

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Wireless Weekly
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The Lessons of the Wavelength Tests

PROBABLY the main impression gained by those experimenters who sat up on recent nights to listen to the first international wavelength experiments which are reported upon in full on another page, will have been to the effect that they had never before realised how extremely bad, from the point of view of the long-distance enthusiast, are the conditions normally obtaining.

To many it must have come as something of a revelation to find that with the stations spaced out as they have been during the later tests, the ease of tuning from station to station, both home and foreign, was such as most experimenters only dream of. Although the carrier waves of certain stations did actually combine to produce heterodyne whistles, there was actually far less of this trouble than occurs with the usual arrangement of wavelengths, and the great majority of the stations were all separated by such frequency differences as ensured freedom from interference in receivers of normal selectivity. The result, as many listeners have reported, was that numerous stations which are normally entirely outside the scope of a given set, were heard at good strength (in this connection it should not be forgotten that all stations were employing the maximum available power).

One of the first lessons to be derived from these tests would seem to be that a complete redistribution of frequencies is actually overdue, and all possible support should be given to the organisation at Geneva in carrying out and enforcing such redistributions as it finds necessary.

Next, one cannot fail to realise that the tests show that even with the present number of broadcasting stations in operation in Europe, an extension of the broadcast band to something approximating to 1,500 to nearly 500 kilocycles (roughly 200 to 600 metres) is likely to be required, and designers of sets must realise this and make provision for covering such a range.

Another obvious lesson to be derived from these experiments is to be found in the fact that the re-allocation must necessarily be worked out in terms of kilocycle separation, and when we presently find that the stations are being allotted new frequencies, with some system of equal separation, the arguments in favour of working in terms of kilocycles, and the use of straight-line frequency condensers, will be greatly strengthened.

CONTENTS.

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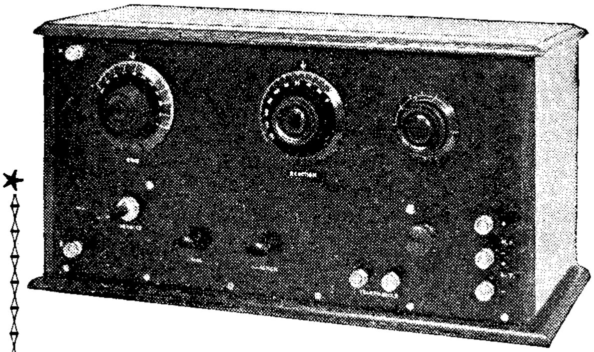
A Single Valve Short-Wave Receiver

By A. V. D. HORT, B.A.

Complete details for the construction of a sensitive short-wave receiver, which is characterised by ease of operation and absence of hand capacity effects.



The valve and coils are enclosed in the cabinet.

MANY receivers and circuits for the reception of short wave signals have already been published, and the set to be described here makes no claim to novelty of circuit, but it incorporates several novel constructional features which may appeal to the experimenter.

It will be noted that the cabinet is of unusual size for a single valve set; it is not, however, intended that L.F. amplifying valves be added inside the cabinet; if desired they may be attached as separate units. Special attention has been paid to the elimination of hand-capacity effects, the whole of the vertical panel being covered with an earthed sheet of copper foil. A special type of plug-in coil-holder designed by the writer for low-loss coils is used, different coil sizes being inserted to cover the band of wavelengths from about 20 to 120 metres (14,991 to 2,499 kc.), and this is placed inside the cabinet so as to bring the earthed screen between the coils and the operator; the space required for movement of the coils accounts in large measure for the dimensions of the cabinet.

Circuit

Reference to the circuit diagram, Fig. 1, will show that a type of circuit akin to the "Reinartz" is employed. The untuned aerial coil L1 and the reaction coil L3 are both variably coupled to the grid coil L2. In practice L3 is set to the position of optimum coupling necessary to provide oscillation over the whole band covered by the grid coil in use as L2, rough control over oscillation being provided by varying the coupling between L1 and L2; bringing these coils closer together introduces damping into L2, preventing oscillation, while loosening the coupling, produces the opposite effect. The reaction variable condenser, C1, provides the requisite fine control over oscillation for the reception of faint signals. L4 is a radio frequency choke coil, in this case a No. 150 or 200 plug-in coil of good make and low self-capacity. As will be apparent from the photographs, the layout of the controls on the front panel is made as symmetrical as possible, consistent with careful disposition of the parts from the point of view of efficiency.

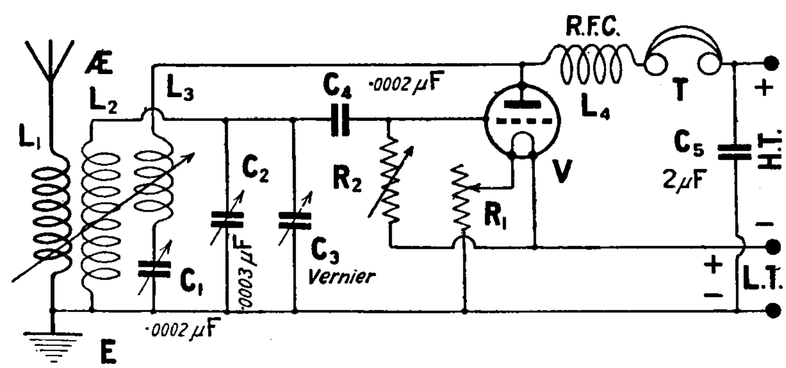


Fig. 1.—The circuit diagram is of a type often used for short-wave reception.

Components

The following list of the components actually used is given for general guidance. Whether the actual makes specified are employed or not, it should be emphasised that only components of the highest quality can be expected to give satisfactory service in a receiver of this type:

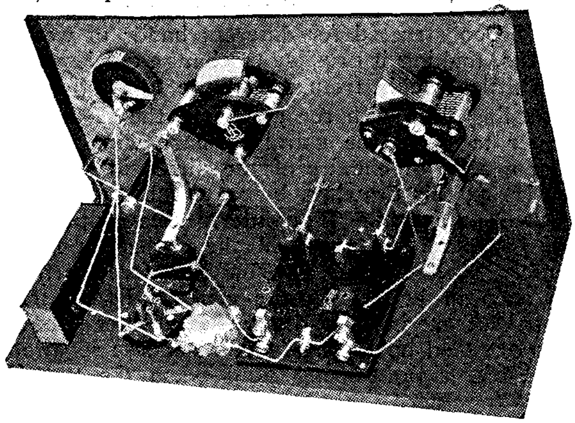
- 1 .0003 μF variable condenser, square-law pattern (Collinson Precision Screw Co.).
- 1 .0002 μF variable condenser, square-law (J.B.).
- 1 .0002 μF fixed condenser, air dielectric (Ormond).
- 1 variable grid leak (Bretwood).
- 1 micrometer condenser (Radio Communication Co., Ltd.).
- 1 2μF fixed condenser (Mansbridge type).
- 1 dual filament rheostat (L. McMichael, Ltd.).
- 1 "Anti-pong" valve-holder (Bowyer-Lowe Co., Ltd.).
- 1 coil plug for panel mounting.
- 7 terminals.
- 2 coil-mounting plugs.
- 8 ebonite panel bushes and 5 ebonite washers.
- Sheet of copper foil—15 by 8 inches.
- 25 ft. No. 16 s.w.g. bare copper wire.
- 1 low-loss coil-holder (Burne-Jones).
- "All-concert" size cabinet, with ebonised ply-wood panel, 16 inches × 8 inches, and baseboard (Carrington Manfg. Co., Ltd.).

2 angle brackets for securing panel to baseboard.

Radio Press panel transfers.

The remainder of the parts required, such as small ebonite strips, etc., will probably be already to hand.

Turning now to the actual construction of the set, the panel should first of all be marked out



After this photograph of the back of the panel was taken, it was found necessary to cut the copper screen well away from the insulating bush of the aerial terminal as shown in Fig. 3.

and drilled in accordance with the drilling diagram, Fig. 5. A wood panel is used, since the sheet of metal with which the back of the panel is covered nullifies any advantage gained by the employment of ebonite. The next step is to fix the copper foil to the back of the panel. Fine woodscrews, ¼ inch long, with flat washers under their heads, secure the foil along the top edge of the panel, and similar screws are inserted down the ends of the sheet, the panel being left uncovered for ½ inch at each end; the lower edge is clamped between the panel and the baseboard. When the foil has been attached at the top and ends, holes should be cut in it with a sharp-pointed knife to correspond with the holes already drilled in the panel; note that at the holes marked X, Y and Z in Fig. 3 the metal is to be cut away well round the holes, as at these points it is essential to avoid contact between earth and the components concerned. The panel may now be fixed to the baseboard by means of screws along its lower edge; two brass angle-brackets are added to give it additional support, and it is then ready for the mounting of the components.

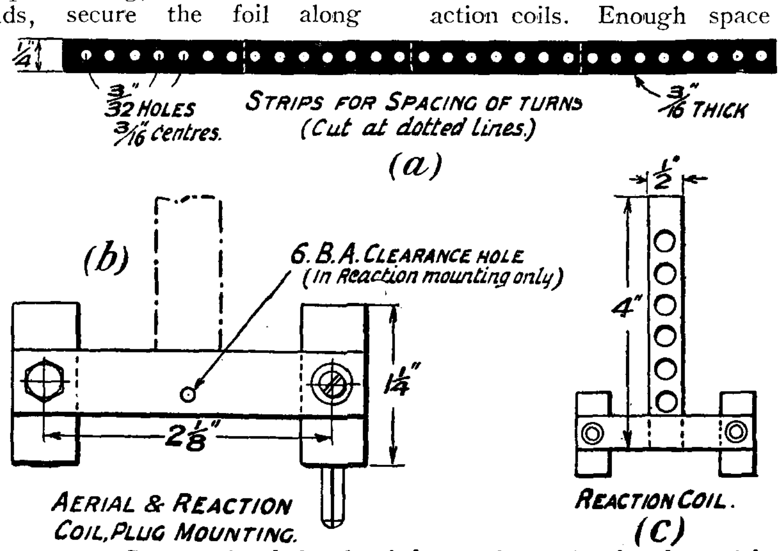


Fig. 2.—Constructional details of the spacing strips for the aerial coil, and of the method of mounting the aerial and reaction coils.

Mounting the Components

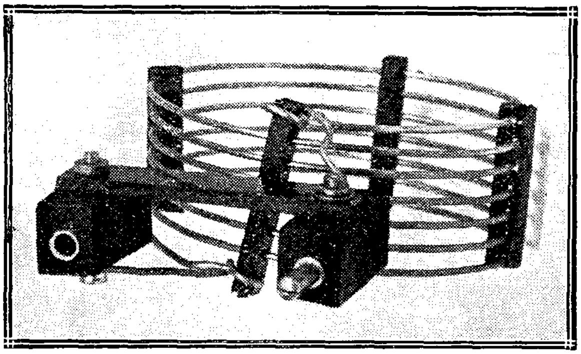
The terminals should be fitted first; all of these are to have ebonite bushes to hold them from the surface of the panel; five of them have ebonite washers at the back of the panel, to insulate them from the earthed screen; the remaining two, the earth and L.T. negative terminals, are equipped with metal washers, in order to provide a good contact with the screen. The mounting of the variable condensers, including the separate vernier, calls for no special comment. In fixing the variable grid-leak in position, an ebonite bush is inserted to insulate it from the panel surface, and a thin mica or ebonite washer is placed behind the panel to keep the soldering tag away from the earthed screen; this end of the leak is to be connected to the positive side of the L.T. battery, so that it must be insulated from earth, to which the negative is connected. To ensure that there shall be no "local noises" in the set due to bad contacts at these points, short lengths of No. 16 s.w.g. bare wire are led from the spindles of the three variable condensers and the filament rheostat and soldered to the metal screen. It is advisable to carry out this operation before proceeding further, as it may be difficult to reach the required points when the rest of the components are in position.

The next step is to fix the coil-holder, grid condenser, coil plug, valve-holder and large fixed condenser to the baseboard, preferably in the order named. Care must be taken to mount the coil-holder accurately in the position shown, as otherwise there may not be sufficient room to allow of free movement of the aerial and reaction coils. Enough space is left to permit of the aerial coil being set to a position at right angles to the grid coil.

The 2 μF fixed condenser is held down to the baseboard by a thin brass or copper strip and two screws; rigid connections from its soldering tags to the terminals on the panel help to keep it secure. The grid condenser is of the air dielectric pattern, since the writer found that this seemed to give slightly better results than the usual mica dielectric type.

Construction of the Coils

We now come to the construction of the coils; these at first sight may appear somewhat complicated, but if the instructions given, together with the photographs and diagrams, are carefully followed, no difficulty should be experienced in building them. Constructional details are given for making one set of coil sizes only, those for use on wavelengths from about 40 to 85



A view of the aerial coil showing clearly the method of securing the ends of the winding.

metres (7,496 to 3,527 kc.), but when one set of coils has been constructed it will be found a simple matter to make coils on similar lines, with more or less turns as required.

The standard form of plug-in coil-holder is adapted to the needs of this receiver, retaining some of the advantages of this style of coil mounting, while aiming at reducing the disadvantages due to self-capacity and dielectric losses. It is not intended that the coils used in one position in the holder should be interchangeable with those in other positions; but different sizes of coils of each of the three types described may be constructed for different bands of wavelengths, making it possible to change quickly and with little trouble from one range to another.

Dealing first with the grid coil, the X-shaped former to carry the spiral of bare wire is cut from a strip of ebonite of the dimensions given in Fig. 4; this drawing, being to full scale, may be used as a drilling template for the strips. It will be found best to drill the holes and to number each " leg " as shown before cutting the strip in half down the centre. Each strip has a slot cut in it at the point indicated; these slots are filed up to be of the exact size required to ensure a tight-fitting joint when the " X " is put together.

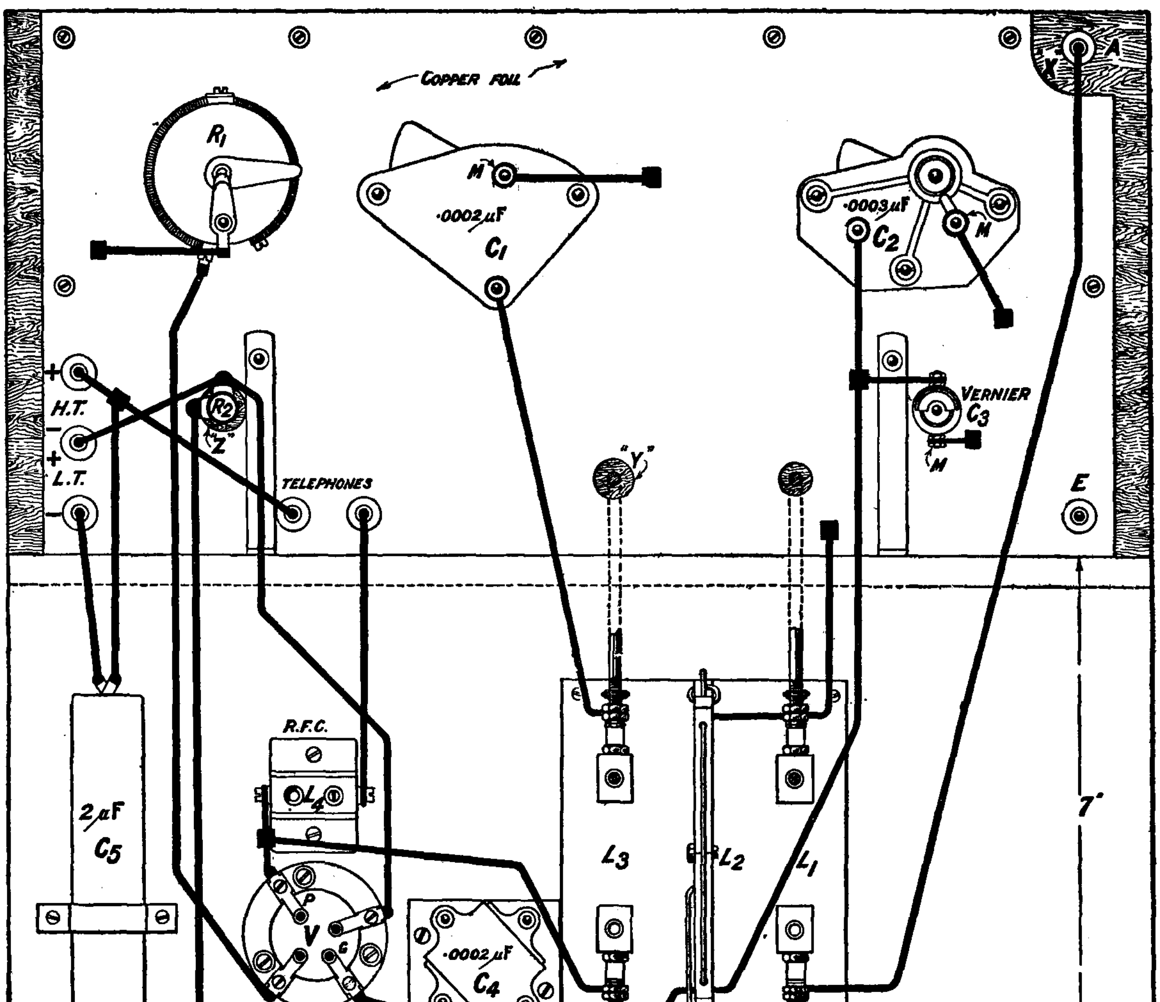
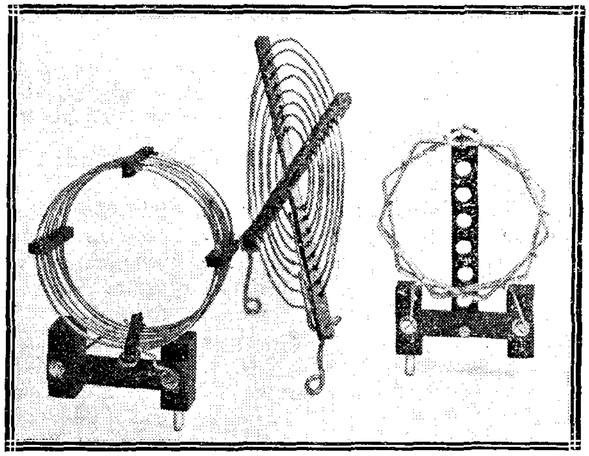


Fig. 3.—Note that the copper foil screen is cut away at the points marked X, Y, and Z on this wiring diagram.

A hole is drilled through the centre of the joint when the strips have been fitted together, and a 6 B.A. bolt and nut inserted to clamp them rigidly in position: it should be noted that, when the former is correctly assembled, the numbers 1, 2, 3, 4 run in order round the legs of the cross. A length of about 10 ft. of the bare copper wire is now thoroughly stretched to remove any bends and kinks, and 19 turns are wound on any convenient cylindrical former about $1\frac{1}{2}$ inch in diameter, the resulting solenoid being slipped off the former when wound. Now holding the "X" former with No. 1 leg at the top and No. 2 to the right, push one end of the solenoid of wire through the innermost hole of No. 1, pass on clockwise through the corresponding hole in No. 2, and so on round and round the former till the outermost hole of No. 4 is reached (not including, of course, the larger hole at the extremity of No. 4 leg).

Care Required in Winding

The wire must be carefully eased round through the holes without forcing it, or the former may be broken; the easiest method is to push an inch or so of wire at a time through the hole in No. 1 leg where the wire enters the former, and ease this right round to the outer end before pushing up another inch from the centre. A few inches of wire should be left over at each end of the winding, to be joined to the supports which connect the ends of the coil to the terminals of the holder. For these, two 3-in. lengths of No. 12 S.W.G. copper wire are needed; push the end of one of these lengths through the large hole at the extremity of No. 1 leg of the former, and carefully, so as not to break the ebonite, bend it completely round the leg; the other end is cut off to a length of $1\frac{1}{2}$ in. from the leg and a loop formed at the end to fit over the 4 B.A. terminal on the coil-holder. When both supports have been made in this manner, the ends of the winding are soldered to them; the inner end passes down No. 1 leg of the former to the support. This completes the grid coil.



These three types of coils, reading from left to right, are used for the aerial, grid, and anode circuits respectively.

For the aerial coil the necessary parts are 6 ft. of No. 16 S.W.G. bare copper wire, one coil-plug, one strip of ebonite $3\frac{1}{2}$ in. × $\frac{1}{2}$ in. × $\frac{1}{8}$ in., and another strip $5\frac{1}{2}$ in. × $\frac{1}{4}$ in. × $\frac{3}{16}$ in. The coil-plug is cut in half between the pin and socket; two 6 B.A. clearance holes exactly $2\frac{1}{8}$ in. apart are drilled in the $\frac{1}{8}$-in. piece of ebonite; in the other strip 29 holes are drilled $\frac{3}{16}$ in. apart throughout its length, and it is then cut up into shorter lengths, 3 of these containing 7 holes and the fourth 8. On any convenient cylindrical former $2\frac{1}{2}$ in. in diameter, 8 turns of the No. 16 S.W.G. wire

(*Concluded on page* 757.)

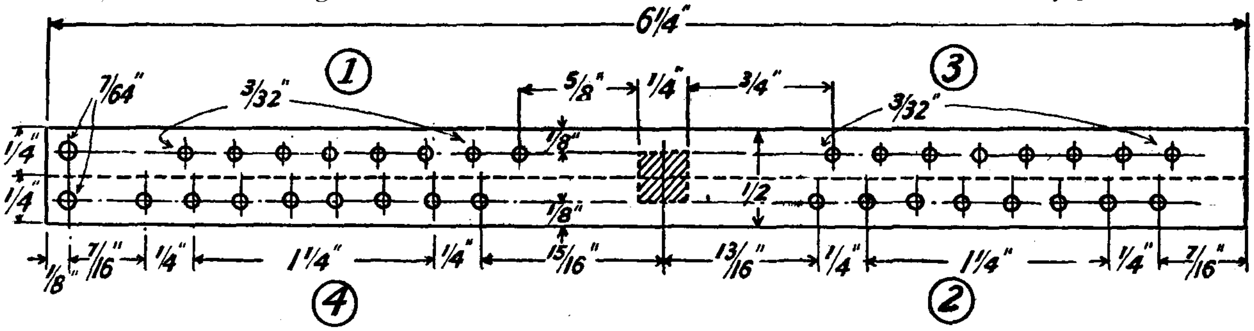


Fig. 4.—This drawing, being to full scale, may be used as a template for marking out the X-shaped former for the grid coil.

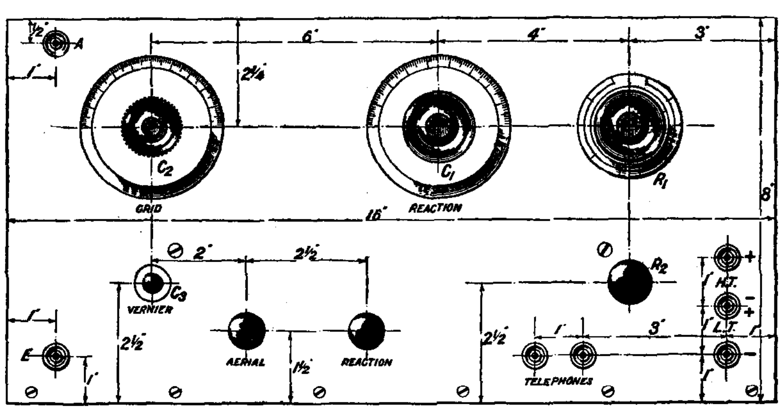


Fig. 5.—Drilling dimensions for mounting the components may be taken from this drawing of the front of the panel.

ADVANCE GUIDE TO THE N.A.R.M.A.T. WIRELESS EXHIBITION

A brief résumé of some of the exhibits of special merit in the exhibition organised by the National Association of Radio Manufacturers and Traders which opens on September 12. A more complete description will be published in our next issue.

SEPTEMBER 12 will mark the opening of the annual exhibition of the N.A.R.M.A.T. at the Royal Albert Hall, London, where several totally new components and accessories will be on view. Among the most outstanding of these will be a new and complete range of valves, which are being exhibited by Messrs. Burndept Wireless, Ltd., on Stands 11 and 12 (Boxes 74 and 75). These include both bright and dull emitters.

On Stand No. 1 (Boxes 59 and 60) the British Thomson-Houston Co. will be exhibiting, among an extensive range of their productions, a portable receiver on the super-heterodyne principle. An interesting feature of this set is that only three valves are used.

Messrs. Autoveyors, Ltd., are occupying Boxes 47 and 76, and one of their main exhibits will be their new model of the well-known three-electrode bridge condenser. This has been improved in such a manner that it now possesses only one control knob, all the moving vanes being mounted on one spindle. One-hole fixing is also incorporated.

A special three-valve receiver, using the reflex principle, will be exhibited by Messrs. Metro-Vick Supplies, Ltd., who are occupying Stand 8. Smith & Sons (M.A.), Ltd., are showing their anode converters, one model of which has been specially designed for use with resistance-coupled amplifiers.

The well-known "Polar Blok" sets, produced by the Radio Communication Co., Ltd., will be shown on Stand 5 (Box 67). There are now five separate models of this type of receiver, which is built up of component sections, which considerably facilitate construction. Two new types of variable condensers will be exhibited on Messrs. Falk Stadelmann's stand. One of these uses a very novel arrangement whereby during the first 180 deg. rotation of the moving vanes the condenser is in series with the aerial coil, whilst during the second 180 deg. rotation it is in parallel with the aerial coil.

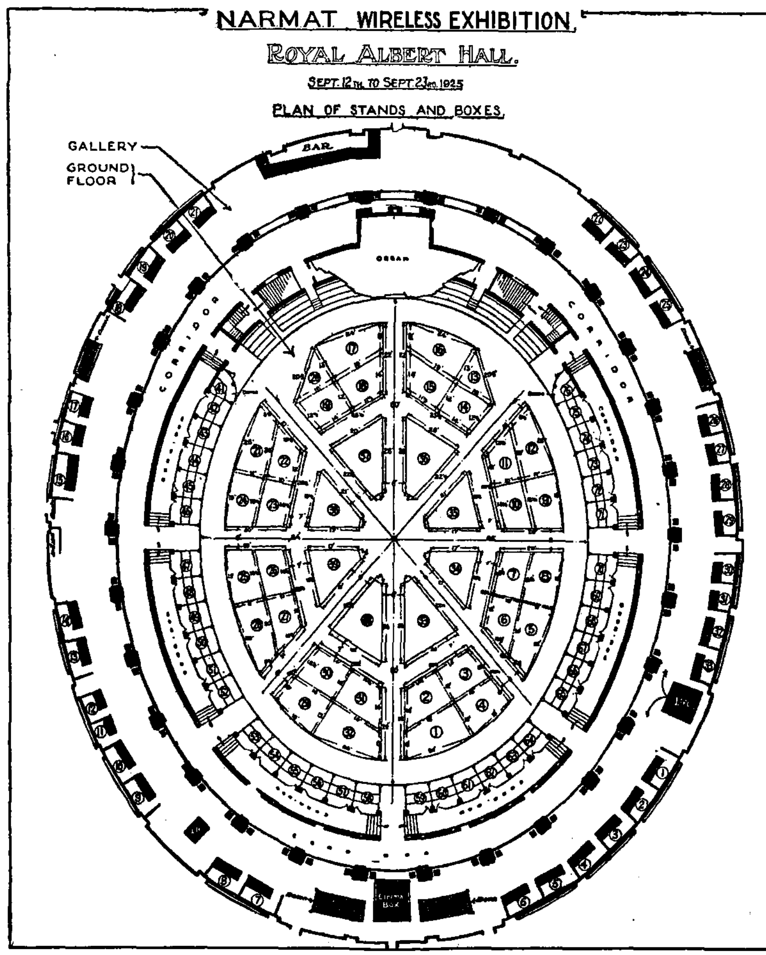
Interest is sure to be attracted at Stands Nos. 30 and 31, where the Marconiphone Co. and Sterling Telephone Co. are exhibiting co-jointly. As well as the magnificent cabinet multivalve receivers exhibited here, a new two-valve receiver (type 21) will be displayed.

The well-known Primax hornless loud-speaker will have a junior companion in the Mellowvox, produced by Messrs. Sterling Telephone Co. In regard to this latter, a very pleasing appearance has been achieved by the colour and design used on the diaphragm.

A complete range of Amplion loud-speakers will be seen on Stand No. 40, which is occupied by Messrs. A. Graham & Co.

The man who uses power

(*Concluded on page 743.*)



A plan of the Albert Hall showing the position of the stands numbered in accordance with those given in the text. Boxes 51 and 52 are to be occupied by Radio Press, Ltd., and No. 73 by "The Wireless Dealer," the new monthly trade periodical, the first number of which will be published by Radio Press on September 12.

Some Properties of Insulators

By E. H. W. BANNER, M.Sc., A.M.I.R.E.

Some interesting facts concerning the most important properties of insulators used in wireless work.

THE study of insulators is most important for radio work, and ordinary considerations of suitable insulators do not always hold with radio frequencies.

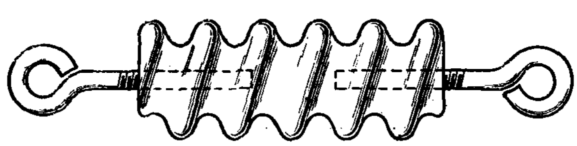
The various classes of insulating materials are as follows:—

Solids.	Natural.	Gums and Resins. Wood. Marble. Slate. Asbestos, etc.
	Manufactured.	Paper. Ebonite. Glass. Moulded Compositions. Porcelain, etc.
	Plastics.	India Rubber. Gutta Percha. Pitch. Waxes, etc.
	Used as such.	Oils.
Liquids.	Solidified on application.	Varnish. Shellac. Paint. Enamel. Japan, etc.
Gases.		Atmospheric air and some other gases.

Desirable Properties

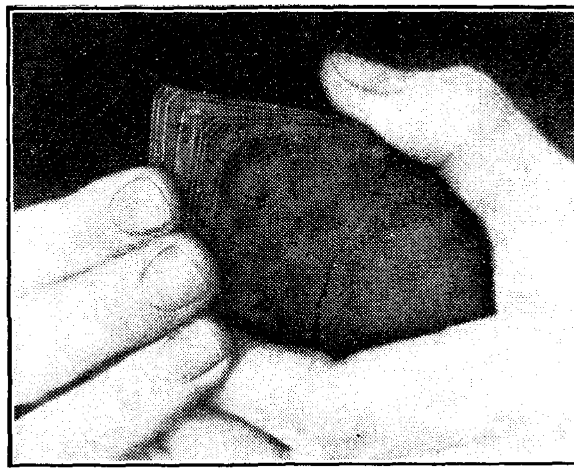
The desirable properties, electrically, are:—

a. High resistivity.
b. Small surface leakage.
c. Great disruptive strength.
d. Low power factor.
e. Low dielectric hysteresis.
f. Low dielectric absorption.
g. Small temperature coefficient of resistance.
h. Low dielectric constant (for high-frequency work).



In an insulator of this type the surface length between the metal bolts is increased by the corrugations of the moulding.

The mechanical properties are obvious, and comprise great strength (tensile, compressive and shearing), non-brittleness, ease of working, etc.



Illustrating how a sheet of mica can be laminated or split into very thin sheets.

Some of the requirements for electrical uses will now be explained.

(a) High Resistivity

Resistivity or specific resistance is the reciprocal of conductance, and so, as high conductance is necessary for the connecting leads, low conductance is required for the insulating materials. This applies to both low and high frequencies.

(b) Small Surface Leakage

In most insulators the resistance of a solid block of the material to current is far higher than the resistance of a surface of the material in contact with air. This is because the surface in contact with air is more or less moist, and attracts dust and other conducting particles from the atmosphere. A satisfactory insulator must therefore have a low surface leakage. The case of moulded insulators is an illustration. The gap between the two metal bolts may be only about half an inch, but the surface length from bolt to bolt is several inches.

The surface resistance is necessarily dependent upon the condition of the air in contact, and is low in humid air and much higher in very dry weather. For both low and high frequencies the surface leakage should be small.

(c) Disruptive Strength

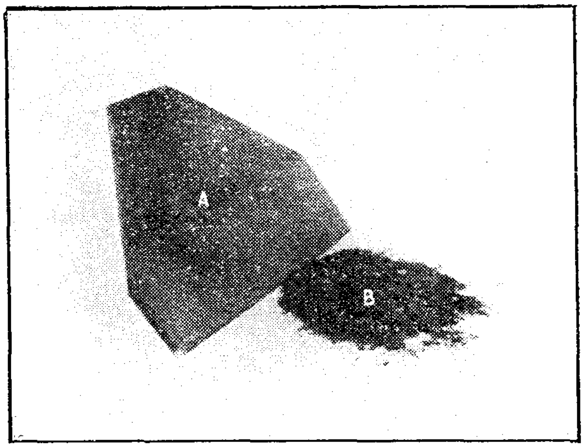
The disruptive strength of a material is its ability to withstand actual physical breakdown caused by electrical means. When a solid insulator has a potential applied to it which is gradually increased, the material will break down at a certain voltage and be either punctured or smashed.

(d) Power Factor

The power factor for a vacuum is zero, and for atmospheric air is negligible. For solids the power factor is not negligible, and as it leads to waste of power it should be as low as possible. This is especially important in condensers for high frequency.

(e) Dielectric Hysteresis

Dielectrics other than air do not acquire their charged condition immediately a potential is applied. The lag of the resultant charge with the applied potential is called dielectric hysteresis, and is similar to magnetic hysteresis in iron. In common with power factor, it is objectionable for high-frequency insulators and condensers.



Specimens of the material used in the manufacture of micanite. A is a sheet of mica and B is flaked shellac.

(f) Dielectric Absorption

A condenser with dry air dielectric is practically perfect, as it has negligible power factor and dielectric hysteresis and a high disruptive strength. Further, when it is discharged the charge is neutralised immediately. With other dielectrics the charge is not all got rid of at once. If the condenser is shorted and then insulated, most of the charge will have been neutralised, but on shorting again after a minute or two another discharge, smaller than the first, will take place. This is due to dielectric absorption, or soaking in of the charge. Similarly, on charging for a long time the condenser will acquire a greater quantity of electricity than if it is charged for an instant only. For air condensers there is negligible absorption.

(g) Temperature Coefficient of Resistance

Most conductors increase their resistance with an increase of temperature. An exception is carbon, which decreases. Thus carbon is said to possess a negative temperature coefficient, while metals have a positive temperature coefficient. As some insulators are organic they are similar to carbon in having a negative coefficient, while others are positive. If a resistance is tested at two different temperatures the resistance found each time will be different, due to this cause.

(h) Dielectric Constant

This used to be called "Specific Inductive Capacity," but as it is not a capacity, but a constant for a given material, the new term is more explanatory. The dielectric constant of free air is considered as unity, and all others are expressed in terms of this. If an air condenser has its air spaces filled with another dielectric the capacity of the condenser will be increased. The ratio of the capacity of the condenser with the material as dielectric to the capacity of the same condenser with air as dielectric, is called the dielectric constant of the material, and will not vary for a given sample of the substance under the same conditions. For insulating work this should be low, as at high frequency a given capacity passes more current than at low frequency. A panel made with a material of dielectric constant of ten will therefore have ten times the stray capacity of one with a material of dielectric constant unity. (Actually, only air and some other gases have values as low as 1.) For dielectrics in condensers the case is different, and the size of a given condenser will be reduced by using a material of high dielectric constant. The material used, must, however, satisfy the conditions in the above list of properties as well, and in general no one substance will satisfy all the conditions.

Some values of the above constants for different materials are now given.

1. Resistivity

		Ohms per cubic centimetre.
Mica ..	.. greater than	8.4×10^{13}
Micanite ..	,,	249.0×10^{13}
Shellac	,,	900.0×10^{13}
Ebonite ..	,,	2800.0×10^{13}
Paraffin Wax ..	,,	3.0×10^{18}
Quartz	,,	1.2×10^{15}
Marble	,,	1.0×10^{9}

These are given as the resistance between opposite faces of a cube of one-centimetre sides. Actually, they are measured with a different size, in which surface leakage is eliminated. Surface leakage is not a constant, and cannot be tabulated.

2. Disruptive Strength

No figures are given for the disruptive strengths of various materials, since these figures seem to vary to a large extent with different samples, particularly for the naturally occurring insulating substances.

3. Power Factor

The power factor is less than 1 per cent. for the following:—

Dry paper, paraffin wax, mica, ebonite, india rubber, and vulcanised india rubber.

It is less than 2 per cent. for glass and gutta percha.

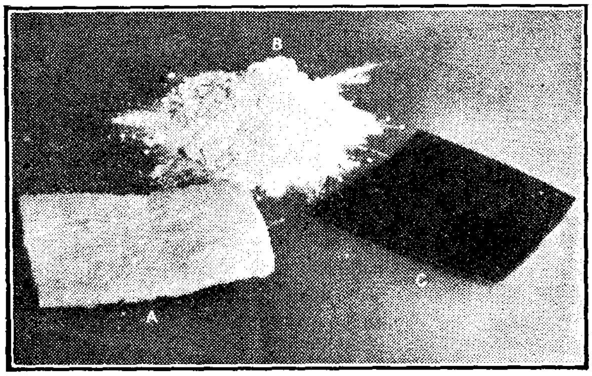
4. Dielectric Constants

Air, dry, at 760 mm. pressure	unity.
Ebonite	2.5— 3.5
Glass, light .. .. to very dense	6.5—10
India Rubber	2.3— 3
Mica	6.6— 8
Paraffin Wax	1.9— 2.5
Porcelain	4.4
Shellac	2.7— 3.7
Quartz	4.5

Some of the insulating substances have been omitted from these lists where serious discrepancies exist between the published figures for the various constants.

Consideration of Some Insulators

Paraffin Wax.—This is one of the best insulators, when it can be used. For research work where the minimum leakage of current is essential, all the insulation is of wax; ebonite and mica are far too low in their resistivities, both volume and surface. Owing to its nature it cannot, of course, be used for panels in wireless work.



The materials used in the manufacture of pure ebonite. A is pure crepe rubber and B is sulphur, and at C is shown a sheet of slightly inferior quality rubber used for a second quality ebonite.

Ebonite.—The best ebonite is a good insulating material, the worst is very bad. It is a hard-rubber composition, and is, in fact, called hard rubber in the U.S.A. As made, it is usually coated with finely-divided tinfoil, which is used in its manufacture.

This gives it a bright, shiny appearance, which is often referred to as "polish." The tinfoil makes its surface conducting, and so if used like this the leakage will be considerable, although the actual insulation through the material may be very high.

Matt and Polished Surfaces

It is often stated that the matt-surface ebonite is the best for insulation. This is not necessarily so, and correctly polished ebonite is usually more satisfactory.

It should be noted that in all high-class electrical instruments the ebonite is invariably polished.

This polished surface must not be confused with the tinfoil surface which is present when the ebonite is bought.

Method of Polishing Ebonite

Commercial ebonite can be polished as follows:—First rub the surface well with glass paper or emery cloth, removing all traces of the original shiny surface. Then rub with very fine emery cloth until the grain is very fine. It should then be rubbed over with a piece of paraffin wax—a candle will do—and then rubbed hard with a dry cloth. The paraffin will be rubbed into the surface and improve the insulation, but its most valuable property is that of resisting moisture.

A panel so treated will be far more satisfactory than one merely ground with emery cloth.

If a polishing bob is available, it may be polished with this, and in this way a high gloss is obtained which is highly resistive to moisture.

Mica and Micanite.—Mica is a natural mineral and has good insulating properties. It is liable to have conducting veins running through it, which somewhat reduce its value.

Mica is difficult to obtain in large sheets, and so for work requiring large pieces micanite is used.

Mica easily laminates, and a piece can usually be split up into laminæ of less than a thousandth of an inch thick.

Construction of Micanite

To make micanite, mica is laminated and the small pieces are stuck together with hot shellac varnish. Whilst the micanite is hot it can be bent into various shapes, and is often made into tubes whilst hot, so that when cold a firm, hard tube of insulating material results.

This process avoids the metallic veins becoming troublesome, as they become separated on lamination.

For wireless work neither is used extensively, excepting mica for condensers.

Wood.—Hard, dry woods may often be used even for wireless work. It is essential to use dry wood, and the hard woods are much more satisfactory than soft.

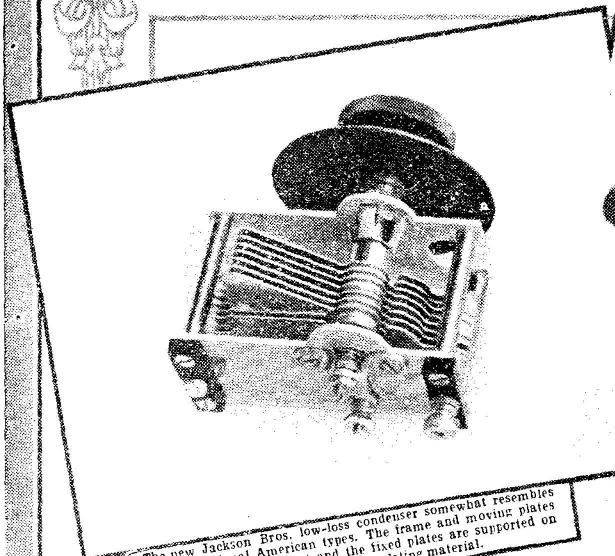
Before use it is best to soak the previously-warmed wood in molten paraffin wax until bubbles cease to rise. The wood, when cold, will then be of high resistance, both volume and surface, and will resist moisture on its surface.

Marble and Slate are used little in wireless work, but in low-tension electrical engineering they are invaluable.

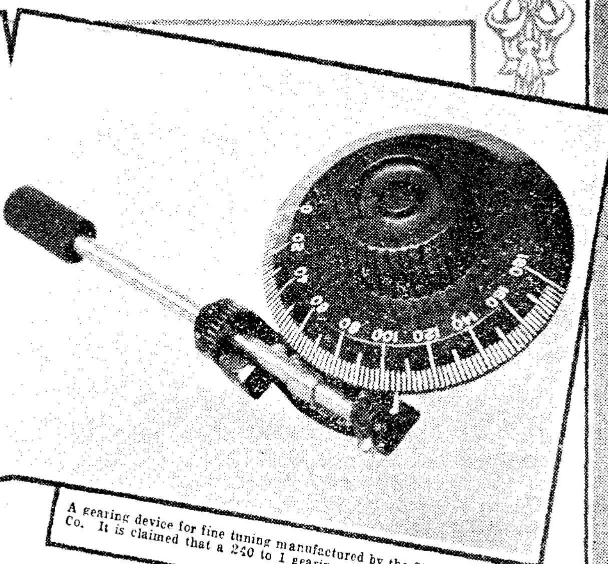

The studio at the Radio-Belge station which is received so well in this country.

To summarise, it is only necessary to point out that for wireless work air is the best insulator, when it can be used, owing to its negligible power factor, hysteresis, etc., and low dielectric constant.

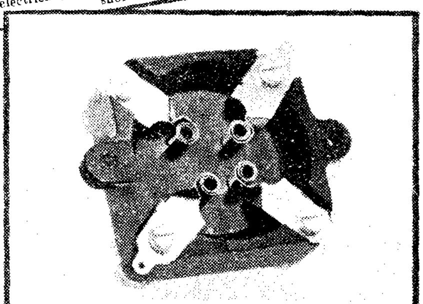
SOME NEW COMPONENTS



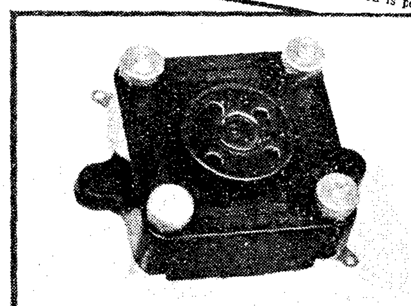
The new Jackson Bros. low-loss condenser somewhat resembles the conventional American types. The frame and moving plates are electrically in contact and the fixed plates are supported on short strips of insulating material.



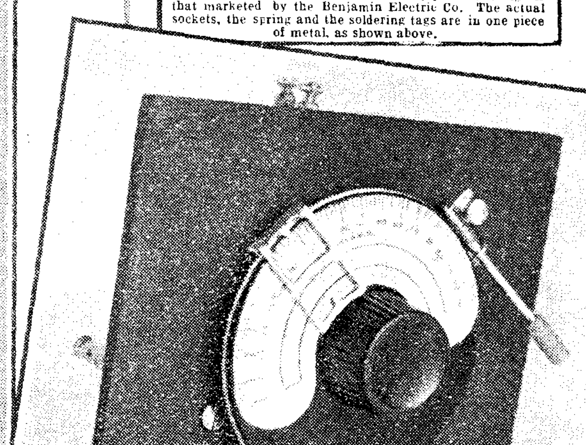
A gearing device for fine tuning manufactured by the Silvertown Co. It is claimed that a 240 to 1 gearing reduction is possible.



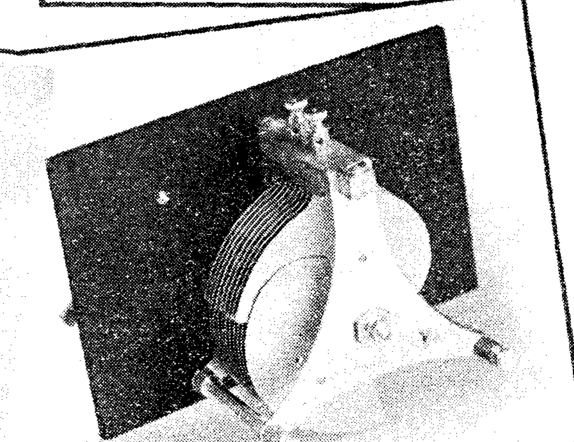
A vibratory type of valve holder of very pleasing design is that marketed by the Benjamin Electric Co. The actual sockets, the spring and the soldering tags are in one piece of metal, as shown above.



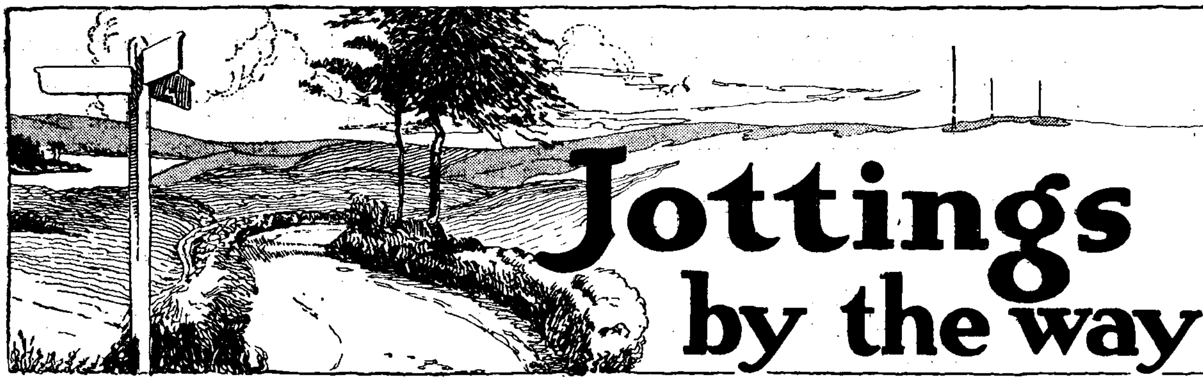
Terminals and soldering tags are provided for connection to the Benjamin valve holders.



The geared dial of the new low-loss condensers manufactured by the Formo Co. A friction device is incorporated and the vernier and ordinary movements are interdependent.



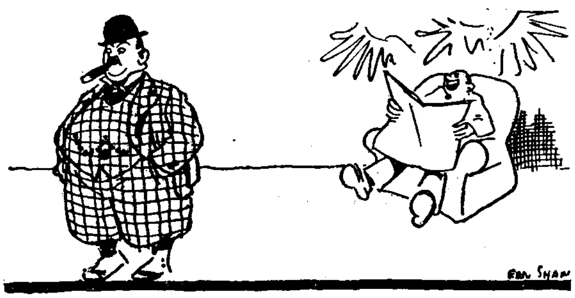
A further view of the Formo low-loss condenser. The plates are made of high percentage copper brass, the fixed plates being supported on a single strip of red insulating material resembling bakelite.



Jottings by the way

All Abroad

I EXPECT that during your trips abroad you have made the acquaintance of that gorgeous collection of unconscious humour, the Visitors' List. It makes its appearance at regular intervals in all Continental resorts. It purports to give a true and exact list of all visitors who are rejoicing the hearts of



. . . *Mr. Simth of Touteing Beque.* . . .

hotel keepers by lending their patronage to the establishments in the district.

As the names have to be sent in some days before the thing goes to press, and as it appears, as a rule, only every ten days or so, what it actually does serve up is a kind of hash of the names of those who *were* staying in the place some time before, but have since passed on to other scenes. The hash part of it is the most amusing. People write their names rather hurriedly in the hotel register, and when these have been copied and passed on to the Continental compositor the results are glorious.

Everyone reads the Visitors' List and revels in such wondrous names as The Miss's Crawksoon of Viggon, Mr. Simth, Esqre., of Touteing Beque, and Medecine Doctor Collik of London. One of the best pastimes for a wet day is to endeavour to work out what the English names really were before the printer had his way with them. It has cross words and acrostics beaten to a frazzle.

Soupe and Gobblepie

I was engaged the other day in this fascinating pursuit when suddenly I came across two names amongst the distinguished visitors at the Hôtel Terrifique, the sight of which made me go hot and cold all over. They were:

M. le Professeur Soupe } *Lettle Poodle Town.*
Sir Gobblepie }

Professor Soupe, Sir Gobblepie, Lettle Poodle Town. . . . Was it possible . . .? Could it be . . .? Surely it must be Professor Goop and Poddleby of Little Puddleton. But supposing that it were they, would they not have fled already to other parts?

I rushed to the Concierge and bade him ring up the Terrifique. He got them, and handed the receiver to me. A voice at the other end was pouring forth some foreign tongue at nineteen to the dozen.

"Er...", I said in fluent French.

The voice continued.

"Ah," I expostulated in German.

The flow of words went on.

I shrugged my shoulders in Italian.

Still no result. We linguists, however, never say die. I fired the last shot in my locker.

"Is Professor Goop staying at the hotel?" I asked.

"Yes, saire. I send instantly to fatch 'im," came the reply. And then in a lower voice, as he turned apparently to despatch the searcher:

"Dis donc, espèce d'andouille; va voir si ce vieux maniaque de professeur est à la maison. Y a un Angliche qui le demande." In the matter

. . . *I rushed to the concierge.* . .

of courtesy the foreigner has always been a shining example to us English folk.

We Converse

In a few moments my ears were enchanted by the sound of my beloved Professor's voice. He appeared to be in a state of considerable excitement, and without pausing to inquire who was at the other end of the line poured into the instrument a flood of bitter complaints. So far as I could make out he had allowed a stranger to take his note-case for a walk on the previous day just to show how deeply he trusted him. The stranger was still walking.

"Rotten luck," said I at last.

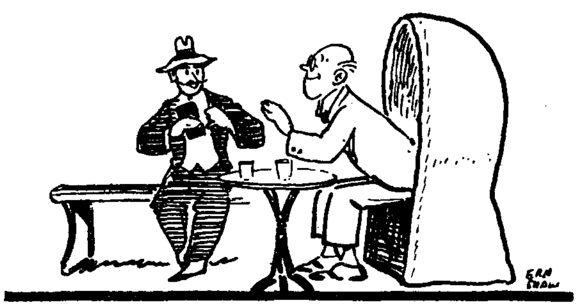
"Who's that?" cried the Professor. "Aren't you the police station?"

I broke the news. "Why, Wayfarer, my dear fellow," he exclaimed, "how splendid. Poddleby and I are here together for a little holiday. Run round as soon as you can to see us. Now that you are here I don't care tuppence about my note-case, for Poddleby still has his."

A Warm Welcome

Arrived at the Terrifique I found Poddleby and the Professor waiting with open arms to receive me. Never have I had so warm a welcome anywhere. At first I put it down to sheer unmixed joy at beholding me once more, but a little later I discovered that several degrees of the warmth were due to the fact that Poddleby's wallet had proved upon examination to contain but a five-franc note and three cigarette pictures which he was treasuring up for the little ones at home. The two were relying upon me—*me,* if you please—to see them through.

Little did they realise that the reason why I had responded so quickly to the Professor's invitation to run round and see them was that my pocket-book was lined at the moment with nothing more substantial than a rather rude letter from my tailor, who has a sordid commercial mind. When I had told them how matters stood a horrid gloom fell over the little company. For some time we sat in silence, and



... Allowed a stranger to take his note case. ...

then Poddleby exhorted us to pull ourselves together and to suggest what should be done.

An Inspiration

I was all for taking Poddleby's five francs to the Casino and staking our whole fortunes upon one throw. But this proposal was vetoed, chiefly because it costs one franc fifty to get into the Casino, and Poddleby said that after the Professor's experience he wasn't going to trust his pocket-book to anyone out of his sight, even if it did contain only five francs. Professor Goop suggested that Poddleby and I might give an acrobatic display in the market place whilst he went round with the hat. Poddleby, however, declined the honour and I felt that without him I should not be at my best.

Then the great idea came to me. "Professor," I cried, "I have it! You must give a lecture on wireless here at the Terrifique."

At first the Professor was a little bit inclined to kick; but after a time we talked him into a proper frame of mind. This done we went all three to interview the manager.

We Click

When I had told him something of the fame of the Professor the manager flung his arms around the great scientist's neck, kissed him

... Kissed him warmly on both cheeks. ...

warmly upon both cheeks, and wept about a quart of joyous tears upon his shoulders. "Splendid! Magnificent! Wonderful!" he cried. "It is choost wat I vant. Ze wezzer he make bad. My guests are embeasted. You, my dear Professor, drop from ze skies!" He undertook to advertise the show, to put the dining-room at our disposal, and to guarantee us what seemed in our impoverished condition like all the francs in the world.

So Near . . . !

I need hardly say that when it was noised abroad that no less a person than Professor Goop was to lecture we were simply snowed under with applications for seats. When the great night came the room was packed like a sardine tin. The Professor chose as his subject the wireless valve, and, after explaining the way in which it does its bit, went on to describe his new process of valve manufacture.

The pip, as he showed by a demonstration with one of the electric lamps, is the weak point in any bulb. So long as you pump air *out* of a bulb you must have a protruding pip. By the new Goop process the vacuum is pumped *into* the bulb, and in the process of sealing the pip is automatically pushed in. The audience rose and cheered itself hoarse.

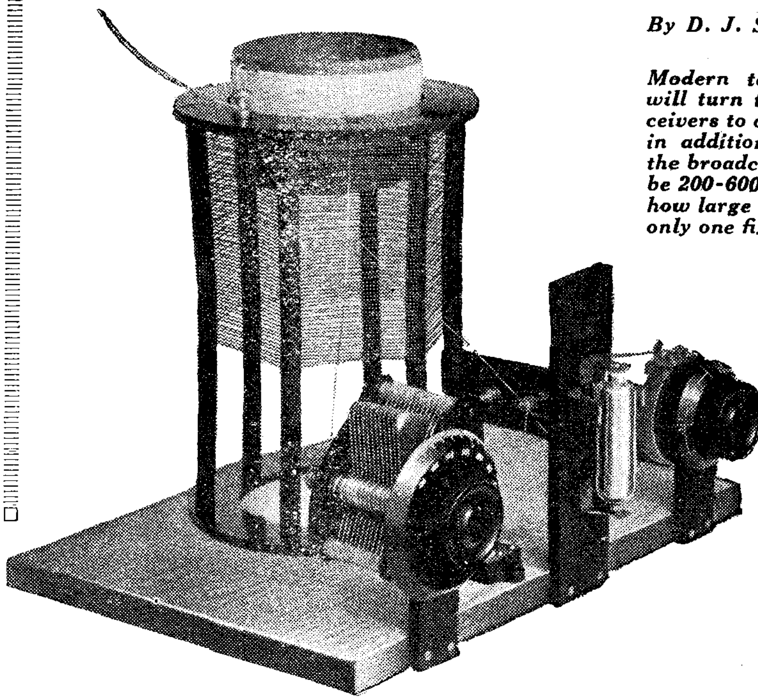
The lecture was a wild success. We were wealthy. . . . We should be still had not the Professor met upon the following morning yet another stranger who begged so urgently to be allowed to demonstrate his trustworthiness that he got away with the entire receipts. Still, there is to be another lecture to-morrow. We are looking forward to a solid meal after it, and meanwhile we have taken up our belts by several holes.

WIRELESS WAYFARER.

Getting the Largest Tuning Range

By D. J. S. HARTT, B.Sc.

Modern tendencies indicate that designers will turn their attention to constructing receivers to operate on the broadcast band only in addition to the "all-wave" sets. Since the broadcast band may now be considered to be 200-600 metres it is interesting to examine how large a tuning range can be covered with only one fixed coil and a variable condenser.



The layout of the single-valve receiver constructed for maximum tuning range.

IN an article in last week's issue I mentioned that at some future date I would give some figures and practical details to show just how large a tuning range it was possible to obtain, using only a fixed coil in conjunction with a variable condenser for tuning.

The factors which determine the extent of the tuning range were discussed at some length in the article, "Are You Restricting Your Tuning Range?" (Vol. 6, No. 20), and it was shown there that in order to secure a large range in a given receiver employing a fixed inductance and a variable condenser it was necessary to comply with certain conditions.

Conditions for Large Range

These are :—

(a) A coil of low self-capacity.
(b) Low wiring and circuit capacities.
(c) Low minimum capacity condenser.
(d) Small effective grid to filament capacity in the valve.

When all these conditions have been satisfied, we still have to employ loose coupling to the aerial to secure the greatest advantage in reducing to a minimum the total stray capacities in parallel with the main tuning condenser.

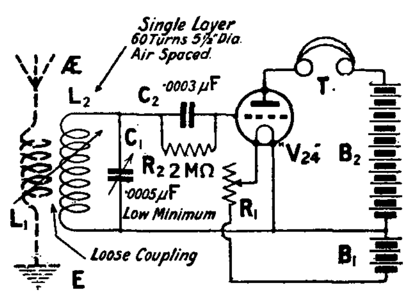


Fig. 1.—The circuit used to determine the order of the maximum tuning range given by a fixed coil and a variable condenser.

Practical Results

The instrument shown in the accompanying photographs was constructed to demonstrate how large a tuning range could be obtained by careful attention to the points outlined above. The figures obtained are certainly remarkable and serve to show how high these casual capacities are in an ordinary receiver where no special pains have been taken to reduce them.

Actual Tuning Ranges

The actual wavelength ranges were measured with an accurately calibrated precision wavemeter and were found to be :—

Loosely coupled to "semi-aperiodic" aerial and earth circuit—

165 metres to 750 metres (1,817 to 399.8 kc.).

Disconnected from aerial and earth—

170 metres to 750 metres (1,764 to 399.8 kc.).

Loose Coupling Lowers Waveband

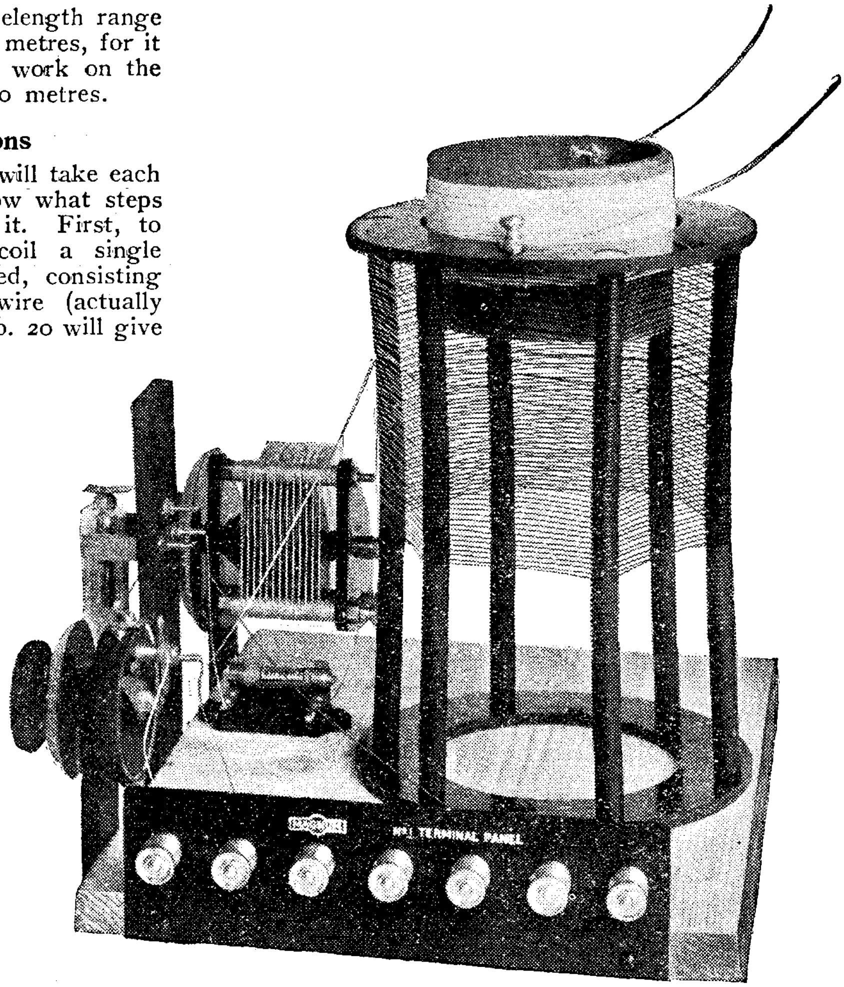
The effect of loosely coupling such a circuit to a separate aerial and earth circuit is to shift the band lower, to a larger extent on the minimum than on the maximum wavelengths. In the present case the latter effect does not seem to have been operative, for the maximum wavelengths are identical.

With regard to the actual instrument, the circuit of which is shown in Fig. 1, this has merely an ordinary detector valve circuit, loosely coupled to a semi-aperiodic aerial, with a pair of telephones in the plate circuit. No provision was made for reaction, which should not have a marked effect on the wavelength range. The type of reaction attributed to Reinartz could, of course, be easily incorporated, and the whole would form a very efficient single-valve receiver covering a large range. In actual practical working under these conditions the wavelength range could be taken, say, as 200 to 750 metres, for it would not be always advisable to work on the lower portion between 165 and 200 metres.

Practical Considerations

In describing the arrangement I will take each condition set down above and show what steps have been taken to comply with it. First, to reduce the self-capacity of the coil a single layer air-spaced coil has been used, consisting of 60 turns of enamel covered wire (actually No. 24 gauge, but gauges up to No. 20 will give sensibly the same results) on a skeleton former of the type supplied by Messrs. Collinson. The spacing given by this means is about 16 turns to the inch. This coil is mounted, as shown, with the windings on the upper part of the former to minimise their capacity to earth.

The condenser used is .0005 μF nominal (J.B.) and is fairly representative of the many low-minimum types available; it is conveniently mounted on a short strip of ebonite away from the baseboard.



Attention has been paid to the spacing of the wiring and reduction of all casual capacities.

Choice of Valve

In addition, the wiring has been carried out with thin gauge wire, and all wires have been carefully spaced. The valve is of the low-capacity tubular type, actually a V 24, and is mounted on a strip of ebonite. Several holes are drilled in the ebonite between those required to secure the supporting clips, as shown in Fig. 2, so as still further to reduce the stray capacities added to the grid to filament and grid to plate capacities by the mounting.

This completes the precautions taken, and these could all be readily applied to the design of any receiver which is to use a fixed coil and a variable condenser for tuning, without any undue complication in the set.

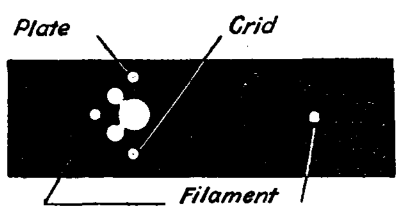


Fig. 2.—The supporting strip for the valve has large holes drilled between those used for fixing the plate, grid, and filament clips.

Set Design

These results are of interest, not merely from a theoretical standpoint, but also from the point of view of the future policy of receiver designers, who will henceforth concentrate, not only on sets to cover both the broadcast band and the 5XX and long wavelengths of continental stations, but also on sets designed to cover a definite waveband only (excluding the long wavelength), such as the broadcast band. The results show that this is easily possible, provided these precautions are taken.

Capacity of Condenser

The point might be raised as to the use of a .0005 μF condenser in a secondary circuit, and it may be said that in some selective circuits tuning will be far too sharp for convenient use of a condenser of this capacity. This objection, and others which may be raised, are not very serious, and the use of a low-minimum geared condenser will solve in a simple manner any tuning difficulties which may be experienced.

Range Without Special Valves

A fairly large range may, of course, be obtained without the use of a special valve such as this in a detector circuit, but, as the title indicates, I have endeavoured to show the order of the maximum *possible* tuning range which is obtainable with a variable condenser and a single fixed coil, designed to cover the wavelengths around the broadcast band.

This is one way of covering a definite tuning range, such as the broadcast band, and seems preferable to that where the stray capacities are disregarded and interchangeable tuning units, such as "plug-in" coils, are used.

Advance Guide to the N.A.R.M.A.T. Wireless Exhibition

(*Continued from page 734*)

amplifiers will find much to interest him on Stand 33 (Box 58). Here Messrs. Vandervell & Co., Ltd., are displaying an extensive range of accumulators, for use as H.T., L.T., and for grid-bias purposes.

A very ingenious novelty may be seen on Stand No. Box 71. This is the Kenmac crystal receiver, constructed in the form of a book with the outer case made of imitation tortoiseshell.

On the gallery stand, G 24 and 25, Messrs. Hobday Bros., Ltd., being dealers in and not manufacturers of radio apparatus, will exhibit a most comprehensive range of all types of wireless apparatus produced by members of the N.A.R.M.A.T.

Apart from the personal pleasure to be derived from a visit to the Exhibition, a good idea may be gathered from the exhibits as to the direction in which modern radio progress inclines.

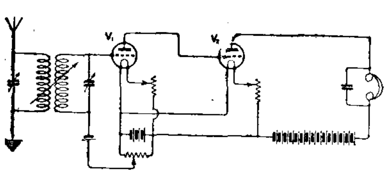
A complete list of the exhibitors and their stand numbers, which are marked on the plan, is given below.

Radio Press, Ltd., will occupy Stands 51 and 52, and *The Wireless Dealer*, the new monthly trade paper to be published on September 12 by Radio Press, will be found on Stand No. 73.

□ □ □

A New Loud-Speaker Circuit

In the above article in last week's issue the circuit of Fig. 2, showing



E. W. B. Gill's limiting device, was incorrectly shewn in certain copies. The actual circuit diagram is reproduced above.

Stand.	*Name.*	*Address.*
10	Auto Sundries, Ltd.	10A, Lower Grosvenor Place, S.W.1.
Boxes 47 & 76	Autoveyors, Ltd. ..	82/4, Victoria Street, S.W.1.
23	Beard & Fitch, Ltd. ..	34, Aylesbury St., Clerkenwell, E.C.
14	Bowyer Lowe Co., Ltd. ..	Letchworth, Herts.
9, Box 72	British L.M. Ericsson Mfg. Co., Ltd.	International Bdgs., 67/73, Kingsway, W.C.2.
1, Boxes 59 & 60	British Thomson-Houston Co., Ltd.	Alma Street, Coventry.
Box 47	British Radio Corpn., Ltd. ..	Elm Grove Rd., Weybridge, Surrey.
11 & 12, Boxes 74 & 75	Burndept Wireless, Ltd. ..	Aldine House, Bedford Street, Strand, W.C.
2	Cables & Electrical Supplies	234, Pentonville Road, N.1.
35	Climax Radio Electric, Ltd. ..	Quill Lane, Putney, S.W.
25	A. C. Cossor, Ltd.	Aberdeen Works, Highbury Grove, N.5.
28, Box 50	Dubilier Condenser Co. ..	Ducon Works, Victoria Road, N. Acton.
22	Eagle Engineering Co. ..	Eagle Works, Warwick.
21	J. J. Eastick & Sons	Eelex House, 118, Bunhill Row, E.C.1.
26	Edison Swan Electric Co. ..	Ponders End, Middlesex.
34	Falk Stadelmann & Co. ..	83, Farringdon Road, E.C.
39	A. W. Gamage & Co., Ltd. ..	Holborn, W.C.1.
17, 18 & 19 Box 42	General Electric Co., Ltd. ..	Magnet House, Kingsway, W.C.2.
7	Gent & Co., Ltd.	Faraday Works, Leicester.
40	Alfred Graham & Co. ..	St. Andrews Works, Crofton Park, S.E.
Box 53	Hirst Bros. & Co., Ltd. ..	Roscoe Street, Oldham.
Box 69	London & Provincial Radio Co., Ltd.	Colne Lane, Colne, Lancs.
6	L. McMichael, Ltd.	Hastings House, Norfolk Street, Strand, W.C.2.
30 & 31	Marconiphone Co., Ltd. ..	Marconi House, Strand, W.C.2.
8	Metro-Vick Supplies, Ltd. ..	Trafford Park, Manchester.
16	Mullard Radio Valve Co.	45, Nightingale Lane, Balham, S.W.
56 & 57	National Wireless & Elec. Co.	42, Gray's Inn Road, W.C.1.
27, Box 49	Pell, Cahill & Co., Ltd. ..	64, Newman Street, W.1.
21a	Radiax, Ltd.	4, Percy Street, W.1.
5, Box 67	Radio Communication Co., Ltd.	34/5, Norfolk Street, Strand, W.C.
36	Radio Instruments, Ltd. ..	12, Hyde St., New Oxford St., W.1.
24	S. Smith & Sons (M. A.), Ltd.	179/185, Gt. Portland Street, W.1.
29-32	Sterling Telephone & Electric Co., Ltd.	210/212, Tottenham Court Rd., W.1.
37, Box 46	Stevens & Co., Ltd., A. J. ..	Walsall St. Branch, Wolverhampton.
33, Box 58	Vandervell & Co., Ltd., C. A.	Warple Way, Acton, W.3.
13	Wootten, F. E., Ltd. ..	55, High Street, Oxford.
G 1 & 2	Brown Bros., Ltd.	20, Great Eastern Street, E.C.
G 32 & 33	A. J. Dew & Co.	33/4, Rathbone Place, W.1.
G 28 & 29	East London Rubber Co. ..	29/33, Great Eastern Street, E.C.
G 24 & 25	Hobday Bros., Ltd. ..	21/27, Great Eastern Street, E.C.
30 & 31	Houghtons, Ltd.	88/90, High Holborn, W.C.
26 & 27	Sun Electrical Co., Ltd. ..	118, Charing Cross Road, W.C.
G 6	H. J. Galliers	32, St. James's Street, Brighton.
G 3, 4 & 5	Selfridge & Co., Ltd. ..	400, Oxford Street, W.1.
15	British Ebonite Co., Ltd. ..	Nightingale Road, Hanwell, W.7.
38	Chloride Electrical Storage Co., Ltd.	Clifton Junction, Nr. Manchester.
Box 48	Bertram Day & Co., Ltd. ..	9/10, Charing Cross, S.W.
Boxes 62 & 63	Hart Accumulator Co., Ltd.	Marshgate Lane, Stratford, E.15.
4	Marconi Osram Valve Co. ..	Osram Works, Brook Green, Hammersmith, W.6.
20	Neutron, Ltd.	Sentinel House, Southampton Row, W.C.
G 8	Henry Quartermaine, J.P. ..	Ferndale, Bath Road, Woking.
G 18	Radio Association ..	Sentinel House, Southampton Row, W.C., until Aug. 29th, after that 24, Queen Victoria St., E.C.4.
G 9	Radio Society of Great Britain	53, Victoria Street, S.W.
G 7	Sylvex, Ltd.	25, Victoria Street, S.W.
Box 71	Kenmac Radio, Ltd. ..	2A, Dalling Road, Hammersmith, W.6.
Box 61	Broadcaster	93, Long Acre, W.C.2.
Box 70	Cable Printing & Publishing Co., Ltd.	7/11, Theobald's Road, W.C.2.
Box 64	Colonial Technical Press, Ltd.	36, Southampton Street, Strand, W.C.
Box 54 & 55	Cassell & Co.	La Belle Sauvage, E.C.4.
Box 44 & 45	Iliffe & Sons, Ltd. ("Wireless World")	Dorset House, Tudor Street, E.C.4.
Box 51, 52, 73	Radio Press, Ltd.	Bush House, Strand, W.C.2.
Box 65 & 66	"Radio Times" (George Newnes, Ltd.)	8, Southampton Street, W.C.2.
Box 43	Trader Publishing Co., Ltd. ("Wireless Trader")	139/140, Fleet Street, E.C.4.
Box 68	"Wireless Times"	1/2 Whitfield Street, E.C.4.
3	S. G. Brown	Acton.

DOES A STRAIGHT-LINE FREQUENCY CONDENSER EXIST?

By SYLVAN HARRIS.

Articles dealing with the straight-line frequency condenser were presented to our readers in recent issues. Some difficulties have arisen in connection with their use, in spite of the fact that these condensers have been obtainable on the American market only a short time, and Mr. Sylvan Harris here deals with some troubles which have been brought to his notice.

A WIRELESS enthusiast came to me a short while ago, and asked if it would be possible for the straight-line frequency condenser to eliminate what he called heterodyning between stations. By this he meant the interference which occurs from the overlapping of the side bands emitted by two stations. If the side bands of two stations separated by 10 kilocycles exceed 5 kilocycles each, it is evident that

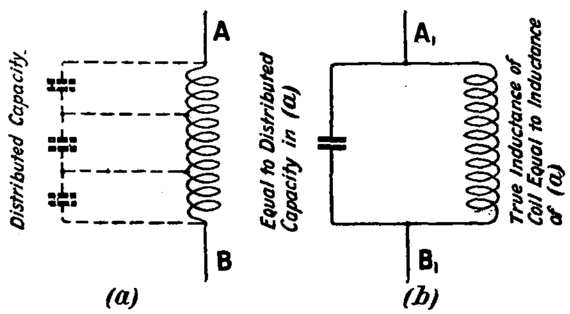


Fig. 1.—The diagram on the right shows the equivalent circuit of a coil having self-capacity as at (a).

some of these modulation frequencies will overlap, and some frequencies will be received simultaneously from both stations.

No condenser—in fact, no tuning apparatus—can correct this evil. The difficulty lies outside the scope of the receiving set; it is not permissible for the receiver to cut out overlapping side frequencies by virtue of high selectivity.

A Misrepresentation

The next thing I wish to talk about comes as a result of a short article which I saw recently, in which it was stated that " there is not at the present time (and never will be) any such instrument." The writer of that article bases his statement on the fact that the characteristics of coils, which are used with the condensers in tuning circuits, vary considerably.

Well, without going much further, I might say that this is a serious mistake. Why this is so will be shown as we proceed. For the moment, however, I might say that the design of a straight-line frequency condenser does not depend at all upon the coil. If the calibration of the condenser departs from the linear because of coil capacity, then the trouble is with the coil, and not with the condenser. In such case, why blame the condenser? The poor condenser has already been blamed for enough trouble.

Practical Considerations

However, we are not interested in such pedantic quibbling. We are entirely interested in the practical side of the matter, and it is this side that we shall consider here in detail. Let us state the problem, first recalling a few essential facts that were explained in *Wireless Weekly*, Vol. 6, No. 16 and No. 17. The design of a straight-line frequency condenser is based upon the assumption of constant inductance in the circuit. It is based upon the formula :

$$f = \frac{159.3}{\sqrt{LC}}$$

in which f is the frequency in kilocycles, L is the inductance in microhenries and C is the capacity in microfarads. By assuming L constant, we can take the square root of L and divide it into the number 159.3 and obtain a constant, K. Then if

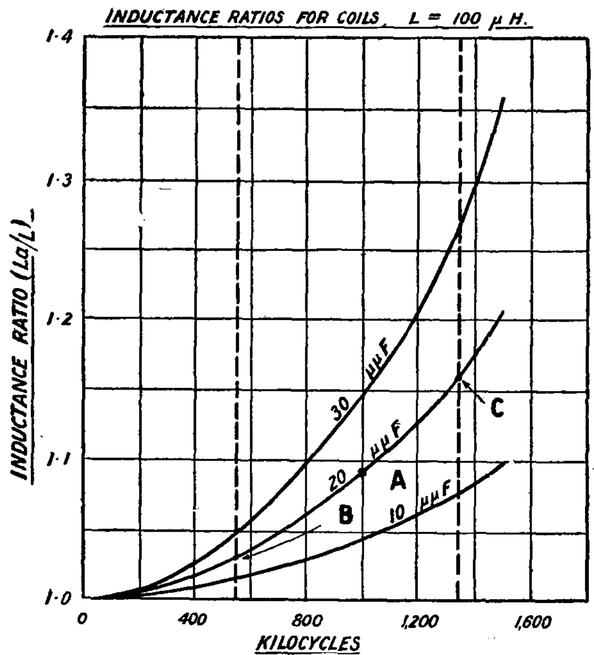


Fig. 2.—The capacities marked on the curves are the self-capacities of the coils, and the curves show how the apparent inductance of such coils depends on the frequency.

C is proportional to $1/d^2$, in which d is the dial reading, we have

$$f = Kd$$

and this formula plotted as a graph will give a straight line.

Effect of Distributed Capacity

Now, remember that this involves the assumption of a constant inductance. If the coil which is used with the condenser has some capacity (distributed), the inductance will not remain constant. We may consider the coil having capacity as equivalent to a coil which does not have capacity connected in parallel with a small condenser equal to the coil capacity. For example, in

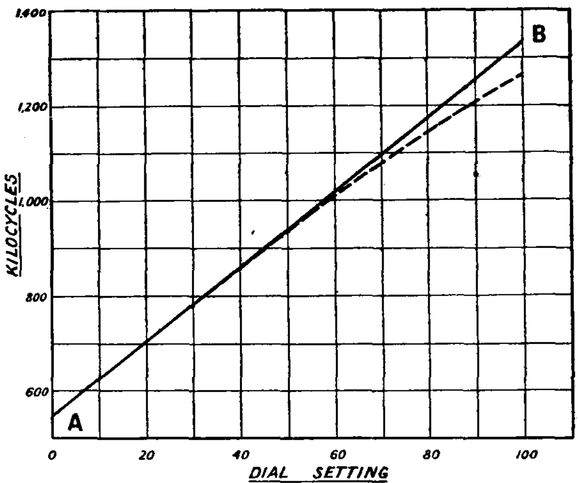


***Fig. 3.**—The presence of stray circuit capacities bends the calibration curve of a straight-line frequency condenser as shown by the dotted line.*

Fig. 1 we have shown at (a) a coil which has considerable inductance and a small distributed capacity. As measured between the terminals A and B, the coil has a certain inductance which is called the "*apparent*" inductance. This is to be distinguished from the "*true*" inductance, which is the inductance the coil would have if it did not possess distributed capacity.

A Simplified Arrangement

In (b) of Fig. 1 we have shown an equivalent arrangement. We have taken the true inductance of the coil at (a) (which is the inductance we should measure between the terminals A and B if the coil had no capacity), and have shunted across it a condenser having a capacity equal to the coil capacity. Such an arrangement would give a measured inductance across its terminals A_1 and B_1 exactly equal to that across A and B, if the measurements were made at the same frequency.

The arrangement at (a) in Fig. 1 is converted into the equivalent circuit at (b) simply for purposes of convenience. We can easily perform computations with circuit (b). We shall now consider how the apparent inductance between A_1 and B_1 varies. We shall call the *true* inductance of the coil L, and the capacity of the coil C.

Resistance Ratio of Conductors

We shall now introduce a new idea, that of the "resistance ratio" which is considered in studying the high-frequency resistance of conductors. It is the ratio of the resistance of the conductor at high frequencies to its resistance at low frequencies, and is symbolised as R/Ro. So we can have the "inductance ratio," which is the ratio of the "apparent" inductance (as measured at high frequencies, taking account of the coil capacity), to the inductance as measured at low frequencies (where the effect of coil capacity is negligible). We may symbolise this as La/L, where La is the apparent inductance and L is the true inductance. The formula showing the relation between these two quantities is:

$$\frac{La}{L} = \frac{1}{1 - 39.48f^2 LC \times 10^{-6}}$$

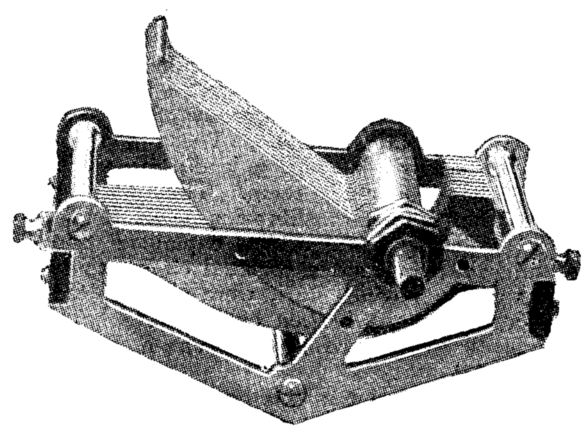
in which f is the frequency in kilocycles and C is the coil capacity in μF.

Curves

To make things easier to comprehend, values of the inductance ratio were computed from this formula, and are shown in Fig. 2. Three curves are shown, all of them applying to inductances of 100 μH, one curve for a coil having a capacity of 10 $\mu\mu$F, one for a coil of 20 and one for a coil of 30 $\mu\mu$F.

The horizontal axis (at the bottom) is calibrated in kilocycles, and the vertical axis (at the left) is calibrated according to the inductance ratio. Thus, a coil of 100 μH, having a distributed capacity of 20 $\mu\mu$F, at a frequency of 1,000 kilocycles (300 metres), would have an inductance ratio of 1.087. (Point "A," Fig. 2.) That is, its inductance under those condition would be 1.087 times its true inductance, an increase of 8.7 per cent.

For the purpose of exaggerating conditions, we have assumed rather large coil capacities for efficient coils, and we shall consider from now on,



An example of a straight-line frequency condenser of American manufacture.

for the sake of argument, coils of 100 μH having coil capacities of 20 $\mu\mu$F.

Inductance and Frequency Changes

Now, remember that the frequency of a circuit is given by the formula:

$$f = \frac{159.3}{\sqrt{LC}}$$

as explained above. If we consider L to change, we can easily find out the variation in the frequency that will occur as a result of this change. Consider the 20 $\mu\mu F$ curve of Fig. 2. The values of the inductance ratio at the limits given by the vertical lines are shown at B and C, and have the values of 1.024 and 1.168.

Theoretical Considerations

In other words, the inductance of the coil changes in the ratio of 1.168/1.024 (or 1.142) in the frequency range 550 to 1,350 kilocycles. That is, if the inductance of the coil at 550 kilocycles were 100 μH, its inductance at 1,350 kilocycles would be 100 x 1.142, or 114.2 μH. Now suppose, instead of using L in the above formula, we use its new value, which is 1.142 L. The equation will then be:

$$f = \frac{159.3}{\sqrt{1.142\,LC}} = 0.936\left[\frac{159.3}{\sqrt{LC}}\right]$$

It will be noted that the form of the formula has not been changed. The part in brackets is the same as that with which we started, the only difference being that we now obtain a frequency which is 0.936 times the frequency we obtained when we assumed the inductance constant. In other words, the frequency is now only 93.6 per cent. of what it would be if the coil had no capacity. For instance, if we happen to have our radio receiver so designed as to tune to 1,350 kilocycles at exactly 100 on the dial, without considering the change of inductance, it would actually tune in 1,350 x 0.936 or 1,263 kilocycles.

Effect on Reception

This same procedure has been followed out for various values of frequency lying within the broadcast range. A perfectly linear condenser calibration has been assumed for the sake of argument in the solid line drawn in Fig. 3, by assuming a frequency of 550 to be tuned in at zero on the dial, and a frequency of 1,350 kilocycles at 100 on the dial. These points are shown at A and B of Fig. 3, and a straight line was drawn connecting them. This line represents a perfect linear calibration.

The points computed as explained above, assuming the coil and associated circuit to have a total capacity of 20 $\mu\mu F$, were also plotted in Fig. 3, giving the broken curve. There is no doubt that this curve is a curve—it is *not* a straight line.

But the main point in this connection is that it is not very far from a straight line. The curvature is not sufficient to cause anyone any trouble in separating the many stations, which is the prime reason for the existence of the straight-line frequency condenser, anyway.

How Condensers are Designed

Let us go a bit further. Suppose the designer of the condenser first determined the approximate shape of the plates by the theoretical method outlined in my article in *Wireless Weekly*, Vol. 6, No. 17, and then put the condenser into an oscillatory circuit. He then measured the frequency that was tuned in at every dial setting and plotted a curve. If the curve was not perfectly straight, he would grind away some of the plates, or build a new set of plates having a slightly different shape. Finally he arrived at a set of plates which gave him a perfectly linear calibration.

The coil he had been using in the measuring circuit was a good one, having low distributed capacity. The problem now is: What will happen if this condenser is used in a circuit with a coil having greater distributed capacity?

The answer is easy. The calibration curve will be *less* curved than the one we have shown in Fig. 3. The curve AB in Fig. 3 was drawn for a condenser associated with a coil which had *no* distributed capacity, and we are comparing it with the curve applying to a condenser associated with a coil of considerable capacity. Certainly there will be an improvement.

Manufacturing Methods

The reader must not be misled by the statements made by those who measure the capacity of a condenser at various settings, and then calibrate the frequency dial-setting curve from these measurements. It is absolutely impossible to judge the straightness of the calibration curve by this method, as I venture to say the majority of the condensers will be made by the cut-and-try method, as described immediately above.

Effect of Low Minimum Capacity on Curve

There is one other point that may prove interesting to many. Purchasers have in the past been accustomed to demand from the dealers condensers which have low minimum capacities. In the straight-line frequency type of condenser the straightness of the calibration curve will often be destroyed by cutting away the plates in the attempt to obtain a low minimum capacity. By reducing the minimum capacity the curve is bent upward.

It has been shown above that the curve will be bent downward when the condenser is used in a circuit with a coil having appreciable capacity. It is apparent, then, that the tendency will be to straighten out the curve somewhat, thereby counteracting, to some degree, the upward curvature due to the low minimum capacity.

Conclusions

In conclusion, I should like to say that, in spite of the fact that we are not able to have anything "*perfectly perfect*" in this universe of ours, the straight-line frequency condenser is about the best thing that has come along, as yet, in the way of helping us tune in the many concerts in the air. Despite some curvature in the calibration curves, most of them, when actually plotted in a radio receiver, will be substantially straight, and, furthermore, it would require a great deal more curvature than we actually do get to cause the confusion among the short-wave stations that has existed heretofore with the use of circular plate condensers.

Wireless News in Brief

We understand that a wireless station is to be constructed in Manila, the capital of the Philippines, by the Radio Corporation of America. It is being designed for the express purpose of relaying news from less powerful stations scattered over the Eastern Archipelago and China. A number of feeder stations are already planned, so that Shanghai, Canton, Macao, Saigon, Batavia, and other centres will soon be in communication with Manila, whence news may be radiated over a wide area.

* * *

While the U.S.A. temporary wireless communication with Etah may be reckoned as the farthest North radio station, the world's most Southerly radio post is being established on the South Orkney Islands; the call sign is LRT. The Argentine Government also has a station on the Orkneys, but this is maintained for meteorological observation only.

* * *

We are informed that a system of lighting by wireless lamps is shortly to be installed in the Vatican. The system is the invention of Mr. Bernays Johnson, the American engineer; by means of it the use of wires to individual lamps is avoided. The marble walls and valuable paintings and tapestries make it difficult to install wires to light some parts of the Vatican artificially, but wireless lighting will overcome this.

* * *

Plans for providing alternative programmes for all wireless listeners were discussed by Captain P. P. Eckersley, chief engineer of the B.B.C., in his address at the Central Hall, Southampton, in connection with the meeting of the British Association.

It was proposed, he said, to raise the power of certain of the main stations, and to link high-power stations to the other main stations, for the interchange of programmes.

The B.B.C. had furthermore a proposal for a new station outside London, so as to give the eight million population there alternative programmes, available even to crystal users, while leaving them with their present station inside London.

* * *

We understand that the Birmingham broadcasting station is being fitted with new transmitting apparatus, the present plant being obsolete.

The new transmitter will be slightly more powerful than the old one, while it will also give considerable improvements in the quality of the programmes.

It will be the only station of the B.B.C. to operate on a water-cooled valve, with the exception of Daventry.

* * *

In the Vacation Court recently, before Mr. Justice Finlay, the British Broadcasting Company, Ltd., moved for an interim injunction, pending the trial of an action, restraining the Wireless League Gazette Publishing Co., Ltd., from infringing their copyright in the *Radio Times*. The Wireless League Gazette Publishing Co., Ltd., submitted that there was no copyright involved. Mr. Justice Finlay said that he was not satisfied that the Wireless League Gazette Publishing Co. were right and would ultimately succeed, but he was satisfied that there were serious and difficult questions of copyright to be tried.

There would be no order, except that the costs be costs in the action, and facilities would be given for an early trial of the action.

* * *

Further to the report on the broadcasting wavelength tests on another page of this issue, additional information has now come to hand.

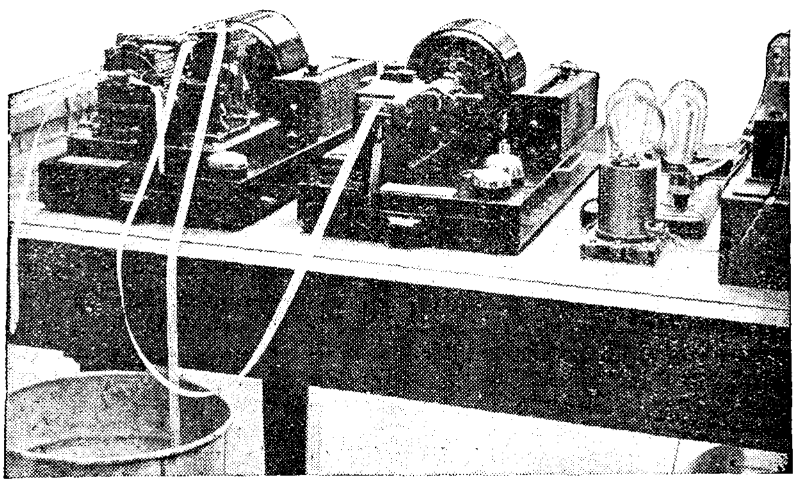
A report from Liverpool states that interference was first experienced by spark signals from Dieppe, Manchester being closed down to enable this interference to be traced, but jamming continued. Hamburg was originally reported on Liverpool, but further reports showed the interfering station to be Spanish or Scandinavian.

Various listeners have sent reports on foreign stations. Berlin, Zurich, Königsberg, Paris, and Toulouse were stated to be clear. A Cheshire listener indicated that the following stations came over well :—Stuttgart, Brussels, Toulouse, Frankfort, Munster and Berlin.

A Malvern listener reported a bad whistle and interference by some other station on Munster.

POST OFFICE WIRE

An interesting descriptio J. H. Reyner, B.Sc. (Hon Editor, of the receiver in us at Wembley Exhibition. example of straightforwar and contains seve



The Creed printing apparatus used with the receiver. The instrument on the right receives Morse signals and translates them into holes punched in a suitable manner in a paper slip. The instrument on the left then translates this punched slip into typewritten letters.

THERE are two main classes of commercial receiver, depending upon the service to be performed. In the first place, there is the long-distance receiver, where the signal to be received is comparatively weak. In such a case the full armoury of selective devices has to be brought into use, and the receiver is fitted with directional selectors and elaborate filtering arrangements to obtain reasonable immunity from interference and from atmospherics. A receiver of this type was described in *Wireless Weekly*, Vol. 6, No. 20, in connection with the account of the Brentwood Receiving Station.

Interception Services

The other class of receiver is that used for interception purposes. In this case the receiver is of a simpler character. The time available for tuning in the required station is limited, for in some cases the calling only occupies some 30 seconds or less, after which all that is received is live traffic and must be written up.

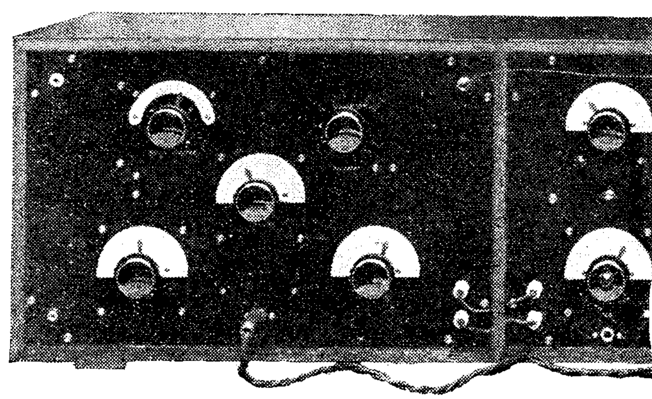
The signal strength in such cases is usually fairly good (although this is not always the case), but in any case the tuning and filtering arrangements must be of a simple nature.

An interesting example of this class of receiver is exhibited in the Post Office Court of H.M. Building at Wembley. This receiver is actually employed each day to receive signals from Leafield during the transmission of the Foreign Office Press, and to print the news received in ordinary characters on a slip of paper.

Leafield Press

Leafield is employed for the purpose because it is illegal to divulge to the public any messages received by wireless unless such messages are prefaced by a "CQ" call. The majority of traffic carried on by the high-power stations is of a private character, but there is a period each day when Leafield sends out this Press to "all stations" (CQ), and this is utilised for demonstration purposes.

The receiver, of course, which is of the standard type employed for interception, is capable of receiving signals considerably weaker than those from Leafield, and is interesting in view of the simplicity of the circuit arrangements.



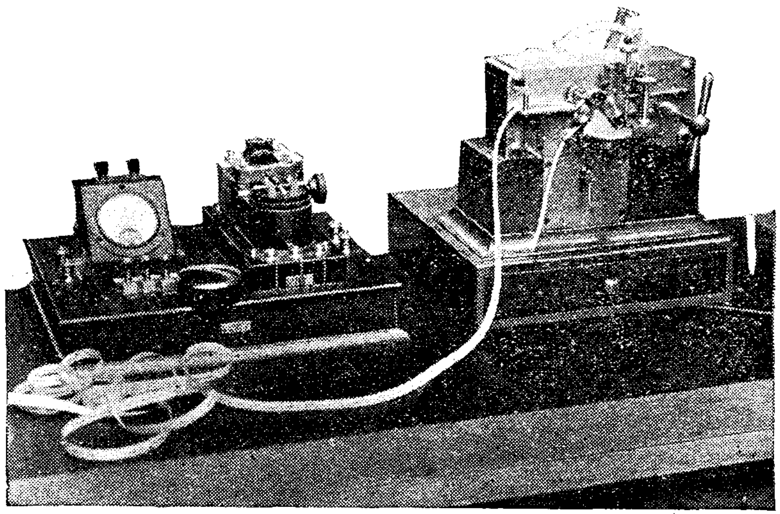
The interception receiver used for receiving the Leafield test panel, note filter and note magnifiers. Note the plu the particular valv

Circuit Arrangements

The receiver possesses no high-frequency stages of amplification, the tuning arrangements consisting of two loosely coupled

LESS AT WEMBLEY

, specially written by Mr. .), A.C.G.I., D.I.C., Staff at the Post Office Exhibit The receiver is a good methods of amplification al novel features.

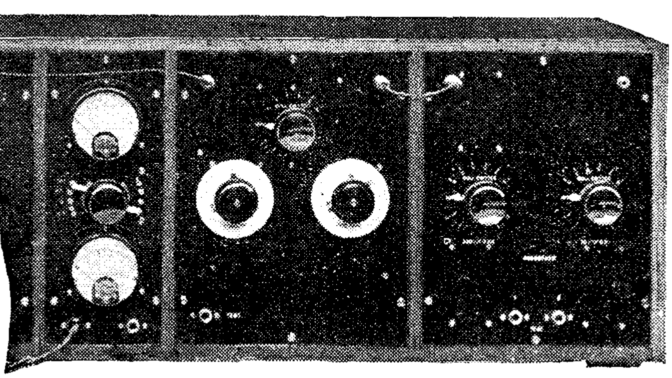


The relay unit which follows directly after the receiver. This unit translates the wireless signals into telegraphic currents which are then applied to the Creed Printer (opposite) 100 yards away. The instrument on the right is a Wheatstone receiver for checking the Morse impulses sent over the line.

low decrement circuits applied direct to the detector valve.

A strong heterodyne is employed to render the C.W. audible, this heterodyne being sufficiently strong to cause the detector to operate on the linear portion of the characteristic (see *Wireless Weekly*, Vol. 6, No. 16). By using an adequate strength of heterodyne it is possible to obtain satisfactory rectification even of weak signals without previous high-frequency amplification.

There are then three stages of low-frequency amplification, after which the signals are applied to a relay which in turn operates the Creed Printer. This latter instrument converts the Morse impulses into typewritten char-



Press at Wembley. The units in order are tuner, heterodyne, for inserting into any required unit to ascertain whether is working correctly.

acters and prints them on a paper slip.

As an additional selective device there is an optional "note filter," which may be inserted before the three-note magnifiers. This filter is of novel construction, and although only a single stage is employed, a band width of less than 100 cycles is obtainable. This means that a station giving a note 50 cycles different from the desired station would be so reduced in strength as to become harmless.

Screening

In view of the small number of tuning circuits and the comparatively high amplification, it is necessary to reduce, as far as possible, any reception of signals by the apparatus itself, and to this end all the high-frequency apparatus is enclosed in screened boxes. The screening is fairly complete, but not absolutely so. In order to achieve complete screening there must be no gap whatever in the copper boxes, and even the leads must be enclosed in copper tubes. For ordinary commercial purposes such refinements are not necessary, and the method adopted simply consists in enclosing the apparatus on all sides by a copper screen, the necessary leads being brought in through small holes.

High-Frequency Tuning

The high-frequency tuning arrangements may be seen from Fig. 2. It will be observed that the aerial and secondary circuits are coupled together by means of a condenser. This method is employed for two reasons. In the first place, the variation of the coupling with the ordinary magnetic arrangement causes a slight variation of tune, since the effective inductance of both circuits is dependent upon the coupling between them.

This variation, which is undesirable in a receiver designed for rapid tuning, is minimised by the use of a capacity coupling as indicated. Secondly, it can be shown that the usual methods of magnetic coupling introduce considerable effective resistance into the circuit. Since the coils employed are special low-decrement coils, any increase in the resistance of the circuit is to be avoided.

Inductance Coils

The coils themselves are wound with a wave winding in a pancake form, the inductance being 8,000 μH. The coils are wound with " Litz " wire and are about 3½ in. diameter and ½ in. thick. They are mounted at right-angles to each other, so that practically the whole of the coupling is under the control of the coupling capacity, and they are arranged well away from the metal screen. If this is not done, eddy currents are set up in the screen which absorb energy from the coils and so increase the effective resistance.

The rectifier is a D.E.3B valve, anode rectification being employed with a potentiometer for control.

The Heterodyne Unit

The heterodyne is a simple oscillator, which is variably coupled to the secondary circuit, the coupling coil being inserted in the lead between the tuned circuit and the slider of the potentiometer as shown in Fig. 1.

A power valve is normally used in this circuit to provide the necessary strong oscillation, but for receiving Leafield a D.E.3 suffices.

This unit is also enclosed in a copper-lined box.

The Note Filter

The circuit of the note filter is shown in Fig. 3. The anode of the rectifier valve contains a high resistance of 60,000 ohms, a Zenite rod being employed for the purpose.

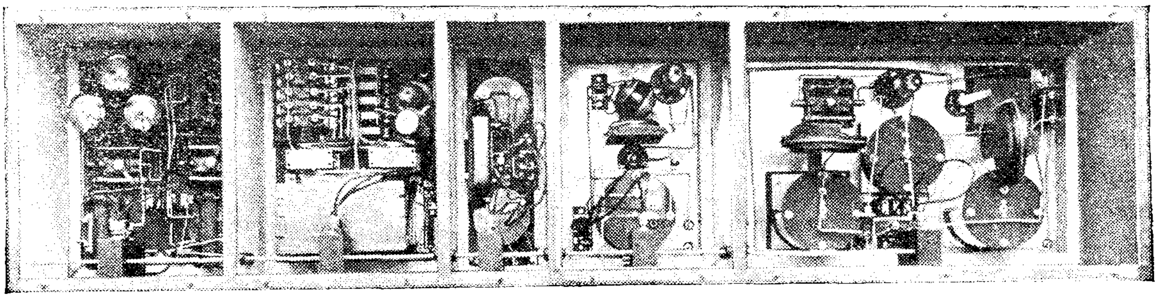
The voltage developed across this resistance is applied to the grid of the filter valve (D.E.3) through a condenser. This condenser is variable in steps of 1,000 μμF and serves as a variable coupling.

Shunted across the grid and filament of the valve, however, is a tuned circuit made up of a toroidal iron-cored inductance having an inductance of about 0.125 Henry, tuned by suitable condensers to frequencies of 800, 900, 1,000 and 1,100 cycles per second.

This circuit acts as a rejector at the frequency to which it is tuned, but as a low-impedance shunt to all others except those very close to the tune. The coupling condenser acts as a control of the selectivity of the device, the smaller the value of this condenser, the sharper the tuning and the less the band width. As has already been stated, in the most selective position the device has a band width of less than 100 cycles.

Note Magnifiers

The low-frequency amplifiers are transformer coupled and merit no special attention. The last valve, however, is a power valve and is arranged to rectify



Rear view of the receiver with the covers removed. The order of the units, of course, is reversed in this photograph. The bus bars carrying the power supply can clearly be seen at the bottom of the set, there being one tapping point in each compartment.

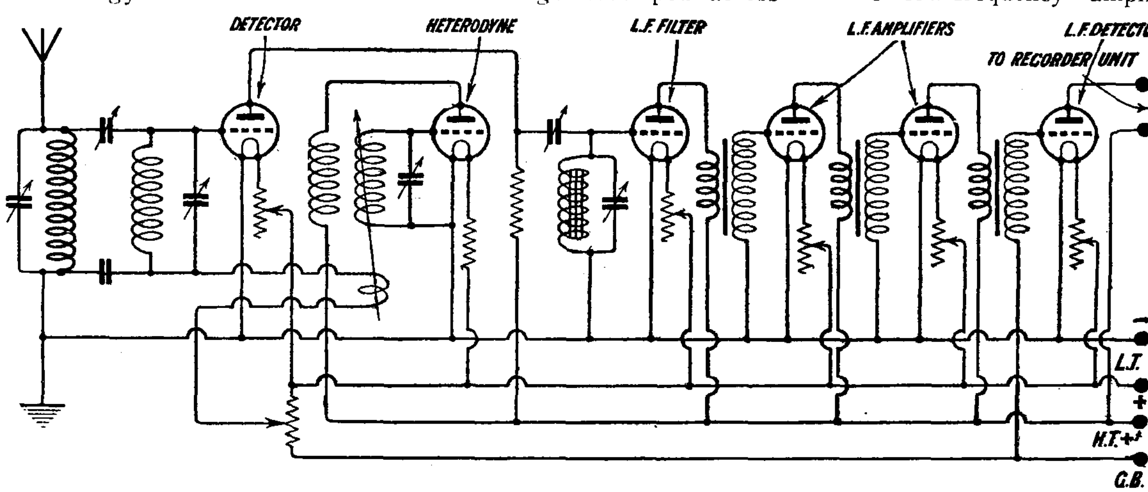


Fig. 1.—Circuit diagram of the Wembley receiver. Note the high-frequency tuning arrangements and the low-frequency note filter.

the signals once again for application to the relay. A relay is a direct-current instrument and will not respond to alternating current, so that this second rectification is necessary to convert the low-frequency oscillations into unidirectional pulses.

Relaying Arrangements

The relay unit is simply a Carpenter relay, made by Messrs. Creed, of Croydon, of a type specially suitable for inclusion direct in the anode circuit of a valve.

On the arrival of a signal of sufficient magnitude the relay is operated and brings into play the local circuits.

Recording Apparatus

The currents in the local circuit of the relay are utilised to operate the Creed printing

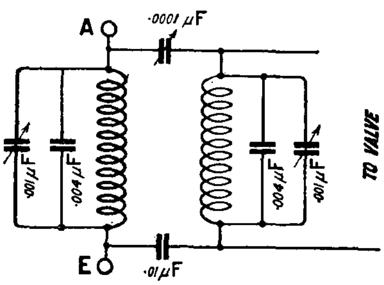


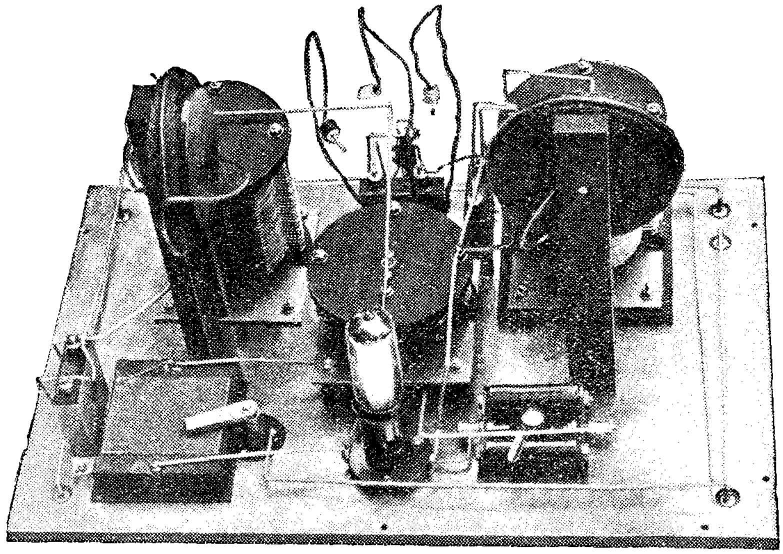
Fig. 2.—The high-frequency tuning arrangements.

apparatus. In the first place, they are sent through a device which causes the Morse impulses to be translated into an arrangement of perforations in a paper slip.

This perforated slip is then passed through the printer, which prints a definite letter on a second slip according to the arrangement of the holes on the perforated paper.

Accessibility

The receiver is interesting from the point of view of the accessibility. All the various units are housed in separate compartments, and the power connections, that is to say, the connections to the various batteries, are made by means of plugs to four bus bars running inside the case at the back of the receiver. Thus by taking out these plugs each unit may be removed from the case.



View of the tuning panel removed from its case. The tuning coils can readily be seen, as also can the copper screen on the back of the ebonite. All the components, of course, are insulated from this screen.

The backs are removable and held in place with screws provided with wing nuts, this construction being adopted because of the screening.

All valves are mounted behind the panels themselves, and in order to ascertain whether any valve is functioning correctly, a plug is provided which can be inserted into each anode circuit in turn and the anode current read.

Test Panel

A milliammeter for reading this current and also a voltmeter for reading the filament, high-tension and grid-bias voltages are housed in a special test panel which can be seen in the centre of the set. By this means all parts except the actual controls are kept out of sight and under protection, yet the operator can always ascertain whether the various parts of the circuit are doing their share of the work.

Simplicity

The keynote of the whole receiver is thus the simplicity of operation. This is obtained by the reduction in the number of tunes made possible by the use of low-loss tuning circuits.

The absence of high-frequency amplification is a further source of simplicity, this being accomplished entirely by the use of an adequate heterodyne strength as has previously been described in these columns.

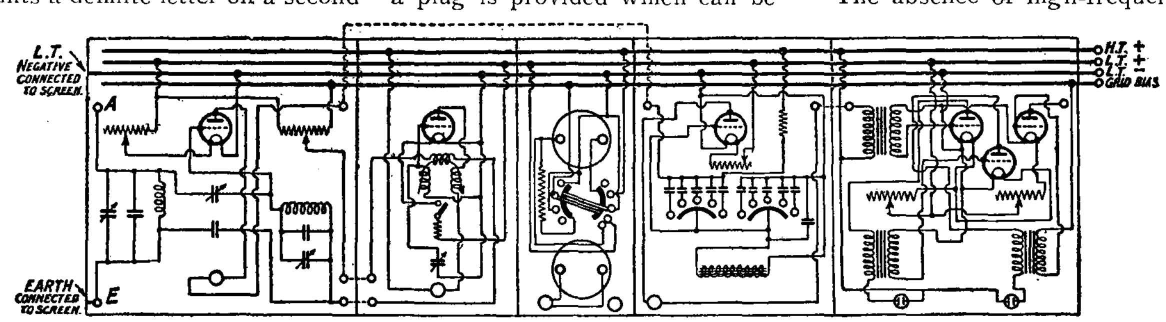
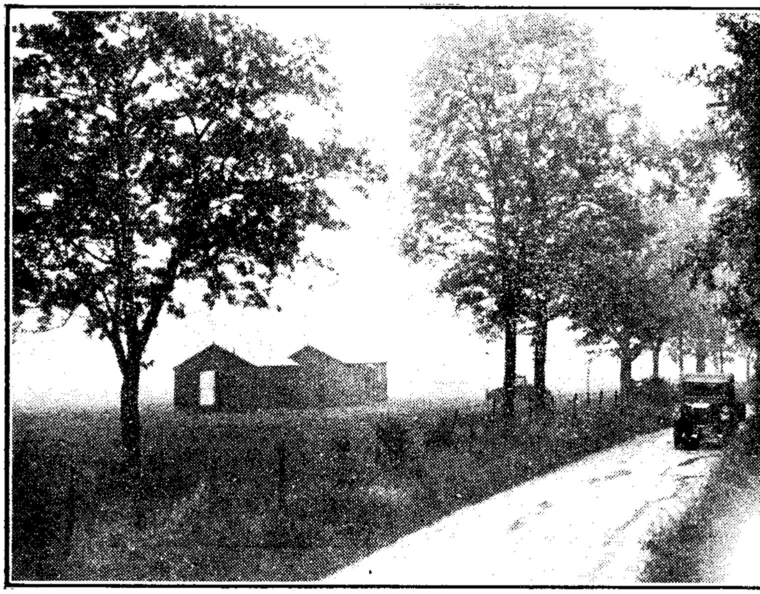


Fig. 3.—Wiring diagram of the receiver. Note how the high-frequency portion on the left is well spaced, while a certain crowding is permissible in the low-frequency stages.

The New Wavelength Tests

Below we give the official preliminary report of the B.B.C. and also the results of some independent tests made by a member of the staff, at 12 miles from London, during the first two tests, made on September 1 and 2, when practically all the broadcasting stations in Europe participated in tests on the newly-allotted provisional wavelengths.



The buildings of the B.B.C. receiving station at Hayes, where tests were carried out for preparation of the official report.

THE first of the series of tests on the new experimental wavelengths allocated by the recent broadcasting conference at Geneva was carried out on the night of August 31 — September 1. Between sixty and seventy British and Continental stations participated. It is not possible as yet to give results as experienced between the Continental stations, but several reports of interference between British and Continental stations have been received.

The official preliminary report issued by the B.B.C. states that

The studio at Zurich, one of the Continental stations participating in the tests.

shortly after the commencement of experiments a report was received from Newcastle of interference by Graz. This was merely due to the fact that Graz had omitted to change to its new wavelength after the cessation of its broadcast programme. About ten minutes later this mistake was rectified.

Cases of Heterodyning

Bournemouth, transmitting on 387 metres, reported a good deal of interference, notably from Oslo, on a wavelength of 392 metres, the power of both stations being equal; also from other stations on lower wavelengths.

Edinburgh, on 327.5 metres, with a power of 400 watts, was jammed by Helsingfors on 325 metres, whose power is 750 watts.

Glasgow, transmitting on a wavelength of 420 metres (1½ kw.), clashed with Munich (414 metres).

Hull (335 metres) was interfered with by Petit - Parisien (347 metres) during the early part of the tests, but this was mitigated to some extent later.

Liverpool (314 metres) experienced a good deal of obstruction from Hamburg (317.5 metres).

Increased Power of German Stations

It is interesting to note that the two German stations by whom interference is reported—Hamburg and Munich—are those whom rumour states have already increased their power to 10 kilowatts.

An English listener reports having heard two foreign stations which it is impossible to identify, completely heterodyning each other through the whole course of the test.

All other stations of the B.B.C. were clear of interference, and the test may be considered as highly satisfactory.

Special Independent Tests

Independent observations at 12 miles from London by a member of the staff on the first night (August 31 — September 1) showed that the British relays were received more strongly and clearly than ever before, using similar apparatus.

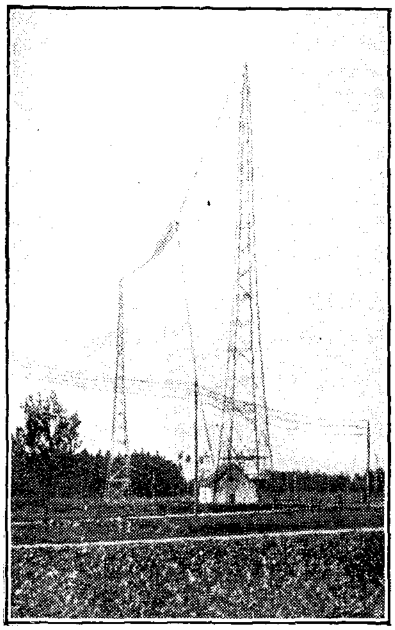
Heterodyning was taking place on wavelengths of 300, 350, and, later on, 355 metres. Sheffield was heterodyned by a loud German station apparently not working on its stated wavelength. During this first test attention was paid to reception of stations on wavelengths below about 350 metres, and in the second test the upper part of the band was explored.

A faint heterodyne whistle was heard in the background when receiving Birmingham on the loud-speaker, probably due to interference between Swansea and one of the German stations.

Glasgow was being badly heterodyned by Munich, a loud, low-pitched heterodyne whistle being the result, and between Cardiff and London another but faint heterodyne was apparent.

Good Reception

During the whole of the tests Bournemouth, Newcastle, Radio Belge Birmingham, Radio Lyon, Toulouse, Liverpool, Dundee, Hull, Plymouth were received at various strengths on the loud-speaker, while Bradford, Stoke, Nottingham, Leeds, Barcelona, Elberfeld, Vienna, Frankfort,



The aerial and earth systems at the Zurich station.

Königsberg, Belfast, Manchester and Cardiff were heard at good 'phone strength.

Rome was obliterated by spark, and Zurich, Aberdeen and Stuttgart were faint.

List of New Wavelengths

The following table, issued by the Office International de Radiophonie at Geneva, indicates the wavelengths and the powers on which the various stations worked during the first midnight test.

The list is incomplete owing to the fact that replies from Italian, Spanish and certain French stations have not, so far, been obtainable, but all the additional details will be made available as soon as they are known.

WAVE-LENGTH. (METRES)	KC.	STATIONS.	POWER IN WATTS.	COUNTRY.
572	524	Budapest ..	2,000	Hungary
561	534	Gratz	1,500	Austria
531	565	Berlin	1,600	Germany
522	575	Zurich	1,000	Switzerland
513	584	Brno	1,000	Czecho Slovakia
512.5	585	Sundsvall ..	1,000	Sweden
504	595	Elberfeld.. ..	550	Germany
496	605	Aberdeen ..	1,500	England
488	614	Swansea	200	England
488	614	Riga	—	Latvia
480	625	Birmingham ..	1,500	England
472.5	635	Königsberg ..	750	Germany
450	666	Vienna	1,500	Austria
444.5	675	Leipzig	550	Germany
438	685	Belfast	1,500	England
432	694	Toulouse ..	1,200	France
425.5	705	Stockholm ..	1,000	Sweden
420	714	Glasgow	1,500	England
414	724	Munich	550	Germany
408	735	Prague (Strasnice)	500	Czecho Slovakia
403	744	Newcastle ..	1,500	England
397.5	754	Dortmund ..	550	Germany
392	765	Oslo	1,500	Norway
387	775	Bournemouth ..	1,500	England
382	785	Frankfort ..	550	Germany
377	795	Manchester ..	1,500	England
368	815	Stuttgart ..	550	Germany
363.5	825	London	3,000	England
351	854	Cardiff	1,500	England
347	864	Paris Petit-Parisien.	460	France
342.5	875	Leeds	200	England
339	884	Plymouth ..	200	England
335	895	Hull	200	England
331.5	905	Dundee	200	England
327.5	915	Edinburgh ..	400	England
325	923	Helsingfors ..	750	Finland
317.5	944	Hamburg ..	550	Germany
314	955	Liverpool ..	200	England
311	964	Prague (Fochova)	500	Czecho Slovakia
308	973	Denmark ..	—	Denmark
304.6	984	Gothenburg ..	1,000	Norway
298.5	1,004	Nuremberg ..	550	Germany
292.5	1,025	Nottingham ..	200	England
287	1,045	Munster	1,100	Germany
284.5	1,054	Lyons	2,000	France
282	1,063	Breslau	550	Germany
276.5	1,084	Dresden	550	Germany
271.5	1,104	Malmo	1,000	Sweden
266.7	1,124	Falun	400	Sweden
264.3	1,134	Norkoping ..	250	Sweden
262	1,144	Brussels	1,500	Belgium
257.5	1,164	Jongkoping ..	25	Sweden
253.2	1,183	Linkoping ..	250	Sweden
249	1,204	Trolhattan ..	250	Sweden
246.9	1,215	Gafle	25	Sweden
243	1,234	Bradford ..	200	England
239	1,254	Stoke	200	England
226.5	1,324	Bremen	550	Germany
224.7	1,334	Eskilstuna ..	250	Sweden
223	1,344	Cassel	550	Germany
221.4	1,354	Karlstad ..	250	Sweden
220	1,363	Hanover ..	550	Germany

A Special Test from NKF

The co-operation of readers is invited in the special tests described on this page. It will expedite the work of analysis if all reports are headed "NKF" in capital letters.

THE arrangements being made with Dr. Taylor, of the United States Naval Experimental Station, NKF, have now reached a point where we are in a position to ask for the assistance of our readers in carrying out a specific preliminary test. Dr. Taylor has just notified us that NKF is now working to the following schedule, and it is proposed to use one of these transmissions for the purpose of the test :—

TIME (B.S.T.)	WAVELENGTH.	FREQUENCY.	CALLING.
6 a.m. to 1 p.m.	41.3 (approx.)	7260	NRRL, NPU, NPM
7 p.m.	20.8 (approx.)	14500	WAP
10 p.m.	17.1 / 25.5	17500 / 11700 } (simultaneously)	Various

The transmission which it is proposed to utilise for this first test is the one taking place at 10 p.m. B.S.T., the wavelength chosen being 25.5 (11,700 kc.). Since receiving the notification from Dr. Taylor this transmission has been heard at extremely good strength on a two-valve Grebe short-wave receiver brought back to this country by Mr. Percy W. Harris, and reports upon this transmission are desired from as many localities in Great Britain as possible. It is therefore hoped that all readers who desire to take part in these tests will listen for NKF for the next few days at 10 p.m., and let us have their reports. The information required to be of service to Dr. Taylor is as follows :—

1. Signal strength.
2. Presence or absence of fading.
3. Purity and steadiness of note.
4. Variation in strength from night to night.

In giving these particulars readers should, of course, state the number of valves and the circuit being used. Reports upon the other transmissions given in the schedule will also be of service, but the one at 10 p.m. is the principal one. Reports on the NKF transmission at other times on the 25-metre wave are also desired, and the following message has been heard being sent from NKF :—" Please ask all foreign amateurs listen for our signals after 2 p.m. G.M.T. on September 9 for 10 minutes after each hour on 25 metres, till further advice, and report to Superintendent, Radio Division, Naval Research Laboratory, Bellevue, Anacostia, D.C." Readers who hear any of these transmissions may include them in their reports of the one which we are using for the preliminary test, and information will be transmitted to Dr. Taylor promptly.

Conditions Improving

The period immediately following upon our first announcement of our endeavour to arrange these special tests with Dr. Taylor proved to be a distinctly bad one for transatlantic work, and some difficulty was experienced on receiving NKF's transmissions; but conditions are now improving very much and NKF is being heard very strongly. Mr. J. A. Partridge, who operates the well-known station G-2KF, informs us that he has recently worked with NKF and that signals both ways were then extremely steady and dependable. Little difficulty is therefore to be expected with any reasonably efficient short-wave receiver in picking up NKF's signals, and the main points to report upon are the relative strength from night to night, presence or absence of fading, and the other points which we have mentioned.

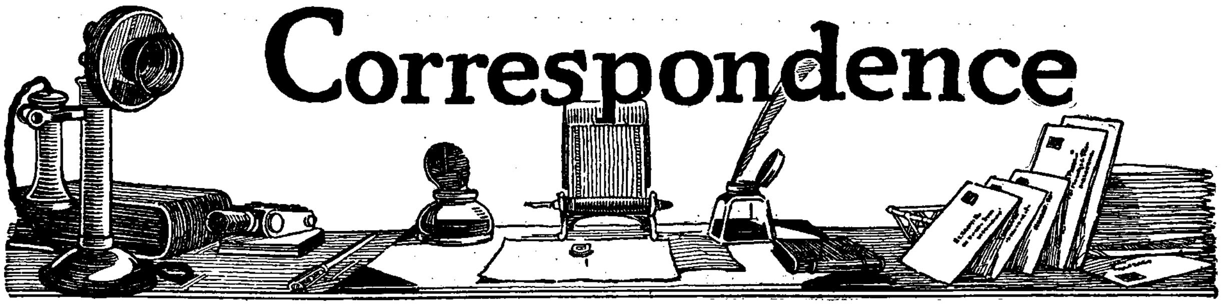
A Practical Note

One or two readers have reported some difficulty in getting down to the shorter wave transmission, mainly the one upon 20.8 metres (14,500 k.c.), and for their benefit it should be noted that those who are using the Reinartz circuit should give attention to the size of the choke coil which they are using. With certain types of valves a considerable advantage is sometimes found in reducing the size of the choke coil much below the normal value. For example, when plug-in coils are used, it is sometimes useful to come down to quite a small size, such as a Gambrell a, or Burndept S2 or S3. Further, in the Reinartz circuit care should be taken to adjust the reaction coupling turns to a suitable value, the best results being usually obtained with as small a number of turns as will give the desired self-oscillation.

FORTHCOMING FEATURES.

Some special features of great interest will be appearing in forthcoming issues of "Wireless Weekly," which will appeal to all sections of its readers. Special articles will be appearing from the pens of Mr. John Scott-Taggart, F.Inst.P., A.M.I.E.E., and Mr. Percy W. Harris, M.I.R.E. Major James Robinson, D.Sc., Ph.D., F.Inst.P., will contribute a series which will convey a new conception to many readers of the functioning of aerials and their relation to a number of fascinating problems of wave transmission, while another series by Mr. J. H. Reyner, B.Sc. (Hons.), A.C.G.I., D.I.C., will deal with the results of the latest researches into the problems of wave propagation and the nature of the Heaviside Layer. Particular reference will be made to fading and blind spots, and certain suggestions as to special aerial arrangements to counteract these effects will be put forward.

Correspondence



RADIO PRESS SETS IN BURMA

SIR,—With an "Efficient Single Valve Set" (R. P. Envelope No. 9, by Herbert K. Simpson) I am able to tune in the local broadcasting station at very loud headphone strength. Considering my aerial, which is only 30 ft. high and 20 ft. long, thickly screened by big trees, the results seem to exceed all my expectations.

By the way, before I made this set I had a little crystal set, constructed according to Mr. John Scott-Taggart's instructions in the book, "Simplified Wireless" (R. P. Books, No. 2). With this set I could pick up every day morse signals from ships three or four miles off. This set was tested on a much shorter aerial than that described above.

Now I am making the "ST100 Receiver" according to the R. P. Envelope No. 1, by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E., and shall report you about results after a fortnight's test.—Yours faithfully, AN INDIAN READER.

A "TRANSFORMER - COUPLED THREE-VALVE RECEIVER"

SIR,—For the last few months I have been using regularly for general work the "Transformer-Coupled Three-Valve Receiver," which I made up from the theoretical circuit given by Mr. Stanley G. Rattee, M.I.R.E., in his interesting article in the November 12, 1924, issue of *Wireless Weekly*. It is a very good circuit indeed, and very clearly described by Mr. Rattee in his article; as a matter of fact, I have not had to depart in the smallest detail from the circuit given, except as regards switching arrangements for bringing the aerial in series or in parallel. As regards the H.F. transformer, I believe it is hard to beat just an ordinary two-coil holder; the variations possible with these coils are very interesting, and some experimenters might be surprised at the really tremendous signal strength obtained (especially on the high wavelengths) by using as big coils as possible.

Reception is very clear and the set is selective; as a matter of fact, I have sometimes tuned out one foreign station and another in *with simply a half turn of the vernier* (one plate), which I use on both variable condensers. I know some people boast of the stations they have heard, but I can really honestly say I have already carefully identified some 20 or 30 different stations from at least six different countries —Great Britain, France, Germany, Holland, Italy and Spain. Of course the distant stations are only to be clearly tuned in under good conditions at night. I have tried many other circuits, but for general work I doubt whether this one can be beaten.—Yours faithfully,

SWITCH OFF.

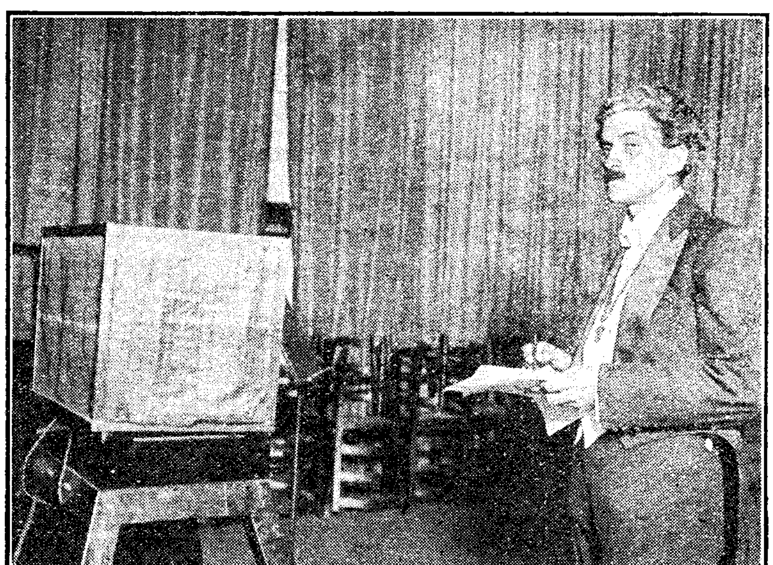
Hastings.

RECEPTION OF NKF

SIR,—With reference to your article in *Wireless Weekly*, Vol. 6, No. 20, entitled "An Opportunity for the Experimenter," may I just convey a sympathetic appreciation of the good work attending the arrangement of this schedule. Personally I shall be delighted to help as far as our licences permit, but this confines our activity to reception only as far as the request for a 24 hours schedule is concerned. The transmitting permits, as you are doubtless aware, restrict us to a total of half an hour's maximum work in any consecutive 24 hours, and the recent activity of the authorities on the shorter wavelengths in dealing strictly with infringements of these terms is having the effect of limiting the amount of useful work one may attempt in this direction. The 20.8 metre times are particularly interesting, as this wavelength has given, up to the present, discouraging results in comparison to 40 metres, and the need for study on a fixed schedule is therefore the more necessary.

If you feel that I can assist you in arranging for regular schedules by amateurs here to meet NKF's times I shall be only too pleased to do what I can.

A word of thanks for the excellent assistance you are giving to the amateur cause. *Re* last week's Editorial, we are endeavouring to have all members state their exact wavelength at the end of every transmission before the call-sign. There is still a large discrepancy in our



Mr. Marcus Adams, President of the Professional Photographers' Association, who broadcast a talk recently from 2LO in connection with the Photographic Centenary.

wavemeters, though.—Yours faithfully,

W. G. Dixon, Secretary,
British Section, International
Amateur Radio Union.

THE BEST AERIAL COUPLING FOR SENSITIVITY

Sir,—Having read the very instructive article by Mr. Cowper on "Aperiodic Primaries and Signal Strength" in *Wireless Weekly* for June 17, 1925, perhaps my experiences of real distant reception would be of interest. I worked for three months almost nightly with a single valve with reaction at Roorkee, about a hundred miles from Delhi. In the course of that time, after using countless tuning arrangement of the various types mentioned by Mr. Cowper, I came to the conclusion that the apparently out-of-date loose-coupled tuned primary was far the best for sensitivity, which was my sole object, the local station on which all comparisons were made being a 1 kw. broadcast station at Calcutta, a thousand miles away.

Using this circuit, one could hear the carrier waves of several stations on about 400 metres any night after 12 p.m., but modulation could not always be detected. However, on two occasions the B.B.C. Saturday night simultaneous transmission was heard, on both occasions from Glasgow; this being deduced solely from the fact that the tuning was so close to that for Calcutta, whose wave is 425 metres.

With all the other forms of tuning and coupling I had no success in picking up European telephony, although Calcutta could occasionally be heard.

The great drawback of the tuned loose-coupled primary, as I found it, is the tedious tuning involved by the use of variable magnetic reaction close to the point of oscillation.—Yours faithfully,

H. L. Moscardi.

Meerut.

BOLTON AND DISTRICT RADIO SOCIETY

Sir,—I enclose a report of a recent meeting, etc., of the Bolton and District Radio Society, which I trust may be of interest to your readers.—Yours faithfully,

N. Isherwood.

Bolton.

At a meeting of the Bolton and District Radio Society on August 11, Mr. C. H. Bamber, B.Sc., delivered a most interesting lecture on "Accumulators: Their Care and Charging." A few of the many items dealt with included design and pasting of plates, heavy and light discharges, importance of strength and purity of electrolyte, use of distilled and tap water for "topping," importance of first charge, the chemical process of charge and discharge, charging from D.C. and A.C. mains, general care necessary to ensure long and satisfactory "life" of accumulators, etc. Forthcoming events: September 22, general meeting; October 14, lantern lecture, "Radio Ramifications," by H. A. Hankey, Esq., Assistant Chief Engineer of the B.B.C.

J. Grimshaw, 70, Church Road, Bolton, Hon. Sec.

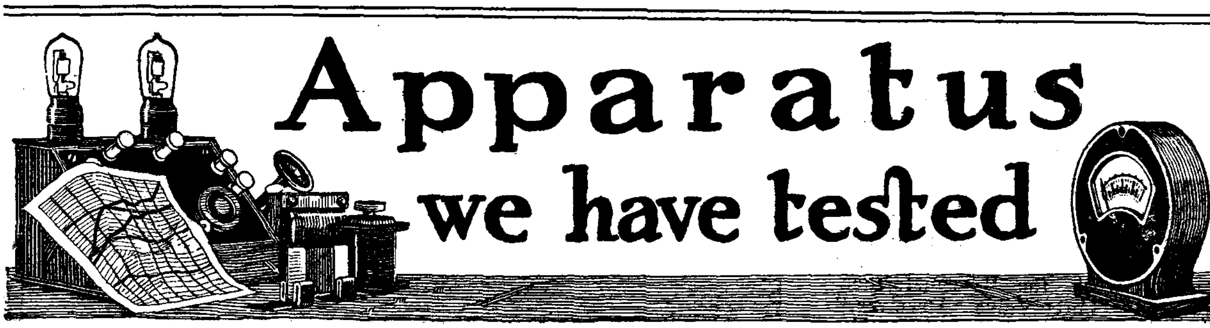
IRISH AMATEUR COMMUNICATES WITH U.S.A.

Sir,—Your readers may be interested to know that the *first* amateur two-way communication between Ireland and the U.S.A. took place on the 22nd ult., when 5NJ, operated by me, was in communication with 1PL, of Boston, Mass.

The power used at 5NJ was just under 20 watts, and, in view of this fact, it is interesting to note that 1PL reported "terrific" static at his end when the communication took place. The wavelength employed was 45 metres.—Yours faithfully,

F. R. Neill.

Chesterfield, Whitehead,
Co. Antrim.



Conducted by A. D. COWPER, M.Sc., Staff Editor.

Radio Ribbon Aerial

From Messrs. S. Guiterman & Co., Ltd., comes a sample of their "Radio Ribbon" aerial, which is in the form of a reel of 100 ft. of bright golden-coloured metallic ribbon, made up of some fourteen narrow strands of thin foil woven with yellow thread into a continuous ribbon ¼ in. wide and very pliable. A tag terminal is provided at the end. It is claimed that this ribbon needs no insulators, and can be tacked around the wall or thrown over a tree-branch; we have grave doubts as to the efficiency attainable with such an arrangement in a damp climate. For practical and impartial test an indoor aerial was fitted up with this ribbon, using the ordinary porcelain egg insulators at each end and suspending the aerial well away from walls and ceilings; first, with a single 30-foot length (and vertical lead to the next floor), and finally with the whole length arranged on several insulators zig-zag fashion, at a dozen miles from the local B.B.C. station. A 30-foot indoor aerial was fitted up with standard 7/22 stranded copper wire at the same time for comparison; and the test was carried out with an ultra-low-loss proportionally-tapped crystal receiver and good direct earth to the lead sheathing of the lighting cable. Under these circumstances, at optimum setting the Radio Ribbon registered 2.2 microamperes, as against 2.5 microamperes for the standard 7/22; by rapid switching there was a just noticeable difference in the audio strength. Signals were faint but quite readable with either aerial. There was little difference in the capacity; if anything, the ribbon showed slightly lower capacity, but an identical crystal-tapping point for optimum signals. Evidently this stranded ribbon material offers an appreciably higher resistance at this frequency (821 kc.), under practical working conditions, than the large stranded cable. With the whole length of ribbon in use the signal-strength rose to 4.2 microamperes.

The compactness of this ribbon-aerial when wound up on its reel, its light weight, and extreme flexibility, suggest useful applications where a slightly higher effective H.F. resistance is not of great moment. Thus for frame-aerials and for occasional use with proper insulators as a picnic aerial, this ornamental and pliable ribbon will doubtless be popular.

A Single-Valve Short-Wave Receiver
(Concluded from page 733)

are wound, the turns being then slipped off the former; owing to the springiness of the wire the resulting coil will consist of about $7\frac{1}{2}$ turns and will be about 3 in. in diameter.

Mounting the Aerial Coil

Now the four drilled ebonite strips are together threaded on to this coil, the largest being put on first, and arranged round the coil as shown in the photo. An inch or two of wire is left over at each end and these spare ends are formed into loops to be secured on the bolts passing through the pin and socket of the coil-plug; note that the loops are placed on opposite sides of the pin and socket, so that in one case a bolt is needed long enough to pass right through the loop, the plug, and the strip joining the two halves of the plug.

The Reaction Coil

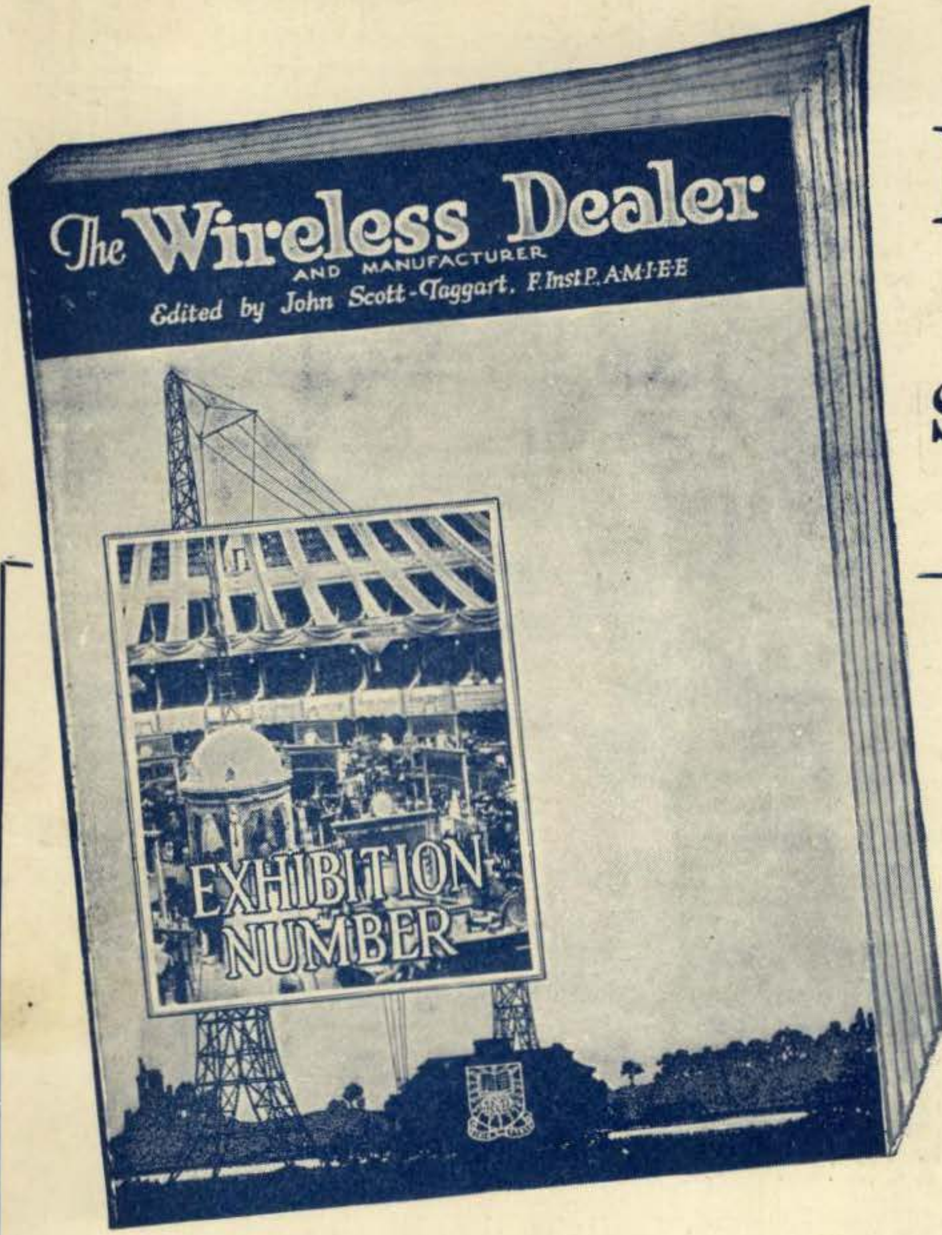
The reaction coil is an ordinary edge-wise "basket-weave" type of winding, wound with No. 22 S.W.G. d.c.c. wire to a diameter of 3 in. on 11 pegs in a board, 9 turns being put on; the points where the wires cross are securely tied with thread before removing the pegs. The arrangement of the pin and socket for this coil is similar to that for the aerial coil described above; but in this case a 6 B.A. clearance hole is drilled centrally in the ebonite strip between the pin and socket. At this point another $\frac{1}{8}$-in. ebonite strip $\frac{1}{2}$ in. wide and 4 in. long is bolted at right-angles to the first strip; $\frac{1}{4}$-in. holes may be drilled in this strip in order to reduce the amount of solid dielectric present, and the coil is tied to it at the top and bottom with thread.

Wiring

The wiring of the receiver is carried out with No. 16 S.W.G. bare copper wire, not tinned. Valves of any type may be tried in the receiver, and most of the ordinary 4-pin kinds should give fair results down to about 40 metres, but the use of a small power-valve is recommended, such as the B4, D.E.5, and D.F.A., or one of the D.E.5b type.

Results

On testing the set as soon as completed on a short indoor aerial and temporary "gaspipe" earth in N.W. London, using a small power-valve and 60 volts H.T., several Morse transmissions were picked up at once between 70 and 80 metres from Holland, France, and Sweden. Harmonics of 2LO came in at good strength in the telephones. On a subsequent test a Porto Rican amateur transmission was heard several times round about 40 metres, and many other amateurs were picked up. The short-wave transmission from KDKA was tuned in without difficulty shortly after midnight, the grid tuning condenser being set at about two-thirds of its maximum value, using the coils described.



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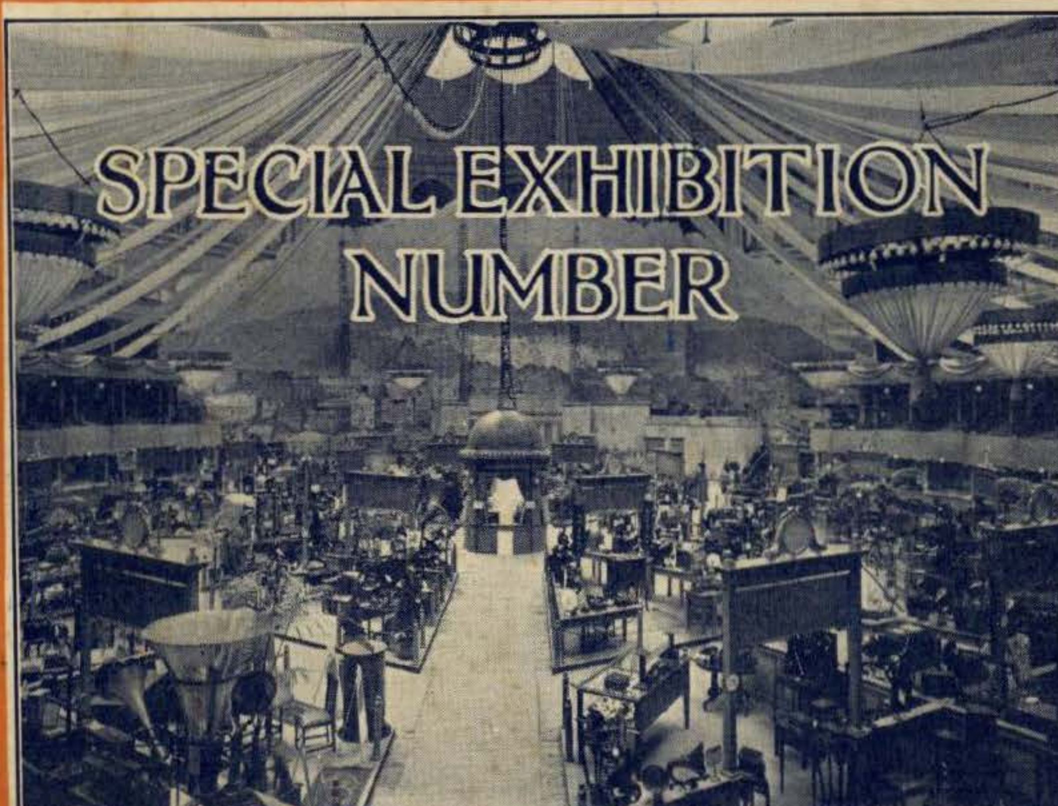

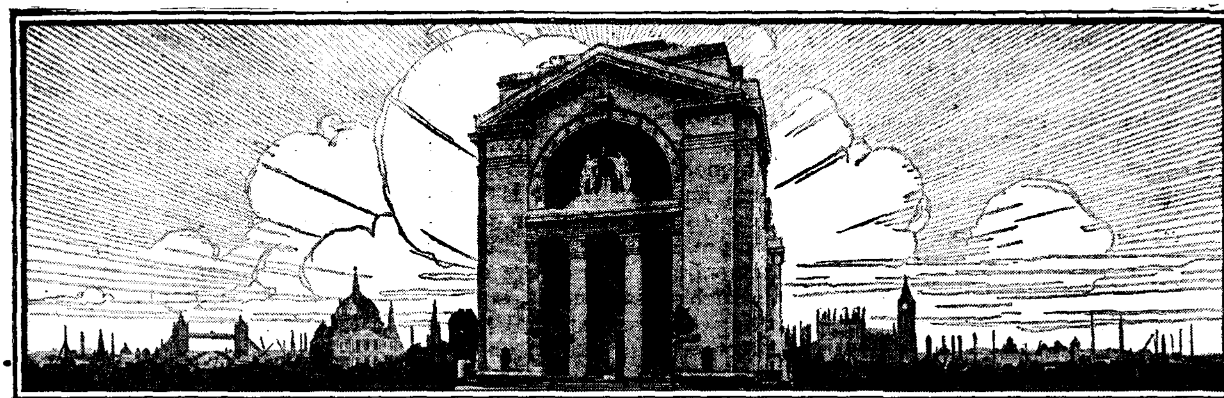

Radio Press Ltd

Wireless Weekly

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The Exhibition

LAST Saturday there were revealed to the public eye new sets, components, and accessories of which many have been for months past jealously guarded secrets, and which are now released by their designers and producers as the result of a year's development. In this fact we see exemplified both the strength and the weakness of the exhibition system. The majority of progressive industries which cater directly for any considerable section of the public employ the system, and there can be no question that the annual event provides a most powerful stimulant to progress.

A Salutary Effect

Every year the firms join in exhibiting their latest developments, and the enforced comparisons between the achievements of one and another intensify the naturally keen competition existing, and this is naturally a most wholesome tendency. In considering the virtues of the exhibition system, mention must be made of a very great one from the point of view of the general public, namely, the opportunity which is given of making a rapid survey of all the latest developments of the manufacturers.

CONTENTS.

The weakness of the exhibition system, which must be regarded as an inherent one, is that it tends to promote development in a series of steps every twelve months, with something which may appear to the general public to be stagnation taking place in part of the intervening intervals.

A Dangerous Tendency

Such stagnation, of course, is more apparent than real, since the period preceding the exhibition is always one of intense activity for the designers and manufacturers. The fact remains, however, that there is inevitably a considerable tendency upon the part of all those who are developing new things for some considerable period preceding an exhibition to hold up their new ideas and to disclose them all for the first time at the exhibition itself. For some indeterminate period following the exhibition, too, most manufacturers feel that they may justifiably rest content with their achievements for a while.

This tendency to advance in a series of steps is least felt in the case of components, where progress is usually more or less continuous, but is most dangerous in the case of complete receivers. In this instance there is undoubtedly a genuine danger that a given model may become seriously

Edited by
JOHN SCOTT-TAGGART, F. Inst. P., A.M.I.E.E.

September 16, *Vol.* 6, *No.*24.

out of date as a result of changes in conditions, or in the light of further technical developments. In this connection an article by Mr. Percy W. Harris in the first issue of *Wireless* (published on the 15th), well repays consideration.

Need for Continuous Advance

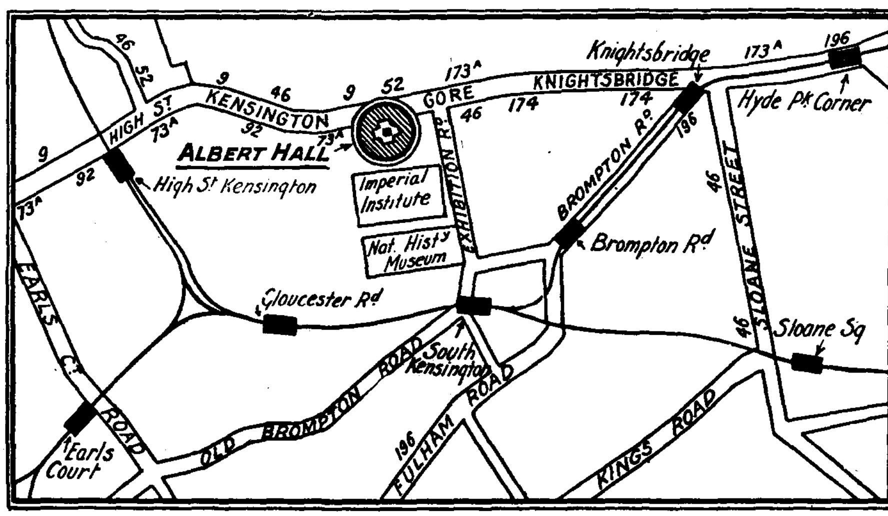
Critics have suggested that there is a considerable disparity between the current British designs and the latest American ones upon such scores as selectivity, but it is hoped that the advent of the latest models at the exhibition will bring the British products fully into line once more. It will thus be seen that the danger of falling behind current practice inherent in a system of from our description. The prominence of "Low-Loss" components is of particular interest, the majority of these it will be observed being variable condensers. In connection with the development of low-loss components and circuits, it is satisfactory to note that manufacturers are realising that further refinements of control are called for in such arrangements, and are devoting the necessary attention to effective slow motion or slow adjustment devices.

New Loud-speakers

Many set designers have felt for some time that one of the main difficulties in the production of an instrument giving really true and faithful loud-speaker reproduction probable extensive adoption of the super-heterodyne circuit in the more elaborate receivers have been proved to be justified, and a number of interesting instruments are to be seen at the Albert Hall. It is significant that several of these instruments use only quite a limited number of valves, an interesting indication of the views of the manufacturers as to the selling chances of a really large instrument.

A Regrettable Feature

We feel that it would be impossible to conclude our consideration of some of the salient points of the exhibition without again pointing out that as was the case last year, only exhibitors who are members of the N.A.R.M.A.T.



A map of the 'bus routes and the nearest tube stations serving the Exhibition area.

progression mainly in twelve months' advances, is a very real one.

It would therefore seem pertinent to urge upon all British manufacturers the advisability of making definite endeavours to improve upon the present exhibition models before the end of the year, for it cannot be expected that in so young and growing a science as wireless any one model can remain up-to-date for so long a period.

This Year's Tendency

A large section of this issue of *Wireless Weekly* is devoted to a review of some of the most interesting exhibits at the Albert Hall, and even those who are not in a position to visit the exhibition itself will be able to draw a number of interesting inferences lies in the fact that so many of the loud-speakers available fall considerably below the standard of equal reproduction of all frequencies which is obtainable in the receiving circuit itself. This is particularly so at the base end of the register, and another satisfactory feature of the exhibition is to be found in the fact that there are quite a number of entirely new loud-speakers, of which many embody notable departures from common practice. It is perhaps in this connection that the British manufacturer has the greatest cause for satisfaction, when comparing his products with those of the foreign firms as a whole. There can be little doubt that the average British loud-speaker is definitely superior to the equivalent instrument in America.

The forecasts made as to the (National Association of Radio Manufacturers and Traders) are admitted. The exhibition, therefore, cannot claim to be a really representative display of the products of British wireless firms, and it seems to us that it is indeed a great pity that such a really national exhibition is rendered impossible by the dissensions among the trade themselves.

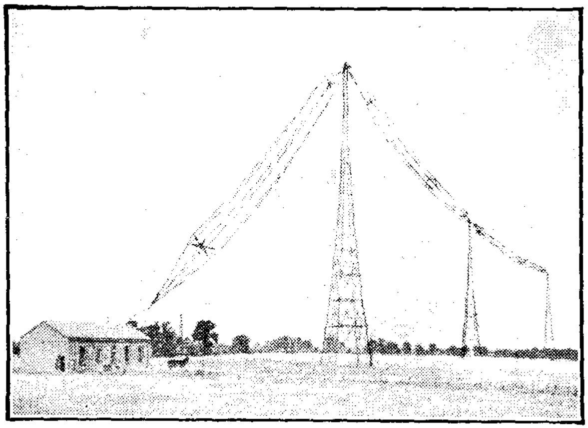
Our readers should bear in mind that for very good reasons some manufacturers prefer to keep out of a combine, and there are many firms outside the exhibition whose apparatus is up to the highest standard of any company showing at the Albert Hall.

The best exhibition in the world is the advertisement section of the wireless papers, where all reputable firms can show their products.

Tendencies in Wireless Developments

By MAJOR JAMES ROBINSON,
D.Sc., Ph.D., F.Inst. P.,

Director of Research to Radio Press, Ltd.



A typical long-wave aerial system is that in use at the Marconi "B" station at Ongar.

IN the early days of wireless, thirty years ago, when the chief experimenters were Marconi, Sir Oliver Lodge and Sir Henry Jackson, attention was concentrated on short waves and the use of aerial systems similar to Hertzian oscillators. Hopes were chiefly centred on comparatively short-distance communications, for the waves were known to be of the same type as light, i.e., of electro-magnetic nature, and it was considered that they would obey the same laws, particularly as regards straight line propagation. The complexion of the whole subject was changed by the discovery of Marconi that earthing one of the halves of the Hertzian oscillator, or, in fact, using the earth as one-half of the oscillator, increased the range of communication enormously.

It was not long before the distance used was so great as to make it essential to give up the idea that wireless waves were propagated in straight lines, and all doubts on this matter were finally dispelled when Marconi succeeded in transmitting messages across the Atlantic.

Early Aerial Systems

The position at this stage of the development was that the aerial consisted of a vertical wire, which was one-half of the Hertzian oscillator, and thus the length of the aerial was equal to one-quarter of the wavelength. At the open end of the aerial the oscillating current is zero, and at the earth end it is a maximum, the current varying along the aerial AB, as shown by the dotted curve BC (Fig. 1).

Increase in Height and Capacity

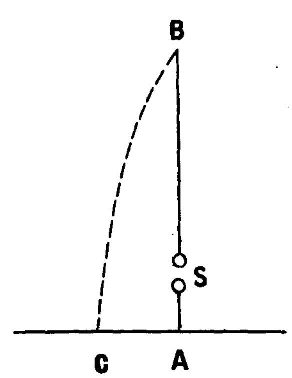
It was soon appreciated that better results could be obtained, first, by raising the height of the aerial, and, secondly, by using more power, which resulted in increasing the aerial current. There was obviously a limit to the increase in height of the aerial from mechanical reasons, and thus, to obtain still further radiation, another expedient had to be employed, that of increasing the capacity of the aerial. This was done by having a horizontal top to the aerial, which enabled more aerial current to be obtained, and thus greater radiation.

The effect of raising the height of the aerial was to increase the wavelength, as the natural wavelength was four times the length of the vertical aerial. (This is only approximately correct, the actual figures being 4.2 to 4.3.) Again, adding capacity at the top of the aerial led to the same result, and thus we see how development of wireless was led into longer and longer wavelengths.

The technique of wireless transmission for long-distance communication, until the last two or three years, consisted in getting as much power as possible into as large an aerial as possible. This involved minimising losses to the utmost by keeping all forms of resistance, apart from actual radiation resistance, as low as possible, but this aspect, which involves the type of earth or balancing capacity employed, will not be discussed in this article.

Radiation of Energy

The radiation of energy from an aerial causes an additional loss of energy, which may conveniently be expressed in terms of fictitious "radiation resistance." The meaning of this can be made clear by considering a simple circuit consisting of a battery E and a resistance R (Fig. 2). The current produced is $I = \frac{E}{R}$



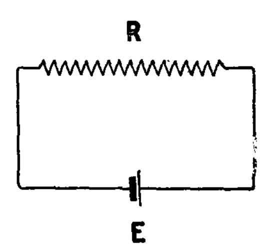
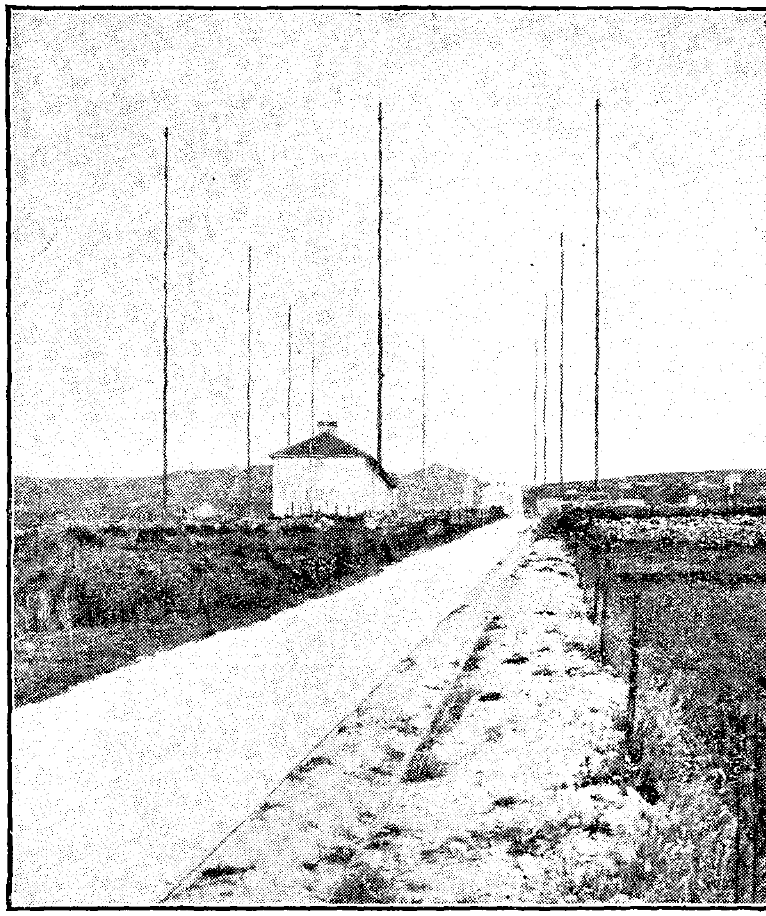


Fig. 1 (left).—The dotted line shows how the aerial current in a vertical aerial varies from zero at the top to a maximum at the earth end.
Fig. 2 (right).—The simple circuit discussed in the text.

This article is the first of a special series in which Dr. Robinson will review the development and present state of our knowledge of some of the most important fundamental principles. Particular interest attaches to the discussion of the functioning of aerials and its influence upon the wavelengths employed in general practice.



A typical high-power long-wave station is that at Carnarvon, the long aerial system necessitating the use of many lofty masts.

As long as the current flows the battery loses energy, which is consumed in the resistance R, and shows itself in the form of heat. The energy W is equal to I^2R, being proportional to the resistance and to the square of the current. This simple and fundamental law applies also to oscillating currents, and thus wherever we have a loss of energy where current is flowing, it is proportional to the square of the current and to another factor which we can call the resistance.

Radiation Resistance

In the case of a transmitting aerial energy is supplied to it, and some portion of this energy is radiated into space and thus is lost as far as the aerial is concerned. Using the formula $W = I^2R$, we can introduce the constant "R," which gives a measure of the radiating ability of the aerial. We call this the Radiation Resistance.

It is not proposed to discuss here how the actual Radiation Resistance is calculated. This involves a considerable amount of mathematics, which is outside the scope of this article. The calculation is also complicated by the fact that the aerial current is not constant along the length of the aerial. There are means, as shown below, by which it is possible to have the aerial current very nearly constant throughout the vertical height of the aerial, and in these circumstances we get a formula for the Radiation Resistance as follows:—

$$R_a = \left(\frac{39.7h}{\lambda}\right)^2 \text{ohms}$$

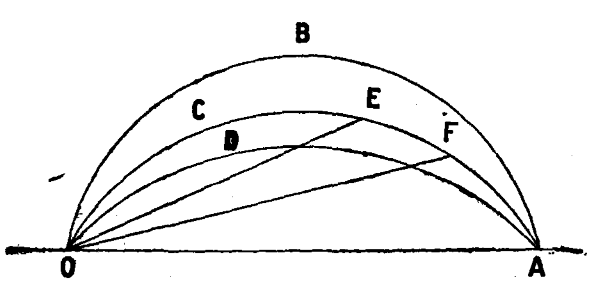


Fig. 3.—Illustrating the amount of radiation in any direction from two types of aerials.

where h is the height of the aerial in metres, and λ the wavelength in metres.

Direction of Radiation

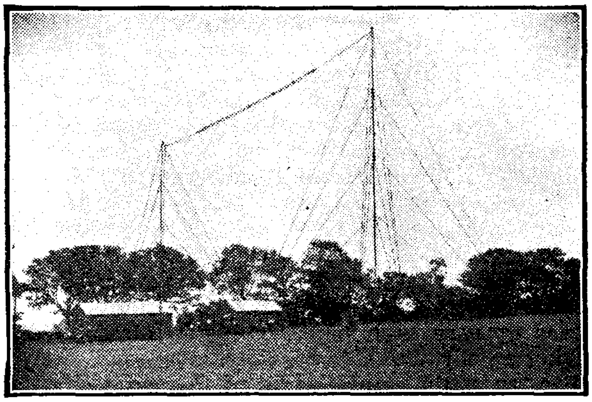
The total energy radiated from an aerial is then given by I^2R, where I is the aerial current in amperes. The radiation from an aerial spreads out all round, and also upwards at various inclinations to the ground, to different amounts in each direction, depending on the shape of the aerial. Usually there is no radiation absolutely vertically, and this is particularly the case with a simple vertical aerial.

In Fig. 3 some idea is given of the amount of radiation in various directions. This diagram is a polar diagram. The actual amount of radiation in any direction upwards from the horizon is given by curves O C A for the case of a vertical aerial. In the case of a flat-topped aerial the curve is shown as O D A. For purposes of reference a semi-circle O B A is shown. Consider one of the curves, say that for the vertical aerial, for which the curve is O D A. The distance from point O to any point on this curve O C A, say the point E, gives a measure of the amount of radiation at the angle given by E O A.

It is thus seen that the amount of radiation from both types of aerial is a maximum along the horizontal direction O A. The greater the angle of inclination to the horizon, the less is the amount of radiation. Vertically upwards it is seen that there is no radiation at all for either of these aerials.

Vertical and Flat-topped Aerials

Another point in connection with these two curves is that in the case of the vertical aerial there is relatively better radiation in an upward direction than in the case of the flat-topped aerial.



A view of the complete aerial system at the B.B.C's receiving station at Hayes. It was here that Mr. Austen Chamberlain's speech was picked up from the continent for re-broadcasting from the British stations on September 10.

It can be seen from these curves that for aerials of ordinary types quite an appreciable percentage of the total radiation is transmitted in an upward direction. This fact will be made use of later in this article.

Strength of Received Signals

Regarding the strength of received signals at a distance from the aerial, this is also somewhat difficult to calculate, again involving a considerable amount of mathematics. There are two chief methods of measuring the radiation at a distance, one in terms of the electric field strength itself, which is usually expressed in microvolts per metre, and the other by specifying some of the constants of the receiving aerial.

In this article it will be better to consider the actual aerial current received in a simple receiving aerial. This current will be designated by I_r. Various other factors must be considered, such as the wavelength λ and the resistance of the receiving equipment, which we shall call R. The distance "d" from the transmitting aerial to the receiving aerial is assumed to be comparatively small, so that the effect of the curvature of the earth is not appreciable. The modifications required when this is not the case will be considered later. For this simple case the current in a tuned receiving aerial is given by the expression:

$$I_r = \frac{377 h_r h_t I_t}{R\lambda d} \text{ amperes.}$$

where

I_t = Current in transmitting aerial (amperes).
h_t = Height of transmitting aerial (metres).
h_r = Height of receiving aerial (metres).
R = Resistance of receiving aerial (ohms).
λ = Wavelength employed (metres).
d = Distance between the two stations (metres).

Effectiveness of Transmitting Aerial

In this formula the aerial current is assumed to be constant throughout the length of the aerial, which, we know, is not actually the case, but which can be made very approximately true. It will be noticed that the received current I_r is proportional to the aerial current of the transmitter, and to the height of the transmitting aerial, and thus we can make use of these two factors, the height of the transmitting aerial and the aerial current, to define the effectiveness of the transmitting aerial.

In evaluating this product, the height is usually expressed in metres and the current in amperes, so that it has become customary to refer to the "Metre-amperes" of a transmitting station. Various transmitting stations can thus be classified according to their "Metre-amperes," and figures for a number of high-power stations are given in the following table:—

Transmitting Station.	Metre-amperes.
Saint Assise	240,000
Saigon	120,000
Bordeaux	80,000
Carnarvon	30,000
Nauen	120,000
Buenos Aires	115,000
Long Island	100,000
Malabar	200,000

A simple calculation will show how these figures are obtained. For an aerial height of 250 metres (approximately 820 ft.) and an aerial current of 400 amperes the Metre-amperes are equal to 100,000.

It will be noticed that only the vertical height of the aerial is considered. This means that the horizontal portion of large transmitting aerials has no influence on the useful radiation. This can quite readily be understood, as the horizontal portion of the aerial would tend to transmit waves with the electric field horizontal, and as these are transmitted horizontally along the surface of a good conductor, i.e., the earth, they are rapidly absorbed. We can thus afford to ignore the horizontal portion of the aerial.

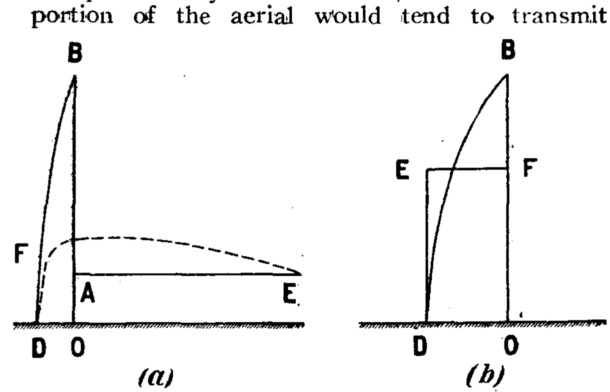


***Fig. 4** (a).—Shows the current distribution in a simple aerial, and Fig. 4 (b) illustrates the method for obtaining the "effective" height of an aerial.*

Considerations of Height

With regard to the assumption that the aerial current is constant throughout the height of an aerial, it must be pointed out that it is impossible to have this absolutely true, although it is possible to approach very nearly to this condition. Consider an aerial, as shown in Fig. 4 (a), of height OB. The usual distribution of current is shown by the line BD, which shows that the maximum current is obtained at the base of the aerial, and no current at all at the top of the aerial, the actual current varying along the height of the aerial as shown by this curve.

Near the base of the aerial, however, the actual current is very nearly constant, as shown by the portion of the curve DF. If we can restrict ourselves to an aerial which only occupies this small portion of the curve DB as regards the vertical height of the aerial we can be reasonably sure that the aerial current is fairly constant throughout the height of the aerial. This, however, means that the vertical portion of the aerial is only a small fraction of the total length. Supposing that we make the aerial as high as it is mechanically possible, we can obtain this effect by putting a large capacity at the top of the aerial, and then this is equivalent to bending the line DB into the portion DF and FE, the latter portion being approximately horizontal.

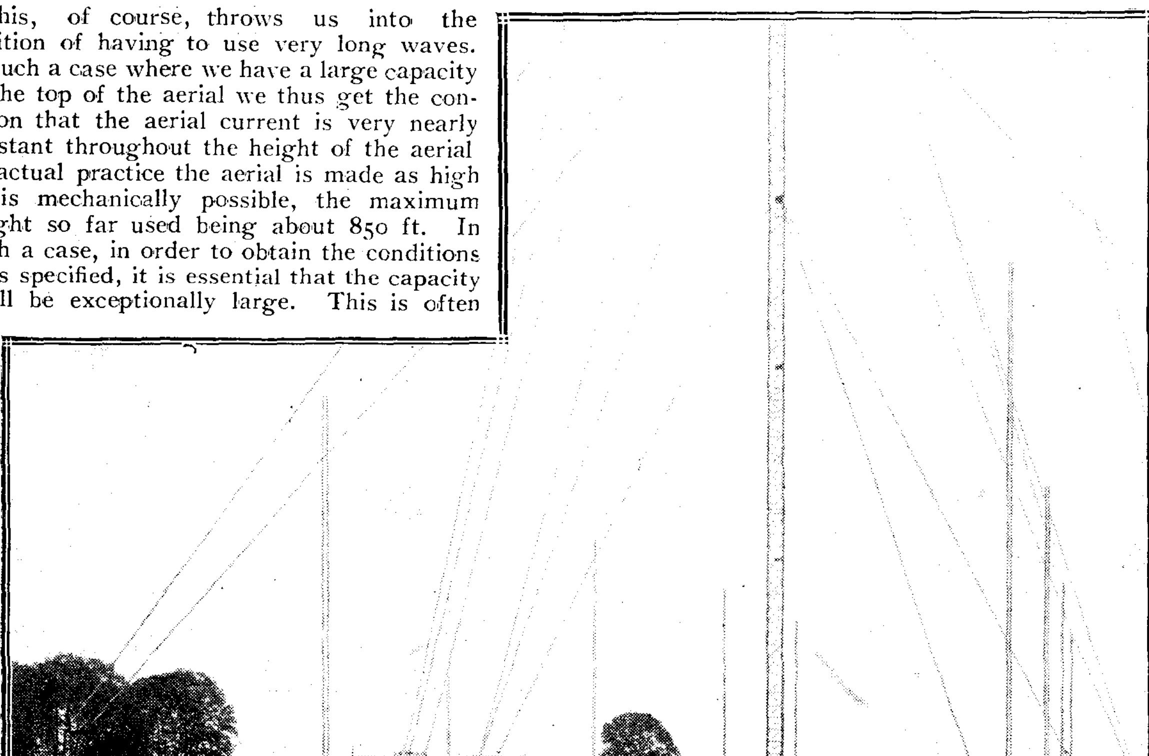
Use of Long Waves

This, of course, throws us into the position of having to use very long waves. In such a case where we have a large capacity at the top of the aerial we thus get the condition that the aerial current is very nearly constant throughout the height of the aerial In actual practice the aerial is made as high as is mechanically possible, the maximum height so far used being about 850 ft. In such a case, in order to obtain the conditions thus specified, it is essential that the capacity shall be exceptionally large. This is often done by having a number of parallel wires which are stretched for a very considerable distance, also at the same height as the vertical portion of the aerial. In the case of Nauen, this length is three-quarters of a mile.

Effective Height

Even under these circumstances the aerial current throughout the height of the aerial is not the same as that at the base of the aerial, and, of course, it is the current at the base of the aerial which is always measured, for obvious reasons. In the formula given above it was assumed that the current throughout the height was the same as that at the base, and thus a certain correction must be introduced. This correction is usually introduced by the use, in the foregoing formulæ, of an "effective" height, which is the height the aerial would have if the aerial current were constant throughout the whole height of the aerial. Obviously, it is obtained by taking a mean value, and in the cases of very high power stations it results in giving an effective height, which is approximately .9 to .95 of the actual height of the aerial.

This will be made clearer by considering the case of a simple plain vertical aerial. In this case, without any capacity at the top, the distribution of current is shown as DB in Fig. 4 (b), this curve being of trigonometrical form. The effective height can be obtained by simple mathematics, but it can



The giant towers which carry the aerial system at the St. Assise station form a landmark for many miles round.

be also obtained graphically, as shown in Fig. 4 (b). What is required is to construct a rectangle DEFO which shall have the same area as that enclosed between the curve DE and the aerial BO and the base DO. In this case the effective height is .636 of the real height.

Long Distance Communication

The era of high-power transmitting stations has been full of success for wireless communication, and we have still to consider the effects obtained at long distances. There are also certain features which have induced wireless engineers to search for improvements along different paths, such as the speed of signalling. How this and other features have led to the development of short-wave communication will be discussed in succeeding articles.

For the Short-Wave Experimenter

FOR the benefit of the ever-increasing number of readers who are working on short wavelengths and desire to calibrate their receivers, we publish below a list of "Official Wavelength Stations" of the American Radio Relay League, as given in the League Journal, QST. These stations have no fixed schedule to which they work, and their transmissions are not the same as those of NKF or WWV, and no attempt is made to secure the extreme accuracy that is provided by the two stations mentioned in addition to 9XI and 6XBM. Their wavelengths may, however, be depended upon to one per cent. accuracy, and in any case their transmissions are checked up periodically by 9ZT—9XAX to ensure correctness.

The number of Official Wavelength Stations is now so large that everyone can use these stations to spot calibration points on wavemeters and receivers.

The stations are as follows. Unless otherwise specified they are located in the United States:—

NKF
1XAM
6BQB
7BK
5MN
9AAL
Z2AC (New Zealand)
2WC
9ZT—9XAX
1MK
8GU—8XC
9XI
9ZA
7GE—7ZX
1IV
9EIB
7GQ
G2NM (England)
6TI
1CK
1AWW
3BE—3ZW
8AA
8EQ
3APV
4XE
5ZAV
9DXN
9EGU
6ZH
5AKN—5XHB
2MU
4BY
C3NI (Canada)
C9AL (Canada)
2DS
1BZQ
6BGM—6CUO
2XI
9IG
7ACI
1ZL—1AVW
2CLA
6ZE
6TS—6XAG
8GZ—8ZG
9BKG
6XAD—6ZW
6CDN
WNP (Macmillan Expedition)
6CGW
NRRL (U.S.S. Seattle)
6LJ
5OX
9BMR
6BCP
1AAC—1ZO
8BZT

These stations will indicate, at the end of each transmission, the wave they are using—for example, 9ZT will send "U 9ZT 76," indicating that it is the United States station 9ZT sending on a wavelength of 76 metres.

British amateurs should listen for these stations when desiring to calibrate their sets, as many of them are regularly received in this country.

J. W. B.

Mr. G. S. Kemp, Senator Marconi's first wireless assistant, photographed with the first transmitting apparatus used by Marconi at Balonga in 1895. This apparatus is on view in the historical exhibit of the Marconi Co.

Provision of L.T. and H.T. Voltages from A.C. Mains

An interesting Patent has been taken out by the Société Française Radio-Electrique for the use of a special balancing arrangement in utilising alternating current for the low-tension and high-tension supply to

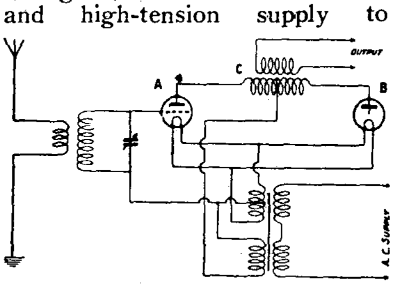


Fig. 1.—The valve B acts as a balancing valve and eliminates A.C. hum.

valves. The essence of the arrangement is shown in Fig. 1. The valve A is the active valve, which is receiving signals in the usual manner, and the valve B is a balancing valve. The high tension is supplied to both these valves at a tapping point at the centre of the primary winding of the output transformer C.

It will be observed that from the symmetry of the arrangement any variation in filament brilliancy or anode voltage due to the fact that the supply is alternating, will cause current to flow through the two halves of the primary of the output transformer in opposite directions, and thus, by a suitable adjustment, which can be made once for all, these variations of current can be balanced up, so that no effect is produced in the output circuit.

Any signals, however, which are received on the aerial, will affect the valve A, and this will cause variations of current in the left-hand half of the transformer primary only, so that these variations will be communicated to the output circuit. The valve B may be a simple two-electrode valve, or if exact symmetry is desired, it may be a similar valve to the active valve A. (Patent No. 228,178.)

Improvement in Basket Coils

The ordinary basket-coil winding, though admirably suited for the lower wavelengths, is not satisfactory for coils having a large inductance. A patent has been taken out by O'Keeffe and the Dickinson Electrical Manu-

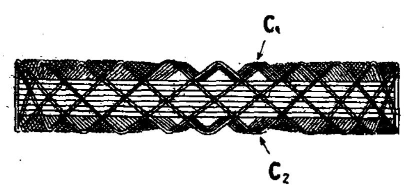


Fig. 2.—A type of combined lattice and cylindrical winding suitable for fairly large inductances.

facturing Co. for a coil which is a compromise between the basket type and the cylindrical type. The first layer is wound on a former in a lattice or basket formation, the second layer being a simple cylindrical layer over the first layer. Successive layers are then alternately lattice and cylindrical, the resultant coil having a comparatively low distributed capacity and yet, if desired, a reasonably high inductance. A view of the completed coil is given in Fig. 2. (Patent No. 238,081.)

Somewhat similar coils, of course, have been described previously, a particular example

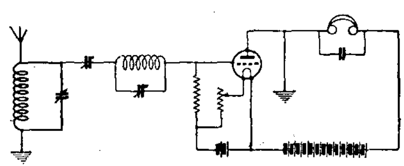


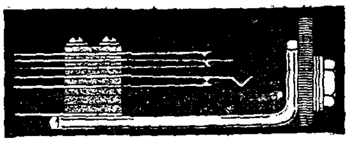
Fig. 3.—A new circuit, which is claimed to be both sensitive and selective.

being that mentioned by Mr. G. P. Kendall, on p. 51 of "Tuning Coils and How to Wind Them."

A New Form of Selective Circuit

Improved signal strength and particular selectivity are claimed for a circuit which has been patented by Melinsky in Patent No. 238,003. This circuit is illustrated in Fig. 3, and will be seen to consist of a tuned aerial circuit which is coupled to the grid circuit of a valve through a variable condenser in series with a tuned oscillatory circuit. The anode of the valve which is connected through the telephone to the high-tension battery in the normal manner is also connected directly to earth. In operation, both the aerial circuit and the oscillatory circuit in the grid lead are tuned to the incoming signal, and it is claimed that by this means very great selectivity is obtained.

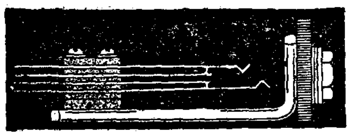
PITFALLS WITH JACKS



A double filament jack.

By R. W. HALLOWS, M.A., Staff Editor.

Probably few home constructors realise that in wiring jacks for switching L.F. stages in or out of operation, the leads must be connected in a certain way so that the current shall flow in the correct direction through the telephones or loud-speaker. This short article shows how mistakes in wiring jacks may be avoided.



A double closed circuit jack.

PLUGS and jacks are extensively used by constructors nowadays either for wiring a series of rooms so that the loud-speaker may be used in any one at will or for enabling stages of low-frequency amplification to be thrown into or out of use in the easiest possible way. If they are properly used plugs and jacks, besides being more convenient than switches, afford a handy and efficient means of cutting out circuits or portions of circuits at will.

Construction of Plugs

Fig. 1 shows diagrammatically a section of a common type of plug. It consists, as will be seen, of three main parts. There is first the body or sleeve, which forms one of the contacts. Next there is the stem, which forms the second contact, and lastly there is the insulating ring which separates the one from the other. Now if we examine the first jack J_1 in Fig. 2, we see that when the plug is not inserted the low-frequency intervalve transformer is in circuit. The plate of V_1 is connected to the lower spring contact *a* of the jack. This springs naturally upward and makes connection with the leaf *c*, which is connected to IP of the transformer T1, T2. OP of the transformer is connected to the leaf *d*, against which the upper spring contact *b* presses. If now we insert a plug such as is shown in Fig. 1, the spring contacts *a* and *b* will be thrust apart and the transformer will be cut out altogether. The sleeve of the plug will bear against the upper spring leaf *b* which is connected to high-tension positive, and the point of the stem against the lower contact *a* connected to the plate of the valve. So far so good.

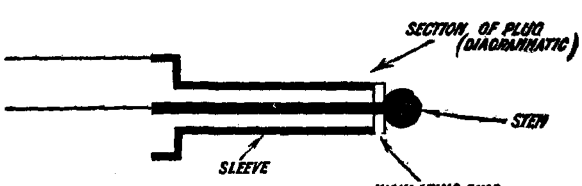


Fig. 1.—A sectional drawing of a plug, the fine lines on the left representing the connecting wires to the telephones or loud-speaker.

Different Types of Jacks

The first jack J_1 is called a double closed circuit jack; the second, J_2, is a single open circuit jack. There is no need to use a closed circuit jack here since we do not wish plate current to flow from V2 unless the telephones or loud-speaker are connected up. Now suppose that we wire J_2 with connections made in the same order as those to J_1, what will happen when we plug in? In this case there is no lower spring contact, connection with the tag Y being made through the sleeve of the plug when it is pushed

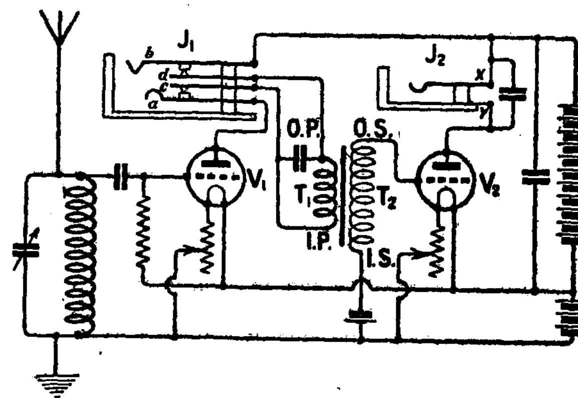


Fig. 2.—When jacks are wired in this way current from V1 and V2 flows in opposite directions through the telephones or loud-speaker.

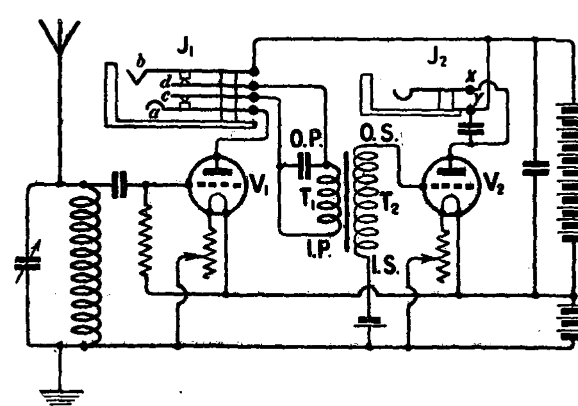
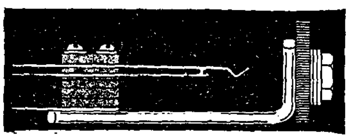


Fig. 3.—Showing the correct method of wiring up the jacks.

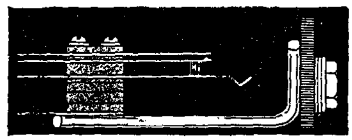
home into the socket of the jack. The spring contact X, when the plug is pushed home, bears against the point of the stem. Thus, though when the plug is inserted into the first jack the lead connected to its sleeve is the positive one, we find that when the plug is thrust into J_2 the lead connected to the stem becomes positive.

Wrong Method of Connection

If we wired up the jacks in this way, current from V_1 and V_2 would flow in opposite directions through the telephones when plugged into one or the other. As it is of the utmost importance that current should always flow in the proper direction through the telephone receivers or loud-speaker, we must alter the wiring of the second jack so that it does so when either valve is in use.



A single closed-circuit jack.



A single circuit filament jack.

A single open-circuit jack.

A Simple Alteration

This is very easily done in the way seen in Fig. 3. We simply connect the plate of V_2 to X and the high-tension positive busbar to Y of J_2. The lead connected to the sleeve of a plug will then be the positive one in either case.

Wiring-Up Several Rooms

When wiring a house so that the loud-speaker can be used in any one of several rooms, a good jack to make use of is the single closed circuit

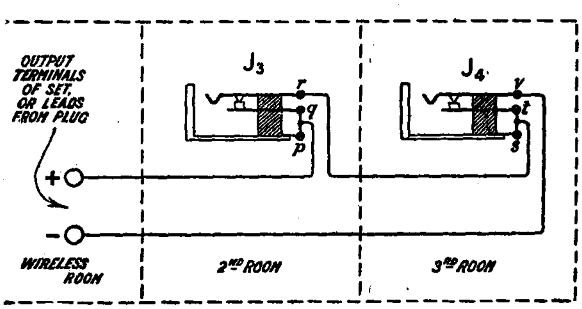
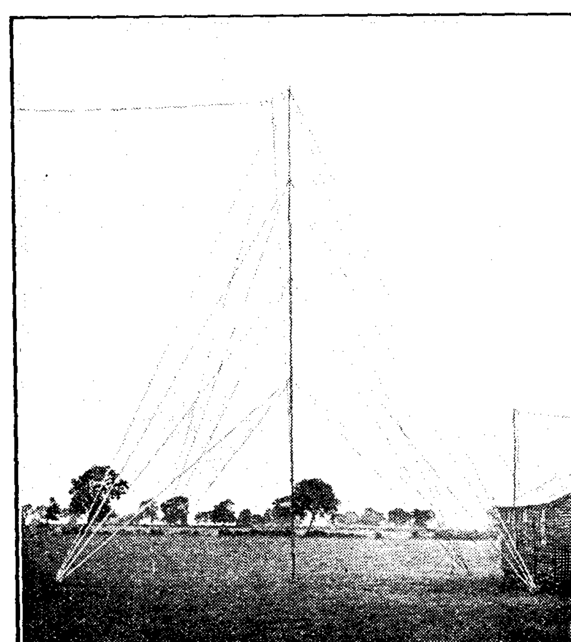


Fig. 4.—This method of wiring up the various rooms in a house possesses the advantage that the length of wire in circuit always remains constant.

seen in Fig. 4, J_3 and J_4. This type of jack has a single spring contact (r, v) and one leaf (q, t). As in the case of the single open jack, connection with the third tag (p, s) is made with the sleeve of the plug when the latter is pushed home into its socket. If the positive tag of the loud-speaker is connected to the sleeve of the plug, we can make sure that current through the loud-speaker flows always in the right direction, whether contact is made with the set direct or with a jack in another room. In the case of J_3 we connect together the two lower tags p and q. These we connect to the positive lead. From r, the spring contact, a lead is taken to the lower tags, t and s, of the next jack. The spring contact, v, of J_4 is taken either to the two lower tags of the following jack or direct to the negative lead if it is the last of the series.

Advantages Secured

One advantage of wiring a house in this way for the loud-speaker is that at no matter where it is plugged in there is always the same amount of wire in the circuit. Hence the tone of the loud-speaker does not vary from room to room as might be the case if the wiring were done in other ways owing to the greater or smaller capacity existing between its leads.

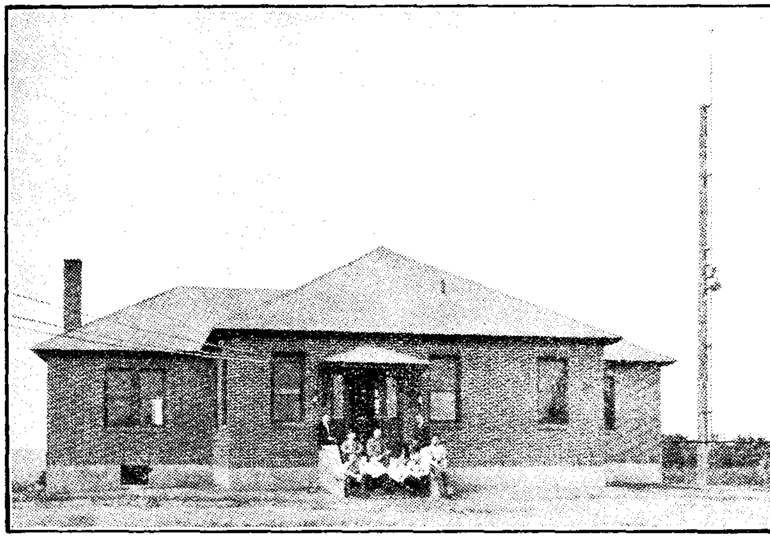


One of the aerial masts at the B.B.C. receiving station at Hayes. A smaller mast for a lower aerial is seen on the right.

IS THERE A HEAVISIDE LAYER?

By J. H. REYNER, B.Sc (Hons.), A.C.G.I., D.I.C., Staff Editor.

So much interesting progress is being made in the investigation of the problems of wave transmission that this special series of articles on the subject has been prepared. The author reviews the several conflicting theories now in existence and later on shows how these theories may be applied to explain absorption, fading, blind spots and such like peculiarities which are observed in practice.



A view of the well-known short-wave station KDKA. Readers who have heard KDKA's transmissions will know of the peculiarities of short-wave transmission which are discussed by Mr. Reyner.

THE problem of the transmission of wireless waves round the surface of the earth is one which has exercised the minds of investigators for a considerable period. The ordinary wireless wave travelling free and unhindered by any external influence is propagated in a straight line. Now, it is obvious that such a wave generated at a point such as A in Fig. 1 could never reach the point B, but would continue to travel outwards into space, unless it was deflected from its course by some other agency, which caused it to curve round the surface of the earth. Transmission

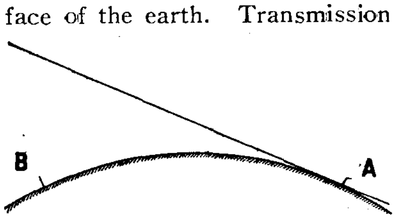


Fig. 1.—A wave transmitted from A would never reach B unless deflected by some external agency.

through the earth itself can be shown to be an inadequate explanation.

Since, however, wireless waves do travel round the earth, there must be some external deflecting influence, and the nature of this influence is the problem which has been troubling the most eminent scientists of the day, ever since the phenomenon of long-distance transmission by wireless was first experimentally observed.

Short Waves

Based on the comparatively long waves which, for reasons outlined in Dr. Robinson's article elsewhere in this issue, are almost exclusively used in long-distance commercial services, several theories were advanced which certainly gave a reasonable explanation of the observed facts, although in some particulars the theories failed lamentably. The theories, however, have had to undergo considerable revision in order to explain the very peculiar behaviour of ultra-short wavelengths which have come into prominence of recent years. These waves appear to defy all the existing conceptions of long-distance transmission, with the result that the existing theories have required to be investigated in very much greater detail.

Several Theories in Existence

One result of this upsetting of all preconceived ideas has been that theories which appeared under the old regime to be more or less ruled out of court, have been brought to life once again, so that there are now several theories which are all being actively discussed. It is proposed in these articles to review somewhat briefly the various theories which have been put forward, and to indicate wherein they achieve the same final result, and in what particulars they differ. It is then proposed to discuss in further articles the question of absorption, fading, and blind spots, and to show from the previous considerations how these defects may be reduced or eliminated. Thirdly, the problem of short-wave transmission will be considered, and reasons will be brought forward for some of the peculiar effects which are noted.

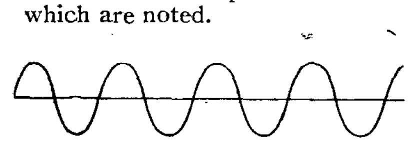


Fig. 2.—A type of diagram which is often supposed to explain wave motion.

Hitherto the question of wave propagation has been one which has been of interest principally to the scientist and the mathematician. With the increasing development of short-wave transmission and reception, however, the phenomena which are obtained depend to such a large extent upon the factors of absorption, reflection, refraction, etc., that these terms are becoming household words. The time is ripe, therefore, for a concise description of the whole mechanism of wave propagation in order that our readers may be fully conversant with the latest developments.

What is Wave Motion?

It will be advantageous at this stage of the proceedings to obtain a clear idea of what a wireless wave really is. A wireless wave is very often represented by a wavy line somewhat as indicated in Fig. 2, which has a perfectly

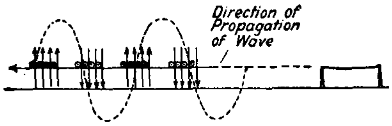
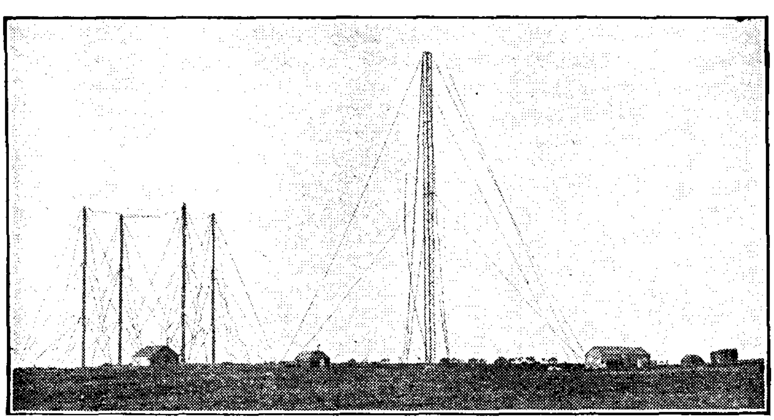


Fig. 3.—A wireless wave consists of a series of electric fields, first in one direction and then in the other, travelling in a direction at right angles to the fields.

definite meaning to the physicist or the mathematician, but which conveys very little to the average amateur.

The best conception of a wireless wave can be obtained from the following simple considerations. The current in a wireless aerial, which flows alternately up and down the aerial, gives rise to a series of electric fields. An electric field is a state of strain in the ether similar to that which exists between the plates of a charged condenser. Here one plate is at a different potential from the other, and the result is that there is an electric strain or field in the space between the plates.



The aerials of the coastal wireless station at Flamborough Head, which is shortly to be dismantled.

Electric Fields

Similar electric strains or fields are produced by the currents in a wireless aerial. These fields are first in one direction and the next instant in the opposite direction. When the current rushes up the aerial a strain is produced vertically upward, and when the current rushes down again half a cycle later the strain is vertically downwards (see Fig. 3). We thus have a series of vertical electric fields alternately upwards and then downwards separated by equal intervals, the time elapsing between bands in the same direction being the equivalent of that taken by the current in the aerial to complete one cycle.

It is obvious that these various fields must be connected in some way since they are all produced by the same current, and of course if the complete field that is produced is considered, then an arrangement somewhat similar to that shown in Fig. 2 is obtained (as indicated by the dotted line in Fig. 3). It is from this, of course, that we obtain the wavy line which is usually spoken of as representing a wireless wave.

It will also be clear that at some distance above the earth's surface the electric fields will not necessarily be vertical. This point will be referred to in the future articles.

Magnetic Field

We see, however, that as far as practical considerations are concerned, the wireless wave consists of a series of bands of electric fields alternately in one direction and then in the other. These bands of electric fields travel outwards from the transmitting aerial with a very considerable velocity, in the neighbourhood of 186,000 miles or 300 million metres per second.

It may be remarked in passing that these fields in motion produce magnetic effects which wax and wane in strict synchronism with the electric fields. These fields are at right angles to the electric fields, and are represented by the small circles in Fig. 3. This condition of affairs is only obtained at a distance of several wavelengths from the transmitter.

Rectilinear Propagation

Now these wireless waves travel outwards on all sides of the transmitting station, just in the same way as rays of light travel out in all directions from the point at which they are generated, and moreover, these waves normally travel in a straight line.

The fact, therefore, that the waves do travel round the curved

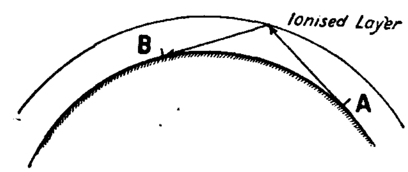


Fig. 4.—According to one theory the waves from A are reflected at the Heaviside layer and so reach B.

surface of the earth demands that there shall be some external influence on these waves, which is causing them to curve in their transit. Now there are several possible theories which can be put forward to explain the phenomenon. These theories are all similar to those which apply to the case of light waves, since light is only a different type of electro-magnetic radiation.

The Heaviside Layer

One of the earliest theories was proposed by Heaviside and elaborated by Dr. Eccles as early as 1912. This theory suggested that there was a layer of ionised air at a considerable height above the surface of the earth. Ionised air is air of which some of the electrons in the atoms of the gases have been released by some agency or other so that the air contains a large quantity of free electrons and is thus in a semi-conducting state.

Now a conductor of electricity acts as a reflector of electro-magnetic waves, just as a mirror will reflect light waves. The theory put forward, therefore, was that this ionised layer reflected the waves travelling outwards from the transmitting point, and so caused them to return to the earth. In this way transmission round the curved surface of the earth was possible by one or more reflections somewhat as indicated in Fig. 4.

The Refraction Theory

The original theory of Eccles explained the bending in terms of reflection at an ionised layer of gas. Subsequent investigators have shown that the electrified layer could also, under certain conditions, produce refraction.

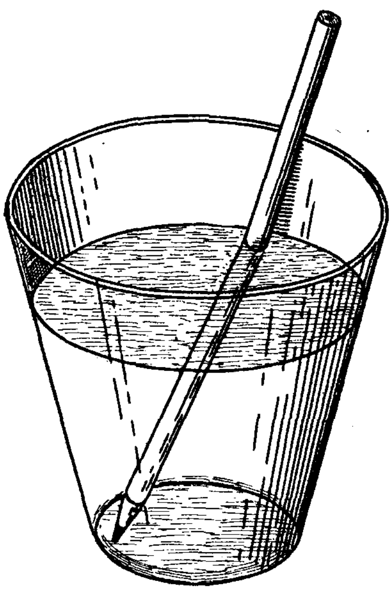


Fig. 5.—A pencil in a glass of water, viewed obliquely as above, will appear to be bent, due to the refraction of the light waves.

Now refraction is the phenomenon which is observed if a pencil is allowed to rest in a glass of water and viewed obliquely. It will be observed that the pencil seems to bend at the point where it enters the liquid, and would appear to be made in two parts, the join occurring at the surface of the liquid, as illustrated in Fig. 5. When the pencil is removed from the water, of course, it is seen to be one perfectly straight rod. This effect is due to *refraction* of the light rays due to the difference in the optical properties of air and water.

Refraction of Wireless Waves

Now in a similar manner it can be shown that wireless waves in travelling through the air can be refracted in this way if there is a change in the medium through which they are travelling. It is suggested that this ionised or electrified layer of upper atmosphere constitutes this change of medium, corresponding to the sudden change from air to water in the analogy we have just considered, and this will cause a bending or refraction of the wave just as the pencil appears to bend.

It can be shown that under certain conditions the bending will be such as to cause the wave to bend right round and return to the earth again. The effect, therefore, will be the same as that obtained with the reflection theory, but the agency through which it is produced is due to bending or refraction rather than reflection. Furthermore, it can be shown that the qualities which would have to be possessed by the electrified layer in order to produce this refraction are not beyond the bounds of possibility or even probability.

The Earth Resistance Theory

There is another theory which, however, has not achieved as much prominence as the other, which is that the earth resistance is responsible for the bending of the wave around the surface. It is well known that, owing to the fact that the earth is not a perfect conductor, the electric field at the surface of the earth is not exactly vertical, but is slightly inclined forward, as shown in Fig. 6. This may be understood by considering that, due to the resistance of the earth, the feet of the electric wave lag behind the higher portions to some extent, and so give a leaning effect, as illustrated in this figure.

Results of Research

Now, this slope of the wave front can be calculated theoretically, and it can be shown that with the values of earth resistance which are known to apply, the slope in the wave front would be of the same order as that which is known to exist in practice. Conversely, Smith-Rose and Barfield, of the Radio Research Board, in some recent work, have actually measured the slope of the wave front at the surface of the earth and thereby have calculated the value of the earth resistance in various localities.

Now, the theory proposed in some quarters is that this earth resistance by itself is sufficient to keep the feet of the waves on the earth, instead of permitting them to drift out into space as one would expect with a rectilinear propagation. The signal strengths obtained in practice, however, are much stronger than would be expected on the basis of this theory. The recent developments in short-wave work, moreover, and researches which have been conducted into the problem of fading and suchlike phenomena would indicate that this theory does not explain all the observed facts.

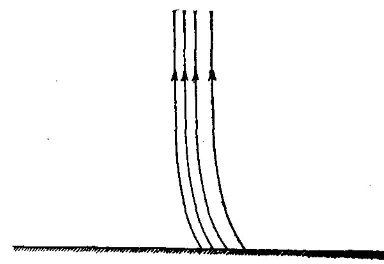


Fig. 6.—Owing to earth resistance the electric fields at the earth's surface drag behind slightly. The above figure illustrates this lagging with a wave travelling from right to left.

The Meissner Theory

A theory which is a much more serious rival to the Heaviside layer theory is that which has been put forward by Meissner in Germany, which explains the bending of the wave in terms of a gradual change in the quality of the atmosphere at increasing heights above the earth's surface.

The propagation of electric waves through any medium depends to some extent upon the dielectric constant of the medium in question. The capacity between any two planes in space is dependent upon the dimensions of the planes and their distance apart, and also upon the nature of the substance in between them. The particular property of the substance which affects the capacity is termed the dielectric constant of the material, and the value of this constant is known to vary according to the height above the earth.

England Visible from Mont Blanc

Now Meissner argues that this variation in the atmosphere is all that is necessary to explain the bending of wireless waves. It is well known that under certain conditions it is possible to *see* enormous distances.

A particular example of this is the fact that the coast of England can, at times, be seen from the top of Mont Blanc in the Alps.

The English coast, however, is well below the normal horizon, even allowing for the height of Mont Blanc above sea-level, so that some considerable refraction of the waves is taking place.

If, therefore, it is possible to see over such enormous distances (over 450 miles in this case) and *to explain the phenomenon in terms of the varying density of the air* at different altitudes, it is argued that a similar explanation should hold good for wireless waves.

Effect of Water Vapour

Schwerz has shown that the presence of water vapour in the air will cause a *decrease* in the dielectric constant of the atmosphere as the height above the earth increases.

This will cause the waves higher up to travel faster than at the earth's surface, so that the electric field always remains normal to the earth as indicated in Fig. 7, and the direction of propagation, which is always at right angles to the electric field, is thus curved.

According to this theory, moreover, the refraction occurs within a height of one to two

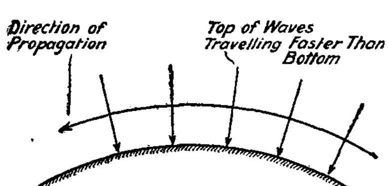
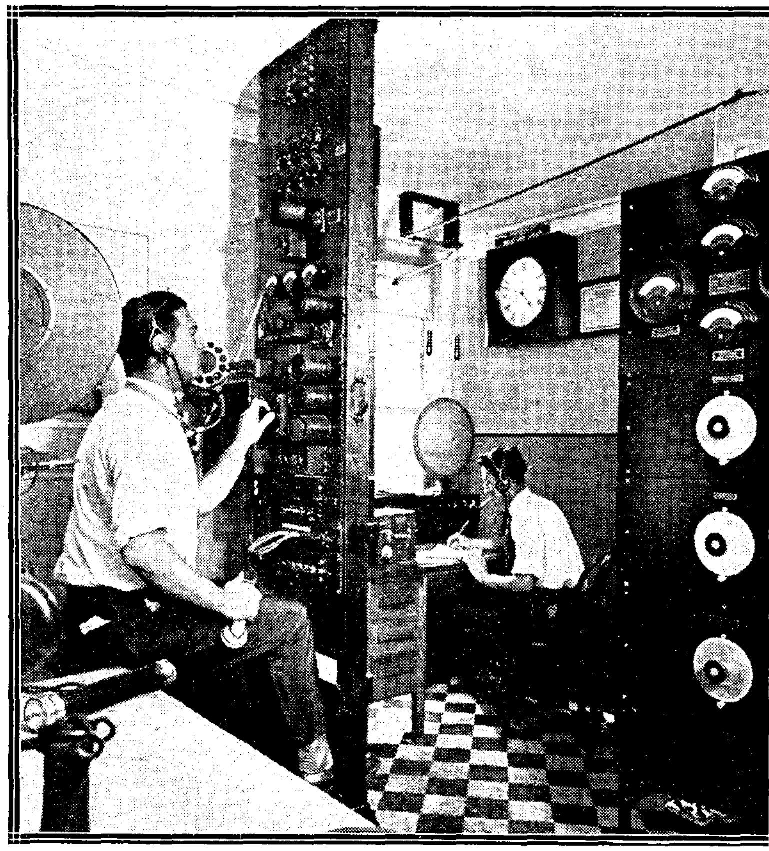


Fig. 7.—The top of the wave travels faster than the bottom, and so bending is produced.

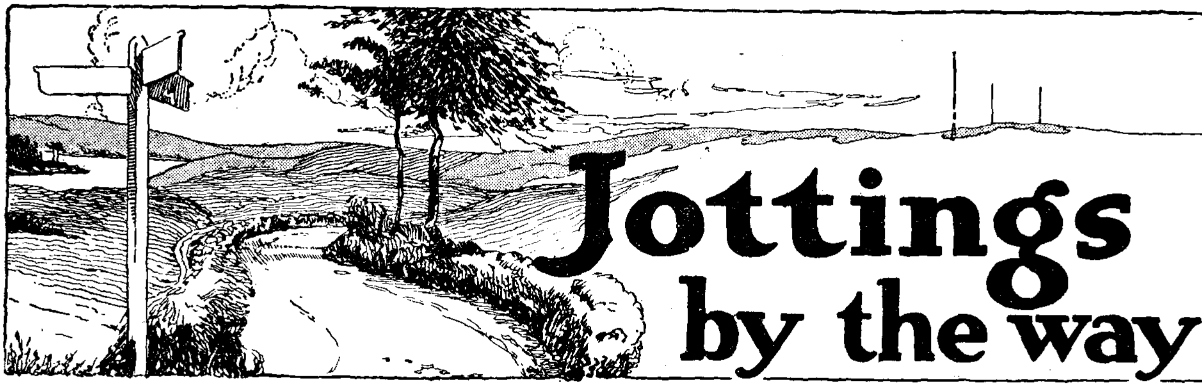
kilometres from the earth's surface, whereas the electrified layer which produces the reflection and refraction in the previous theories is estimated to be from 60 to 100 kilometres from the earth's surface.

Which Theory is Correct?

It only remains, therefore, to discover which of these theories is the most correct one. It is probable that, of all the theories which have been put forward, a certain proportion of each theory is true. That is to say, the curved path of the wireless wave is due, in part, to creeping round the earth's surface, in part to reflection and refraction, and in part to bending due to the difference in the dielectric constant of the medium. Recent researches, however, tend to indicate that certain of these factors have a greater effect than others, and in my next article I shall discuss such effects as absorption of the waves at various frequencies, night variations, fading, etc., and show how these various phenomena are explained by the modern theories.



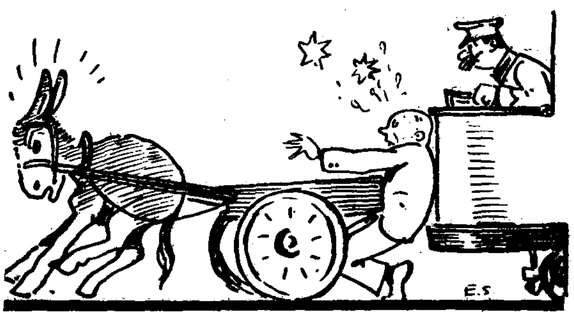
In previous issues we have given several photographs of the station WRNY, operated by the American wireless magazine "Radio News." This new photograph shows another view of the control room.



Jottings by the way

The Second Lecture

IN my last report from the Continental front I told you how the Professor, Poddleby and I were successful in raising the wind during a terrible financial calm by means of a lecture. I recounted, too, the sad loss of the proceeds shortly afterwards owing to the Professor's pathetic trust in human nature. Luckily we were saved by the second lecture, delivered upon the following evening. The Professor chose as his subject oscillating currents, and dealt with them in his usual masterly manner. No small



. . . A terrible collision between a tramcar and a donkey cart . . .

part of his reputation has been gained by the part that he has played in pulverising popular heresies. In speaking of oscillating currents Professor Goop began by outlining the popular conception of them, which is that they surge up and down like the waves of the sea. This, he pointed out, was entirely wrong since they really wobble sideways.

He had a little difficulty in drawing the switchback things to illustrate his lecture, since when a blackboard is placed in the ordinary way you can only draw things that go up and down. This, however, we got over by suspending the blackboard horizontally from the ceiling and placing the Professor in a hammock slung below it. Poddleby, who is fat and cushiony, stood below to break his fall in case of accidents, and, except on one occasion, he performed his task so skilfully that he nearly always succeeded in catching the Professor when he fell. I must admit that Poddleby was somewhat second-hand looking at the end of the lecture, though the Professor was in thoroughly good repair, for at the only time that Poddleby missed him he fell upon about two tons of starving Hun and simply bounced back into the hammock.

Too Busy to Return

The money taken for seats at the lecture ran into a very satisfactory sum, and we were able to move into one of the best suites at the Hotel Terrifique, where we have since been able to do ourselves nearly as proud as if we were Germans. Things in fact looked so rosy that we determined to prolong our stay abroad for quite a while.

You may imagine my disgust when I received one morning a letter from the office asking rather pointedly when I should be expected back. I replied pointing out that I was working day and night upon the investigation of wireless on the Continent, similar to that carried out recently by Mr. Hercy Parris in America. I also enclosed my hotel bills and a brief statement of expenses. These were returned to me, if you will believe me, with a still more pointed covering letter, and no cheque. However, as you know, it takes something like a difficulty to down me. I simply wrote to the stationmaster at Dijon, enclosing a telegram, which I asked him very politely to send for me. The wire said, "Pinned under engine in last French railway smash. Hope sufficiently recovered to return in about month."

. . . There came to us a pair of scientists . .

The stationmaster, I am sorry to say, failed to play the game, for he merely posted on to Bush House the telegram and the letter that I had sent with it. I am now waiting to hear from London again, but I have still a shot in my locker, for I have made friends with a Yugo-Toblazian doctor who has promised, should the need arise, to write on my behalf from Kastoff giving the fullest details of my shattered condition owing to a terrible collision between a tramcar and a donkey cart in that beautiful city.

The Interpreter

On the days following the second lecture there was a continual stream of distinguished callers to the Professor's apartment. Eminent scientists of all nationalities who were staying in the town came to shake him by the hand, and to ask his views upon various wireless problems.

The main difficulty during these interviews lay in the language question. The Professor, as I have told you before, is not practised in foreign tongues, whilst Poddleby, if English is not understood, relies upon the language of signs, in which he is extremely skilful. I have known him at a

. . . Driving his points home with swats from his shoe . . .

restaurant order clear soup, salmon mayonnaise and cutlet entirely in this way. When it came to making signs like a square-law variable condenser or a low-loss inductance Poddleby found himself rather out of his depth. It therefore fell to my lot to act as interpreter on most occasions. Luckily the foreign scientists wished to do all the talking, and all that I had to do was to say " oui " or " non " at appropriate intervals, to shrug my shoulders, or to do physical jerks with my arms as required.

Distinguished Visitors

The other morning there came to us a pair of scientists whose general appearance proclaimed them at once as being a cut above all that we had previously seen. Both of them spoke English. The first introduced himself as Mr. University-scienceprofessor Funk. He had a beard like a bird's nest, a bald head and large damp hands. He had apparently borrowed his coat from a museum, where it must have been used for the cultivation of mosses and lichens. His lamentable nether garments fell in folds to a pair of gym shoes, and about his neck he wore a celluloid collar adorned with a natty little made-up tie with pink and yellow stripes. The second, Professor Gobemouche, was garbed in much the same way, though in an absentminded moment he had apparently forgotten to put on any collar at all.

An Invitation

Having greeted Professor Goop warmly, the pair informed us that they had come to take him, Poddleby and myself to supper with them that very evening, and then to devote the remaining hours before bedtime to theoretical and practical wireless. Having had a look at them we hastily declined the supper, but accepted the invitation to a wireless evening. Both of them rushed at Professor Goop with the intention of embracing him, but he dodged rather neatly from between them, with the result that they were embracing each other before they knew where they were. Such was the violence of their impact that their beards became entangled, and we had to cut them apart with tin shears borrowed from the handy man at the hotel.

After dinner that evening the three of us went to their house prepared to uphold the honour of Little Puddleton whatever might befall. Things started quite peaceably with a general discussion of Professor Goop's great inventions, over which our hosts were most enthusiastic.

The Argument

Towards the end of the evening I quite unwittingly introduced the apple of discord by mentioning the question of high-frequency amplification. Professor Goop gave his views on the subject of suitable circuits, and was promptly contradicted flatly by Professor Funk. Professor Goop merely shrugged his shoulders and smiled benignly. What tore it was the entry into the discussion of Professor Gobemouche, who proceeded flatly to contradict Professor Funk. Professor Funk did not shrug his shoulders, nor did he smile benignly. For a moment or two he was speechless. Then rising from his chair he rushed at Professor Gobemouche, stamped upon his toes, and shook his fists in his face. " Pighound " he screamed. Professor Gobemouche was not the sort of fellow to stand that kind of thing. With a sweeping movement of the right arm he removed a handful of his rival's bird's-nest beard, saying quite simply, " Species of stuffed one."

A Quiet Discussion

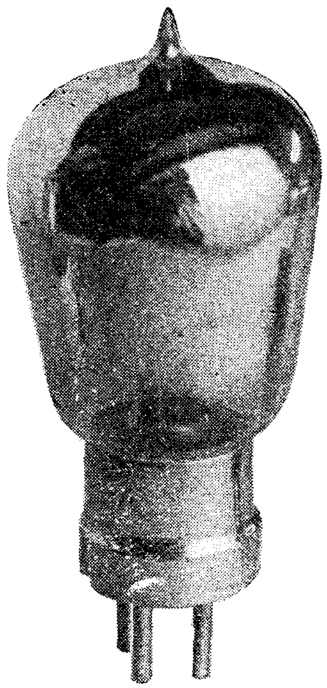
" Do not be alarmed," I said to Poddleby and the Professor. " They are not really quarrelling." By this time Professor Funk was kneeling on Professor Gobemouche's chest, and was driving his points home one by one with swats from his shoe. It looked really as if there were going to be a scene. Luckily Poddleby was able to relieve the tension by a sudden inspiration. Deftly he flicked out the high-tension positive wander plugs of the receiving set, whose loud-speaker was adding to the din by providing dance music from 5XX. He then pointed out to the recumbent pair that a breakdown had occurred. Both combatants leapt to their feet, Professor Funk opening his mouth to thank Poddleby and releasing Professor Gobemouche's ear. The former replaced his shoe, and the two of them, now brothers in adversity, set about discovering the cause of the breakdown. So deeply engaged were they in their researches that they did not notice our departure as we tip-toed from the room.

WIRELESS WAYFARER.

Are Dull Emitters as Good as Bright?

By J. H. REYNER, B.Sc. (Hons)., A.C.G.I., D.I.C., Staff Editor.

There is a tendency to regard dull emitter valves as inferior to the bright-emitting type. This article gives some interesting information on the subject.



A dull emitter power valve with a thoriated tungsten filament.

IN the early days of dull emitting valves, while the new development was welcomed from the point of view of economy in filament current, there was an impression that the new valves were not quite up to the standard of the old bright emitters in

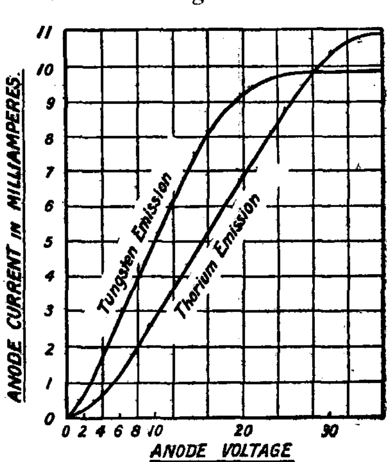


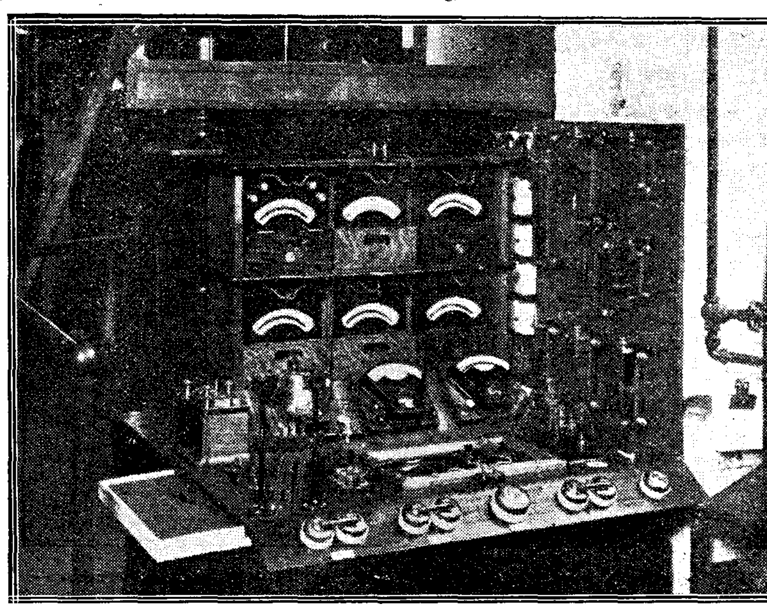
Fig. 1.—Characteristic curve for the same valve used as a bright or a dull emitter.

point of efficiency of operation. This was certainly noticeable in certain circuits, which lent colour to the impression.

The Filament

It is probable, however, that this apparent loss of efficiency or liveliness was due to the fact that the circuits in which the valves were tried were designed for bright emitters, and were not so efficient when used with dull emitters having different values of internal impedance and amplification factor.

There are two principal types of dull emitter, the one having a platinum filament coated with suitable oxides and the other type having a thoriated tungsten filament, heat treated to form a very thin layer of thorium on the surface. It is proposed in this article to consider only the latter type of valve.



One of the testing tables at the Marconi Osram Valve Works. Complete apparatus for obtaining rapidly and accurately the characteristic curves.

Dull Emitter Characteristics

Perhaps the best indication of the actual difference between the bright and the dull type is the experiment of taking the characteristic of a valve both as a bright emitter and a dull emitter. It is possible to make up a valve with a thoriated filament, and to run this valve as a bright emitter and so to take a set of characteristics.

The filament may then be given a suitable heat treatment so that it possesses dull-emitting properties. If this is done and the characteristics are again taken, then any difference which may be observed is entirely due to the difference in the filament, since the valve is in all other respects identical with the original one.

The anode-current/anode-voltage characteristics are shown in Fig. 1, from which it will be seen that, with the dull emitting filament—

(*a*) The slope of the curve is less, which means that the internal impedance is higher;

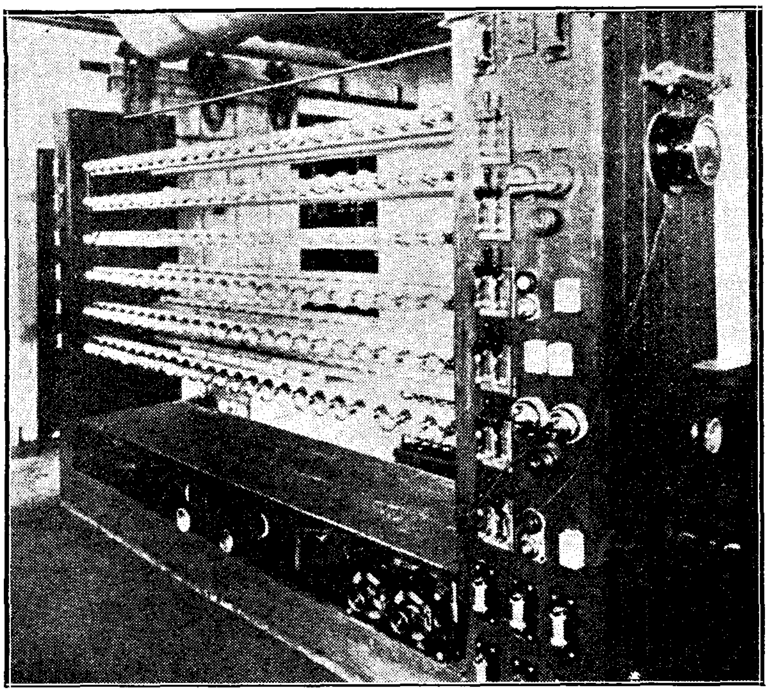
(*b*) The saturation effect is more gradual. This has little effect on the working of the valve.

Grid Bias

The anode-current/grid-voltage characteristics are shown in

Fig. 2, from which it will be observed that the current at any particular grid voltage is less with the thorium emission than with the tungsten emission (bright emitter).

This has the effect of shifting the characteristic over to the right so that the negative bias required on the grid of a dull emitter is somewhat less than that necessary with a bright emitter. The slope of the curves will be seen to be approximately the same. Hence, since the internal impedance is higher, the amplification factor will also be slightly greater.



An "ageing" rack for receiving valves. In each of these racks provision is made for 300 valves.

Anode Voltage

If a circuit is designed to suit dull emitters, however, these differences in the characteristics should not affect the results obtained, which should be equally as good as with a bright valve.

A point where there is a slight disadvantage with dull emitters is that of the anode voltage permissible. All valves nowadays are specified for use with certain anode voltages. With a bright emitter the maximum voltage given may be exceeded without serious results, but in the case of a dull emitter this is not the case.

Injury from High Anode Voltage

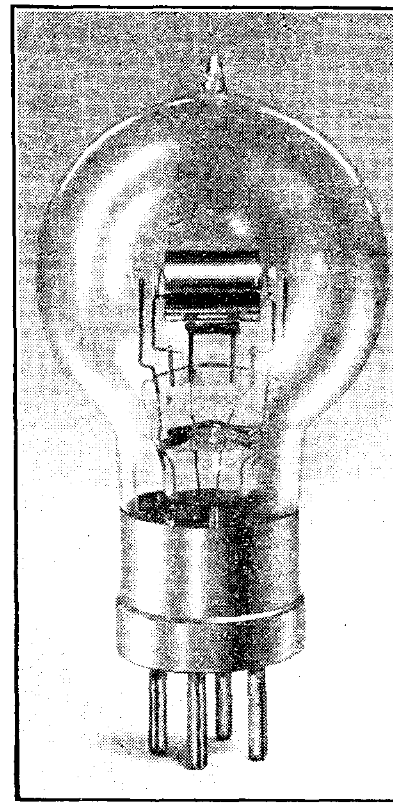
As the anode voltage is increased stray electrons emitted by the filament escape past the anode and reach the bulb. If they are travelling with sufficient velocity when they strike the bulb they may ionise any occluded gases contained therein, and the heavy positive ions ultimately drift to the filament and bombard it, so destroying the delicate thorium layer on the surface thereof.

Limits of Anode Voltage

The velocity of the electrons depends on the anode voltage, so that for a given size of bulb there is a limiting value of the anode voltage which must not be exceeded or else the valve may lose its dull-emitting properties. With the valves in use to-day, all the results required can be obtained with anode voltages within the limits specified.

Excessive Filament Current

The effect just described, therefore, is not one affecting the relative efficiency, but indicates that it is possible to spoil the valve more readily than a bright emitter. The same applies to the filament current. An excess filament current on a bright emitter



One of the older types of bright emitter, similar to the ones on which the tests were carried out.

does no harm except to reduce the life, although in extreme cases it will cause a burn-out. With a

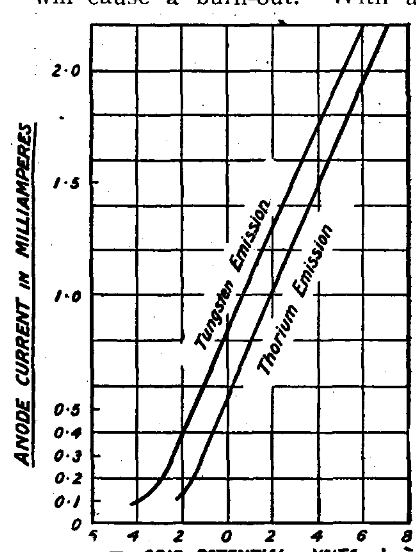


Fig. 2.—Grid-volts/anode-current curves for the same valve with a bright and a dull emitter filament.

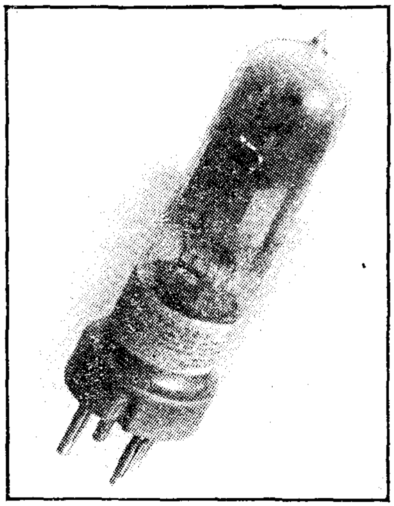
dull emitter, however, the effect of undue increase of filament current is to destroy the thorium layer and so to spoil the valve.

Re-conditioning Damaged Valves

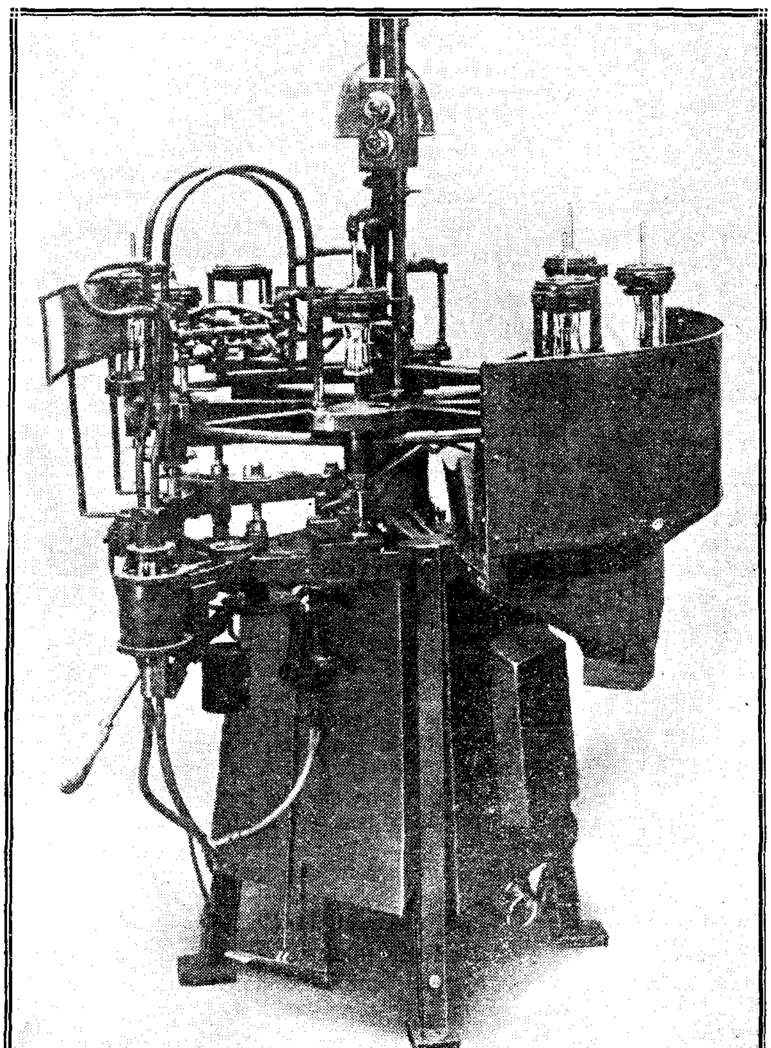
Fortunately, should the valve lose its dull-emitting properties from any cause, it can usually be re-conditioned by suitable heat treatment. This may be done at home by running the valve at its normal temperature *without the anode voltage on* for some hours, which enables the thorium layer on the surface of the filament to re-form.

Strength of Filament

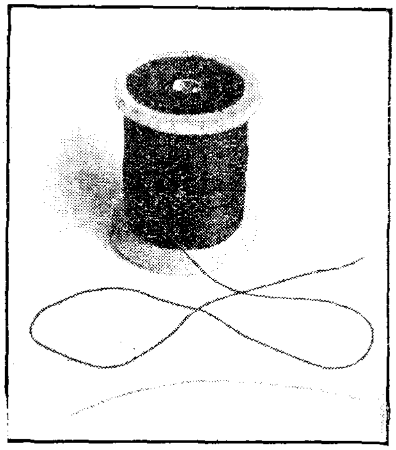
A few remarks here concerning the strength of the filament may not be out of place. It is often thought that because the filaments of dull emitters, particularly the 60 milliampere class, are so fine, that they must necessarily be very fragile. This, however, is not the case. Tungsten, when cold, is very ductile, and the actual wire used in making a 60-milliampere filament requires considerable force to break it. The filament retains this strength and ductility when heated until a certain critical temperature is reached, when a change occurs in the crystalline structure and the filament becomes very brittle. Ordinary dull emitters never run the filament up to this critical temperature, so that the filament remains ductile, whereas bright emitters are run at a temperature exceeding the critical value and the filaments therefore are comparatively brittle. Hence the mechanical strength may be even less than the much finer dull emitter filament.



A typical .06 ampere dull emitter. Note the "gettered" bulb.



A "Sealing-on" Machine for small valves. The electrodes are first mounted on a glass stem which is subsequently sealed into the bulb.



An interesting comparison: a piece of .06 ampere filament wire and sewing cotton.

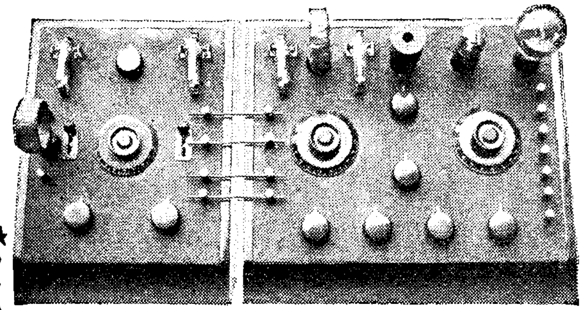
END OF VOL. 6.

The present issue is the last of Vol. 6, and our readers are reminded of the facilities for binding which have been arranged with the publishers. Binding cases may be obtained, in cloth, price 2/6 (2/10 post free), or in half leather, 4/6 (4/10 post free). Readers, however, may have their back numbers bound, complete with an index, for 4/6 (5/6 post free) in cloth; and 7/6 (8/6 post free) in leather. This price, of course, includes the cost of the cover. The index itself may be obtained separately, price 1/- (1/1 post free). The cover in all cases, is blue, with an attractive gold lettering.

Some Further Notes on the New Loud-Speaker Circuit

By **G. C. BEDDINGTON (5KA)**
(Trinity College, Cambs.)

In our September 2 issue we published an article on "A New Loud Speaker Circuit." Since the preparation of that article Mr. Beddington has done some more experimental work on the circuit and embodies his results in a further article given below.



A set used by the author employing a circuit similar to that given in Fig. 7 of the previous article.

SINCE the article on the new loud-speaker circuit developed by Major C. E. Prince, and described by the writer in *Wireless Weekly* of September 2 was first written, the power of broadcasting stations has been increased, more types of valves have been put on the market, and as a result the circuit is now of even greater use than before.

Valves with fine grids and high amplification factors, such as the Marconi D.E. 5B and the Mullard D.3 (H.F.), are now easily obtainable, and therefore the circuit can be further simplified by doing away with the detector potentiometer and grid battery shown in the first article, and by connecting the lower end of the oscillating circuit direct to the negative end of the filament. Adjustments for best results can then be made by means of a filament resistance in the lead to the positive end of the filament of the detector; this resistance should have a large range, as usually it will be found best to run the detector filament much under its normal current rating. With this arrangement it is also convenient to use a smaller detector anode battery, two or three 4½-volt flashlamp units working very well.

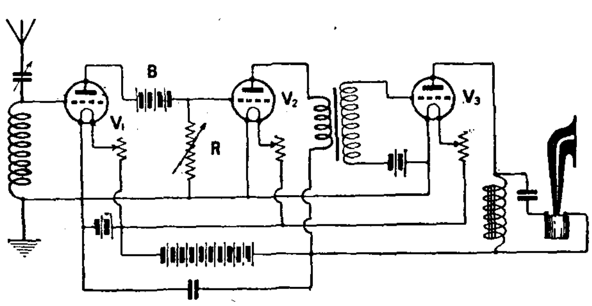


Fig. 1.—A practical diagram of the complete loud-speaker circuit, one stage of normal low-frequency amplification being included for the best results.

Addition of Low-frequency Stages

To take full advantage of the virtues of the trigger circuit one stage of low-frequency amplification may be used. A satisfactory arrangement is shown in Fig. 1. The series aerial condenser is of advantage with some aerials on the 300-500 metre (1,000-600 kc.) band, but for Daventry a larger coil should, of course, be used with a condenser in parallel. The detector anode battery B, as mentioned above, may be made up from two or three flashlamp cells—avoiding, as far as possible, capacity effects between it and the common negative or earth. For this reason also it is of some advantage on the shorter waves to use low-capacity valve sockets for both the valves V1 and V2. It is convenient to have the gridleak resistance R variable, unless the set is to be left in totally unskilled hands. When listening to weak and distant stations this gridleak may be as high as 5 megohms, but when listening to Daventry, or to the local station, in order to prevent choking due to too great negative potentials summing up on the grid of the second valve, its resistance may profitably be brought down to 100,000 or even 50,000 ohms.

Power Valves Preferable

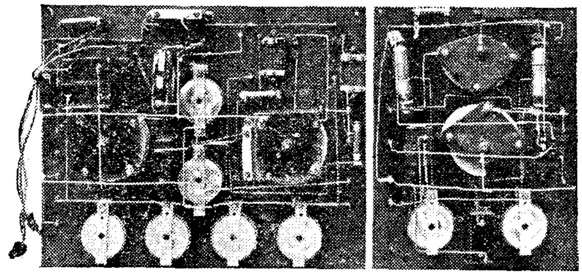
The first valve should be, as explained, one with a high amplification factor. The second valve should be one of the R types, or a small power valve, and the low-frequency transformer should be chosen accordingly. It is essential that the latter should be of sound design, and, so far, the writer has found the Ericsson, the Marconiphone Ideal, and the General Radio Company's transformers suitable; no doubt there are other suitable ones.

The third valve should be of the power type, with its grid given a suitable bias, and also it should be of a type designed to deal with as large a swing of grid-voltage as possible.

High Amplification Obtainable

The need for this is demonstrated by the fact, which also indicates the enormous amplification obtainable, that, with the circuit properly adjusted, a buzzer wavemeter held near the tuning coil will cause a neon lamp substituted for the loud-speaker to light brilliantly. It may be pointed out that with the arrangement of choke and condenser shown in the output circuit, no direct current passes through the loud-speaker or the lamp, so that it is plain that the modulation-voltages light the lamp unaided.

The circuit seems to approach the ideal more nearly than anything so far produced, where quality is the first consideration rather than long distance work, but, naturally, high-frequency amplification may be used when desired in front of the detector as long as reaction effects are avoided as much as possible. The circuit is also suitable for use as a "second detector" in supersonic heterodyne sets.



The wiring of one of the receivers used by the author. The front of panel view is given on the previous page.

Better Reproduction than with a Crystal Detector

Curiously enough a single low-frequency stage of amplification used with the trigger circuit seems to give better quality reproduction, apart from much greater volume, than even a single stage of low-frequency amplification following a crystal. Though it is true that given a sufficient input a crystal gives practically linear rectification, and that the first two valves of the trigger circuit together give rectification that is probably not quite linear, nevertheless, since their combined characteristic curve is a falling one the effect is to improve by compensation the reproduction of the low-frequency stage, which, of course, tends to amplify the higher frequencies better.

Tone Control Unnecessary

One detail is worth mentioning, and this is that when using the trigger circuit, neither the primary of any low-frequency transformer nor that of a telephone transformer or choke used with it should be shunted by any fixed condenser. With more usual circuits this is often done to make the tone more "mellow," in other words, to damp down the higher frequencies, whereas with the trigger circuit and good components no such faking is needed.

The human ear is an adaptable instrument, and therefore often somewhat deceptive; it is critical psychologically rather than mathematically, and so the writer can safely say that the trigger circuit gives more pleasing and more "natural" reproduction than any other he has ever heard of comparable loudness. And even if the reproduction is not mathematically exactly correct—and the ear itself is a variable and puzzling factor—the circuit may seem so good and so faithful possibly because it has a quality of correcting the reproduction as at present broadcast, if, indeed, any correction is needed.

Recording

For those amateurs who are interested in recording Morse signals with an inker or a syphon recorder this trigger circuit provides a method of amplification of the same order as that of the Turner oscillating valve trigger relay and yet considerably simpler to work.

A recording unit to be used after any receiver can be made on the lines of the circuit shown in Fig. 2. As voltage step-up is the chief consideration rather than distortionless amplification, the transformer T may have a turns-ratio of 10 to 1 or more. The valve V1 should be a D.E. 5B, or of a similar type, the valve V2 may be a power valve, and the gridleak R—on which the trigger action depends—should be of a resistance high enough for as much amplification as possible to be allowed without the dots and dashes running into one another. On slow transmitters and weak signals it may even be omitted altogether, or a small condenser used in its place. The latter naturally increases the cumulative action of negative potential on the grid of the recording valve.

It is plain that the relay R is worked by a shutting-off of the anode current flowing through it. Thus, if the relay works the inker every time its contacts "make," then it should be so adjusted that a spring tends to pull the tongue over to "make" while the steady anode current is just strong enough to pull the tongue away and "break," except when dots or dashes are received.

A Fruitful Field for Experiment

In conclusion, the writer hopes that the trigger circuit may prove a fruitful field for experiment; for instance, to settle the point whether, when a low-frequency stage is used, it is best to use some negative potential on the detector grid, together with a large detector anode voltage and a high resistance gridleak, or whether a smaller detector anode battery and lower gridleak resistance should be used without any negative potential on the grid. The circuit of Fig. 1 is probably the best to try out just as it is, but the essential things to remember are these: use a real power valve in the last stage, use an adequate loud-speaker, and if no high-frequency amplification is used look for quality and volume rather than sensitivity and selectivity.

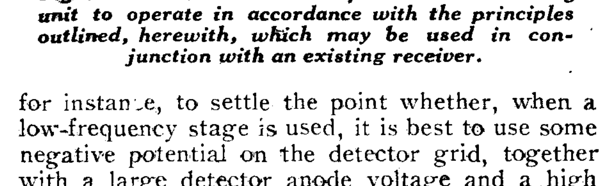


Fig. 2.—The circuit of the amplifier for a recording unit to operate in accordance with the principles outlined, herewith, which may be used in conjunction with an existing receiver.

Wireless News in Brief.

The Indian Beam Station. We are informed that the Indian Radio Telegraph Company has now acquired all the agency rights of the Marconi and allied companies in Britain, Germany, France and America. The Marconi engineers, who have gone to Poona to arrange for the erection of the new beam station there, are sanguine that with improved apparatus there will be no difficulty in overcoming the atmospheric interference which has spoiled radio messages to India up till now.

* * *

Wireless in Burma. The amalgamation of the Radio clubs operating in Burma has made it possible to arrange local programmes for broadcasting, and a new interest is being created. Up till now, the only possible thing for wireless enthusiasts in India was to try to listen-in to Calcutta. Madras, though ordinarily easier, was too weak, and Calcutta was often interrupted by atmospherics. Now that local programmes are possible, wireless should make good headway.

* * *

It is announced from Novonikolaevsk that a new Soviet radio station is being constructed at Chuguchak in Western China for meeting in the first place the requirements of the Soviet trading organisations and the Consuls.

* * *

A Symphony Concert will be given at the Manchester Station on Thursday, September 24, by the 2ZY Augmented Orchestra, conducted by Mr. T. H. Morrison, Miss Annette Blackwell (soprano) and Mr. William Heseltine (tenor). In answer to many and repeated requests, Bach's "Brandenburg Concerto in G" has been included in the programme.

Mr. Paul McGee, Chief Radio Operator with the MacMillan Arctic Expedition, who has been instrumental in the successful transmission of speech and music from Etah, in Greenland, to Australia.

The St. John's Church Boys' Prize Choir, of Blackburn, conducted by Mr. Thomas L. Duerden, who were the first prize winners at this year's Eisteddfod at Pwllheli, will broadcast from Manchester on Saturday, September 26. They will include in their programme test pieces sung by them at the Eisteddfod.

* * *

Wireless for Missionaries. News is to hand from Australia that the Australian Inland Mission party have set out on a tour of Central Australia provided with every facility for wireless communication. Provision has been made to transmit on 600, 250, 80, and 70 metres at definite periods during the entire trip. Each Sunday, at noon, Eastern time, a 20-metre set will transmit news, and it is not at all unlikely that signals may be received in this country. The call sign to be used by the mission party will be 8AC.

* * *

The MacMillan Expedition. A message has been received from Commander McDonald of the MacMillan Arctic Expedition at Etah, Greenland, that at the end of last month the Expedition was consistently in touch with Australia and New Zealand every night by wireless. It is stated that this achievement and also the successful transmission of Eskimo songs and music for re-broadcasting to American listeners via the Zenith Radio Corporation Stations 9XN and WJAZ in Chicago, are mainly due to the efforts of Paul McGee, the Chief Radio Operator on board the s.s. *Peary*. The broadcasting of the musical programmes was carried out while broad daylight and sunshine were prevailing at Etah.

In the new Public Health Act, which came into force on September 8, wireless is the subject of a special section to prevent danger or obstruction by installations. Apparatus must not be so placed as to be liable to fall on the public.

* * *

Wireless in Russia. We understand that experiments are in hand for the relaying of opera from Moscow. M. Poliakov has been sent to England to represent the Russian broadcasting authorities in this connection. M. Poliakov reports that people in Nijni-Novgorod already dance habitually to the Savoy Bands as broadcast through the B.B.C. High-power Station. If the projected experiments are successful—and there are strong reasons for believing they will be—British listeners should have the opportunity next winter of enjoying some of the best programmes of ballet and opera produced in Russia.

* * *

Wireless "Lighthouse." A demonstration was recently given at the South Foreland by Senator Marconi of his new "wireless lighthouse." The basis of the invention is the beam system of directional signalling, and a revolving aerial arrangement is used. The compass is divided into 64 sections, to each of which is allotted a separate Morse character. Thus when one of these characters is picked up in the receiver of a passing ship, reference to a chart shows its position relative to the transmitting station, its distance from that station being determined by the strength of the received signals. The automatic transmitter operates on a wavelength of 6 metres (49,970 kc.).

* * *

Rights of wireless communication in China and from China to other countries have led to differences between foreign companies which have conflicting claims. The Peking Government, it is reported, threatens to revoke a concession granted to an American company to build a high-power station, thus giving the Japanese company, which has a station at Peking, far-reaching control of wireless developments in China. The Marconi Company's representative here states that he will push the claims of his company in case the American and Japanese companies reach an agreement as has been suggested. The Marconi Company, he declares, has a contract with China which goes further back than any of the others.

* * *

Geneva broadcast. On September 10 the speech by Mr. Austen Chamberlain at the Assembly of the League of Nations at Geneva, was picked up from the Eiffel Tower by the B.B.C. station at Hayes, in Kent, and rebroadcast through 5XX and 2LO. Although Mr. Chamberlain's voice was clearly audible it was almost impossible to understand a complete sentence, and at times only single words were distinguishable.

The loud applause which greeted the Foreign Secretary and the ovation he received when he had finished were, however, very effectively transmitted.

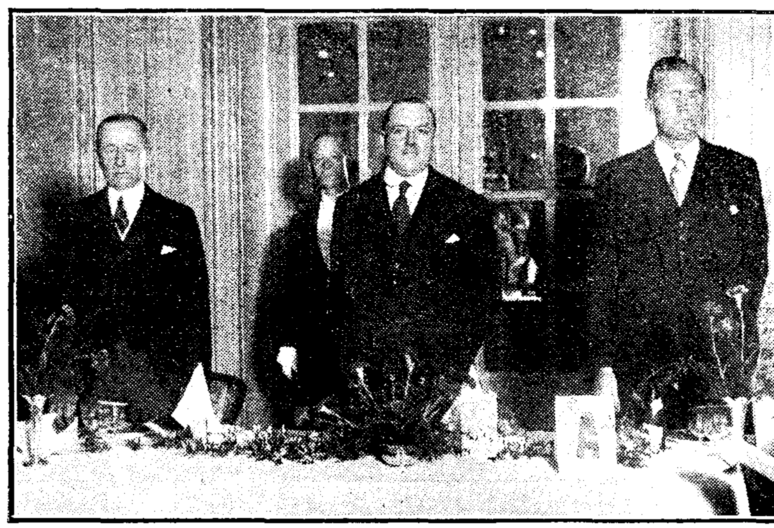
The B.B.C., in an official report, state that the experiment proves that the utilisation of a long land-line across international boundaries is not satisfactory in existing circumstances. On the other hand, it proves the feasibility of the wireless link. The signals were inevitably mutilated at the end of the land-line from Geneva to Paris. Thus, however faithful was the subsequent reproduction, it was too heavily handicapped to be successful.

The B.B.C. engineers regard these experiments from Geneva as of considerable technical value and believe that they will provide a basis for the future development of international transmissions, to which the B.B.C. attaches first-class importance.

* * *

Debates by Wireless. We are informed that the New South Wales Cabinet is considering a scheme whereby Parliamentary debates will be transmitted by wireless to Ministers' rooms, thereby enabling them to avoid attendance in the House while transacting their ministerial duties.

Both transmitting and receiving sets would probably be installed so that Ministers can reply direct, through the medium of loud-speakers.

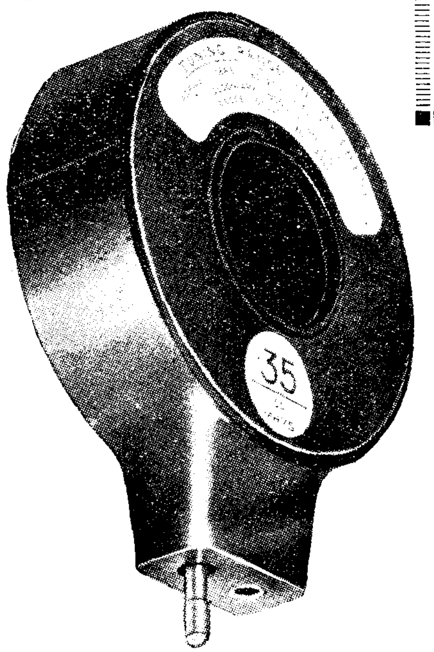


To celebrate the 30th Birthday of Wireless the National Association of Radio Manufacturers and Traders gave a luncheon at the Savoy Hotel on Friday, September 11. Interesting speeches were made by Senator Marconi, Mr. W. W. Burnham, Mr. J. C. W. Reith, and others.

Experiments were recently carried out on board the North German Lloyd steamer *Columbus*, when an endeavour was made to keep in constant telephonic touch by wireless throughout the voyage from New York to Bremen. Reports now to hand announce the complete success of the experiment, and, as a result, further efforts are now being made to extend the service. The liner *Munich* broadcast messages recently while at sea which were not only picked up in Germany, but subsequently relayed by land-line to Bremen, Hanover, Münster, Cassel, and Frankfurt. The messages were sent on a wavelength of 85 metres (3527 kc.).

SOME FEATURES AT TH

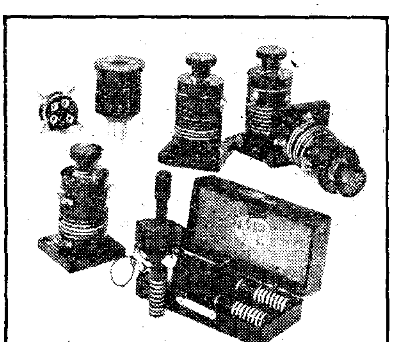
In last week's issue a brief outline and advance guide by the National Association of Radio Manufacturers and and illustrations of the latest type



The new plug-in coil produced by Burndept Wireless, Ltd.

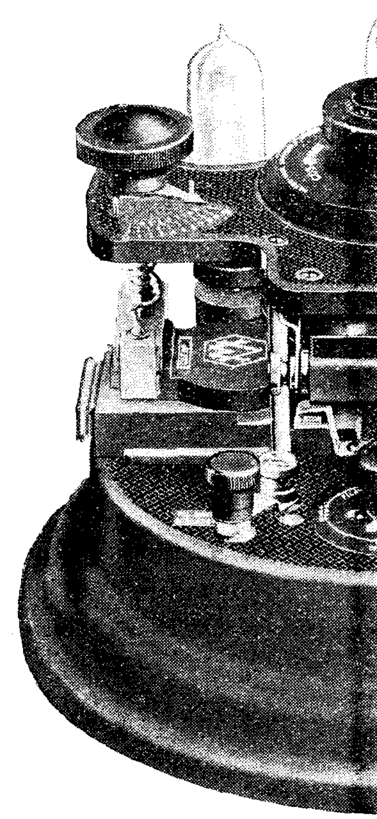
THERE can be little doubt that those wireless enthusiasts who are able to go to the wireless exhibition at the Albert Hall this year will not regret their visit. The exhibits comprise an array of apparatus from complete multi-valve receiving sets down to the smallest accessories required by the constructor, so that everyone, from the beginner in wireless to the advanced experimenter, can find something to arouse his interest. The opportunity also presents itself of observing the general trend of design in modern wireless instruments and the manner in which new theories are applied to the designing of practical apparatus.

To many visitors the chief attractions are the complete receivers for broadcast reception, of which many types are to be seen. The British Thomson-Houston Co., Ltd. (Stand No. 1, Boxes 59 and 60), for instance, show a comprehensive range of crystal and valve receivers. Among other exhibits is a six-valve cabinet super-heterodyne receiver, which is completely self-contained. One interesting feature of this receiver is that two frame aerials are fitted inside the cabinet at right angles to each other, a switch on the panel enabling either aerial to be used so that it is not necessary to turn the receiver in order to obtain some of the advantages of selective reception obtainable with a frame aerial. The well-known B.T.H. valves are also shown.

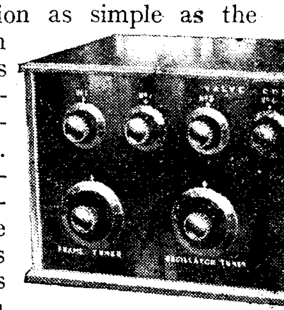


L. McMichael, Ltd., are showing a large range of new super-heterodyne components.

The "Ethophone" crystal and valve receivers, together with the "Ethovox" loud speakers, form part of the exhibit by Messrs. Burndept Wireless, Ltd. (Stands Nos. 11 and 12, Boxes 74 and 75). A special short-wave receiver is also shown, with a tuning range from 110 down to 32 metres (2,726 to 9,369 kc.). It is claimed that reception with this receiver is reduced to an operation as simple as the reception of stations on the normal broadcast band. An interesting innovation here is the series of valves which Messrs. Burndept



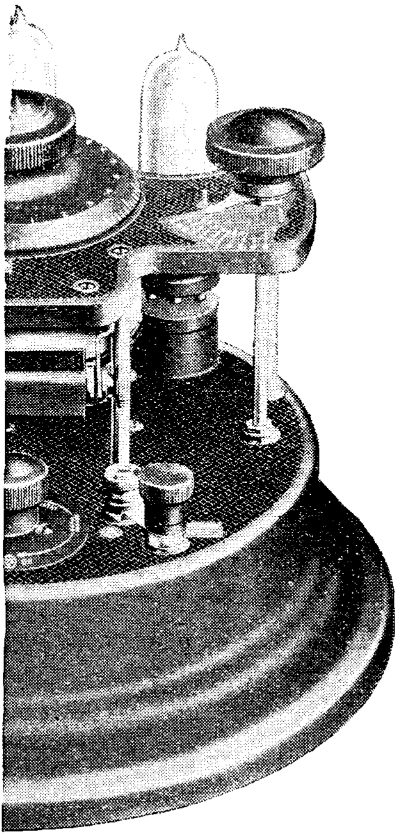
Metro-Vick Supplies, Ltd., ar three-



The super-heterodyne Radio Ele

E WIRELESS EXHIBITION

to the Wireless Exhibition at the Albert Hall, organised Traders, was given. Here we give more complete details s of apparatus on view at the show.



showing this novel and compact e receiver.

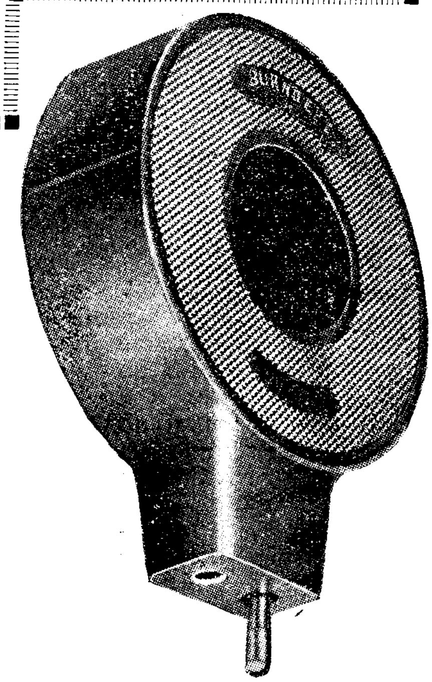
Wireless, Ltd., are showing for the first time. They have also re-designed their familiar plug-in coils, these being now completely enclosed in a moulded container of a material which possesses high insulation properties and low-power fac-

xhibited by the Climax tric, Ltd.

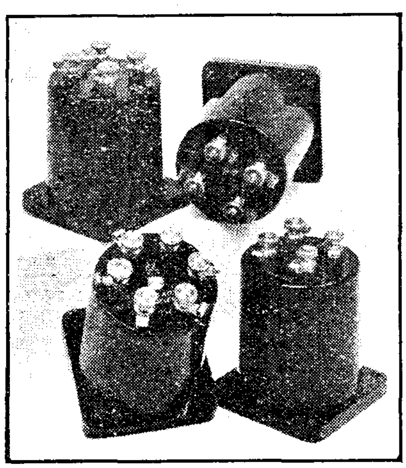
tor; the coils have also been re-numbered to correspond with somewhat similar sized coils of other makes.

Those who find their chief interest in super-heterodyne receivers will find two examples among the "Gecophone" sets shown by the General Electric Co., Ltd. (Stands Nos. 17, 18 and 19). These receivers, one a six-valve and the other an eight-valve set, are designed to receive over a wavelength range of 200 to 3,000 metres (1,500 to 100 kc.). The accessories and components exhibited on these stands represent every practical need of the wireless constructor and experimenter. Of special interest is a new low-loss slow-motion variable condenser of the square-law type, with a wide capacity range. By means of a patent reduction device a micrometer adjustment is obtainable with one control knob, so that a separate vernier plate is rendered unnecessary.

A facsimile of the set supplied to the South African Government for the use of the Prince of Wales in Johannesburg is to be seen among the exhibits of Messrs. L. McMichael, Ltd. (Stand No. 6). By means of this set and six loud-speakers the Prince of Wales addressed a gathering of 30,000 natives. The set shown allows broadcast programmes to be received and reproduced on the loud-speakers; alternatively a local microphone may be used for broadcasting speech. A number of well-made components for super-heterodyne receivers are also exhibited. These comprise an input filter, intermediate frequency transformer, special autodyne units, and the M.H. reactor. These components form a very successful receiver when used with the autodyne circuit (a form of the tropadyne).

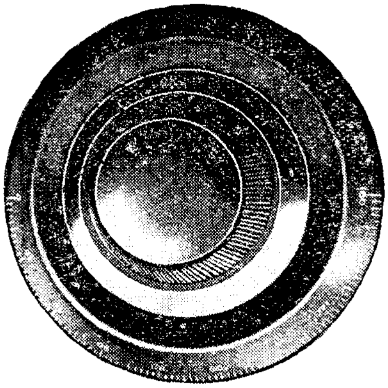


A bakelite moulding completely encloses the new Burndept coil.



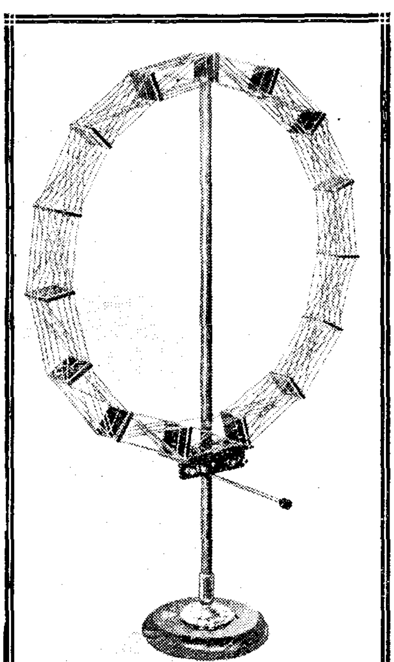
Some of the Bowyer-Lowe super-heterodyne parts.

Many of the familiar M.H. units will be on view in magnified size, so that details of their construction may be easily appreciated.



The Burndept Super-Vernier dial.

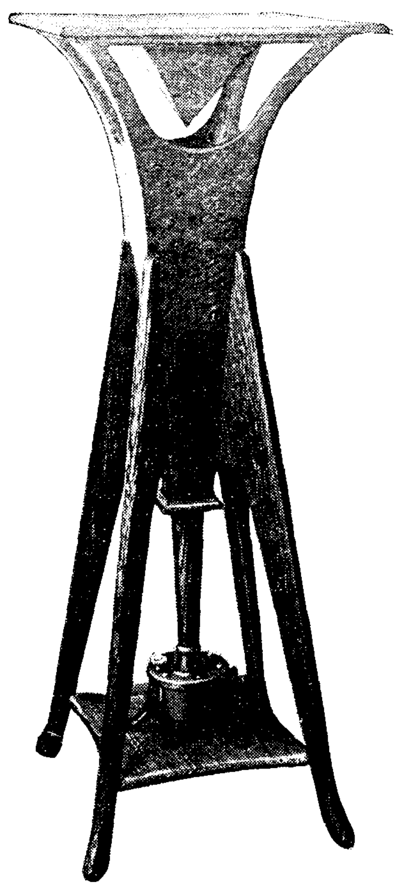
The inclusion of a complete accessory specification with all models of their receivers is a feature which will appeal to those who are attracted to the display by Messrs. A. J. Stevens & Co. (1914), Ltd. (Stand No. 37, Box No. 46). This specification includes the necessary valves, batteries and telephones, so that the intending purchaser



A novel frame aerial produced by Radiax, Ltd.

sees at once what will be his outlay for the whole installation. The firm are also exhibiting their new tubular steel telescopic aerial masts. These are made in two sizes, 35 ft. and 50 ft. when erected, and are supplied with all necessary fittings; either of them can be easily and quickly erected by two men without the use of special erecting gear.

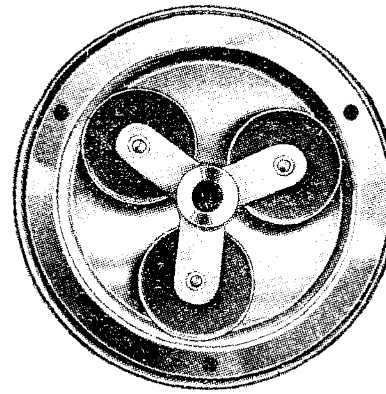
Considerable ingenuity has been applied to the design of receivers which appear, when not in use, to be merely ordinary commonplace articles. A novel type of crystal receiver on these lines constitutes the only exhibit by



A new loud-speaker, the "Tameside" exhibited by Hirst Bros., & Co., Ltd.

Kenmac Radio, Ltd. (Stand Loggia 71). This receiver takes the form of a small book with no external indication of its contents and gives excellent results. The Eagle Engineering Co., Ltd. (Stands No. 68 and 69), too, show a single-valve receiver built into an old-fashioned salt box or tea caddy. Other interesting features on these latter stands, besides the various models of "Chakophone" receivers shown, are the "Chakophone" unit constructor's system, and a full range of the components needed by the amateur constructor in building his own set.

In view of the possible exten-



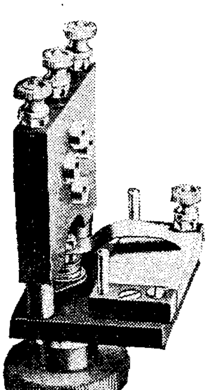
The friction-driven epicyclic gearing of the Burndept dial gives about 7-1 reduction.

sion in the future of the band of wavelengths at present allotted to European broadcasting stations, a four-valve "Efescaphone" receiver shown by Falk, Stadelmann & Co., Ltd. (Stand No. 34), is of interest among others, in that it is intended to cover a range of from 150 to 4,000 metres (2,000 to 75 kc.) without the use of plug-in coils or external tuning devices. Many components and accessories are also exhibited by this firm, including the Efesca "Vernistat"

The Brown H4 loud-speaker is 10in. high.

and "Carbostat" filament resistances, and a series of high-tension batteries which employ cells large enough for satisfactory use with multi-valve sets over long periods.

The Marconiphone Co., Ltd., and Messrs. Sterling Telephone & Electric Co., Ltd. (Stands 29–32), are exhibiting together. A new two-valve Marconiphone receiver (Type 21) is shown, good quality loud-speaker performance being claimed at distances up to 40 miles from the broadcasting station under average conditions. Among other amplifiers the B2 model is exhibited. The makers claim the entire elimination of distortion with this amplifier, no matter what degree of volume is produced. Marconiphone "Ideal" transformers are used in this instrument, these being now available in four ratios. The Sterling long-range receivers have a possible tuning range of 40 to 5,000 metres (7,500 to 60 kc), special aerial circuit arrangements being employed on the shorter waves. For the well-known "Primax" loud-speaker it is claimed that no effectiveness is lost by dispensing with the horn, and that music and speech are produced with great realism; a new addition to the Sterling range of reproducing instruments is the "Mellovox," which offers the advantages of the hornless type of loud-speaker at a price within the compass of a wider public.

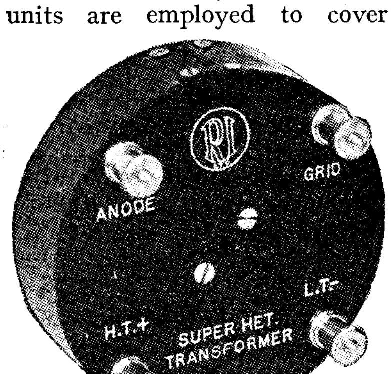


Hirst Bros. combined rheostat and valve-holder.

An addition to the range of "Polar" sets displayed by The Radio Communication Co., Ltd. (Stand No. 5, Box No. 67), is the Polar Four, which has been the subject of extensive experiments. Remote control is provided, which allows the receiver to be operated from any distance up to 150 yards from the set. Two new types of variable condenser are also being shown, one a cam vernier compensating square-law type, with specially shaped plates, in order to make allowances for inherent capacities in the circuit; it is claimed that true straight-line tuning is obtained and also that wavelengths are actually proportional to the dial readings.

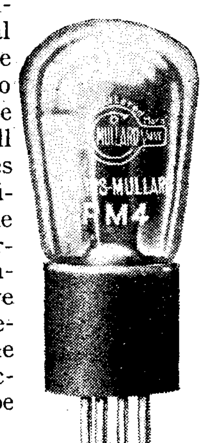
The "Success" Cabinet 8-valve super-heterodyne is an imposing piece of furniture (Beard & Fitch, Ltd.)

Simple and speedy change of wavelength range has received attention in the "Cosmos" Universal Valve Set, made by Metro-Vick Supplies, Ltd. (Stand No. 8). The change from one range to another is effected by means of single plug-in units, so constructed that they cannot be wrongly inserted in circuit; three of these units are employed to cover wavelengths from 300 to 3,000 metres (1,000 to 100 kc.). Various types of "Cosmos" valves are shown, including the short-path dull emitter S.P. 18 type, this being designed in two forms—for low-frequency and general purpose use and for high-frequency amplification respectively. A new low-loss square-law variable condenser is fitted with a slow-motion gear giving a ratio of 10 to 1. This model can also be used for remote control, and the operating knob may be mounted in any convenient position, irrespective of the position of the condenser itself.



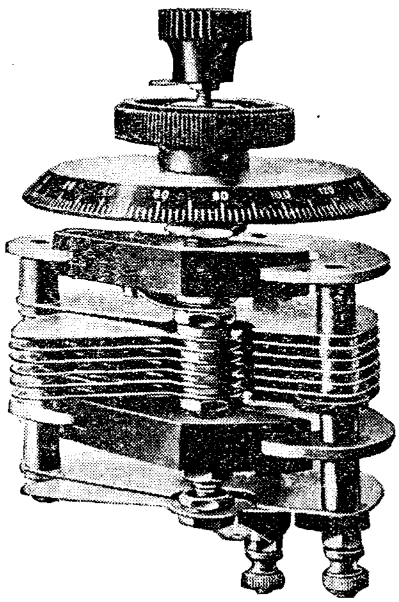
One of the R.I. super-heterodyne components. The input filter and long-wave transformers are of the same external appearance.

Another new type of variable condenser is that produced by Radio Instruments, Ltd. (Stand No. 36). This has a gearing ratio of 11 to 1, and it is claimed that the method of gearing is new and that it obviates backlash. This condenser is obtainable in three capacities—.001, .0005 and .00025 μF. The sets shown by Messrs. Radio Instruments, Ltd., are now all installed in mahogany cabinets, and dual rheostats are fitted so as to allow of the use of bright or dull emitter valves without modification of the sets. Super-heterodyne components have also been designed for the use of constructors of this type of receiver.



The P.M. 4 dull-emitter power valve (Mullard Radio Valve Co., Ltd.).

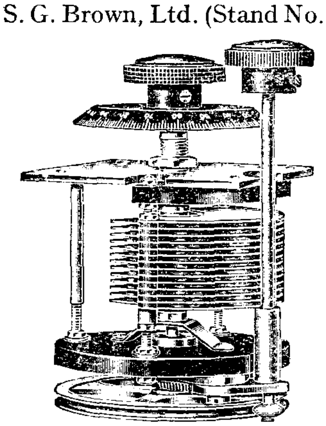
Selectivity and ease of manipulation are claimed for their receivers by The British L. M. Ericsson Manufacturing Co. Ltd., (Stand No. 9, Box No. 72). A new two-valve loud-speaker set is shown. This has both valves and coils enclosed and it is stated that it will work a loud-speaker up to a distance of 50 miles from a broadcasting station. Together with the popular Ericcson headphones are shown models of the "Supertone" loud-speakers. A special attraction demonstrated by Gent & Co., Ltd. (Stand No. 7),



A square-law condenser with vernier produced by Hirst Bros.

in addition to their "Tangent" sets and components, is the "Pul-synetic" Electric Clock. The apparatus shown is adapted to work from the daily time signals sent out from the Eiffel Tower, the clock switching on the valves of a receiver half a minute before the time of the signal, and being itself synchromised with the signals through the medium of the receiver.

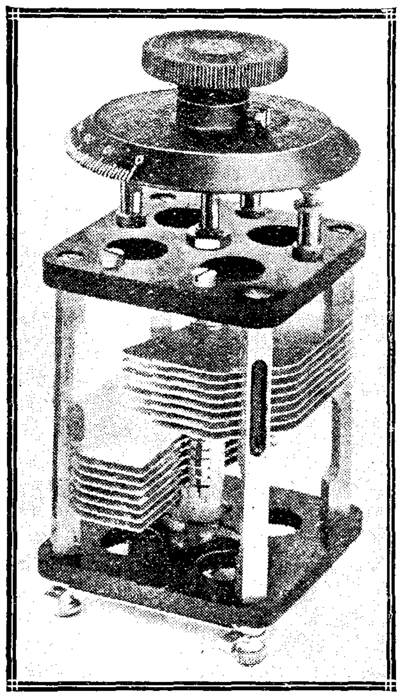
S. G. Brown, Ltd. (Stand No. 3),



The new Radio Instruments geared condenser.

are showing new models both of loud-speakers and headphones. The "A" type of headphone has been re-designed and the new model is sold at a greatly reduced price. An effort to break away from stereotyped designs of loud-speakers has been made by Hirst Bros. & Co., Ltd. (Loggia Box 53), who exhibit the "Tameside" pedestal type of instrument, designed as a pleasing piece of furniture. This firm have also a full display of "Tameside" receivers and constructional components.

Messrs. Alfred Graham & Co. (E. A. Graham) (Stand No. 40), whose practical experience of loud-speakers dates back as far as 1893, show the current types of their Amplion loud-speakers, which incorporate the latest

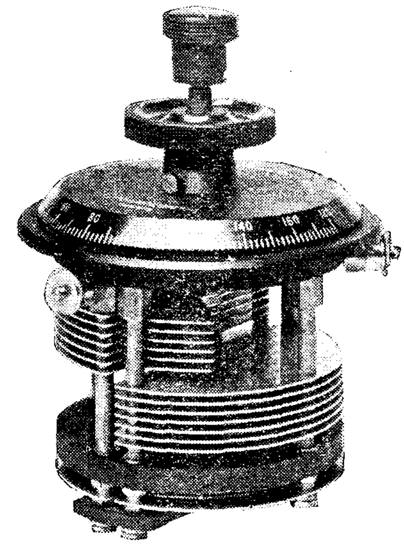


The new Bowyer-Lowe "Four-square" condenser.

developments in the direction of better reproduction.

Valves of every type may be seen in the comprehensive collection of the products of The Mullard Radio Valve Co., Ltd. (Stand No. 16). Over a dozen forms of receiving valves are displayed, among them the P.M.4 type, a dull emitter power valve with a filament of high emissivity. The range of transmitting valves is even larger, from the 5-watt valve for low-power transmission to a metal-glass valve capable of handling 30-kw.

A new addition to the range of Cossor valves is a power valve, known as the P.3. This is constructed with the usual Cossor arched filament and hooded anode, and consumes .175 amps. at 4 volts. For the Wuncell valves it is claimed that the

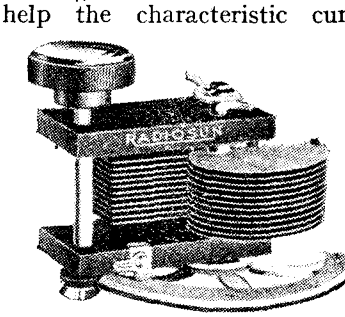


One of the Dubilier range of variable condensers.

particular method of construction employed renders them absolutely free from microphonic noises.

The Edison Swan Electric Co., Ltd. (Stand No. 26), have also made some additions to their series of valves since the last exhibition. They are employing a new method of sealing their valves before issuing them for sale, which is intended to ensure that the purchaser receives an absolutely new valve.

In view of the multiplicity of valves now obtainable, the valve testing instrument shown by The Bowyer-Lowe Co., Ltd. (Stand No. 14), is of interest; with its help the characteristic curves

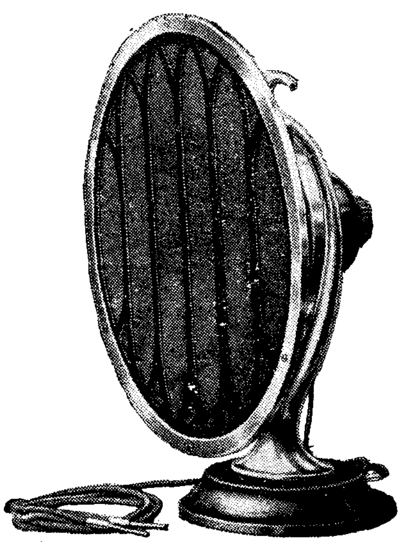


This square-law condenser exhibited by Auto Sundries, Ltd., has a 50-1 reduction gearing.

of valves can be readily plotted. A series of super-heterodyne receivers is also shown on this stand, together with other new exhibits.

Accumulators for high-tension supply as well as for filament heating are being adopted by a considerable number of amateurs. C. A. Vandervell & Co., Ltd. (Stand No. 33, Box 58), are showing their 60-volt H.T. units, which are made up in pairs if desired, with a fuse link between the units. Loud-speakers and component parts also form part of the exhibits on this stand.

The Chloride Electrical Storage Co., Ltd. (Stand No. 38), being specialists in the construction of storage batteries, confine their

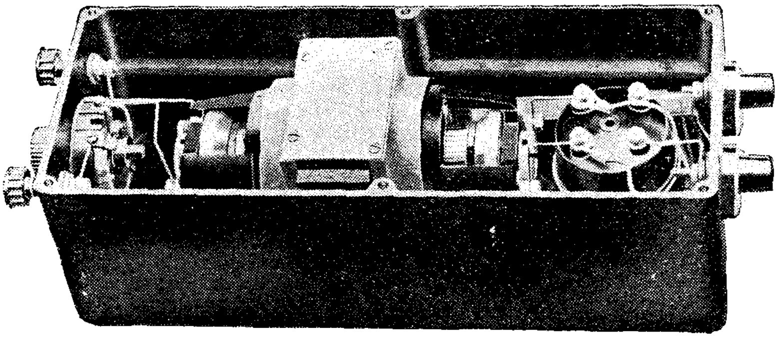


A new hornless loud-speaker (Type E) is being shown by B.T.H., Ltd.

exhibit to this class of product.

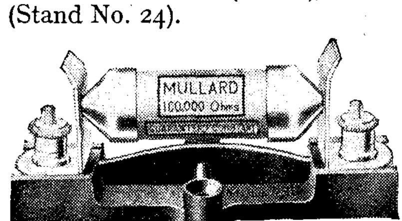
The Hart Accumulator Co., Ltd. (Loggia Boxes Nos. 62 and 63), who show a complete range of accumulators for all purposes, have adopted the system of specifying the actual (continuous current) capacities of their accumulators, disregarding the ignition rating, which tends to be misleading.

Alternative methods of providing the H.T. supply are shown in the form of an H.T. battery eliminator to supply current from the mains, exhibited by Neutron, Ltd. (Stand No. 20), and the anode converter displayed by



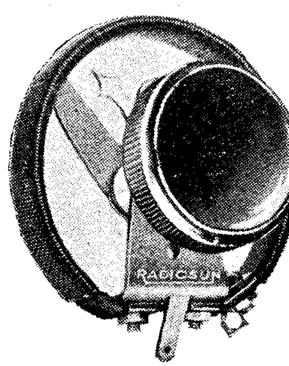
S. Smith & Sons (M.A.), Ltd., are showing the well-known M.L. Anode Converter.

S. Smith & Sons (M. A.), Ltd. (Stand No. 24).



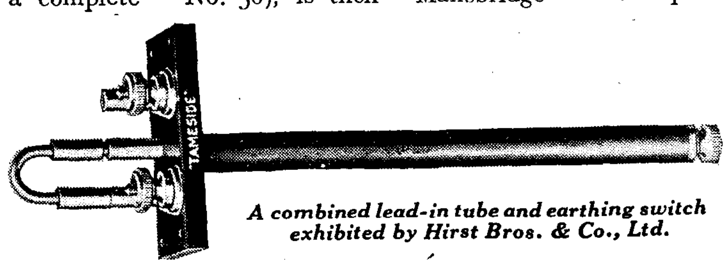
The new Mullard anode resistance.

A recent addition to the products of the Dubilier Condenser



One of the filament rheostats by Auto Sundries, Ltd.

Co. (1925), Ltd. (Stand No. 28, Box No. 50), is their "Mansbridge"



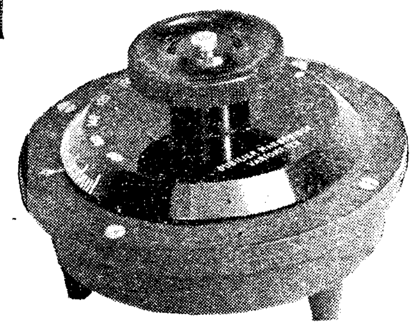
A combined lead-in tube and earthing switch exhibited by Hirst Bros. & Co., Ltd.

variometer. Typical transmitting condensers for high-power stations and condensers for use as laboratory standards are to be seen, as well as the familiar types designed for receiving sets.

At stands Nos. 51, 52, and 73 may be seen a most comprehensive range of authoritative wireless publications, all of which are produced by Radio Press, Ltd.

The monthly periodicals—*Modern Wireless* and *The Wireless Constructor*—cater for all wireless amateurs and experimenters; whatever their skill or knowledge, they will find material help and useful information from these books.

The new trade journal—*The Wireless Dealer*, of which the first number was published on September 12—will be of inestimable value



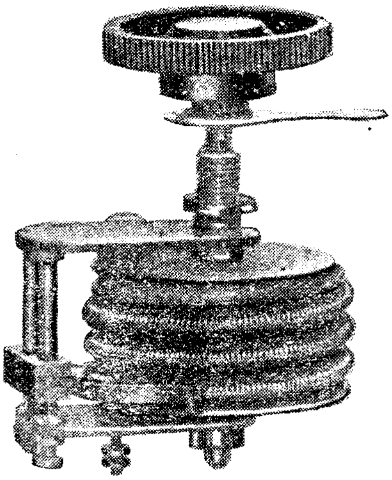
The new Dubilier "Mansbridge" variometer.

to the manufacturer of wireless goods, as well as to the dealer.

This monthly trade journal, produced by the Radio Press organization, with its following of nearly 500,000, can obviously do for the wireless traders more than would be possible by any other publishing house.

The weekly publications include *Wireless Weekly*, and a new popular-priced periodical, *Wireless*, the first number of which was published on September 15.

It deals with wireless in an interesting and popular manner, and is designed to meet the requirements of all classes of broadcast



The "Efesca" vernistat (Falk, Stadelmann & Co., Ltd.).

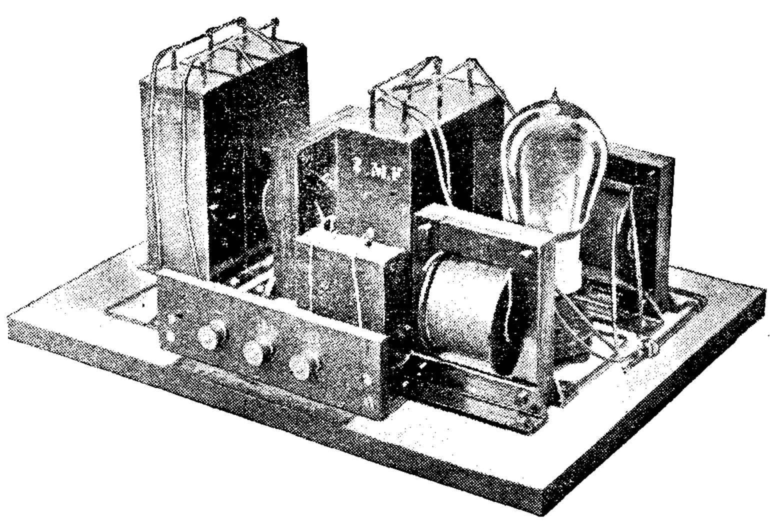
listeners who appreciate the latest reliable news and views of their hobby.

Besides these periodicals, the whole range of Radio Press Books, Envelopes, Panel Cards and Simplex Radio Charts will be shown, as well as Radio Press Panel Transfers.

Among the further features of interest is the three - electrode bridge condenser produced by Messrs. Auto-veyors, Ltd. (Stands Nos. 41 and 76). This has been re-designed so that all the controls are now operated from one compound knob. Since all the electrodes are secured on one spindle, the ordinary one-hole fixing method of mounting is employed.

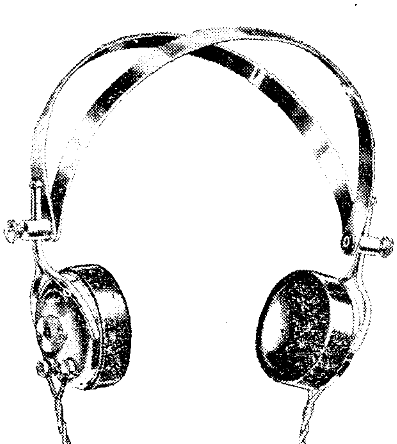
The well-known Clix connectors are also to be seen in this exhibit, including plug-in sockets, insulators, bushes, adapters, and series connectors. An H.F. relay, which is stated to be different from those hitherto employed in radio transmission and reception, is also exhibited; this was described in *Wireless Weekly*, Vol. 6, No. 20.

With the "Success" tapped frame aerial, shown by Messrs. Beard & Fitch, Ltd. (Stand No. 23), a compass is supplied, mounted on the revolving stand; this allows the operator to judge the direction of the station he is desirous of receiving by reference to a marked map provided by the makers. An eight-valve super-heterodyne receiver is also exhibited on this stand, intended to be used in conjunction with the frame aerial.

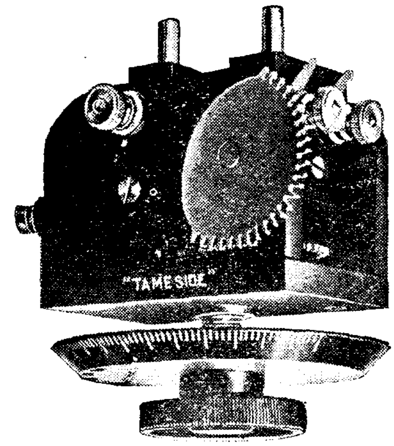


Gent & Co., Ltd., are exhibiting the "Tangent" A.C. rectifier.

A feature of the exhibits by The British Radio Corporation, Ltd. (Stand No. 47), is the "All Break Switch," which takes the place of terminals to the L.T. and H.T. batteries, it being possible by means of this switch to disconnect all batteries by one simple movement; leads are fitted ready for connecting the batteries. A wide-range tuner is also shown, which gives a continuous range of wavelengths, from 200 to 2,000 metres (1,500 to 150 kc.), without the necessity for changing coils.

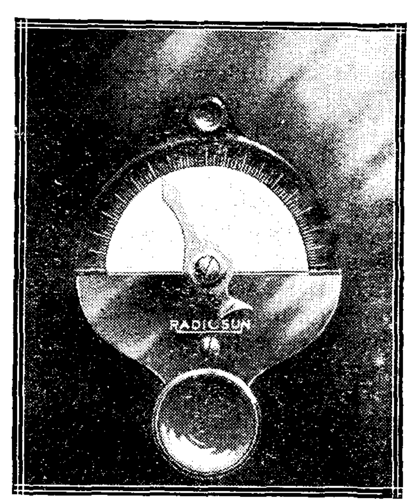


The new "A" type headphones shown by S. G. Brown, Ltd.



A one-hole fixing coil holder and dial (Hirst Bros. & Co., Ltd.).

Alternative reception on either the shorter or the longer broadcast wavelengths is also provided in the valve sets shown by The Cable and Electrical Supplies (Stand No. 2). A useful addition to their sets is the special type of battery plugs employed, which prevent the high-tension voltage being erroneously applied across the valve filaments.



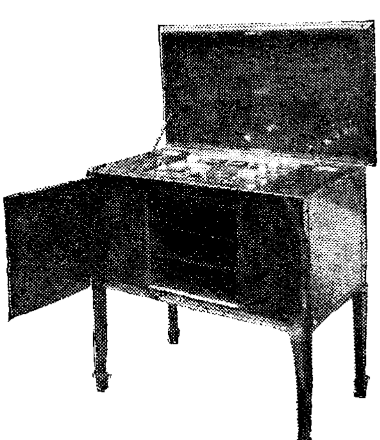
The geared dial exhibited by Auto-Sundries, Ltd.

A handsome three-valve portable receiver is being shown for the first time at the exhibition by Messrs. A. W. Gamage, Ltd.

The HQ Model Brown loud-speaker.

(Stand No. 39). Satisfactory loud-speaker reception up to 15 or 20 miles is claimed for it, and, of course, a much greater headphone range. Another new exhibit by this firm is a Remote Control Switch, which is designed for the purpose of switching on or off the wireless set from any room in which the loud-speaker is working; this operation is performed through the medium of a small press-button.

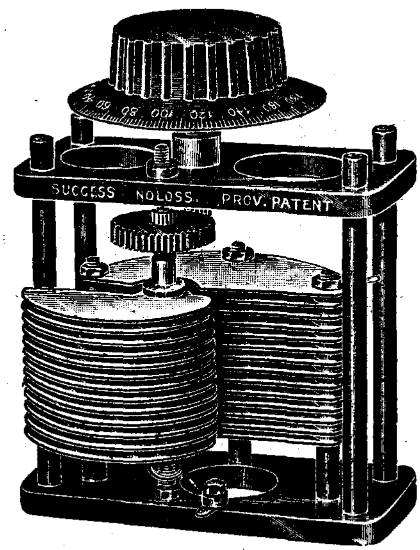
As a substitute for the ordinary knob and dial on the shafts of condensers, variometers, rheostats, and so on, Pell, Cahill & Co., Ltd., are showing their " Pelican " Univernier. This is a special form of knob and dial designed to give vernier control of any instrument to which it is fitted.



The B.T.H. six-valve super-heterodyne cabinet receiver.

Two types of detectors are shown by Sylvex, Ltd., (Stand G.7), Sylverex and Kathoxyd. The latter is a new production. It consists of a metal plate covered with a chemical compound, and is used with either a zinc-iron or a graphite contact, these being employed for short and long-distance reception respectively.

Details of the various processes employed in manufacturing high-grade ebonite are demonstrated by The British Ebonite Co., Ltd. (Stand No. 15), who are one of the very few firms making and specialising in ebonite and nothing else. Black and grained hand-

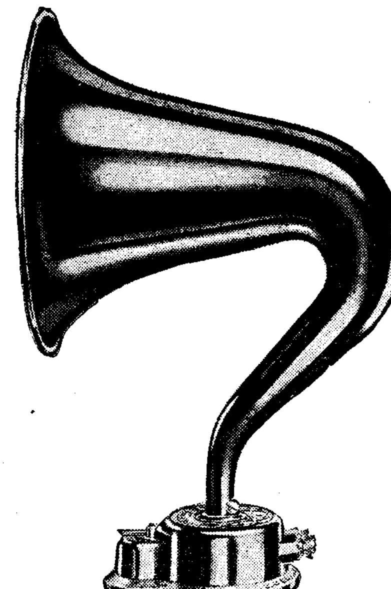


The " Success " No-loss condenser (Beard & Fitch, Ltd.).

polished " Becol " panels are on view, and also a large range of rods, tubes and mouldings.

An information bureau for members and non-members of the Radio Society of Great Britain (Stand No. G.9) is ready to supply particulars of the Society's activities, together with information about the local societies serving various areas of the country.

A representative selection of apparatus by members of the National Association of Manufacturers and Traders is shown by A. J. Dew & Co. (Stands Nos. G.32 and 33), who are wholesale distributors. The opportunity presents itself here of comparing, side by side, similar articles by various manufacturers. Included in a similar exhibit by Messrs. Brown Bros., Ltd. (Stand Nos. G.1 and 2) are the " Duco "

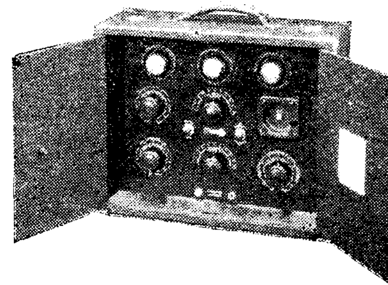


The Brown H3 type loud-speaker is 15 inches high.

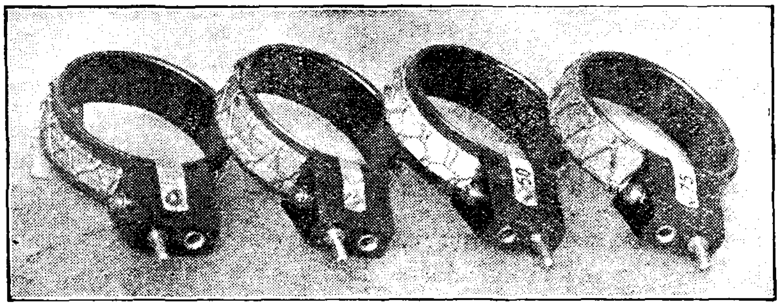
Knockdown cabinets for wireless receivers, which are supplied in finished sections, ready for assembling with the help of the screws provided.

At most of the manufacturers' stands at the Exhibition, it is of course, not possible to buy on the spot articles which are on show, orders only being accepted. For the benefit of those visitors who wish to purchase and take away goods from the Exhibition, Messrs. Selfridges (Stand No. G 3 and 5) are showing some of the products of the leading manufacturers, and purchases can be effected at their Stand.

A sketch map, indicating the position of the Exhibition and some of the facilities for reaching it, will be found on another page of this issue.

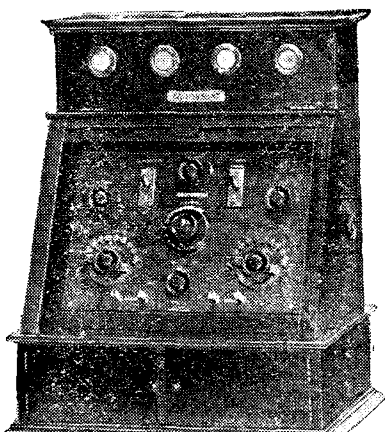


The B.T.H. three-valve portable super-heterodyne receiver.



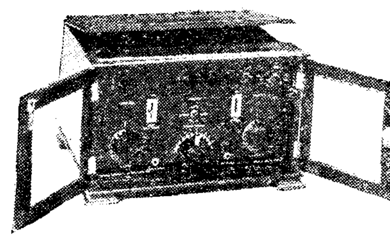
A group of "Tangent" plug-in coils shown by Gent & Co., Ltd.

The B.T.H. six-valve super-heterodyne receiver with the doors closed.

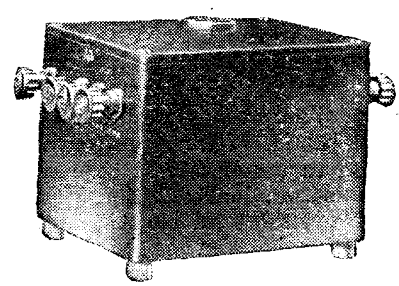


The four-valve self-contained "Efescaphone" receiver, made by Falk, Stadelmann & Co., Ltd.

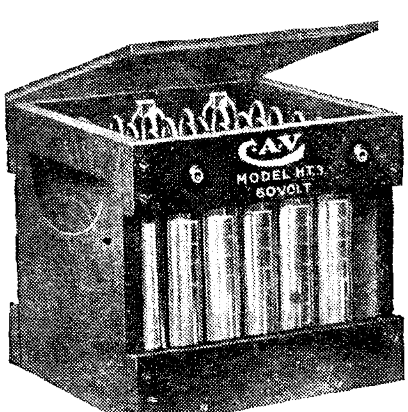
A set of super-heterodyne components produced by Radiax, Ltd.



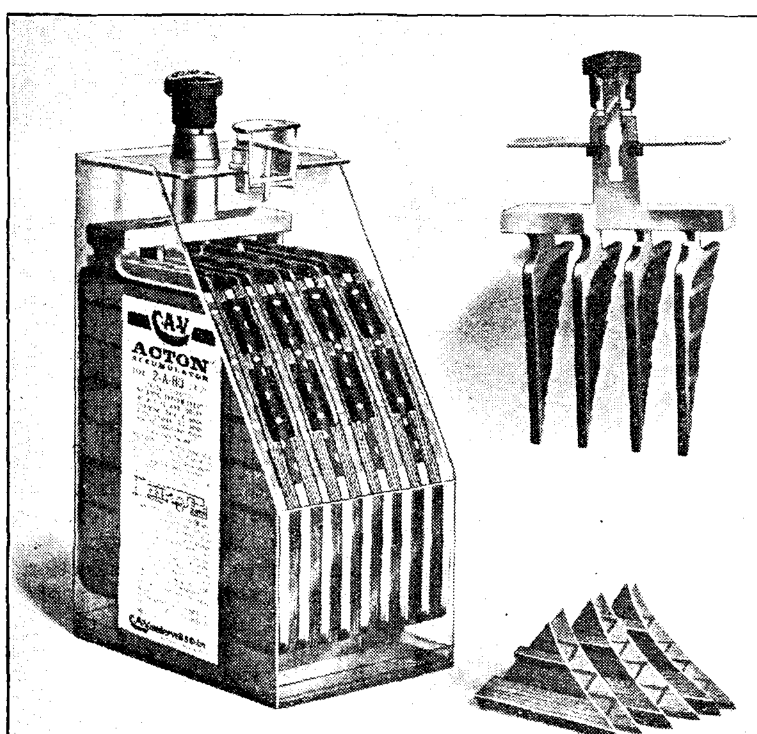
A self-contained receiver shown by the National Wireless & Electric Co.



The voltage box shown by S. Smith & Sons (M.A.), Ltd., for use in conjunction with their Anode Converter.

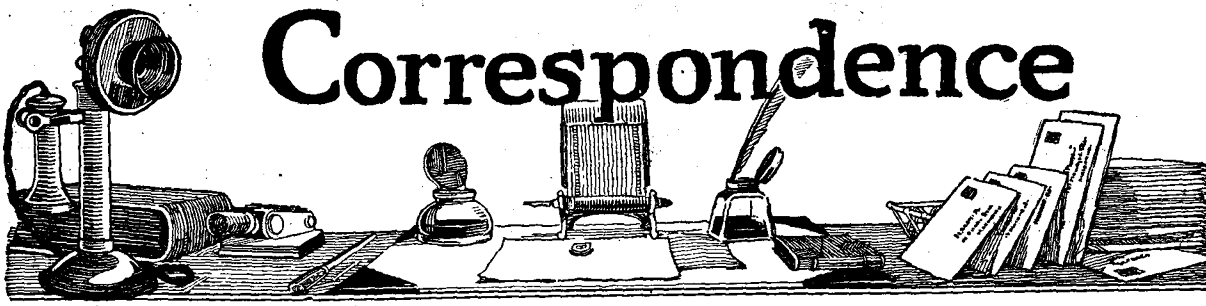


A 60-volt high tension accumulator exhibited by C. A. Vandervell & Co., Ltd.



A sectional view of one of the C.A.V. low tension accumulators, to show the construction of the plates.

Correspondence



ILLEGAL USE OF CALL SIGN

SIR,—In the course of the last twelve months, and even when I have been abroad, and while my transmitter has been dismantled, I have many times seen my call sign, 5KA, in the "calls heard" lists in wireless papers on both sides of the Atlantic.

Finally, I have had a letter from the Postmaster-General saying that a Government station is accusing me of having worked on the unlicensed wavelength of 83 metres at a time when, actually, my station was completely dismantled.

Curiously enough, no QSL cards ever reach me in answer to these "pirate" transmissions, but if anyone can help me to hunt down the offender I shall be most grateful. His conduct speaks for itself.

I sign myself with my address.—Yours faithfully,

GUY C. BEDDINGTON (5KA).

The Beeches, Penn, Bucks.

A "STABLE THREE-VALVE" RECEIVER

SIR,—I have just completed building a set modelled on the Stable Three-Valve Receiver, by C. P. Allinson, described in your issue of December 31, 1924.

It certainly is one of the best sets for three valves I have had, after experimenting with many of your most notable circuits, including the ST100 (Envelope No. 1, by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E.), Transatlantic V (June, 1924, issue of *Modern Wireless*, by Percy W. Harris, M.I.R.E.), T.A.T. 5-Valve Circuit (*Modern Wireless* for November, 1924, by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E.), and various smaller one-valve circuits. The general circuit is the one you have given, plus the addition of two extra valves, and comprises H.F., Detector, 2 stages L.F. choke-coupled, with one extra stage of transformer-coupled L.F. using a power valve. I did not include the wave-trap, intending to make that a separate unit if necessary, but I find that the local station (Manchester, 7 miles away) is cut out dead, with about 4 degrees on the vernier! For this station I use only four valves, which gives ample volume on a large loud-speaker requiring considerable power to work it. For other stations to get really loud volume I usually use the extra L.F. valve. A push-pull switch controls L.T. and H.T., and extra H.T. plus terminals are fitted. Using H.T. accumulators, which I find a vast improvement on dry batteries, and a 6-volt 90 a.h. block accumulator with the three cells in parallel, these accumulators last about three months each charge. It is very selective, and there is no trace of Manchester when getting other stations, except London. The purity is also a revelation compared to any two stages of transformer-coupled L.F. I have tried. The choke coupling seems to me to be much better than resistance capacity coupling, as it gives greater amplification.

The set is fitted with reaction on to the grid-coil, but this is usually shorted, as the potentiometer and the loose-coupled aerial circuit give the finest possible control of reaction. There is grid bias on the first valve, as shown in the original circuit, and also on the last valve. There are no switches, two extra terminals being used to cut out the last valve. The master switch on H.T. and L.T. makes the set capable of being left fool-proof for family use.

The lay-out is on the American panel idea, but using only a small panel with the controls on it and a large baseboard carrying valves, resistances, chokes, fixed condensers, etc. Chokes used are the secondaries of two old transformers that I had by me.

I find this set simpler to handle than a Neutrodyne, less liable to oscillate than most H.F. circuits, and very selective. All terminals are carried on a strip, at one side; one coil-holder is on the top, and one at the side, no cabinet being used, as the set fits in a large cupboard I use for the purpose.

I am deeply indebted to *Modern Wireless, Wireless Weekly*, and *The Wireless Constructor* for much help, information and stimulating ideas.—Yours truly,

J. W. BYROM.

Altrincham.

A "WIRELESS WEEKLY" ULTRA-SHORT WAVE RECEIVER

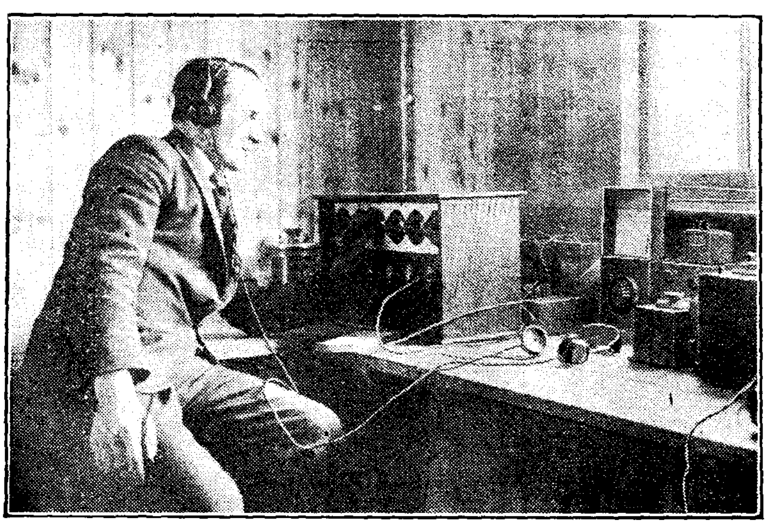
SIR,—I am enclosing herewith a photograph of my "Ultra-Short Wave Receiver" as described by Stanley G. Rattee, M.I.R.E., in *Wireless Weekly*, Vol. 6, No. 12. The design has been faithfully copied, although some of the components differ. For tuning the grid coil I use a .00015 μF Colvern selector, which I find works very smoothly and quietly with no hand capacity

Mr. Ralph Bates (50D) with his "Wireless Weekly" ultra-short wave receiver on which he has received a number of stations.

effects, even on 20 metres. I also find the fine low-gear arrangement a great boon. The reaction condenser is one I had by me taken from an old R.A.F. control unit, the capacity being about .0001 μF. The radio-frequency choke I made in a few minutes at the cost of about twopence; it contains about 190 turns of 36 d.s.c. wire on a cardboard tube 1 in. diameter. The L.F. transformer is a French "Croix" shrouded pattern 5 to 1. I have used a low-loss "Anti-pong" valve-holder for the detector valve. I am using 2-volt dull-emitter valves, the detector being an Ediswan power valve P.V.6 D.E. The L.F. valve is a double green ring "Mullard" D3. I use a 30-ft. length of rubber-covered bell wire indoors for aerial connected to a .0005 μF variable condenser and coupled to two turns of 15 gauge tinned copper wire loosely coupled to grid coil. The earth consists of bell wire, two lengths about 12 ft. long lying on the floor. I can get the set to give the familiar grid-leak howl when using the 11 turn coil, and oscillation is easy over the whole scale of the condenser. The "motor noises" are readily picked up. Brown's A type 'phones, 120 ohms, and telephone transformer are used. I have only used the set a few nights, and the following is a list of calls heard: RDW (Russia), AGA, PCMM, WIZ, WIR, WQN, CA, 1MT (Italy), D49A, 1SF (America), OSV, SOC.—Yours faithfully,

RALPH BATES (5OD).

Lincoln.



The new B.B.C. receiving station at Hayes, in Kent, has been of great value in the wavelength tests carried out by European broadcasting stations, and in picking up foreign stations for re-broadcasting purposes.

SHORT-WAVE TESTS

SIR,—Kindly note that in future the Testing Station of the Manchester Wireless Society will transmit regularly on the following wavelengths at the times stated:—

Saturday—6.30 to 7 p.m., G.M.T., 45 metres.
Sunday—7 to 7.30 p.m., G.M.T., 90 metres.
Wednesday—5 to 6 a.m., G.M.T., 25 metres.

Example:—
Test de G6MX, etc.
QRA Manchester.
QRH 90 (giving wavelength).
P50 (denoting input in Watts).
AA 1.5 or pnt 5 (radiation).
Pse. QSL AR K de G6MX, etc.

Reports should be sent to the Hon. Secretary, Mr. Y. W. P. Evans, 66, Oxford Road, Manchester.

Special tests can be arranged, and members of the Society are prepared to report on the reception of any transmission, from any part of the world. Stations replying to test calls are requested to transmit each call three times only, and complete their transmission with the same procedure.

Experimenters willing to co-operate in tests on 3 to 5 metres, please notify the Hon. Secretary as early as possible. The Society is prepared to try any commercial apparatus in their various short-wave tests, same being returned on completion, with full report.—Yours faithfully,

Y. W. P. EVANS,
Hon. Secretary.

A READER'S EXPERIENCES

SIR,—I notice you ask for reports about the Radio Press wireless sets, and herewith append my experiences with several of them.

I started wireless about a year ago, and have since then read every book on the subject that I could buy, including all the Radio Press publications, which, I think, are by far and away the best books on the subject.

My first set was an ordinary two-valve tuned-anode receiver, but, being a novice, at first I could not get very good results, but I received London, Bournemouth, and Chelmsford regularly. After a while I wanted to work a loud-speaker, so I made the "Two-Valve Amplifier de Luxe" (R.P. Envelope, No. 7, by Herbert K. Simpson), and the above three stations were easily obtained on the loud-speaker, but I could not get any more stations, however much I tried.

Wishing later to get as many distant stations as possible on the loud-speaker, I made up the "S.T.100" (R.P. Envelope, No. 1, by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E.), and was very pleased with the results obtained, and also the ease of control, and the stations mentioned below were received by me last winter:—

Cardiff, London, Manchester, Bournemouth, Newcastle, Glasgow, Belfast, Birmingham, Aberdeen, Chelmsford; also the following relay stations:—Sheffield, Leeds-Bradford, Liverpool, Edinburgh, Dundee, Plymouth, Nottingham, Swansea. These were received in the evenings, and Leeds, Plymouth, Sheffield, Nottingham were received during daylight, between 11 a.m. and 12.30 p.m., so it shows what the "S.T.100" is capable of doing.

Besides the stations mentioned above, I received the following foreign ones:—Brussels, Petit-Parisien, Madrid, Rome, Berlin, Ecole Superieure, Berlin, Radio Paris, and Eiffel Tower. I also received many more foreign stations, but could never get their call-signs.

I have also made up the "Omni Receiver" (R.P. Envelope, No. 5, by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E.), and have made up all the circuits given with and for it, and must really say it is a splendid set for the man who likes trying different circuits and also likes to try a bit of experimenting, as it is so simple to wire up. I always got good results with all my circuits: London, Bournemouth, Chelmsford, Manchester, and Newcastle were obtainable on all the valve circuits.

I am now using the "Three-Valve Dual" (*Modern Wireless* for June, 1923, by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E.), on which I have received most of the main B.B.C. stations and some Continental.

I can therefore recommend any of the above sets, especially the "ST100," and in time I hope to send you the reports of some more of your sets, including the well-known "Anglo-American Six" (*The Wireless Constructor*, January, 1925, by Percy W. Harris), which I am shortly about to make, having seen several good reports on it in the Radio Press publications. I have been a regular reader of *The Wireless Constructor* ever since it started, and at the same date I started *Modern Wireless*, and in December, 1924, I started to take in the *Wireless Weekly*, and have been a regular reader of all these books ever since, and whenever a new Radio Press book or envelope is published, I always buy it.

My aerial is 35 ft. high, with a length of 30 ft., and a 30-ft. down lead. It is a twin, inverted L type, made of three strands of multi-strand wire twisted together, and my earth is a strand of 7/22 wire, running through a half-inch thick rubber tube to a 3-ft. iron pipe driven into the ground immediately under the lead-in.

The house is situated nearly at the top of a hill near Seven Dials.—Yours faithfully,

Brighton. H. R. EVANS.

THE B.B.C. AND SUMMER RADIO

SIR,—Surely "Regular Reader" cannot really mean that he wants the B.B.C. programmes to consist entirely of items such as he would choose for his own entertainment.

What about those who are not satisfied to remain, as it were, in the nursery in regard to music and who want good music?

For my part, since the B.B.C. exist to serve the public as a whole, and not me alone, so long as they give us good music, symphonies of Beethoven, works of Bach and Wagner, acknowledged by all the world to be masterpieces, as well as lighter music, and music for those who, as it were, are content to remain in the nursery stage of words of one syllable, I am content. I also enjoy most of the talks; those on scientific subjects are most interesting, and those of travellers in other lands help to broaden the mind of an insular people.

To expect always a programme to suit oneself is surely selfish and not what I hope I am.—Yours faithfully, "BROADMINDED."

Newdigate, nr. Dorking.

SIR,—I am heartily in sympathy with "Regular Reader," but consider that his view of a day's programme lacks a certain amount of detail. I am entirely in favour of one station for all the highbrow dope and another for "regular readers."—Yours faithfully,

Pinner. E. T. PIERCE.

NEW CALL SIGN

SIR,—I should feel obliged by your kindly noting that I have been allotted the call sign 2YU, and hope to commence experiments on 150-200 metres on C.W. and telephony very shortly. I should welcome reports from any amateurs who hear my signals, and would also be glad to hear of any amateurs who may be willing to co-operate with me in tests.

Perhaps you would give this publicity in your valuable Radio Press publications.—Yours faithfully,

W. H. WILKINSON (G2YU).

Rawdon, nr. Leeds.

A "GENERAL PURPOSE TWO-VALVE RECEIVER"

SIR,—I had intended to write some time ago to tell you how pleased I am with the performance of a "General Purpose Two-Valve Receiver" built according to Mr. John Underdown's instructions in *Wireless Weekly* (Vol. 6, No. 5).

I get excellent loud-speaker results from 5IT, my local station and Daventry is also at very good loud-speaker strength.

Here are a few of the stations I tuned in one night during one of the B.B.C.'s two-hour tests: Birmingham, Newcastle, Bournemouth, Manchester, London, Cardiff, Nottingham, Bradford, Toulouse, Oslo, Liverpool, Stoke, Glasgow, and one or two French and German stations which I could not identify through their not giving call-signs.

I have also heard Radio-Paris, Petit-Parisien, Madrid, Barcelona and Eiffel Tower. All these stations are at *good* 'phone strength. I can hear speech from Toulouse on the loud-speaker.

With best wishes for putting such a fine set within the reach of amateurs.—Yours faithfully,

THOS. E. PRESTON.

Birmingham.

TRANSATLANTIC IV

SIR,—I am writing to tell you of the very satisfactory results obtained from a Transatlantic IV set (by Percy W. Harris, *Modern Wireless,* November, 1924, issue), which I have constructed. This is only the second set I have built. I have used the designer's components with only two small exceptions. The H.F. transformer connections I have changed in accordance with Messrs. McMichael's diagram.

Results.—On a rather good aerial about 60ft. high and 80ft. long five miles from 2LO, supposed to be a blind spot, 2LO comes in loud without a plug-in coil and with the reaction shorted. Daventry, if anything, is louder under the same conditions. Birmingham, Aberdeen and Belfast are at good 'phone strength. Cardiff, Nottingham and Manchester are all good when 2LO is off, mostly in daylight.

At night Rome and Madrid come in quite nicely, also one or two German stations.

On Sundays, under good conditions, in daylight, Radio-Paris is excellent loud-speaker strength. Unfortunately, in the evening Daventry smothers it out, but I can generally clear the Eiffel Tower of any signals from Daventry.

I am very pleased with this set, and I send my congratulations to the designer of the circuit. The valves I use are A.R.D.E. H.F. for the high-frequency, a cheap Dutch valve for detector, and a Cossor for L.F., and I make good use of the H.T. tappings.—Yours faithfully,

H. G. FROST.

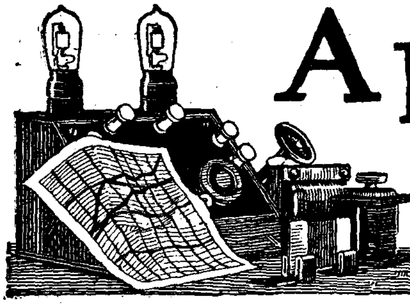
Forest Gate, E.7.

TRANSATLANTIC V

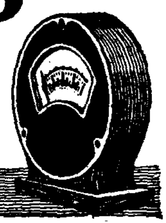
SIR,—I have constructed the Transatlantic V (by Mr. Percy W. Harris, in *Modern Wireless* for June, 1924). It is the best set I have ever yet built, as it is wonderfully pure and well worth listening to. It seems to me that L.F. resistance coupling is the best for purity, but not quite so loud as transformer coupling, and I would advise readers to make up as the original and not make their own alterations. I get good loud-speaker results from Chelmsford, London, Cardiff, Radio-Paris and Königswusterhausen on Sunday mornings. The valves I use are H.F. Ediswan A.R.D.E. (.3 amps.), B.T.H. B3 detector (.35 amps.), and for L.F. a Marconi R (.65 amps) works well, but is not quite so powerful as 2D.E. 5B; the fifth valve is a B.T.H. B.6. The five D.E. valves are very economical. In conclusion I can assure readers great success if they comply with the directions given in the article.—Yours faithfully,

W. HAYNES.

Portsmouth.



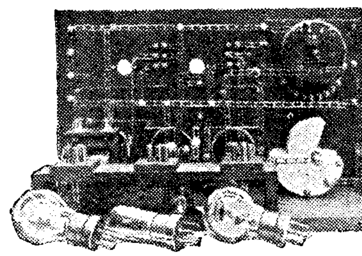
Apparatus we have tested



Conducted by A. D. COWPER, M.Sc., Staff Editor.

Connecting Strip

A substitute for the ordinary round or square tinned bus-bar wire for wiring up radio receivers, permanently or temporarily, is offered in the perforated connecting strip, samples of which have reached us from Arthur Edwards. This consists of ¼-in. wide tinned copper strip, perforated throughout its length with oval holes of a width corresponding to No. 4BA clearance size, and with but narrow spacing bars between the holes, so that no difficulty will be found in adjusting the strip over the back studs of any two terminals, or connector screws, which have to be joined up behind the panel. Right-angle and diagonal bends are made simply by folding over the strip; it is evident also that **T**-joints can be made with ease by the aid of small No. 4 B.A. bolts and nuts, all without the use of solder. By cutting off the end



A receiver wired with the new connecting strip.

of the strip at the proper point a spade-terminal end is left, convenient for applying to some terminals. Since the strip is tinned throughout, permanent connections can also be made readily when desired by soldering.

It is evident that this method has considerable possibilities for experimental work, and that the superior stiffness of the perforated strip may facilitate some intricate wiring schemes.

"Crinvac" Detector

A curious type of semi-automatic crystal detector, in which the crystal is sealed up in a glass bulb somewhat similar to that of a valve, is the "Crinvac," a sample of which has been submitted for test by the makers, Messrs. Crinvac, Ltd. The bulb was mounted on a small circular base fitted with terminals; three sharp points projected up into the narrow portion of the stem, two being connected to the one terminal and the other single point to the remaining terminal. The fragment of crystal was loose in the bulb, and if jerked up came necessarily to rest so that it generally touched all three of the sharp points. The idea is presumably that one at least of the double points will be touching a non-rectifying region of the crystal, whilst the chances are that the single point may be resting against a good rectifying spot. If this is not the case, it is an easy matter to try another position of the crystal.

On actual trial, using the local station's wave, which on a standard hand-set galena crystal gave 28 microamperes rectified current, after many blank tries two positions giving rectification were obtained in the manner indicated; one gave 7 microamperes rectified current, the other 6 microamperes in the opposite direction. It is evident that not much reliance can be placed on this fortuitous method of setting a catwhisker. The makers state that the crystal is enclosed in a vacuum, but on opening the bulb under water by breaking off the tip of the seal, hardly enough water entered to wet the interior surface of the bulb, so that the sample submitted for test cannot have been very completely evacuated.

Ferranti L.F. Transformer

Messrs. Ferranti, Ltd., have submitted specimens of their L.F. intervalve transformers, Type AF2, for test. These are medium-sized instruments, with horizontal coil and open frame; the terminals, of generous dimensions, are arranged in an accessible manner on a moulded insulating top plate. The iron core is of moderate cross-section; no bolts pass through the laminations. An earthing tag is provided on the frame, which also supplies holding-down lugs. Particulars are given by the makers of elaborate tests to which each instrument is subjected before being marketed; our own tests of insulation-resistance between windings and from windings to frame confirmed the stringency of these. The D.C. resistance of the primary was unusually low; that of the secondary was also not of a high order. Practical trial under optimum conditions of high plate voltage and proper grid-bias, and in conjunction with the best available loud-speaker equipment, showed that in comparison with the large standard transformers the build-up of signals with these instruments was of a satisfactory order, but that there was a certain high-pitched effect and lack of body which would imply a smaller primary impedance, even when used with a detector valve of low impedance compared with the average R valve. This was most noticeable with two stages of L.F. amplification in use, with signals detuned to give an intensity which the valves (small power valves) could safely handle; the raising of the general "pitch," accompanied by a distinct drop in amplification, was quite marked. Whilst we are glad to note that the makers advocate the use of the comparatively high ratio (4 : 1) after a power-valve in a second stage, it is evident that these instruments will operate with most satisfaction in conjunction with a low-impedance detector and a low-pitched loud-speaker in a circuit involving only one stage of L.F. amplification. The workmanship and finish of the instruments appeared to be of a high order.

"Cellulite" Valve Windows

Samples of their "Cellulite" valve windows have been submitted by Messrs. the Cellulite Manufacturing Co. These are self-fixing without screws, a hole 1 in. in diameter in the panel being required. A ring is inserted from the front of the panel, with curved rim which overlaps the edge, whilst from the rear a rimmed cup-shaped centre portion is pushed in, so as to fit tightly into the ring and lock the whole in position. The windows are made in a variety of colours, with coloured or transparent centres, and also in decorative contrasting tints. The material is described as "non-flam." celluloid. On test it caught light with great ease and burnt vigorously, but not with the semi-explosive violence characteristic of ordinary celluloid. Great care should accordingly be used in soldering near these windows; it would be better to remove them entirely—a matter of a second only—than to risk a fire by bringing a hot soldering iron near. The windows proved easy to apply once the large hole was made in the panel; the colour schemes available will, no doubt, appeal to many home constructors.

"Wade" Square-Law Condenser

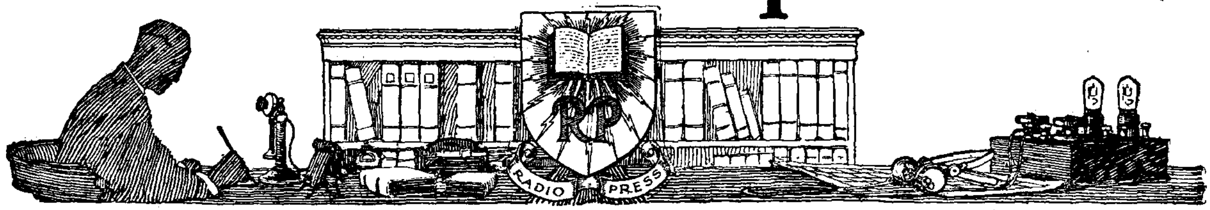
An interesting type of "straight-line-wavelength" condenser which attempts by a particular arrangement and shape of plates to achieve a linear relationship between scale-readings and wavelength is the "Wade," a sample of which has been submitted by Messrs. C. G. Vokes & Co.

This has two similar banks of eight and nine plates respectively, each of an irregular pentagonal (or blunt spear-point) form, mounted in approved "low-loss" manner on transverse strips of insulating material and provided merely with small screws for connections, no metallic connection being present with the other parts of the instrument. One bank is held stationary at the farther end of a large rigid brass frame, this frame being mounted by the ordinary one-hole-fixing device behind the panel. The second inner bank of plates has a parallel motion to and fro, by means of screw shafts on which long nuts operate at each side of the frame. These shafts are in turn driven by gear wheels, and a train of gears in a compartment at the inner end of the frame gives a slow motion to these when the central external knob is rotated, thus controlling the mutual engagement of the plates and the effective capacity. A 4-in. engraved metal dial has a separately-geared slow motion so adjusted that a complete rotation corresponds to the total adjustment range of the instrument, and is divided into 100 divisions around its periphery. The whole device is massive and is evidently made to a high standard of workmanship and finish; it operated, on trial, with great smoothness. The maximum measured capacity was but .00013 μF; the minimum capacity had the commendable value of 2.8 $\mu\mu$F. There was no appreciable H.F. resistance to record. With a suitable inductance it proved possible to cover *e.g.* a range of from 731 to 1,363 kc. (410 to 220 metres) when used in an ordinary valve-circuit with inevitable casual and distributed capacities; the wavelength scale-reading curve showed, however, the usual marked divergence from a linear relationship in the first third of the range, just as is generally observed with other forms of "square-law" condensers which have not been specially adjusted to avoid this effect.

"THE WIRELESS CONSTRUCTOR," OCTOBER ISSUE ON SALE YESTERDAY, PRICE 6d.

Do not forget to remind your friends who are beginning wireless that this is the ideal monthly magazine for them.

Information Department



T. H. M. (ST. HELIER) states that he is using the "All Concert de Luxe" receiver which until recently gave excellent results. Reception, however, is now marred by a series of crackling noises, and is intermittent. He has replaced the high-tension battery with a new one, tested the components and wiring by the "click" method, using telephones and a dry cell, and finds everything apparently correct. The insulation of the panel, that between windings and windings, and core of the low-frequency transformer and also of the various condensers, is shown to be of a satisfactory order on a "megger" borrowed from a friend. He states that the crackling is particularly pronounced when altering the setting of the reaction coil in endeavouring to receive distant transmissions.

From our correspondent's letter the tests conducted would seem to indicate that there is little radically wrong with the set, and the last sentence gives a clue to the most probable cause of the trouble. Since the crackling noise is most pronounced when the reaction setting is altered, we are inclined at once to suspect the flex leads which make connection with the moving coil block. When flexible rubber-covered leads are used, and these are subjected to a certain amount of strain, it is by no means unusual for a partial break to occur, which, although not entirely preventing the set from working, gives rise to cracklings when slight vibrations occur. Switches should also be carefully examined and bent so as to make definite contact if this is at all doubtful. We think, therefore, that if attention is paid to the switches and new flexible leads are substituted, the trouble will disappear.

K. E. N. (SALISBURY) is experiencing trouble with his Family 4-valve receiver. Signals are good on H.F. and detector, but when the first L.F. valve is switched into circuit signals decrease in strength. The addition of the fourth valve gives an appreciable step-up in volume, but quality is poor.

From practical experience we are inclined to at once suspect the low-frequency transformer situated to the right-hand side of the panel in the receiver. It is most likely that the primary winding of this instrument has broken down, such a fault giving rise to such symptoms as our correspondent mentions. We would therefore advise him to test the windings for continuity, using the "Click" test. To carry out this test join one tag of a pair of telephones to a small dry cell, such as is used in a flash-lamp battery, the free side of the battery to IP, and tap the OP terminal with the free telephone tag. The normal connections to the transformer should be removed during the test. If loud plonks are heard this indicates that the winding is continuous, but not necessarily in satisfactory working order. If, however, no plonks, or only extremely faint ones, are heard, the transformer should be changed. The test should also be carried out across the secondary winding and between winding and winding and the core. Clicks obtained in any except the tests betwen IP and OP or IS and OS indicate that the insulation of the instrument is faulty and a new one should be substituted. We think, however, it is almost certain that the test across the primary winding will locate the fault.

O. M. (WINCANTON) asks for an elementary explanation of the Beam system of wireless transmission.

An analogy with light radiations will perhaps make the subject clear to our reader. When it is desired to obtain a parallel beam of light from a lamp this may be done by placing the lamp at the focal centre of a suitable concave parabolic reflector. Within limitations the same principle may be utilised to obtain directional beam transmission. Wireless waves are essentially the same in nature as light waves, excepting that the wavelengths of the former are very large compared with those of the latter, which are only a small fraction of an inch in length. The size of the reflector should be large in comparison with the wavelength, and it follows therefore that only comparatively short wavelengths may be used for this system of transmission, since otherwise the reflector would be too large for erection in practice. For very short wavelengths Hertz originally employed parabolic sheet-metal mirrors to direct electric waves, but at present where the wavelengths are considerably longer than those employed by Hertz, a system of wires is erected in skeleton parabolic formation, which although offering but little resistance to the wind, effectively reflects electric waves in a beam. This results in the signals being radiated in one direction only, thus effecting a useful concentration of energy and preventing receivers outside a limited distance on either side of a line between the transmitter and the station to which its transmission is directed from intercepting the messages sent.

T. H. (CHEDDAR) has constructed the 4-valve Family receiver and is obtaining very good results. He wishes to know, however, whether he can add a further stage of high-frequency amplification to this set in order to increase his range of reception.

The four-valve Family set contains one high-frequency valve, a detector and two low-frequency valves. While it is quite possible to provide additional high-frequency amplification, the precautions necessary to obtain selective tuning and freedom from self-oscillation are such that we do not recommend this course of action. Unless particular care is taken the use of two high-frequency valves will not give appreciably better results than one, so that we strongly recommend the use of a set which was specifically designed for use with two high-frequency valves. Such receivers are the Transatlantic V or, more recently, the Harmony IV, which was described in the September issue of *Modern Wireless*. Both of these sets were designed by Mr. Percy W. Harris, and were particularly arranged to operate with two stages of high-frequency amplification.

I. S. (WOOLWICH) asks us how he can obtain an approximate idea of the capacity and the natural wavelength of his aerial and earth system. He has a calibrated buzzer wavemeter available.

With a buzzer wavemeter available, even if uncalibrated, it is a simple matter to obtain a comparatively accurate idea of the capacity of an aerial. Rig up an ordinary crystal circuit employing an ordinary type of circular-plate condenser of known capacity in parallel with a plug-in coil. Connect aerial and earth in the normal manner, and with 'phones on adjust the wavemeter to buzz and tune it to a suitable wavelength to give maximum signals on the set, when the condenser of the latter is set at some small arbitrary value, such as 20°. The wavemeter should be used as loosely coupled to the set as possible, so that tuning is sharp.

Having tuned the wavemeter to give a sharp reading as above, leave it set and remove the aerial and earth from the crystal set. Retune on the latter until the buzz from the wavemeter is again heard at maximum strength and note the new setting of the condenser. Neglecting the aerial inductance, which is usually very small compared with its capacity, it is obvious that the increase in capacity in the second case is equivalent to that of the aerial. Subtracting the two readings will give the aerial capacity by simple proportion; thus, if the second reading is 80°, the first 20°, the condenser scale division 180°, and the maximum capacity .001 F $\frac{80 - 20}{180} \times .001 = .00033\ \mu F$. This follows, since with an ordinary circular plate condenser the relation between scale degrees and capacity is directly linear. Obviously the accuracy of the figure obtained will be largely governed by the accuracy to which the value of the variable condenser is known.

The natural wavelength of the aerial is much more difficult to determine and beyond the scope of our correspondent with only a wavemeter available. If the length of wire in the aerial in metres is known, this figure multiplied by 4 or 5, say $4\frac{1}{2}$, will give a fair idea of the natural wavelength. Strictly this only applies in the case of a single wire, but the figure thus obtained will be sufficiently accurate where merely an approximate one is required.

A. D. C. (BELFAST) has until recently successfully used an ST 100 employing 4-volt bright emitter valves. One burnt out and our correspondent then substituted 2-volt type valves in order to obviate so frequent battery charging. He finds that the change is one for the worse, signal strength being very weak.

From A.D.C.'s letter a clue to the trouble is given. He states that he employs a 2-volt accumulator for his present valves and that this stands about 6ft. from the set in order that it should not be conspicuous. No mention of the leads employed is made.

The two valves our correspondent now employs are rated for 1.8 to 2 volts and .35 amperes. If, therefore, a pressure drop of more than 2 volts takes place in the leads or the filament resistances and filament wiring the valves will not receive sufficient voltage to function satisfactorily, and this would easily account for our correspondent's trouble. A simple application of Ohms Law will show that if the resistance of the leads exceed about .3 ohm, the valves will not receive 1.8 volts. The remedies are obvious. Shorten the leads, employ heavier flex, and see that all the resistance of the filament rheostats may be cut out if necessary.

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Wireless Weekly, 6d. Net. Wednesday September 23rd, 1925

Wireless Weekly

Vol. 7. No. 1.

A bigger range of Burndept Standard Precision Condensers

—*obtainable with Super-Vernier Dials*

THE introduction of Burndept Standard Precision Condensers last season met with instant success. Wireless enthusiasts will be pleased to learn that a new type—*Corrected* Square Law pattern—has been added to the range and, further, that these Condensers may be obtained with ordinary dials or with the new Super-Vernier Dial which has attracted so much interest.

Burndept Standard Precision Condenser, fitted with Super-Vernier Dial and with Dust Covers on.

Owing to careful design, the Burndept Condenser absorbs less than 0·05 per cent. of the power applied—a remarkable approach to theoretical perfection. It is ruggedly constructed and the spindle is self-aligning. The upper bearing runs in a flexible steel housing and the lower bearing consists of a metal cone running in gun-metal. Contact is perfect, and the movement is very smooth. These Condensers are absolutely noiseless even when used on waves as low as 40 metres. To protect the plates from dust and to obviate hand capacity effects, metal snap-on covers are provided.

The description, "*Corrected* Square Law," needs a little explanation. Most square law condensers are designed without regard to initial circuit capacity, but the plates of the Burndept Corrected Square Law Condenser are of special shape giving wave changes *truly* proportionate to dial settings.

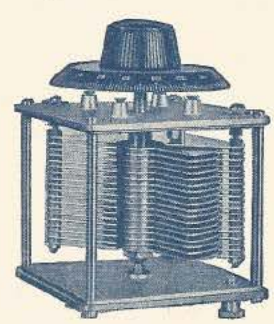
STANDARD CONDENSERS. All Metal, completely enclosed type.

Model S. V. Fitted with Super-Vernier Dial and Knob.

No. 917.	Corrected Square Law, .00027 mfds.	**£1 7 6**
No. 918.	Corrected Square Law, .0005 mfds.	**1 12 6**
No. 919.	Normal Type, .0005 mfds.	**1 7 6**
No. 920.	Normal Type, .001 mfds.	**1 15 0**

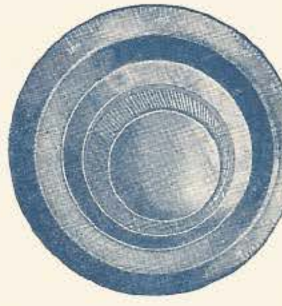
Model N. Fitted with Black Bakelite Dial and Knob.

No. 921.	Corrected Square Law, .00027 mfds.	**£1 2 6**
No. 922.	Corrected Square Law, .0005 mfds.	**1 7 6**
No. 923.	Normal Type, .0005 mfds.	**1 2 6**
No. 924.	Normal Type, .001 mfds.	**1 10 0**



Burndept Standard Precision Condenser fitted with ordinary dial, and with Dust Covers removed.

The new Burndept Super-Vernier Dial is ideal for controlling vario-couplers, etc., as well as condensers and enables fine adjustments to be made with ease. It is no larger than an ordinary dial and can be fitted to almost any set without dismantling the instrument. The reduction of about 7:1 is effected by means of a novel friction-driven epicyclic gear, which is perfectly smooth and silent in operation. The gear ratio of 7:1 has been selected after careful trial as the most suitable. There is nothing whatever to go wrong and slight wear is self-compensated. Dials have required no adjustment after an experimental run of half a million revolutions.



The Burndept Super-Vernier Dial looks like an ordinary dial, but the concealed mechanism enables critical adjustments to be made quite easily.

No. 905.	*Model A.* For $\frac{1}{4}$" spindles (no projections above panel) complete with knob, etc. ...	**7/6**
No. 907.	*Model B.* For $\frac{3}{16}$" and $\frac{1}{4}$" spindles (one-hole fixing condensers, etc.) complete with knob, distance ring, etc.	**8/6**

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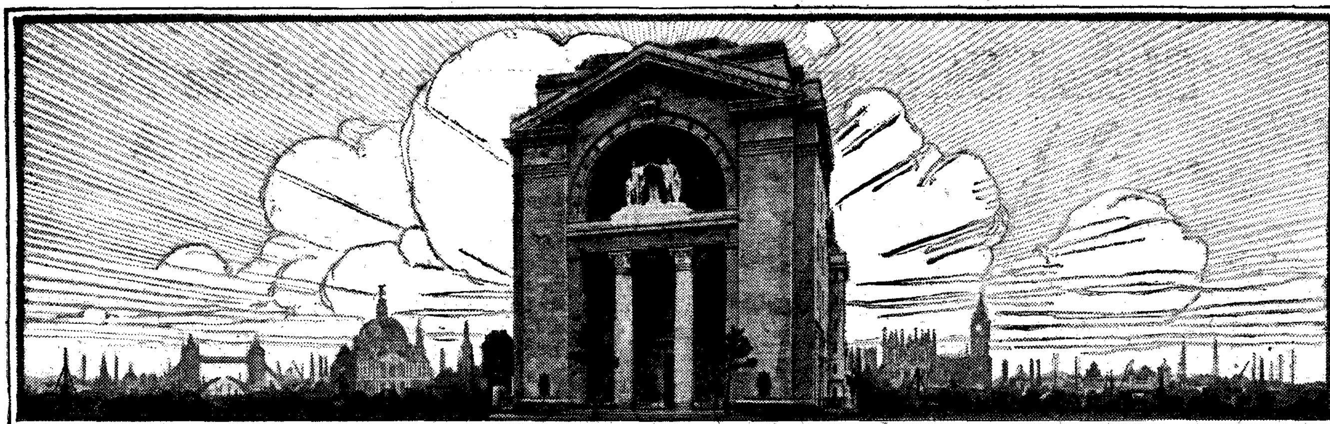

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The B.B.C. and their Wavelength Standards

ON another page we publish some interesting and highly important figures relating to the wavelengths of the British Broadcasting Company's stations. Technically the figures speak for themselves, but there are other aspects of the case which we think are of equally vital importance.

The British Broadcasting Company, in our opinion, should set the highest possible standard in all matters with which it deals. We, in this country, are justly proud of our broadcasting service, and its praises have been sung by visitors from all parts of the world. Thousands of sets have been designed for no other purpose than to listen to the concerts from these stations, and a vast amount of experimental work is continually in progress. Should we not assume that when the British Broadcasting Company publishes the wavelengths of its stations reasonable accuracy may be expected? A slight and occasional variation from the published figures would be understandable, as accidents happen in the best regulated stations, but for some time we have been seriously concerned with the consistent divergence from the published figures of more than one of these transmissions. The most glaring case is, of course, that of London. Here the published wavelength is 365 metres (821.4 kc.), whereas our own laboratory measurements show the figure to be 357.7 (838.19 kc.). For months past the wavelength of the London station has been nearer 360 than 365 metres.

For a considerable time manufacturers of wavemeters have been worried by complaints from their customers that the instruments are wrong. In most cases it has been impossible to persuade the customers that the B.B.C. wavelengths are not correctly given. This attitude on the part of the customer is easily understood, for when he is asked to choose between the British Broadcasting Company's official figures and the statements of a manufacturer, he will naturally take the word of the B.B.C.

Again, on the question of selectivity, there are still more worrying problems. London, according to the published wavelengths, falls at a certain definite distance between Manchester and Cardiff. For a long time it has been almost impossible in certain areas to separate the Cardiff station from London, although the difference in wavelength according to the published figures should enable such a separation to be effected. An examination of the figures published in Dr. Robinson's article will show that the kilocycle difference between the two stations is so small as to make selectivity, with any other instrument than a super-heterodyne, a most difficult task.

If the B.B.C. change their actual wavelengths to "dodge" interference from foreign stations, these latter are themselves in a quandary. By making such changes a position arises similar to that when two people meet and each tries to dodge the other. Collision is, in most cases, inevitable. It is worth noting that in the United States, where the congestion of stations is one of the biggest problems to be solved, such fluctuations in wavelength are never permitted, and a station which consistently broadcast on a wavelength different from that allotted to it, would have its licence suspended.

CONTENTS.

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September 23, Vol. 7, No. 1.

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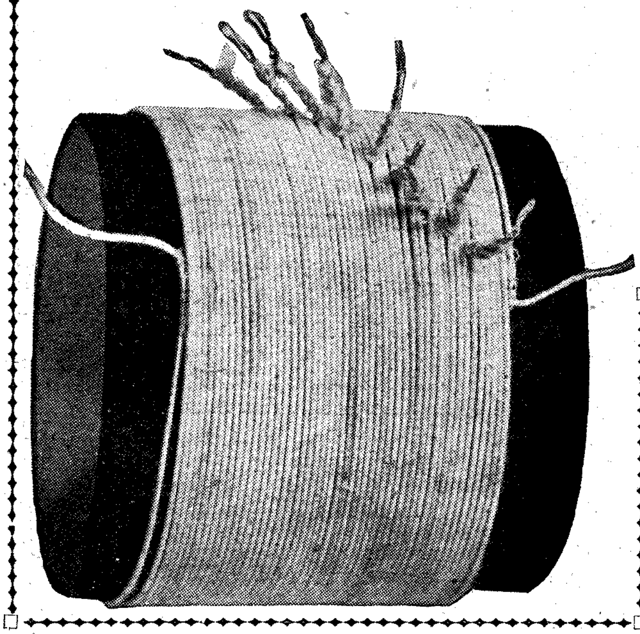
Signal Strength and Tapping Points



By A. D. COWPER, M.Sc., Staff Editor.

The growing vogue of untuned aerial circuit arrangements raises several questions relating to the design of the primary winding. The results given here of some preliminary experiments made by Mr. Cowper should prove extremely suggestive. Further tests upon the effect of coupling variations are suggested to those readers possessing the necessary simple equipment.

IN a number of modern types of selective circuits a tapping point is taken from an aerial or secondary inductance for the purposes of rough tuning, giving what is called (for lack of a better name) a "semi-aperiodic" system. Tuning is thus greatly simplified, in many cases the number of tuning points being reduced whilst still permitting of fine, selective tuning at some other point in the circuit.

Without careful design, however, serious loss of signal-strength may result from this compromise. It seemed of interest, therefore, actually to measure the signal-strength in a low-loss secondary circuit with various "semi-aperiodic" couplings, at various different tapping points, in comparison with conventional tuned coupling arrangements and with the optimum value obtainable by any means available.

Method of Measurement

Measurements were made by the familiar Moullin voltmeter method upon the local station's wave and on a large high aerial of fairly low resistance in conjunction with a good earth. A previously calibrated R valve was used, with 48 volts H.T. and 4 megohms grid-leak; under these circumstances the scale is fairly linear up to 3 volts signal-voltage. In any case, relative rather than absolute values are required, and the observed signal-strength is recorded in virtual "volts."

The usual precaution was taken to provide a low-resistance H.F. path from the anode to the filament circuit by blocking condensers across 'phones and milliammeter. The transmission varied slightly in strength during the measurements; comparison was made in each case with the current value on a standard coupling.

Effect of Primary Tappings

Fig. 1 shows the observed change of signal-strength in the secondary with different primary turns, when using a separate tapped primary fairly loosely coupled at 2 in. below the filament end of the low-loss grid inductance. This corresponds roughly to the conventional Reinartz type of circuit, with semi-aperiodic tapped primary, though rather more loosely coupled than with some versions of that circuit. A marked optimum tapping point is noticeable, and the shape of the curve suggests that quite fine tapping of the primary would be advisable for *critical* work. The 30 turns of No. 22 d.c.c. on a 3-in. former were found, on separate test with a crystal rectifier (to avoid introducing extra stray capacities), to tune the large aerial to the frequency of reception, about 821 Kc. (about 364 metres).

Comparison with Auto-coupling

A marked improvement over direct series-condenser coupling of the same low-loss (secondary) inductance to the aerial was shown in this case, even with very roughly adjusted primary tappings. The practical optimum was reached with auto-transformer (aerial tap) coupling at the 11th turn on the grid inductance. This was of the same order as the optimum with separate primary of 30 turns.

Effect of Filament Tapping

Fig. 2 shows the effect of connecting the filament circuit to a tapping point part of the way up the grid

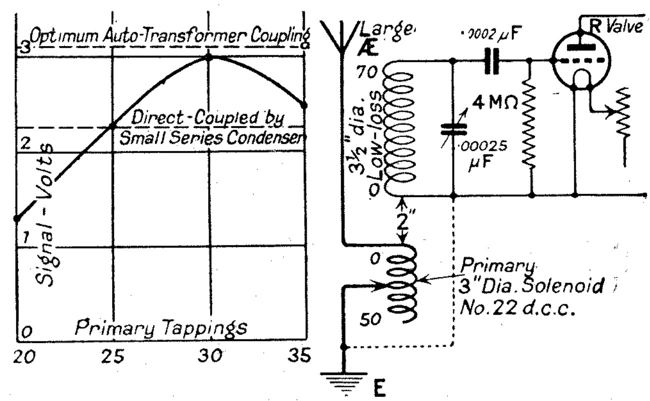


Fig. 1.—When the coupling between primary and secondary is fairly loose the author finds that a definite optimum value exists for the primary turns for a given wavelength.

inductance, thus including a smaller number of turns across grid and filament, and naturally diminishing the *proportion* of the total H.F. voltage across the tuning-inductance applied to the grid. When this tapping point is made halfway up, we obtain an arrangement recalling the familiar Hartley transmitter circuit, but omitting the anode connection of that circuit.

Unexpected Results

Rather surprisingly it is found that the available grid signal-voltage is *not* greatly diminished by this device, even when the tapping point is made one quarter of the way up the inductance; a mean of around 90 per cent. of the maximum available signal-voltage was registered with a one-quarter filament tap, and even with a centre (Hartley-type) tap the actual voltage registered was 75 per cent. of the maximum. The diminished grid-damping had evidently compensated to some extent for the voltage-partition. Since in some types of capacity reaction circuits a filament tap is taken thus at a point part way up the grid tuning inductance, it is of considerable interest and importance to note that very little signal-strength is lost in this manner. A constant optimum primary coupling of 30 turns on a 3-in. solenoid of No. 22 d.c.c. at 2 in. below the filament-tap-end was used in this series of measurements.

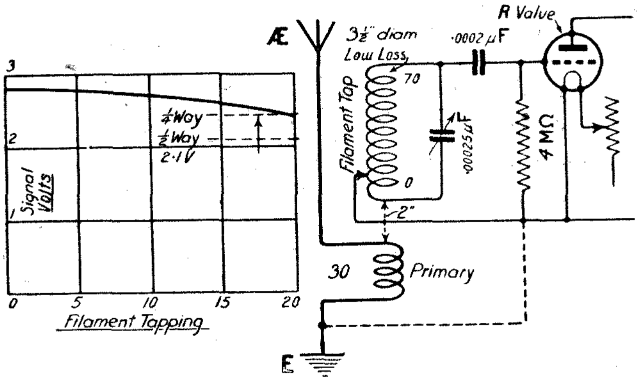


Fig. 2.—The use of a filament tap produced a surprisingly small reduction in signal strength.

Aerial Tapping Points with Filament Tap

Trying now the effect of different aerial tapping points in conjunction with a ¼ filament tap circuit, with the aerial tapping point outside the filament tap (Fig. 3), it was found that there was very little change as the tapping point was moved inward, until the point was reached at which 11 turns were included in the aerial circuit—the number previously found as optimum for plain auto-transformer coupling. Below this the signal-strength fell off rapidly, as might be expected. The maximum number of turns available, 17 in this

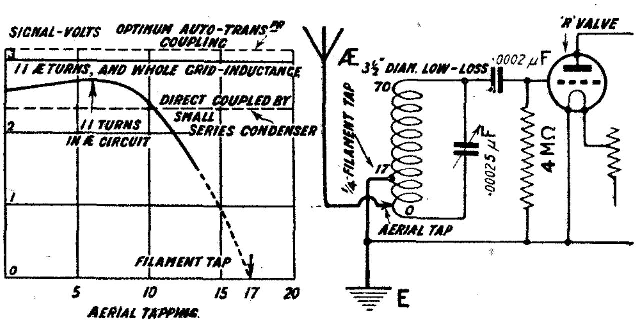


Fig. 3.—Showing the relation between signal strength and aerial turns when a filament tap is also employed.

case, did not suffice at all to tune the aerial to the frequency of reception.

Fine Aerial Tapping Suggested

It was noted that the selectivity increased with a smaller number of aerial turns in use, as should obviously be the case. The optimum value of signal strength reached with this arrangement was in one series 87 per cent., and in a second series 91 per cent. of the practical optimum attained with auto-transformer coupling and full grid inductance in use. A fairly fine tapping for the aerial connection is evidently desirable in this type of circuit, but with this provision the signal-strength can be very satisfactory.

Closer Coupling

The last arrangement investigated (Fig. 4) was that of a close-coupled small primary of rather "high-loss" design inserted actually inside the secondary, after the manner of some American receivers. In this case the secondary was the same 3½ in. diameter low-loss coil of 70 turns of air-spaced large gauge enamelled wire used in the other experiments, and the primary was placed close to but actually just beyond the end of the secondary winding. This corresponds closely to the case of a fixed tapped primary wound on the same former beyond the secondary, with *e.g.*, a ¼ in. gap between, or to the original Reinartz arrangement.

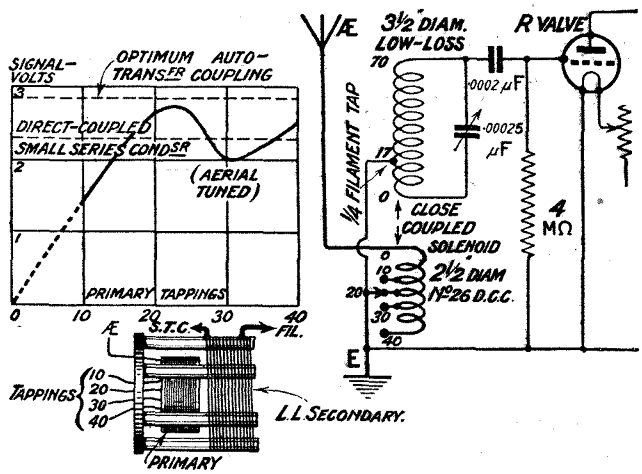


Fig. 4.—When the primary and secondary coupling is tight a peculiar shaped curve results.

The one-quarter filament tap was used, as before, and the primary was a small solenoid of 40 turns of No. 26 d.c.c. wire closely wound on a 2½ in. diameter cardboard former and tapped at turns Nos. 10, 20 and 30. Separate tests showed that this tuned the large aerial very closely to the frequency of reception with 30 turns. The effect of this close tuning and close coupling is shown in a marked manner by the curve; a rapid increase when 20 turns of primary inductance are used, compared with the poor showing with but 10 turns, and then a decrease with 30 turns, followed by an increase to almost the optimum figure with 40 turns.

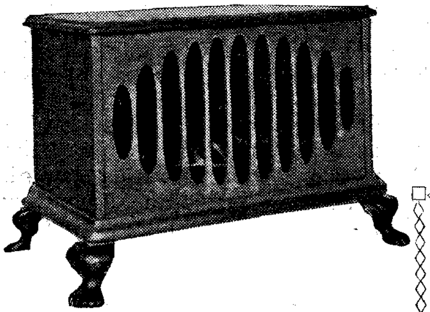
Advantages of Detuned Aerial Circuit

The effect on reaction requirements in a reaction circuit of this phenomenon is quite prodigious, and the curve should emphasise a point which the writer has frequently dwelt upon in connection with such circuits with semi-aperiodic couplings, namely, that the aerial circuit should be kept a little *detuned* above the frequency of reception for best results.

The signal-strength is again excellent, being some 95 per cent. of the optimum with most favourable auto-transformer coupling, compared with 65 to 74 per cent. observed on my aerial with direct series-condenser coupling.

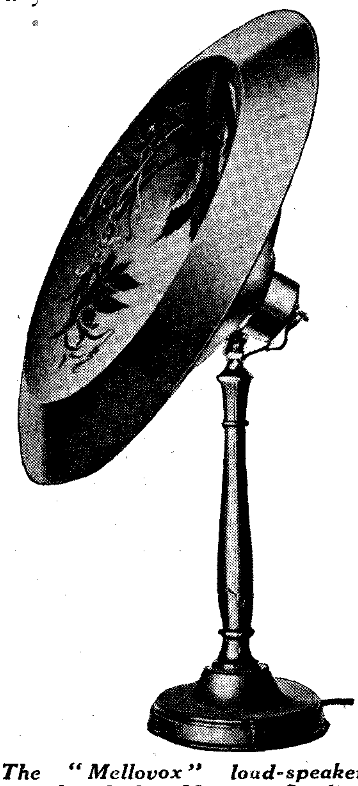
Some New Loud-Speakers at the Exhibition

Each year the Exhibition provides something in the nature of a summary of progress in loud-speaker development during the previous twelve months. A special description appears on these pages of some of the latest instruments seen at the Albert Hall by a representative of "Wireless Weekly"



The C.A.V. hornless loud-speaker.

If a careful survey of the loud-speakers exhibited at the Albert Hall is made to see what improvements in design and construction have been effected in the past year, the result in the aggregate is rather disappointing. In very many cases models will be found to



The "Mellovox" loud-speaker, introduced by Messrs. Sterling, operates upon a similar principle to that employed in their larger model (the "Primax").

be practically the same as last year, and, with the exception of one or two cases, any improvements made are merely in the details, and not in the fundamentals of construction and design.

A feature that has been adopted fairly generally is the wood or semi-wood horn, and there also is a certain tendency towards the use of non-resonant materials for the construction of loud-speaker horns. The external finish would appear to be slightly better than that shown last year, and sound boxes are a little heavier in some cases.

Research Work

Many manufacturers have spent considerable money in experiment and research on loud-speakers, but most of them confess that they have been little able to improve on their last year's models, such improvements as have been effected being in regard to smaller details of construction.

Ornamental Types

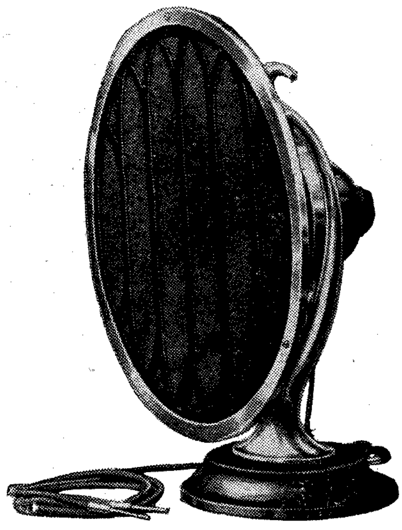
There is a definite movement in the direction of making the loud-speaker an ornament, and one or two models of pedestal loud-speaker are to be seen, which provide a very effective disguise. Other loud-speakers of conventional design are obtainable in various styles of finish so as to match with different types of furniture. Cabinet instruments are also available in different makes.

The Radiolux Amplion

Two rather decided new departures are the Radiolux Amplion and the Polar Audalion speakers. The first of these is built to resemble the English bracket clock. It incorporates several distinctive features in its construction. The electro-magnetic unit has a threaded nozzle, by means of which it is screwed into the tone arm or duct. This duct curves into a reflecting bowl of special contour, the two being supported on a perforated steel-ribbed plate. The whole is mounted in the wooden casing by means of rubber washers, so as to insulate it from the cabinet. The steel base plate is perforated so as to afford free circulation round the radiating or reflector bowl, and so avoid the possibility of unwanted resonance due to the vibration of an imprisoned air column. The two terminals are of the spring type, to take either pin or spade tags, and similar terminals are fitted to all the new Amplion models.

The New Polar Instrument

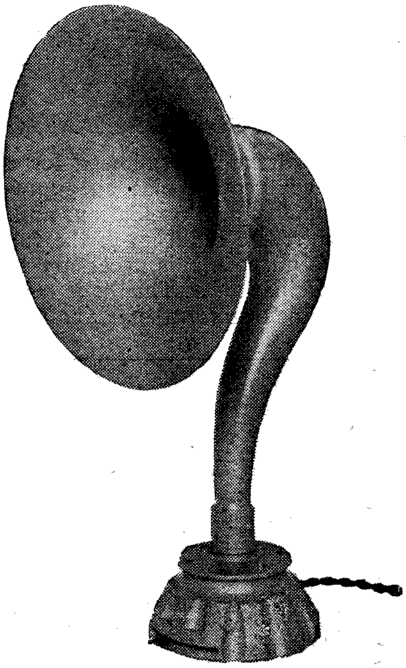
The Polar Audalion is also quite distinctive in appearance. A light wooden frame with end pieces has within it a coloured silk screen. Within this, but not visible, is a cylinder of specially prepared material to which wires are attached. These wires are fixed at their other ends to the armature of the electro-magnetic system by means of which the vibrations are transferred to this cylinder. It is claimed that since no horn is used radiation of sound is attained without introducing "horn" distortion, and that it takes place all round, that there are no metal parts to cause "tinniness," and that it has no noticeable resonance over the whole frequency range up to 15,000 vibrations



The B.T.H. type E loud-speaker is a hornless instrument.

a second. We understand that the armature is of the reed type, and that the magnets are adjustable.

What is claimed to be an important improvement in the C2 model B.T.H. loud-speaker is the use of a moulded instead of a metal base. The magnet assembly is moulded into a composition housing which screws into the base proper. This has been done with

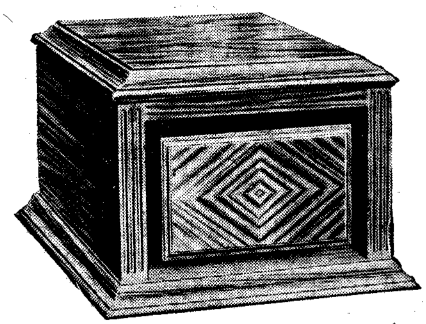


The new Ericsson loud-speaker incorporates an improved magnet assembly.

the object of eliminating any ring due to the presence of unnecessary metal, and further to conduce to this the diaphragm is clamped between cork washers. The magnets are, of course, adjustable.

A Hornless B.T.H. Model

Then there is the new B.T.H. model E hornless loud-speaker, in which the diaphragm is not supported at the periphery, so as to give freedom from unwanted resonance. Another feature is their loud-speaker which is disguised as a table lamp, and which may be used as such.



The Brown cabinet loud-speaker.

New G.E.C. Diaphragms

A feature of the General Electric Co. loud-speakers is the fact that all their diaphragms are nickel-plated. This has been done as it was found that the enamel on stalloy diaphragms was liable to chip, and that, being magnetic, it fell between the pole pieces of the magnets, where it was liable to set up annoying chatter.

An Improved Assembly

Messrs. the British Ericsson Manufacturing Co. state that their new magnet assembly allows the magnets to be adjusted without any risk of the whole unit vibrating, and thus setting up unpleasant effects.

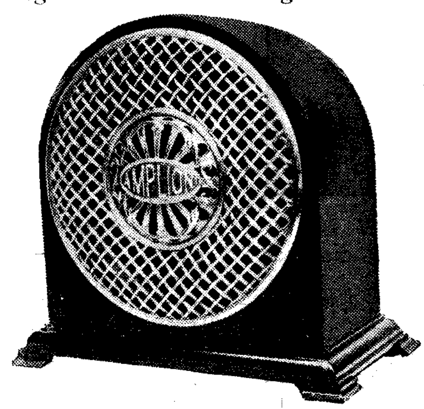
C.A.V. Developments

In order to prevent cushioning effects Messrs. C. A. Vandervell have drilled a hole through their loud-speaker diaphragms, while a recent patent of this firm covers the method of cutting slots in diaphragms and filling these slots with lead or some such metal to prevent resonance effects.

Messrs. C. A. Vandervell also produce a cabinet loud-speaker, which has a pleasing appearance, and should harmonise with most receivers.

New Brown Instruments

In the new "Q" type loud-speaker made by Messrs. S. G. Brown a new diaphragm is fitted, which is doubled back on itself and clamped on the inside, the other side of it being clamped to the reed at the centre; it thus has a free edge as well as a larger surface.



The compact new Amplion has been named "Radiolux."

This arrangement is claimed to be a great improvement. In their new cabinet type a new shape of horn is used, which, although unconventional in theory, in actual practice, we understand, is most successful. Their new power loud-speaker employs two diaphragms in opposition. Two reeds are used with aluminium diaphragms which have been made as light as possible.

SHORT-WAVE CALIBRATION SIGNALS

For the benefit of those of our readers who are experimenting upon the very short waves, and who wish to have some means of calibrating their sets, we give a further list of the principal stations working upon wavelengths from 20 metres upwards to 90 metres. These stations are located in different countries, as indicated below; the majority are received quite strongly in this country on a single valve receiver. In the first column we give the wavelengths, while in the second will be found the frequency in kilocycles per second, followed by the call signs and location of each station.

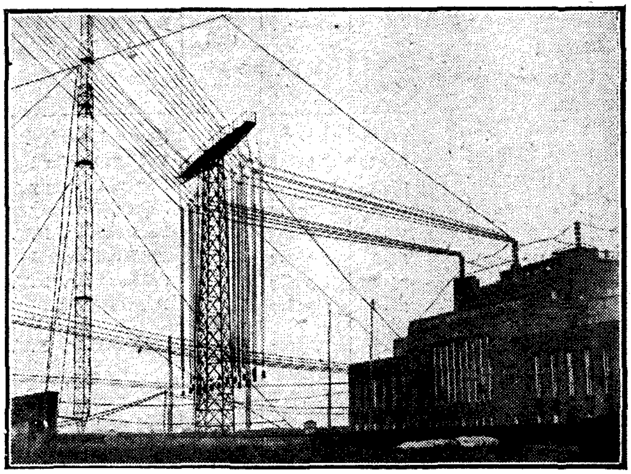
Wave-length in metres.	Frequency in kc.	Call Sign.	Location.
20.0	14,991	POX	Nauen, Germany.
25.0	11,992.8	2YT	Poldhu, England
25.0	11,992.8	POY	Nauen, Germany
26.0	11,531.5	POX	Nauen, Germany
30.0	9,994	2XI	Schenectady, N.Y.
32.0	9,369.4	2YT	Poldhu, England
35.0	8,566.3	2XI	Schenectady, N.Y.
36.0	8,328.3	LPZ	Buenos Aires, Argentine
38.0	7,837.3	2XI	Schenectady, N.Y.
40.0	7,496	1XAO	Belfast, Me.
43.0	6,972.5	WIR	New Brunswick, N.J.
47.0	6,379.1	POZ	Nauen, Germany
50.0	5,996	NKF	Anacostia, D.C.
56.0	5,353.9	KFKX	Hastings, Nebraska
58.79	5,099.8	KDKA	East Pittsburgh, Penna.
60.0	4,997	1XAO	Belfast, Me.
60.0	4,997	2YT	Poldhu, England
62.0	4,835.8	KDKA	East Pittsburgh. Penna.
67.0	4,474.9	8XS	East Pittsburgh, Penna.
70.0	4,283	POX	Nauen, Germany
71.5	4,193.2	NKF	Anacostia, D.C.
74.0	4,051.5	WIR	New Brunswick, N.J.
75.0	3,997.6	SFR	Paris, France
75.0	3,997.6	WGN	Rocky Point, L.I.
76.0	3,945.0	POX	Nauen, Germany
83.0	3,612.3	RDW	Moscow, Russia
84.0	3,569.3	NKF	Anacostia, D.C.
85.0	3,527.3	SFR	Paris, France
85.0	3,527.3	8GB	Paris, France
86.0	3,486.2	NQC	San Diego, California
90.0	3,331	6XO	Kahuku, T.H.
90.0	3,331	1XAO	Belfast, Me.

LONG OR SHORT WAVES?

By MAJOR JAMES ROBINSON, D.Sc., Ph.D., F.Inst.P., Director of Research to Radio Press, Ltd.

In this article (the second of his special series) Dr. Robinson discusses some extremely interesting problems of wave propagation, and considers some of the factors governing the choice of wavelength for long distance communication.

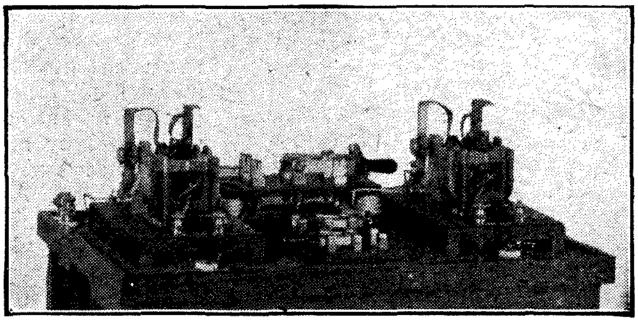
THE brief description of some of the characteristics of high-power long-wave stations in last week's issue will suffice to show that the design of such stations is a highly technical problem, and no doubt exists that these stations have become excellent engineering propositions which can guarantee good service. They are operating at the present day, and there is no doubt that they will continue to operate for many years to come in the general form in which they exist at present. An excellent feature of this type of station is that good service can be guaranteed. A daily service of nearly 24 hours can be guaranteed over distances of 2,000 to 3,000 miles, and, in fact, if very high power is used, this complete daily service can almost be guaranteed over ranges up to 8,000 miles. The famous case of the Malabar station in Java can be referred to where 19 hours' daily service to Holland is guaranteed throughout the whole year, the distance being 7,500 miles.



The down-lead of the main aerial at Nauen.

There is naturally a difference of strength between night and day, but this difference is not so great as that which is obtained on short-wave stations. For the Malabar to Holland service it is found to be better to use shorter waves by night than by day. The best wavelength by day is 16,000 metres (18.74 kc), and by night 7,500 to 9,000 metres (39.98 to 33.31 kc.). Atmospherics are bad on the long wavelengths which are used for these high-power stations, but much progress has been made in the way of minimising such disturbances.

The greatest objection, however, to the use of long waves is that it is impossible to put up the speed of signalling beyond about 50 words per minute. The reason for this can be very readily understood. It is that in order to appreciate a Morse signal there should not be too much distortion and that both dots and dashes must be fairly accurately reproduced. As the speed of signalling is increased the time allowed for a dot gets smaller. Long waves require also an appreciable amount of time for one complete oscillation, and, obviously, some time is required to build up to the full resonance value, and for this purpose it is necessary to allow 10 or more complete oscillations. Thus it is seen that in order to obtain the quickest form of signalling it is essential to cut down the wavelength. The extent to which wireless has been used in recent years has made this problem of high speeds of signalling very pressing.



An automatic key, as used by the Marconi Co., Ltd., at their high-power commercial stations.

In the radiation formulæ already given, no attention was given to the effect of long distances on the radiation. In the early days of wireless it was very soon discovered that the ideas of rectilinear propagation of electro-magnetic waves had to be abandoned, for signals were being obtained around the curvature of the earth.

Diffraction

This fact was very startling to scientists, who had expected that electro-magnetic waves would travel in straight lines. Their first attempt to explain why waves travelled around the curvature of the earth was obtained by an analogy with optics. There is an effect in optics called "diffraction," which means that light can be bent around the corners of sharp objects. Mathematicians attempted to explain on these principles of diffraction how electro-magnetic waves could be bent. In optics very little light is diffracted, and mathematicians soon discovered that the amount of electromagnetic waves which could be diffracted, or bent, around the earth, was very small indeed. Their theoretical results on this basis gave signal strength at distances of greater than 1,000 miles of an order 500 to 1,000 times too small. According to their calculations on the diffraction theory, no signals would be heard at all at long distances. In other words, very much more energy was being sent around the earth than the diffraction theory could account for.

Almost simultaneously, Heaviside and Kennelly suggested that there might be a conducting layer some distance up in the atmosphere. This was an attractive idea to wireless engineers, for it immediately gave a suggestion as to why signals could be obtained at the

Antipodes. Various scientists took up this idea and attempted to explain how a conducting layer could exist at such a height in the atmosphere. Eccles put forward views which were widely accepted for many years, and which, with certain modifications, are still generally accepted in this country. These suggestions were that as the atmosphere is rarified at these great heights ionisation is produced by the sun's rays, particularly ultra-violet radiations, and thus, at a suitable height, there are large numbers of electrons and ions, thus providing a conducting layer. On this basis electro-magnetic waves found themselves between two conducting layers, (1) the surface of the ground, and (2) the inner surface of the Heaviside layer, and thus, once electro-magnetic waves were produced they would be propagated between these layers.

Austin-Cohen Formula

Mathematicians did not attempt for a considerable number of years to develop this idea accurately in order to obtain quantitative values of signal strength at great distances, and it was left to practical engineers to work out a formula which would give the signal strength at considerable distances. The best known formula is called the Austin-Cohen formula, which modifies the formula given above by a factor which shows how the waves are diminished in strength as the distance increases. The received current I_r in an aerial is given in the following formula :—

$$I_r = AI_t \frac{h_t h_r}{\lambda d} e^{-0.0015d/\sqrt{\lambda}} \quad \ldots\ldots\ldots\ldots (1)$$

where A is a constant,
I_t is the current in the transmitting aerial,
h_t is the height of the transmitting aerial,
h_r is the height of the receiving aerial,
λ is the wavelength,
d is the distance between transmitting and receiving aerials,
e is the base of the natural logarithms,

Comparing this with the formula given last week for the received current which was

$$I_r = \frac{377\, h_t h_r I_t}{R\lambda d} \quad \ldots\ldots\ldots (2)$$

we have the following differences :—In the present formula (1) all distances are expressed in kilometres, whereas in formula (2) all distances are in metres.

The constant A in (1) takes the place of the factor $\frac{377}{R}$ in formula (2), which, of course, is constant for any one aerial for a given wavelength. It also allows for the change of units from metres to kilometres.

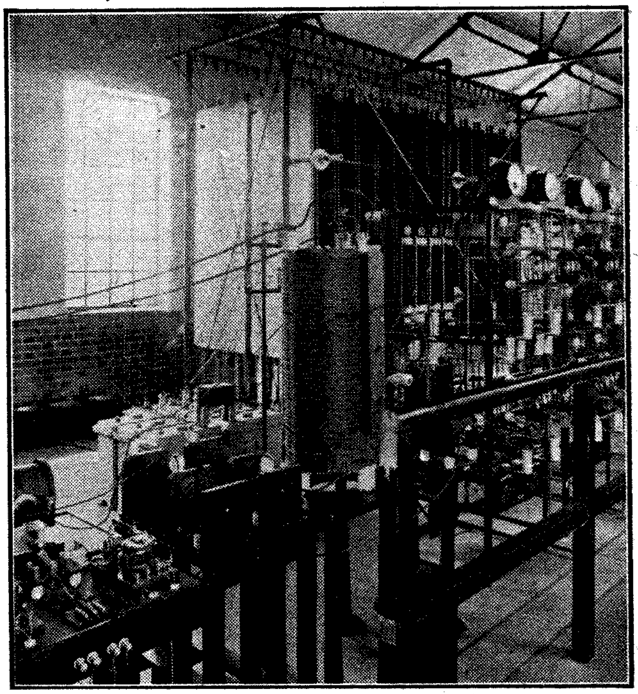
An Attenuation Factor

The important change is, however, the introduction of the quantity $e^{-0.0015d/\sqrt{\lambda}}$ which is equivalent to an attentuation factor. This factor was, as already mentioned, determined from actual measurements, and the actual values have been the subject of much discussion. The fact remains, however, that it gives better agreement with actual results than any other formula, although no formula exists at present which gives any real interpretation of all the facts.

From this formula a little mathematical manipulation shows that there is a best wavelength for transmission over a given distance. For a distance of 1,000 kilometres the best wavelength, according to the formula, is 562 metres (53.40 kc.), and for the distance of 4,000 kilometres the best wavelength is 9,000 metres. In actual practice, however, the optimum wavelengths are not given accurately by this formula, although there are best wavelengths. These discrepancies are due, first, to the fact that the formula is not quite accurate enough for all distances, and, secondly, to the fact that it does not take into account the very important features of differences between night and day transmissions.

Atmospherics

Then again there is the question of atmospherics to be considered, whose effect depends to some extent on the wavelength. Generally speaking, for long-distance communication the formula demands optimum wavelengths which are very large indeed, much larger than the wavelengths actually found to be best. We have seen that for the Malabar transmissions to Holland the best wavelengths have been found to be 16,000 metres (18.74 kc.) for daytime working, and 7,500 to 9,000 metres (39.98 to 33.31 kc.) for night working, whereas the formula gives a value for the best wavelength many times greater.



A view in the transmitting room at the Ongar station of the Marconi Co., Ltd. The Ongar group of transmitting stations work on wavelengths between 2,950 and 5,100 metres (102 and 59 kc.).

Day and Night

This formula of Austin-Cohen was obtained as a result of practical measurements on a ship travelling across the Atlantic. It gave quite considerable agreement with practical results in various parts of the world at distances up to 2,000 miles. However, it was soon found that there were other variations; for instance, the difference between night and day signal strength, which could not be accounted for by the formula.

In the last few years attempts were made to obtain an accurate formula by the use of the Heaviside layer, and a rigid theory was worked out by Watson which agrees very favourably with the actual signal strength obtained at considerable distances.

The Heaviside layer is not the only expedient which has been suggested to account for the bending of waves round the world.

Various attempts have been made to account for this bending of the waves by considering that the properties of the atmosphere vary with height. The speed of propagation depends on the dielectric constant of the atmosphere, and if this is such as to increase the speed of the waves above the surface of the earth, a condition will be obtained when the waves bend actually round the earth.

Properties of the Atmosphere

It will be necessary to account for the waves travelling more quickly in the upper layers of the atmosphere in order to keep in step with those lower down, as they have further to travel, being required to travel on a larger circumference. Of course, very little is actually known about the dielectric constant of the atmosphere at different heights. To start with, the atmosphere is not merely a mixture of oxygen and nitrogen, but it has other ingredients, such as water vapour, and again, at great heights, it is very doubtful what the actual constitution of the atmosphere is.

One of the more serious objections to the long-wave station is to be found in the very elaborate engineering work involved by the large aerials.

One scientist (Dr. Schwers) has shown that by considering the water vapour alone within the first three miles above the surface of the earth, the dielectric constant should vary in such a way as to cause the waves to follow the curvature of the earth. This theory was published in the Proceedings of the Physical Society of London in 1917.

The famous German wireless engineer Meissner has recently followed up this idea of the variation of the dielectric constant of the atmosphere to account for the bending of the waves round the earth, and has so convinced himself of the possibility that he denies that it is necessary to postulate a Heaviside layer at all. He gives analogies with the case of visible light, which can be bent under certain circumstances.

An Optical Effect

One example cited is that it is sometimes possible to see the shores of England from the summit of Mont Blanc, which is 450 miles away, and he argues that if light can thus follow the curvature of the earth, then electro-magnetic waves, which are of the same nature, should do the same. The phenomena of the mirage and the twinkling of stars are very similar.

In England most attention is given to the Heaviside layer theory. Various experiments have been suggested to attempt to prove this theory. There are various phenomena which need explanation. First of all, there is the fact that for long waves there is a difference between night and day signal strength. There is next the fact that as the waves become shorter, say in the neighbourhood of 300 to 400 metres (999.4 to 749.6 kc.), the day range and the night range differ very considerably.

On this range of wavelengths (200 to 600 metres, 1,499 to 499.7 kc.) there is a very considerable difference in daylight and night ranges. There is also the fact that fading occurs on these wavelengths, in other words that signals may be heard at one instant, and in a few minutes they will completely vanish, only to come back again later at some indefinite period. As the wavelength diminishes to 100 metres (2,998 kc.) the fading becomes very pronounced. Again, going still lower in wavelength, we find that in the neighbourhood of 20 metres wavelength (14,991 kc.) there appears to be a reversal of this effect, whereby day ranges are as great as or greater than the night ranges.

Some of the work in the following sections was suggested in order to test whether there is a Heaviside layer at all. On this theory, fading and difference in day and night reception are explained by the fact that certain waves are propagated upwards and other portions of the wave are propagated horizontally and are conducted along the surface of the ground. At a considerable distance these various components—some from the upper layers and some travelling along the surface of the ground—intermingle, and at times help each other and at times oppose each other, thus accounting for large variations in signal strength.

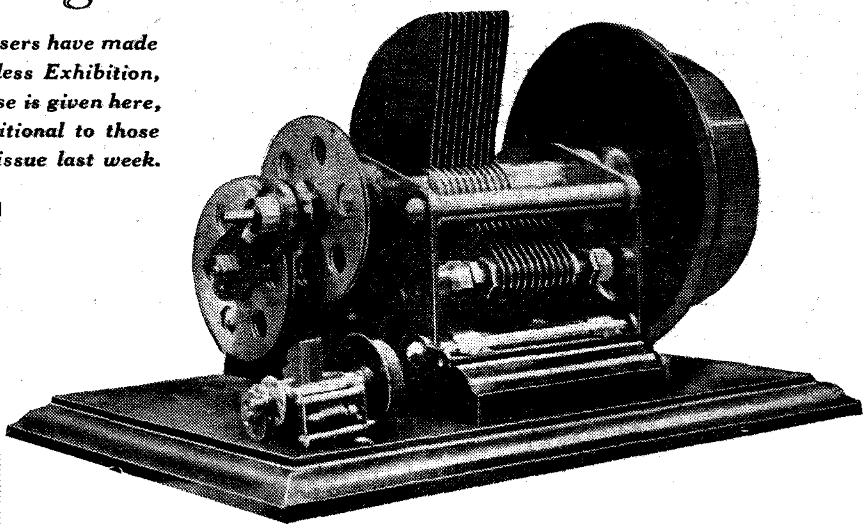
Meissner's Explanation

Meissner's theory accounts for a somewhat similar effect, whereby there are ground waves and also waves which are shot upwards from the aerial and are quite free from the earth. These are sometimes bent down towards the earth to intermingle with the ground waves. In a similar way these can intermingle with each other and so produce strengthening or weakening of the waves. At very considerable distances the ground waves will be completely washed out, for the absorption of electro-magnetic energy by a conducting surface like the earth is considerable, and the ground waves particularly will be completely washed out at considerable distances, such as two or three hundred miles.

The whole of these discussions show how wireless has developed in the last two years, and it is interesting to note that everything has pointed to the fact that it is essential to propagate waves away from the surface of the earth in order to obtain long-distance communication. This applies particularly to short waves, and in next week's issue this question will be discussed.

Some New Designs of Variable Condensers

Several new types of variable condensers have made their appearance at this year's Wireless Exhibition, and a short description of a few of these is given here, together with some illustrations additional to those published in our Special Exhibition issue last week.

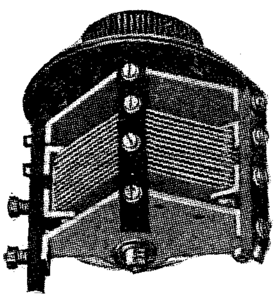


A large working model of their geared variable condenser was shown by the General Electric Co., Ltd., with an instrument of normal size beside it.

In view of the recent developments in design of low-loss variable condensers, we have made a special inspection of the various models shown at the Wireless Exhibition, and the following notes have been prepared for the benefit of readers who were unable to visit the Exhibition in person.

A New Three-Electrode Variable Condenser

Messrs. Autoveyors have produced a new model of their bridge or balanced condenser, in which the control is centralised upon one spindle with concentric knobs. All the electrodes are mounted on one spindle, and the arrangement



The "Cosmos" Low-loss Square-law Variable Condenser.

enables it to be mounted on the panel by the usual one-hole fixing method.

A New Friction Drive Condenser

A new component has been produced by Messrs. Auto Sundries, Ltd., which is known as the Radiosun. This has special new features, among which is that of a friction drive giving a 50 to 1 reduction gear, thus facilitating fine tuning. The friction drive can be tightened up by means of the adjustments provided, and thus it is claimed that backlash is entirely eliminated. The indicating device consists of a pointer fixed directly to the moving vanes, this providing a direct indication of the condenser setting. A hinged scale is provided behind which a piece of paper may be placed, which may be used for recording the settings at which certain stations may be found.

A New Geared Variable Condenser

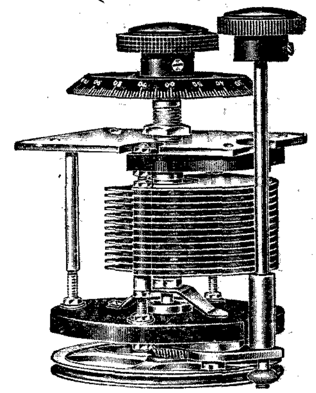
An interesting new instrument is produced by the General Electric Co., and is being exhibited at their Stand. The dial, which is divided into two portions, enables the vernier and direct drive to be used at will, the upper portion providing the fine tuning. In this case again the dial moves in accordance with the moving plates of the variable condenser, and thus the vernier movement is registered automatically upon the dial.

The Metro-Vick Low-loss Condenser

Another new variable condenser is that produced by Metro-Vick Supplies, Ltd., known as the Cosmos Low-loss Square-law Variable Condenser. We understand that this condenser gives a true square-law effect, and the design and construction reduce the losses to a minimum. The slow-motion models have a gear ratio of 10 to 1, and it is claimed that the method used ensures the absence of backlash. This instrument can also be used with a remote control arrangement, full instructions for which are contained in the carton.

Polar Innovations

The Radio Communication Co. have produced a new variable condenser, known as the Polar Cam Vernier Condenser, which is of the compensated square-law type. In this instrument both the fine movement and rough adjustment are made from the same knob, the vernier movement being registered upon the dial. Most of our readers will be familiar with the vernier arrangement in the Polar Cam Vernier Coil Holder, and it is a similar type of movement which is incorporated in this variable condenser. The dial of this condenser is graduated in a somewhat unusual manner, the maximum being marked 100 and the remainder of the scale divided evenly down to the minimum figure of 26, it being claimed that this corresponds to a

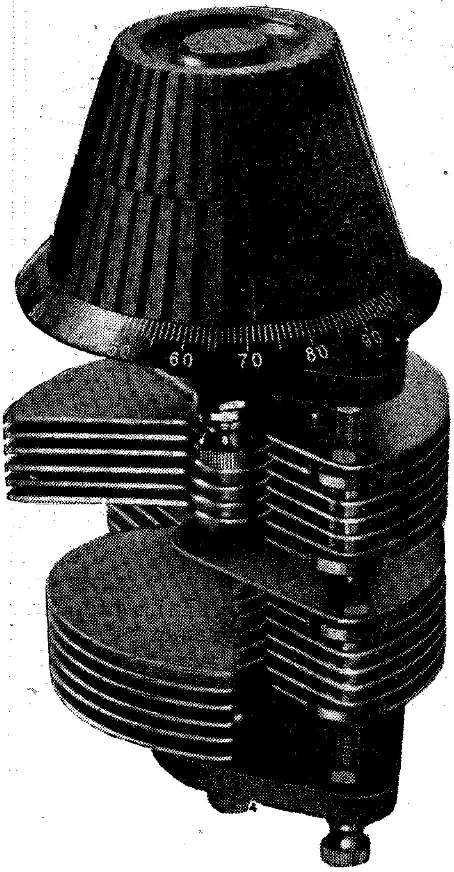


The new Radio Instruments slow-motion condenser.

tuning of 26 metres when a coil of such a size that it will give 100 metres maximum wavelength is used. A very low minimum capacity is claimed, and each condenser is sold with a printed guarantee of satisfactory performance.

The Polar Junior Variable Condenser

This condenser is modelled upon similar lines to the well-known Polar Mica Condenser, and is designed to fill the need for a cheap though efficient variable condenser. It is of the simple one-hole fixing type, and is provided with two terminals at the base, by which connection may be made to the external circuit. A very low minimum capacity is claimed for this instrument, and we also understand



Messrs. Autoveyor's new model of their three-electrode variable condenser.

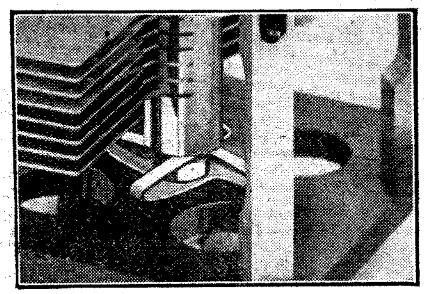
that the condenser gives an approximately straight-line frequency curve. It is totally enclosed in a dust-proof metal case, thus obviating the possibility of undesired noises due to dust collecting between the plates.

The Radio Instruments Slow-motion Condenser

Messrs. Radio Instruments, Ltd., exhibited a new geared type of variable condenser, which has a reduction ratio of 11 to 1. It is stated that the method of gearing is new and that it obviates backlash. The method of construction of the variable condenser is similar to that of their present models, the vernier adjustments being made by means of a separate knob at the side of that giving the direct drive.

The Bowyer-Lowe "Four-square"

Messrs. Bowyer-Lowe Co., Ltd., were exhibiting their four-square con-



Showing the lower spindle bearing in the Bowyer-Lowe "Four Square" condenser.

denser, which will by now be known to many of our readers. This condenser may be used as a dual type of instrument, or, alternatively, the two halves may be put into series or parallel or either half used by itself. Thus it will be seen that a very wide range of uses is available for this instrument. At this Stand one may also examine the process of manufacture of these condensers from the very first stage to the finished instrument.

An interesting feature in this connection is the contact spring, which forms part of the lower spindle bearing. This is stamped out from the flat, and then has its four arms bent up in one operation, thus ensuring that the bends are made correctly and to a sufficient extent. The supporting pillars for the fixed plates are cut away, as seen in the photograph above, in order to reduce the minimum capacity by increasing the distance between the moving plates when in the full-out position and the upright supports.

A VARIABLE CONDENSER TIP

There are few experimenters who do not possess a variable condenser or two mounted in a small wooden case with terminals for external use in experimental work.

Such a condenser may be used to try the effect of tuning circuits where no provision is made normally for tuning, or it may be used in experiments on wave traps, for capacity reaction, and in experimental hook-ups of one kind or another, and is really a very valuable piece of apparatus to possess.

Frequently such a condenser is connected in a circuit where it is important that the moving plates be connected to the low potential side in order to reduce hand capacity effects. For instance, it may be employed in a selective low-loss circuit, in which position, if not correctly wired up, tuning becomes extremely difficult. When receiving a distant transmission, all may be well till the hand is removed from the condenser knob, whereupon the station vanishes.

It is necessary, therefore, to mark in some way the terminal which is connected to the moving vanes. The simplest method of doing this is to use a transfer of an arrow, which may be applied so as to point to the terminal which is wired to the moving spindle of the condenser. This is easily done with the aid of a Radio Press panel transfer, and there is then no doubt as to which terminal is which.

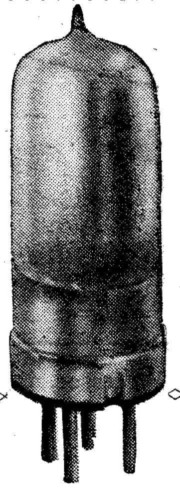
When used as a series aerial condenser, the aerial will be connected to the fixed plates, in a grid circuit the moving vanes are connected to L.T., and in an anode circuit to H.T.+.

This scheme reduces hand capacity effects in normal circuits to such proportions that little trouble is experienced except on the very short waves, in which case, of course, an extension handle may be needed.

C. P. A.

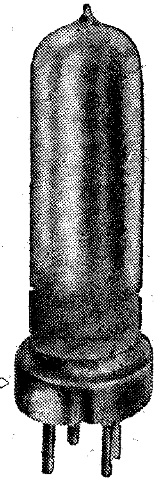
AT THE WIRELESS EXHIBITION

The receiving apparatus supplied by Messrs. Radio Communication Co., Ltd., for the use of liners, the battery charging board being seen on the wall above the receiver.



WHY DULL EMITTER VALVES ARE SILVERED

In addition to its action in cleaning up the vacuum, the " gettering " of a valve has a further important function which is described in this article.



THERE are many processes which are used in the exhaustion of valves of various kinds. In the old days of bright emitter valves the bulb, when the valve was completely evacuated, was perfectly clear. When dull emitter valves came into use, however, the great majority were provided with silvered bulbs, and this type of bulb is now practically universally used for any dull emitter valve—at any rate, for the type having a thoriated filament.

Removing Occluded Gases

It is well known that this silvering of the bulb arises during the exhaustion process of the valve, but there are one or two points in connection with the process which are of considerable interest.

In the first place, owing to the necessity in dull emitter valves for removing all traces of water vapour, carbon monoxide, and other gases which are present in the ordinary air, and which are fatal to the formation of the thoriated filament, a certain " getter " is introduced into the bulb just prior to the exhaustion process. This getter consists of some metal or element which readily combines with the particular gases to be eliminated, and when the valve is heated up during the exhaustion process, it volatilises and rapidly combines with any spare traces of impurity in the vacuum.

Discoloration of Bulb

The getter then deposits itself all over the bulb, so producing a discoloration of the glass. If the substance used is magnesium metal, as is very often the case, the bulb takes on a silvered appearance, or if some other getter is employed, the discoloration will be different. One particular case of this is the substance employed by the B.T.H. Co. for some of their valves which produces an amber discoloration.

Grid Current

This use of the getter to assist in the evacuation process is comparatively well known. There is, however, another use for this magnesium getter which is rather subtle and is not by any means so widely known. There are several processes in which a valve is employed for which it is necessary that a certain grid current shall flow. One such case in point is when the valve is used as a detector with the cumulative grid method of rectification. This method, of course, depends upon the minute grid currents which flow every time the grid is positive to the filament, so charging up the grid condenser.

Working Point on Characteristic

Now the working point on the characteristic of the valve depends

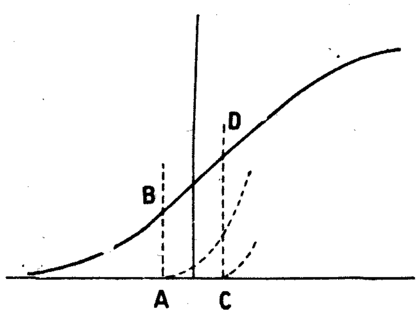


Fig. 1.—Illustrating the effect of grid current on the working of a valve.

upon the grid-current characteristics. Referring to Fig. 1 it will be seen that if the grid current lifts at the point A—that is to say, with a slightly negative grid voltage—the working point on the anode current for this voltage characteristic will be somewhere in the neighbourhood of B.

Similarly if the grid current lifts at a point such as C, say slightly positive, then the working point on the anode current characteristic will be somewhere in the neighbourhood of D. Actually, of course, the working point on the characteristics is not quite as indicated, because the presence of the gridleak causes a small permanent grid current to flow, and this means, therefore, that the working point on the characteristic will actually correspond to some point where there is a small grid current and not at the actual point where the grid current is zero. This difference, however, is of comparatively minor importance.

Grid Electro-Positive to Filament

The important point is that if the grid current is to commence to flow at a reasonable value of the grid voltage and not one which is excessively positive, it is necessary that the grid should be electro-positive to the filament. All metals have a certain potential relative to each other, and the difference in the potential between any two metals is called the contact potential between them. It is found in valve design that if the grid current is to commence to flow at a value suitable for normal operation the grid should be electro-positive to the filament by a certain amount, which depends upon the temperature of the filament and other details of that nature. With the normal bright emitter valve having a filament of tungsten and a grid of molybdenum or nickel, this condition is usually

(*Continued on page 25.*)

Home, Sweet Home

ALL things must have an end. This is strikingly true of both cash and holidays. For some time, as I have already told you, Professor Goop, Poddleby and I kept ourselves going on the Continong by means of lectures delivered by the eminent scientist. For some weeks we drew crowded houses, and we prospered accordingly. The Professor, however, is far too good natured, as you will have realised before now, and he found himself quite unable to say "No" to any applicant for a free ticket. This fact having become noised abroad, it was not long before the entire audience had provided itself with complimentary vouchers from the great man.

. . . Selling the Professor's autograph . . .

Lecturing to a crowd of deadheads is doubtless noble and unselfish work, but it does not help enormously towards paying one's hotel bill. These things being so, we decided that the season abroad was nearing its end, and that it behoved fashionable folk like ourselves to make tracks once more for home. As we all had return tickets, there was no difficulty about doing this, though cash had run rather low. However, Poddleby and I did fairly well by selling the Professor's autograph to Americans at ten francs a time. We might even have prolonged our stay for another week by this means had not some of our clients discovered that the Professor apparently signed his name in two entirely different ways, and begun to ask awkward questions. It is unfortunate that Poddleby's handwriting should be so dissimilar from mine, but I was able to quell the brewing storm by explaining that the Professor wrote with both hands.

The Departure

On the morning of our departure Poddleby and I arranged to go on first to the station with the luggage. We also took the precaution of carrying with us the available supplies of cash with the exception of five francs. These we left with the Professor, instructing him to distribute them as largesse amongst the hotel staff. We thought that tips would come better from him than from us. The Professor was trembling like an aspen leaf when he reached the station only a minute or two before the train went. He described in vivid terms the horror of his progress through the hall of the hotel to the door between the ranks of expectant servants from bootboy to head waiter. Not knowing what to do he handed the five francs to the first person he saw—this he realised later was Professor Funk, who had come to say farewell—and fairly ran for it. He had also to run for the train, since we had forgotten to leave him a small surplus for his taxi fare. The journey home would have been without incident had the Professor's great brain not suddenly started working. As we were flying along at heaven knows how many miles an hour, he rose and, without a word of warning, pulled the communication cord. He explained later that he had been struck with an idea for an entirely new type of safety device, and in the meantime he wished to see whether these things worked as efficiently in France as they do in England. This one certainly worked all right. The brakes went on with a jerk that dropped my two suit cases neatly on to the head of the sleeping Poddleby, and in a moment the carriage was filled with officials, each

. . . We left five francs with the Professor to be distributed as largesse . . .

of whom seemed to be trying to shout louder, to talk faster, and to gesticulate more wildly than all the rest. It was only by explaining that the Professor, walking in his sleep, had mistaken the communication cord for an aerial halliard, and by distributing our entire remaining funds, that I was able to straighten matters out.

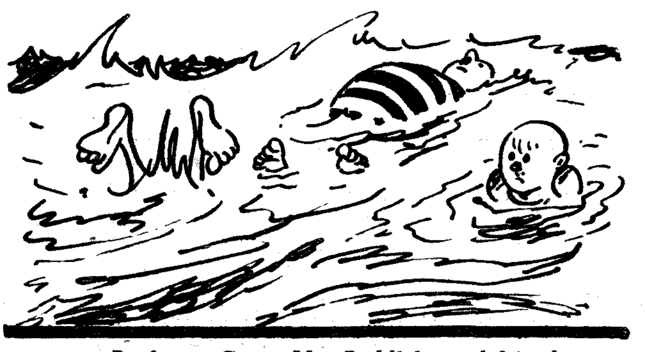
A Welcome!

Before leaving I had taken the precaution of getting my Yogu-Toblazian medical friend to write from

Kastoff to the Office, saying that I was now practically recovered from my terrible accident, and might return to do light work. I got him to underline the "light" three times. On the way to the Office I applied sticking plaster cunningly to various parts of my face, and having been helped out of the taxi by the driver and two kindly policemen, I limped in, a very passable imitation of an ex-stretcher case. "*Bonjour, mes vieux,*" I said in a weary voice. . . . "Oh, I beg your pardon, I was forgetting that I was in England. How are you, my dear fellows?" Somebody gave a grunt, but the rest simply went on working. Something had to be done. I slapped Mr. Mousee heartily upon the back, which caused him to jump so satisfactorily that his inkpot landed in the midst of his opposite number's waistcoat. And then they all began to talk at once. I was back at last, was I? And about time too. And all sorts of things of that kind. With a little resigned sigh I told them that they must have been overworking in my absence, and left the room in search of Mr. Hercy Parris. He, at any rate, I felt sure, would give me a proper welcome.

The "Splash"

"Hullo, Hercy," I said when I had found him, "I am not really fit to come back yet, but though the doctors tried to keep me in hospital, I simply insisted on returning to work." "What's the matter with your face?" asked Mr. Parris. "Been playing the bone in a dog fight?" "Surely," I said, "you heard from my friend in Yugo-Toblazia, Dr. Pzrschoff? He wrote every day to report my progress whilst I was in hospital, and his final letter despatched two days ago reported that I was fit for *light* duty." "Oh, yes," said Mr. Parris, "he wrote all right. But he used a French stamp and the postmark was Trouville." This was rather a facer, but I was not done. "All Yugo-Toblazians," I said, talking rather quickly, "send their letters to friends in France to post. You see, they save a lot by doing that, for



. . . Professor Goop, Mr. Poddleby and friend taking their morning dip . . .

a stamp in Yugo-Toblazia costs eight million snitchers, and in France . . . ." "Wait a minute," said Mr. Parris. He opened a drawer, and produced from it a two days old copy of the *Daily Splash*. Turning to the middle page he placed his forefinger upon a picture, and passed it across to me. Beneath the picture I read:—

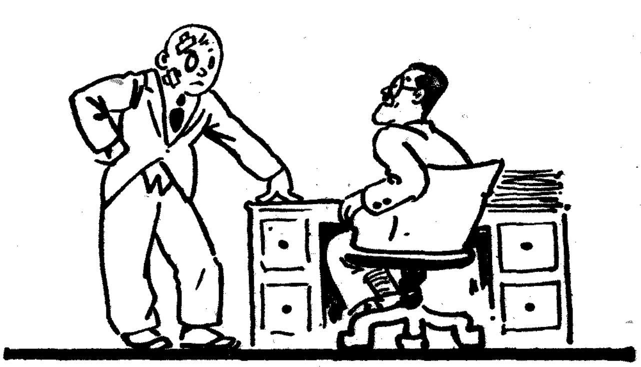
"CELEBRITIES AT TROUVILLE.

"Professor Goop, Mr. Poddleby and friend taking their morning dip."

There was no doubt about it; it was us all right. The Professor and Poddleby were a good deal blurred, but there was no mistaking myself. I was too stunned even to resent the insult of "and friend." I handed back the picture, smiling rather wanly.

A Hectic Time

"It is a pity," I said, "that the *Splash* should have got hold of this." "Isn't it?" asked Mr. Parris grimly. I held up my hand. "Let me tell you all," I said. "Directly the Professor, Poddleby and I had set foot upon foreign soil, we realised that we were being followed. By making cautious inquiries and keeping a most careful watch we discovered that a gang had planned to abduct the Professor and to extract from him, under torture if necessary, details of his latest and most secret invention. We have had



. . . began to ask me awkward questions. . . .

to keep constantly on the move in order to throw them off the scent. We led them to think that we had gone to Kastoff. We simply could not return, since gunmen were watching all the ports for us. Just a week ago the entire gang was arrested by the police, and we retired to Trouville in order to restore our shattered nerves. It has been a hectic time."

"H'm," said Mr. Parris.

"Of course," I went on, "I was engaged all the time in conducting my investigations into the wireless conditions upon the Continent. I have returned with a mass of valuable matter."

All's Well . . .

At this point Mr. Parris stirred himself and began to ask me a lot of awkward questions. Not having so far had time to read the French wireless papers, which I had bought on the journey home, I was a little short of facts. I therefore pleaded that I had seen so much and had collected such a mass of details that I could not possibly keep them all in mind. I did, however, mention that the French seldom use crystals for reception of telephony at more than a hundred miles, and that the loud-speaker is more popular in that country than headphones at wireless dances. If these things are mentioned next week in "Random Technicalities" you will know where he got his information. At this point I deftly changed the topic by asking Mr. Parris to tell me something about his latest set, "The Nerve-soothing Nine." That did it. Mr. Parris talked nineteen to the dozen and covered simply reams of paper with drawings and diagrams. "And now," I said at length, looking at the clock and remembering that if I was broke Mr. Parris was probably not, "let's go and have lunch." We went.

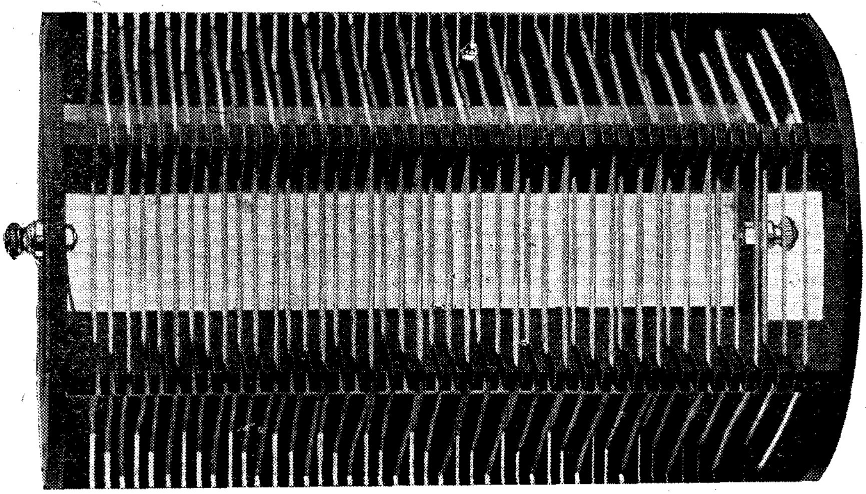
WIRELESS WAYFARER.

WHEN TO USE A LOW-LOSS COIL

By G. P. KENDALL, B.Sc., Staff Editor.

To obtain the full benefit from the use of a low-loss coil it is necessary that it be employed at a suitable point in the receiver. These notes are intended to give a clear understanding of the limiting factors which govern the use of such inductances in normal types of circuit.

TO anyone who has advocated the need of greater efficiency in our tuning coils as persistently as the present writer, it is a great satisfaction to see the widespread adoption of the low-loss idea in relation to coils, but there is yet a possibility of some disappointment in the use of these improved tuning inductances unless certain fundamental facts are grasped in relation to their functions.



One of the latest low-loss coils: the "Three-step" coil described by Mr. Kendall in the first number of "Wireless."

Possibilities of Disappointment

We have seen something of this sort happen in the case of the low-loss variable condenser, for most of us have now discovered for ourselves that if we replace any good normal type of variable condenser with one of the latest low-loss type, in quite a number of circuits we shall discover that little, if any, improvement results. The resulting disappointment has led some people to wonder whether there is anything in the low-loss idea at all. Now, this is simply a case of not being able to see the wood for the trees, the trouble being that we have not in many cases devoted sufficient thought to the matter to realise that the losses in the particular component we were considering were not the only ones in the circuit.

Loss Ratio

The most obvious example, of course, is to be found in the aerial circuit, where the total high-frequency resistance may be really quite large, and where the actual proportion of it represented by the variable condenser is practically negligible (I am speaking, of course, of the broadcast frequencies only). This one example will suffice to draw the reader's attention to the fact that there are certain circuits in which there are other losses of so great a magnitude that they swamp to a large extent the losses taking place in the tuning coil and the associated variable condenser.

An Example

The aerial circuit is a good example of one in which discretion should be used in carrying out the low-loss idea in the tuning coil, and a general rule can be laid down that with the great majority of aerial and earth systems the other losses due to earth resistance, radiation resistance of the aerial, and all the other factors which result in a high value of high-frequency resistance, to a large extent swamp the losses in the tuning coil. By the time as high a degree of efficiency has been obtained in the tuning coil as will result from the use of a simple single layer coil of, say, No. 24 gauge wire, further improvements usually have little effect upon signal strength and selectivity. It would therefore seem to be indicated that a coil of reasonably good design should be used in the aerial circuit, but that no very elaborate efforts should be made to secure the best possible low-loss effect.

A Promising Field

The more promising circuits from the point of view of the reduction of losses are undoubtedly the secondary and inter-valve circuits, so long as they are not tightly coupled to such a high-loss circuit as the aerial system. Thus, the secondary of one of the popular "aperiodic aerial" arrangements represents a good field for improvement, and here the very best of low-loss designs is worth using.

Our main object in seeking "low-loss" is to sharpen the peak of the resonance curve of the circuit in which we are endeavouring to reduce the losses, with a view to improving the selectivity of the receiver and increasing signal strength to some extent. We have seen that the aerial circuit is not a suitable place for such improvements, since the coil losses do not form a sufficiently large proportion of the total circuit losses, and we therefore turn our attention to such circuits as the secondary of a loose-coupled tuner, intervalve circuits, and so on. This statement in itself needs some qualification, lest it be imagined that *any* circuit which is separated from the aerial circuit to a sufficient extent is a suitable place for low-loss development.

Grid Current Damping

The recent work of Mr. Cowper, published in this Journal, has clearly demonstrated that the damping produced by the grid current of a rectifying valve working on the grid condenser and leak principle may be, and usually is, sufficient to produce a decided flattening of tuning. This effect may be regarded as equivalent to that of a series resistance of quite considerable value, ranging from about 40 to 80 ohms in many cases. Where so high an equivalent resistance obtains it is evident that the reduction of coil losses below a certain point will produce little improvement in results. It will thus be seen that we must add to our first generalisation a further one to the effect that where we have connected across the circuit a valve with a considerable grid current, it is useless to employ ultra low-loss tuning inductances.

Practical Applications

Let us see how these principles work out in practice, taking a common type of circuit as an example. In Fig. 1 will be found a three-valve neutrodyne circuit of a quite conventional type, employing one high-frequency valve, detector and one note magnifier. Here there is an untuned aerial circuit in which the coil L1 is connected, thus forming what is commonly called an "aperiodic aerial circuit." There is little point in reducing the losses in the coil L1 below a certain very easily achieved point, and any such construction as a simple basket coil with, say, No. 22 gauge wire, will serve perfectly well here. The coil L2, on the other hand, is situated in a circuit where the damping can be extremely low, provided that there is only a moderate degree of coupling between the secondary circuit and the aerial circuit, and also with the further proviso, that the first valve shall be so adjusted as to function without perceptible grid current.

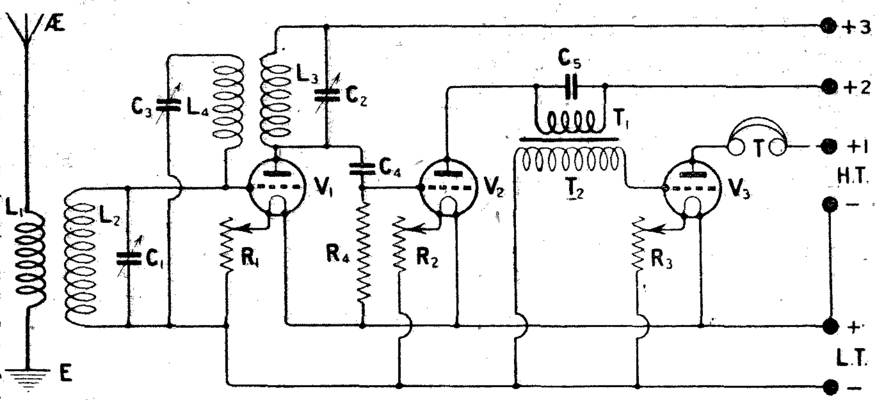


Fig. 1.—In this circuit the coil L2 may be of the ultra low-loss type, while little advantage will be derived from a reduction of the losses in L1 below an easily reached value.

Necessity for Neutrodyning

Under conditions such as these, of course, the provision of a tuned anode coupling between this valve and the next valve would naturally lead to considerable trouble from self-oscillation, and therefore one of the common types of neutrodyne arrangements is shown. Granted, then, that the coupling between the aerial and secondary circuit is not too tight, and that a neutrodyne arrangement is provided so that the grid of the valve can be kept fully negative, it follows that the design of the coil L2 is well worth study. Here an ultra low-loss inductance is worth while.

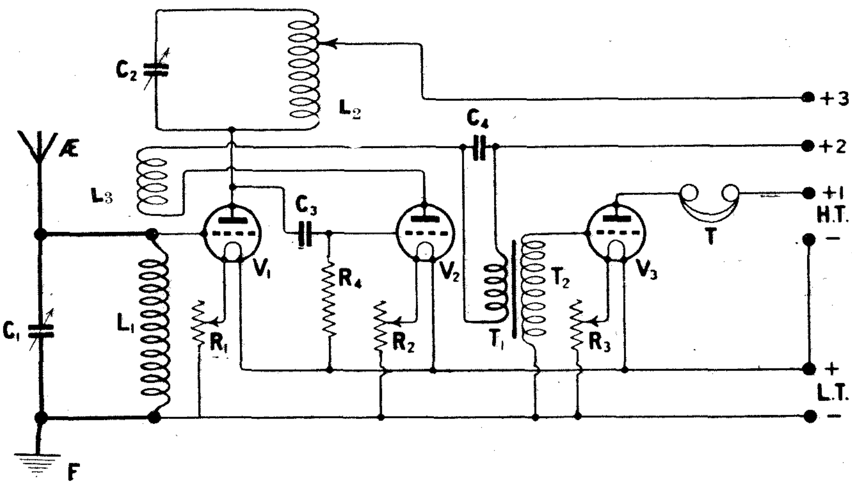


Fig. 2.—The use of a tapping upon the coil L2 provides a method of reducing the damping produced by the grid current of the detector.

Intervalve Circuits

Turning now to the inter-valve coupling circuit, in which we find the coil L3, it is at once apparent that we have here the factor of grid current damping, since the second valve is the detector and considerable grid current flows. The coil L3, therefore, will not repay careful design to such an extent as will take place with L2, and here quite a moderately efficient design will serve. For example, Mr. Cowper has shown that an ordinary single layer winding of moderate gauge upon either a carefully dried cardboard tube or a thin ebonite tube, will give results which very closely approach those of the best low-loss design.

A Neglected Point

The winding L4, which comprises the neutrodyne coupling winding, is one which has been curiously neglected as a possible source of loss in the grid circuit of the first valve, and it seems to me that this should receive a greater amount of consideration. In the way in which I have drawn the circuit it will be quite clear that this winding L4 in series with the neutralising condenser is connected in parallel across the ultra low-loss circuit in which L2 is located, and it is evident, therefore, that imperfections in the winding L4 may result in an appreciable addition to the losses present in this circuit.

Reducing Grid Current Damping

The effects of grid current damping and their influence upon the design of a circuit as regards losses is one which is likely to receive considerably more attention in the future than has been devoted to it in the past, and upon another page of this issue will be found an interesting article from Mr. Cowper showing that one of the usual schemes adopted to reduce these losses, namely, the tapping of the

(*Continued on page 27.*)

The Problems of Absorption and Fading

By J. H. REYNER, B.Sc. (Hons.), A.C.G.I., D.I.C., Staff Editor.

This is the second article of the series which is being specially written to provide our readers with a clear idea of modern theories concerning wave propagation.

IN my previous article I discussed the various theories which had been put forward to account for the fact that wireless waves would travel round the curved surface of the earth. These theories, it will be remembered, were briefly as follows:—

One school of thought suggests that the electric waves are reflected at an ionised layer of gas in the upper atmosphere, at a height of about one hundred kilometres above the earth's surface. A second school of thought suggests that the waves are not reflected at this layer, but are refracted, that is to say, caused to bend round at this layer, and so return to earth; while the third school of thought suggests that bending round the earth's surface is solely due to a change in the di-electric constant of the atmosphere, which occurs comparatively close to the earth's surface, and therefore that the Heaviside layer is not required to explain the bending at all.

Absorption

We will consider this week some of the other problems which present themselves in the transmission of wireless waves round the world. Of these, two of the most important are the problems of absorption and fading. It is well known that wireless waves do not travel unhindered. In the process of their passage round the earth they are attenuated by some means or other, the result being that the signal strength at the far end is considerably less than one would expect from the simple theoretical formulæ.

Dr. Robinson, in his article last week, gave formulæ showing the received currents which one would expect in a receiving aerial if there were no attenuation or absorption. It is found, however, that the actual signal strength is considerably less than this, and various formulæ have been put forward from time to time, most of which were arrived at as a result of practical tests, in order to allow for this absorption which is known to be occurring.

I do not propose in this article to discuss these various formulæ, beyond remarking that all those which have so far been proposed have not been particularly successful under the majority of conditions. A formula which is useful for a wavelength range of, say, 600 to 4,000 metres (499.7 to 74.96 kc.), is quite inadequate for wavelengths of 10,000 to 20,000 metres (29.98 to 14.99 kc.), and in the past the design of long-distance transmitting stations has been very much on the lines of getting as much power as possible in the aerial at the transmitting station, and hoping for the best.

Electrons are much smaller than atoms. The lightest atom known (hydrogen) has 1,800 times the mass of an electron. The proportion is as the dome of St. Paul's is to a halfpenny.

Ionic Displacement

The original Heaviside layer theory assumed the electrified layer to be composed of ions, which are atoms from which some of the negative electrons have been removed, so leaving a comparatively heavy positively-charged body. The wireless waves, in travelling through this medium, would cause the ions to vibrate somewhat in the same way as electric currents are induced in a receiving aerial placed in the path of the waves. This vibration of the ions naturally abstracts some energy from the waves, with the result that the wave is attenuated, or reduced in strength.

The theory was that during the daytime the Heaviside layer was irregular, and, moreover, the ionisation of the air due to the sun's rays extended considerably lower than at night. Consequently during the day the waves encountered a large number of these positive ions, and the result was that the absorption was comparatively heavy. At night, however, it was thought that the ionisation nearer the earth's surface disappeared when the sun's rays were absent, with the result that there was a more or less well-defined layer of ionised gas which acted more as a pure reflector, and consequently the absorption was not as heavy.

Varying Velocity

Ordinary reflection and refraction effects, however, depend, to a large extent, upon absorption, and it was pointed out that, in order to produce sufficient bending by this simple theory, the absorption would have to be so great as to reduce the strength of the wave almost to zero.

Eccles then proposed that the velocity of the waves could be changed in an electrified medium, which

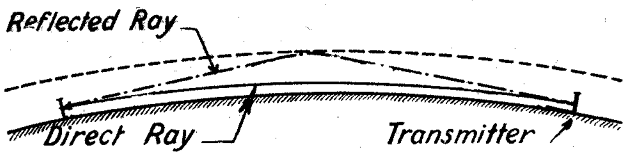


Fig. 1.—Fading is thought to be due to interference between two waves arriving at the receiver by different routes.

would cause the waves to bend round in a somewhat similar manner to that explained last week in dealing with the Meissner theory.

The Larmor Theory

This theory was not satisfactory, however, from many points of view, and it seemed that a deadlock had been reached, until Sir Joseph Larmor recently put forward certain further modifications which completely altered the position.

The two principal modifications were the substitution of electronic vibrations for ionic displacements, and a somewhat different conception of the mechanism by which the velocity of the waves in the electrified medium is increased, so giving rise to bending.

This theory is capable of providing reasonably sound explanations of the observed phenomena, and has aroused considerable interest. We will consider some of the effects in greater detail.

Ionisation by Collision

If an electron is caused to move with a considerable velocity, and in doing so encounters an atom, it will ionise this atom, that is to say, it will knock one of the electrons in this atom out of its course, and so leave the atom ionised. This, of course, requires an expenditure of energy, and it is suggested that it is this ionisation of the other atoms which causes the absorption from the wave.

In defence of this theory, it is pointed out that very short waves such as are now being employed do not suffer absorption to anything like the same extent as the longer waves. It is found that with normal waves, that is to say, waves from 300 up to 20,000 metres (999.4 to 14.99 kc.), the longer the wavelength, *i.e.*, the lower the frequency, the less is the absorption. This almost follows from the dictates of common sense, if the theories which have just been considered are assumed to be correct.

The less rapid the vibration of the ether waves, obviously the less opportunity there will be for this ionisation by collision, due to the response of the free atoms in the upper atmosphere. So far, therefore, we are in accordance with the observed facts, namely, that as the frequency increases, that is to say, as the wavelengths get shorter and shorter, so the absorption increases to a fairly marked degree.

Absorption Less on Very Short Waves

It is found, however, in practice, that with very short waves of the order of 100 metres or less, the absorption appears to be almost non-existent, and the remarkable ranges which have been achieved in the past year or two indicate that these waves are travelling almost unfettered through the ether. It is suggested, to account for this phenomenon, that the "mean free path" of the electron is coming into play.

The mean free path of an electron is the average distance it will have to travel before it meets an atom of gas which it can ionise. The length of the mean free path depends upon the pressure of the gas. At normal atmospheric pressures—*i.e.*, at the earth's surface—the mean free path is very short indeed, and if an electron is set in motion, it has no time to acquire a reasonable velocity before it meets another atom. The electron, therefore, cannot ionise the gas because it has not acquired sufficient velocity.

As the pressure is decreased, however, so the mean free path increases, the electron gathers speed, and ionisation becomes possible. In very rarified atmosphere, on the other hand, the mean free path of the electron becomes so long that it is quite possible for the electron to travel for a considerable distance without ever meeting an atom.

Travel of the Electron

Now the actual travel of the electron will obviously depend upon the frequency of the vibration. The higher the frequency the shorter the time the electron has to complete its oscillation, and thus the shorter the travel. It is suggested that at the very high-frequencies corresponding to wavelengths of 100 metres or so, the travel of the electron is less than the mean free path at the particular height of the Heaviside layer. The result is, therefore, that the electron is merely oscillating in free space and never, or very rarely, meets with an atom of gas which it can ionise, so that the absorption is almost negligible, the only energy extracted from the wave being that required to keep the electron in oscillation. This again appears a plausible explanation of the state of affairs.

The Effect of the Earth's Magnetic Field

The theory, moreover, is borne out by a most interesting development which was recently brought to light by Messrs. Nichols & Schelleng, in America.

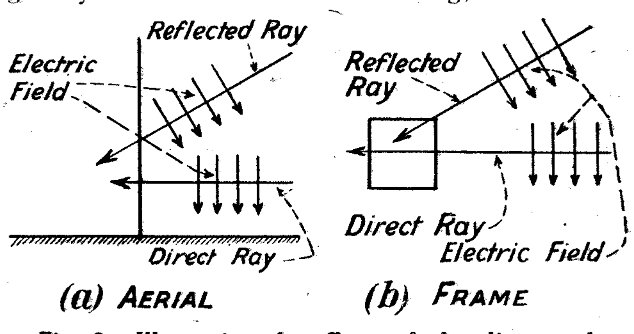


Fig. 2.—Illustrating the effects of the direct and reflected rays at the receiving point.

This development was reviewed briefly in the "Inventions and Developments" column some time ago (*Wireless Weekly*, Vol. 6, No. 18). These two investigators have shown that the effect of the earth's magnetic field on the vibrating electrons in the upper atmosphere is to cause them to vibrate in an elliptical orbit instead of straight up and down. More important still, however, they show that due to this magnetic field there will be a particular *resonant* *frequency,* at which point the vibration of the electrons will suddenly increase enormously, so that at this point the travel of the electrons far exceeds the mean free path. This will result in almost total absorption.

Bad Transmission on 200 Metres

They then followed up this theory by substituting in the formulæ the value of the earth's magnetic field, and they obtained the surprising results that this natural frequency of the electron was in the neighbourhood of 1,400 kilocycles per second, corresponding to a wavelength of 214 metres. Now it is a fact which has been established in practice that most peculiar effects occur in the neighbourhood of 200 metres, and communication on this wavelength and a little over is difficult to accomplish over anything like a long distance. This, therefore, would appear to be almost direct proof that the theory of electron displacement was correct in accounting for absorption.

Fading

The latest researches, moreover, seem to favour the Heaviside layer theory, despite the arguments of Meissner. This is particularly emphasised in a paper given by Professor E. V. Appleton before the British Association at Southampton, describing the work done at Cambridge by himself and Mr. Barnett on the subject of fading.

According to their theory the electric field at the receiving station is made up of two components, one of which has arrived via the direct path along the surface of the earth, while the other has arrived by reflection from the Heaviside layer. Fig. 1 illustrates the two waves at the receiving point.

Interference

This theory in itself is not new, having been formulated by other investigators some years ago. The present development, however, shows that, owing to changes taking place in the upper atmosphere, these two waves may sometimes be in step or " in phase," to use the technical term, while at others they may be out of phase. Thus the resultant signal strength will be varied depending upon the relative phases of the direct and the reflected waves.

The phase differences between the two waves are due to a twisting effect, which occurs to the reflected ray. This point will be referred to in greater detail next week.

Effect of Distance

The extent of the fading depends upon the distance of the receiving station from the transmitter. If the two stations are fairly close the direct wave will preponderate, and the effect of the reflected wave will be to cause slight variations only, while at medium ranges, where the direct and reflected rays are about equal, the fading will be very marked.

In long-distance communication, however, particularly with short waves, the direct ray is to all intents and purposes non-existent. In such cases there are two possible theories.

One is that interference is obtained between two reflected rays arriving at different angles. The other theory is that the energy is arriving in some sort of beam and only reaches the ground in certain areas.

It would seem that the two conceptions are merely different views of the same phenomenon, for the effect of interference, as suggested in the first hypothesis, would be to produce bands of good reception alternating with blind areas.

Loop Fading Greater than Aerial Fading

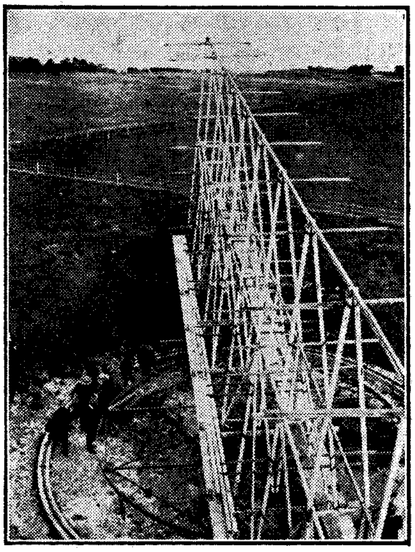
These effects are to a certain extent borne out in practice, but there is little, so far, to indicate that this theory is any more correct than the others which might be put forward.

On this theory, however, Appleton has shown that the fading effects obtained with a loop or frame aerial are greater than would be obtained with a simple " open " aerial.

Practical Verification

Experiments conducted at Cambridge indicate that this is actually the case in practice, so that the theory is amply verified by practical evidence.

Moreover, from the experimental results, the actual angle at which the reflected wave is arriving can be measured. For example, the reflected wave from 2LO arrives at Cambridge at an angle of about 60 deg.



The Marconi " lighthouse " at the South Foreland, seen from above.

Both Theories Correct ?

These results obtained by Professor Appleton therefore seem to indicate fairly definitely the presence of some reflecting or refracting layer at a considerable height above the earth's surface. From the figures which they have obtained they are able to deduce the actual height of this reflecting layer, and the results agree well with the previous estimates—that is to say, about 100 kilometres.

It should be observed, however, that this theory also requires a direct ray which is required to travel round the earth's surface, and it is possible that here the Meissner theory may be of assistance in explaining how such a direct ray is possible over distances for which the curvature of the earth is appreciable.

Next week I shall consider some other aspects of the problem, dealing with the concentration of energy at the Antipodes, a factor which assists in the very long-range transmissions, and I shall also refer to the rotation of the waves in their transit from one point to another.

Wireless News in Brief

On September 11 a large gathering of Wireless and Press representatives met at a luncheon at the Savoy Hotel, at the invitation of the National Association of Radio Manufacturers and Traders, to celebrate the thirtieth anniversary of the invention of wireless telegraphy. The guest of honour was Senatore Marconi, while there were also present: Mr. W. W. Burnham (Chairman of the N.A.R.M.A.T.), Sir Herbert Blain, Mr. J. C. W. Reith (Managing Director of the B.B.C.), and Captain Ian Fraser, M.P.

* * *

In case the notice on this subject issued lately may have escaped attention in some cases, owing to the holiday season, the Postmaster-General wishes again to point out that the legal obligation to take out a licence for a wireless receiving set—whether crystal or valve—has been placed beyond any doubt by the Wireless Telegraphy (Explanation) Act. The Postmaster-General trusts that any persons who have failed hitherto to take out licences will do so at once; and he thinks it right to repeat that he proposes in future to institute proceedings in cases coming to his knowledge in which wireless sets are installed or used without licences.

Wireless receiving licences can be obtained on application at any Post Office at which money order business is transacted, on payment of the annual fee of ten shillings.

* * *

An interesting exhibit at the Wireless Exhibition is on the Marconi stand. It is the microphone which has been made for the King's exclusive use.

Covered in silver gauze and decorated beautifully with symbols in silver by the Goldsmiths Company, the microphone has on it a silver plate upon which is engraved every occasion and date upon which it is used.

* * *

We are informed that police forces in different parts of the country are about to follow the example of Scotland Yard in the use of wireless for catching criminals.

For more than a year Scotland Yard has recognised the value of wireless, and several motor-vans used by the flying squad have got beyond the experimental stage and are being used in expediting the pursuit of criminals.

To prevent the leakage of information into wrong channels a secret code is used by the police.

* * *

Radio-telephony is to be brought into general use for co-operation between troops and aeroplanes at the forthcoming Army manœuvres, and an opportunity will be provided for proving its practicability under active service conditions.

Each divisional headquarters will be accompanied by a tender carrying a receiving set for the reception of radio-telephonic messages from the air.

Successful two-way radio-telephone communication between aeroplanes and the ground was established for the first time in the U.S.A. anti-aircraft test manœuvre just concluded at Fort Tilden. In the final tests the communication between aeroplanes and land station was as clear as that over an ordinary telephone line.

Aviation officers conducting the test said the aviators using the radio-telephone could hear the land station from a distance of eighty miles, while the airman could talk with the station from a distance of thirty miles.

* * *

It is announced that Britain has accepted an invitation to be represented at the International Radio Conference next spring.

* * *

The success of recent experiments in the wireless transmission of photographs was demonstrated by an exhibit at the seventieth annual exhibition of the Royal Photographic Society. The apparatus on which these radio-photographs were received can, it is understood, be constructed at a cost which will enable it to be retailed at about £10, a price which would bring it within reach of the amateur broadcasting enthusiast.

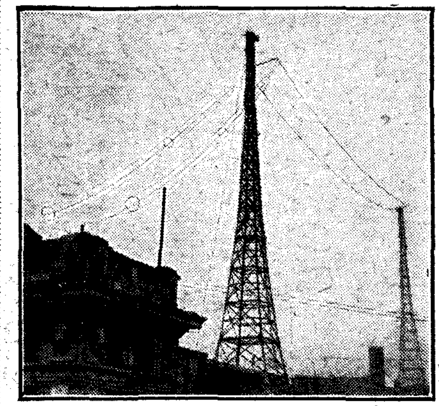
* * *

Coincident with the opening of the German Wireless Exhibition in Berlin, the German postal authorities have withdrawn their regulations which hitherto prohibited the use of reaction in receiving sets, and henceforward German makers are allowed an entirely free hand as to the wavelength range embodied in their sets, instead of being restricted to the lower German band of wavelengths. In addition, home construction is now to be freely permitted. The effect of these alterations is very noticeable in the new instruments which are now exhibited, these being now built upon English lines.

The B.B.C. and Their

By Major JAMES ROBINSON, D.Sc., Ph.D., F

Some technical details, with actual figures, relating to the pr



The London Station, whose aerial is seen in this photograph, departs from its published wavelength by as much as 7.3 metres.

We have recently made some measurements of the actual frequencies of some of the B.B.C. stations, and we have already published the results in the first number of our new periodical, *Wireless*. These figures will be of interest to readers of *Wireless Weekly*, and they are repeated here.

Station.	Official.		Actual.		Discrepancy.		
	Metres.	Kc.	Metres.	Kc.	Metres.	Kc.	
London	365	821.4	357.7	838.19	7.3	16.78	−
Manchester	378	793.2	372.1	805.75	5.9	12.55	−
Daventry	1,600	187.4	1,607	186.57	7	0.83	+
Glasgow	422	710.5	424.6	706.12	2.6	4.38	+
Bournemouth	386	776.7	383.6	781.59	2.4	4.89	−
Swansea	482	622.0	484.0	619.46	2	2.54	+
Newcastle	403	743.97	401.5	746.74	1.5	2.77	−
Birmingham	479	625.9	477.6	627.76	1.4	1.86	−
Cardiff	353	849.35	351.8	852.24	1.2	2.89	−
Stoke-on-Trent	306	979.8	305.5	981.40	0.5	1.60	+

It is at once obvious that there are considerable differences in some cases between the wavelengths announced by the B.B.C. and the actual wavelengths, amounting to 7.3 metres (16.78 kc.) in the case of London, and 5.9 metres (12.55 kc.) in the case of Manchester.

I do not propose to discuss the serious question of policy involved in publishing inaccurate wavelengths and varying them by accident or design. I only intend to give the facts, together with some technical data.

Progress in Measurement

In these days we do not expect to have wavelengths inaccurate. There has been very great progress in recent years in the measurement of frequency and maintenance of a constant frequency. In fact, progress with frequency measurement has probably been greater than in any other branch of wireless. It has needed to be so, in order to allow of the use of the large number of services required. The demand for wireless communication has increased enormously in recent years, and is still increasing, and naturally there is a constant clamour for allocation of wavelengths for special services. It would be impossible to satisfy all demands without crowding the wavelengths allocated together. This crowding of wavelengths is bound to lead to absolute chaos unless each service restricts itself very closely to the wavelength given to it.

Standard Expected

For this reason much technical work has been done in various countries to obtain the very best means for measuring frequencies, and in this country we have not been behind. Actually, some of the most important work has been done in this country. The progress has been so great that we now do not expect a fixed ground station to be more than a small fraction of 1 per cent. away from its published wavelength. In the case of mobile stations (*i.e.*, ships and aircraft) a little more latitude should naturally be allowed.

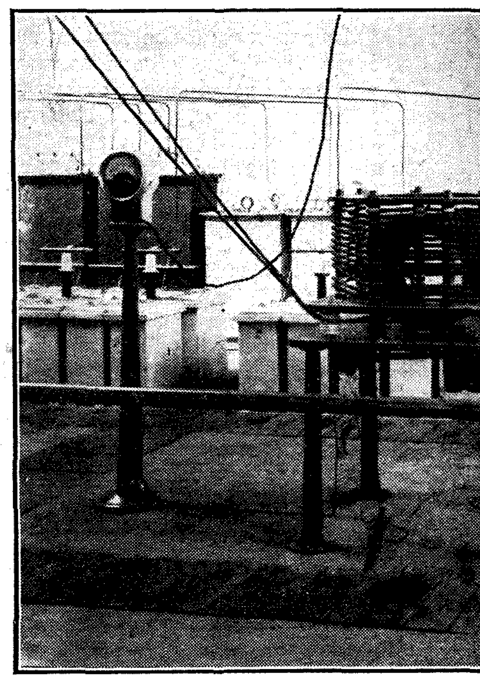
Methods Available

Let us consider briefly what means are at our disposal for measuring and standardising frequencies.

It is possible to standardise wireless frequencies in the most absolute way. The standard of frequency is, of course, one vibration per second, and thus we are thrown back to the accurate measurement of time. Accurate measurement of "Time" has absorbed the attention of scientists for centuries, particularly in the realm of astronomy.

The Multivibrator

It is possible to use the standard of time such as one second, and to obtain an instrument which gives an accurate frequency of one vibration per second, and compare that with any frequency we wish up to a frequency of millions per second. The instrument used for the purpose of this comparison is called the Multivibrator, and a considerable

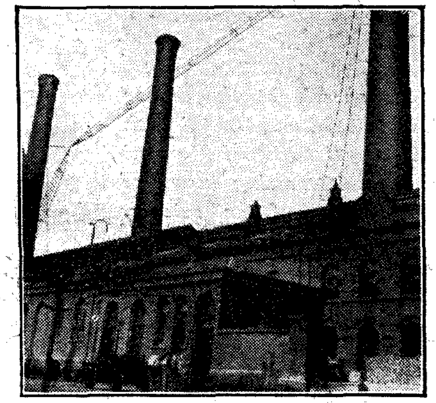


One of the difficulties encountered in ma lies in the fact that the large inductances

Published Wavelengths

...P., Director of Research to Radio Press, Ltd.

...em of the maintenance of constancy in broadcast transmission.



The Glasgow aerial indicates, by its proximity to other bodies, one of the reasons for the adoption of the master oscillator system.

amount of work has been done on this by Dr. Dye, of the National Physical Laboratory. (A fuller description of this instrument will be given at a later date.)

Thus wireless frequencies can be measured and compared ultimately with standard clocks, and this is the very highest order of measurement that has ever been made.

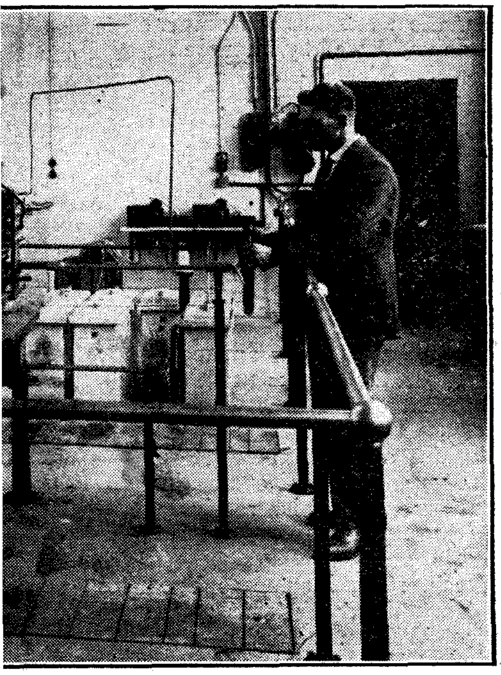
Use of N.P.L. Standards

We do not expect the B.B.C. to have such elaborate equipment as the Multivibrator at all their stations, and, in fact, it is possible to obtain very great accuracy without them. The N.P.L. standards are available, and the wavemeters used by the B.B.C. can be very accurately calibrated.

The Quartz Resonator

Another subject in which great developments have occurred is in the case of Quartz Resonators, some details of which were published in the September issue of *Modern Wireless*. It is possible to have these quartz crystals ground very accurately to a definite wavelength. They can be used to control the wavelength transmitted from any station.

At the National Physical Laboratory a very high standard of wireless frequency is maintained, and a series of transmissions takes place periodically on wavelengths which are controlled by the Multivibrator, and thus the actual wavelengths transmitted are absolutely standard. If means are not available for obtaining absolute frequency measurements by reference to one's own standard clock, the standard transmissions from the N.P.L. can be made use of so as to calibrate our wavemeters.



...ining a constant frequency in transmission ...d may undergo variations in their constants.

Requirements in Heterodyne Wavemeters

A heterodyne wavemeter is preferable because it is capable of giving the highest accuracy, that is, a wavemeter which uses an oscillating valve. The inductances and condensers should be so constructed as to be absolutely constant, and the values of inductance and capacity should be very accurately known. As regards the condenser, there should be smooth and uniform movements, and the actual values of the condenser for various readings should also be very correctly known. In fact, the variable condenser should be one of the best that it is possible to obtain. It is essential to guarantee that the conditions of this circuit shall be absolutely constant as referred to above. The anode current may have influence on the frequency, and thus it is advisable to work without any extra anode voltage if possible, and it is usually possible to use the heterodyne wavemeter on filament voltage alone. The same valve should be used throughout, for on changing a valve quite different readings of frequency may be obtained. Every time a valve is changed it is necessary to recalibrate.

The constancy of the filament current is of the utmost importance, and a voltmeter should be used and the voltage measured from time to time in order to guarantee absolute constancy.

To obtain different ranges of wavelength it is advisable to have a number of coils of various inductances, and to plug these in as required, using the same condenser throughout.

Calibration

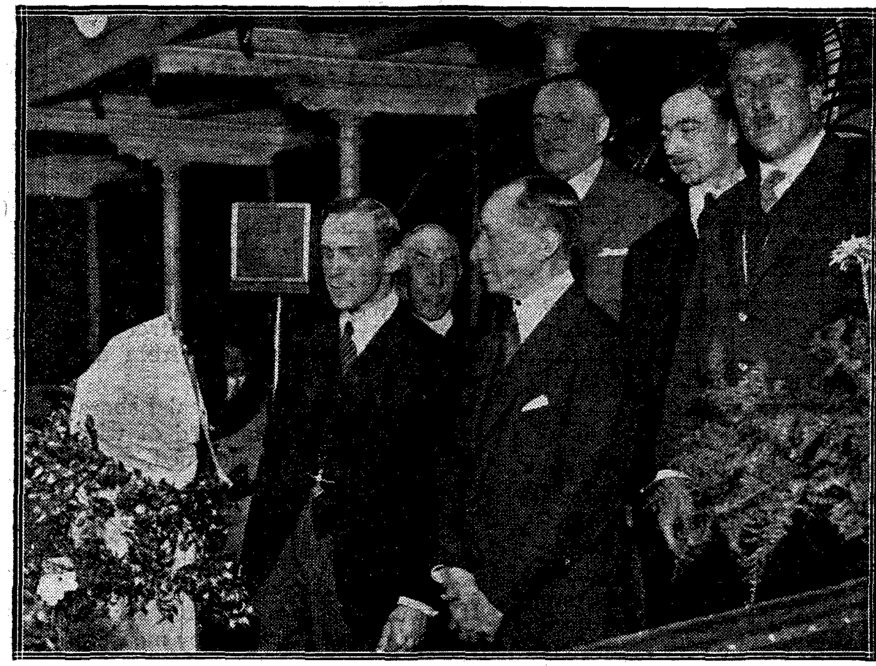
To calibrate this wavemeter one standard wavelength from the N.P.L. should first of all be listened to and a reading of the wavemeter observed. Then another oscillating circuit should be used and adjusted to give a frequency identical with that of the transmission from the N.P.L. This can be done very accurately by adjusting it to give zero beat note with the wavemeter. Let us suppose that the wavelength is 2,400 metres (124.9 kc.). We now make use of harmonics of the local oscillator, *i.e.*, 1,200 metres (249.9 kc.), 800 metres (374.8 kc.), 600 metres (499.7 kc.), 480 metres (624.6 kc.), and so on, *i.e.*, we use the 2nd, 3rd, 4th, 5th, etc., harmonics, and observe the reading on the wavemeter in each case correctly. In this way a number of standard frequencies have been observed, and some points

(*Continued on page 27.*)

Thirty Years of Wireless—A Survey

By Senatore G. MARCONI, G.C.V.O., LL.D., D.Sc.

In his speech at the dinner given to celebrate the thirtieth "birthday" Senatore Marconi made an interesting survey of the progress of the science.



Senatore Marconi (third from left) at the opening of the N.A.R.M.A.T. Exhibition by Viscount Wolmer (first on left).

LOOKING back over a period of thirty years is not always a very easy task, but I must confess to a feeling of very great satisfaction, mingled perhaps with bewilderment, at the wonderful progress made by wireless or radio science since my first experiments and tests at my father's country house at Bologna in Italy.

I well remember, when I was a boy, reading of the classical and epoch-making experiments carried out by Professor Heinrich Hertz, which proved that Clerk Maxwell's hypothesis of the existence of ether waves was correct, thereby giving the world a new insight into the hidden mechanisms of nature.

Somehow or other, I soon came to realise the idea that these waves might be eminently adapted to a new system of communication through space which would possibly work over long distances.

Early Experiments

My first plan was to produce these waves, and radiate them in a beam, by means of a metallic reflector, in the same way as had already been done within laboratories by Hertz, Lodge and Righi, and I hoped that by devising improved transmitters and receivers I might be enabled to communicate telegraphically over a distance of several miles.

I always believed that such a system, if workable, would be far superior to flashlights, or optical methods of signalling, by virtue of its independence of fog and mist.

After several attempts and failures I succeeded in the summer of 1895, which is just over thirty years ago, in obtaining telegraphic signals through space over a distance of $1\frac{3}{4}$ miles.

These results encouraged me to further pursue my experiments, and to test all kinds of arrangements which, to my then very scant knowledge of the subject, seemed likely to permit the attainment of the object in view.

Very Short Waves

My arrangement, employing reflectors and a Righi oscillator, utilised very short waves, that is to say, waves less than 1 metre in length, and therefore a good deal shorter than the shortest waves which have lately attracted the attention of radio experts and amateurs all over the world.

This system, however, at that time seemed only to work across clear space and would not operate if obstacles, such as houses or hills, happened to intervene between the two instruments.

Introduction of Aerial Wire

I therefore tried other arrangements, but what gave the most promising results, and at the same time constituted a new departure, came about by the discarding of the reflectors, connecting one terminal of the spark-gap or oscillator to earth and joining the other terminal to a vertical wire connected to a plate or capacity suspended high up in the air, the distant receiver, which at that time consisted of a coherer arranged so as to be able to work a telegraphic instrument, being similarly connected to earth and to an elevated and insulated conductor.

This system, with the rudimentary means then at my disposal, gave reliable communication at about one mile, but the transmissions seemed to be quite unaffected by intervening bodies or obstacles.

Development of Aerials

This arrangement, which was essentially a broadcasting system, soon developed into the elevated or vertical wire system, thus becoming the basis of all systems of long-distance radio communication.

I clearly remember thinking that this arrangement would be able to work really big distances and overcome the curvature of the earth and such apparent obstacles as mountains, etc., were it possible to efficiently utilise a large amount of transmitting energy in connection with much more sensitive receivers.

Post Office Assistance

In March, 1896, I came to England and submitted my ideas to the late Sir William Preece, then Engineer-in-Chief to the Post Office.

Sir William Preece was greatly impressed with what I was doing, and I believe that he was one of the very few scientists who at that early date realised something of the enormous possibilities of electric waves.

Although he had himself been working at the problem of wireless telegraphy on a method which utilised ordinary electromagnetic induction, he quickly realised that I was on a new track, and at once offered me his encouragement and assistance in the demonstrations and tests which he arranged for me to carry out for the Post Office.

I shall ever be grateful to the memory of Sir William Preece, and also to the authorities of the Post Office, who at such an early date realised the importance of the work in which I was then engaged.

Greater Range of Communication

The first public mention of my experiments was made by Sir William Preece at the meeting of the British Association for the Advancement of Sciences, held in Liverpool in September, 1896, and subsequently at other lectures he delivered in London. In June, 1897, at the Royal Institution, he was able to exhibit the apparatus in working order and describe results obtained in South Wales, where the distance of communication was extended to 9 miles.

It would be needless for me to dwell on the progress made since that date.

At times it may have appeared slow, whilst at others extremely rapid.

Research and Progress

But on the whole you will, perhaps, agree with me that the science and art of radio communication in the last 30 years has made gigantic strides, in many ways far exceeding the anticipations of the very few persons who, like myself, so many years ago believed in its future.

This wonderful progress has been made possible by the patient work of a host of investigators and experimenters the world over, amongst whom my own assistants should not be forgotten, nor should we either forget the important part played by the great radio companies and manufacturers in assisting and promoting research.

The Inventor of Wireless

In regard to myself, I must confess being at times amused at the discussions which occasionally take place as to who is the real inventor of wireless.

To my mind, wireless existed when the prehistoric man first understood or felt the meaning of a smile of encouragement from the prehistoric girl, when human beings first succeeded in talking to each other or were able to understand or decipher signals or signs made to them from a distance.

What I think I did discover is that electric waves are capable of travelling and being received across very great distances.

Transatlantic Tests

The successful tests of wireless telegraphy which I carried out across the Atlantic Ocean in December, 1901, 24 years ago, proved for the first time that the possible range of these waves was enormously greater than almost anyone before that time had supposed, that the curvature of the earth was no real obstacle, and that radio communication would probably be possible across any distance on our earth.

Broadcasting

No remarks of mine are required to tell you what radio is doing at present, or into what an enormous industry it is growing.

Telephonic broadcasting, which became possible after the invention of the thermionic valve, is rapidly becoming a necessity in every civilised country as a potent means of disseminating instructions, information, and entertainment. In the short period of three years the number of licence-holders is now close on one and a-half million, representing a total audience of habitual and occasional listeners-in of 10,000,000 in this country alone.

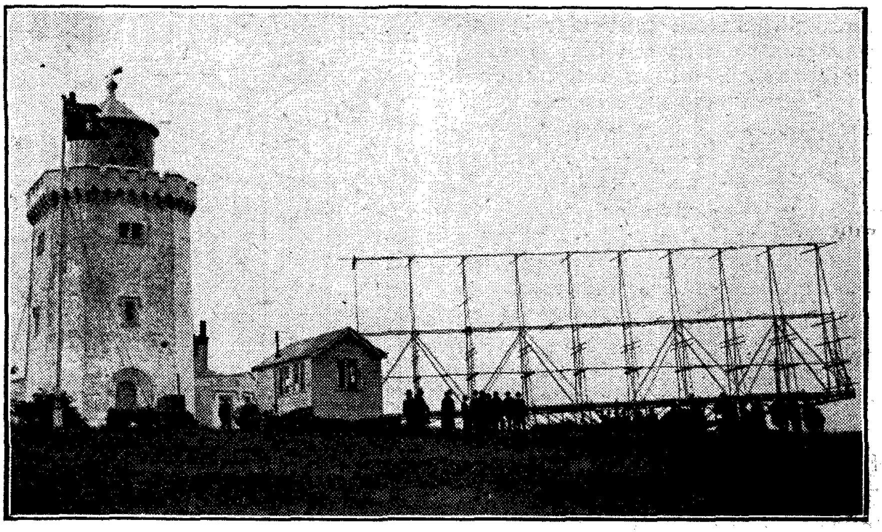
We should not, however, forget what wireless has done for many years for commercial telegraphic communications, the all-important part it played in the Great War, and—above all—where nothing else so far can take its place, in diminishing the perils of navigation and in the saving of life at sea.

But the art of radio communication is now undergoing a complete process of evolution, the effects of which are still difficult to foresee.

New Developments

The extraordinary results obtained in recent years by means of short waves and the possibility of projecting these waves in beams covering only a limited angle or area, seem to indicate that the previously planned powerful and very expensive stations will no longer be necessary for long-distance communications, and that better and more reliable services can be established and maintained by means of much less costly stations working at higher speeds and utilising a far smaller amount of electrical energy.

Electric waves are proving to be far too valuable to be always broadcasted in all directions, especially when it is desired to communicate only with one particular place or area, and it is also for this reason that the new stations operated on what is called the "Beam System," which are now being erected for communicating between England, India, the Dominions, and foreign countries, are likely to provide what might almost be considered a new method of communication destined to fill a position of the greatest importance in further facilitating and cheapening communication throughout the world.



Senatore Marconi recently gave a successful demonstration of his new wireless "lighthouse," the aerial of which is seen here beside the South Foreland Lighthouse.

Inventions and Developments

Under this heading Mr. J. H. Reyner, B.Sc. (Hons.), A.C.G.I., D.I.C., of the Radio Press Laboratories, will review from time to time the latest developments in the radio world.

A PATENT has been taken out by C. and C. J. E. Dixon for a combined valve holder and rheostat. This apparatus is illustrated in Fig. 1, and it will be seen that one end of the resistance

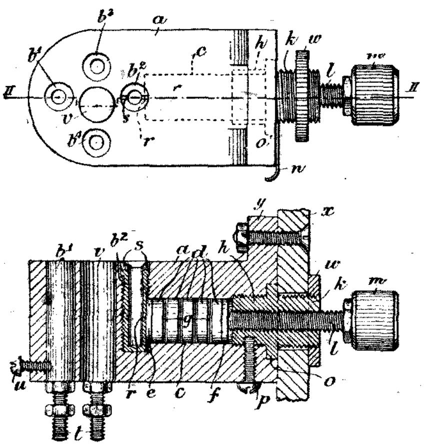


Fig. 1.—A combined valve holder and rheostat.

is connected direct to one of the valve legs, the other end of the resistance being brought out to a terminal. In the particular instrument shown a carbon disc rheostat is illustrated, although the use of any type of resistance is claimed in the patent.

Patent No. 238,459.

A New Form of Low-loss Condenser

Patent No. 238,162, by Wilkins and Wright, Ltd., and J. H. Hewitt, describes a form of condenser in which a low-loss construction is aimed at by the elimination of one of the end plates. In order to accomplish this a particularly robust form of bearing has to be provided, and this is accomplished in the particular case by the use of a fine-threaded screw, in place of the more usual plain bearing. By this means a single bearing is enabled to give the necessary rigidity for the condenser. By the use of a suitable spring which tends to press the moving plates away from the bearing, a good electrical contact between the threaded spindle and the screwed bearing is obtained.

Losses in Masts

There are one or two Canadian patents of interest to our readers. One of these relates to the losses which are obtained in the masts of an aerial system. Due to induced currents in the mast itself, a certain proportion of the energy supplied to the aerial is wasted. In order to obviate this, it is proposed that the mast should be insulated from earth, but that the aerial should be connected direct on to the mast. The mast, or masts, are then supplied with current substantially in phase with the current actually supplied to the aerial.

By this means the mast actually serves as an additional lead-up, and the currents therein are therefore useful instead of being wasteful. This principle may conceivably be of interest to the amateur transmitters in this country, although the insulation of the mast itself presents certain difficulties.

Conduction Current in Metallic Coatings of Valve Bulbs

It has been found that in transmitting valves which have been exhausted by a process causing the deposition of a metallic film on the inside of the bulb, that eddy currents are set up in this film, which is conductive, so causing additional losses and other undesirable effects. *Patent No.* 201,585

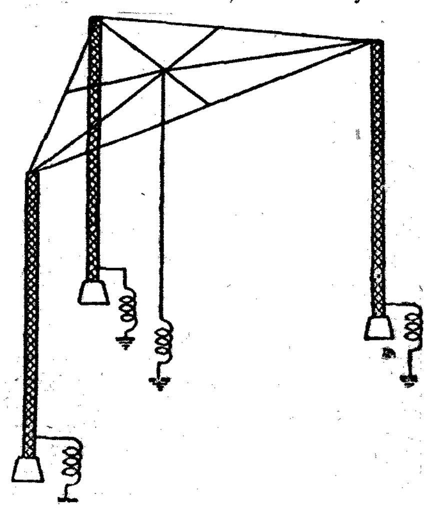


Fig. 2.—An arrangement for using the masts as part of the aerial, in order to reduce losses.

describes a method of reducing these currents by the connection of a metallic ring between the anode and the bulb.

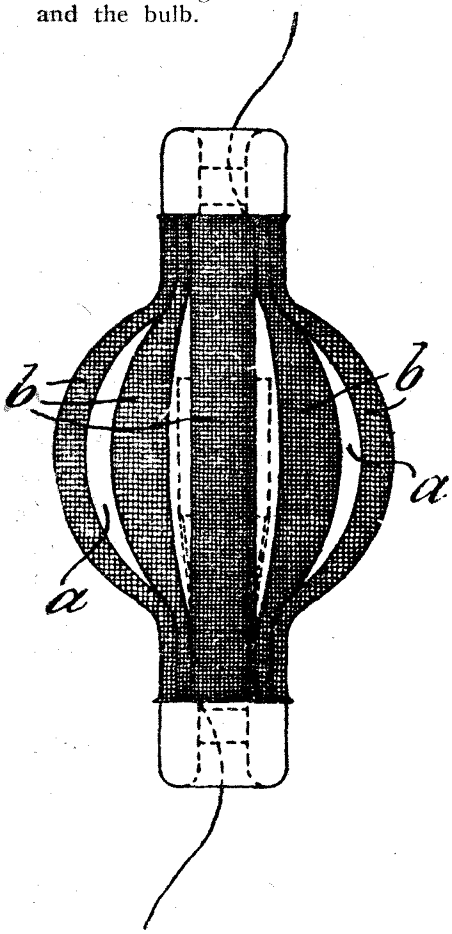


Fig. 3.—The screening arrangement described in Patent No. 238,265.

It is claimed that improved results are obtained by providing a conducting screen over practically the whole of either the outside or the inside of the glass bulb. This screen, being of a comparatively low resistance, has the effect of short-circuiting the metallic deposit of the bulb, which is of fairly high resistance.

The screen may, if necessary, be held at a fairly heavy negative potential to prevent it from attracting any electrons to itself or to the glass bulb. An illustration of the device, fitted as an external shield to an ordinary small type of transmitting valve, is shown in Fig. 3.

Patent No. 238,265.

WHY DULL EMITTER VALVES ARE SILVERED

—(*Continued from page* 11)

secured, and even if the grid is connected to the negative terminal of the filament, the contact potential causes the grid to remain slightly electro-positive to the filament, so that a grid current flows.

Dull Emitter Filaments

In the case of dull emitter valves, however, having a filament of thoriated tungsten in the dull-emitting condition, or of alkaline earths, it is found that this contact potential between the grid and filament is in the opposite direction and therefore the grid is slightly negative with respect to the filament. This means, of course, that a certain positive potential must be applied to the grid before any grid current can commence to flow. In practice this necessary positive grid potential may be applied by connecting the grid (through the leak if necessary) to the positive side of the filament. This explains to some extent why the practice of connecting the gridleak to the positive of the filament has become now almost a standard practice.

This method of making the grid positive through the filament, however, fails if the voltage across the filament is less than 2½ volts. This is actually the case in some valves, notably the D.E.R. type of valve, on which the filament voltage is 1.8 only, and in this case, therefore, it would be necessary to connect the gridleak to some point even more positive than the positive leg of the filament. To obviate this difficulty, however, the grid of the valve is coated during manufacture with some highly electro-positive metal. The grid then fulfils the condition that it shall be electro-positive to the filament, and consequently satisfactory results can be obtained without the additional complication of an extra battery.

Use of Magnesium

Now it so happens that magnesium is one of the most electro-positive metals there is, so that in the manufacture of the valve the magnesium which is used in the gettering process is placed on the inside of the anode of the valve, so that when it volatilises in the exhaustion process, it deposits itself all over the surface of the grid as well as on the bulb itself. The use of magnesium, therefore, serves the double purpose, not only of cleaning up the vacuum inside the valve, but also it has this very subtle effect on the characteristic of the valve itself, and renders it more suitable for use as a grid rectifier.

J. H. R.

THE LORENTZ COIL

A VERY simple way of winding a coil of particularly low capacity is provided by what is known as the "Lorentz" method. This coil resembles a simple basket turned edgewise so that it becomes roughly cylindrical, and the resulting low-capacity inductance is particularly suitable for use as a radio choke in short-wave sets.

Obtain first of all a base of hard wood or ebonite which may be either

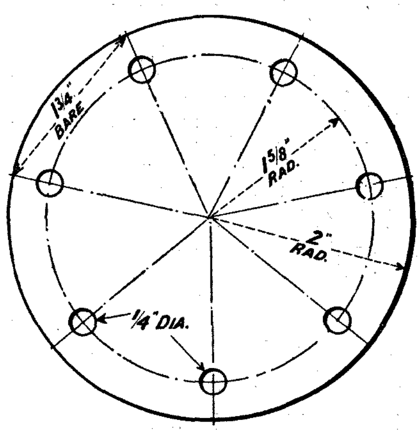
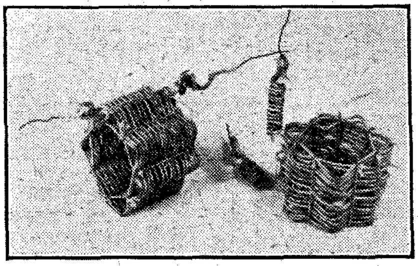


Fig. 1.—Dimensions of the circular base which supports the pillars.

square, or circular, as shown in Fig. 1. If circular it should be 4 in. in diameter, and if square the sides should have the same measurement. Fig. 1 shows how the circular former is laid out and drilled. I have used seven pillars in this design, but nine or eleven may be fitted if desired. To divide a 4 in. circle into seven parts set the points of a pair of dividers slightly under 1¾ in. apart. Make a mark at some point on the circumference, and using this as your starting point travel round with your dividers. Then rule radial lines from the centre to each mark. Next describe a circle with a radius of 1⅝ in. At the points where the seven radii cut the circumference of this circle make punch marks, and at each drill a ¼-in. hole.

Now cut off seven suitable lengths of ¼ in. round ebonite rod and insert them into the holes. They will, as a rule, fit so tightly into the holes that no further fixing is necessary; but if the drill is a trifle over size or the rods slightly less than their nominal



Coils of somewhat similar type to those described, the turns being tied together before slipping the coil off the former.

¼ in. in diameter they may be fixed by drilling and tapping 6B.A. holes into them from the edge of the base and inserting ½ in. screws. If the former is of wood smaller plain holes may be drilled, fixing being done with fine ¾-in. nails, such as those used for fixing fretwork together.

We are now ready to wind the coil. Anchor the starting end in the following way. Drill a hole through one pillar quite close to its lower end and through this insert the end of the wire. Take a turn with the wire round the pillar and all will be secure. The wire is wound on basket-fashion over the first pillar, under the second, and so on, putting the turns on fairly tightly and continuing until as many as are required are in place.

When all the turns are in place take a knitting needle and space them out evenly and as far apart as possible at each pillar. This gives the maximum amount of air spacing

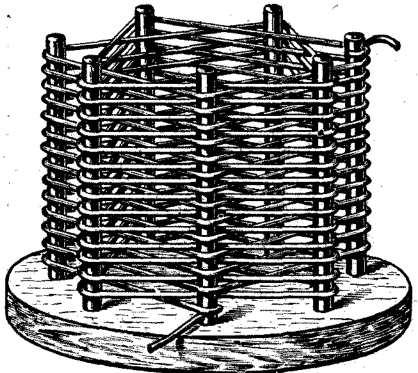
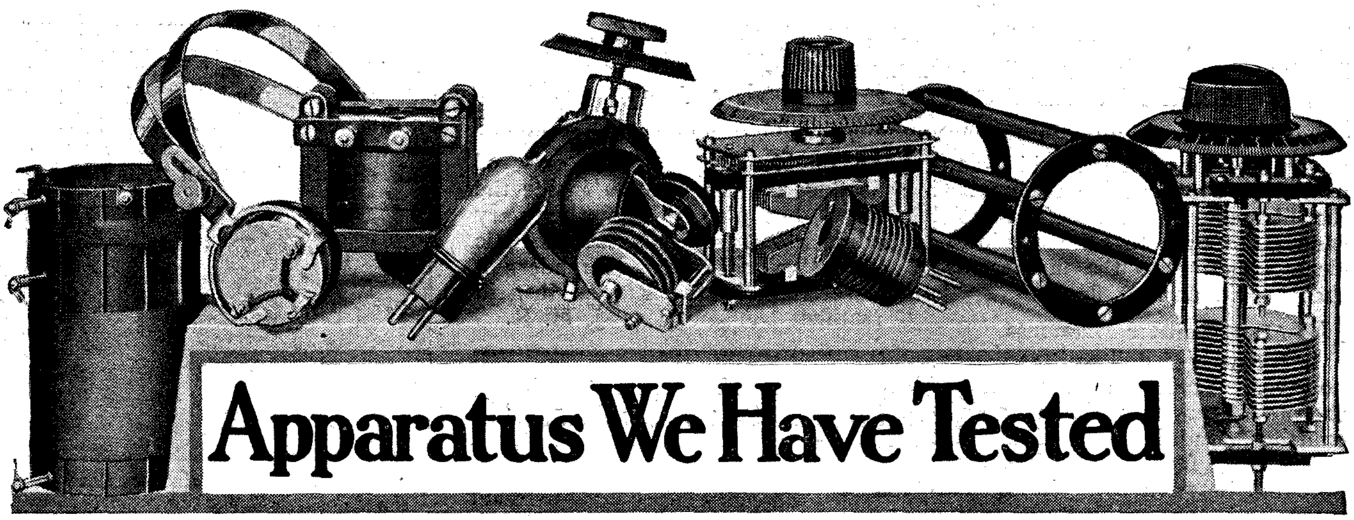


Fig. 2.—The completed coil can be left on the former.

and adds materially to the efficiency of the coil. By using pillars 2½ in. in length a very efficient 10- or 12-turn coil for short-wave work can be made.

R. W. H.



Apparatus We Have Tested

Conducted by A. D. COWPER, M.Sc., Staff Editor.

Armour-Clad Rheostat

Messrs. Electrical Equipment and Carbon Co., Ltd., have sent for test a sample of their "Armour-Clad" filament rheostat for D.E. valves. This has the usual flat spiral of resistance wire fitted closely inside a circular metallic casing of only 1½-in. diameter, an insulating lining being interposed. The contact-finger works round on the exposed rim. Neat and accessible terminals, and one-hole fixing are provided. Both contact-finger and knob, with its pointer, are secured in a most substantial and mechanical manner to their spindles; the whole device is made in a manner which suggests reliable service, and is highly finished. The resistance, on test, came out close to the nominal, 30 ohms; the instrument controlled satisfactorily the ordinary .06 type of D.E. valve, and would carry the current for an ordinary two-volt .3 amperes type, though warming up considerably in the latter instance.

Armour-Clad Potentiometer

Messrs. Electrical Equipment and Carbon Co., Ltd., have also submitted a sample of their "Armour-Clad" potentiometer, uniform with the D.E. filament resistance reported on above; the barrel in this instrument is 2 in. in diameter, and the necessary three terminals are provided. The resistance proved to be no less than 600 ohms, so that the instrument can be used across the L.T. battery with every confidence that rapid exhaustion of the battery will not result.

Re-wound Headphones

It is well known that telephones, in general, gradually lose their sensitiveness, particularly when used on a valve set without much care as to polarity of connections, or when allowed to fall about and receive rough usage. A break will often develop at an inaccessible point in the winding of perhaps one bobbin in an otherwise perfectly serviceable pair of 'phones not of the inexpensive variety, and the permanent magnets naturally lose some of their power with age. Messrs. The Varley Magnet Company have submitted for our trial and criticism a pair of ordinary headphones which they have totally re-wound to 4,000 ohms resistance, re-magnetised and adjusted. Practical test of these exhibited a sensitiveness which compared favourably with that of a new pair of well-known make; the resistance was as stated, and the company appear to have made a thoroughly good job of the overhauling. Those who possess a favourite head-set which is beginning to show the effects of constant usage would be well advised, judging from this sample of their work, to send the 'phones along to Messrs. The Varley Magnet Co. for re-winding and re-magnetising.

Lissen Wire Filament Resistance

Messrs. Lissen, Ltd., have sent for our test and criticism a sample of a new type of filament resistance of their manufacture, in which, unlike their well-known "Lissenstat" types, the resistance is in the form of a wire spiral. The bright-emitter pattern submitted had a flat spiral of resistance wire around the periphery of a circular moulding, and the usual spring contact-finger working on the edge of the spiral. A reliable central spring connection is made to this brush; small terminals and soldering-tags are provided, together with the customary one-hole fixing device. A knob and pointer and a neatly engraved metal scale for mounting outside the panel are also supplied. We were glad to note the substantial means for securing the knob and contact-finger; there is little probability of these working loose with hard wear. On trial, the resistance was around 10 ohms; the wire heated up on 1.7 amperes, but carried .7 amperes readily, and gave smooth, silent control of an R valve. Finish and workmanship were of a high order.

Lissen Potentiometer

Uniform with the filament resistance in general appearance and build, the wire-wound potentiometer submitted by Messrs. Lissen, Ltd., proved to have the satisfactorily high resistance of 420 ohms on test, and gave a uniform control of potential when used as usual across the L.T. battery. The provision of an engraved external scale was found very convenient in practice; in particular the instrument gave close control over a detector valve when used for adjusting grid-potential through a fixed leak. It can be well recommended.

Resin-cored Solder

Messrs. W. H. Agar have submitted a sample of their resin-cored solder for our practical trial. This is in the form of a narrow tube of the alloy in which a thread of resin is enclosed, which acts as a flux in soldering operations. The latter is evidently always available, and is applied just where needed; the convenience and cleanliness of this method of applying the flux became very noticeable in a practical test, particularly when soldering connections in a somewhat inaccessible position in a receiver. Resin is, in addition, a very safe flux for electrical work, and is often recommended for this purpose. The solder is rolled up in a neat spiral which provides a convenient handle whilst working. It can be recommended for home-constructional work.

THE B.B.C. AND THEIR PUBLISHED WAVELENGTHS

(Continued from page 21.)

on the wavemeter definitely and accurately determined.

Now we take another standard wavelength from the National Physical Laboratory, say 2,800 metres (107.1 kc.), and again take the 1st, 2nd, 3rd, 4th, 5th harmonics, and so obtain still further points of calibration. In this way sufficient points can be obtained to enable us to calibrate the wavemeter over its whole range of wavelengths.

The wavemeter must be constantly checked to guarantee that it is correct.

Causes of Variation

We understand the difficulties of maintaining the wavelength of a transmitting station constant.

For example, changes in the disposition of the parts of the transmitter produce changes in the interaction, which causes changes in the inductance in the set, and thus the wavelength alters. Again, when any considerable power is used in transmission, heat or moisture may cause changes in dimensions of coils and other parts, and thus small changes in inductance may occur. As regards the valves, changes in temperature of the filament, the heating of the grid and of the anode may produce changes in the actual dimensions of these electrodes, and thus changes in the relative disposition, which will alter the characteristics, tending to produce a change in frequency unless special precautions are taken.

The Master Oscillator

Again, alteration of the anode voltage has an influence on the actual frequency unless very special precautions are taken. Nevertheless, there are means of making these influences small. The use of an independent drive, which is really a low-power oscillator controlling the main transmitter, and which can further be controlled by a quartz oscillator, is one of the best means of obtaining constancy of wavelength, and is to be recommended, so that it may be stated that there is no technical reason why an accuracy of one-half of 1 per cent. or better should not be arrived at and maintained.

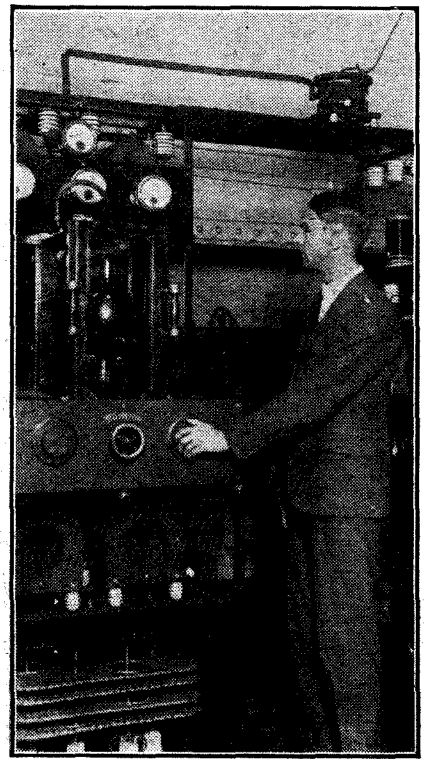
The Human Factor

In addition, there is the human element to be considered, and this, of course, makes mistakes unavoidable. This necessitates constant watch by the B.B.C. on the actual wavelengths of their stations, and any discrepancies should be immediately dealt with. However, the disciplinary methods of the B.B.C. are outside of the scope of these remarks.

Hope of Improvement

We expect very great accuracy of frequencies from the B.B.C., and they should aim at making their transmissions complete standards of frequency. We have considerable hopes that this will eventually be the case, for we have been observing the frequencies of the B.B.C. station during the Geneva tests. There is a very different story to tell here, and quite reasonable accuracy is being obtained. In some cases the wavelengths were absolutely accurate.

It will be our privilege, with the facilities of the laboratories at Elstree, to keep a friendly watch on the wavelengths used by the B.B.C., and the results of our tests will be published from time to time.



The "drive" or master oscillator panel at the Glasgow station.

WHEN TO USE A LOW-LOSS COIL

(Continued from page 15.)

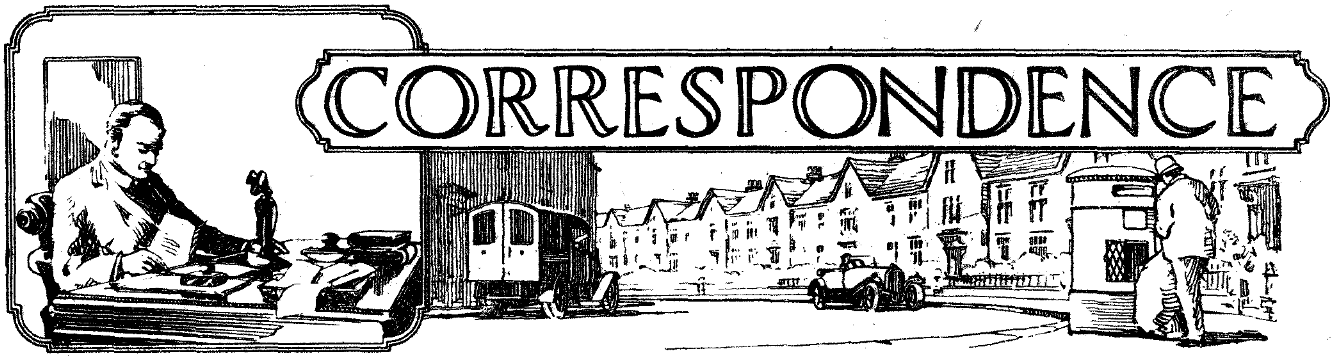
valve across only part of the inductance in its grid circuit, does not lead to a really marked decrease in signal strength. The relief of damping in the circuit produced by tapping the valve across a portion of the total voltage evidently compensates to a large extent for the diminution in the proportion of the voltage which is applied to the valve.

In this way it is quite possible to sharpen considerably the tuning of the circuit across which the detector valve is connected, and I show in Fig. 2 an example of this method. It will be seen that this circuit is in the main a simple three-valve arrangement employing tuned anode coupling between the high-frequency valve and the detector, but that the connection to high-tension positive from the tuned anode is taken through a tapping which is located at some little distance along the coil. Since, so far as high-frequency potentials are concerned, this tapping point is equivalent to a lead from the filament of the rectifying valve, it will be seen that this valve is connected across only a part of the whole tuned circuit, and therefore that the desired reduction in damping will take place.

A Heavily Damped Circuit

In the grid circuit of the first valve, however, we have the familiar direct-coupled arrangement with parallel condenser, and here it is practically useless to employ a really low-loss inductance. Since the damping of this circuit is usually fairly heavy, no neutrodyne arrangement is shown, but on the contrary actual positive reaction upon the aerial circuit is indicated. With most aerials and earths, of course, this is a perfectly practical arrangement.

I hope that this very brief discussion of some of the salient points which decide where to use the type of coil commonly known as a low-loss inductance, will show that a certain amount of consideration is involved in the proper employment of these coils, and that unless one devotes this consideration to the subject, one is apt to receive a disappointing impression of the capabilities of such improved tuning inductances.



A "SUPER-FIVE" RECEIVER

SIR,—I would like to write and tell you that I have made up a "Super Five" as described in *Wireless Weekly* (Vol. 5, Nos. 13 and 14). The results are all you claim, are really wonderful, and no matter what the station or where it is, nothing is out of reach. Headphones are never used; it is the best set I have ever made or operated, and the one I intend keeping for myself.—Yours faithfully,

A REGULAR READER.

Woking.

A "SIMPLE SELECTIVE SET"

SIR,—I feel certain that a few results obtained with one of the circuits from your excellent journal will be of interest to other readers.

The set I wish to thank Mr. A. D. Cowper, M.Sc., for especially is the "Simple Selective Set," adapted for plug-in coils, in the issue of *Modern Wireless* for July, 1925, Vol. 4, No. 6.

I have built this receiver as a portable set, and am getting really excellent results, using a Mullard .06 L.F. valve with only 45 volts H.T. and a dry battery for L.T. supply and the components as described.

In the early part of August I took the set away on a camping holiday on the River Thames, and was able each evening to tune in 2LO and 5XX without the slightest difficulty. I was using 18ft. of rubber-covered flex as the aerial, and after experiment found the terminal A3 the best to use. No earth connection whatever was necessary. Signal strength, from Staines right up to Pangbourne, over 40 miles from London, was really good on the telephones, in some cases audible up to several feet from the headpieces. These results were obtained with only 18ft. of flex thrown up into the most convenient tree, often quite a small willow. One night, near Henley, after the B.B.C. had closed down, two Continental stations, Brussels, SBR and one German station were quite clearly heard.

I think this is by far the best single-valve circuit I have tried. I intend to add two stages of L.F., and I shall be glad to give you some results when the set is completed.

On the original set it is quite easy to get several foreign stations and other B.B.C. stations with a good outdoor aerial, and I hope with the L.F. amplifier to bring these up to loud-speaker strength.

I have had very good results from the several sets I have built during the last two years, and thank you for your valuable help.—Yours faithfully,

G. A. RIPPON.

Palmers Green, N.13.

AN "IMPROVED TWO-VALVE RECEIVER"

SIR,—In March last I constructed for a friend of mine the "Improved Two-Valve Receiver" (*Modern Wireless*, February, 1925, by Stanley G. Rattee, M.I.R.E.). The components and layout I modified a little, as my friend wanted the valves mounted under the panel, otherwise all the components were as specified. I might add I only entered into wireless in October last, and previous to constructing this set I had only constructed one for my own use.

The "Improved Two-Valve Receiver" which I had constructed I installed for my friend one evening about 6.30 p.m. (daylight), and the first station to come in was Hamburg, on good 'phone strength. This, as you might guess, highly pleased him. He has since told me that he has received all the B.B.C. main stations on it at various times, and frequently Spanish, French and German stations at good strength. But that is not all. Last week he asked me to get him a loud-speaker. This speaker is now being worked on Daventry, this station being about 80 to 100 miles from Swindon, at quite good strength for a normal room. At times he is working the loud-speaker and two pairs of 'phones at the same time at a comfortable strength. I think this will take some beating, and is, of course, ample praise for your wonderful and well-described set.

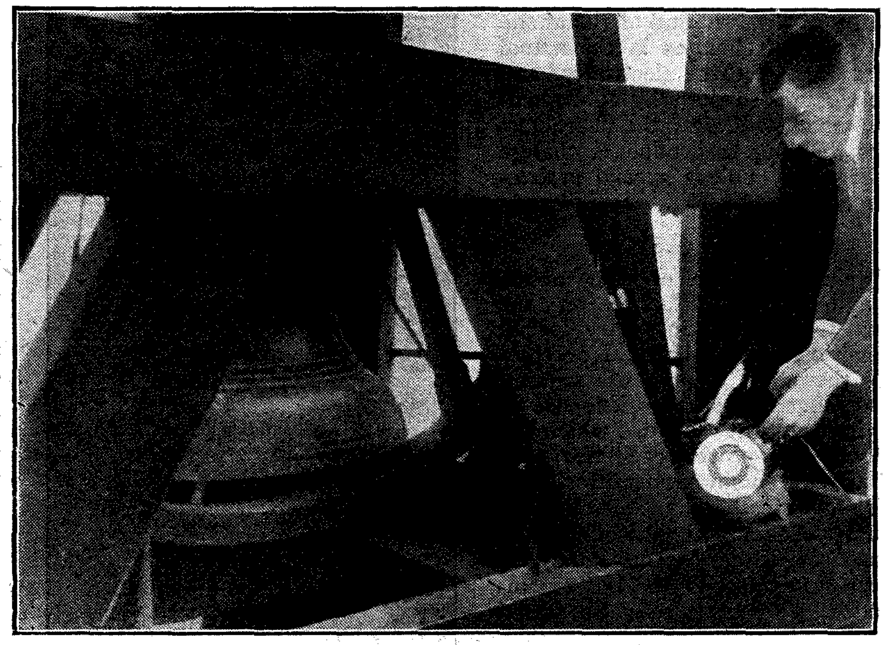
I wish your papers every success in the future.—Yours faithfully,

F. A. GRIFFITHS.

Swindon.

THE "HARMONY FOUR"

SIR,—I have this week built up roughly the "Harmony Four" Receiver, published in this month's issue of *Modern Wireless*, by Percy W. Harris, M.I.R.E. Congratulations to Mr. Harris for such a fine circuit, quite the best I have ever hooked up, and I have made a number now, including a seven-valve set. Tone is beautiful, no noisy background; I can tune in without bringing set to the point of oscillation.



An engineer of the B.B.C. fixing the microphone in the belfry of St. Martin's in the Fields for broadcasting the sound of the bells.

London is very loud, Madrid very nice on the loud-speaker, and Birmingham almost as loud as London. Many other stations can be got quite well. I am using Cossor dull emitters and Cossor power valve. Have not yet had Daventry because I am waiting for some higher wave-band H.F. transformers.—Yours faithfully,

A WIRELESS ENTHUSIAST.

High Wycombe.

SIR,—I wish to let you know that I have just completed the "Harmony Four" (described by Mr. Percy W. Harris, M.I.R.E., in the September number of *Modern Wireless*), in which I have also incorporated a wave trap to assist in cutting out London, since I am so close to it.

After giving the receiver a trial I can honestly say it is as good as any I have ever handled, and I think this is about my 50th set from your papers.

As to results, I have received all B.B.C. stations at loud-speaker strength and several Continental. The volume from the nearer stations is terrific, and although I have a power valve I have no need to use it.

Considering there are three condensers, the set is simple to tune once one gets the hang of it, and even so one has no coils to fiddle about with. I find it far and away the best set yet, and a great feature is the purity with which signals are received. Using the finest components and new H.T. batteries, I have secured a silent background, which is a great asset to tuning in long-distance stations.—Yours faithfully,

B. GLADSTONE.

W.14.

A JUNIOR READER'S EXPERIENCES

SIR,—I thought you might be interested by the results I have obtained with the "Three-Valve All-Concert Receiver," described by Mr. Percy W. Harris, M.I.R.E., in "Twelve Tested Wireless Sets." On a rather poor aerial, 18 miles from Birmingham, I receive Daventry and Birmingham at full loud-speaker strength, also London, Nottingham, Manchester, Stoke-on-Trent, Bournemouth School of Posts and Radio Paris are excellent on the loud-speaker; Madrid, Hamburg, Brussels and Eiffel Tower are good 'phone strength. Belfast and Newcastle are rather difficult to tune in, but I get Vienna, Voxhaus and Rome very well. There are lots of other stations that I have not identified, but I have had one American station, although I do not know which it was. Tuning is critical, because I use two .0005 μF variable condensers, but I have fitted a Colvern Vernier which improves the tuning. I use three Ediswan A.R.D.E. valves, and I have made my own coils.

I am only 14, but I have built about eight different sets, though I have not got much knowledge of wireless. Wishing you every success.—Yours faithfully,

JOHN F. ARGYLE.

Tamworth.

ENVELOPE No. 1

SIR,—I have completed building the ST100, and thought that you would be pleased to hear of the splendid results.

The instrument is wired according to the diagrams in Envelope No. 1 (by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E.); all the component parts are as specified, with the exception of the 100,000 ohm resistance.

With a No. 50 fixed coil, a No. 75 movable coil, Mullard "Ora" valves and 69 volts H.T., I have succeeded in getting *all* the B.B.C. stations at 11 miles south of 2LO, but cannot get Cardiff, Bournemouth, or Manchester when London is working, owing to interference. Newcastle, Aberdeen, Glasgow and Birmingham are very powerful, and with another valve would work a loud-speaker well.

One peculiarity of the circuit is that London is too loud on the telephones and works a loud-speaker fairly well with no aerial at all, and with a wire flex about four feet long it is splendid.

Up to the present the only Continental station received is l'Ecole Superieure, comfortably loud on the telephones, but up to now no others have been tried for.—Yours faithfully,

EDWIN J. BALDWIN.

East Croydon.

THE "TWIN-VALVE" RECEIVER

SIR,—I think you may be interested to hear of the results obtained with the "Twin-Valve" Receiver (Radio Press Envelope No. 10, by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E.). It is a remarkably sensitive set, and receives 5XX without aerial or earth. In this case the aerial was connected to earth outside the house, about 10 ft. away from the set. The reception was at moderate telephone strength, using a No. 200 coil in the aerial circuit and a No. 150 for reaction.

On an indoor aerial consisting of 20 ft. of twin flex running along a passage, 5XX comes in at comfortable loud-speaker strength, and London, Radio-Paris and Newcastle quite loud on the telephones.

With an outdoor aerial 100 ft. long and about 26 ft. average height, the following stations are obtained with great regularity:—5XX, too loud on the loud-speaker to be comfortable, and easily heard all over the house (I usually de-tune to a moderate strength); London, Newcastle, Bournemouth, Radio-Paris and Petit-Parisien are received at good loud-speaker strength.

All other main stations and relays come in easily on the telephones, and, of course, dozens of Continental ones. I am also agreeably surprised to find that the set is almost as easy to handle on the shorter waves as on the long ones. I have had a great number of amateurs on wavelengths varying from 125 to 300 metres. I am delighted with the receiver, and feel that it is only right to let you know how satisfied I am. Wishing your excellent publications every success. — Yours faithfully,

HAROLD C. LEE.

Herne Bay.

AMATEUR CALL SIGN

SIR,—I should be pleased if you could announce in your papers that the call sign 5TG has been allotted to me. Power 10 watts, wavelengths 23, 45, 90 and 150-200 metres, C.W. and telephony.

Transmission on about 180 metres will commence shortly, and I should welcome reports.—Yours faithfully,

W. J. TARRING.

Forest Gate, E.7.

The control amplifiers installed in the Church of St. Martin's in the Fields, whence services are frequently broadcast.

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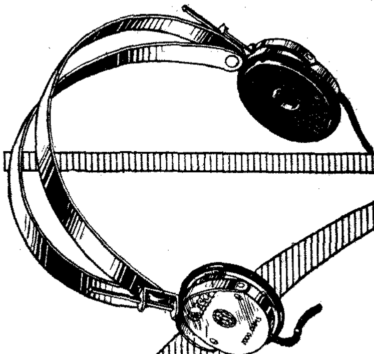

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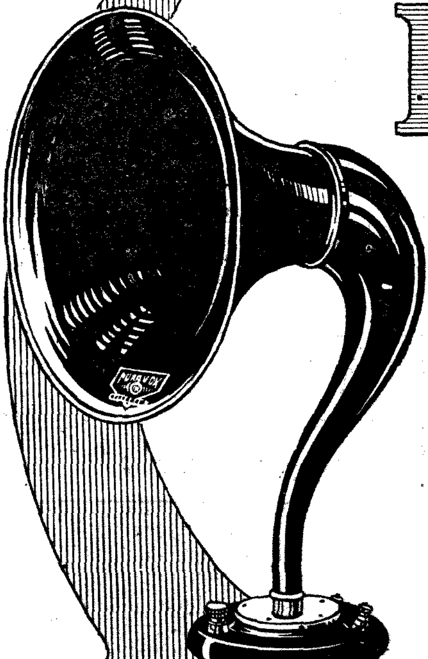

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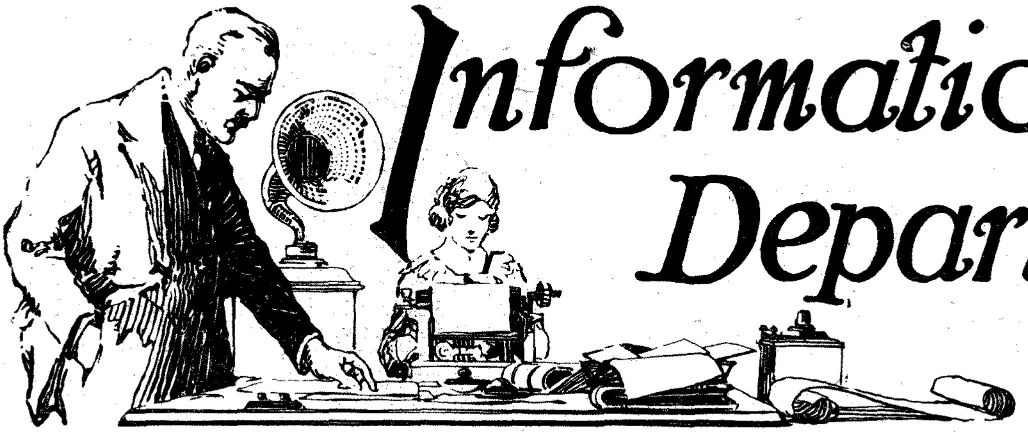


Information Department.

H. F. (BASINGSTOKE) is puzzled by the somewhat strange behaviour of his All-Concert de Luxe receiver. When the filament of the H.F. valve is switched off signals are received, but as soon as this is switched on silence reigns. This phenomenon has only been observed during the last few days and previously the set worked satisfactorily.

A somewhat obscure fault of this nature is usually located in the high-frequency valve itself and not in the grid-leak, as our correspondent suspects. The explanation is very simple, although not obvious unless similar trouble has been experienced before. The cause of the signals coming through when the valve is not alight and ceasing when it is lit is that the filament has sagged so as almost to touch the grid when cold and expands when hot so as to do so completely. This results in directly connecting the aerial to earth, so that there is no potential difference between grid and filament, and hence signals cease. When the valve is switched off on its rheostat the filament contracts so as not to touch the grid and signal energy is transferred to the detector valve through the internal capacity of the H.F. valve.

A cure may sometimes be effected by heating the filament to normal brilliancy, holding the valve in an appropriate position and giving it a number of smart taps with the hand. This may cause the filament to bend in a different direction and give a somewhat lengthened life. Even if this brutal treatment completely breaks the filament, it is not material, since the valve would anyway be useless.

R.N.A. (WEST WICKHAM) wishes to know whether the Midget amplifier described in the September issue of "The Wireless Constructor" would be suitable for use in his locality. He has a crystal set on which he can hear London and Daventry but no other station, and he wishes to know whether the use of this amplifier would help him to bring in other B.B.C. stations.

The Midget amplifier referred to is a single-valve low-frequency amplifier. As a general rule low-frequency amplifiers are only useful for increasing the volume of signals which are already audible. Although in certain cases the addition of a low-frequency amplifier to a crystal set will result in stations being heard which are inaudible on the crystal set alone, it is usually preferable to employ high-frequency amplification if it is desired to extend the range of a crystal set. By amplifying the incoming signals before they are applied to the detector the latter is enabled to operate more efficiently, and a correspondingly greater signal strength is obtained. This results in signals being audible from stations which are not heard on the crystal set alone. We would recommend our correspondent, therefore, to make up a high-frequency amplifier for his set rather than to use the amplifier to which he refers.

L. M. O. (GLOUCESTER) wishes to know whether "neutrodyning" a high-frequency amplifier is worth the extra trouble. He wishes to know whether a neutrodyne high-frequency stage will give better results than an ordinary tuned anode.

This matter is somewhat outside the scope of the Information Department, which exists more for the purpose of replying to specific queries. We may say, however, that a "neutrodyning" arrangement or some suitable form of neutralising the effect of the inter-electrode capacity of a valve is undoubtedly of great service in a high-frequency amplifier. The difficulty with ordinary high-frequency amplification is that when the amplification per stage reaches a certain value continuous oscillation or howling is produced. The more efficient the particular stage of amplification is the more readily is this howling produced. The use of a neutralising arrangement enables the amplification to be made reasonably efficient whilst at the same time the tendency to self-oscillation is counteracted. This means, of course, that the actual amplification of the particular stage can be greater with a neutralising arrangement than without, so that there is a distinct advantage in the use of a neutralising scheme. The answer to the second part of our correspondent's query is one which depends to a large extent upon the actual conditions existing in the particular set, but as a general rule, if both the tuned anode and the neutrodyne arrangements are tolerably efficient and properly constructed, there would be a superiority exhibited by the neutrodyne arrangement. The best course of action, of course, would be to combine the two and to employ a neutrodyned tuned anode circuit. Such a circuit, if properly constructed, is capable of giving very good results.

J. C. W. (DARTFORD) has constructed a "Family" 4-valve receiver from Radio Press Envelope No. 2, with which he is obtaining very unsatisfactory results. He reports that with the detector only no signals whatever can be received. The addition of the high frequency valve allows him to obtain the London station at very poor strength, the set oscillates in a very uncontrollable manner, is extremely prone to howling, and no control of reaction is given by adjustment of the potentiometer.

Experience has shown us that with a set of this type difficulties such as our correspondent is experiencing may generally be traced to a defective potentiometer, which should be changed. Whenever a four-valve Family receiver behaves in a peculiar manner, oscillating freely, and howling badly when the low-frequency stages are switched into circuit, the potentiometer should be suspected. It is not necessary to change this component to decide definitely whether it is the offender, since it can easily be cut out of circuit. Reference to blue print No. 2 will show the two ends of the potentiometer winding connected respectively to F+ and the long lead which joins one side of the filament resistances to L.T. negative. These two leads should be disconnected from the potentiometer as should the one to the slider from the earth terminal. Now join the latter lead to the one from F+, leaving that from L.T. negative free and arranged so as not to touch any of the other wiring. Connect the set up in the normal manner and tune in to any available transmission. If the receiver is now found to be stable and the valves to give the expected step-up in signal strength, the potentiometer is undoubtedly responsible for the previous poor results, and should be changed for a new instrument.

R. S. P. (KINGSDOWN) finds an ordinary buried earth unsatisfactory, since he is surrounded by shingle, and asks our advice on how to erect a counterpoise.

An effective counterpoise arrangement, and one that is generally adopted by large commercial transmitting stations, is one which extends past the free end of the aerial to a distance, roughly equivalent to one-half of the horizontal length of the aerial, and consists of a number of parallel wires extending on either side to a distance usually equal to the height of the aerial. The whole of this system is suspended on a series of masts 20 or 30 feet high, and is thoroughly well insulated from earth, the parallel wires being joined together and led into the station in a similar manner to the aerial.

Our correspondent will, however, for reception purposes, not find such an elaborate system necessary. Two wires well insulated, preferably 6 feet or so up, stretched directly underneath the aerial, well insulated and led in through the same type of lead-in tube as employed for the aerial should prove satisfactory. Ordinary 7/22 hard drawn copper wire will prove suitable, and equal care with its insulation should be taken as with the aerial. With such an arrangement tuning will probably be found considerably sharpened and reaction demands lessened so that a smaller reaction coil than is used with a buried earth will generally give satisfactory control of oscillation.

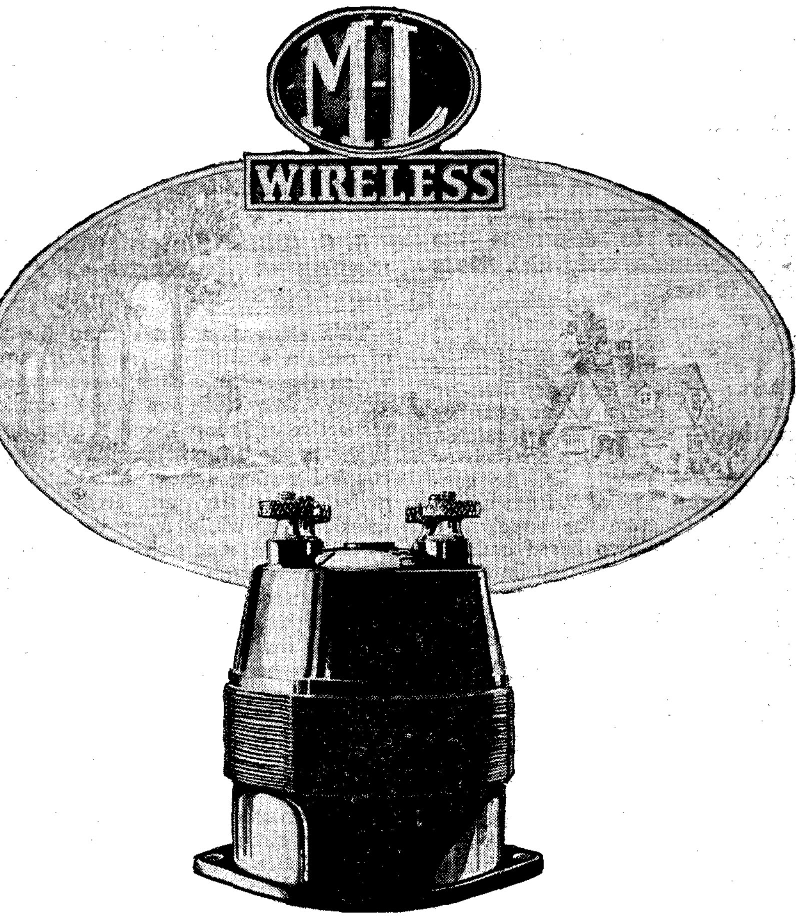
E. M. (TONBRIDGE) wishes to use his direct current supply mains for charging accumulators in conjunction with a bank of lamps and asks our advice on how to determine the polarity of the mains and which side is connected to earth.

A very simple and effective test which will easily determine the polarity of direct current mains may be made as follows:—Fill an ordinary jam-jar with water and add a small quantity of common table salt. Two insulated leads with ends bared for an inch or two at one end, should now be connected from the " point " from which it is desired to take the supply for charging, and the two bared ends of the leads should be inserted into the water in the jar and held separated at a distance of two or three inches. Electrolysis will take place and bubbles will arise round both wires. Around one lead, however, considerably more bubbles will arise than around the other. The particular lead from which most bubbles rise is the negative. Care should be taken not to touch the bared portion of the leads when the current is switched on, and they should not be allowed to come into contact or a short-circuit will take place which may blow the house fuses.

Which side of the mains is earthed can easily be found if an ordinary lamp, such as is used on the supply, is connected in turn between each lead and earth. The lead which does not permit the lamp to light, when connected in the above manner, is the one which is earthed.

J. C. (BRISTOL) asks what is the meaning of the expression "tune stand-by switch"?

This expression dates from the use of certain commercial receivers, upon which there was a change-over switch, whose two positions were marked respectively " tune " and " stand-by." When in the " tune " position, a loose-coupled tuning system was employed, giving selectivity and freedom from interference, while upon the " stand-by " side, a single-circuit tuner was used whose tuning was less sharp, and was consequently employed by the operator when standing by for signals, since it made the picking up of the call more certain. A similar switch is useful in any receiver which possesses a loose-coupled circuit, since it enables one to switch over to the simpler direct-coupled arrangement to pick up distant stations. When the station has been accurately tuned in upon the primary circuit one can change over to the loose-coupled arrangement and tune in upon the secondary circuit.



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THE INNER HISTORY of the GRINDELL-MATTHEWS DEATH RAY, by Major JAMES ROBINSON, D.Sc.

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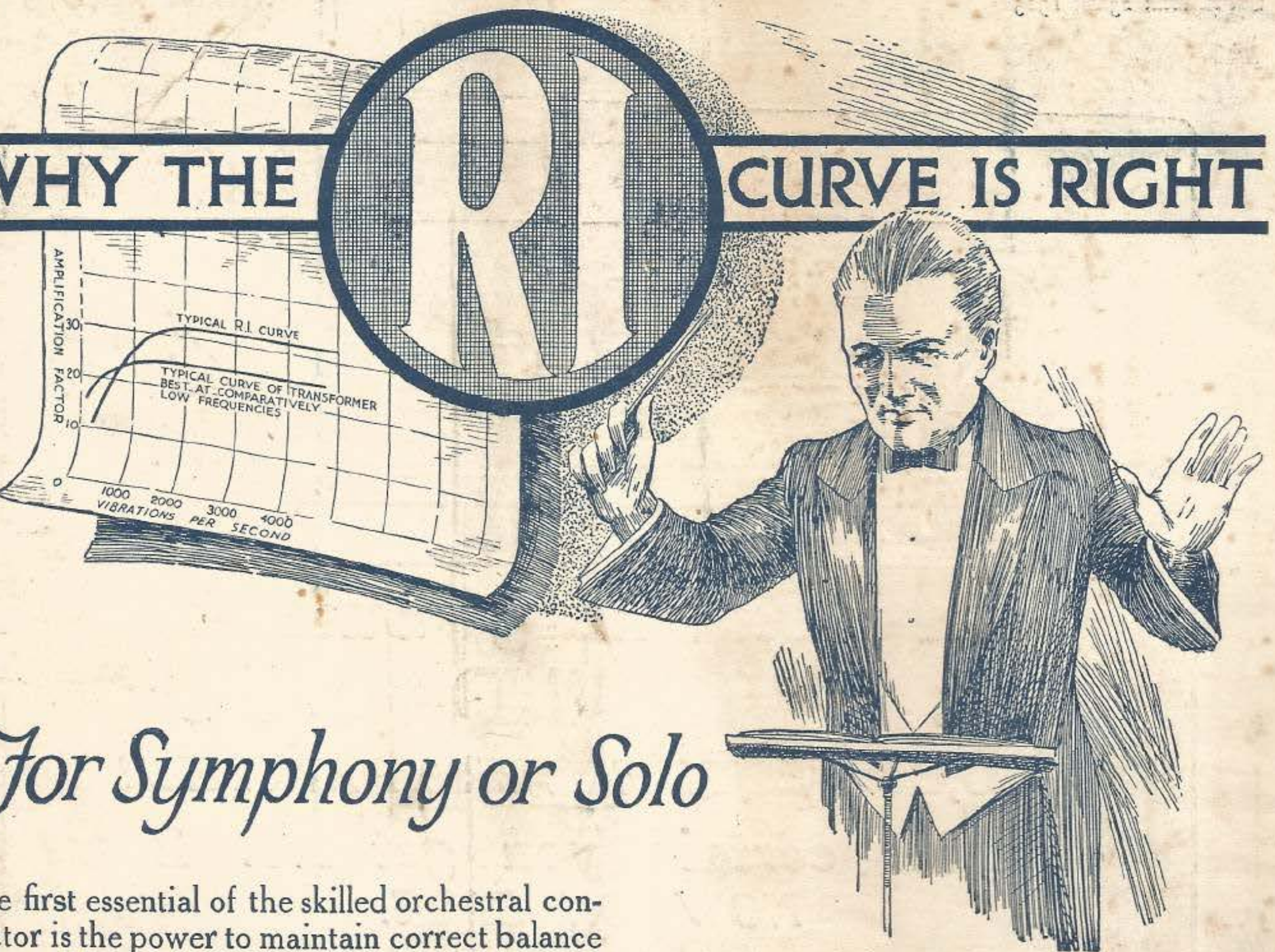

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Wireless Weekly, 6d. Net. Wednesday September 30th, 1925

Wireless Weekly

Vol. 7. No. 2.

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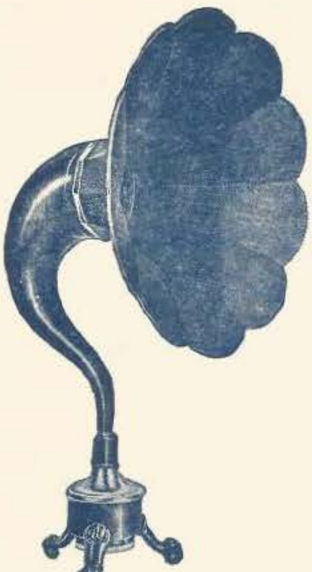

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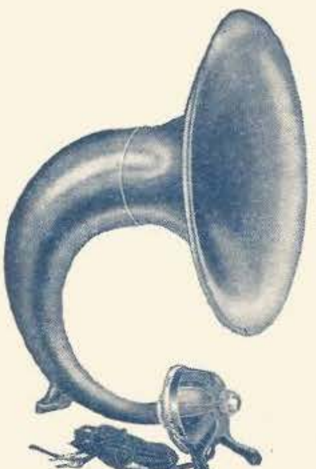

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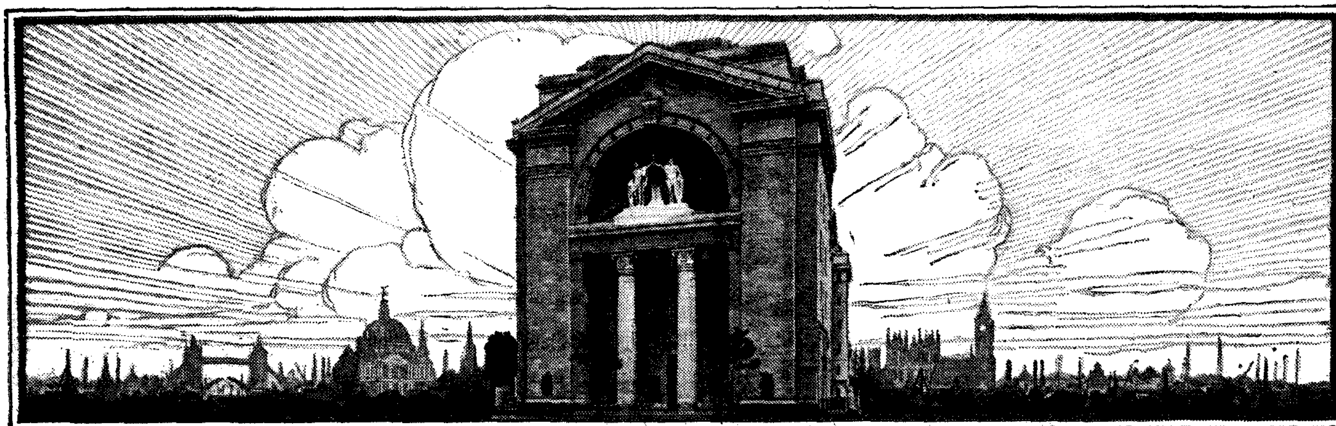

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Selectivity

IT has been pointed out upon several occasions recently that there can be no question that the detecting and low frequency amplifying portions of British receivers are unquestionably at least the equal of the corresponding apparatus in the United States. It would seem, however, that in the development of high frequency amplifying circuits of the special types called for to obtain a really high degree of selectivity, a point has been reached in the United States which makes it incumbent upon us to devote a good deal more attention to this subject.

The conditions prevailing in the United States, where there are commonly quite a number of fair-sized broadcasting stations operating in each large city, have made it essential that any receiver which is intended for the reception of distant stations shall possess a really high degree of general selectivity, and the forcing effect of this state of affairs upon development has resulted in rapid progress.

The advantages to be derived from a receiver of high selectivity need no emphasing in view of the increasingly crowded condition of the European ether, and here is to be found a field for experiment which can be entered by any reader who possesses quite simple apparatus and the necessary patience and perseverance. Elsewhere in this issue will be found a very suggestive article from Mr. A. D. Cowper, M.Sc., in which the author outlines one method of achieving the desired high selectivity, sufficient data being given to form an effective starting point.

CONTENTS.

No one doubts the ability of the British experimenter to deal with a problem once it has definitely been presented to him, and there is here a very interesting opportunity for all to assist in bringing our receiving apparatus up to the standard called for by present-day conditions of crowding of stations in a limited frequency band. In the article to which we have referred will be found a survey of the problem, and it is advisable to obtain a clear idea of the requirements to produce the desired degree of selectivity before attempting to devise special methods of achieving this end.

There is a familiar and well-established method depending upon the use of weak couplings between successive circuits, and the employment of this device is usually accompanied by some reduction in signal strength, which has, no doubt, been largely instrumental in preventing the British experimenter from making very much use of it up to the present.

He has felt that his main interest lay in obtaining the longest possible reception distances with the minimum number of valves, but the change in conditions which has gradually taken place is resulting in a state of affairs in which the long-distance receiving powers of a set may be very much curtailed by lack of selectivity.

The more general precautions, whose object is the reduction of damping in all tuned circuits, must also, of course, receive due attention, and a considerable amount of study should be given to the subject of the elimination of stray coupling between the earlier circuits of the receiver and those nearer to the detector, as a preliminary to any attempt to make a useful contribution to the subject.

Edited by
JOHN SCOTT-TAGGART,
F. Inst. P., A.M.I.E.E.

September 30, Vol. 7, No. 2.

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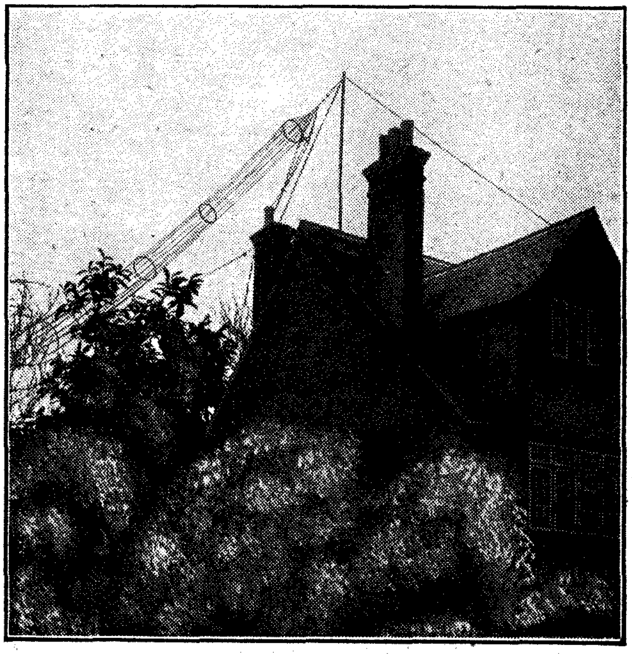
AERIALS FOR SHORT WAVES

By Major JAMES ROBINSON, D.Sc., Ph.D., F.Inst.P., Director of Research to Radio Press, Ltd.

In the last two articles of this series in "Wireless Weekly" some questions of the propagation of waves were considered, and it was shown how there is a tendency to attempt to transmit wireless energy at an angle to the horizontal.



A typical cage aerial used for amateur transmission on short wavelengths.

WE will now consider how it is possible to transmit energy into the upper atmosphere. It has already been shown that from a simple vertical aerial, or from an aerial which is flat-topped, a considerable amount of energy is propagated at an angle to the surface of the ground. Curves were shown for the type of aerial and radiation when fairly long wavelengths were used, that is, when the wavelength used was longer than the natural wavelength of the aerial.

Horizontal and Vertical Radiation.

We shall now discuss the alternative case where the natural wavelength of the aerial is longer than the wavelength used. Consider an aerial which is not earthed but which is of the form of a Hertzian oscillator, such as that shown in Fig. 1, where A is the point where the power is put into the aerial. Now consider that this is excited by a wave one quarter the natural wavelength of the aerial in such a way as to obtain the complete oscillation of BAC as one wavelength. It is obvious that along a line OAX which is perpendicular to the aerial BAC there will be no radiation at all, because there will be an equal and opposite effect produced by the two halves of the aerial BA and CA. Further, we know that there will be no vertical radiation, so that we have the whole of the radiation shot up at an angle to the surface of the ground. It is possible to work out conditions for an aerial excited with an eighth of the wavelength, with a sixteenth of the wavelength, and so on. In fact, it is possible to work out the conditions when the wavelength used is some irregular fraction of the natural wavelength. This was done by Van der Pol in the year 1917, and was published in *The Proceedings of the Physical Society of London.* Further theoretical results have also been published recently by Ballantine in the Proceedings of the Institute of Radio Engineers.

Distribution of Radiation

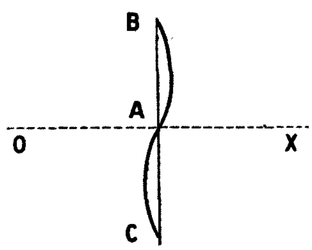
A number of figures showing how the radiation is distributed vertically are given from Fig. 2 to Fig. 5. The curves are again polar diagrams. Referring to Fig. 2, O is the point representing where the aerial is situated; OX represents the horizontal direction, and OY the vertical. The relative amount of radiation in any upward direction is given by the length of the line drawn from O to the curve OBAX. Thus, if OX represents the amount of radiation in a horizontal direction, then on the same scale OB represents the amount upwards at an angle BOX with the horizon, and OA at an angle AOX, etc.

Current Distribution

Fig. 2 is for the ordinary case of the wavelength in use being greater than the natural wavelength of the aerial, or, in other words, greater than 4.2 times the length of the aerial.

On the left of the figure the current distribution along the aerial is given. This is for an aerial earthed in the formal way, and without a capacity at the top. In such a case the current is zero at the top and a maximum at the bottom.

In some of the other figures the current distribution along the aerial is also shown, and in some cases it will be seen that the current is shown as zero at the bottom of the aerial. This appears to be a contradiction, but, in fact, is not so, for special arrangements can be made to have zero current at the base, and in these cases the aerial is not earthed at that point.



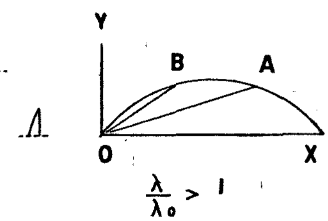


Fig. 1 (left)—The radiation from an aerial which takes the form of a Hertzian oscillator. Fig. 2 (right)—The horizontal and vertical radiation components for an aerial whose natural wavelength is less than the transmitted wavelength.

Further Examples

Fig. 3 is for the case of the wavelength in use equal to the fraction 0.39 of the natural wavelength of the aerial. In this case it is seen that there is considerable radiation horizontally, and that at an angle of 35 deg. with the horizon the radiation is zero. The

In this (his concluding) article Dr. Robinson discusses the problems of transmission on short wavelengths, and indicates how the principle of harmonic radiation may be utilised to advantage.

radiation splits up into two parts, there being a small amount of radiation nearly vertically.

In Fig. 5 this splitting up of the radiation into various parts is seen to be more pronounced. This is for the case where the wavelength used is $\frac{2}{3}$rd of the length of the aerial, or actually $\frac{1}{6}$th of the natural wavelength of the aerial.

Fig. 4 shows the upward distribution of radiation for the wavelength equal to the length of the aerial, corresponding to the aerial shown in Fig. 5. In this case there is seen to be no horizontal radiation.

Actual Trials

Both Van der Pol and Ballantine suggested that this effect might be used in order to test the Heaviside layer theory, and, in fact, tests have already been made by the French on these lines. Professor Mesny instituted tests in the year 1923, in which he transmitted a certain form of radiation on 45 metres whereby the wavelength used was equal to the natural wavelength of the aerial, or somewhat greater than that, in other words, where the normal form of aerial was used. He also transmitted on 45 metres, whereby the length of the vertical portion of the aerial was equal to the wavelength and thus harmonic radiation was used. It was considered that in the latter case more radiation was sent into the upper atmosphere than in the former case. Observations were made by amateurs and by scientists in various parts of France, and, in fact, in England. The results which were obtained were very inconclusive, so that Professor Mesny could not definitely say that the results with harmonic type of radiation were any better than those with the more ordinary types of aerial.

Long Distance Communication

Very little appears to be known in England of this type of radiation, and very few records exist as to harmonic radiation having been used. The reason for

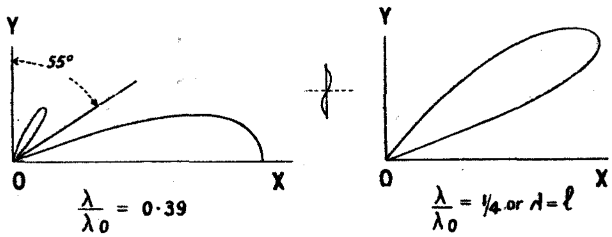
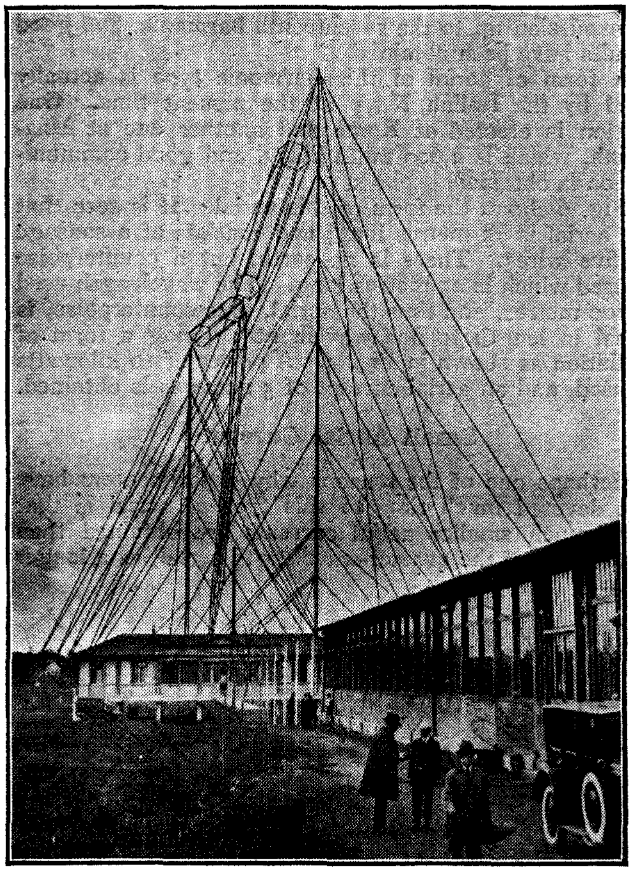


Fig. 3 (left) and Fig. 4 (right) show the angles of radiation for the conditions indicated by the formulae.

this appears to be that on short wavelengths such remarkable ranges have been obtained with such exceedingly small powers that experimenters have not troubled to consider whether they are using the most efficient form of aerial.

Future Restrictions of Power

The time is not very far distant, however, when experimenters will be compelled to devote



The elaborate aerial system erected by M. Belin at his private station at Malmaison, in France.

considerable attention to this point. In the case of commercial companies, it will be absolutely essential to consider the most efficient form of radiation. It will not be sufficient for a commercial company to state that it has got communication to Australia at a particular time of the day, but it will be necessary to guarantee communication for a considerable number of hours per day. In these circumstances the very best efficiency will have to be considered, and special attention will undoubtedly be given to this form of aerial. When a considerable number of experimenters, commercial companies and services are using these short wavelengths, there will be such a scramble for the use of wavelengths that power allowed may be subject to considerable restrictions. In these circumstances, experimenters, Services and commercial companies will undoubtedly devote considerable attention to use of harmonic aerials, and it will not be long before the merits of these aerials will be recognised.

Short-wave Phenomena

A peculiarity of short-wave working has often been reported that signals cannot be obtained from some transmitting stations at distances of 200-400 miles, but that at greater distances good signal strength is obtained. This appears to have an obvious explanation that there is no little horizontal radiation from these aerials, and that the only useful radiation from them is in an upward direction, and it does not get bent back to the earth under distances of 400 miles or more.

Practical Harmonic Aerial System

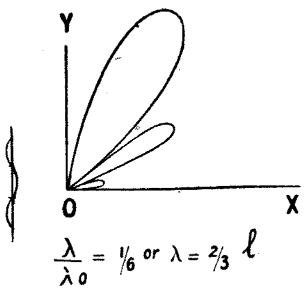
The Eiffel Tower aerial has been used for harmonic transmission up to the seventeenth harmonic, and good results have been obtained.

A form of aerial of this harmonic type is actually used by the Italian Navy at the present time. One station is erected at Rome and another one at Massauah, which is 2,600 miles away, and good communication is obtained.

Fig. 6 shows the form of this aerial. It is seen that the aerial is 75 metres long, and consists of a sausage of five wires. There is no earth, but a counterpoise is used which is 25 metres long. The wavelength used is 100 metres, and thus the aerial, plus counterpoise, is equal in length to one wavelength, giving a form of radiation as shown in Fig. 4. A power of 10 kilowatts is used, and an aerial current of 5 amperes is obtained.

Small Aerial Current

Perhaps one of the reasons why experimenters have not devoted much time to this type of aerial is that very much smaller aerial currents are obtained than in the case of the quarter-wavelength aerial, as a longer



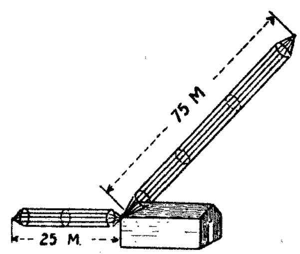


Fig. 5 (left) illustrates the splitting up of the radiation for the case where the wavelength used is two-thirds of the length of the aerial. Fig. 6 (right).—A form of aerial and counterpoise of the harmonic type in use at the present day.

aerial is used with the same input of energy. Suppose we use a three-quarter-wavelength aerial as compared with the normal quarter-wavelength aerial.

From the formula already given for radiation resistance, $R_a = \left(39.7\frac{h}{\lambda}\right)^2$ ohms, we see that this varies with the length of the aerial. This formula relates, of course, to the case where the aerial current is almost constant throughout the length of the aerial, and thus we cannot employ it directly in the case of harmonic aerials in which the aerial current varies from zero to a maximum. The same general law holds, however, that the radiation resistance increases as the length of the aerial increases.

Thus, in the two cases of one aerial of the normal quarter-wavelength type, and of another with a three-quarter wavelength, the latter is three times as long, and thus has much greater radiation resistance. In case the input is the same in both cases, it is obvious that the aerial current must be smaller in the case of the three-quarter-wavelength aerial. This, however, does not mean that the distance which the wave will travel is smaller, for the total radiation is not necessarily diminished.

Experimenters should therefore not be discouraged on short waves because they sometimes cannot get large aerial currents.

Experiments in America

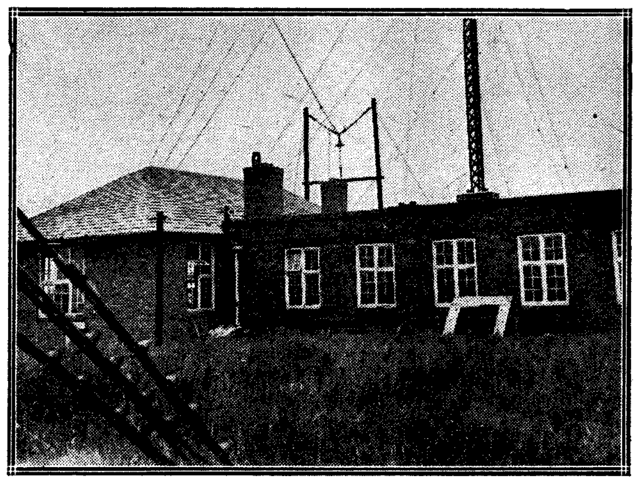
In the United States amateurs have used harmonic aerials to a considerable extent, but for very different purposes. One of the reasons has been that they already possess long wavelength aerials, and they have desired to use these aerials for shorter wavelengths. A method for doing this is to tune the aerial to three, five, seven or nine times the wavelength to be used. Then tune the primary circuit of their transmitter to the wavelength to be used. In this case the aerial is used as a harmonic aerial. Quite good results are reported with aerials of this type from the United States.

Aerial Design

There is one great precaution which must be taken with short-wave aerials. This is that the aerials must be taut in every respect and that they must not be allowed to blow about by the wind or to be jerked in any other way, for the slightest variation of an aerial will cause a variation in capacity to earth and capacity to other parts of the aerial, and thus cause a slight change in wavelength. When received by the heterodyne method of reception, obviously this small change in capacity will produce very considerable change in intensity of signals received. A point to recommend about short-wave aerials is that they should be built of solid rods which can be made quite rigid, while at the same time, if they are of the correct material, they can have exceedingly small resistance losses.

Conclusions

In this series of articles some general ideas have been given of the types of transmission and propagation which have been and are being used. The general tendency to the use of short waves has been indicated, and it is interesting to note that this tendency is brought about from practical considerations and also on theoretical grounds. Two of the most important theories of propagation, the Heaviside layer theory and the Meissner theory, have both shown how advantages can be obtained by using waves of shorter wavelengths than



The aerial lead-in of the Post Office wireless station at Northolt.

those which have been in common use up to the present. These theories have only been briefly discussed in these articles, but elsewhere in this journal it has been indicated that work in this country, principally by Professor Appleton, tends to show that the Heaviside layer theory gives a much fuller explanation of all the facts.

Extending the Broadcast Range

By SYLVAN HARRIS.

The possibility of an extension of the band of wavelengths allotted to broadcasting in America may conceivably be paralleled in Europe as a result of the recent tests. Some of the problems which confront the designer of receivers to cover the extended band for the new conditions are discussed in this article.

THERE is not a shadow of a doubt that there will be considerable consternation on the part of many American radio enthusiasts when the broadcasting wavelengths are lowered. There is also no doubt that the wave band will be lowered. There is nothing else to be done to clear up the congestion which now exists in the ether. Everyone is expecting it to happen soon.

There will probably be a great hue and cry when the extension comes. People will say: " It has been

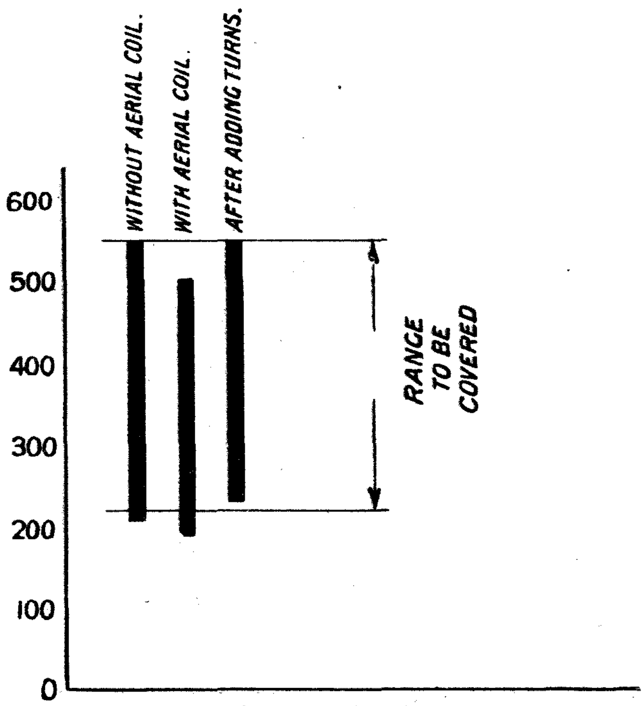


Fig. 1.—Showing the alterations effected in the tuning range of a receiver by changes in the aerial coil.

difficult enough up to now to cover the range of 550 to 220 metres (545 to 1,363 kc.). How will it be possible to cover a range of 550 to 150 (545 to 1,999 kc.)?

Tuning Over a Wide Range

There will be many arguments pro and con, but in the end, no matter how much arguing is done, ways and means will be found to overcome the difficulties. At least, if the total range cannot be covered in a single step, as is now done, it will have to be done in two or more steps.

As to the possibility of covering such a wide wave band—that is another question. Let us look at the problem from the point of view of the variable condenser, which is generally employed for tuning. But first there are three ideas which we must grasp firmly in order to discuss the matter properly.

The Basic Principles

The first of these three is the idea of *capacity ratio.* This is very simple. It is merely the maximum capacity of the condenser divided by the minimum. In other words, if the maximum capacity of the condenser is 500 $\mu\mu$F and the minimum capacity is 20, then the capacity ratio of the condenser is 500/20 or 25 to 1. This is generally written 25 : 1.

The next idea, that of wavelength ratio, is just as simple. It is merely the longest wavelength we are considering, divided by the shortest. If we are considering a range of 600 to 200 metres, the wavelength ratio is 600/200 or 3 : 1.

The third and last of these ideas needed here is that which considers the relation between the capacity in the tuned circuit of a receiver and the wavelength to be received. This is generally known; the wavelength is given by the formula:

$$\lambda = 1884 \sqrt{L \times C},$$

in which L is the inductance in the circuit in microhenries (μH), and C is the capacity in microfarads (μF). The point that is of importance in connection with all this is that the wavelength is proportional to the *square root* of the capacity in the circuit.

Capacity and Wavelength

That is to say, we shall have to quadruple the capacity to double the wavelength, or increase the capacity nine times to triple the wavelength. Or to look at it another way, we may regard the capacity as proportional to the square of the wavelength; to

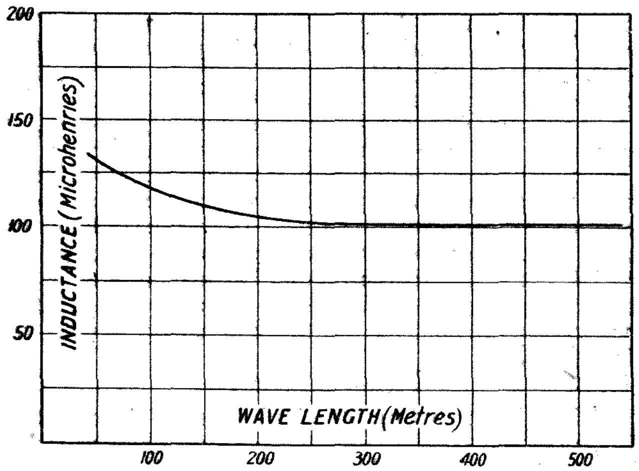


Fig. 2.—Illustrating how the inductance of a coil increases with an increase in frequency (decrease in wavelength).

double the wavelength we shall have to quadruple the capacity, etc.

Having assimilated these basic ideas, let us now co-ordinate them for the purpose of analysing our problem. Suppose we are considering a wavelength range of 600 to 200 metres (499.7 to 1,499 kc.). This is a wavelength ratio of 3 to 1. Since the capacity is proportional to the square of the wavelength, we should then require a capacity ratio in our tuning condenser of 9 to 1 to cover the range completely.

It is a relatively simple matter to cover a 3 to 1 wave range with a coil and condenser isolated in space. But when the coil is coupled to another coil, as our secondary tuning coil is coupled to the aerial coil, there is another consideration. This is that the mutual inductance between the aerial coil and the secondary reduces the effective inductance connected across the tuning condenser.

Experimental Proof

This can be shown by experiment. A simple single-layer coil is connected in series with a condenser and thermo-galvanometer. This coil has a primary of a few turns wound directly upon the secondary winding. The circuit is then excited by a small oscillator, and the wavelength range of the coil and condenser noted for both the maximum and minimum settings of the condenser.

This is done by placing the condenser at the desired dial settings and measuring with a wavemeter the wavelength at which the galvanometer deflections are a maximum.

The primary coil is then connected to the aerial and earth, and without making any other changes in the circuits, similar measurements of the wave range are taken. Measurements are given in the following table from an experiment carried out on these lines :—

	Maximum Capacity	Minimum Capacity
Without aerial ...	550	215
With aerial	507	198

This was not done for the purpose of expounding a new theory. The principles have been known for a long, long time. But it is surprising how much the aerial coupling coil can affect the wavelength range.

Adding Aerial Turns

Now, it was noted above that the aerial coupling has a maximum wavelength of 507 metres. This will not permit us to tune in stations above 507. The wave band in America now extends to 550 metres (545 kc.). Suppose we add a few turns of wire to the coil to make up for this deficiency. What will happen?

To begin with, we shall reach our 550 metres, of course. But, at the same time, we shall raise our lower wavelength limit, and instead of being able to tune to 198 metres (1,514 kc.), we may be able to go only to, say, 220 metres, or even 240 metres. How low we shall be able to tune depends upon how closely the aerial is coupled to the secondary, and also upon the other capacities existing in the circuit, and whether or not the inductance of the coil changes with the frequency.

Lowered Range

This is illustrated graphically in Fig. 1. The vertical black column on the left indicates the range of wavelength obtainable without connecting the aerial and earth to the primary coil. This range is 550 to 215 metres (545 to 1,395 kc.). With aerial and earth connected, the wavelength range is lowered to 507 to 198 metres (591 to 1,514 kc.). This makes it impossible to reach the longer wavelengths, although we can reach the shorter ones. This is shown by the middle column in Fig. 1.

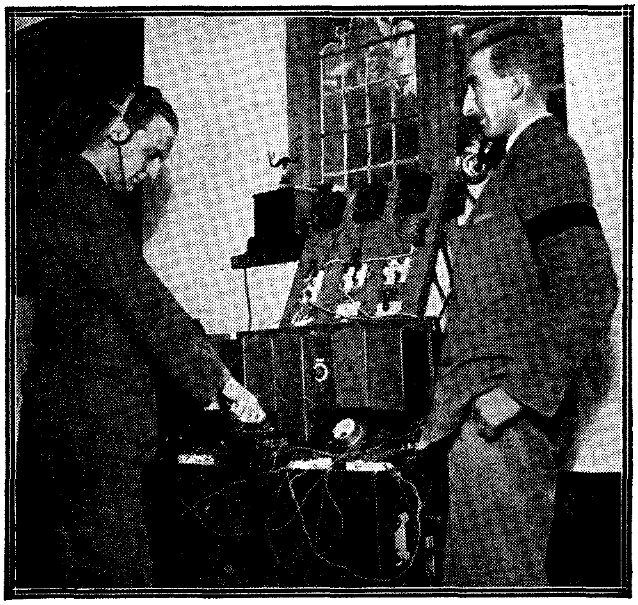
When we add sufficient turns to the secondary coil to make up for this loss of inductance, the wavelength is raised to 550 to 240 metres (545 to 1,249 kc.). We are now able to tune to the upper wavelengths as before, but are not now able to tune to the lower ones.

The reason for this is that the coupling of the aerial circuit to the secondary lowers the upper limit more than it lowers the lower limit, whereas the addition of the extra turns of wire changes both limits to nearly the same extent. This is indicated by the right-hand vertical column in Fig. 1.

Inductance and Frequency Changes

When a coil has considerable capacity, as is the case with multi-layer coils, the inductance changes as the frequency (or wavelength) changes. (See Fig. 2.) Over the longer wavelengths, say from 600 to 300 metres (499.7 to 999.4 kc.), the inductance does not change appreciably, but it is likely to increase very rapidly as the wavelength is made shorter and shorter. This will add to our difficulties in getting down to the low wavelengths.

Now let us consider what difficulties we shall meet when we try to get down to 150 metres (1,999 kc.).



Some of the apparatus installed by the B.B.C. in Stoke Poges Church, whence a successful broadcast was recently carried out.

The total range of 600 to 150 metres represents a wavelength ratio of 600/150 or 4 to 1. As has been explained above, this would require a capacity ratio of 16 to 1. In the old case, where we covered a range of 600 to 200 metres (499.7 to 1,499 kc.), there would have been no difficulty in covering the range. The secret of the problem lies in employing loose-coupling between the primary and secondary, and in using coils with low distributed capacity.

The two cases are compared in the table below :—

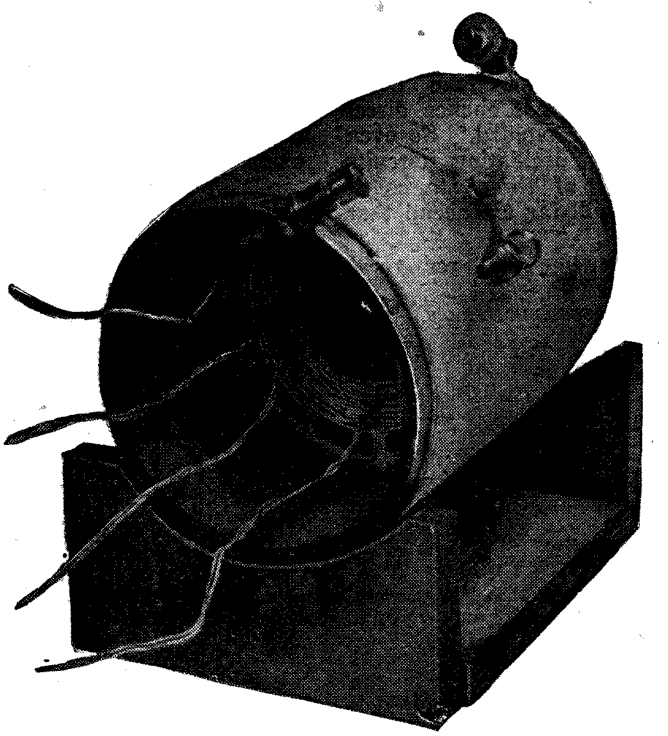
Wavelength Range Desired.	Wavelength Ratio.	Capacity Ratio Required.
600-200	3 : 1	9 : 1
600-150	4 : 1	16 : 1

(Continued on page 60.)

The Interference Problem

By A. D. COWPER, M.Sc., Staff Editor.

In this article some of the factors governing selectivity are discussed, and a method is suggested for overcoming the difficulties involved.



The solenoid grid coil described by Mr. Cowper with the tapped aerial coil placed under the filament tapping point.

COAST dwellers and those in the immediate vicinity of a commercial wireless station experience extreme local interference which is not confined closely to one frequency. Similar local interference is threatened in London if and when another broadcasting station is opened in a south-eastern suburb to provide alternative programmes. For cutting through such interference in order to receive distant stations there are available at the present time two practical alternatives.

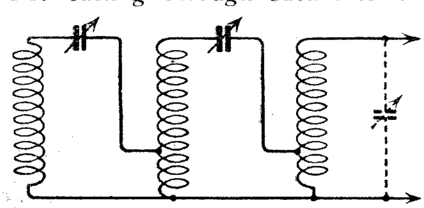


Fig. 1.—A classic type of H.F. "filter" circuit.

These are the super-heterodyne with its many valves and small frame aerial, and the multiple filter-circuit used in conjunction with an ordinary outside aerial. A single interfering station is easy to eliminate by a proper trap, if fairly sharply tuned; the real difficulties arise when the same extreme degree of elimination is needed on many frequencies.

Tight H.F. Couplings

Since extreme local interference with broadcast telephony has not been so conspicuous and universal a problem in Great Britain as it has become during the last year or so in the States, the attention of the British experimenter has been directed principally towards the obtaining of some degree of efficiency in high-frequency *amplification* by various types of (in effect) "tight" intervalve H.F. couplings, where such couplings are used in broadcast receivers, increase of range rather than extreme selectivity at all costs has been his object.

It is a commonplace to any careful observer that the natural selectivity of any reasonably well designed oscillating circuit, not deliberately damped for the sake of an expensive stability, is sufficient in all ordinary cases for the separation of *distant* telephony stations which are not actually giving an audible mutual heterodyne, i.e., for any useful purpose in broadcast reception.

Single Circuits

Practical experiment under conditions of extreme local interference of a fairly broadly-tuned variety has convinced the writer that it is not practicable to obtain a sufficiently sharply-peaked resonance curve in a *single* secondary circuit to cut down the intensity of, e.g., the local broadcast station's signals at suburban distances to an extent that merges them in the inevitable mush

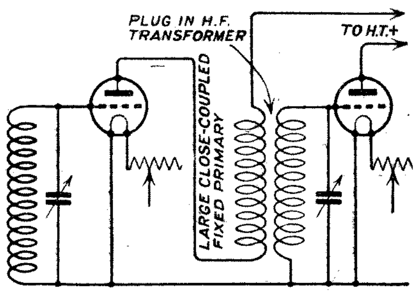


Fig. 2.—A common form of H.F. coupling employs tightly-coupled windings in the transformer.

or beneath the threshold value of local noises; that is to say, practically to extinguish them. This is in connection with an outside aerial of fair efficiency, and considering the practical case of reception of another

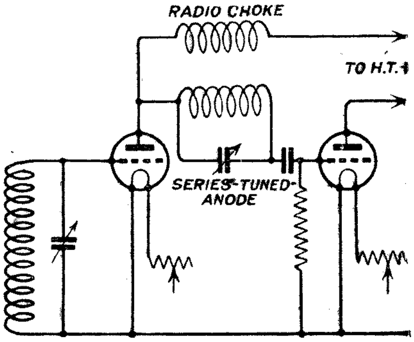


Fig. 3.—Another form of "tight" H.F. coupling is the series tuned anode method.

distant broadcast station on a *neighbouring* frequency not actually interfering directly by audible heterodyning with the first.

Reaction Distortion

Even with the use of critical reaction to eliminate much of the grid damping, except with some tricky, unstable circuits with tuned reaction effects, London will always come through audibly, in my experience, over most of the scale, and swamp the other stations. The question of reaction distortion (due to narrowing the resonance peak to such an ex-

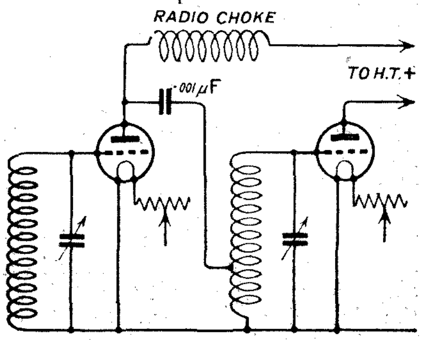


Fig. 4.—Auto-transformer H.F. coupling may be described as a form of loose " filter " coupling.

tent that it will not accommodate safely the audio-modulation side bands which necessarily accompany the main wave) begins to be serious when this degree of selectivity is attempted. The familiar hollow sound and " plummy " speech become prominent when reaction is pushed too far in an attempt still further to sharpen the resonance peak.

Multiple Filter

However, if one is prepared to sacrifice a certain amount of high-frequency amplification, and add one or two valves, for the sake of a sufficient degree of selectivity, the problem is very simply solved. By

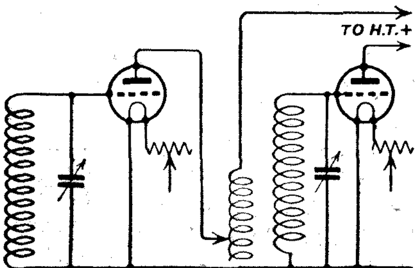


Fig. 5.—A type of coupling similar in effect to that shown in Fig. 4, with tappings on the primary of the H.F. transformer.

loosening the coupling at each stage and by introducing oscillating circuits of fair design and of but moderate resistance at each point in several successive stages, the selectivity of the whole circuit is very greatly increased, without introducing extraordinarily fine tuning or troublesome instability.

Multi-stage Filters

If we have several lightly-coupled circuits of roughly the same resonance characteristics, the degree of selectivity of two stages is something like the square of the degree of selectivity of the one, and with three stages (other things being equal), it approaches the cube, always provided that chance direct back-coupling is avoided. So even with mediocre oscillating circuits the selectivity of three stages of " filtering " will far transcend that

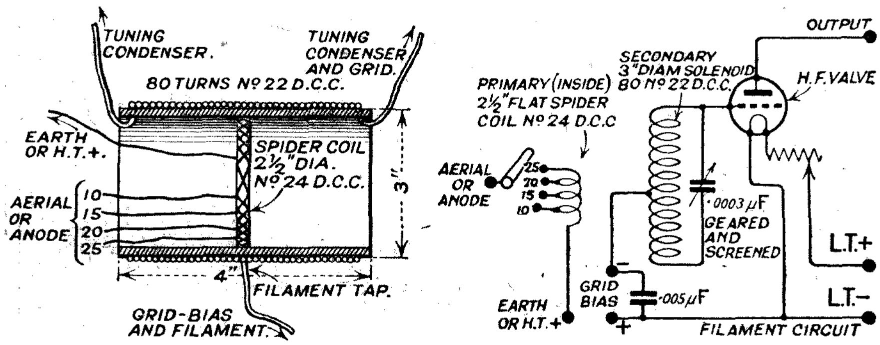


Fig. 6.—The circuit and the arrangement of aerial and grid coils described by the author.

of one first-class circuit, whilst at the same time there will not be the excessively narrow resonance peak which spells audio distortion as well as hair's-breadth tuning.

Selectivity and Stability

Fortunately, that very loosening of the coupling and complete elimination of all avoidable back-coupling

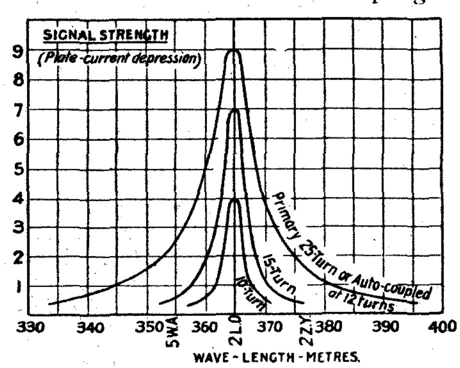


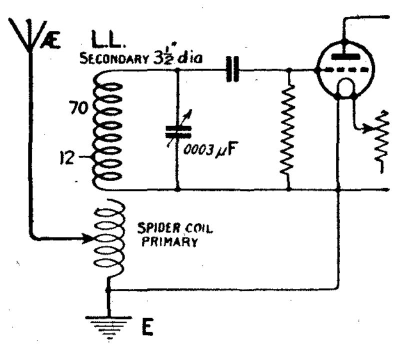
Fig. 7.—Resonance curves for various numbers of turns in the primary inductance, plotted on 2LO's transmission.

required for *selectivity* will at the same time make for *stability*. It might be questioned whether it is really necessary to use valves at all for coupling such a multiple filter-circuit, since amplification is not its purpose; practical experiment again shows that the actual degree of coupling necessary in a conventional type of tuned filter-circuit (Fig. 1) (such as has long been in use in commercial wireless telegraphy receiving circuits), for the short waves at least and for broadcast telephony, does not permit of attaining the required degree of selectivity with two low-loss circuits in series.

Loose H.F. Couplings

The present writer has described (*Wireless Weekly*, Vol. 3, No. 11; Vol. 6, No. 14) extremely selective circuits in which the light inter-valve coupling is obtained by an auto-transformer device, with an " anode tap " on what is, in each case, practically a tuned anode. By lowering this tapping point towards the " earth " end of the tuned anode inductance, whether this be connected to H.T. plus or actually to the filament circuit, the coupling is proportionately lightened, and, incidentally, the natural stability of the circuit is increased.

The latter fact is utilised effectively in one form of commercial



H.F. coupling device after this plan. It is easier in some cases, however, to get the requisite light coupling by the use of an independent tapped primary anode inductance, with a light magnetic coupling to the following secondary grid coil; in other words, with a loose-coupled H.F. transformer of special design.

Capacity Couplings

The importance of casual *direct* capacity coupling has been emphasised by several writers. Since such casual electrostatic effects are roughly aperiodic, they will be operative (within the frequency-belt considered) with almost undiminished intensity throughout the tuning-range of the receiver, rendering the tuning-out of the local interference impossible at any point. The effective elimination of an important part of this casual coupling is facilitated by the device suggested in an article in *Wireless Weekly*, Vol. 6, No. 19, by making the small tapped primary of each coupling transformer in the form of a flat spider coil (or small thin basket) wound on a slotted disc of cardboard and inserted inside a secondary inductance wound as a single-layer solenoid of a substantial gauge of wire on a dry cardboard or skeleton low-loss former. By making a "filament-tap" in the length of the latter inductance, and placing the primary directly under this point, the casual capacity coupling is reduced to a very small degree indeed, as only the outer edge of the flat primary coil is presented to secondary turns themselves very nearly at earth potential.

Ease of Control

A kind of "Hartley" type of circuit results, and the particular suggestion made here is to repeat this light magnetic coupling between a small symmetrically placed primary and fairly low-loss Hartley-type secondary (without the usual anode connection of transmitting circuits) at *each* of two or three stages, using only some type of direct reaction on the last of the series, and utilising the inherent stability of such lightly-coupled circuits to prevent self-oscillation at preceding stages. No neutrodyning expedients are then needed, and the circuit becomes fairly easy to handle in spite of the several necessary tuning-points.

Filter-Unit

A filter-unit can therefore be made up, consisting of a coupler with a tapped spider primary inserted within a solenoid secondary of moderately good design. The latter provides the grid-tuning inductance of the succeeding valve, the anode of which is connected to the following filter-unit or rectifying unit. The only essential difference between the filter and rectifier unit is that the latter must be equipped with grid-condenser and grid-leak, and some reaction device. A grid-bias cell is suggested for reducing grid-damping in the coupling valve.

The aerial-coupling unit is identical with the subsequent filter stages, the primary being connected to aerial and earth in place of to preceding anode and H.T. plus respectively. With identical inductances and light coupling the tuning of each such unit will be substantially the same. On practical trial it was found that two filter stages could be readily handled by a double tuning condenser with isolated rotors; the first and last (or detector) stages are better controlled separately.

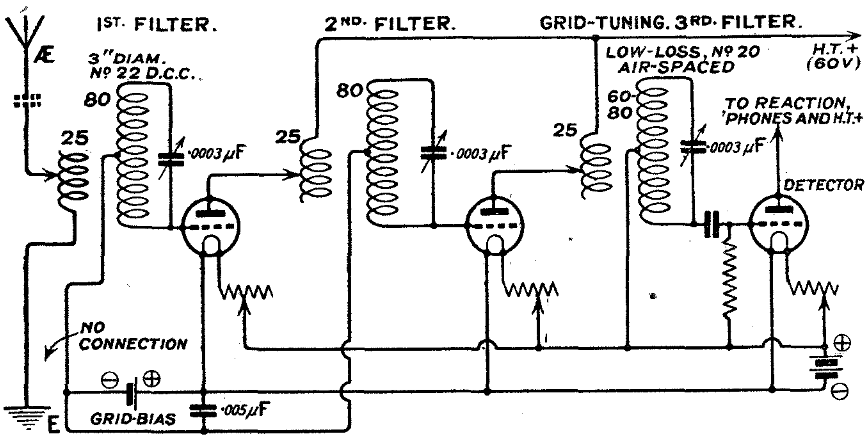


Fig. 8.—The circuit diagram of the complete receiver, recommended as a result of the experiments described.

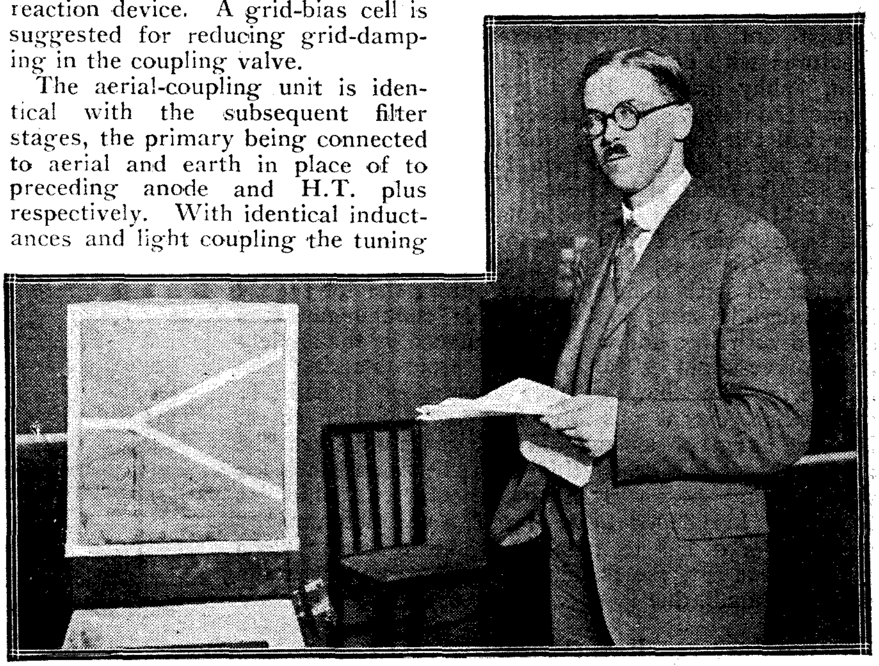
Short Waves

On very short waves, where the natural frequency of the aerial is approached, a low primary tapping or even a series detuning condenser in the aerial may be needed. In the tests made with the circuit on a large high aerial close in to the disturbing stations (2LO and Northolt), the best tapping point appeared to be at about 15 turns in each primary when two separate filter-stages were in use, or 20-25 turns with one stage, the best aerial connection depending, of course, on the characteristics of the aerial used, and on the frequency being received.

Practical Trial

No trouble at all was experienced with self-oscillation, provided that the inductances were arranged carefully with minimum magnetic coupling, i.e., at right-angles and well separated; sensitive reaction was then applied on the last (detector) valve alone, a small amount of inherent reaction being inevitably left in the tuned filter stages. An enormous increase in selectivity was immediately noticed on addition of the one stage to the loose-coupled receiver, and a small increase of signal-strength when reaction was very carefully handled. The power-

(*Continued on page* 60.)



Mr. Harris broadcast a talk from the London station on September 18 on the subject of "Broadcasting in America."

For it Again

AND now I see that " a noted physician " has been having a go at you and me and it. By it I mean, of course, wireless. There is nothing really strange about this, for ever since I can remember this fellow and other " noted physicians " have been discovering all kinds of latent and terrible possibilities in the nation's hobbies. When I was a boy, cycling suddenly leaped into popularity. Every member of every family provided himself or was provided with a pair of wheels, and the whole nation took to the roads and the country lanes. Noted physicians, observing that they were enjoying themselves, at once began to examine the true inwardness of cycling.

Doleful Forecasts

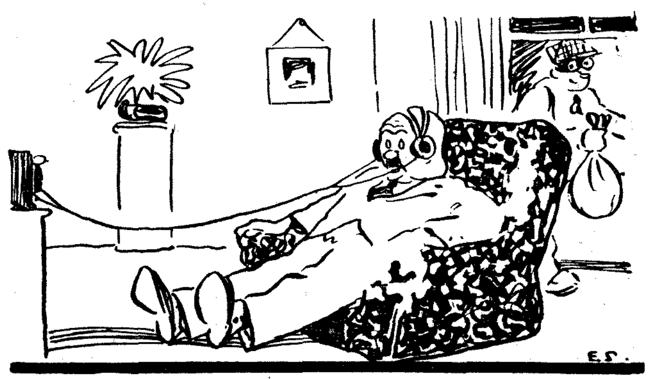
They wrote to the papers all kinds of letters and articles, in which they were unanimous in foretelling that in twenty years' time (as they were writing in 1895 that would make it 1915) the nation would consist entirely of round-shouldered, bandy-legged creatures with enormous bulging calves, flat feet and thin, flabby arms. But there was something even worse than this. They stated that they had already observed the bicycle face, which was produced by the cyclist being forced to give his whole attention to the road in front of his nose. The bicycle face, which they told us would become a national attribute within the same period of time, was by no means a thing of beauty. The eyes, bulging a good deal, were turned downwards with a fixed glassy stare; the lower jaw hung slightly ajar, and the whole countenance was covered with lines and wrinkles produced by the anxiety and nerve-strain which resulted from steering the bicycle. The bicycle face somehow failed to materialise, except possibly in a few sporadic cases, but the noted physicians did not cease to warn the nation that other dread things might be in store for them if they persisted in their hobbies. Amongst these were lopsidedness due to golf, a complete atrophy of the legs owing to indulgence in motoring, the gramophone ear, the dancing splay-foot, and even the dealer's thumb, due to over indulgence in bridge.

Poor Wireless

Other noted physicians have discovered that devotion to wireless produces perfect health, complete wreckage of the human system, deafness, over-acute hearing, insomnia, sleepy sickness, dulness, brilliancy, moral rectitude and criminal tendencies. Their methods remind me a little of my friend Poddleby's racing system. Poddleby has only one flutter during the year, on the Derby. As he simply cannot stand failing to back the winner he makes sure of success by putting a shilling on every horse in the race. The latest noted physician, however, has struck up a new line all to himself. It appears that the number of articles left behind by people in trains, 'buses and trams is steadily increasing. A few years ago it was, as you will recall, customary to leave your umbrella in the rack when you stepped out of the train. There was nothing extraordinary about this; everybody did it. But the modern traveller rises to far greater heights of forgetfulness.

Absentmindedness

It appears that often he will step from the carriage *minus* all sorts of queer things. Wooden legs, wigs, babies, tiger cubs, wads of bank notes, and so on are now commonly found by train searchers. You might think that the fellow who removed his boots in order to ease his feet and placed them in the rack would attract attention as he walked across the platform in his socks. But he apparently passes unnoticed amongst the crowd that streams from the train, almost every one of whom has made his little contribution to the lost property office. Stand upon the platform of any great station and watch them pass. That fat man in his shirt sleeves is a stockbroker who has mislaid his coat; behind him comes a stout lady trailing a mackintosh by one sleeve and fondly imagining that she is holding little Willie's hand; the man who is

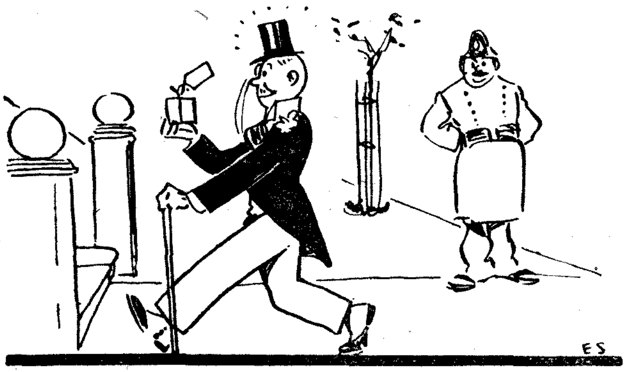


. . . ***Oblivious of his surroundings*** . . .

making unintelligible noises to a porter has left his teeth upon the carriage seat; and so on and so on. What is the reason of it all? Why does the golfer abandon his clubs, the fisherman his rod, the sweep his brushes, the circus owner his elephant? Simply because wireless has caught these unfortunate people in its dread grip.

So Simple

Our noted physician tumbled to the cause at once. When he was interviewed he did not hum and ha or play for time whilst he sought an explanation. Not he. He merely gave an airy wave of the hand and said that such a state of affairs was a sign of the times. To him it was as clear as mud that the widespread use of wireless has a devastating effect upon the activity of the brain. Is it not obvious that any man who sits for hours on end with the headphones clamped to his ears and his eyes fixed upon the condenser scales must become utterly oblivious of time and space and his surroundings? After a few evenings passed in this way the brain becomes numbed, the association-centres paralysed, and the memory blurred. In three months' time, such is the anti-pelmanising effect of wireless, the victim finds it utterly impossible to travel anywhere by any kind of conveyance without leaving behind him a trail of derelict garments, parcels and personal possessions. There are, of course, stronger natures, like my own, which rise superior to this kind of thing, and can even profit not a little from the absentmindedness which devotion to wireless produces in others. Not long ago I was invited to a wedding, and was just about, with the utmost regret, to decline the invitation, since I remembered that my wardrobe contained no suitable wedding garments.



. . . *Provided with a full wedding outfit* . . .

It's an Ill Wind . . .

However, a sudden inspiration came to me, and I journeyed to the place at which my friend the bridegroom was to receive his life sentence by a circuitous route which involved several changes. Picking my company with care during the journey, I led the conversation in each compartment in which I sat to the subject of wireless. This worked like a charm. The very first passenger to alight left behind a beautiful glossy topper, which fitted me to perfection. By the time that I reached my destination I was provided with a full wedding outfit of morning coat, pale grey trousers, patent leather boots, the correct tie, faultless gloves, a gold-mounted cane, an eyeglass, and even a gardenia for my buttonhole. I had also a charming little present for the bride in the shape of a pair of silver curling tongs. This just shows what a little initiative can do.

Professor Goop's View

Thinking that as a noted physician had been interviewed Professor Goop should have a similar chance, I repaired forthwith to " The Microfarads " to ask his opinion upon the subject of wireless and forgetfulness. When I was ushered into his study I found the Professor running distractedly round in circles looking for a valve which he was quite sure he had laid upon the desk a moment before, though now he simply could not find it anywhere. Noticing at length that I was there, he advanced with his usual geniality to greet me. As he extended his right hand in order to grip mine a valve fell from it with a tinkling crash upon the floor. " Ah, there it is ! " he said, " or rather there it was. I knew it could not be far away. Anyhow it does not matter, for at the moment I forget for what purpose I required it." I led him to a chair, and, having got him to sit down, proceeded with the task of interviewing him. " My dear Professor," I said, " some famous doctor—all doctors are famous when they get into print—has discovered that devotion to wireless produces forgetfulness and absentmindedness. I feel sure that readers of *Wireless Weekly* would like to hear what you have to say upon the subject." " Absolute nonsense," said the Professor, " utter drivel, complete tosh. Why, my dear fellow, wireless has exactly the reverse effect upon everyone who takes it up.

The Proof of the Pudding

" Take my own case, for example. Before I specialised in wireless I never could for the life of me remember just how many whatsitsnames there were in a thingemejig. Now I can tell you without a moment's hesitation that there are 644 . . . . or, let me see, is it 1,728? I used to be rather absentminded, which led me unwittingly into little eccentricities in my dress. Now I think I may say that, entirely owing to my wooing of Mistress Radio, as the poets would say, my attire would be described by lady novelists as immaculate." He paused to straighten his tie, a process which he would have found easier had there been a tie to straighten. " But to turn for one moment from the subject which you have set me," he continued, " I am a little worried this morning about my health. For some reason that I do not understand my gait appears to be uneven. I have noticed ever since I got up that as I walk I am coming down heavily with the left foot and very lightly with the right." I pointed out as tactfully as I could that one was apt to be a little lopsided if one wore a hob-nailed boot on one foot and a carpet slipper on the other. " Thank you, thank you," said the Professor. " How foolish of me. Excuse me for one moment whilst I rectify matters." He left the room and returned presently wearing a golosh over the boot. " Some men," he said, " would have gone to the trouble either of taking off one boot or of putting on another. Such people are not blessed with the mental keenness engendered by wireless. As you see I have saved myself all the trouble by the simple expedient of donning a golosh, which now makes both my footfalls equally soft."

The Professor's Dictum

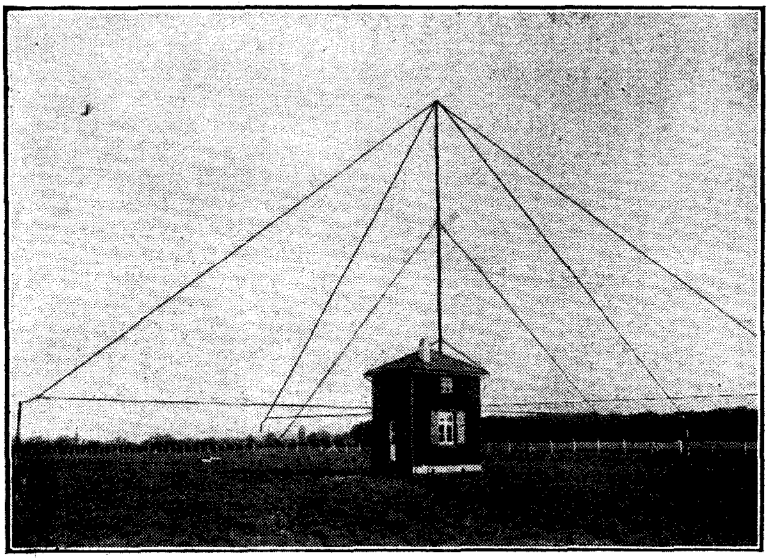
" Wayfarer, sit down at once, and contradict on my authority this latest and basest charge levelled against wireless. I do not wish to hide behind any pseudonym such as ' a famous scientist ' or ' a well-known inventor.' No, you may tell the world that Professor Goop states emphatically that wireless does not produce forgetfulness or absentmindedness. You will forgive me—will you not?—if I leave you now and run away back to my own house, for I have important work to do." And, seizing my hat and stick, he left his study and ran.

WIRELESS WAYFARER

DO WIRELESS WAVES ROTATE?

By J. H. REYNER, B.Sc. (Hons.), A.C.G.I., D.I.C., Staff Editor.

In this concluding article of his series on modern problems of wave transmission Mr. Reyner discusses some of the peculiar phenomena noticed in long-distance communication, and shows how modern theories may be applied to explain them.



The peculiar "night errors" obtained at direction finding stations are probably due to a rotation of the wireless wave on its reflection at the Heaviside layer.

A COMPARATIVELY short time ago the problems of wireless transmission over long distances were reaching a point where it might have been thought that some finality was being achieved. Experience shows that although with waves of the order of 300 to 3,000 metres (999.4 to 99.94 kc.) certain peculiar freakish effects could be obtained, wavelengths of the order of 10,000 to 20,000 metres (29.98 to 14.99 kc.) were very much more well behaved, if one may use the term, and with such comparatively low frequencies a reasonable degree of consistency could be obtained.

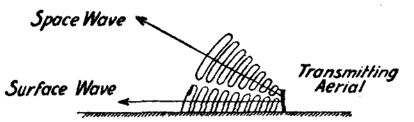


Fig. 1.—Illustrating the production of space waves and surface waves.

The use of short waves, however, has caused us to revise our ideas on the subject very considerably, owing to the very long ranges which can be accomplished at such frequencies with a ridiculously small power.

Space Waves

Let us consider some of the effects which are obtained with very short waves. We have seen that in the case of the long-distance communication, there are two waves arriving at the receiving point. One of these is the surface wave, and travels along the surface of the earth, the other being the space wave, which travels through space to the electrified layer, where it is caused to bend round and return to earth.

Now the shorter the wavelength of the vibration, the more rapidly is the surface wave attenuated, and in the case of the very short waves this surface wave is almost negligible at a very short distance from the transmitter. Thus, in this case, practically the whole of the transmission is effected by the space wave. Fig. 1 illustrates the production of the two types of wave at a transmitting aerial, and shows that the space waves are propagated in a direction inclined to the horizontal and will thus travel upwards in their flight until they reach the electrified layer, when they will be returned to earth in the manner which we have previously described.

In short-wave work, therefore, we are dealing almost entirely with these free space waves, which, having nothing to do with the earth, are subject to somewhat more peculiar effects.

Polarised Waves

One of the peculiar effects which is noted with these space waves is that the plane of polarisation of the wave is altered at its reflection at the Heaviside layer. To understand this very interesting effect, it is desirable to consider some of the phenomena of polarisation of light. We have seen that an electromagnetic wave consists of a series of bands of electric fields alternately in one direction and then in the other, and we have also seen that these bands travel outwards at right angles to themselves. This is illustrated in Fig. 2, which is reproduced from my previous article.

Now it will be obvious that there is an infinite number of directions in which the vertical fields may lie, and still be at right angles to the direction of propagation of the wave. For instance, referring to Fig. 3, the electric fields may be parallel to the line A B, or to the line C D, which is at right angles to A B, or in any intermediate position. The electric fields will still be at right angles to the direction of propagation, which is X Y, so that there are, as we have just stated, a variety of possible directions for the electric fields.

Light Waves

Now the light emitted by any source is a vibration of the ether just as a wireless wave is, and is of the same type as the wave motion we have just considered. Moreover, in the case of light, the ordinary light we receive from any source is composed of vibrations in all directions out of the infinite number possible. That is to say, some vibrations will be as A B in Fig. 3, some as C D, and others in one of the multitudinous intermediate positions.

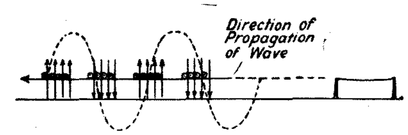


Fig. 2.—A wireless wave consists of a series of electric fields, first in one direction and then in the other, travelling in a direction at right angles to the fields.

In certain circumstances, it is possible to eliminate all the vibrations except those which happen to be in a definite plane. For example, if the light is passed through a tourmaline crystal it is found that the light received on the other side of the crystal is composed of vibrations all in the same plane. That is to say, only vibrations of the type A B, or C D in Fig. 3, but not both, would pass through the crystal. Such light is said to be *polarised.*

Wireless Waves Polarised

The ordinary wireless wave is polarised when it leaves the transmitter. That is to say, the electric fields which are produced by the currents in the transmitting aerial, normally all lie in the same plane, usually the vertical plane. Thus, the normal wireless wave is of the type shown as A B in Fig. 3. Consequently, if an aerial is to respond to a wireless wave of this type, the aerial wire itself must be arranged vertically upwards. If the wire were placed horizontally, with no vertical

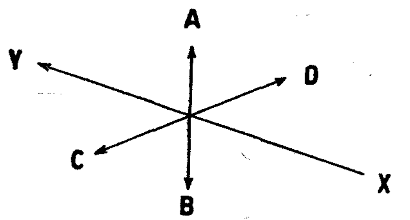


Fig. 3.—The electric fields in a wireless wave may be in any direction at right angles to XY.

portion at all, the response to the wave passing over it would be practically nil.

Rotation of Plane of Polarisation

There are various methods in optics for determining whether a light wave is polarised or not. I may perhaps at some future time describe one or two simple experiments which can be carried out with ordinary light which illustrate the phenomena of polarisation and which will help the student to obtain some idea of the phenomenon of wave motion in general. For the present, however, it will suffice to remark that if a ray of light is passed through a tourmaline crystal, and emerges the other side polarised, that is to say, with all the vibrations in one plane only, then it is possible by certain devices to discover the exact direction of this plane of polarisation.

Further, it is found that by passing this polarised ray of light through certain quartz crystals or other suitable substances, the plane of polarisation is rotated. That is to say, that if the wave was initially vibrating in the plane A B, in Fig. 4, then, after passing through the quartz crystal, it would be vibrating in another plane. Consequently, if we had some device which was arranged to respond at a maxi-

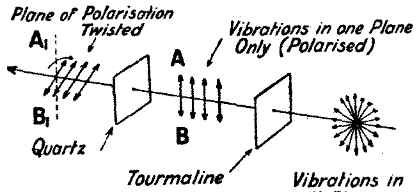


Fig. 4.—A quartz crystal will cause a rotation of the plane of polarisation in a light wave.

mum to waves polarised in the plane A B, this device would only respond partially to the waves after they had passed through the quartz crystal, owing to the fact that they were no longer polarised in the same plane.

Rotation at the Heaviside Layer

Now this rotation of the plane of polarisation can be explained mathematically on the wave theory of light. Following this up, it is possible to show mathematically that a similar rotation could be produced in certain circumstances at an electrified layer during reflection from an electrified layer of upper atmosphere in the case of a wireless wave.

A wireless wave is similar in nature to a light wave, the only difference in the two cases being one of the relative dimensions of the waves themselves and the obstructions which they encounter. By making suitable assumptions, therefore, which are justified by our knowledge of the conditions, we can show that it is possible for a wireless wave to be twisted in this manner at this Heaviside layer.

Eckersley's Theory

As far back as 1920, T. L. Eckersley put forward a theory in

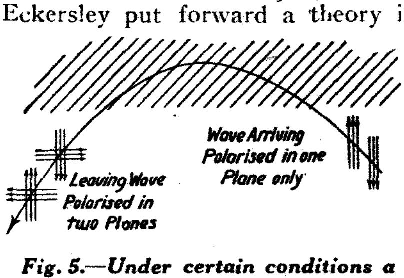


Fig. 5.—Under certain conditions a second wave is produced by reflection at the Heaviside layer.

which he showed that during the reflection from the Heaviside layer two waves were produced. One of these continued in its reflected course, polarised in the same plane as before, and the other one was propagated downwards together with the first wave, but polarised in a plane at right angles to the first. This is illustrated in Fig. 5, which should make my meaning quite clear. The theory was developed to explain the night errors which were obtained in direction finding.

Night Errors

It is well known that at night time the bearing obtained on a frame aerial is very often quite incorrect. A bearing is taken by rotating the frame until the signal strength is zero, when, theoretically, the frame is at right angles to the direction of propagation of the waves. Now it is often found that the directions obtained by this method at night time are hopelessly incorrect, often by as much as 30 degrees or more. Eckersley showed in his paper that this peculiar effect could be explained quite satisfactorily by assuming the existence of this second wave polarised in a plane at right angles to that of the ordinary wave.

It will be observed, of course, that this theory necessitates reflection from an electrified layer of atmo-

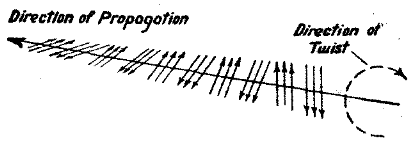


Fig. 6.—Due to the earth's magnetic field a wireless wave slowly rotates in travelling from point to point.

sphere. The theory was admirably backed up by practical tests, and would seem, therefore, to be further evidence of the existence of a Heaviside layer.

Effects of Reflection

Recently, however, we have obtained still more interesting developments. It seems fairly well established that the reflection of the waves at the Heaviside layer produces waves polarised in different planes from the original wave. This theory has been developed by Appleton to explain the fading of wireless signals which is observed, and as I mentioned last week, the results obtained on his theory agree remarkably well with the results obtained in practice. I also showed last week that Messrs. Nichols and Schelleng have investigated the effect on wireless waves of the earth's magnetic field, showing that certain resonant effects were obtained in the neighbourhood of 1,400 kilocycles, corresponding to a wavelength of 214 metres.

Twisting Waves

They showed further, however, that another interesting effect resulted from the presence of the earth's field, and that was that the plane of polarisation of the wave

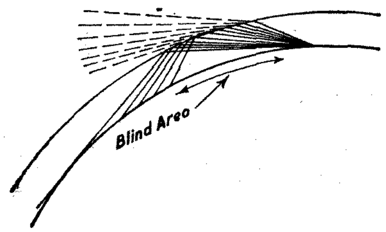


Fig. 7.—In some cases reflection does not occur at the Heaviside layer until after a certain distance, pro ducing blind areas.

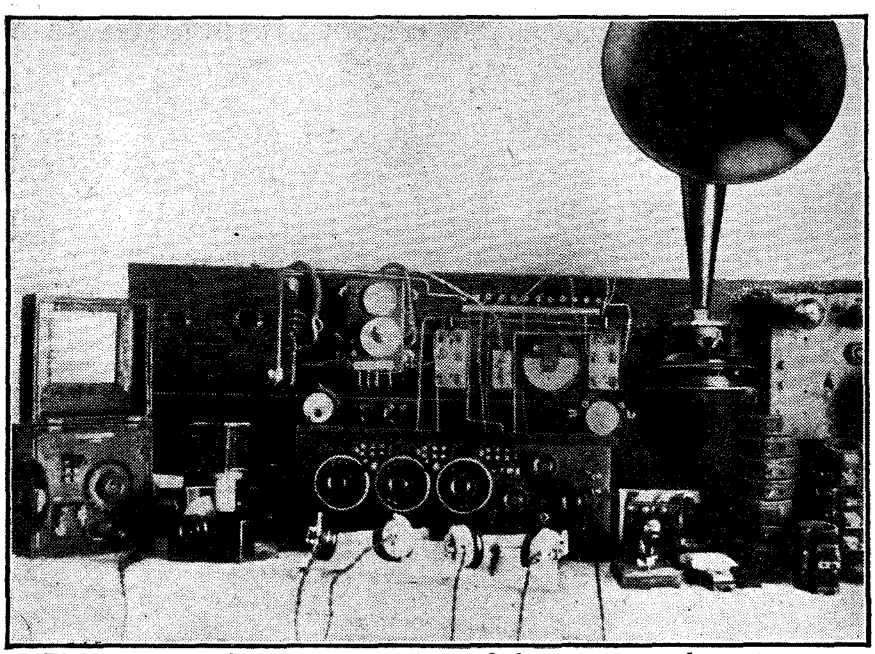
would rotate in its transit from point to point. That is to say, a wave would slowly twist round and round in corkscrew fashion somewhat as indicated in Fig. 6. It will be noticed that the electric fields are always at right angles to the direction of propagation of the wave. This is, of course, essential, because the ether, as we know it, is incapable of transmitting vibrations in any other manner.

Now it can be shown by analogy with the theories of light that the reflection of a wave from a suitable surface depends upon the manner in which the wave is polarised. A wave in which the vibrations are parallel to the reflecting surface is reflected in a different manner from the wave in which the vibrations are at right angles to the reflecting surface. This rotation of the plane of polarisation, therefore, would explain in some measure the great differences which are observed with the very short waves in the range of transmission.

Skip Distances

To consider one of the problems only, that of skip distances, it is well known that with some waves it is impossible to hear the transmission until the range is greater than a certain distance. This means to say that the wave is not reflected from the Heaviside layer until after a certain distance. We can explain this by assuming that at this particular wavelength the twist in the wave is such that it reaches the reflecting layer polarised in such a manner that it is not reflected appreciably. It is easy to show by analogy with light that there are certain critical angles at which the light is not appreciably reflected. In a similar way the wireless wave in this case would not be reflected at the Heaviside layer, but would travel straight through it.

A little further round the surface of the earth, however, the wave would have rotated a little farther, the result being that the plane of polarisation is then different, and at this point the reflections may possibly be appreciable. In particular it is found in the case of light that when these waves are polarised in a plane parallel to the reflected surface, the waves are reflected irrespective of the angle at which they impinge, whereas, if they are polarised in a vertical plane, there are critical angles below which no reflections can take place.



The equipment of an amateur station in India, with which long-distance reception has been achieved.

This point is illustrated in Fig. 7, which indicates how it is possible for a wireless wave to be reflected at certain parts of the upper atmosphere only, the result being that it only reaches the earth in certain patches.

Dead Spots

The intervening distance, therefore, will not receive any reflected ray, nor will it receive a direct ray, as this has been damped out almost immediately after it has been transmitted. A particular instance of this was mentioned to me the other day by an observer who pointed out

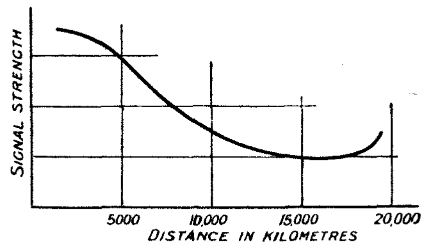


Fig. 8.—At distances of 18,000 kilometres the signal strength from Lyons was found to increase.

that when a British amateur was working New Zealand, he himself, only a few miles away, was quite unable to hear the transmitter.

Transmission to the Antipodes

I intimated last week that in addition to the ordinary theories of reflection at electrified layers, there is another factor which is responsible to some extent for the success of very long distance transmission. A short time ago some experiments were carried out by the French ship *Aldebaran*, in which the signal strength from Lyons and Nantes was measured daily for a considerable period at gradually increasing ranges. It was found that, as one might expect, the signal strength gradually fell off as the distance increased, but that at ranges of 18,000 to 19,000 kilometres, that is to say, very nearly half way round the earth, the falling off in signal strength was by no means as rapid as one might expect, and, moreover, towards the end the signal strength actually began to increase again. Fig. 8 illustrates the kind of curve which was obtained, plotting signal strength against distance from the transmitting station.

These results, therefore, indicate that, in addition to the ordinary attenuation of the wave during its progress round the earth, there is some additional factor entering into the transmission which acts in the opposite direction and tends to counteract the absorption of the wave. Professor Howe, in discussing the results of the *Aldebaran* experiments, put forward a theory to account for this phenomenon, the essence of which, curiously enough, was the same as one which had been previously proposed by Mr. Percy Harris as far back as 1915. The theory will be understood by reference to Fig. 9. If we assume a

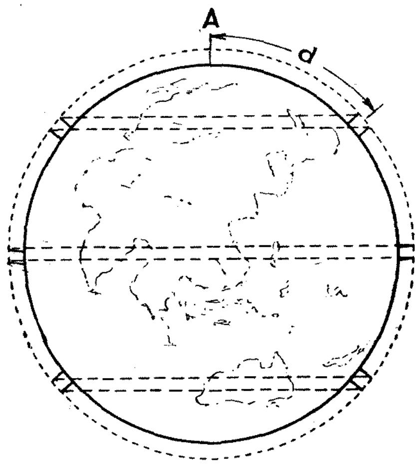


Fig. 9.—Illustrating the increase of signal strength due to the narrowing of the zone of energy near the Antipodes.

certain energy radiating from the transmitting station, this energy must travel outwards in all directions in a series of concentric circles, somewhat like ripples radiating from the disturbance caused by throwing a stone into a pond.

The ripples will, in the main, be confined within the space between the earth's surface and the Heaviside layer. Now neglecting the attenuation of the wave during travel, the energy in any one ripple travelling outwards will remain the same. The actual size of the ripple, however, increases as the distance from the transmitting station increases, and consequently the electric field strength will decrease in inverse proportion to the distance away. This is in accordance with the ordinary laws of the transmission of waves.

Increased Signal Strength

It will be obvious, however, that at a point one-quarter of the distance round the earth the diameter of the ripple will be a maximum, equal to the diameter of the earth. As the ripple continues its progress round the earth it will begin to decrease in size, and the electric field strength will correspondingly increase, until when it reaches the exact opposite point to the transmitting point, the electric field strength will be exactly the same as it was at the transmitting station.

This, of course, is neglecting the effect of any absorption. We have, therefore, to superimpose on this effect the continual absorption of the wave during its progress round the earth, and the actual signal strength will be the sum of the two. From the *Aldebaran* experiment it will be seen that this increase of field strength, due to the gradual narrowing of the zone near the antipodes, is so rapid as to counteract the effect of the absorption, so that an actual increase in signal strength may result.

Conclusions

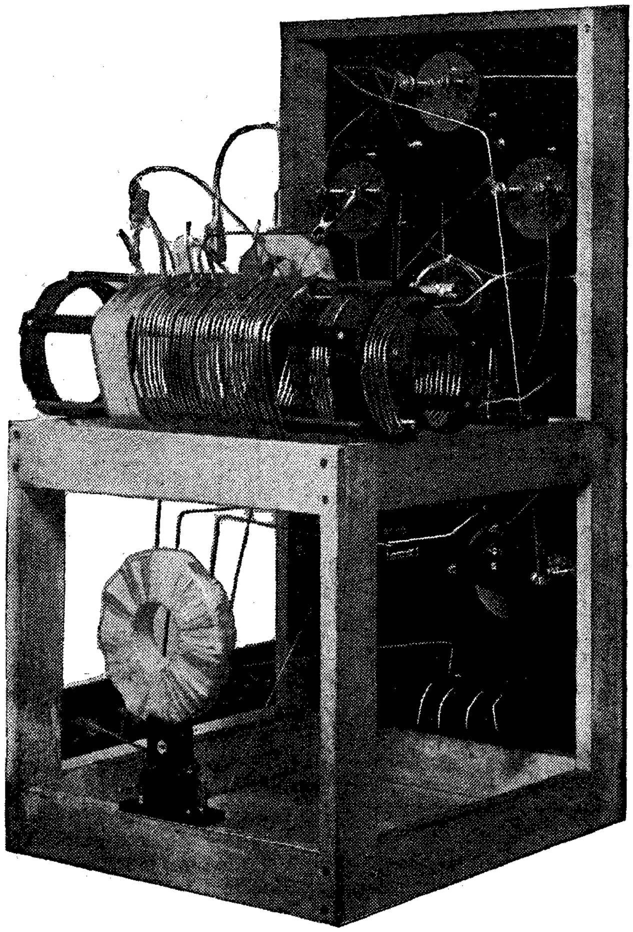
We see, therefore, that there is considerable evidence that the Heaviside layer is responsible for the phenomena of long-distance transmission with all its vagaries. The existence of such a layer is fairly well established from other sources, and the real problem is whether this layer of electrified gas is capable of providing the several effects which are observed in practice. It appears that, with the modifications proposed by Larmor, Appleton and others, all the observed phenomena can be satisfactorily explained, so that the modern tendency is towards re-establishing this theory once again.

By means of a quartz crystal, shown with a high-power transmitting valve for a comparison of the sizes, the frequency of a transmitting station may be accurately controlled.

Loose-Coupling in Transmitting Circuits

By C. P. ALLINSON (6YF).

The importance of steadiness of the emitted wave, especially in low power transmission, is generally recognised, and this article suggests one method of improvement in this direction.



The aerial coil is here shown mounted inside one end of the main inductance coil in order to obtain a loose coupling.

THE amateur transmitter in the United States is now compelled to use loose-coupled aerial systems, partly on account of the interference that may be caused to broadcast listeners by the use of the direct-coupled transmitter, especially where raw A.C. or unsmoothed rectified A.C. is being used as a high-tension supply, but also to help eliminate " key-click," a form of interference that can be heard for quite a great distance, and is very annoying, as it cannot be eliminated by any means in the receiver. In England the use of the loose-coupled circuit is not, of course, compulsory, but it has certain advantages, and in some cases marked advantages, that make it well worth while experimenting with.

Effect of Swinging Aerial

With a close-coupled aerial system, when working on the very short waves, the swinging of aerial, earth, or counterpoise leads may be sufficient to throw the wave-length out quite a considerable extent, thus causing a swinging of the signal at the receiving end. On those wet, blustery nights, when conditions for reception and long-distance transmission seem to be at their best, this trouble will manifest itself most noticeably.

Constant Wavelength

It is not always possible to erect an aerial, and to arrange the down-lead in such a way that the system

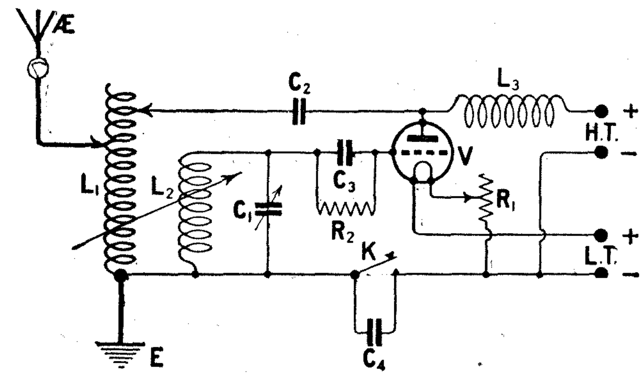


Fig. 1.—A typical direct-coupled transmitting circuit of the reversed feed-back type.

will not swing in a high wind, and it therefore becomes incumbent upon the transmitter to seek some other means if he is going to keep his emitted wave steady; and, apart from the master oscillator system, something can be accomplished in this direction by loose-coupling the aerial to the oscillating system.

Harmonics

In some cases it may even be found necessary to work with extreme loose-coupling, which is, of course, a disadvantage, as this results in less energy being transferred to the aerial. It is, however, much easier

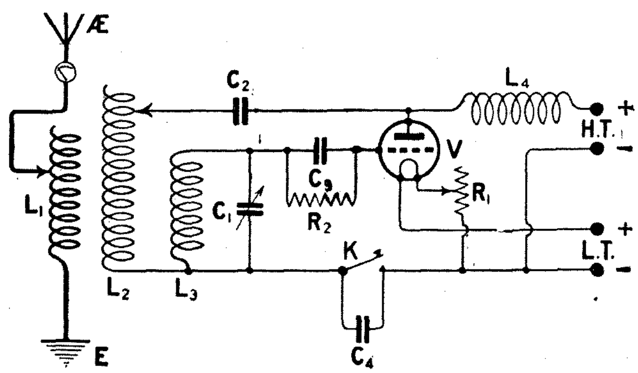


Fig. 2.—The circuit of Fig. 1, with the provision of loose instead of direct aerial coupling.

to read and copy weak and steady signals than to attempt to follow the vagaries of strong but swinging signals. Another advantage with the loose-coupled circuit is that it is less likely to radiate harmonics than the close-coupled transmitter, in which case, of course, it means that practically the whole of the energy transferred to the aerial is being radiated on the particular wavelength on which you are working. It might here be mentioned that a point which is often confused by the amateur is the fact that aerial current and aerial radiation have often little bearing on each other. It is possible to have a high aerial current, a small percentage of

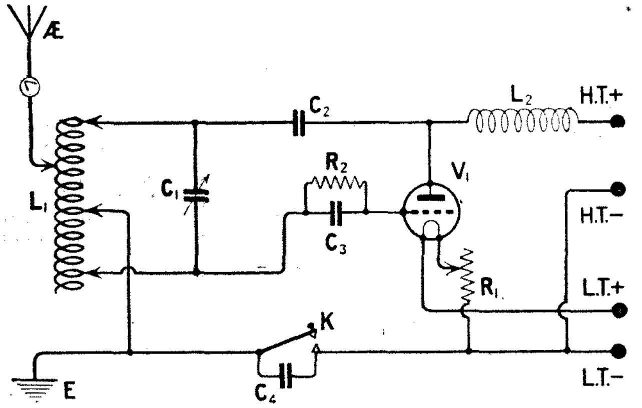


Fig. 3.—A form of Hartley circuit employing direct coupling.

whose energy only is actually being radiated. It may often be found, in fact, that an adjustment which gives a smaller aerial current will result in signals being received at a greater distance, and that an adjustment that gives a higher aerial current will result in signals only being received at a very short distance.

A Direct-Coupled Circuit

Fig. 1 shows a typical direct-coupled transmitting circuit of the reversed feed-back type. The wavelength transmitted is governed by the amount of inductance

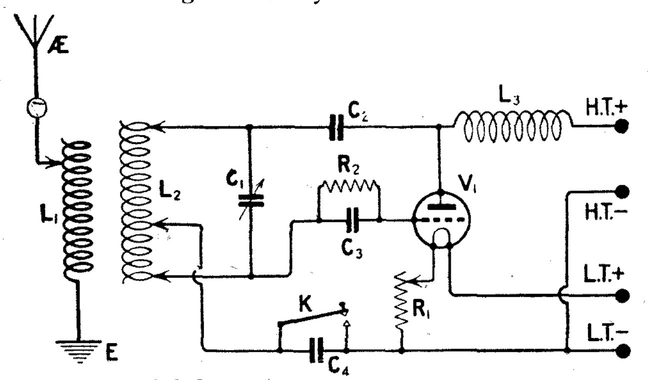


Fig. 4.—With loose coupling the adjustment of the Fig. 3 circuit is greatly simplified.

included between the aerial tap and earth. The adjustment of the anode tap and the grid circuit, however, have a decided effect on the aerial current and will need readjusting with every change of wavelength made. It will be seen, therefore, that any alteration of the capacity of the aerial will seriously affect the wavelength, and the swinging of the aerial or the swinging of the lead may be sufficient to cause such a change in capacity, with a resulting variation in wavelength.

An Improvement

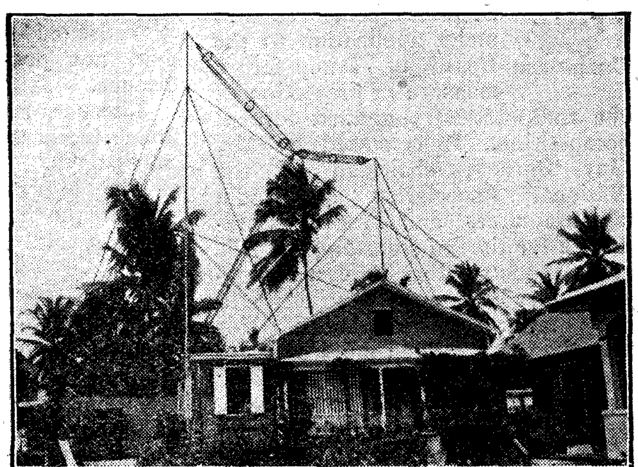
Fig. 2 shows a similar circuit, only using a loose-coupled system. In this case the frequency of the transmitter is controlled mainly by the closed circuit L3C1, the anode tap as before giving reaction control. When the aerial and this circuit are in tune we shall get, of course, the largest aerial current, and it will now take a much larger alteration in the capacity of the aerial to affect the emitted wavelength to any appreciable extent. In fact, if the coupling used is very loose, it may not influence it at all.

An Alternative Circuit

A direct-coupled transmitter is shown in Fig. 3, and in this, as before, the frequency of the emitted wave is governed by the amount of the inductance between the aerial and earth taps, the positions of the plate and grid taps and the setting of the variable condenser C1 being adjusted to give the maximum aerial current. The loose-coupled circuit shown in Fig. 4 is preferable from several points of view. Not only does the question of a swinging wave become less serious, but also the adjustment of the circuit becomes much simpler. In each of these circuits the position of the filament tap is fairly important if the maximum output is to be obtained, and it will be seen that in Fig. 3 the alteration of this tap would also alter the wavelength being emitted. In Fig. 4, however, we have a simple oscillatory circuit L2C1, which is coupled to the aerial circuit. The frequency of the emitted wave is governed by the circuit L2C1, and the aerial tap and coupling between L1 and L2 are adjusted to give the maximum aerial current. It will be found that if the coupling between L1 and L2 is too close, as the condenser C1 is turned, two resonant points may be shown by the aerial ammeter. This is due to the mutual inductance between the two coils. The coupling should therefore be loosened until only one resonant spot is found, but should not be loosened beyond this point unless the wave is reported to be swinging badly.

Conclusions

In concluding, I would therefore recommend to the amateur who suffers from a swinging wave to experiment with loose-coupling in his transmitter. Not only will it help him to cure this trouble, but it will also give him a more sharply defined wave, which, in the experience of many long-distance amateurs, has been found to carry better and to be read more easily at great distances. It will also help to eliminate key-click and that annoying "quacking" which occurs in some cases.



The aerial system employed by an amateur transmitter at San Juan in Porto Rico.

Wireless News in Brief.

Wireless in Northern Canada. During the 2,000 miles' trip to the Far North of Canada, recently completed by Lord Byng of Vimy, the Governor-General of Canada, the party was in constant touch with the South by means of wireless. The North-West territories wireless system is operated by the Royal Canadian Corps of Signallers. It appears that broadcast reception in the Far North is very popular, especially during the autumn and winter. The long daylight hours of summer make broadcast reception almost impossible. Wireless telegraphy with the Governor-General's party was but little affected except in certain places, such as between high river banks, where reception faded or died away entirely, to re-appear when the boat emerged from between the high banks.

* * *

Foreign Trade Competition. Steps are being taken to make application to the Board of Trade for a measure of protection of the radio industry against foreign competition. It is stated by Mr. Guy Burney, chairman of the National Association of Radio Manufacturers' and Traders' Committee for the safeguarding of the radio industry, that foreign competition has been most destructive in the matter of headphones. Not less than two million pairs of these were sent into our market last year at prices approximately 50 per cent. below the price at which we can afford to market them in this country. Last year it became evident, he continued, that the Germans, Austrians and French meant to capture our market, and what they have already done in headphones they can just as readily do in loud-speakers and all other component parts that go to make up a wireless set.

* * *

Arrangements have been made for broadcasting a special tango band from the Savoy Hotel. This will in no way interfere with the usual relays of the Savoy Orpheans or the Selma Four.

On October 5 Miss Daisy Kennedy will provide the special feature at the London station, when she will broadcast a violin recital prior to her departure on an American concert tour.

* * *

Wireless Licences. The latest figures show that the number of wireless licences issued up to the end of last month was 1,423,000. During August 86,000 were issued—44,000 to people who had not previously taken out a licence.

Listeners on the wireless in Germany increased in July and August to 852,537.

The biggest increase—13,000—was in the Berlin area, thus bringing the total of Berlin listeners to 366,558.

* * *

The Telefunken Gesellschaft has secured the order for the construction of the new broadcasting station in Vienna, in competition against American and British tenders. The Vienna station is to be two-and-a-half times as powerful as the station just erected in Berlin.

Wireless Contracts with China. We understand that pressure by the United States on China to fulfil the terms of her agreement with the American Federal Wireless Company, and counter-pressure by Japan on the ground that the conditions of the contract of the Federal Wireless Company conflict with the terms of the Mitsui wireless agreement, have recently resulted in an effort on the part of the Chinese Government to compromise with the conflicting parties.

* * *

This year some 200 villages in the province of Moscow have been provided with reading rooms and wireless equipment, and in the city of Moscow itself there are 350 radio clubs with 15,000 members. There is also a fortnightly radio magazine, the *Radio Amateur*, issued in Moscow, and this has already achieved a large circulation.

* * *

Progress Abroad. Jamaica and Bermuda may now be added to the list of high-power wireless telegraph stations, and another distant colony (Rhodesia) is making active preparations for the extension of wireless communications. Salisbury will, under this scheme, soon be linked up with Pretoria, and as the preparations for beam reception and transmission are already well advanced in South Africa a new interest will be added to life in Rhodesia, which will then be practically in direct communication with Great Britain. The subsequent problem of efficient relaying from the main receiving station should not be difficult to solve.

AN ABSORPTION WAVEMETER

Some notes describing how a simple form of resonance indicator can be used for checking the wavelength of either a receiver or transmitter.

A wavemeter of the type described can be very simply made up, the only parts required being shown here, changes in the wavelength range to be covered being effected by the use of different sizes of coils.

THE novice in wireless work may regard the construction of a wavemeter as a rather difficult or costly proceeding, that will also involve further outlay in getting it calibrated. There is, however, a simple form of wavemeter that can be used not only for reception work, but also for transmission. It consists of two components only, and can be put together in very little time. As will be seen from the photograph it consists simply of a coil or inductance and a variable condenser. The question, of course, that promptly arises is, how can such a circuit without any buzzer, crystal and 'phones, or indicator of any kind be used as a wavemeter? The answer is very simple, and can best be given by a description of the procedure to take in calibrating the instrument.

Method of Calibrating

Tune your receiver to your nearest broadcast station, of which you know the wavelength, bring the coil of the wavemeter (which may be a plug-in coil, or a home-made one fitted, as shown in the figure) close to your tuning coil, and turn the dial of the wavemeter condenser. You will probably find that, if the wavemeter is placed close to your receiver, the signal strength of the station you are receiving will go down over quite a large angle of the tuning condenser. Note the two readings where the weakening of signals begins and ends. Now remove the wavemeter a few inches from the set, and repeat the proceedings, till a certain distance from the set is found at which the wavemeter will cause the signal strength to drop only on one setting. This is the calibration point on your wavemeter for this wavelength.

Utilising Distant Signals

On distant signals where reaction or high-frequency amplification is being used, the same procedure can be employed, but a better reading can be obtained in the following manner. If the set is just on the oscillation point, it will be found that with comparatively loose coupling a reading can be found on the condenser, where the set will come right away from this oscillation point, and therefore the resonance point of the wavemeter will be much more marked than on the local station. You can thus obtain a reading from all the stations you can receive and of which you know the wavelength, and draw a wavelength-capacity curve. It is then a simple matter when receiving an unknown station to bring up the wavemeter, determine the reading on the condenser that brings about a diminution in signal strength, and read off the wavelength from the chart. By procuring a number of different sized coils it is possible to cover any wavelength.

As a Transmitting Wavemeter

For use with a transmitter the procedure should be modified as follows:—Set the transmitter oscillating, and place the wavemeter about two feet or eighteen inches away from it, having connected a suitable coil to it, of course, with regard to the wavelength on which you wish to transmit. Now with the aerial ammeter in circuit, slowly rotate the dial of the wavemeter condenser till the aerial current is seen to drop a trifle. If this does not occur bring the wavemeter a little nearer to the transmitter and repeat the process. Eventually a position will be found where one setting, and one only, on the wavemeter condenser will cause a slight drop in aerial current. Your wavemeter chart will then tell you what wavelength you are actually working on.

G. L. H.

WIRELESS I
MANO

By Major JAMES ROBI
Director of Resear

This special article will enable our
into wireless methods in the Serv
information regarding

A portable wireless transmitting and receiving set in use under conditions similar to those prevailing on active service.

THE season of the Army Manœuvres is the great time for the two Services — the Army and the Royal Air Force. It is the time when the training for the whole year is put to a severe test; all schemes and instruments which have been designed in the course of the year are put under the most rigorous conditions—the equivalent of actual war conditions. By such a rigorous test various schemes can be approved or condemned, and, as regards instruments, weak points are then further brought out which do not appear in the ordinary course of the year's work.

Importance of Wireless

Wireless in the Army Manœuvres now takes a very large part, because the secret of efficiency in the Services depends upon good Communications. It is essential for the Commander-in-Chief to be instantly in touch with all units of his Command, and this is only possible if the Communications are in excellent order. As the years go by, wireless is taking a more and more important part in the Communications of our Forces.

As regards the Army, during the last war they relied on a variety of means for Communications, such as land-lines, visual signalling, etc. Wireless was also used to a considerable extent. Land-line communication between various units was subject to interruption by shell fire, and parties were detailed for no other purpose than to keep the land-lines in repair.

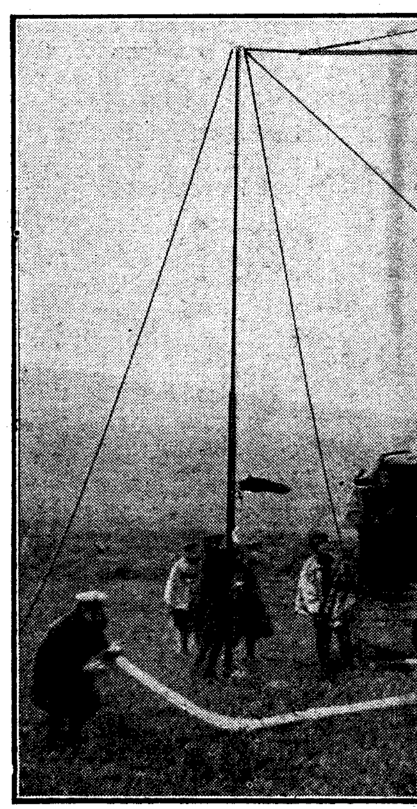
Wireless is replacing land-lines to a considerable extent, although land-line communication in the present manœuvres still exists. This latter form of communication between Battalions and Brigade, and between Brigades and Division, etc., is in the control of the Army Corps of Signallers.

Mobility

Modern armies employ aeroplanes and tanks to a very large extent. With such mobile bodies it is obvious that the chief form of Communication must be wireless, although other forms of signalling are still made use of. Although these mobile units have their special functions to perform, they cannot act in all respects as independent units, and they must communicate with the more stationary units, and, further, they must communicate with each other. The Royal Air Force acts as the eyes of the Army, and it communicates directly with all units of the Army—infantry, artillery, cavalry and tanks.

Organisation

The magnitude of the organisation required is obtained from a perusal of the large list of lines of communication which are required. The Commander-in-Chief must have direct communication with his armies; these in turn must have direct communication with their corps and divisions, and divisions with brigades, who must be in touch with the battalions. The Royal Air Force must provide information for the Army, and this falls under various headings. For each respective duty the various squadrons, and sometimes various



Erecting the masts and laying out th

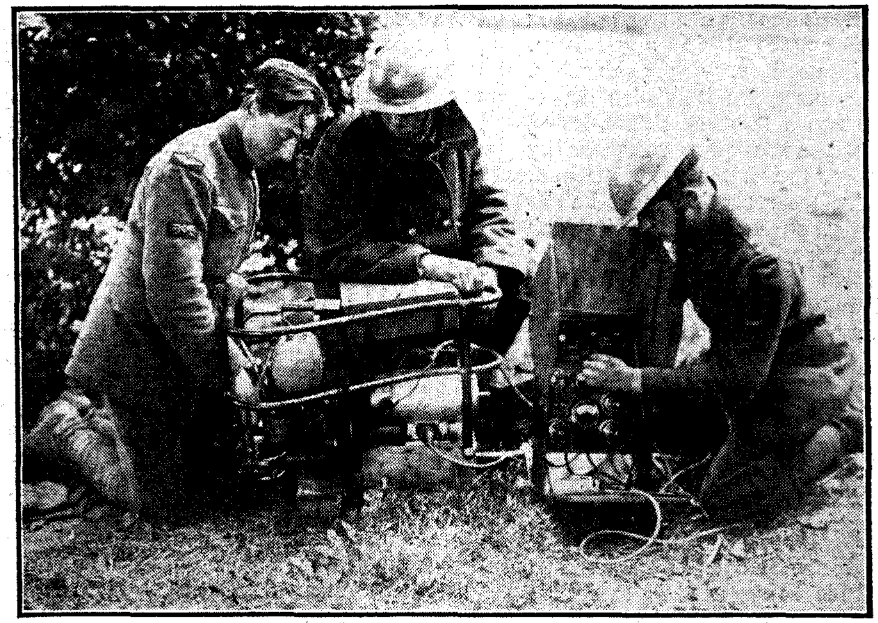
N THE ARMY UVRES

ON, D.Sc., Ph.D., F.Inst. P., to Radio Press, Ltd.

lers to gain a most interesting insight . Dr. Robinson gives much exclusive actual frequencies in use.

flights, must have different lines of communication, *i.e.,* frequencies. Then, again, there is cross communication from the aircraft to the infantry, from the aircraft to the tanks, and from aircraft to artillery. Again, there is inter-communication inside the Royal Air Force. There is communication between squadron headquarters and the aeroplanes, and also there is communication inside the squadrons during flight. All these forms of communication are equivalent to different lines of communication. A huge organisation is therefore called for in order that each line of

earth mats for a mobile wireless station.



The generator and switchboard of one of the wireless sets used by personnel of the Royal Air Force.

communication shall be kept in perfect order. The efficiency of the Army as a whole depends vitally on the reliability of all these lines of communication; such a vast organisation is put to a very severe test in the Army Manœuvres. Different lines of communication are obtained by using different frequencies, and it is obvious that a very large number of frequencies is required in operations on the scope of the present manœuvres.

"Frequency" Replacing "Wavelength"?

It is interesting to note that our Services are tending towards the use of frequencies in place of wavelengths. In such a large organisation the convenience of using frequencies is very great.

Such a large number of frequencies is in demand that there is considerable crowding. The frequencies in use vary from about 4,000 kc. to about 100 kc., and in some regions of this frequency band there is such crowding that the frequencies are only 2½ kc. apart. It is obvious that there must be a very great accuracy in adjustment of frequency to guarantee that these lines of communication will be reliable, and it is no easy matter to keep transmitters accurate within the limits given. This difference of 2½ kc. makes it somewhat difficult to separate neighbouring transmissions by the heterodyne method of reception, even when both are accurate. A small deviation from the frequency of a number of stations may easily produce chaos.

Accuracy

In order to guarantee accuracy of adjustment of frequencies, the Air Ministry is sending out standard transmissions on different frequencies at different times of the day, and thus the various units can guarantee to have their wavemeters identical.

In the neighbourhod of 3,000 kc. (100 metres) the transmissions differ by about 200 kc. In the neighbourhood of 750 kc. (400 metres) the transmissions differ by no more than 7 kc. From about 270 kc. (1,100 metres) to about 140 kc. (2,200 metres) the lines of communication are so crowded that at times they are as close together as 2½ kc. This is the band of frequencies which includes Daventry, which is on 187.4 kc. (1,600 metres), and we can thus understand the desire of the Services to curtail the activities of Daventry during the course of the manœuvres.

Apparatus Employed

Some details of the actual functions of wireless and the actual apparatus employed in the Manœuvres will be of interest. There are so many lines of communication required that it is necessary to use transmission of a form which absorbs as small a frequency band as possible. Thus spark transmission is not employed in any form. C.W. is used very considerably, and in some cases it is also necessary to use a form of transmission which will not require reception by means of the heterodyne method, and therefore reception must be obtained with apparatus which requires very little adjustment. The ideal form of transmission for this would naturally be spark, but as this creates so much jamming, tonic train or interrupted continuous wave is used instead. Naturally telephony requires some reference, as considerable use is being made of wireless telephony in the present manœuvres. Some reference is also required to direction finding, which is of immense importance in any war operations. One case in which it is being used is to enable aeroplanes to note their position definitely, and more particularly to enable them to find their way back home after their operations are completed.

As regards the Royal Air Force activities, these come under various headings.

Reconnaissance

It is necessary to find out immediately what the enemy is doing at some considerable distance behind the lines, say up to 100 miles. Reconnaissance aeroplanes fly to such distances, and any information of importance can be sent immediately to the base by means of wireless. For this purpose telegraphy is used, such aircraft usually carrying a wireless operator. Amongst the restrictions of aircraft are naturally the weight and space available, and the number of *personnel* that can be carried is very limited. A wireless operator on this type of aircraft has, in addition, other functions to perform; in fact, the general duties of an observer.

Apparatus on Aircraft

The apparatus carried on reconnaissance aircraft consists of a C.W. transmitter, consisting of two A valves in parallel. This transmitter is very much on the same form as that used in the War, which was called the type 57. Wavelengths from 1,000 to 2,500 metres may be employed. A trailing aerial is used, this aerial being let out by the operator by means of a suitable winch, usually to a length of 200 ft. Power for the transmitter is obtained from a generator which is driven by means of a windmill. The generator is sometimes placed on the wing of the aeroplane and sometimes placed at the side of the fuselage. In the latter case it can be rotated on a vertical axis, so that the windmills get full on to the wind or sideways, in the latter case, of course, no voltage being possible. Any position between these two extremes can be obtained, and this naturally regulates the voltage obtained on the aeroplane. A fairly straightforward form of receiver is employed, using one high-frequency valve with reaction and two low-frequency amplifiers, the first valve also acting as detector.

Generally speaking, it is important to keep down the weight of apparatus carried on the aeroplane to a minimum. It is thus of the utmost importance to keep down the filament consumption of the valves, and thus low consumption valves are used.

Ground Station

A receiving station for working with the reconnaissance aeroplane is usually with the squadron. This station employs a transmitter of about half a kilowatt. The transmitter is very similar to one of the first valve transmitters ever used, which was called the type 56B transmitter. It employs a 250-watt valve, with an anode voltage of 2,000. Reception is carried out by a form of receiver very similar to the aeroplane type, except that more selectivity is introduced. The whole of this ground station is mobile, and this is installed in a lorry. Light masts are used, the earthing being provided by means of earth mats.

Communication with Infantry and Tanks

For this purpose telephony is used, and the telephony set has many points of interest. In the first place, it makes use of no trailing aerial. This is necessary because for communicating with the infantry, aircraft very often fly low and trailing aerials would tend to be pulled off. The use of a fixed aerial on an aeroplane naturally restricts the wavelength which can be efficiently used, and thus the present telephony wavelengths are in the neighbourhood of 60 to 100 metres. The aerial may be of two forms. In some cases it is actually fixed inside the wing of the aeroplane. The position usually chosen for this is the trailing edge of either the upper or lower wing. In this case, however, a counterpoise is used of a similar type. For instance, the wire on the trailing edge of the aeroplane may be the aerial, and that on the lower wing may be the counterpoise. Sometimes, however, better results can be obtained by the use of the metal work of the aeroplane as a counterpoise, and the type of aerial which is being used very considerably in the present manœuvres is stretched from the wing tips to the tail of the aeroplane. In this case, usually

An R.A.F. portable wireless station used for receiving signals from aeroplanes for the control of artillery.

the body of the machine is used as a counterpoise or earth. Considerable work is being done on fixed aerials on aircraft by the Royal Air Force, and they have obtained remarkable results with this form of aerial.

A transmitter is used which consists of a control valve and two power valves, the whole consumption of power being less than 100 watts. The wavelength of the transmitter is variable on the range already indicated. The power for the transmitter is obtained in the former case from a wind-driven generator placed in the wing. A special form of receiver is employed on the aeroplane, which employs a number of valves, using up-to-date principles. Again, low consumption valves must be used in order to minimise weight of batteries.

Telephony

The problem of telephony on aircraft is not simple, the conditions being very much more rigorous than in the case of the British Broadcasting Co.'s transmitting stations. Space is restricted, there is a tremendous noise ever present, and, in addition, there is the noise produced from the magnetos of the engine, this magneto noise being really equivalent to that obtained from a number of spark transmitters a few feet from the receiver. The wavelength of the disturbance from the magneto is of the order of 5 to 30 metres, and thus it is not very different from that actually employed for communication purposes on this type of aircraft. The Royal Air Force has tackled this very serious problem of magneto interference and has obtained great success in its elimination.

Microphones

The microphone must receive special attention, for if this is left open or put in the wrong place the general noise of the aeroplane will actually be transmitted to the receiver on the ground or to another aeroplane. Thus it is necessary to guarantee that the rush of wind is kept away from the microphone, as well as the general engine noises.

Engine Noises

As regards reception, it is absolutely necessary to shut out all noises in order to hear signals which are coming through. An excellent form of helmet is used, which can enable all such noises to be eliminated. For telephony purposes it is usually not possible to carry a wireless operator, and very often communication is required on single-seater aeroplanes. It is thus necessary to arrange for the pilot to perform the transmission and reception. This, again, introduces difficulties, such as training the pilot to speak properly, and designing the apparatus in such a form that it can be operated by a person with little or no knowledge of wireless. Another feature is that it is necessary to place the transmitter and receiver out of the reach of the pilot, for he has many other instruments to deal with in addition to the wireless instrument, and there is very little space in his cockpit.

Remote Control

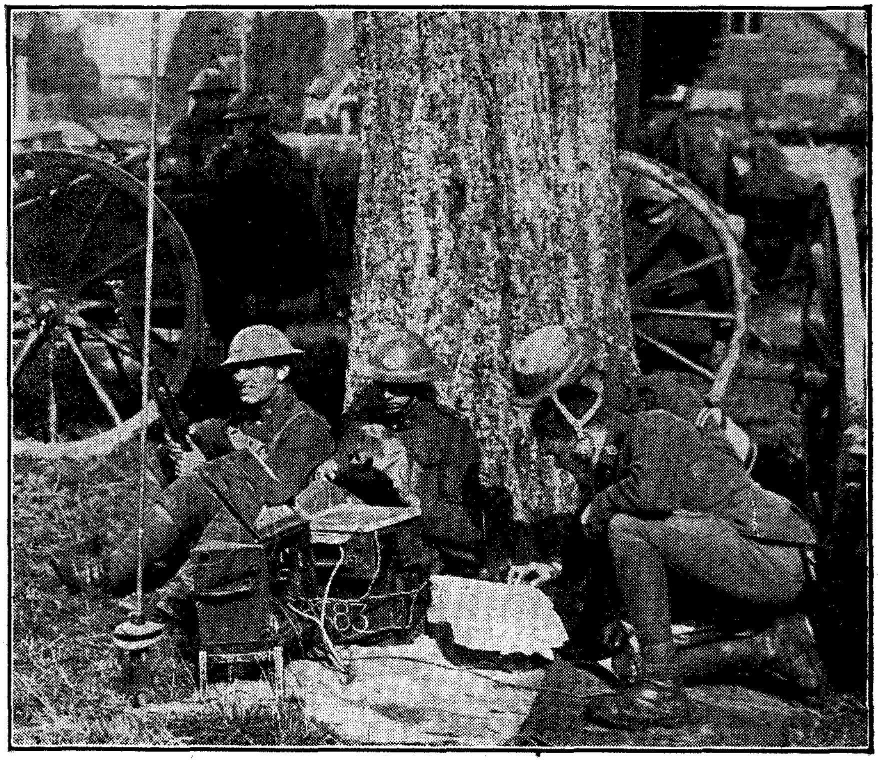
A form of remote control is employed which gives great satisfaction. This control gives similar results to the Bowden wire control, but is actually different from the Bowden wire principle.

Close Reconnaissance

In addition to the lines of communication with infantry and tanks, telephony is used on aircraft for close reconnaissance work, and communication is kept up by telephony with the base. The base station is usually mobile, and contains similar apparatus to that on the aeroplanes, but in this case being installed on a tender. This form of communication is being found to be of great use, for it enables the General Staff to obtain very early information of enemy activities at comparatively close distances up to 10 and 20 miles. In this case some member of the General Staff can actually be in telephonic communication with the aeroplane which is flying over the enemy's lines.

Intercommunication between Aeroplanes

Telephony is also used for this purpose. The Squadron Commander is able to give orders to all his pilots, and can thus easily control his whole squadron. A demonstration of this form of squadron control was given at the last Aerial Display at Hendon, when a squadron of the Royal Air Force was put through a number of evolutions by wireless telephony controls.



A typical Army portable station which can be very speedily erected and dismantled

Developments

The good results being obtained with telephony in the Army and the Royal Air Force is a result of a number of years' training and development. Telephony over fairly long ranges from air to ground and vice versa, and between aeroplanes has been done for a number of years, but it is one thing to give demonstrations on one or two aeroplanes and quite another to have efficient operation with large numbers of aeroplanes.

(To be concluded.)

CONSTRUCTIONAL NOTES

Some items of general interest to the home constructor will be found on this page.

Shortening a Honeycomb Coil

IT sometimes happens that a honeycomb coil of standard size is a little too large to suit a particular circuit. On one of my sets, for example, with the tuning condensers in use a No. 75 coil is just too large to allow the closed circuits to be tuned down to 300 metres, whilst at the other end of the scale it will tune to a good deal beyond the ordinary broadcast wavelengths. As it is rather a nuisance to have to change inductances when one is trying round for various stations the simplest method is to reduce the 75 coil by a few turns.

The first thing to do is to separate the coil from its plug-and-socket mounting, taking care not to damage the connection of the end of the wire to the plug. Should the coil be wrapped with Empire tape this must be removed carefully. Now unwind two or three turns from the end of the wire which will be found attached to the socket. Cut off, bare the end, and make a temporary attachment to the socket by means of the screw which secures it to the ebonite block of the mounting. Test the coil on the set to see what effect the reduction has upon the maximum and minimum wavelengths obtainable. Proceed in this way, unwinding a few turns at a time and testing after each operation, until the required range is reached. Then solder the "out" end of the windings to the socket and refix the coil securely to its mounting, replacing the Empire tape binding if this is used.

If necessary the wires can be secured temporarily whilst tests are being made by means of a small piece of sticking plaster. R. W. H.

An Effective Aerial Insulator

The glass tubes sold as towel rails can be used as very efficient aerial insulators. They are very light and quite suitable for a single wire aerial, provided they are properly attached.

If they are just tied in, as shown in Fig. 1, they will be subjected to an uneven strain and are likely to be broken.

The best way to fit them is as follows: Prepare the ends of the

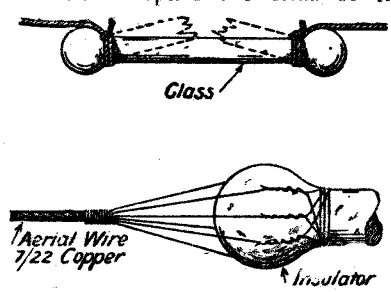


Fig. 1. The method of securing the wire to the insulator shown in the lower diagram will prevent breakage.

7/22 aerial wire by putting a seizing on it about 8 in. from the end, then unstrand the wire down to the seizing and remove the central core wire. The six outer wires should then be fanned out and fastened, one at a time, around the neck of the insulator, as in Fig. 1 (top), taking care to make them all the same length.

The knot securing the halliard to the other end of the insulator should be made as in Fig. 1 (bottom). The loops should be made by eye-splicing or by knots. The head of the insulator is placed through the hole A and the three loops drawn tight so as to space the tails evenly. If

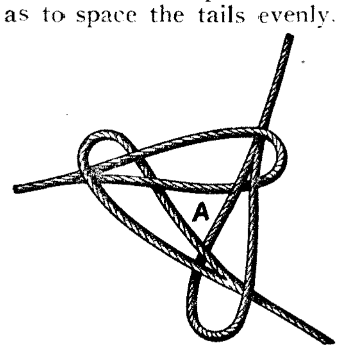
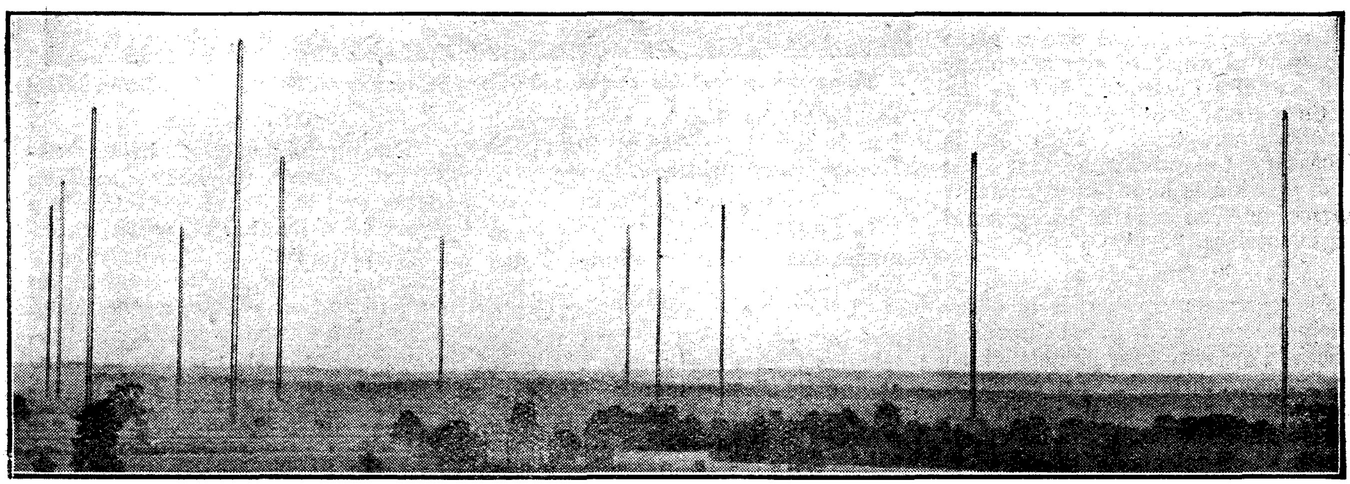


Fig. 2. Showing how the loops for securing the insulators are formed.

these are made of thick string, they should be knotted together and made fast to the halliard.

Care should be taken in erecting, as these glass tubes are very brittle, but they will take a great strain if they are attached in this manner. As they are about 18 in. long their electrostatic capacity is small, and this is further reduced by their hollowness. (The towel rails referred to can be obtained quite cheaply from Woolworth's Stores.)

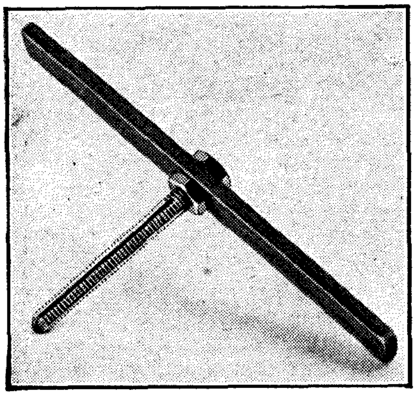
H. W. P.



The twelve aerial masts of the Government wireless station at Hillmorton, near Rugby, are each 800 feet high.

A HOME-MADE TAP FOR EBONITE

Taps for thread-cutting in ebonite are an almost essential part of the constructor's tool-kit, and taps for this purpose of any required size can be made with the aid of a small file only, as described in this article.



The tap described in the accompanying article may be mounted in a strip of brass as shown.

THERE are, no doubt, many amateurs who do not possess a tap among their kit of tools. In some cases it may be a question of expense that stops amateurs from purchasing these, or, in other cases, there may be so little use for them that it does not seem worth while getting one. A very satisfactory tap, however, for cutting threads in ebonite can easily be made from a piece of screwed brass rod or studding; and that shown in the illustration was from this material. The 2 BA and 4 BA sizes can be made without much difficulty, but if one is to be made out of 6 BA a certain amount of skill is required.

Holding the Rod

The procedure to be adopted in making the tap shown is as follows. A short length of screwed rod of the required gauge is fixed in such a manner that it is firmly held. This may be done either in a vice, in which case jaw-guards should be used so as not to damage the thread, or on the edge of the bench, by clamping a piece of wood on top of it. A small slotting file or some other small sharp-edged file is then used to cut a slot lengthwise in the threaded rod.

Filing the Slots

The one edge of this slot, which is the cutting edge, should be along the radius of the rod, while the other is filed away to give the necessary clearance, as shown in the sketch. Three slots are cut in this manner, spaced equally round the circumference of the rod, and care should be taken that the slots are large enough and deep enough to accommodate the ebonite dust resulting from the cutting action.

Spacing of Slots

Care should be exercised in cutting these slots, otherwise they may be unequally spaced, which spoils the appearance of the tool (although without actually affecting its efficiency to any material extent), but chiefly so that the cutting edge be correctly set, otherwise it may be found that the tap will not cut easily, and requires a certain amount of force to use.

Cleaning Up

Having completed the cutting of the slots, a nut may be run round to remove any burrs that may have been left on the edges of the thread by the file.

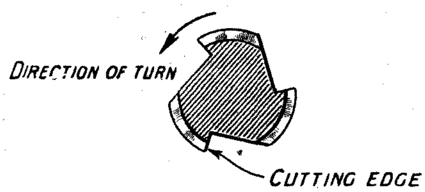


Fig. 1.—Careful setting of the angle of the cutting edges will ensure an efficient tool.

It should be noted that when cutting the slot with the point of the threaded rod towards you, the right-hand edge of the slot will be the cutting edge, the left-hand one being filed down to give the clearance. If this point is not observed the tap will not, of course, cut.

The Holder

The next step is to make the holder for the tap, and this may easily be made from a piece of flat brass strip. A suitable size for this brass strip is $\frac{3}{8}$ in. wide by $\frac{1}{8}$ in. thick and 4 ins. in length. A hole is drilled in the centre which will just clear the size of rod being used, which is next cut to the required length. It is then fixed into the holder by means of two lock nuts on each side of the strip of brass. These nuts are tightened up as far as possible, and may be locked in position either by putting a number of centre-punch marks in the angle formed between them and the screwed rod, or by running solder around so as to set the nuts solid.

C. P. A.

A Cheap Transmitting Milliammeter

THE question of meters is a serious one for the amateur transmitter with a limited purse, and, though second-hand aerial meters of the hot wire type can be picked up cheaply enough at certain disposals shops, a plate milliammeter reading up to 100 milliamps or so is not so easily or cheaply obtained.

A Good Substitute

An excellent substitute is, however, to be found in one of the cheap low-resistance voltmeters that are now everywhere on the market. An instrument of this description reading up to 10 volts may be obtained for five or six shillings, and has only a resistance of about 200 ohms, a negligible resistance when placed in the plate circuit of a transmitting valve being supplied with 200 volts and upwards.

Calibration

A meter purchased by the writer was found to register 10 volts in this position when about 100 milliamps was being passed, and it was calibrated against a milliammeter which was known to be fairly accurate. A calibration curve was plotted, and from this another scale was made and pasted over the volts scale of the meter. Accurate reading could not be obtained below about 8 milliamps, but a very fair idea of the plate current being passed was obtainable. Being of the flush-mounting type, its appearance is quite neat, while its small cost recommends it to the amateur who does not mind obtaining readings that are not accurate within a few per cent.

P. A. G.

EXTENDING THE BROADCAST RANGE

(*Continued from page 40.*)

Capacity Ratio of Condenser

The condenser used in preparing this table had a maximum capacity of 500 $\mu\mu$F, and we cannot count on a minimum lower than about 25 $\mu\mu$F, because of the wiring, etc. Furthermore, it is not well to use the condenser at the very low dial settings, as it is very inefficient at these points. The resistance of a condenser increases to very high values at the low dial settings.

The capacity ratio was, therefore, 500/25 or 20 to 1. It is very interesting to note that, although we require a capacity ratio of 9 to 1 to cover the 600-200-metre range, and although we have condensers having capacity ratios of 20 to 1, still many have not been able to cover the range completely. It is quite a mystery to the writer why this has been so difficult. He has constructed many radio receivers, and has not had any difficulty at all in covering the total broadcasting range.

But to deal with the range of 600-150 metres we should have to keep things in the same proportion. So, if we could cover the range 600-200 with a 20 to 1 condenser, requiring only a 9 to 1 ratio, then to cover a range 600-150, requiring a capacity ratio of 16 to 1, which is about twice the 9 to 1 ratio, we should have to have a capacity ratio of about twice 20 to 1, or 40 to 1. This high capacity ratio is not obtainable in the small-sized condenser. A 0.001 μF condenser may fill the bill, however, for this can be counted on to have a capacity ratio of at least 40 to 1. Thus, a condenser having a maximum of 1,000 $\mu\mu$F and a minimum of 25 will have a capacity ratio of 1,000/25 or 40 to 1.

Another Difficulty

There will be difficulties involved here, however, which will make it necessary to go to other means of extending the range. The main difficulty lies in the great congestion of stations which will be found on the lower half of the condenser dial. Besides this, it will be difficult to tune the set sharply, as everyone knows who has tried to tune with large condensers.

We come to the end of our journey, therefore, with the tentative conclusion that the difficulty is perhaps most satisfactorily overcome by the use of tapped coils in the tuned circuits. Of course, it is not entirely necessary to use three ranges. Two ranges will be satisfactory for most purposes; but the advantage of spreading out the stations as much as practicable is, of course, the elimination of crowding.

Much ingenuity will have to be exercised in keeping down the number of switches and controls. But difficulties such as this will be overcome, for there is scarcely anything for which a suitable switch cannot be designed.

THE INTERFERENCE PROBLEM

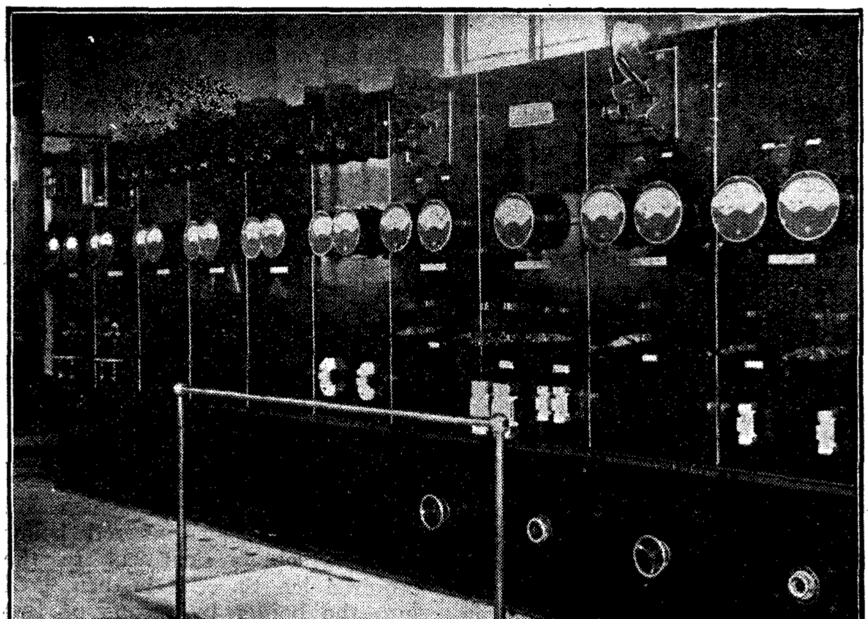
(*Continued from page 43.*)

ful local station was cut out almost completely all over the scale, and the intense belts of arc mush which normally make DX reception practically impossible here for long periods every day were reduced to a moderately noisy background only.

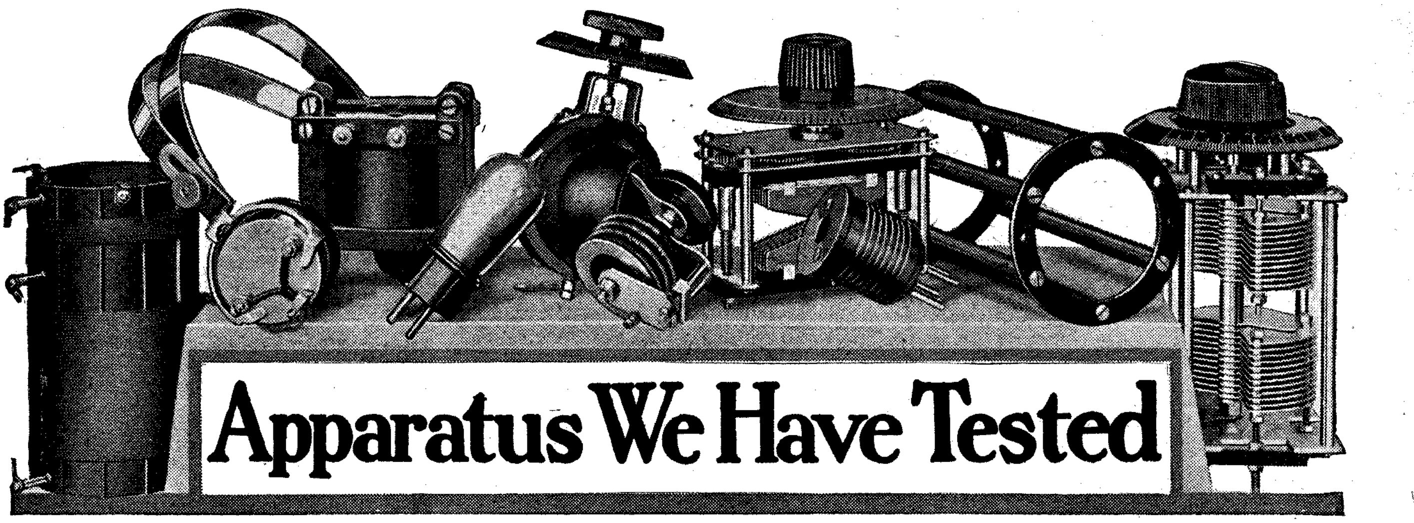
By loosening still further the coupling by tapping at the 15th or 10th primary turn, London was cut out by one filter stage on Manchester and Cardiff. With two separate filter-stages the local station had to be searched for; mush had almost vanished, and both Manchester and Cardiff could be obtained at any loud-speaker strength required completely free from London, but subject, of course, to the usual mush-to-signal-ratio rule, and to parasitic L.F. interferences.

Signal strength diminished perceptibly with two filter-stages in use, but not prohibitively; it could be readily compensated for by silent L.F. amplification, and was more than made up for by freedom from the arc mush. Provided that sensitive and uniform reaction control was available, the tuning was quite simple once calibrations had been obtained by means of a wavemeter for each tuning-point. With the addition of two stages of transformer-coupled power L.F. amplification, a receiver was obtained on which it was not difficult to go the round of a number of distant stations without using headphones at all, and that within a few miles of powerful interfering stations.

It is possible that at very short distances from a broadcasting station special care will have to be taken to avoid direct pick-up by the filter-unit inductances themselves. This effect was not noticeable at 12 miles.



The switchboard in the power-house at the Post Office Wireless Station at Northolt, which deals with general Continental traffic.



Conducted by A. D. COWPER, M.Sc., Staff Editor.

"660" Valve

An interesting valve which is fitted with a thorium-coated molybdenum filament, in place of the usual thoriated tungsten, has been submitted by Messrs. The Electron Co., Ltd. This is of the 2-volt D.E. class, the rating being given (in the usual vague and rather unhelpful manner) by the makers as 1.5 to 2 volts filament voltage and 30 to 100 volts for H.T. requirements. Structurally the valve follows conventional lines, with a nearly vertical cylindrical anode of fair size and a somewhat open spiral grid.

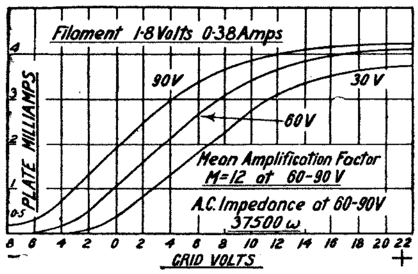


Fig. 1.—Characteristic curves of the "660" valve.

The valve has a cylindrical bulb and is about 3in. high; the base is made of a mottled red insulating material.

On trial, a fair emission of 1.8 milliamperes was registered with high plate potential and positive grid bias when 1.5 volts were applied to the filament; with 1.8 volts this emission increased to 5 milliamperes, and at 1.9 volts on the filament to 7 milliamperes. Accordingly the characteristics were determined with 1.8 volts, at which rating the filament took about .38 amperes. The curves showed a power to handle considerable energy without departing from a straight characteristic, with 90 volts or more of H.T.; a 4-volt swing was permissible on 90 volts, corresponding to a moderate degree of loud-speaking without distortion from overrunning the valve when used as last-stage L.F. amplifier. On practical trial this was found to be the case, and with 120 volts H.T. and 4 volts negative grid-bias quite a deal of power could be handled. The grid-current characteristic showed a very rapid rise about .5 volts positive; with a low value of H.T. and a high grid-leak (4 megohms) excellent detection resulted on weak signals. The very satisfactory mean amplification factor of 12 found was consistent with this; the A.C. impedance was moderate, about 37,500 ohms in the 60-90 volt region. In H.F. amplification the valve operated normally, but oscillated with considerable ease, so precautions had to be insisted on for ensuring stability. The valve in general showed itself to be a useful general-purposes one, with special merit as a detector for critical work.

Silvertown Verniometer

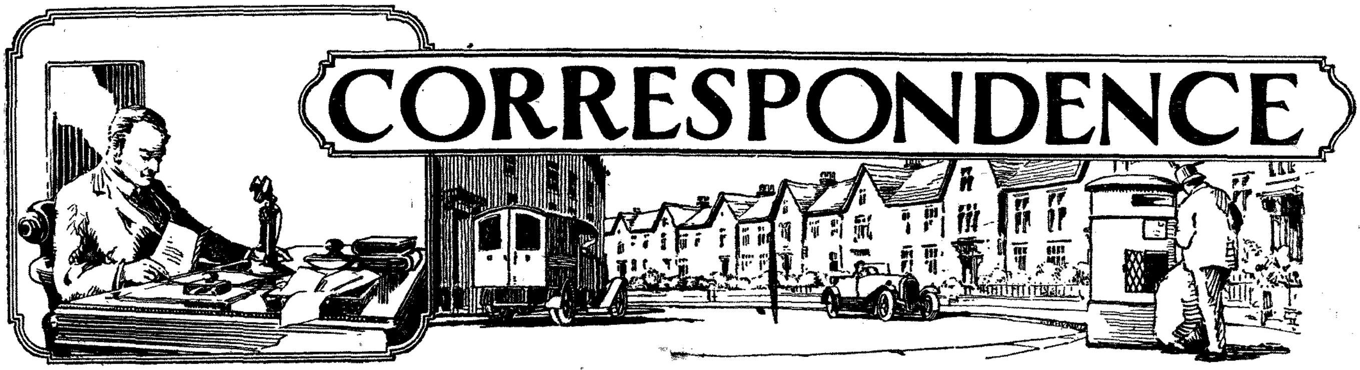
A slow-motion fine adjustment device which can be applied to existing condenser and variometer spindles without elaborate alterations is the "Verniometer," a sample of which has been submitted by Messrs. The Silvertown Co. This consists of what at first appears to be an ordinary bevel scale 3 in. in diameter, which can be affixed on a ¼-in. plain spindle by means of a set-screw. But it is noticed that the base of this scale is a brass plate, around the periphery of which is cut a worm-wheel; with this engages, when required, a fine screw-worm on a tangential spindle 4 in. long, mounted in bearings on a small bracket to be fixed on the panel by two small screws. This spindle has a controlling knob, and has also a circular scale on it for fine settings. An ingenious mechanism enables this fine-adjustment device to be swung out of engagement when doing preliminary rough tuning or searching. On trial, the control was found to be fine enough for any reasonable purpose, and the mechanism operated smoothly. A desirable refinement, which would not be a difficult matter to install, would be the provision of a non-conducting spindle for the fine adjustment or equivalent isolation for hand-capacity effects at some other point; there is a complete metallic connection from the condenser, etc., spindle to the spindle under the small fine-adjustment knob at present.

Hales Aerial Control

Messrs. The Wholesale Wireless Co. have sent in a sample of their "Hales Aerial Control" and "Lead-in Control." The former consists of a strong spiral spring about 5 in. long, fitted with an insulator at each end. This is intended to be introduced between the end of the aerial wire itself and the halliard. Under ordinary conditions it is a difficult matter to maintain an aerial taut, on account of the expansion and contraction of the wire and halliards with temperature and moisture, and of the swaying of the poles in the wind; the result is a certain loss of effective height, and often a periodic fading due to alterations of tuning through the varying aerial capacity resulting. The "Aerial Control" appears to possess the right degree of springiness to counteract this effect, enabling the aerial to be pulled up taut at all times, and providing at the same time a sufficient degree of "give" to allow for these variations in length without unduly straining masts or halliards.

The lead-in control, consisting of a similar spiral of phosphor bronze 2 in. long, is designed to keep the lead-in wire taut. A spring eye is provided to fix on the end of the lead-in fitting and acts as an automatic locking device here; the main spring comes at the end of a bent arm, which supplies, at its lowest point, a drainer for rain water running down the lead and helps to maintain the lead-in insulator dry. These devices should certainly add to the appearance and practical efficiency of an outside aerial system.

(Continued on page 64)



THE THREE-VALVE DUAL RECEIVER

SIR,—I herewith enclose you a small and, I am afraid, a rather poor photograph of my "Three-Valve Dual Receiver" (*Modern Wireless*, April, 1924, by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E.) This set has given great pleasure to myself and many others.

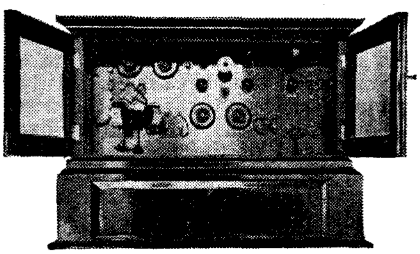
I am able to go round all the main English and as many foreign stations. Simply by tuning with the loud-speaker all stations come through at full loud-speaker strength, and I have yet to find a straight four-valve circuit that can equal it for volume and purity.

I have wired the set with bare square section wire, but the components used are as specified by Mr. Scott-Taggart.

With sincere thanks for publishing such an excellent circuit.—Yours faithfully,

C. A. BIRTWHISTLE.

Weston-super-Mare.



The handsome 3-Valve Dual Receiver built by Mr. Birtwhistle.

THE NINE-VALVE SUPER-HETERODYNE

SIR,—I have constructed the "Nine-Valve Super-heterodyne" set described by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E., in the May issue of *Modern Wireless*, and want to tell you that I am exceedingly satisfied with it. It is certainly the best set I have ever had, although I have already constructed about 30 different sets with a number of valves varying from 2 to 11. I have received the following stations at full loud-speaker strength on a very small frame in a house surrounded by steel concrete buildings, with lots of iron machinery in them:—Berlin, Breslau, Vienna, Zurich, Aberdeen, Toulouse, Rome, Hanover, Dresden. These results were obtained whilst the local station, Nuremberg, about a third of a mile from my house, was working with an output of about 1 kw., without any interference.

Thinking that this statement might be of some interest to you, I wish to remain,—Yours faithfully,

K. NISTER.

Nuremberg.

A TWO-VALVE DOUBLE REACTION RECEIVER

SIR,—Knowing that letters of appreciation are always welcome, I feel that I ought to let you know how satisfied I am with the "Two-Valve Double Reaction Receiver" published in the August issue of *The Wireless Constructor*, by Stanley G. Rattee, M.I.R.E. I built this set recently, not with the components given, but with equally good ones. I have up to date logged the following stations (all at good strength):—Newcastle (very loud), Leeds and Bradford, Bournemouth, 2LO, Cardiff, Aberdeen, Hull, Manchester, Dundee, Glasgow, Edinburgh, Belfast, Liverpool, Frankfort and two other German stations unidentified, Oslo, Radio Toulouse, Radio Paris, Radio St. Sebastian, E.A.J.8 testing. I can get this last station each evening at 11.30 p.m., 300 metres. WGY testing on September 8, 11.45 p.m. Daventry comes in on loud-speaker quite well. I have a Louden 6-volt F.E.R.1 dull emitter and a B.T.H. B4 power valve as the second. I have had all stations several times excepting WGY once only, Oslo twice, Belfast once, Liverpool once. I have a "Family" four-valve set as well, and, strange to say, I cannot touch some of these stations with it.—Yours faithfully,

H. LEWIS.

Scarborough.

THE "TWIN-VALVE" RECEIVER

SIR,—I think you may be interested to hear of my experience of Mr. Scott-Taggart's "Twin-Valve" Receiver, described in the January issue of *The Wireless Constructor* and Radio Press Envelope No. 10. I have built this set twice, but I have been unable to tune down to the Sheffield station's wavelength (301 metres), the .0003 μF variable condenser being at zero for Manchester (378 metres). By following the instructions of the makers of my H.F. transformers and tuning the primary winding instead of the secondary winding with the .0003 μF variable condenser I was enabled to tune Sheffield and other relay stations at excellent loud-speaker strength.

Trusting my experience may be of value to some other experimenters similarly perplexed, and wishing you every success.—Yours faithfully,

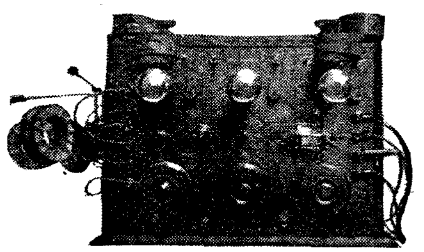
EDGAR H. RIDGWAY.

Rotherham, Yorks.

THE OMNI RECEIVER

SIR,—Please find enclosed a photograph of my "Omni" Receiver, which I constructed soon after it was published in *Modern Wireless* (January, 1924, issue, by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E.) and *Wireless Weekly* (Vol. 3, No. 4, and subsequent issues).

I have spent many hours experimenting with the set, trying out various circuits, and I have learnt much from *Wireless Weekly* and *Modern Wireless* with the aid of my "Omni."



The Omni Receiver which, together with the coils, was constructed by Mr. Brett.

All coils are of my own construction, again due to the tuition gained by being a regular reader of Radio Press publications from No. 1.

Wishing you further success.—Yours faithfully,

S. J. BRETT.

Clapton, E.5.

ENVELOPE NO. 3

SIR,—You are almost sure to have received more communications concerning your "Simplicity" set than are pleasant to deal with. Yet the remarkable results, in my humble opinion, prompt me to express at least my thanks for the assistance of Envelope No. 3 (by G. P. Kendall, B.Sc.), in making up this set for a customer.

My customer *insisted* on provision of space for the addition of a fourth valve. I tried to dissuade him in vain. I assured him he would not require same. But I made the panel 10in. x 18in. instead of 10in. x 14in., and did not alter the general arrangement otherwise.

Tinned square copper wire was used for wiring, and all joints were soldered.

The list of stations heard so far includes Daventry, London, Bournemouth, Toulouse, Munich, Madrid, Eiffel Tower, Breslau, Petit-Parisien, Cardiff, Barcelona, Dortmund, Radio Paris, Oslo, Zurich, Cadiz, Birmingham, Aberdeen and Danzig.

The aerial used is a twin wire in the loft of the house underneath the roof, and is about 35ft. high and 42ft. long.

The ease with which I "picked up" the various stations mentioned surprised me—and my customer. A loud-speaker has not yet been tried.—Yours faithfully,

ERNEST F. HOLDEN.

Folkestone.

AN ST100 RECEIVER

SIR,—I am sure it would greatly interest you to hear of my results using your ST100 circuit. I took the diagram from your handbook, "More Practical Valve Circuits (Radio Press Books, No. 15, by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E.), and chose my own components, including Cossor Wuncell valves and basket coils for tuning. My aerial is a single wire, 35ft. long, 20ft. high and screened at one end. To begin with 2LO, this is too strong for my loud-speaker, and has to be detuned, using 80 volts on the plate. Just a little less in volume is 5XX. Birmingham, Newcastle and Bournemouth usually come in on the loud-speaker comfortable enough to hear, the rest of B.B.C. stations, except Belfast, being very good on 'phones. Relay stations picked up at fair 'phone strength include Nottingham, Bradford, Plymouth, Liverpool, Dundee and Hull.

These, however, are less consistent than the main stations.

Coming to Continental stations, results are even more gratifying, Radio-Paris being quite easy to get on the loud-speaker, as one should expect from their power. To be brief, my list is as follows, and they are most consistent:—Voxhaus, Radio Belge, Radio Iberica, Petit-Parisien, Stuttgart, Bremen, Ecole Superieure, Hilversum, Breslau, Rome, Radio Toulouse, Zurich, Hamburg, and others that I have not been able to recognise. Many of these have been heard very often at fair loud-speaker strength, but all of them are regularly good 'phone strength. I may add that most of these are heard on Sundays between 2LO hours. Regarding the selectivity of this set, I use no wave trap, and, as you will see, I am not far from 2LO, yet on certain spots of the crystal I can cut them out and receive Birmingham and Radio Belge without a whisper from London, but only below and above those wavelengths. This must be undoubtedly the best two-valve reflex yet. I have tried numerous two- and three-valve circuits, but they did nothing near so great. Last winter I worked the ST100, but not this particular set, and I heard WGY on three or four occasions, and this year I hope to do better. To sum up the set, it is economical, it is consistent, though I always read the reverse of reflex circuits, it is a range getter and a powerful set. I feel so satisfied that I haven't troubled since to try any more circuits out. I am even doubtful whether the new ST100 would give me my present results.—Yours faithfully,

G. WARNER.

London, S.E.17.

A READER IN AUSTRALIA

SIR,—I would like to tell you of the great interest with which I have followed the description of the nine-valve supersonic heterodyne receiver in the May and June issues of *Modern Wireless*, by John Scott-Taggart, M.C., F.Inst.P., A.M.I.E.E. In the very near future I am going to try my hand at constructing this set, for I believe it will go far towards a solution of two of the great problems here, viz., selectivity and distance.

Another of our troubles is "Static" with a capital "S." It is truly terrible during the summer months, and quite often very bad even in the depth of winter, if it is desired to listen to any but the home station (supposing always that the listener-in dwells in a capital city), the shortest distance between any two broadcasting stations on the Continent being at least 300 miles, and no relays are employed.

Take, for example, the State of Queensland. The only station in operation is in Brisbane, in the S.E. corner, and this has to supply programmes as far away as proves to be possible. At frequent intervals, in cold weather, the writer has heard X's so bad that they completely obliterated all signals from a 5K.W. station 60 miles away for half an hour on end, except perhaps for a word here and there to show that the station was still working.

Still another of our problems is the wide wave band employed by our stations. One station in N.S.W. operates on 1,100 metres, and one in W.A. somewhere about the same wavelength, while the remaining five stations in the Commonwealth use wavelengths varying from 350-450 metres. This makes it very difficult to construct a set with other than plug-in coils to cover the range, and yet to be sufficiently selective to tune through the local station and pick up a distant one near the same wavelength. We are looking forward with interest out here to the articles to be written by Mr. Harris on his return from U.S.A. and Canada, as we believe that some of the conditions prevailing in those countries will apply here, especially those pertaining to the West Coast of America and the Southern States.

I would take this opportunity of thanking you for the valuable information published in your very excellent papers, and would crave pardon for having taken so much of your time with my woes.—Yours faithfully,

ALAN S. QUAIFE.

Brisbane.

THE TRANSATLANTIC IV

SIR,—I am just writing to let you know how well our "Transatlantic IV" is working (*Modern Wireless*, November, 1924, by Percy W. Harris, M.I.R.E.). I get all the main British stations and most of the relays. Also Ecole Superieure, an unidentified French station, Oslo (Norway), Rome, Madrid, Munich and Munster at loud-speaker strength.—Yours faithfully,

A. B. DICK.

Alvechurch, Worcs.

MAIDSTONE RADIO WEEK

SIR,—I hope that the following announcement may be of interest to your readers.—Yours faithfully,

H. T. COGGER.

Maidstone's Third Annual Wireless Exhibition will be held in the Concert Hall, Corn Exchange, and will be opened by G. Foster Clark, Esq., J.P., on Tuesday, October 13, at 6.45 p.m., and will continue until October 17.

Organised by the Maidstone and District Radio Society, the Exhibition promises to be a very successful event. An attractive programme has been arranged, and includes lectures by the B.B.C., the R.S.G.B., a Dance, a Concert in aid of the Maidstone Hospitals, wireless installation and an open competition for the best home constructed crystal to three-valve set. Entry forms for this competition may be obtained from the Hon. Secretary. All entries close on October 8.

An imposing display of all up-to-date apparatus and accessories will be on view at the stand of the most prominent wireless firms of Maidstone, and demonstrations will be given by them each evening. There will also be a good display of amateur work.

Further particulars may be obtained from the Hon. Secretary, Mr. H. T. Cogger, 44, Postley Road, Maidstone.

BOLTON AND DISTRICT RADIO SOCIETY

SIR,—I enclose a report with reference to a forthcoming event arranged by the above Society, which I hope may be of interest to some of your readers.—Yours faithfully,

N. ISHERWOOD.

A grand lantern lecture will be given on Wednesday, October 14, 1925, in the Y.M.C.A. Buildings, Deansgate, Bolton, by H. A. Hankey, Esq., Assistant Chief Engineer of the B.B.C., London. Subject: "Radio Ramifications." His Worship the Mayor of Bolton (Councillor J. F. Steele, Esq., J.P.) will preside, and Victor Smythe, Esq. ("Uncle Victor" of 2ZY) will be present in support. Commence 7.30 p.m.

Hon. Sec.: J. GRIMSHAW, 70, Church Road, Bolton.

THE B.B.C. AND THEIR WAVELENGTHS

SIR,—May I congratulate you on your exposure of the B.B.C.'s laxity in regard to its station's wavelengths? We have always taken for granted that a great semi-official company such as the B.B.C. would be scrupulously exact in all matters relating to its broadcast transmissions. The plea of inefficient apparatus cannot—or should not—be advanced, since the Company's balance sheet for last year indicates large financial resources.

Dr. Robinson's disclosures serve to explain a matter which has been causing me some uneasiness, and which doubtless affects other readers of *Wireless Weekly.* I possess a heterodyne wavemeter, whose accuracy is guaranteed to [illegible] metre. A couple of months ago, being interested in the proposed new wavelengths, I decided to devote some time to experimenting with my wavemeter.

Greatly to my surprise, I found that on tuning to 365 metres with the aid of the wavemeter 2LO could not be found on that wavelength, but was apparently transmitting on one several metres lower. Certain other stations gave similar—though not so pronounced—results, Manchester being a bad offender. Not unnaturally I blamed my wavemeter, thinking the transmissions themselves above reproach.

The matter is now explained by the article in No. 1 of *Wireless* and Dr. Robinson's disclosures in yesterday's *Wireless Weekly.* The satisfaction I feel at the proved accuracy of my wavemeter is tempered by annoyance at what is either culpable negligence or deliberate deceit on the part of the British Broadcasting Company. That the world's best broadcasting service should be connected with technical inaccuracies is little short of scandalous, and it is, in a way, fortunate that the matter has been brought to light by a British scientist rather than by a foreign listener.

I earnestly hope that the Radio Press, Ltd., will thrash out the matter with the B.B.C., and that the Elstree laboratories will continue to investigate such matters of public interest.—Yours faithfully,

G. V. LARKIN.

September 24, 1925.

TRANSATLANTIC V

SIR,—I think that you may like to have a report on my "Transatlantic V" Receiver (by Percy W. Harris, M.I.R.E., in *Modern Wireless* for June, 1924). This I have now had installed in regular use for some months, and I must say that I am extremely pleased with the results obtained.

I made up the set as described by Mr. Harris, and I am using home-made coils. My aerial is rather badly screened, and has an effective height of only about 20 feet, the earth lead being taken to a water pipe in the usual way.

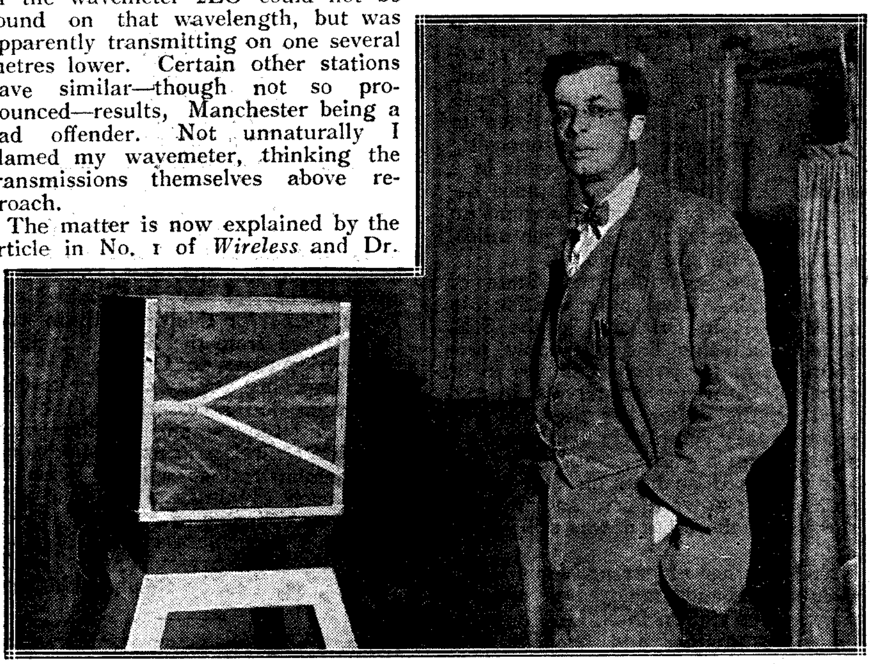
I had America several times early this year, but have not done much in that direction lately. KDKA and WGY came in at wonderful strength, using the five valves.

Using three, or sometimes four, valves I can go the round of most of the Continental stations, loud-speaker results being obtainable from many of them when all five valves are in circuit.

Several of my friends have been persuaded by my good results to make up similar sets. Wishing you every success.—Yours faithfully,

R. B. WEST.

London, S.W.



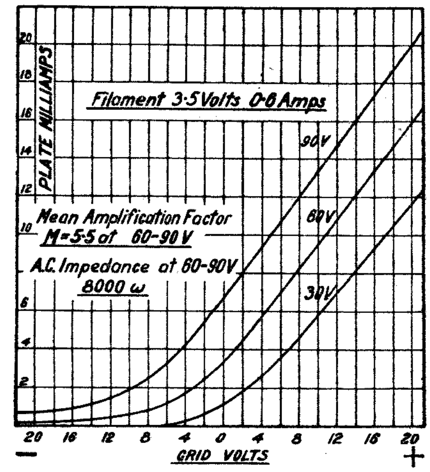
Professor Julian Huxley, who is broadcasting a series of scientific lectures from the London Station.

APPARATUS TESTED

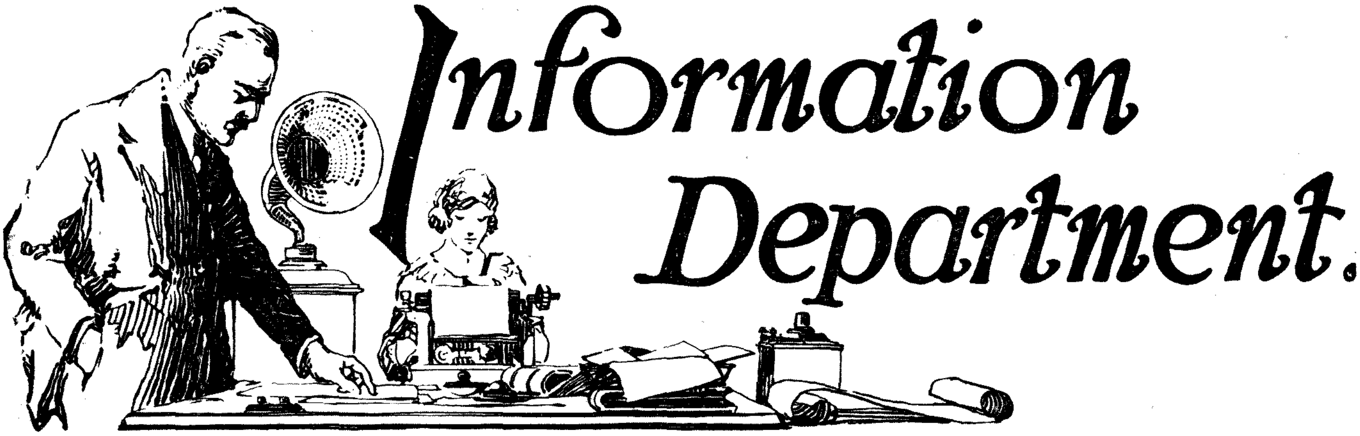
(*Continued from page 61.*)

"C.A.C." Valves

Samples of the "C.A.C." bright-emitter general-purpose valve have been submitted by Messrs. C.A.C. (Radio), Ltd., and have been subjected to an extended test. The construction is of the standard type associated with the R valve, with an unusually open spiral grid. It was to be expected, therefore, that the valves would display a small amplification-factor and a low impedance; this was confirmed on test. 3.5 volts appeared to be ample on the filament, the three specimens submitted showing a saturation current at this rating of 13, 14 and 23 milliamperes respectively, with ample H.T. and positive grid bias. The current taken was between .55 and .6 amperes with 3.5 volts on the filament. The characteristic curves gave a mean amplification factor of but 5.5, with the low mean A.C. impedance of 8,000 ohms, corresponding thus rather to a valve intended primarily for L.F. amplification. With 120 volts H.T. and the ample grid bias denoted by the curves of 9 volts, the valves proved able to handle really powerful signals, and gave excellent loud-speaking on the local transmission when used as first-stage L.F. valves. As a detector the low amplification factor was against the valve, though it oscillated with extreme ease. As a high-frequency amplifier the performance was not striking, much positive grid bias being needed for stability. The grid-current curve showed a decided current below zero grid volts; accordingly an unusually high grid-leak is required, as experiment confirmed, whilst the valve would operate smoothly as a detector without a grid-leak at all. In general, this type can be recommended for L.F. amplification, with proper H.T. and ample grid-bias, when there is a fair amount of signal energy to be handled, and under proper conditions (60 volts H.T. and a high grid-leak value) as an emergency detector.



The characteristic curves of the C.A.C. valves submitted for test.



Information Department.

C. O. S. (NEWCASTLE-ON-TYNE) has submitted a wiring diagram of a 3-valve receiver, with one high-frequency stage stabilised by the neutrodyne method. He states that when he connects the high-tension supply to the high frequency valve, a flash is obtained.

Examination of our correspondent's wiring diagram at once showed the cause of his trouble. The grid condenser, connected between the plate of the first valve and the grid of the second was of a type in which the grid-leak clips were arranged so that the grid-leak was connected in parallel with the condenser. Instead of arranging that the grid-leak was inserted only into the clip on the side of the condenser which was connected to the grid of the detector valve, the leak was placed in both clips, so that it was in parallel with the grid condenser, and the clip which was connected to the plate of the first valve was also taken directly to L.T.+. This, of course, resulted in short-circuiting the high-tension battery through the anode winding of the neutrodyne unit.

To rectify the fault the lead from the clip of the grid-condenser to L.T.+ should be removed, one end of the leak should be inserted into the other clip (connected to the grid of the detector valve) and its free end should be joined to low-tension positive. This latter connection should be effected by means of a further clip into which the end of the leak should be gripped and not by soldering directly on to the metal end cap, since the heat of the iron is likely to impair the efficiency of the component.

G.S.P. (HOBART, TASMANIA) wishes to construct a 3-valve receiver, using a loose-coupled circuit, with reaction on to the secondary, a valve detector and two stages of transformer-coupled low frequency amplification. He states that he has a number of plugs and jacks which he wishes to utilise, and encloses sketches of these.

From our correspondent's sketches of his jacks we find he possesses a "single closed" jack, a "single filament" jack and two "double filament" jacks. The three latter will be suitable for use in the circuit requested.

The required circuit is given in Fig. 1. From this diagram it will be seen that the tuning arrangements are quite normal, parallel tuning being indicated for the aerial circuit in which a suitable value for C1 will be .0005 μF. The coils will, of course, be determined by the wavelength range it is desired to cover. L2 C2 forms the secondary circuit, and for C2 we would suggest a value of .0003 μF. Leaky grid condenser rectification is used, the normal values of .0003 μF and 2 megohms being suitable. L3 is the reaction coil. The aerial, secondary and reaction coils will, of course, be mounted in a three-coil holder.

Dealing with the remainder of the circuit it will be seen that two double filament jacks and one single filament jack have been used. The connections to these look somewhat complicated, but actually in practice the wiring is usually fairly simple, and short leads may be obtained if the components are suitably spaced. Reference to the diagram will show that when the telephones are plugged into the single filament jack all the valves are lit and brought into circuit, provided the filament rheostats are suitably adjusted. With the 'phones in the second double filament jack the last valve is automatically switched off, the 'phones placed in the plate circuit of the second valve and the first two valves only used. With the plug in the first double filament jack the filaments of the last two valves are extinguished and the 'phones placed in the plate circuit of the detector valve in place of the primary of the first L.F. transformer. The connections to C4, the by-pass condenser, should be noted, these separate grid biasing batteries to the last two valves have been indicated so that varying types of valves may be used to their full advantage.

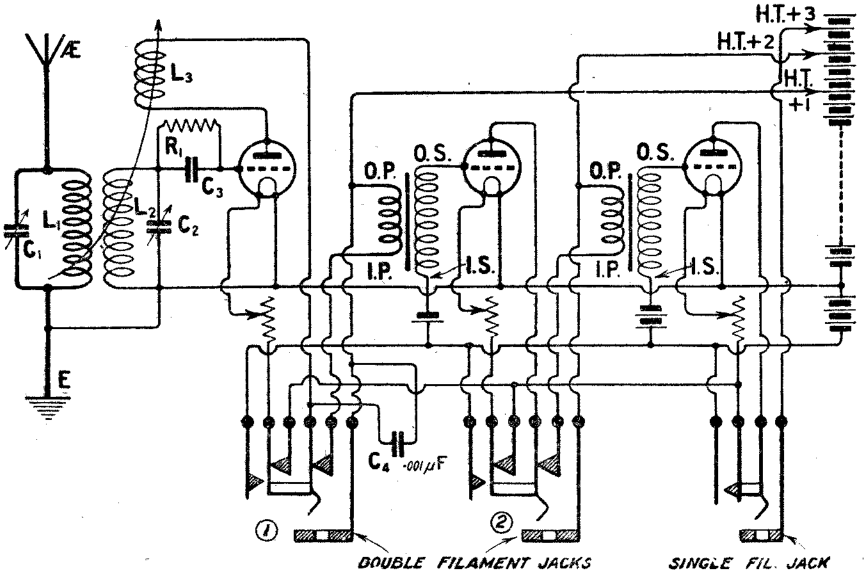


Fig. 1.—A straight 3-valve circuit consisting of a detector valve and two note magnifiers, in which jacks are incorporated to enable one, two or three valves to be used.

being arranged so that this condenser is in parallel with either the telephones or the primary of the first L.F. transformer according to whether one or more valves are being used.

Separate high-tension tappings and If desired, a common value of high tension may be applied to all three valves by joining H.T. +1, +2 and +3 together, but this practice is not to be advised where a considerable amount of power is to be handled, since a power valve, taking a higher value of high tension than the other valves, will be found advantageous in the last stage. Similarly the first L.F. valve will probably require a higher value of anode supply than the detector for most satisfactory working.

Shunt condensers across the high-tension tappings are also to be advised, and these should be connected between H.T. negative and H.T. +1, 2 and 3 respectively. Suitable values would be 1 or 2 μF. These have been omitted from the diagram for the sake of simplicity.

M.A. (CHELMSFORD) asks what is meant by "spacing" and "marking" waves in wireless telegraphy.

When an arc is employed for telegraphic transmission it cannot be stopped and started in a very short space of time, and it has, therefore, to be continuously maintained in operation during the whole of the time in which a message is transmitted. The arc is therefore arranged to oscillate at a certain wavelength whilst the key is up and to radiate at a different wavelength when the key is depressed. This is effected by making the key operate a magnetic relay which short circuits a part of the aerial tuning inductance. Two waves are thus radiated by the arc transmitter, one when the transmitting key is up, and a shorter wave when the key is depressed. The first-mentioned wave is known as the "spacing" wave and the other as the "marking" wave.

F. E. (POOLE) wishes to employ a power valve in the note magnifying stage of his All-Concert de Luxe receiver and asks us what alterations will be necessary in the wiring.

To use a power valve to full advantage our correspondent will have to make but two slight alterations to the wiring of his receiver, in order that this valve shall receive a higher value of high-tension than the H.F. and detector valves and also grid bias.

If reference is made to the wiring blue print enclosed in Radio Press Envelope No. 4, a short lead will be seen connected from the right hand middle contact of the "telephone or loud-speaker" switch to a long lead joining the moving plates of the .00025 μF condenser to high-tension positive. This short lead, which ends near the figures ".00025," should be removed and the middle right-hand contact of the switch should then be connected to a further terminal which will be used for the high-tension positive terminal for the last valve. The 2 μF condenser at present connected across the high-tension supply to all valves, will now be across the supply to the high-frequency and detector valves only. It is therefore advisable to connect a further 2 μF condenser between H.T. negative and the new high-tension positive terminal.

In order to insert a grid-biasing battery it will be necessary to remove the lead from the IS terminal of the L.F. transformer to L.T. negative and to bring a connection out from IS to a further terminal which will become grid-bias negative. The positive end of the grid-bias battery can be connected directly to the L.T. negative terminal which will also still serve to take the lead from the negative side of the low-tension battery.

W. C. (WOKING) is experiencing trouble with his "Powerful 3-valve Receiver," described by Mr. Harris in the April issue of "The Wireless Constructor." When first constructed the set functioned in a very satisfactory manner, but of late signal strength has tended to decrease, and finally, after the set had not been in use for a week, when again put into service, only a loud buzzing or howling noise could be obtained.

From these symptoms we would advise that the high-tension battery be renewed. When signal strength gradually falls off and finally the set buzzes or howls the cause is most often located in the high-tension battery, which has run down and developed a high internal resistance. This resistance is common to the plate circuits of all valves, and thus exerts coupling effects which cause the valves to oscillate at low frequency. The note of the howl will not be changed by tuning on the condensers, but adjustment of the filament resistances of the note magnifier valves will alter its volume. If the tendency towards buzzing is only slight the placing of large condensers, of 2 μF or larger, across each high-tension tapping will effect a temporary cure.

2D EVERY TUESDAY WEEKLY

THE EDITOR:
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TECHNICAL DIRECTOR:
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