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Wireless Weekly

and The Wireless Constructor

No. 9

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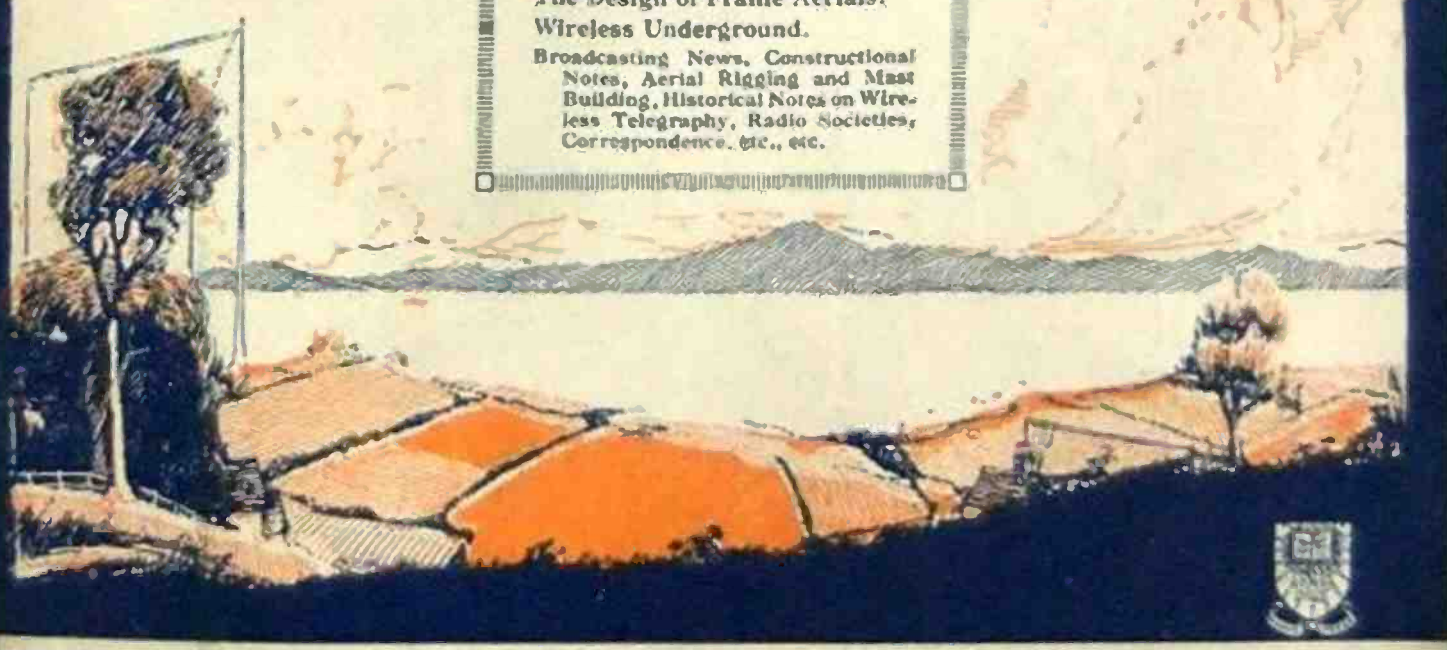

The Pallophotophone—A New Development

Wireless Weekly

Vol. 1. No. 9.
June 6, 1923.

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Editor: JOHN SCOTT-TAGGART, F.Inst.P.
Assistant Editor: E. REDPATH.

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Scientific Adviser:
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Editorial

That Interim Report.

ANOTHER week has passed without appearing to bring us any nearer to a settlement of the broadcasting controversy. In the meantime the wireless industry is rapidly declining owing to the inevitable stagnation consequent upon the unjustifiable delay in effecting a settlement of the licence question, coupled with a suspicion on the part of the public that broadcasting may not continue.

At least three weeks have now elapsed since the accumulated applications for licences, which eventually totalled nearly 50,000, were examined and classified. Of these, probably only 1,000 were found to justify experimental licences, the issue of which, we are pleased to learn, is proceeding forthwith.

The authorised activities of the remaining 49,000 applicants are suspended, awaiting a decision of the Broadcasting Committee, which will enable constructional licences to be issued.

Practically everyone behind the scenes knows that a constructional licence will be issued, so why should the public be kept in suspense? All that is required is an interim report from the Broadcasting Committee, and the new licence forms can be printed and issued immediately. Public confidence will be automatically restored and the present depression greatly alleviated.

Shakespeare Broadcast

We must congratulate the B.B.C. upon their recent success in broadcasting "Twelfth Night." The experiment of modifying the book so that the action could easily be followed appeared very satisfactory. After all, Shakespeare's plays were originally produced without any scenery, and it ought not to be difficult to broadcast an improvement upon the placard which informed the audience that a wooden partition or a plaster wall represented a woodland dell.

We foresee that in the near future we shall have plays specially written for broadcasting, just as we have them specially written for the cinema.

Interference

From all parts of the country we are receiving complaints regarding local interference due to radiation from self-oscillating receiving sets. In our opinion this trouble is going to prove one of the most formidable obstacles to the successful development of broadcasting, and, unfortunately, it is a trouble which will get much worse as the numbers of listeners-in increase.

Apart altogether from the question of regulations, it behoves every listener-in, and especially every beginner, to make absolutely certain that his apparatus is incapable of causing interference. After all it is only the decent thing to do. We have heard of the *malicious* use of reaction, but are loth to believe such a charge. Interference may be caused *unwittingly*, by the careless manipulation of apparatus or by the *unscrupulous* use of reaction, as when a listener-in insists on obtaining the last ounce out of his apparatus, and knowing that his set is oscillating, leaves it so.

If every listener-in will only play the game the difficulty will be overcome without any further regulations or red tape.

THE MAGNETIC MODULATOR

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

This article describes the circuits and principles of E. W. F. Alexanderson's invention, now popularly known by the above name.

THE various systems of modulating the output of continuous wave transmitters most commonly used by experimenters in this country can be roughly classified under three headings, *i.e.*, choke control, grid control, and control effected by varying the resistance of the aerial system.

The first two systems

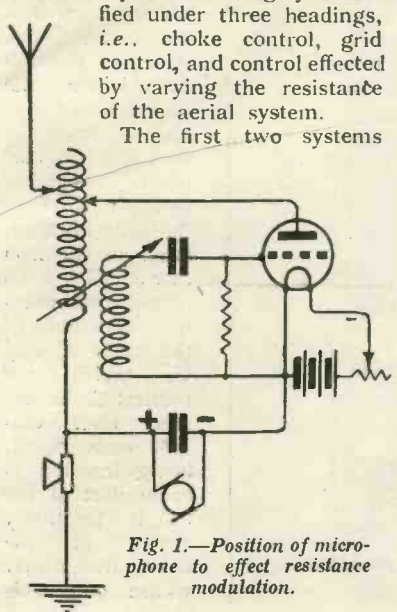


Fig. 1.—Position of microphone to effect resistance modulation.

will not be described in detail in this article as they are well known, but for purposes of comparison with the third system a few facts should be noted.

Choke Control

The chief disadvantage of choke control is that at least two transmitting valves are needed, the expense of the extra valve being a consideration to many in these days of economy. The great advantage, however, is that the control or modulator valve, which is shunted across the power valve and the high-tension supply, alternately subtracts from and *adds to* the voltage applied to the anode of the power valve. This is due to the "kick-backs" or back-E.M.F.'s produced at speech frequency across the iron core choke inserted in the positive lead of the high-tension supply, which is, of course, common to both valves. Thus, if a modulator valve is added to a C.W. transmitter in a choke control circuit and the normal output of the transmitter is 10 watts, then if the maximum power absorbed by the modulator valve is 7 watts, the total output of the transmitter during speech will vary from 3 to 17 watts. The foregoing is, however, a very rough example.

Grid-control

The commonest grid-control circuits only need one valve. Generally the secondary of a microphone transformer, shunted by a suitable condenser, is inserted directly in the grid circuit of an oscillating valve, and the fluctuating potentials applied to the grid when the microphone is spoken into serve to control the output of the valve. The operating point of the latter is moved up and down the characteristic curve of the valve according to the varying voltages applied to the grid, and it is obvious that, in order to avoid distortion of speech, this operating point must be confined to a linear part of the curve. Unfortunately, this state of affairs cannot usually be brought about if the valve is arranged to be working with maximum efficiency as an oscillator. However, grid-control has the merit of simplicity, to which it owes its popularity.

Those who are particularly interested in the subject are recommended to read pp. 186-188 of J. Scott-Taggart's "Wireless Vacuum Tubes," where a new and extremely interesting method of grid-control is described, said to give exceptionally pure articulation.

Aerial Resistance Modulation

The easiest way to effect aerial resistance modulation is to insert a low-resistance microphone either directly in the earth lead of a C.W. transmitter, as is shown in Fig. 1, or to shunt it across a few turns of the aerial tuning inductance, as in Fig. 2. In either case, speaking into the microphone varies the resistance of the aerial.

Dr. Eccles states in his "Handbook of Wireless"* that, in order to obtain the maximum degree of efficiency, *i.e.*, in order that both the maximum output and the maximum fluctuations of output should be as great as possible, the average microphone resistance M should be made equal to the mean of the radiation and ohmic resistance of the aerial system, the latter being measured with the microphone shorted. In other words, if Ra is the aerial radiation resistance in ohms and Rw the actual ohmic resistance of the aerial system as a whole, then the formula for finding the best value for the average microphone resistance M is

$$M = \tfrac{1}{2}(Ra + Rw).$$

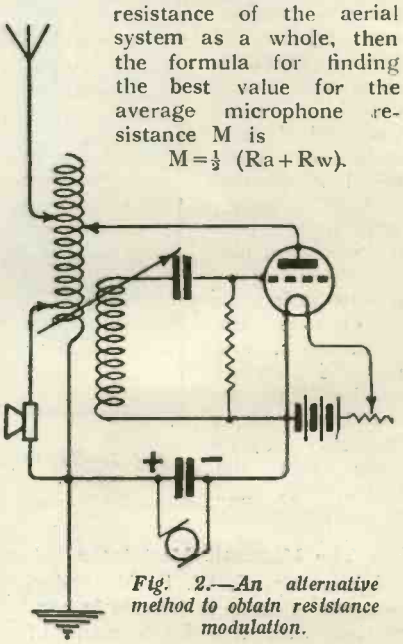


Fig. 2.—An alternative method to obtain resistance modulation.

* See also P. R. Coursey's "Telephony Without Wires."

For powers of 5 watts and below the arrangements shown in Figs. 1 and 2 often give surprisingly good results, but ordinary microphones are not suitable for carrying heavy high-frequency currents, and with greater powers the carbon granules are apt to pack together and so paralyse the instrument.

In the early days of radio-telephony, when systems of varying aerial resistance modulation were in great favour, the problem of obtaining better and more powerful telephony transmission was thought to be largely one of designing a microphone to carry heavy high-frequency currents. As a result all kinds of weird and wonderful microphones were evolved. Some employed a jet of liquid, the resistance of which was varied at speech-frequency, some a continuous trickle of carbon granules, some were water-cooled, others consisted of many microphone units wired in parallel and sprouting forth from a central standard like roses growing on a rose-bush. In each case the main object was to avoid excessive heating due to the heavy high-frequency currents that the instruments had to carry.

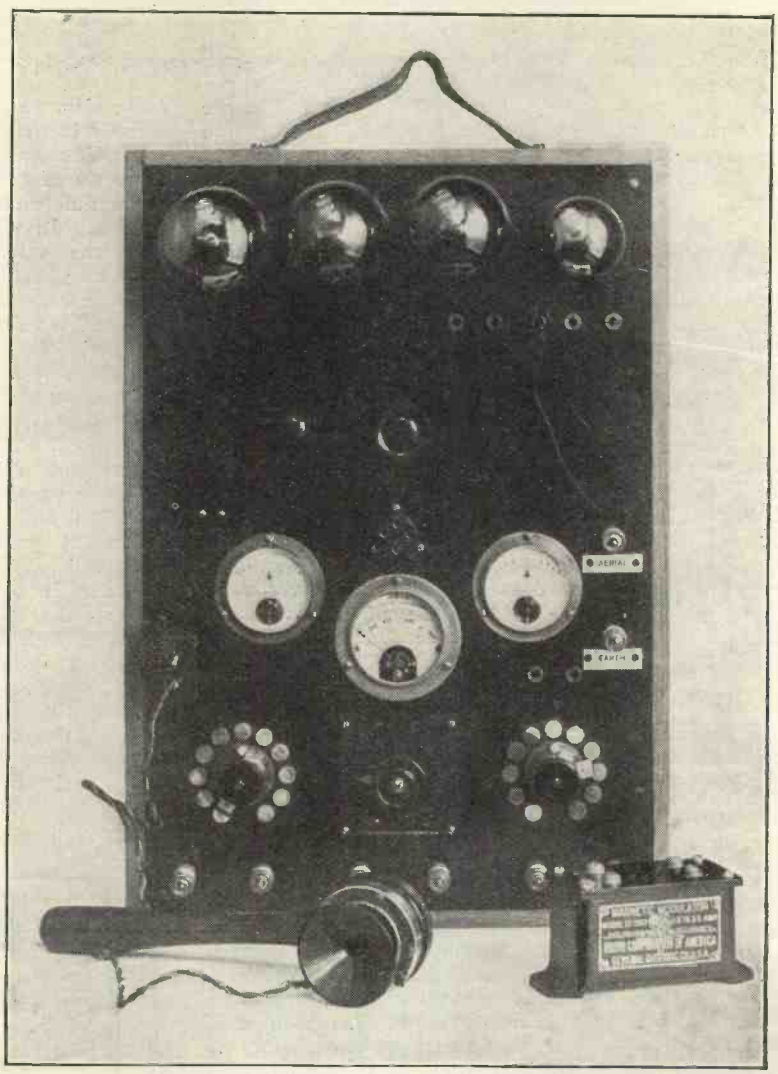


Fig. 3.—The magnetic modulator (on the right) shown alongside the transmitter of 5 KA to give an idea of its compactness.

The Magnetic Modulator

Ultimately, E. W. F. Alexanderson, whose name is famous in connection with the development of high-frequency alternators, invented what is now known as the magnetic modulator. This is in effect an instrument which enables the resistance of a high-frequency circuit to be varied at speech-frequency without the necessity of introducing a microphone directly in that circuit.

The magnetic modulator depends for its working upon the fact that the permeability of iron is not constant under all circumstances, but is a function of the magnetising force applied to it, or, in other words, of its state of magnetic saturation. Now the effective inductance of a coil wound round an iron core depends upon the state of magnetic saturation of the core. Hence, if two coils are wound on one core and the current passing through one coil is varied, then the magnetising force applied to the core (and therefore the state of magnetic saturation of the core) is varied; as a result the effective inductance of the other coil is also varied.

The magnetic modulator consists of two coils wound on one core and is shown diagrammatically in its simplest form in Fig. 4. A microphone M and microphone battery B are connected to the ends P, P_1 of the coil Z. When the microphone is spoken into the fluctuating currents passing through Z vary the state of saturation of the iron core C, and hence the effective inductance of the coils X and Y, which are connected in series, their outside ends A, A_1 being inserted in some part of the high-frequency circuit of the C.W. transmitter whose output is to be modulated. The special form of core and winding is necessary so that there should be no direct induction of radio-frequency currents from the high-frequency circuit $AXYA_1$ into the low-frequency circuit $MPZP_1B$, and *vice versa*. Under certain circumstances it is better to connect the coils X and Y in parallel, in which case stopping condensers have to be inserted in the circuit $AXYA_1$. These condensers pass high-frequency currents, but prevent the circulation of audio-frequency currents.

Alexanderson used similar modulators to control as much as 75 kilowatts of high-frequency energy by connecting them in shunt across the output terminals of his alternators.

Recent Developments

The Radio Corporation of America has lately developed and put on the market a range of magnetic modulators suitable for the use of amateurs. The three models are designed to deal with an aerial current of 0.5 to 1.5 amps., 1.5 to 3.5 amps., and 3.5 to 5 amps. respectively. For greater currents two or more of the largest models may be used in series. They are designed for use on a wavelength of 200 metres, on which wavelength the control is linear, so that practically no distortion of speech or music takes place apart from such distortion as may be due to the microphone or other parts of the transmitter.

These modulators can be inserted in series with the earth lead of any C.W. transmitter, as shown in Fig. 5. The modulator should be as near to the actual earth connection as possible, and for best results the aerial system should have a resistance of less than 15 ohms. In order to reduce the aerial resistance as much as possible it is generally advisable to use a counterpoise earth consisting of a number of insulated wires suspended about 7ft. from the ground and extending beyond and on either side of the aerial. Such an arrangement of wires should be used instead of the more ordinary arrangement of plates or wires buried in the soil in order to provide a return path for the aerial currents. This path along the wires is of considerably lower resistance than any path through the soil beneath the aerial, through which the return currents are prevented from flowing by the screening action of the counterpoise.

Hints on Operation

The current that should flow through a microphone used with any of these modulators is fairly critical; it should be about 300 milliamperes when the microphone is idle, and during speech may vary from 100 to 650 milliamperes.

Fig. 6.—A close-up view of the instrument.

The transmitter should first of all be tuned and adjusted for maximum output with the terminals A, A_1 of the modulator shorted. The shorting wire should then be disconnected and the set retuned with the microphone and microphone battery connected in series to the terminals P, P_1, under which circumstances the extra resistance of the modulator will cut down the aerial current to about three-quarters of its normal value.

Results can often be improved by connecting a 0.0003 μF variable condenser across the A, A_1 terminals of the modulator. The set should first of all be tuned with the microphone and microphone battery connected and with this condenser set at zero. The condenser should then be varied until the aerial current is reduced to about half its former value, which reduction is due to the fact that the condenser and the high-frequency winding of the modulator together constitute a rejector circuit, the normal impedance of which depends upon the setting of the condenser. During speech this impedance is varied by the action of the modulator and its normal value for maximum efficiency should be found by experiment, as distortion results if it is made too great.

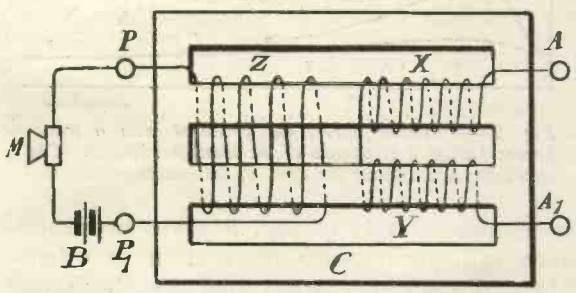


Fig. 4.—Diagrammatic sketch of the modulator, shewing windings.

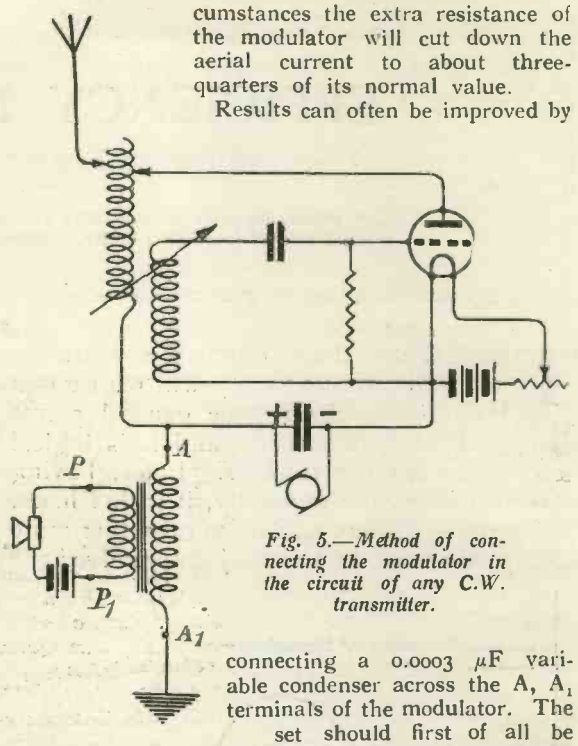


Fig. 5.—Method of connecting the modulator in the circuit of any C.W. transmitter.

Summary

The magnetic modulator probably provides the simplest method of modulating the output of a single-valve C.W. transmitter. Once set, the magnetic modulator needs no further adjustment, and, as, ultimately, amateur transmissions will probably be confined to the 200 metre wavelength, it should provide an interesting subject for experiment.

EFFICIENCY IN RECEPTION.

By P. P. ECKERSLEY, Chief Engineer of the B.B.C.

This article, the third in our series dealing with the technicalities of broadcasting, is of especial interest to all who desire to eliminate distortion of received speech, music, etc.

THOSE who have followed my articles in the *Wireless Weekly* will realise that I have treated on some general points as regards the transmitter, and it is logical now to discuss the receiver. Later, having covered the ground generally, it will, I hope, be interesting to my readers to go rather more deeply into some of the subjects involved.

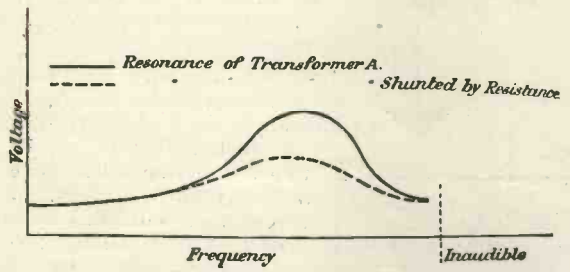


Fig. 1.—Illustrating the resonance curve of a transformer responding to the upper frequencies. The dotted line shows the smoothing produced by the addition of resistance.

The Receiver and Distortion

The receiver is as important a link in the broadcasting of music and of speech as the transmitter. It is just as easy to distort broadcast in the receiver as it is in the transmitter. Many people complain of certain transmissions. They say, perhaps, the quality was poor, too high-pitched, too low-pitched; or that there was "blasting," or that it was "mushy"; and in many cases it has been found that on our check circuits the quality has been perfectly good. The fault, then, would appear to lie in the receiver, and very often *does* lie in the receiver.

We can send out high-pitched stuff or low-pitched stuff, and we can completely change the transmission from one kind of quality to another. In the one case we shall please some listeners-in; in the other case we shall please others—all depending upon what receiving apparatus they are using—and it is a matter of some embarrassment to know how to please the greatest number of people. It is not so much the high-frequency circuits that are responsible for the idiosyncrasies in the receiving apparatus. Most of the variations come in on the low-frequency circuits.

Low-Frequency Circuits and Loud-Speakers

It is a very interesting experiment to get hold of three or four different equipments of loud-speaking apparatus and connect them to the same receiver one after the other. It will be noticed that some equipments accentuate the higher tones, others seem to give mellowness, and others still seem to give that peculiar buzzy and blurred reception—all from exactly the same transmitter, and all with exactly the same frequency circuits.

Resonance in Telephones or Loud-Speakers

If my remarks on microphones* have been followed, it will be realised that very much the same sort of thing applies to the receiving diaphragm—be it loud-speaker or head 'phones—as to the microphone. Every head telephone, for instance, has a moving diaphragm, and this has its own particular

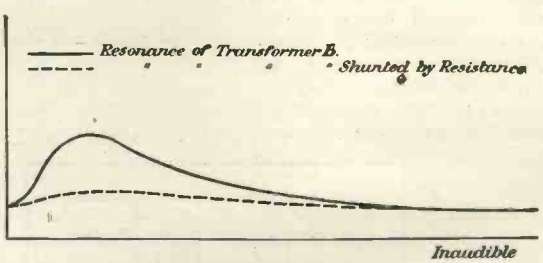


Fig. 2.—A similar curve, but produced with a transformer having a resonance of the lower frequencies. The dotted line again shows the effect of introducing resistance.

resonance, that is to say, it gives predominance to certain notes more than to others. Most diaphragms are tuned to about one

* An article which appeared in No. 2 issue.

thousand frequency, as this is the optimum voice frequency. Thus the telephone itself tends to cut off the higher and lower tones, but how much it does this is dependent upon its mechanical construction. One particular form of telephone may be tuned at its optimum a little lower down the scale than another, and it may therefore give apparently a quite different sort of quality.

The same applies to loud-speakers; some are on the high-pitched side, due to their diaphragm resonance, and others have different characteristics. The results from loud-speakers are mostly obtained by giving a diaphragm a certain resonance, and then damping this resonance by means of a small air-gap; but even if this is done, there is undoubtedly a tendency in all loud-speakers to give predominance to certain notes, and I think I am right in stating that there is not a single loud-speaker on the market that can be considered absolutely aperiodic, that is to say, there is not a loud-speaker that will absolutely faithfully reproduce in sound the electrical disturbances that are put into it.

It is an interesting experiment, however, to try and modify the loud-speaker by means of external electrical connections so that it should give better quality or, possibly, quality more pleasing to the user. Thus something can be done sometimes by connecting a variable condenser across the loud-speaker. If this condenser is made big, then the upper tones will be cut off more, perhaps, and very often some addition may be found where a harsh transmission can be made smooth and mellow by this means. But much more can be done by attending to the low-frequency amplifier.

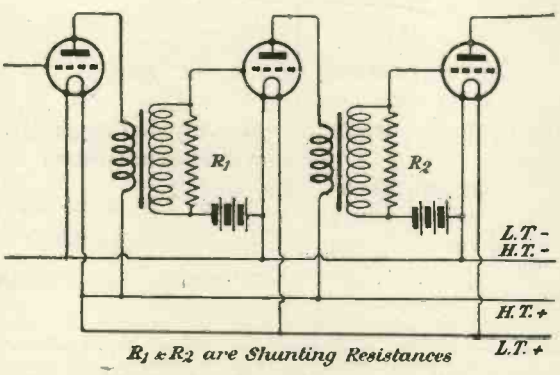


Fig. 3.—Showing how the resistances may be connected across the transformers.

Resonance in the L.F. Amplifier

You may perhaps have set up two note magnifiers with transformers bought locally, and you may be surprised to find that this arrangement gives harsh or bad stuff. The reason probably is that not only has the loud-speaker got a particular resonance, but each of the transformers, due to their inductance and self-capacity, have also a resonance.

Now it is useless in this case changing the resonance point by connecting condensers across the transformers, because this will only mean that the resonance point is shifted. It is impossible to do away with resonance by putting condensers in the circuit. The best plan is to get some resistances similar to those used for gridleaks and connect them across the grid and filament of the note-magnifying valves.

Refer to Fig. 1. This shows a resonance curve of a particular transformer. It will be seen that in the upper limits of frequency there is a pronounced resonance. By connecting a resistance across the transformer a curve something like the dotted line might be obtained. This shows that the resonance is damped out by putting the resistance across. An interesting point to notice is that the less resistance that is connected across, the less will the higher tones be accentuated.

Turning again, to Fig. 2, it will be seen that with a transformer that has a resonance of the low frequencies, the smaller the resistance the less will the low tones be accentuated. Thus it is impossible to lay down any definite rules as to the value of resistance to be used to get the tone balance right, because it is impossible to predict whether the iron-cored transformers will have a high note resonance or a low note resonance. It is purely a matter for experiment, and these little resistances are quite cheap, and it is amazing what a lot of improvement in quality can be obtained by judicious application.

In order to make the foregoing remarks clear I have drawn in Fig. 3 a note-magnifying circuit showing where these resistances should be connected.

Grid Current

Many people do not seem to realise that a valve has a quality called "grid current." All this means is that if the grid becomes

more positive than the filament, then a current flows between grid and filament, whereas if the grid is more negative than the filament, no such current can flow.

Thus if, as in Fig. 4, an alternating voltage is superimposed on the grid—the steady voltage being O—then to the right of O there will be a current flowing between grid and filament; to the left of O no such current will flow. This means that if a transformer is supplying the alternating E.M.F. it will be loaded on one half of the alternation and not on the other. This means, of course, that distortion will occur. To get over this, a steady negative potential should be put on the grid so that the peaks of the positive voltage do not go beyond O, and the opposite peaks do not go below P (see Fig. 4).

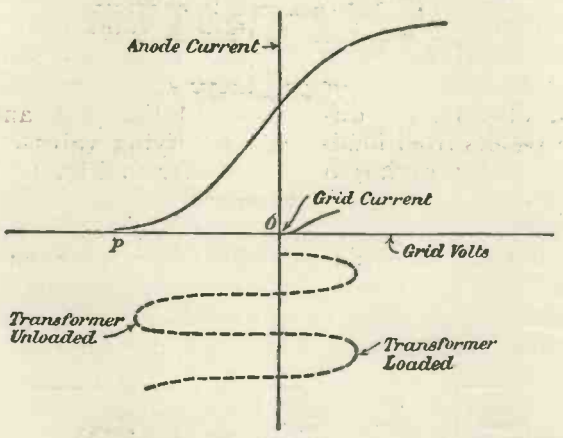


Fig. 4.—Illustrating "grid current" effect.

This will mean that distortionless amplification will result, and it is often worth while to put a little negative potential on the grid of the amplifying valve. The presence of grid current always gives that "blurry" and fuzzy sound which so spoils the purity of broadcasting.

Conclusion

The above remarks are general remarks as to receiving good quality broadcast. No mention has been made about the high-frequency circuits because these are not usually responsible for distortion.

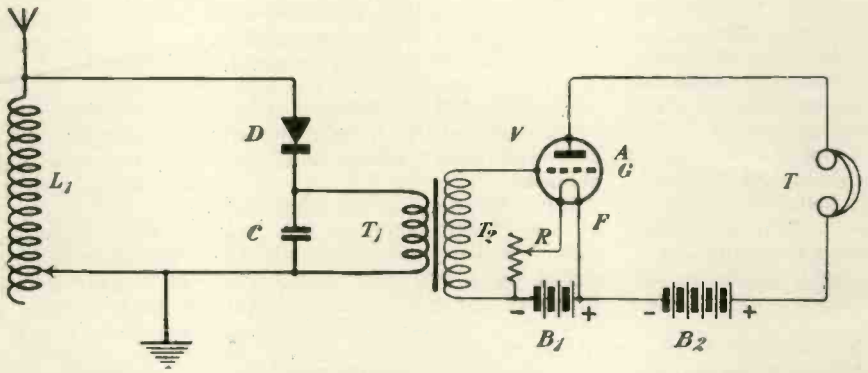
I suggest that a little attention to detail, as indicated above, will be productive of really good results. I have listened so often to broadcasts which go out with perfect quality but which are completely marred on reception and give the lay listener an entirely wrong impression of the efficiency of wireless telephony as a means to amuse.

[*In his next article Mr. Eckersley will discuss the question of high-frequency circuits.* —ED.]

Wireless Weekly Circuits

No. 9.

A Simple Crystal and Valve Receiver.



COMPONENTS REQUIRED.

L_1 : A slider type variable inductance.
D : A crystal detector.
C : A fixed condenser of 0.002 μF.
T_1 T_2 : A step-up intervalve transformer.
V : A three-electrode valve.
A valve panel complete with rheostat R.
B_1 : A 6-volt accumulator.
B_2 : A high-tension battery, having a value of 40 to 80 volts.
T : A pair of high resistance telephone receivers.

GENERAL NOTES.

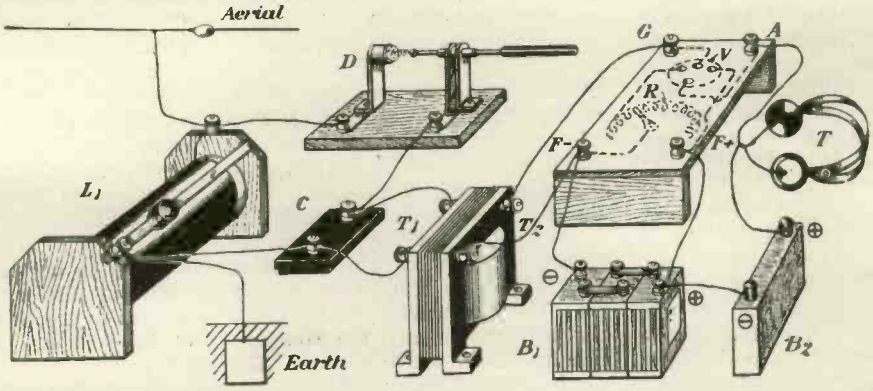
This circuit employs a valve as a low-frequency amplifier, the rectified signals from the crystal detector being passed through the primary T_1 and thence transferred by T_2 to the grid and filament of the amplifying valve V. This circuit is not particularly suitable for long wave reception, but may be used where signals are already audible on the crystal detector.

VALUES OF COMPONENTS.

The intervalve transformer is best purchased and a good make obtained. The variable inductance is of the slider type, and for broadcasting wavelengths may consist of a cardboard tube, measuring 4in. in diameter by 5in. long wound for a distance of 4½in. with No. 24 gauge enamelled copper wire. If it is desired to receive Paris (2,600 metres), the inductance may be wound for a distance of 10½in. on a cardboard tube measuring 4in. in diameter and 11in. long.

NOTES ON OPERATION.

This circuit is exceedingly simple to operate, and the only adjustment is the variable inductance L_1. The crystal detector is first adjusted ; the filament brightness is also adjusted.



THE PALLOPHOTOPHONE

By C. A. HOXIE of the General Electric Company, Schenectady, N.Y.

This article deals with an important American development. Something of a similar nature has been tried at the Manchester broadcasting station.

Reprinted from the Proceedings of the American Institute of Electrical Engineers.

THE name pallophotophone has been given to a new device used both for permanently recording speech in a wavy trace on a moving photographic film, and for transforming the air vibration of sound into exactly corresponding electrical vibrations for transmission directly, for example, to wireless broadcasting generators. The syllables "pallo" of this new word are taken from the Greek and with the following syllables indicate "dancing light." This particular function, involving a rapidly vibrating beam of light, seems to be the most distinctive one of the combination.

To explain the operations briefly, perhaps it would be more illuminating to start with resemblances and differences as compared to the well known telephonic devices and talking machines.

With proper translating means either device can reproduce the sounds recorded. In the translating mechanism is the difference between the two methods of recording speech. The gramophone employs a needle set into vibration at one end of a lever, the other end of which is attached to the central point of a thin disc of mica. On the other hand, in the case of the pallophotophone, a dark wavy trace on a photographic film, moved in front of a slot, allows variable amounts of light to fall on a photo-electric cell. In turn, the photo-electric cell varies the electric current passing through it in direct proportion to the change in light. The human ear cannot hear the wavy light, neither can it hear the variations of current in the photo-electric cell, but if the variations of current are passed into a telephone receiver or loud-speaker, either directly or through the intermediary of wireless waves, the diaphragm of the telephone transforms the electric vibrations into air vibrations of sound. As compared with the simple mechanism of Edison's talking machine, the pallophotophone seems to traverse a wide detour. Each, however, has its particular uses. The pallophotophone has its marked advantages—some of which are quite evident and others hidden until explained.

When the artist is available and at the broadcasting studio the pallophotophone dispenses with the record on a film and passes the energy of speech and music to light vibrations, and thence electric vibrations which pass directly to the wireless generators. Important to note, there are no microphones or other telephonic devices involved in these transformations.

Nevertheless, the nearest analogous operation to the pallophotophone transmitter is in the familiar telephone transmitter. The telephone has a mouth-piece at the end of which is a diaphragm which vibrates with the sound waves. So also has the pallophotophone. However, its diaphragm is much lighter in weight. But from there on the resemblance disappears. The diaphragm of the telephone receiver pushes against loose particles of carbon and changes their ohmic resistance, thereby giving an electric current proportional to the vibrations of the diaphragm. On the other hand, the diaphragm of the pallophotophone has attached to it, by a lever, a tiny mirror, the combined weight of which is about half that of the head of an ordinary pin. The diaphragm, the lever, and the tiny mirror are the sole mechanical parts which vibrate. The mechanism of the pallophotophone transmitter, being so exceedingly light in weight, is capable of responding to the overtones of sound and music which give the fine distinctive quality and timbre of different voices and instruments. While the telephone transmitter still has the practical advantage of compactness, simplicity, and a single step from sound vibration to electric vibration, it has a greater mass and therefore is unable to respond to the distinctive overtones. While this loss of the overtones has little to do with clearness of speech it takes away from the cultivated enjoyment of musical qualities both of voices and instruments. The pallophotophone has this improving feature that will spread, still further than the telephone can, the emotional pleasures of a fine art.

In the pallophotophone the light from an incandescent lamp is focussed upon the tiny mirror of the transmitter. The reflected dancing beam of light, illuminating more or less the photo-electric cell, induces a current in the cell corresponding to the frequency and intensity of the sound vibrations that impinge on the diaphragm of the transmitter. Thus the photo-electric cell in the pallophotophone performs a service corresponding to the carbon granules in the telephone transmitter.

In the realm of small dimensions there are features of interest in what the pallophotophone will accomplish. For example, the photo-electric cell will respond to a movement of the beam of light of one-thousandth inch (0.0024 cm.) at the cell opening, and this movement, too tiny to be visible to the naked eye, will give a fairly loud reproduction of speech or music in a pair of head-'phones in the circuit of the first pliotron. Calculating back to the corresponding movement of the diaphragm, the resulting figures seem incredible. The dia-

phragm's movement is magnified two thousand times in the movement of the light on the photo-electric cell. Therefore, when the light has moved one-thousandth of an inch the diaphragm has moved only a half-millionth of an inch. In other terms, a movement of the diaphragm of only twenty-five times the diameter of a molecule

The pallophotophone is fundamentally a device designed to convert sound vibrations into corresponding electrical oscillations, by means of a beam of light. This beam can be made to produce the electric energy direct or to record the original vibrations on a photographic film by means of which the same variations of light can be re-

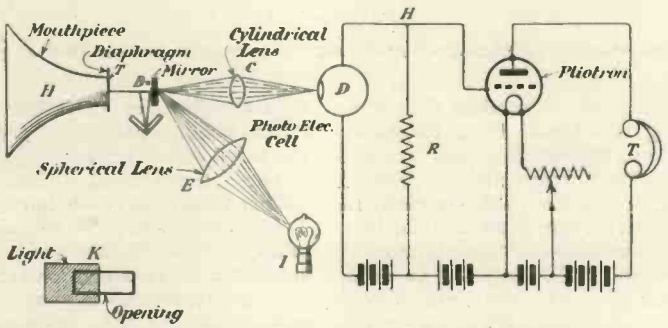


Fig. 1.—Diagram showing elements of the Pallophotophone.

will be reproduced in clear speech and music.

If instead of projecting the dancing light on to the photo-electric cell, to translate the dance of light into electric current, the reflected beam of light is caused to fall on a moving film the sound is, so to speak, "canned" photographically on the film for future use. This combination will be shown later. The reproduction of the voice either directly or through the means of a film is so identical that hundreds of audiences, who have been asked to decide which reproduction was from the voice directly and which from the film of the same voice, have been unable to distinguish between the two.

To follow briefly through the consecutive steps of the pallophotophone—first come the voice vibrations; second, the corresponding vibration of the diaphragm which carries the tiny mirror; and third, reflected from the vibrating mirror the vibration of light which falls either on the moving film to form a permanent record of the sound or, otherwise, on a photo-electric cell which gives faithfully perfect electric oscillations for wireless broadcasting or telephone receivers.

The foregoing description gives the essential elements—in addition, there are, of course, amplifiers of current, motive power for moving films, horns, and the various mechanical parts in detail which will be described.

produced, thus making it possible to obtain the corresponding electric oscillations whenever and as often as desired.

The conversion of sound waves into electric energy is brought about by causing a variation in volume of a beam of light entering a suitable light sensitive cell to correspond to the sound waves produced. By a light cell we mean a device that when placed in circuit with a suitable e.m.f. will give a freedom of current flow depending upon the amount of light entering the cell.

In order to show the method by which this is done we will refer to Fig. 1. In this figure a special incandescent lamp is shown at L. The light from this lamp is focussed by means of the spherical lens E on to the small mirror B and is reflected through the cylindrical lens C on to the light cell D, the shape of the light beam as reflected on the cell opening being shown at K Fig. 1. When the sound waves enter the mouth piece or horn H the diaphragm F and mirror are made to vibrate, causing the reflected light beam to move horizontally to and fro across the opening, thereby varying the light entering the cell. This in turn varies the current flowing through the resistance R, thus producing a change of potential at the point H that is in strict accordance with the sound waves entering the mouthpiece. This varying potential may be applied to the grid of a pliotron in the usual way and amplified sufficiently to operate either a loud-speaker, head-'phones or any other suitable electrical device.

The two principal pieces of apparatus on which the success of this device depends are (*a*) the vibrating elements and (*b*) the special light cell used. I will first give a brief description of the vibrating element. Referring to Fig. 2, S is the cross section of a small steel shaft having a knife edge which rests in two sets of jewels, one set of which is shown at J, set at right angles as shown. The back of this shaft is connected by means of the small rod I to the diaphragm on which the sound waves impinge. The knife edge of the shaft is held firmly in the bottom of the V formed by the jewels by means of the permanent magnet M. The mirror B is fastened firmly to the steel shaft between the two sets of jewels. It is thus readily seen that as the diaphragm is moved to and fro by the impact of the sound waves a rocking motion is given to the mirror. The distance between the back of the shaft and the knife edge is considerably less than one one-hundredth part of an inch, so that it is seen that a very slight movement of the diaphragm will cause the mirror to move through a relatively large angle. This large amplification of motion is one of the principal features of this device. The movement of the light at the surface of the cell, which is

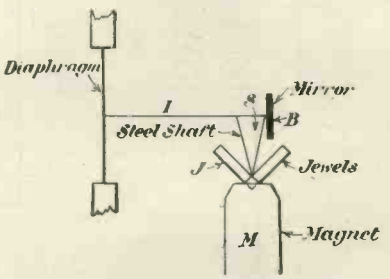


Fig. 2.—Details of vibrating system.

only a few inches from the mirror, is approximately two-thousand times the movement of the diaphragm. A movement of the light beam at the cell opening of 0.0011in. will produce a fairly loud reproduction of speech or music in a pair of head-'phones in the plate circuit of the first pliotron.

(To be continued.)

WIRELESS RECEPTION IN EDINBURGH

By D. A. FAIRWEATHER, B.Sc.

An account of the results obtained with a five-valve receiver built from bought components.

EVEN previous to the advent of the new Glasgow Broadcasting Station, wireless enthusiasts in Edinburgh have been well catered for by the English stations. Of these London is unique. 2LO comes in very much better than any of the others, even Newcastle. It is clearly audible on one valve, though, of course, fading renders reception unreliable.

The writer's station is situated in one of the higher suburbs of Edinburgh. The aerial consists of a single wire 65 feet long, of which only 35 feet are horizontal at a height of 36 feet, the remainder sloping down sharply to the apparatus.

The circuit at present in use is shown in the theoretical diagram. Tuning is effected by a three-coil tuner of the usual type, taking plug-in De Forest coils. It will be seen that the five-valve set consists of two H.F., one detector, and two L.F. valves. The "tuned anode" method of H.F. coupling is used between valves one and two. Reaction is arranged on the anode coil, De Forest coils being used as before. Coupling between valves two and three is by a H.F. transformer with four tappings on the primary, which is further tuned by a small variable condenser. The L.F. valves are transformer coupled as shown. Reaction can be had either on the aerial or "tuned anode" coil by shorting the one or the other, or on both. The latter arrangement gives slightly increased signal strength.

The "tuned anode" and transformer couplings were found to be a suitable compromise between efficiency and convenience. Louder signals were obtained by replacing the transformer by a second tuned anode coil, but the set was then somewhat difficult to control and too selective for ordinary use.

None of the apparatus employed is home-made. For satisfactory results in long-distance telephony it is essential that the components be of the very best quality obtainable.

Very special attention has been given to the problem of obtaining purity of amplification. This is not necessary for the reception of telegraphy, but is of paramount importance for telephony, both speech and music. The use of a

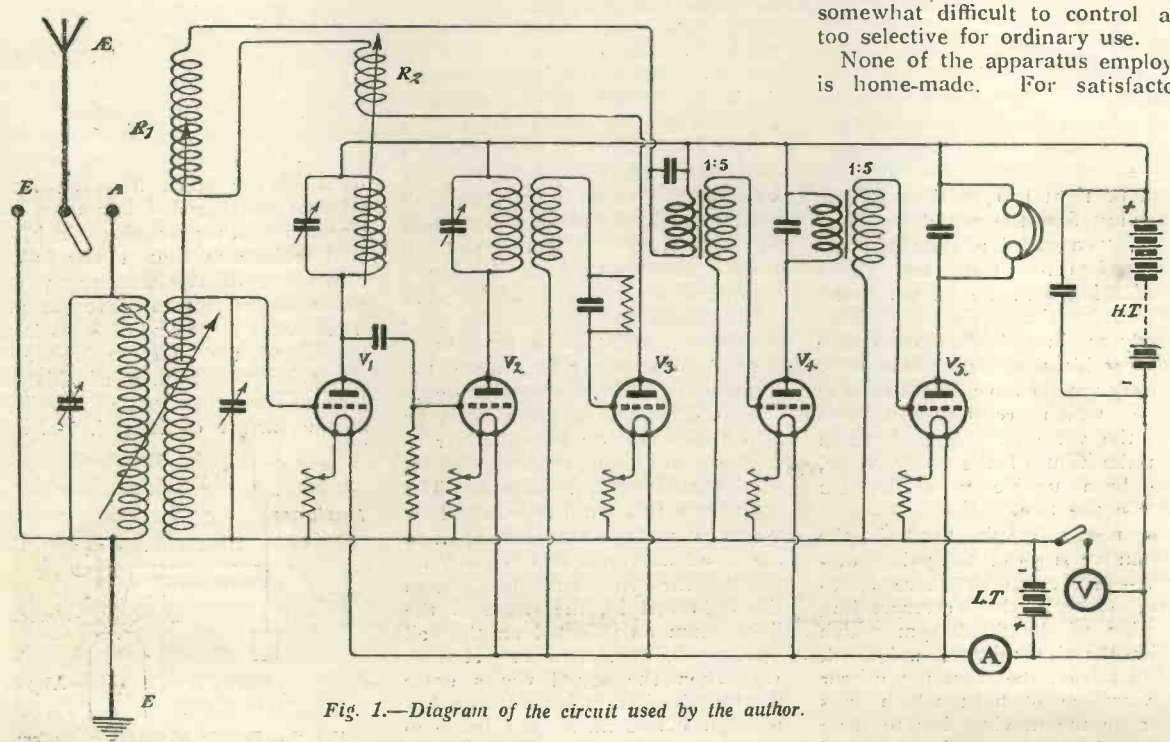


Fig. 1.—Diagram of the circuit used by the author.

loose-coupled secondary coil and two stages of H.F. amplification with their tuned circuits has been found to eliminate spark jamming almost entirely. Careful balance between the valves must be obtained if the original purity of tone of instrumental music is to be preserved. It must not be assumed that because the set is not actually howling, the amplifying valves are working to the best advantage. When the anode and grid terminals of each valve are touched successively no squeal or even hollow click should be audible in the 'phones. The offending circuit is easily identified in this manner.

Three pairs of telephones—one on 70 feet of flex to enable it to be taken to any room in the house—are connected up to the set with switching arrangements to permit of one, two, or three being used in series. (Not shown in diagram.)

With four valves in use 2LO is received as loudly as is desirable. Pianoforte solos come in especially well; it is possible to distinguish clearly the moment at which the pianist releases the sustaining pedal at the conclusion of an item.

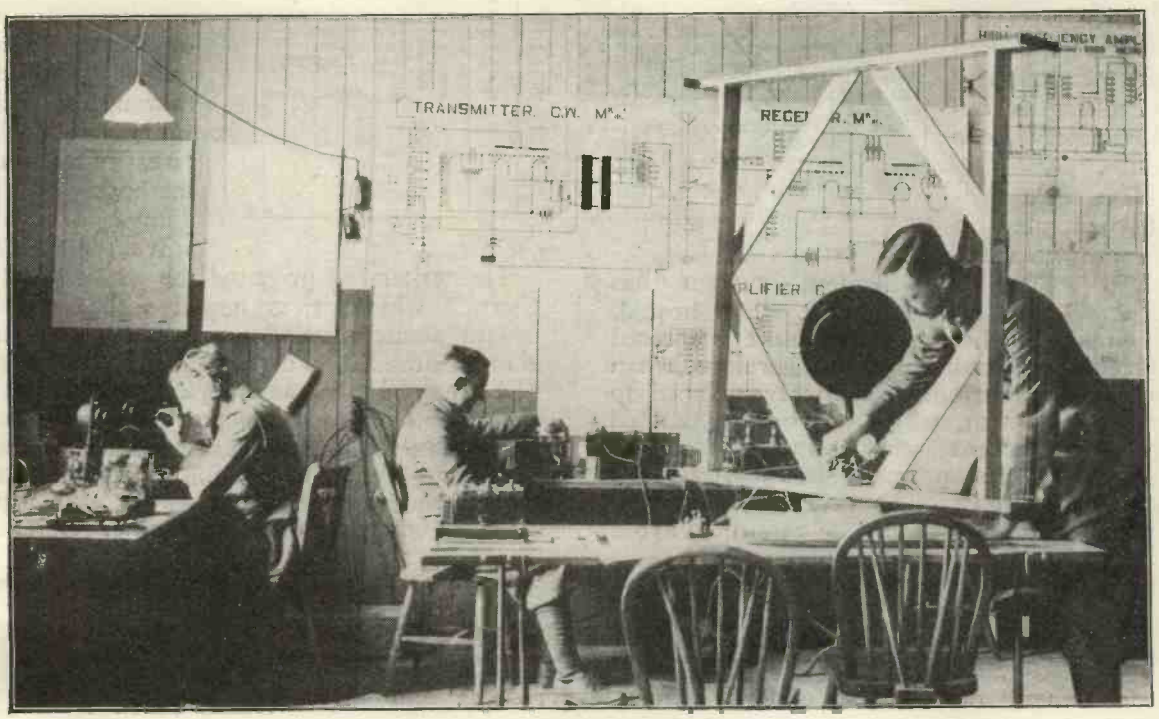
2LO can be heard distinctly with the aerial earthed. On good nights it is even possible to make out the news items. When trying this it should be remembered that additional capacity, corresponding to that lost by disconnecting the aerial, must be added to the aerial tuning coil.

The fifth valve is seldom used for broadcast reception. Its chief function at present is to assist in deafening unwary friends with Paris time signals.

5SC has improved enormously since the station was opened. At first it was decidedly poorer than 2LO on four valves. Now two valves are the most that can be used in comfort with head-'phones.

In conclusion it may be stated that Ediswan E.S.2 valves are used. These require the low anode voltage of 25-30 volts; and the usual 6-volt accumulator as L.T.

MILITARY WIRELESS



The photograph shows a corner of the Royal Military College at Sandhurst. The cadets in the illustration are learning to apply wireless to military uses.

CONCERNING VALVES

By "EXPERIMENTER."

A contribution of especial interest to readers who are commencing to use valves.

ALTHOUGH valves have come down considerably in price during the past twelve months, the average experimenter is not yet in a position to treat them with contempt. After a certain amount of experimenting one gets to know the little fads of the various types of valve, and can treat them accordingly, but a beginner who has little, if any, knowledge of valves, will perhaps be glad to take a little advice from one who has passed through the "filament breaking" stage.

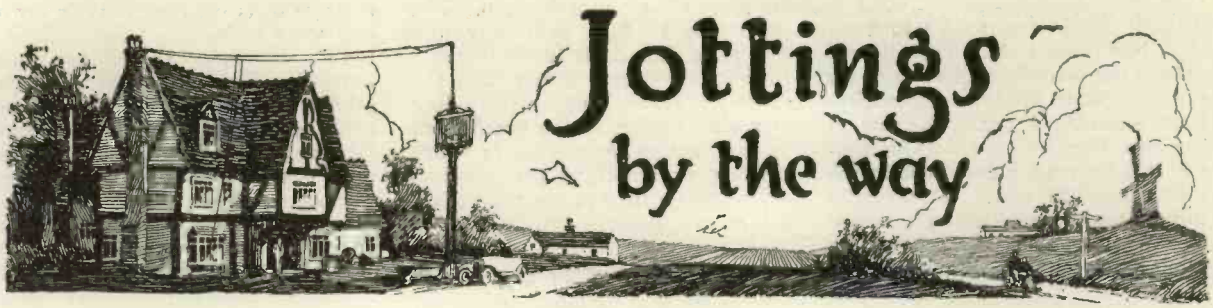
The average life of most receiving valves, if used with care, may be taken as approximately 1,000 hours.

The most sensitive moment in the life of a valve is just after the filament current has been switched off. A metal, when heated, expands, and when the temperature is lowered will contract accordingly. Therefore, when the filament current is suddenly reduced to zero, the element, which has been expanded while the current was passing, will slowly contract to its normal size. Obviously, during this contracting process, it is very sensitive, and one should be careful to avoid rough usage; the slightest knock will in most cases damage it.

It is advisable to mark the H.T. and L.T. terminals of one's set, as it is quite easy to connect up *vice versa* accidentally; this generally proves fatal to the valve. When closing down, unless a cut-out switch is provided, the accumulator leads should always be disconnected. Always employ a filament resistance which will carry double the nominal current of the valve. Do not attempt to utilise the house-supply for heating the filaments of your valves, unless you are thoroughly conversant with the various methods of so doing, or your valves will suffer.

Valve.	Type.	Voltage.		Fil. Current.	Suitable for			Remarks.
		Anode.	Fil.		H.F.	Det.	L.F.	
Marconi .	"R"	60	4	0.7	x	x	x	
	V24	36	5.2	0.75	x	x	x	
	R4B	50—70	3.8	0.65	—	x	x	
	"Q"	50	5.2	0.7	—	x	—	150 volts a amplifier.
	QX	50	5.2	0.7	—	x	—	
	L.T.1	36—50	1.8	0.4	x	x	x	Special Low Temp. Valves.
	L.T.3	36—50	1.8	0.11	x	x	x	
	AT25	1000	5.5	1.25	—	—	—	Transmitting.
	AT40x	1000	7	1.5	—	—	—	Transmitting.
Mullard..	"R"	40—50	4	0.65	x	x	x	
	"ORA"	30	3.5/4	0.7	x	x	x	A good all round valve.
	O20	200-400	5.7	1.5	—	—	—	Transmitting.
	O30	400—600	7	1.25	—	—	—	Transmitting.
	P.A.	100—300	3.5/4	—	—	—	—	Power Amplifier.
Cossor ...	P.1.	30—80	3.5/4	0.4	x	x	x	
Ediswan .	"AR"	30—80	3.5/6	0.75	x	x	x	High amplification.
Economic Elec. ..	Magnos	25—40	3.8	0.5	—	x	—	
	"Xtra-udion"	50	4	0.5	x	x	x	
Rivers Moore .	"RMR"	30—45	4	0.75	x	x	x	

The writer has prepared the above "Valve Chart," which it is hoped will prove of use to amateur valve users. Although this is only intended as a rough guide, the values given may be taken as fairly accurate. To the experimenter who is constantly using different types of valves, the writer advises him to draw up a chart similar to the one shown, and find by experiment the best values for each type, the chart being preserved for further reference.



"Dang they New-fangled Notions."

THE war now being waged by actor-managers, musicians, and others against the British Broadcasting Company is very sad and not a little ridiculous. It is, of course, no more than an exhibition of the opposition which mankind in general and our nation in particular always offer to any new thing. Nothing could have been more strenuous than the efforts made during the early days of the last century to strangle the railways at birth, and there has been similar well-meant, but quite misguided, opposition to every innovation of importance. Think, for instance, of what took place when machinery was introduced into the cotton mills; of the ridicule poured on the bicycle in its early days; of the efforts made by legislation thirty years ago to prevent the motor car from becoming of practical use; and of the outcry raised by sailors when marine engines were invented. Each and every one of these things was regarded as a potential scourge to humanity, likely to cause widespread unemployment; and each and every one of them has proved such a boon that we cannot now imagine the world without it. Far from causing unemployment, they have all given rise to great new industries providing work for millions where no work was before their arrival. The theatres have had experience in the past of a form of broadcasting, though the fight that they then put up took place so long ago that it has been forgotten. When the electrophone was introduced it provoked bitter lamentations, just like those of to-day. Everyone would instal the device, and as theatrical performances could be heard at one's own fireside no one would go to theatres. The electrophone came. Thousands installed it. There was no fall in theatre receipts. No doubt when Eve sat stitching her first fig-leaves Adam shook his head mournfully, pointing to the despoiled trees and prophesying that if that sort of thing went on figs would shortly become extinct.

Why this Thusness?

For the life of me, I cannot see why there should be any objection to the broadcasting of copyright songs. I had always thought that if you wanted to make money out of a song, the best way was to get every barrel-organ to grind out its melody and every errand-boy to whistle it. It thus became well known, giving great joy to some and driving others to the verge of insanity. The admirers went out and bought every man his one copy; while those whom its notes filled with hatred, fury, and despondency also fared forth to the music-shops buying up all available copies and consigning them to the flames. In either case the writer and the composer made money, which, I take it, is the main thing. But if new songs are to be kept as grim secrets, then how on earth is anyone to be induced to invest in them? If they are good songs they will obtain an enormous advertisement from broadcasting. Can it be that they are mostly so bad that to hear one of them is to resolve that nothing shall ere make you buy it? Surely not. The Americans, who have had a considerable experience now of the effects of broadcasting, do not find that it leads to closed theatres or to the workhouses being chock-a-block with ruined composers. On the contrary, Uncle Sam, who gives nothing for nothing and darned little for a dollar, has discovered that it is an excellent thing for trade. If all the dreadful things foretold here were likely to come about, they would have happened in the States, where one person in every thirty of the whole population possesses a wireless receiving set. The plain fact is that they have not happened there.

The Sabbath Peace.

Sunday is nominally a day of rest and peace. Paterfamilias, having helped himself far too liberally at the traditional heavy midday meal, used to make tracks for the biggest chair in the house, in which he slumbered heartily all the afternoon. Then he stoked up again with cold beef and baked potatoes, and retired early to bed. All this is changed since wireless became the prevailing hobby. The head of the family now lunches off the merest snack, after which, resisting all the allurements of the padded chair, he sallies out to his workshop to tinker with variometers and condensers and things of that kind. His couch knows him not until the wee small hours, for he is to be found in his den, with receivers fixed upon his head, eagerly listening for distant transmissions, and logging Northolt's harmonics as messages from dozens of different Yank amateurs.

Little Worries.

The Sabbath peace has departed, and the erstwhile day of rest has become filled with exasperating moments. I have never been able to understand why it is that all manner of things that behave beautifully on week-days select Sunday for breaking down, conking out, or getting lost. On week-days it matters not a jot, for they can be replaced; but when this kind of thing happens, as it always does, on Sunday, nothing can be done. Here is a case for you. I have two accumulators—the vulgar may here exclaim "Swank!" if they wish to. One of them lives on the bench, whilst the other remains at the

charging station until wanted. Thus if the first runs down I merely trot him round for a refill and collect the second, which waits for me charged to his utmost capacity. Last Saturday I tested the one in use and found all well. On Sunday it, of course, petered out in the most approved style. Could anything be more maddening? There was a fully charged accumulator lying ready within a stone's throw, yet as "ungetatable" as if it had been at the North Pole. It's just the same with everything else: no matter how careful you are to lay in everything that can possibly be wanted before the shops close on Saturday, something of vital importance is always found to be missing, or some indispensable tool breaks on the next nerve-racking day.

Glorious Uncertainty.

It is most curious to notice the way in which one's receptions vary. A week ago I could get Manchester whenever I liked, even though 2LO and Birmingham were working at the same time. Now 2ZY has disappeared altogether, and tune I ever so wisely I cannot induce him to break silence. One can understand that reception may be very much better on some days than on others, but why in the name of all that oscillates the selectivity of one's tuning arrangements should vary is most puzzling. Yet so it seems to be. For the moment both 2LO and 5IT are poaching, and poaching badly, on other people's preserves on my condenser dials. Is it that their transmissions are tuned much more flatly on some days than on others? I do not know. It is just these little problems that make wireless the most interesting of all hobbies.

The Prevailing Passion.

The passion for constructing has taken a firm hold of the great British people. Schoolboys evolve marvellous sets from cocoa-tins, bell wire, and bits of curtain-rod; whilst even the most staid of elders may be heard boasting of the super excellence of the fixed condenser which he ran together an evening or two ago. If we don't construct, we improve. We cannot leave things as they are, but must add a gadget here, a gadget there. No one with any soul can allow his wireless set to remain in one form for more than a month or so. You have only to fight your way into any shop that deals in small parts to see how deeply bitten with the craze for set-building or rebuilding is a vast section of the population. In fact, not to be engaged in either making or redesigning a wireless set stamps a man at once as rather behind the times.

The Sad Case of Broggsworth.

It is to this national urge, and to the keen desire not to be out of the running, that I trace the downfall of Broggsworth. Not long ago he was one of the most respected of citizens, a churchwarden, the sort of man who might easily become mayor if he were not careful, a business man of undoubted integrity, the father of a model family. To-day Broggsworth's name is mud. The man, despite his noble record in the past, is discredited; the finger of scorn (sometimes in the case of schoolboys four fingers of scorn, with the thumb of derision applied to the nose of mockery) is pointed at him. He appears in the streets now only at night; knowing that he is safe then, since everyone else is at home listening-in. He is a broken man. But let me tell the story. Six months ago wireless fever broke out in Little Puddleton; the epidemic spread like wildfire, and its victims were numbered by the dozen. All Broggsworth's friends went down with it; he himself had a mild attack. Within a week or two they were building sets. Broggsworth had never been mechanical, nor was he scientific. In spite of all his reading, he had considerable difficulty in distinguishing between an anode and an ampere.

The Downfall.

Spurred on by their taunts, Broggsworth announced one day that he, too, was in the throes of construction. In course of time his seven-valve receiver was completed, a large boxed-in affair covered with knobs, degree scales, and long ebonite handles. Friends saw and admired, saw but never heard. Whenever they called there was always some trifling defect which prevented the set from being brought into action. This, of course, did not surprise them, since they were all in the habit of reporting similar minor casualties to *their* friends whenever their own sets were under inspection. Eventually, however, suspicions were aroused. The friends heard each other's sets working. Though in every case reception was only a quarter as good as it had been on the previous evening when the owner was alone, still it was reception. Broggsworth, however, despite the fact that he professed to eschew home broadcasting in favour of amateur concerts from the South of France, had never given them a demonstration even of the muffled, distorted type that all self-respecting sets reserve for their owner's visitors. One evening three of them were shown into his den by the maid, who bade them sit down a moment, as her master was engaged. They moved towards the set. Quite unconsciously and with no malice aforethought one of them produced a screwdriver from his pocket, and in a moment the ebonite top was severed from its cabinet. A profusion of knobs and things decorated its upper side, as we have seen. But what of the depths beneath? Ah, my brothers, how shall I tell it? The beautiful cabinet was as empty as the taxpayer's pockets after he has parted with his quota for the upkeep of Merrie England, void as the mighty realms of space. Silently they stole away, helping themselves from the decanter as they passed to steady their shattered nerves. Broggsworth had meant no harm. He could not bear to be out of it, that was all. But he will never live down the scandal, and must go through life a marked man. Poor Broggsworth!

The East Coast's Plaint.

The East Coast of England from Scarborough down to Norwich is probably the worst-served part of the country as far as broadcasting goes. If you glance at the map you will see that dwellers in those regions have no broadcasting station within about a hundred miles of them. Hull would be an ideal centre for an East Coast station, for its transmissions would serve the East Riding of Yorkshire, Lincolnshire, and Norfolk. At present aerials are few and far between in the towns on the coast, for unless a pretty big valve-set is installed there is nothing to be heard from the home stations.

WIRELESS WAYFARER.

A LIMITING DEVICE

By JOHN SCOTT-TAGGART, F.Inst.P., Member I.R.E.

This article deals with a method of limiting the effect of atmospherics or strong signals.

THE particular advantage of a limiter is in repressing particularly strong atmospherics, and although such a limiter is by no means an infallible method of overcoming the effects of atmospherics, yet it frequently provides a palliative.

The most commonly known method of limiting signals is that which employs a three-electrode valve operating near the top bend of its characteristic curve. Obviously, under these conditions, a strong signal cannot be made to have any greater effect on the output circuit of the valve than a weaker signal, owing to the fact that there is a limit to the current which will flow in the anode circuit, this limit being determined by the electron emission from the filament.

In the arrangement to be described quite a different principle is employed. Two valves are used, both as amplifiers, and their output circuits are connected so as to give a common output circuit. Both grids are connected together, although in the lead to the grid G_2 of the valve V_2, shown in the figure, there is a battery B which makes G_2 considerably negative, so that normally there is no current flowing between filament and anode of the valve V_2. The valve V_1, on the other hand, is preferably operated on the straight portion of its characteristic curve.

In the anode circuit of each valve is a high resistance. These resistances are marked R_1 and R_2 in the diagram. A common high-tension battery H is provided, and variable connections may be taken from R_1 and R_2 to the terminals Y and Z as shown.

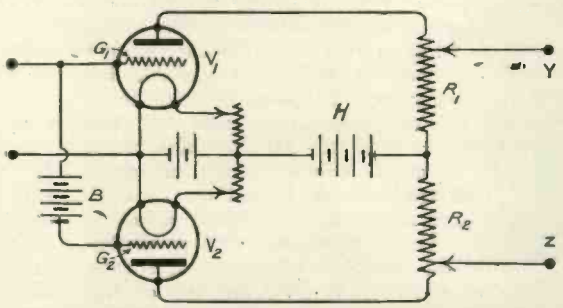


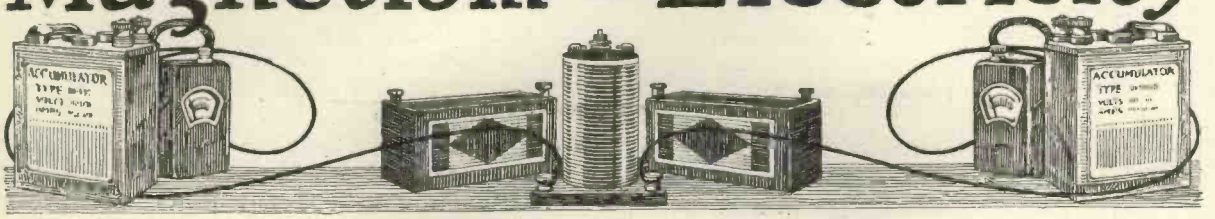
Fig. 1.—The circuit described whereby strong atmospherics and loud signals may be controlled.

When a feeble signal is applied to the input terminals the valve V_1 amplifies in the ordinary way, and a potential difference is set up across the resistance R_1. Owing to the fact that the valve V_2 is not conducting, there is no potential difference across R_2. We then have a potential difference across Y Z which is equal to the potential difference between the slider on the high-resistance potentiometer R_1 and the positive terminal of H. If, however, a strong signal is applied to the input terminals in such a direction as to make the grid positive, the potential on the grid G_2 is rendered less negative, and an anode current begins to flow; this anode current flowing through R_2 sets up a potential difference across Z and the positive terminal of H in such a direction as to oppose the potential produced across Y and the positive terminal of H.

The net result is that though for weak signals the output potential across Y Z may be taken as substantially equal to the potential across R_1, yet for strong signals the potentials across the two resistances tend to balance out, so that the potentials across Y Z are very much reduced, and they even equal zero under certain adjustments.

The output potentials might conveniently be applied to a three-electrode valve for purposes of amplification when it is intended to use the device for loud-speaker work.

Magnetism & Electricity



By J. H. T. ROBERTS, D.Sc., F.Inst.P., Staff Editor (Physics).

Readers who are taking up wireless as a hobby, and have little or no electrical knowledge, will find a careful perusal of this special series of articles of great assistance.

PART IX

(Continued from No. 8, page 475.)

Variable Inductance Coil

FOR some purposes in wireless it is necessary to employ coils, the inductance of which can readily be varied. The inductance of a coil depends upon the number of

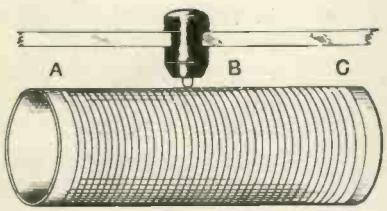


Fig. 1.—Variable inductance with sliding contact.

lines of magnetic force which are called into existence when unit current passes through the coil. Since all the turns of the coil have the same effect one as another, the inductance of the coil will depend, amongst other things, upon the number of turns in the coil. An obvious way, therefore, to vary the inductance in a circuit is to include in that circuit a greater or less number of turns of the coil. This is one of the simplest ways of making a variable inductance. The practical method by which various numbers of turns are included in the circuit is a matter of convenience, but two simple methods which are very commonly used are indicated in Figs. 1 and 2. In Fig. 1 a coil is wound upon a cardboard cylinder and a rod is mounted parallel to the axis of the cylinder and in fairly close proximity to the wire. Upon this rod a contact pin is arranged so that it may slide from one end to the other. The insulation of the wire is scraped away along a line (which represents the path traced out by the sliding contact as it moves along the coil) so that the pin may make actual contact with any turn upon which it rests.

Fig. 2 represents another simple method of making a variable inductance. Tappings are led from the coil every few turns and the wires from the tappings are taken to metal contact studs arranged in semi-circular formation. A contact arm may be rotated so as to make contact with any particular stud. If the circuit arrangements are as shown, the amount of the inductance coil included in the circuit is that of the turns of wire connected to studs 1, 2, 3, 4 (contact-arm W) and those connected to studs A, B, C, D (contact-arm X). Rotating the contact-arms will embrace different numbers of turns.

Variometer

It has been explained that the mutual inductance between two coils of wire depends upon the number of magnetic lines of force from one coil which pass through the other. This mutual inductance is a reaction effect which takes place between the two coils. If the coils are arranged so that the direction of the magnetic field due to the first one is the same as that due to the second, and if the positions of the coils are such that some of the magnetic field from the first coil passes through the region of the second, the total magnetic field in the second coil will be greater than it would be due to itself alone, because it will be receiving some of the magnetic field of the first coil. The same considerations apply to the first coil itself, which receives some of the magnetic field from the second coil. If the second coil be rotated until it is at right angles to the first, the mutual induction will be reduced, and if it is rotated still further until it is again co-axial with the first coil, but in such a direction that its magnetic field opposes the magnetic field due to the first coil, the effect of the mutual induction will be still less. An arrangement of this kind is called a "variometer," and is frequently used in wireless for producing a variable inductance (see Fig. 3). In wireless circuit diagrams, a variometer is

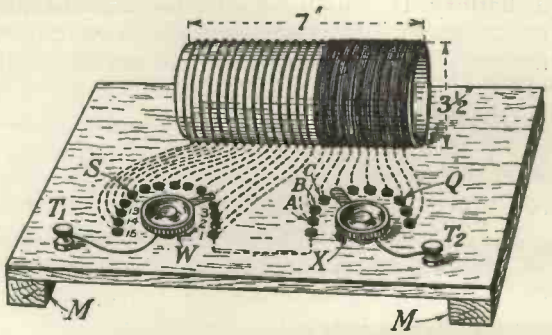


Fig. 2.—Variable inductance with tappings from coils and contact-arm rotating over contact studs.

indicated as shown in Fig. 5b. A variable inductance of the kind described above, with either a sliding contact or a contact-arm rotating over a series of metal contact-studs, is indicated in a circuit-diagram in the manner shown in Fig. 6.

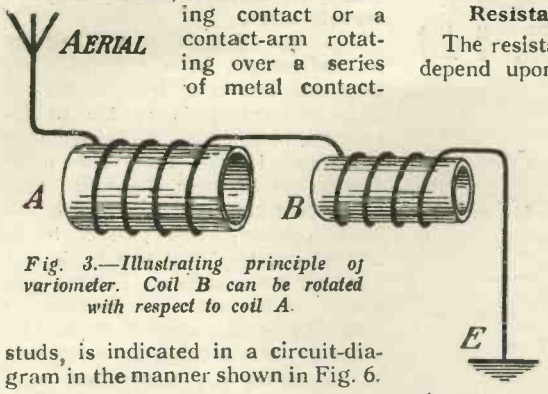


Fig. 3.—Illustrating principle of variometer. Coil B can be rotated with respect to coil A.

The Telephone Receiver

Whilst we are on the subject of electromagnetism, it will be convenient to describe the action of the telephone receiver. This appliance serves the function of converting energy which is in the form of fluctuating electric current into energy in the form of sound-waves in the air. When you speak into an ordinary telephone, the sound-waves produced by the voice impinge upon a small diaphragm and set it into vibration. These vibrations in the latter device, called a "microphone" (which will be described in detail later on) have the effect of setting up variations in an electric current through the microphone, the current fluctuating in accordance with the vibrations due to the voice. This fluctuating electric current is conveyed along the wire to the telephone receiver at the distant end.

The telephone-receiver consists essentially of an electromagnet, in front of which is mounted a small iron diaphragm. The fluctuating current received from the line passes through the coils which are wound upon the electromagnet, and the strength of the magnetic field fluctuates in accordance with the incoming electric current. Consequently, the attractive force on the iron diaphragm fluctuates in a similar manner, and the diaphragm vibrates accordingly. It will thus be seen that the vibrations of the diaphragm of the telephone-receiver will correspond to the vibrations of the microphone-diaphragm which originally received the speech-sounds, and sound-waves will be set up in the air which will reproduce the original speech-sounds.

Fig. 7 shows the general arrangement of the telephone receiver.

Resistance of Telephones

The resistance of a telephone will depend upon the number of turns of wire which are wound upon the poles of the magnet, and upon the diameter of the wire. The reader will have heard of "high-resistance" and "low-resistance" telephones, and beginners frequently ask what is the difference between these two types of telephones.

Generally speaking, the resistance of a "low-resistance" telephone is of the order of, say, 100 ohms, and the resistance of a "high-resistance" telephone may be of the order of 2,000 to 4,000 ohms. A low-resistance telephone has a comparatively small number of turns of fairly thick wire wound upon the magnet, whilst a high-resistance telephone has a large number of turns of extremely fine wire wound upon the magnet.

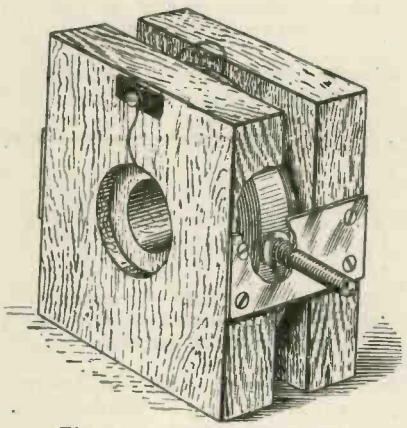


Fig. 4.—A variometer as used in practice.

It has already been explained that the strength of the magnetic field created depends, amongst other things, upon the strength of the current in the coils and upon the number of turns of wire. The sensitiveness of the telephone receiver will, therefore, be greater the greater the number of *ampere-turns*. But in order to increase the number of turns it is necessary to employ finer wire, so as to accommodate the windings within the space available. The use of finer wire means an increase in the ohmic resistance, and so, for a given E.M.F., the current will be reduced. It thus becomes a question whether, in any particular case, it is more advantageous to have a large number of turns of fine wire, or a smaller number of turns of thicker wire.

It is of importance for the reader to understand why high resistance-telephones are employed in certain cases; I am frequently asked what is the *advantage* of high-resistance. The way in which high-resistance telephones are spoken of is apt to give the beginner the impression that there is some advantage in the high-resistance as such. This, of course, is not the case. The resistance is a necessary evil, but it is none the less an evil, and it is only because high-resistance telephones give greater sensitivity, in certain cases, than low-resistance telephones that they are employed. Perhaps the misunderstanding would not arise if the telephones were described in another way. If instead of saying a "high-resistance" telephone we said "a telephone having a large number of turns of wire" the matter would, no doubt, be clearer.

An example will be useful to illustrate this point. Suppose we have a simple wireless circuit which includes a crystal detector in series with a pair of head-telephones. The resistance of the crystal detector may be anything between 10,000 and 50,000 ohms; let us suppose, for the sake of example, it is 40,000 ohms. Let the resistance of the telephones be 4,000 ohms and the

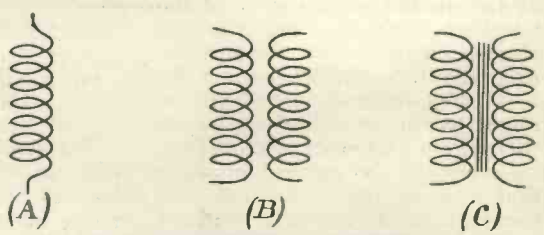


Fig. 5a. — Diagrammatic representation of (A) inductance coil; (B) air-core transformer; (C) iron-core transformer.

total number of turns of wire be 1,000. Then the combined resistance of the telephones and crystal will be 44,000 ohms as against 40,000 ohms before the telephones were introduced. The telephones have the effect of reducing the current in the proportion of 40 to 44, or about 10 per cent. Now let us suppose that we substitute a pair of low-resistance telephones, say, 100 ohms resistance having only 25 turns of wire. The current will be reduced in the proportion of 40,000 to 40,100, or by an amount which is inappreciable. Thus the current through the high-resistance telephones is about nine-tenths of the current through the low-resistance telephones. The *sensitiveness* depends upon the *ampere-turns;* in the case of the low-resistance telephones the ampere-turns will be 25 multiplied by the original current, whereas in the case of the high-resistance telephones the ampere-turns will be 1,000 multiplied by nine-tenths of the current, or 900 multiplied by the original current. Thus the ratio of the ampere-turns with the high-resistance telephones to the ampere-turns with the low-resistance telephones will be, in this case, 900 to 25 or 36 to 1.

Of course, there are many other factors to be taken into consideration, such as the inductance of the telephones and so on, but, broadly speaking, we see that in a high-resistance circuit it is an advantage to use a telephone having a large number of turns, even though it has a high resistance, because the high resistance makes very little difference to the already high resistance of the circuit, whereas the large number of turns obtained makes a considerable difference to the sensitiveness of the telephone as a receiver. On the other hand, in a low-resistance circuit, the reduction of current by the high-resistance telephones might be out of all proportion to the gain in turns of wire. Thus we arrive at the general principle that high-resistance telephones are generally used in high-resistance circuits and low-resistance telephones in low-resistance circuits.

Radio- and Audio-Frequency.

When we were discussing the design and action of air-core and

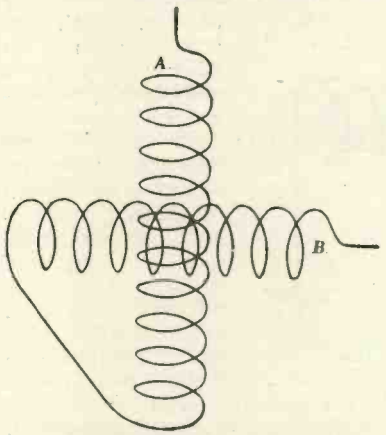


Fig. 5b.—Diagrammatic representation of variometer as used in wireless circuit diagrams.

iron-core transformers, we saw that the inductance of a transformer was enormously increased by the introduction of iron into the coil. In

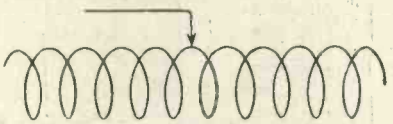


Fig. 6.—Diagrammatic representation of variable inductance as used in wireless circuit diagrams.

wireless we deal with oscillatory currents which may be divided into two main classes, viz., "high-frequency" currents, and "low-frequency" currents.

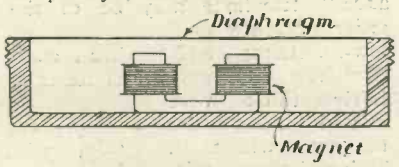


Fig. 7.—Illustrating construction of telephone receiver.

The reader will find, later on, that we may use iron-core transformers with low-frequency currents, but when we come to deal with oscillatory currents with the very high frequencies employed in wireless, we must employ air-core transformers.

A simple illustration will help us to understand, in a general way, why an iron-core transformer of large inductance is unable to respond efficiently to high-frequency currents. If we take the illustration of a boat floating upon water, we see that if we push the boat forward, then pull it back, and so on, applying one push and one pull every second, the boat will move appreciably in accordance with the forces applied to it. If, however, we increase the frequency of the forces and apply them with a rapidity of, say, ten per second, the boat will hardly have commenced to move forward before the force is reversed and it commences to move backwards and so on, with the result that the amplitude of the to and fro motion of the boat will be much smaller.

If now we apply the forces having a frequency of ten per second to a very light boat, or to a small floating piece of wood, whose mass (and inertia) are considerably less than those of the original boat, we will be able to develop a considerably larger amplitude of to and fro motion, even at the rapidity of ten oscillations per second. The inertia of the boat or wood corresponds, in a general way, to the inductance of the transformer, and this simple illustration, no doubt, will show why a transformer or coil having a large inductance is unsuitable for use with high-frequency currents.

In a wireless receiving apparatus, the incoming electrical oscillations from the aerial system are of very high frequency and the inductances and transformers employed are of the air-core type. After the currents have passed through the detector, however, the variations are of a much lower frequency, known as "audio-frequency," and the inductances and transformers employed in this part of the apparatus may be of the iron-core type.

THE BROADCASTING COMMITTEE.

Mr. A. A. Campbell Swinton, F.R.S., Past President of the Radio Society of Great Britain, is to appear as witness before the Post Office Committee on June 7th, representing the Radio Society of Great Britain and Affiliated Societies. Mr. Campbell Swinton's long association with the Radio Society and his whole-hearted work on behalf of the amateur experimenters of this country ensure that any statement put forward will carry due weight.

THE CONSTRUCTION OF A HIGH-FREQUENCY AMPLIFIER

By ALAN L. M. DOUGLAS (Staff Editor).

The following is a description of an amplifier suitable for adding to the single-valve receiver described in last week's issue.

THE chief advantage of this amplifier lies in the fact that whilst very sharp tuning is possible over the broadcasting band of wavelengths, *i.e.*, from 350 to 450 metres, by means of the wave selector switch, it is possible to at once change to resistance-capacity coupling so that amplification may be effected upon all waves from 1,500 to 30,000 metres.

At the same time, the design is such that no alteration is necessary to attach this instrument to any existing valve receiver in which the detector valve is not preceded by high-frequency stages. A glance at the photograph, Fig. 1, will reveal the main features of this device, whilst Fig. 2 shows the internal arrangement. The same constructional details hold good to a certain extent for the construction of this instrument as for the single-valve receiver described in *Wireless Weekly*, No. 8, the same type of open panel design being adopted.

Fig. 3, which shows the wiring of the components as actually carried out on the panel, will at the same time indicate the disposition of the coil, condenser, resistance, and filament rheostat. The ebonite panel on which the various parts are mounted measures 8in. by 6½in. by ¼in. thick, and should be drilled in accordance with Fig. 3. The actual placing of the components is not a matter of great importance, so that working drawings for the exact position of the holes in the panel have not been given.

List of Materials

Before commencing the construction of the amplifier, it will be as well to lay in all the necessary material to complete it. The following parts will, therefore, be required.

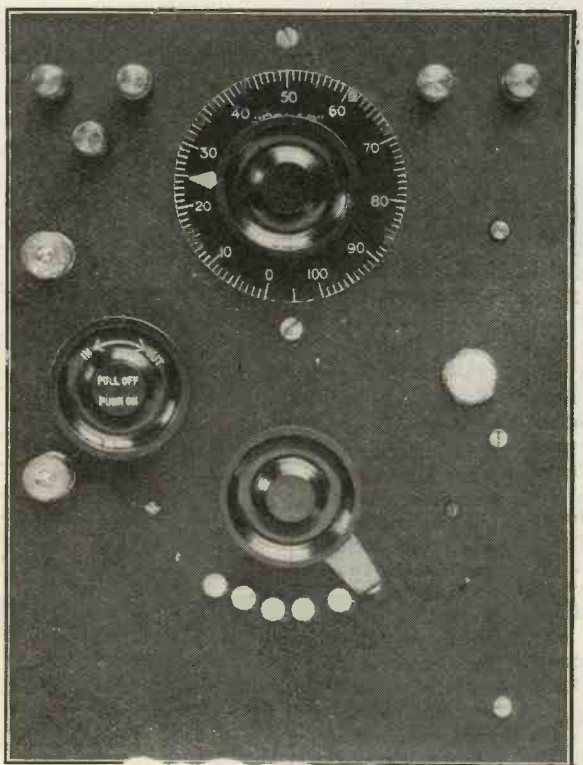


Fig. 1.—The exterior of the panel.

One ebonite panel, dimensioned as in Fig. 3.

One ebonite tube, 3½in. by 4½in.

One variable condenser, 0.0003 μF.

One anode resistance, 80,000 ohms.

One filament rheostat.

One valve holder (and window).

Seven terminals.

One switch arm.

Six contact studs.

And the necessary screws, nuts, etc., for the actual attachment of the component parts.

Fig. 4, which is an elevation of the instrument, will make clear that all that is necessary to make a thoroughly workmanlike job of the amplifier is the usual small selection of tools which every experimenter possesses. For instance, as in the single valve receiver previously described, only three sizes of drills are necessary, namely,

1 6 B.A. clearing.

1 ¼in. Whitworth.

1 9/16th Whitworth.

The only other tools necessary are a pair of pliers and screwdriver.

The Anode Coil

The amplifier works on the tuned anode principle, that is, a coil, having the necessary number of turns of heavy gauge wire, is shunted by a variable condenser of low capacity, so that the frequency of the combined inductance-capacity circuit may be adjusted to that of the incoming oscillatory currents. When the inductance-capacity circuit satisfies these conditions, its resistance to high-frequency currents is practically infinity, and therefore maximum amplification is secured. It is important in constructing a high-frequency amplifier for short wavelengths that the

resistance of the wire with which the coil is wound be as low as possible. By way of an example, the resistance of 100 feet of No. 14 s.w.g. copper wire to currents of a frequency of 1,500,000 (which implies a wavelength of 200 metres) is about 100 ohms. On the other hand, if fine double cotton covered wire is used, and the turns placed close together on the coil, the capacity existing between the turns of wire themselves may have a damping effect upon the circuit. It is therefore generally necessary to attempt to strike a happy medium, as it were, and in this case the amplifier coil should be wound with 22 gauge double cotton covered wire.

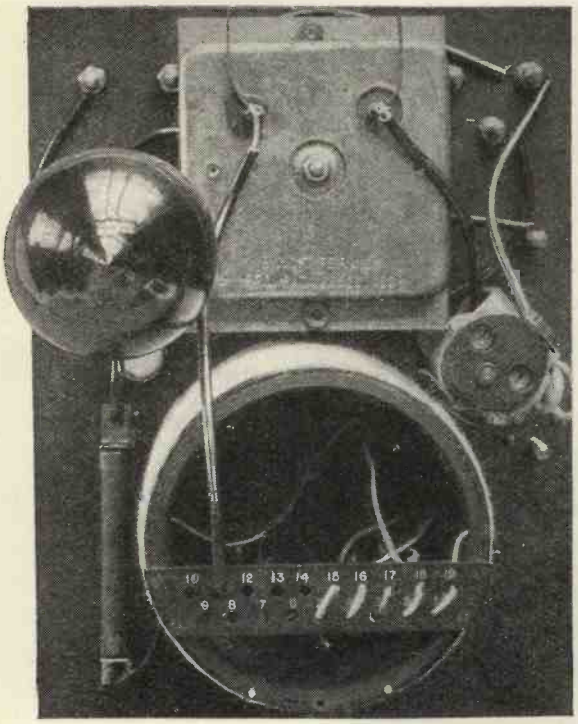


Fig. 2.—Interior view showing the actual connections.

The former, which is 3½in. in diameter and 4½in. long, should be wound with 100 turns of this wire, tappings being taken at every 20 turns. This, in conjunction with the variable condenser of 0.0003 μF, will comfortably cover the specified range and at the same time allow of sufficiently sharp tuning to almost entirely eliminate unwanted stations.

Fig. 6 will show how a small strip of ebonite, drilled with a number of holes, is attached to the end of the amplifier coil so as to form a secure anchorage for the tappings. This may consist of a strip of ⅛in. ebonite, 1in. wide, and of such a length that it may be screwed to the end of the coil. The actual fitting of the former to the back of the panel is effected by means of two 6 B.A. countersunk head screws, these being sufficient to hold it rigidly in position. This completes the construction of the amplifier coil.

The Tuning Condenser

This may be clearly seen from Figs. 2 and 4, and consists of a "Polar" patent mica dielectric continuously-variable panel mounting instrument. This condenser was selected on account of the fact that the frequency change for any one degree movement of the scale on this condenser is approximately equal at all points. This is in direct contrast to the usual moving vane type of condenser, in which the tuning is very sharp when the moving vanes enter the fixed vanes, and very flat when the full capacity of the condenser is approached. It will thus be easily seen that not only is easier tuning possible, but signal strength is also considerably improved when it is possible to accurately regulate the capacity of the condenser. A further advantage of this device is that the instrument is totally enclosed in a brass case which acts as an earth screen.

If the reader wishes to make up his own condenser so that the ordinary vanes and components obtainable from any dealer in wireless accessories may be used, full constructional details were given in *Modern Wireless*, No. 3, to which he should refer. It might be said that a condenser of the ordinary type with a similar capacity would have about 15 vanes, 8 fixed and 7 moving. The mounting of this particular type of condenser, as will be seen from Fig. 4, is remarkably simple; the method by which it is connected in circuit will be seen from Fig. 3.

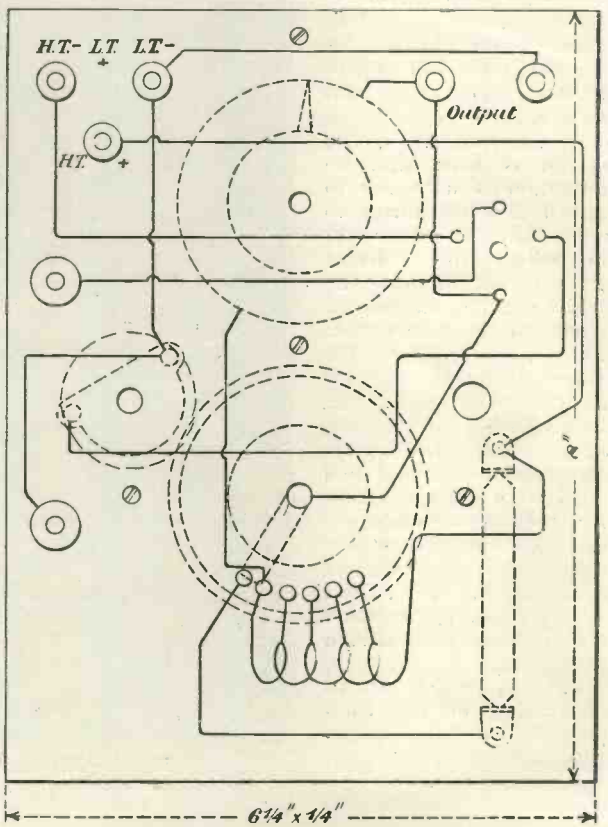


Fig. 3.—Wiring at back of panel.

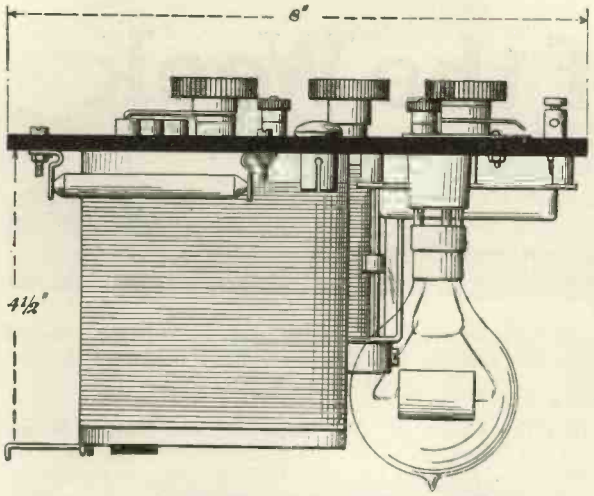


Fig. 4.—An elevation of the complete amplifier.

The Filament Rheostat

The correct filament temperature of valves amplifying at radio-frequency is generally critical, and therefore some type of filament resistance which gives fine control is advisable. The special pattern used in this instrument, which can be obtained from advertisers in this journal, possesses not only the advantage of exceedingly fine adjustment, but has also a switch fitted to one end of it so that by pulling out the knob the current may be cut off. It is also so designed that there is continuous contact with the wire, and therefore no scraping noises, due to intermittency of contact, will be observed in the telephones. Attention is directed to the method of connecting the rheostat in the negative battery lead, so that the grid of the high-frequency valve has a definite negative potential with regard to the filament. It will be appreciated that the adjustment of the rheostat can therefore be made to control the grid potential to a considerable extent.

The Switch Arm

A common fault of the cheaper patterns of switch arms now on the market is that very erratic contact is made with the studs upon which they bear. An inspection of a large number of "home-made" wireless sets reveals the fact that comparatively few take the trouble to round-off the corners of the various leads of which the contact blade is composed, possibly due to the fact that there are thousands of persons who build quite complex receivers but do not even possess a file. Particular care should be taken when fitting the spindle of the switch arm to the panel, so that the necessary tension does not decrease owing to imperfect tightening of the nuts on the spindle, and the experimenter should remember that a small strip of copper foil, if placed underneath the spring washer on the spindle, will ensure satisfactory contact being made with the switch arm.

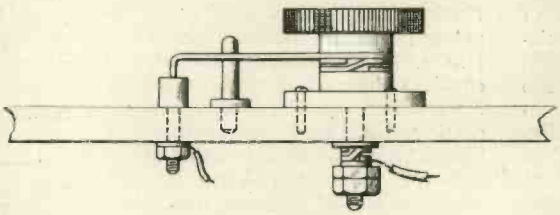


Fig. 5.—The switch arm.

It is also a common fault to buy contact studs of unreliable and indifferent manufacture. These are generally uneven and make very bad contact with the switch arm, and, owing to the very short wavelengths on which broadcasting is carried out, and therefore the abnormally high frequencies which are being dealt with, any small resistance in the amplifier circuit causes an enormous falling off of efficiency. The connections to the back of the studs should be bared and carried out by the nut and washer provided with the studs when they are purchased. If the wire is clean and a sufficiently large area of it is exposed to the washer, a better joint may result than would be the case if solder were used.

Suitable stops for arresting the movement of the switch arm may be tapped into the panel if desired, and in this connection it should be noted that valve pins make excellent stops at a very low cost. These usually have a 4B.A. thread.

The Valve Holder

As it was originally intended that this amplifier should be fitted in a wooden case, the valve holder is attached to the underside of the panel and an Elwell valve window is inserted so that the operator can see the filament burning. The method of attachment will be clear from an examination of Fig. 7, which shows how the valve-holder legs are cut off short and slightly recessed into the underside of the panel. No further explanation of the fitting of this device is necessary, but it should be pointed out that it is an advantage to use some pattern of valve having a low internal self-capacity, such as the V.24. The Cossor Valve Company have now on the market an improved pattern of valve suitable for this work, which the author has personally found to give excellent results, but almost any good valve will function satisfactorily if the

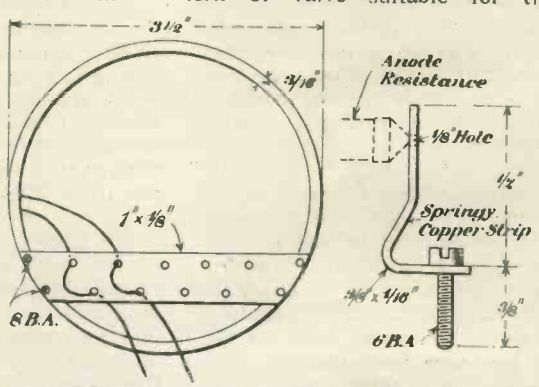


Fig. 6.—Showing how the tappings are made secure.

(*Continued on page* 556.)

News of the Week

A NEW wireless station is being erected at Pendleton by members of the Manchester Wireless Society. The new station is to employ a power of 1,000 watts, and its Call Sign will be 5MS. It is being built for the next series of transatlantic tests, and will work in conjunction with 5MT, the Society's station at Baguley, in Cheshire, which did such good service in the last test.

* * *

In the absence of the much desired relay station, Sheffield amateurs are very appreciative of the local experimental transmissions each Monday evening between 8 and 8.30 on a wavelength of 200 metres. Interest in wireless in Sheffield is increasing rapidly. The Sheffield Wireless Society has now a membership of nearly 200, and several other clubs are being formed throughout the city.

* * *

The Russian authorities have decided to erect a wireless station on the island of Nova Zembla, to communicate with Archangel and other stations in North Russia and Siberia. The station will also serve in a scientific direction, and, in addition to the wireless experts and meteorologists, the personnel will include a geologist and a zoologist.

* * *

A most striking example of the efficiency of a personal broadcast appeal is afforded by the remarkable response to the recent appeal of Lord Knutsford on behalf of the London Hospital. Letters containing amounts varying from 2s. 6d. to £100 have been received from all over the country, even from places as far distant as Stirling and Torquay. Up to the time of going to press the total sum received is £4,190, but, as collections are proceeding in many city offices, this figure is likely to be considerably increased. This response indicates the great extent, and incidentally the character, of 2LO's Sunday evening audience.

* * *

It is announced that the Canadian Government are to proceed with the erection of a wireless station on St. Paul's Island, at the entrance to the Gulf of St. Laurence, 25 miles from Cape North, with which it is connected by cable.

* * *

The Committee, under the Chairmanship of Major-General Sir Frederick Sykes, which was appointed by Sir William Joynson-Hicks, ex-Postmaster-General, to consider the agreement between the Post Office and the British Broadcasting Co., and the future of broadcasting, is now meeting three times a week. Judging by the large amount of evidence which has to be considered, it will be some time before a final decision is arrived at. We have already suggested that an interim report should be issued.

* * *

Lord Riddell, the Chairman of the Newspaper Proprietors' Association, gave evidence before the Committee on the broadcasting of news and its effect on the Press. Further evidence on this aspect of the question is to be given by representatives of the Newspaper Society and the principal news agencies.

* * *

We gather that a movement is on foot with a view to securing a re-radiating or relay station for Hull and district. It is suggested that at present listening-in in the Hull district is proving too expensive to become general.

* * *

The *Times* correspondent reports that the first wireless telephone connection between Copenhagen and the Island of Bornholm in the Baltic Sea has just been opened. King Christian was the first person to use the instrument, by means of which he talked with the Senior Magistrate of Bornholm.

* * *

We learn that the Cardiff Wireless Exhibition proved so successful that it was decided to extend it over another week. The special competition for home-made sets has been an interesting feature of the Exhibition.

* * *

We understand that the Women's Radio Circle held an inaugural dinner on Monday, May 28th, at the Lyceum Club, Piccadilly. Amongst the guests of the evening were Sir Henry Jackson, Lady Jackson, Sir Oliver Lodge, and Senatore Marconi.

* * *

According to the *Irish Times*, a very successful public demonstration of broadcast reception was one of the main attractions at the fête in aid of the Coombe Hospital, recently held in St. James's Park, Dublin. So successful was the experiment that reception was maintained for nearly four hours, songs, piano solos, etc., being clearly received from Manchester, Birmingham, and Newcastle.

* * *

We recently stated that the French already have their "broadcasting controversy" very similar to our own. They have now a further problem in connection with the use of broadcasting as a means of propaganda. This arises out of a political attack on M. Clemenceau, broadcast by General Mangin.

* * *

Just as we go to press we learn that the construction of a further broadcasting station, the eighth station operated by the British Broadcasting Co., is to be proceeded with at once at Aberdeen. This is splendid news for the North Country enthusiasts, who, up to the present, have required more or less

expensive apparatus in order to obtain satisfactory results.

* * *

The circuit suggested by the Editor of *Modern Wireless* (March, p. 141, Fig. 7) as being the best for reception of British broadcasting appears worthy of that recommendation. A Newcastle user of it regularly tunes in 2LO and the Dutch concerts, receiving at ample strength without recourse to low-frequency amplification. He can also obtain all the other British stations similarly.

* * *

We learn that most of the broadcasting stations are endeavouring to alter the times of their morning transmission. The Birmingham station has already made an alteration, as notified elsewhere in this issue.

* * *

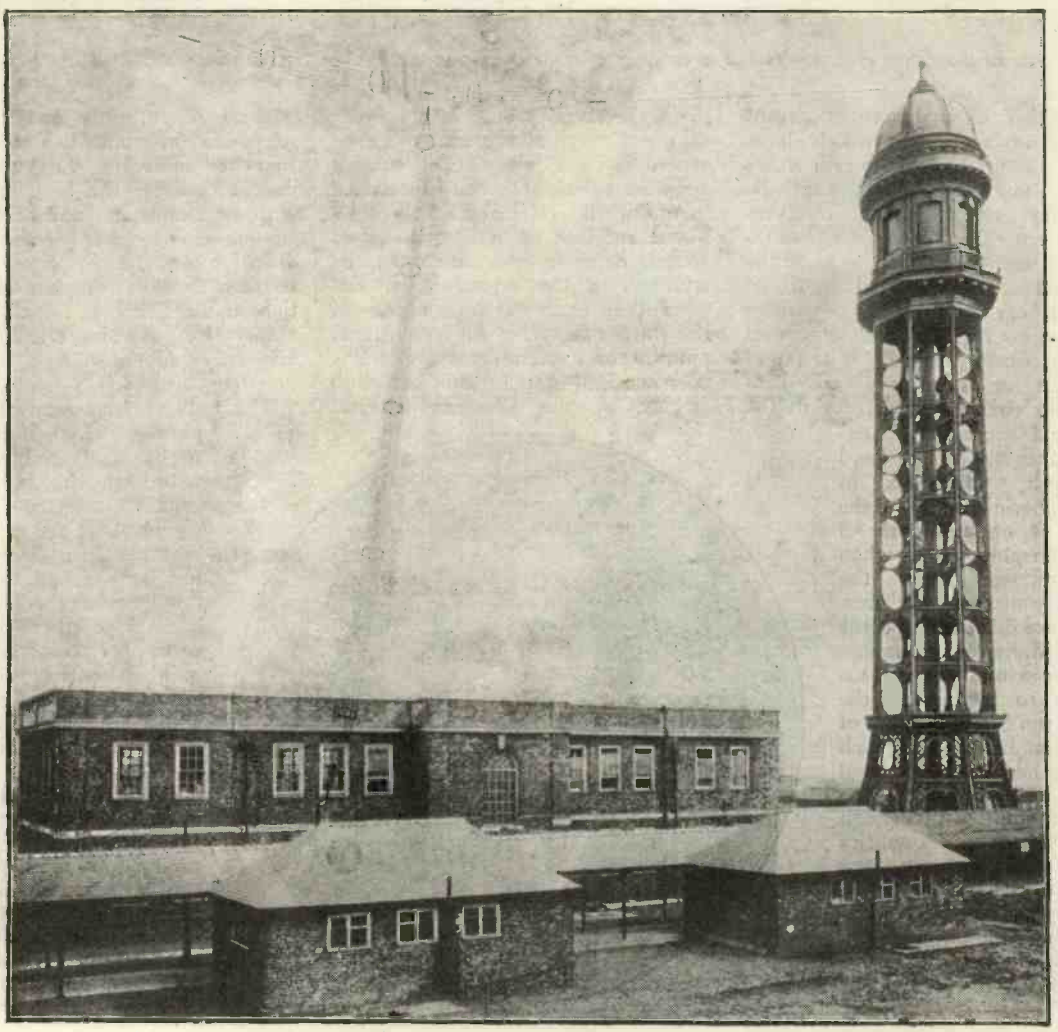
The practical utility of direction-finding methods applied to aerial navigation was strikingly demonstrated recently, when an air express, flying from Manchester to London, having become lost in the fog, called up Croydon aerodrome and obtained the necessary information to enable the pilot to find the aerodrome and make a safe landing.

* * *

According to the suggestion of an amateur meteorological expert, wireless is partly to blame for the bad weather conditions which we are experiencing. Surely there remain a few other things for which wireless can be blamed? Next, please!

* * *

According to the special correspondent of the *Daily Telegraph*, the Australian Broadcasting Conference has resulted in a decision to assist the immediate development of wireless throughout the Commonwealth. A resolution was passed affirming the principle of the decentralisation of broadcasting services on an independent companies basis. Each broadcasting station would be allotted a different wavelength, and licensed receivers in the area surrounding each station would use the same wavelength.



The aerial and out-buildings of the Manchester Broadcasting Station.

PROBLEMS IN TELEPHONY

The following short account is based upon the Kelvin lecture, delivered on May 10th, before the Institution of Electrical Engineers, by Prof. J. A. Fleming, M.A., D.Sc., F.R.S. (the famous inventor of the thermionic valve).

MANY of the more important investigations which have been made in recent years for the purpose of improving the efficiency of telephone receivers have been directed to an examination of the acoustical characteristics and sensitiveness, both of the human ear and of the various diaphragms which are employed for reproducing sound. It is found that the ear is extraordinarily sensitive to changes of density in the air, and according to experiments by the late Lord Rayleigh, variations in atmospheric density of the order of one-millionth of an atmosphere, even when superimposed upon the ordinary atmospheric pressure, are detectable by the ear. Many experiments have been made at various times to ascertain the minimum amplitude of vibration in the air which can be heard by a normal ear, and according to the experiments of Rayleigh and others, this quantity is between 10^{-8} cm. and 10^{-12} cm. In any case, although there are considerable differences in the results obtained by various observers, it is evident that the ear is extremely sensitive to atmospheric vibrations whose amplitude and density-change are exceedingly small.

The telephone receiver is in principle a device for transforming electrical energy into sound energy, and by means of careful experiments, made principally in America, it has been found that the overall efficiency of the device is extremely low, usually of the order of about 1 per cent. That is to say, the energy represented by the sound waves emitted from the telephone receiver is only of the order of 1 per cent. of the energy represented by the alternating current supplied to the telephone receiver.

Again, the efficiency of the telephone receiver as a reproducer of sounds depends, not only upon the loudness of the reproduction, but even more upon the faithfulness of the articulation. An enormous amount of experimental work has been carried out in this direction largely by the Western Electric Company in their various research laboratories in America. Phoneticians in America have divided the syllable sounds of the English language into five main classes, the details of which need not be entered into here. In examining various diaphragms and types of telephone instruments, about five thousand different sounds are repeated through the instrument on various occasions and eventually comparison is made between the dictation and the reception. It will be seen that the complete examination of diaphragms, for their suitability for use in telephone receivers, is an exceedingly laborious and lengthy task.

Dr. J. A. Fleming, M.A., D.Sc., F.R.S., the inventor of the thermionic valve.

The natural frequency of a diaphragm which is intended to be used in connection with speech sounds is usually selected to be round about 800 or 900 vibrations per second. It has been found that if a low-frequency diaphragm is employed there is, under certain circumstances, a gain in energy efficiency but a loss in articulation, whilst if a high-frequency diaphragm is employed there is a loss in energy efficiency and a gain in articulation. It appears that the faithfulness of the reproduction is dependent, to a large extent, upon the presence of upper harmonics, particularly sibilant sounds such as "s" and "z" and also sounds such as "th" and "f" and "v."

The sound energy produced by the human voice was next discussed by the lecturer, who pointed out that although the process of continued speaking or lecturing was exhausting, it was not because the amount of energy produced in the form of sound-waves was large, but because the efficiency of the human being, considered as a speech producing machine, was extremely low. It is computed that even in the case of

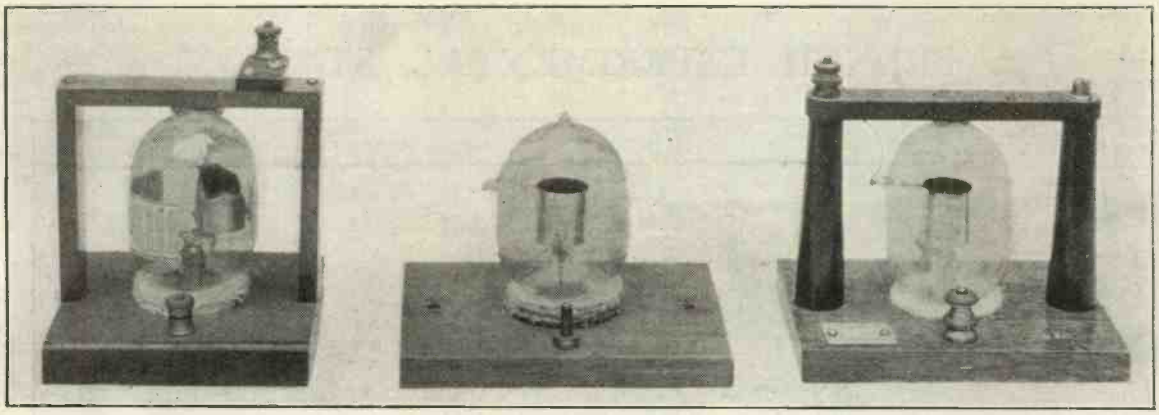
very loud speaking, the energy put forth in the form of sound-waves is only about 1-25th of a foot-pound per hour.

Considering the complicated formation of the human larynx and other voice organs, it is very surprising that a simple and symmetrical object such as a diaphragm, by its vibrations, should be able to give a very fair reproduction of the sounds produced by the voice. Prof. Fleming dwelt at some length upon the various modes of vibration of different kinds of diaphragms. The mathematical problems involved in the investigations of the vibrations of diaphragms are extremely complicated and many of the equations obtained have not yet been worked out. But the lecturer gave a very simple formula for the determination of the frequency of a circular diaphragm of known radius, thickness, and material.

The important subject of telephone line-transmission was next considered, and a very full account was given of the many difficulties due to distortion, attenuation, etc, which are met with in long aerial land lines or underground or submarine cables. It is impossible here to recount the various exceedingly ingenious methods of employing capacities and inductances in various ways for the reduction of distortion. All long-distance lines are now provided with "loading coils" at distances of about every ten miles, the theory of such loading having been very fully and beautifully worked out by Oliver Heaviside.

It is possible by partial use of two telephone lines to send a third message, which is independent of any messages in the original lines, by means of what is now known as a "phantom circuit." By special circuit arrangements, these phantoms can be multiplied, and the lecturer referred to a case in America where in a system of five lines no less than eighty-five different messages can be transmitted simultaneously without interference and with entire privacy.

Coming to the question of attenuation along telephone lines, Prof. Fleming referred to the many ingenious telephone repeaters which had been introduced at various times during the past twenty or thirty years; amongst them he particularly mentioned the microphone repeater of S. G. Brown. In the absence of telephone repeaters, the capital expenditure upon copper wire is enormously greater than it need otherwise be. The lecturer then turned to his own famous invention of the thermionic valve and showed how, owing to the infinitesimal inertia of the moving parts (the electron stream), the lag of the instrument is entirely negligible. He explained in great detail the method of obtaining the characteristic curves of a valve and exhibited a model of the mathematical surface representing the plotting of the three characteristics of a valve, this surface having been worked out by two of Prof. Fleming's students. The amplified current emitted by a perfect valve is an exact reproduction of the input current. Prof. Fleming indicated the manner in which the introduction of the thermionic relay has revolutionised line-telephony, and mentioned that had such a relay been available when some of the main long-distance lines in this country were laid down by the Post Office, an enormous saving in capital expenditure might have been effected. The use of high-power transmitting valves was discussed in detail, and pictures were shown of the valve panels at the Carnarvon trans-Atlantic station and other transmitting stations. The lecturer had much to say in praise of the immense organisation of industrial research in America, and showed many slides of the research department buildings of the Western Electric Company, the General Electric Company, and other American electrical concerns. One of the research buildings of the Western Electric Company alone was stated to have cost no less than £1,200,000 and to accommodate a staff of 1,500 fully trained engineers having no connection with the commercial operations of the company, and being solely concerned with the work of technical development. Prof. Fleming deplored the fact that in this country, with one or two exceptions, no such examples of collective and intensive industrial research work were to be found. He pointed out that Great Britain had never been lacking in furnishing individual examples of genius and originality, but, unfortunately, in too many cases, little or no encouragement was given to the investigator at the time, and the practical fruits of his labours came to us years



Early Fleming valves.

afterwards from other countries than our own.

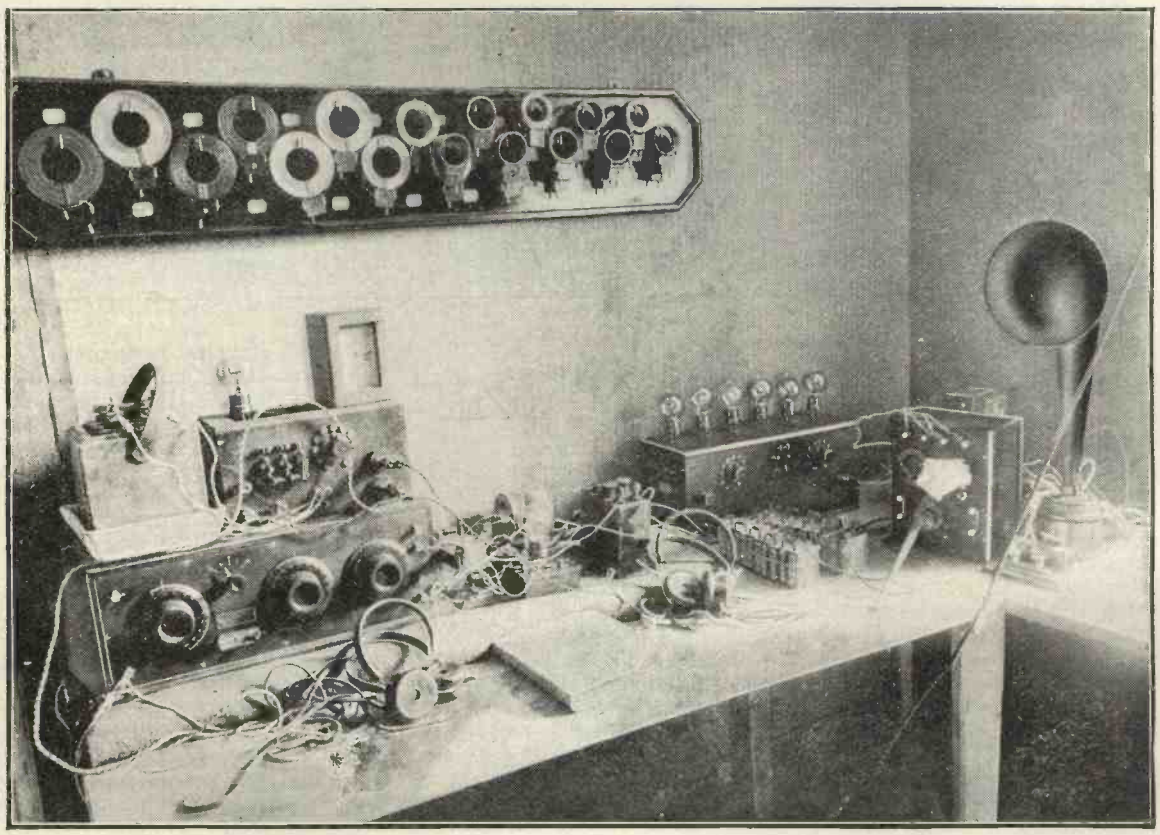
Sir Oliver Lodge, in proposing the vote of thanks to Prof. Fleming, referred to him as one of the great pioneers of telephone engineering, and expressed himself astounded at the vast amount of labour and ingenuity which had been expended upon the development of various systems of line telephony throughout the world—an amount of enterprise of which the ordinary man had not the remotest conception. He added that Prof. Fleming had stated that the human being was an inefficient speech producer, but, in his opinion, Prof. Fleming was the reverse.

Dr. W. H. Eccles, in seconding the vote of thanks, described his visit to the General Electric Company's research laboratories in New York where he was shown the new 1,000 kw. transmitting valve. He was asked if he would care to see the interior, and, on his replying in the affirmative, spanners were procured, various nuts and bolts removed, and eventually a rod, resembling a poker, was withdrawn and thrown upon the floor. "What's that?" asked Dr. Eccles. "Oh! that's the filament," was the reply. The "poker," in fact, was a rod of thoriated tungsten which was produced in the General Electric Company's works at a cost of about five dollars. Dr. Eccles remarked upon the extreme efficiency of a wōrks' organisation which could produce such an article at such a cost.

This lecture of Prof. Fleming was a most important *résumé* of information upon the development of both line-telephony and wireless-telephony. The lecture was packed with interesting and valuable information, and all serious wireless experimenters should take the opportunity of consulting the official reprint when it is published.

Amongst the exhibits were the original two-electrode Fleming valves produced by Prof. Fleming in 1904.

A FRENCH EXPERIMENTAL STATION.



The above is a photograph of the experimental station 8 AB of French nationality. Its neat arrangement and compactness are worthy of note.

LOCAL INTERFERENCE

By E. REDPATH, Assistant Editor.

The following article deals with the principal cause of local interference, namely, self-oscillation, and offers several practical suggestions for its prevention.

DESPITE considerable opposition, which perhaps is more or less to be expected from such a conservative people as ours, broadcasting has made considerable progress.

Consider the great opposition offered to the introduction of railways and, more recently, the motor car, to which broadcasting, as a new and novel public service, is practically a parallel case.

The Experience of Others

In last week's issue of *Wireless Weekly* appeared a very interesting article by an American authority on broadcasting. From the article in question it appears that practically all of the political and financial problems involved have worked out to a fairly satisfactory solution, which justifies to some extent the belief that similar problems now engaging the earnest attention of the parties concerned in this country will very soon be amicably settled.

In America at present the principal difficulty is not due to the broadcast transmitting stations, although there are 700 such licensed stations, and they operate on two wavelengths only, namely, 360 and 400 metres, but to the interference experienced by listeners-in due to radiation from other adjacent receiving stations.

As far as the political and financial problems are concerned, there is little, if any, action which can be taken by listeners-in, but the last-named problem, that of local interference, can be satisfactorily solved by listeners-in and experimenters themselves, and probably without adding any further regulations to the already crowded "wireless statute book" governing experimental work.

The Present Regulations

The third paragraph of the "Conditions" printed upon the back of a Broadcast Licence states: "The station shall not be used in such a manner as to cause interference with the working of other stations. In particular, valves must not be so connected as to be capable of causing the aerial to oscillate."

Now, to the owner of a Broadcast Licence, who, it must be remembered, is not supposed to possess any theoretical or practical knowledge of wireless, the foregoing paragraph does not give much information. It does not explain what is meant by "causing the aerial to oscillate," nor does it explain how to test for the presence of "self-oscillation."

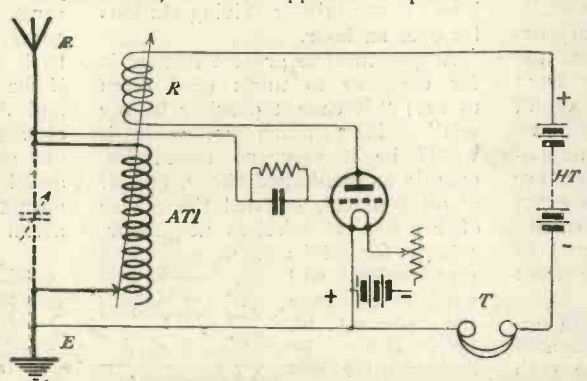


Fig. 1.—Typical regenerative circuit with reaction applied direct to the aerial circuit.

Although the original receiving set has to be submitted by the makers to the Post Office engineers and actually tested by them upon two aerials, one 30ft. long and the other 100ft. long, before similar sets marked "B.B.C." can be offered for sale, it is well known that some approved valve receiving sets will readily "oscillate."

It is extremely likely, therefore, that much of the present interference is caused by owners of "B.B.C." valve receiving sets.

Nowadays even the mere beginner is to some extent an experimenter. He experiments with various types and sizes of aerials, with alternative earth connections, such as a counterpoise, or, with a view to obtaining improved results, he uses a small fixed or variable condenser in the aerial or earth lead, quite extraneous to his receiving set, or reverses his L.T. battery connections.

With any one, or with a suitable combination of these "experiments," an otherwise perfectly safe B.B.C. set may oscillate, and, apart from noticing an increased strength of received signals, and the fact that the speech, music, etc., is not as clear as before, the owner of the set is unconcerned.

Unless he varies the tuning adjustment of his set, and hears the loud note of the carrier wave, he is unaware of what is happening, also that he is probably causing a nasty persistent growl to be emitted by the telephones or loud-speakers connected to other receiving sets within a radius of possibly several miles.

Simple Safeguards

It is not to be thought for one moment that the use of valve receiving sets, B.B.C. or any other, by a beginner, is discouraged. A man does not condemn safety razors because at one careless handling he cuts himself. Nevertheless, he profits by the experience, and takes greater care in future.

The first thing which a beginner who is using a valve receiving set should understand is that, if his set

"oscillates," it is acting as a miniature transmitter, and continuous waves are being radiated from his aerial. Although such waves are themselves inaudible in an ordinary crystal or valve receiving set, when they are received together with the carrier wave from a broadcasting station, any slight difference in frequency between the two waves produces an audible "beat-note."

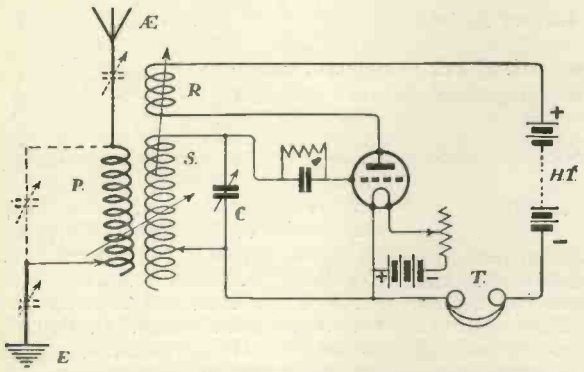


Fig. 2.—A single valve inductively coupled regenerative circuit with reaction applied to the secondary coil.

If the difference in frequency between the wave radiated from the oscillating receiver and that from the broadcasting station is small, the beat-note will be very low-pitched; and, as the tuning adjustments of the oscillating receiver are varied on either side of the exact resonance point for the carrier wave, the beat-notes produced in adjacent receiving sets vary from a low to a very high note.

Similarly, in the oscillating receiver itself, the locally generated oscillations cause a beat-note with the incoming carrier wave. This note also varies as the tuning adjustments are altered, which in itself is a proof that the set is oscillating.

In other words, when listening-in on a valve receiving set, a varying beat-note heard in the telephones when the tuning adjustments are not altered in any way is most probably due to some other self-oscillating receiver. A *steady* note, the pitch of which is not altered by varying the tuning adjustments, is also due to another set, but a varying note which coincides, as it were, with movements of the tuning condenser, variometer, etc., is certainly due to the set itself.

A further simple test for self-oscillation consists in touching the aerial terminal of the receiving set with the moistened finger tip. If the set is oscillating, a distinctive "cluck" will be heard, quite different from the slight click produced when only the incoming carrier wave is present in the aerial.

The Necessary Action

Should any listener-in suspect for a moment that his receiving set is oscillating, he should take immediate steps to stop it. The importance of this cannot possibly be over-estimated, as two or three such receiving sets in operation may effectively prevent reception by dozens of other listeners-in. The writer recently experienced an example of one persistent "oscillator" ruining the reception of at least twenty other receiving stations for over an hour.

At present the great tendency is for everyone to think (and often to say) "it cannot possibly be *my* set." How much preferable it would be if everyone tested frequently as mentioned above, and, if at all doubtful, enlisted the advice of his nearest wireless neighbour, who, for his own sake, will usually be only too pleased to help either by listening for and reporting the suspected interference or, if experienced enough, by inspecting and testing the set in question.

Experimental Circuits

The experienced experimenter who is trying new circuit arrangements may naturally make use of the broadcast transmissions for the purpose. In accordance with the fourth paragraph of the Conditions attaching to his Experimental Licence, "between the hours of 5 p.m. and 11 p.m. on weekdays and all day Sunday, any oscillating valve or valve circuit employing magnetic or electrostatic reaction must not be directly coupled with the aerial or the aerial secondary circuit over the range of wavelengths between 300 and 500 metres. The use of separate heterodyne circuits coupled with the aerial or aerial secondary circuit over the range of wavelengths between 300 and 500 metres is similarly restricted."

In view of the more liberal aspect with regard to qualifications, now taken by the Post Office authorities, it is probable that many new experimenters are not fully acquainted with the particular circuits, the use of which *on the broadcasting waves and during broadcasting hours* is forbidden.

Fig. 1 shows a typical single-valve regenerative receiving set in which the regenerative or reaction effect is obtained by coupling the reaction coil R (included in the anode circuit) with the aerial tuning inductance A.T.I. By this arrangement some of the magnified energy in the anode circuit is fed back into the aerial circuit, and, if the coupling between the coils R and A.T.I. is tightened beyond a certain well-defined point, continuous oscillations are set up in the aerial circuit accompanied by a strong radiation of waves from the aerial itself.

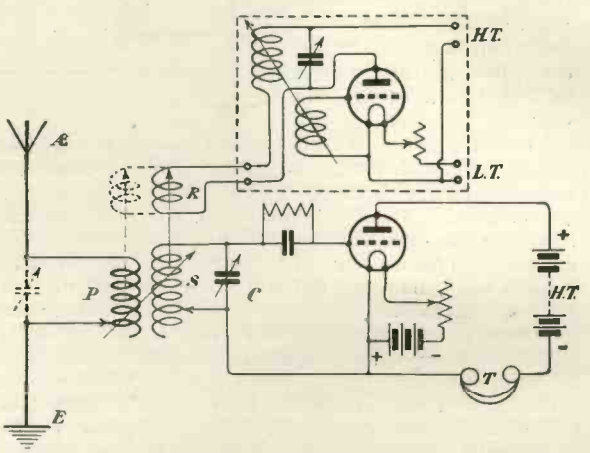


Fig. 3.—A single valve inductively coupled circuit, with a separate heterodyne circuit.

This form of circuit is perhaps the most dangerous of all, from the point of view of ability to cause interference.

Fig. 2 shows an inductively

coupled single valve regenerative receiving set. The coils P and S are the primary and secondary respectively of the oscillation transformer or "coupler," the regenerative effects in this case being obtained by coupling the reaction coil R to the secondary coil S, as indicated by the arrow passing through the two coils.

If the coupling between the coils R and S is made unduly tight, continuous oscillations will be set up in the closed oscillatory circuit S C, and, due to the inductive coupling between the coil S and the aerial coil P, induced oscillations will be set up in the aerial circuit.

Provided that a very loose coupling exists between the coils P and S, the radiation from the aerial is not as strong as in the previously considered circuit (Fig. 1), but, as such radiation is possible, it is clearly forbidden in the terms of the licence.

The lower portion of Fig. 3 shows an inductively-coupled single valve receiving set, in itself a perfectly safe arrangement, until the coupling coil R of the separate heterodyne shown in the upper portion of the diagram is electromagnetically coupled either to the secondary coil S or the primary coil P, an arrangement which is capable of causing oscillations in the aerial and which therefore is contrary to the Conditions of the Licence.

In Figs. 1, 2 and 3, the regenerative effect or reaction, as it is more commonly termed, is obtained by means of electro-magnetic coupling. As it is possible to produce similar results by means of electrostatic coupling (*i.e.*, by introducing a suitable variable condenser between the anode and grid of the valve), this arrangement also is prohibited.

Permissible Circuits

Although the use of reaction in any form by a beginner is deprecated, it is fully appreciated that its use, under proper conditions, affords a very convenient method of magnifying weak incoming signals.

The general principle governing the authorised use of reaction is that there shall be, between the oscillating valve and the aerial circuit, or secondary circuit in the case of an inductively-coupled receiver, at least one valve which itself shall not be capable of oscillating. This, of course, precludes the possibility of using reaction with any single valve receiving set. --The smallest number of valves which safely permit the introduction of reaction is two, and a typical circuit arrangement is shown in Fig. 4, from which it will be seen that the first valve, acting as a high-frequency amplifier, has in its anode circuit the primary winding of an air-core transformer, the secondary winding of which is connected to the grid circuit of the second or rectifying valve. The reaction coil R, which is in the anode circuit of the second valve, is inductively coupled to the secondary winding of the transformer. By this means any self-oscillation which may occur is practically confined to the second valve, although, if a very tight coupling between the transformer primary and secondary is employed, a certain amount of radiation may, under certain conditions, be detected.

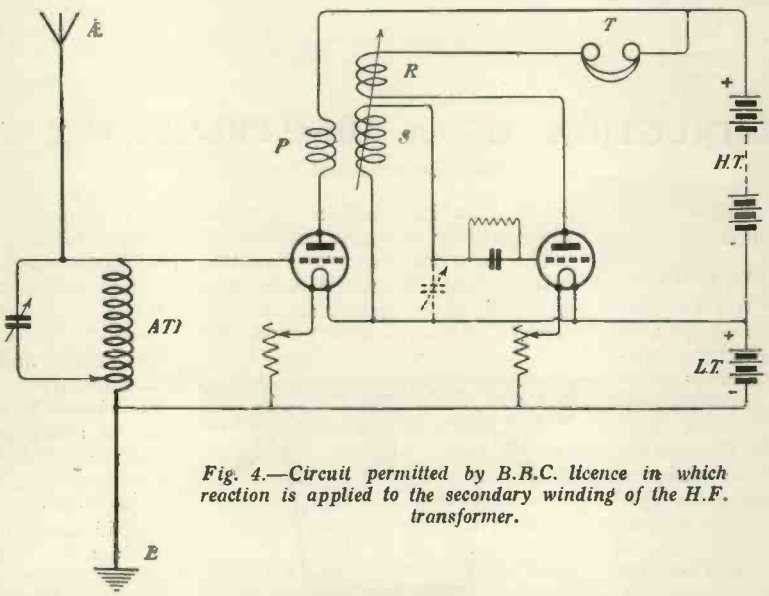


Fig. 4.—Circuit permitted by B.B.C. licence in which reaction is applied to the secondary winding of the H.F. transformer.

Further suitable circuit diagrams have appeared in this journal from time to time, whilst quite a useful collection is contained in the Radio Press Handbook, "Practical Wireless Valve Circuits." The particular point to be noticed, however, is that, when experimenting with various combinations of valves and valve circuits, self-oscillation is always liable to occur, and it is highly desirable that every experimenter should be constantly on the look-out for its occurrence, should be capable of instantly detecting it, and should always take immediate steps to stop it and prevent its reoccurrence, at all events on the lower wavelengths during broadcasting hours.

It unfortunately appears to be rather a common practice for many listeners-in, immediately the nearest broadcasting station announces a two or three minutes interval, to put their sets into an oscillating condition and search for more distant stations. By doing this they probably defeat the efforts of other listeners similarly engaged, and are themselves annoyed by the chorus of whistles and hoots which effectively prevents them hearing the desired station.

If this searching was carried out by all parties, with receiving sets in a sensitive condition but *not oscillating*, everyone would have a chance, and the resumed transmission of the nearer broadcasting station could be tuned in again by all, without the interference which at present often mars the beginning of each transmission.

It used to be rather a frequent occurrence for a broadcasting station to announce that, according to reports received, radiation from oscillating receiving sets was causing considerable local interference in such-and-such a district. This practice appears to have been discontinued lately, probably because the various station directors now find their time fully occupied, and not that the interference complained of has entirely disappeared. In the campaign for the elimination of local interference, it is thought that

occasional announcements from the broadcasting station will help considerably.

Further good work can be done in this direction by the Radio Societies of the country who should see to it that, as far as all their members are concerned, the evils of self-oscillation are clearly understood, and that in decent wireless circles at all events such a thing "simply isn't done."

The attention of the owners of receiving sets, not members of a radio society, can be drawn to this important question by means of the local Press, and there is scarcely any radio society whose secretary cannot write, or have written, a letter giving a clear statement of the case, for publication in the local Press.

The Unscrupulous Self-oscillator.

It will be noted that in the foregoing article the writer has dealt only with local interference caused by the unwitting misuse of valve receiving sets by their owners, who, it is confidently believed, are the chief offenders. When these enthusiasts understand that they are seriously interfering with the enjoyment of others, and mend their ways accordingly, we shall no doubt still have left a few who might be termed unscrupulous self-oscillators.

These are the people who always "search", with their sets oscillating, and who only appear satisfied with received telephony when their oscillating set is tuned to the "silent point" of the carrier wave, on which adjustment, however, they rarely leave the set for more than about two minutes at a time. As already stated, the writer considers that experimenters of this type are in a very small minority, so that, once the unwitting interference is removed, they will be so conspicuous as to be fairly easy of detection, and it is hoped to make this matter the subject of a special article in a future issue of either this journal or *Modern Wireless*.

THE CONSTRUCTION OF A HIGH-FREQUENCY AMPLIFIER

(Continued from page 547.)

correct values of filament and anode voltage are applied.

The Coupling Resistance

In order to render this amplifier useful for wavelengths about 1,000 metres, the wave selector switch automatically disconnects the anode coil and inserts a non-inductive resistance of a value of 80,000 ohms in the anode circuit for long waves. As extreme constancy of operation is essential for the quiet working of this device, the experimenter should purchase a resistance of reliable make rather than attempt to construct one for himself. If, however, he cares to go to the trouble of making such a resistance properly, full constructional details appear in *Modern Wireless*, No. 5, at the end of the article entitled "A Useful Amplifier for Wavelengths of from 1,500 to 30,000 Metres." The particular type of resistance there described will be found remarkably constant, entirely free from atmospheric influences, capable of passing large currents and practically everlasting.

In connection with the operation of this instrument little need be said, except that it is essential that the gridleak of the rectifier which it precedes be attached to the negative filament leg. Several of these amplifiers might be made on the "unit principle," but one will generally be found sufficient.

The arm of the wave selector switch should be placed upon each of the studs in turn, and the condenser dial varied from zero to the

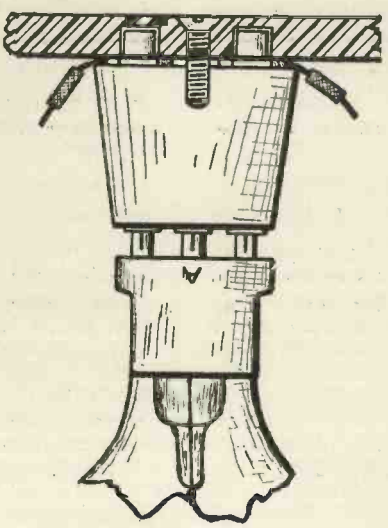


Fig. 7.—Showing method of mounting the valve-holder.

maximum position until signals are stronger. If the aerial circuit is sharply tuned, it will be found that a very small movement of the high-frequency condenser dial will effect a considerable change in the tuning. This is a desirable feature, as it indicates that the amplification is sharp and therefore is at a maximum.

When the switch arm is on the last stud, and the resistance is therefore in circuit, the condenser dial should be set at zero. A number of resistance-coupled amplifiers form a most efficient method of strengthening weak signals on the upper band of wavelengths. The amplification produced by several resistance stages is generally greater than that produced by a corresponding number of transformer stages, and not only is the amplifier easier and cheaper to construct, but it is much more stable in operation. The only drawback to this arrangement is that a higher anode pressure is required, as the voltage drop across the resistances is considerable. Against this, however, is the fact that the total amount of current flowing through the resistances is small, and therefore the high-tension battery will last for a very considerable period.

[*The construction of a note magnifier suitable for adding to this instrument or for that matter to any existing receiver, whether already possessing low-frequency amplification or not, will be described in a future issue.*—ED.]

WIRELESS, OLD AND NEW

By SUSSEX.

A few reminiscences which will be particularly appreciated by old-established experimenters who have experienced the joys and sorrows of pre-war wireless.

BEFORE the war the wireless amateur occupied a privileged position. He was the high priest of a mysterious cult and a repository of all scientific knowledge, or so it seemed to his neighbours.

Now, however, all is altered. The one-time mysteries are simply explained in dozens of handbooks and periodicals; wireless sets can be bought anywhere and installed by the veriest tyro. Results are not limited to the few who can read the Morse code, but anyone can now enjoy a wireless concert.

Nevertheless, I expect there are many who sigh for the good old days. Licences were easy to get then. The size of our aerial was limited only by the risks we were prepared to take in perching the flimsiest and tallest of masts on top of the highest house or tree we could find. The valve, that Aladdin's lamp of wireless, had not made its bow to the public, and all our receiving was done with crystals—a portmanteau word covering detectors using many combinations of weird minerals. Zincite and bornite, tellurium, galena, and carborundum, each man to his choice, and his fancy was bound to be the best.

No longer need the enthusiast apply himself with bated breath to the search for that most sensitive spot on the crystals. No longer need his family creep about on tip-toe for fear of distracting his attention from that infinitely small noise which was all there was to be heard of the good ship " Nonsuch " making known her wishes to Land's End wireless station.

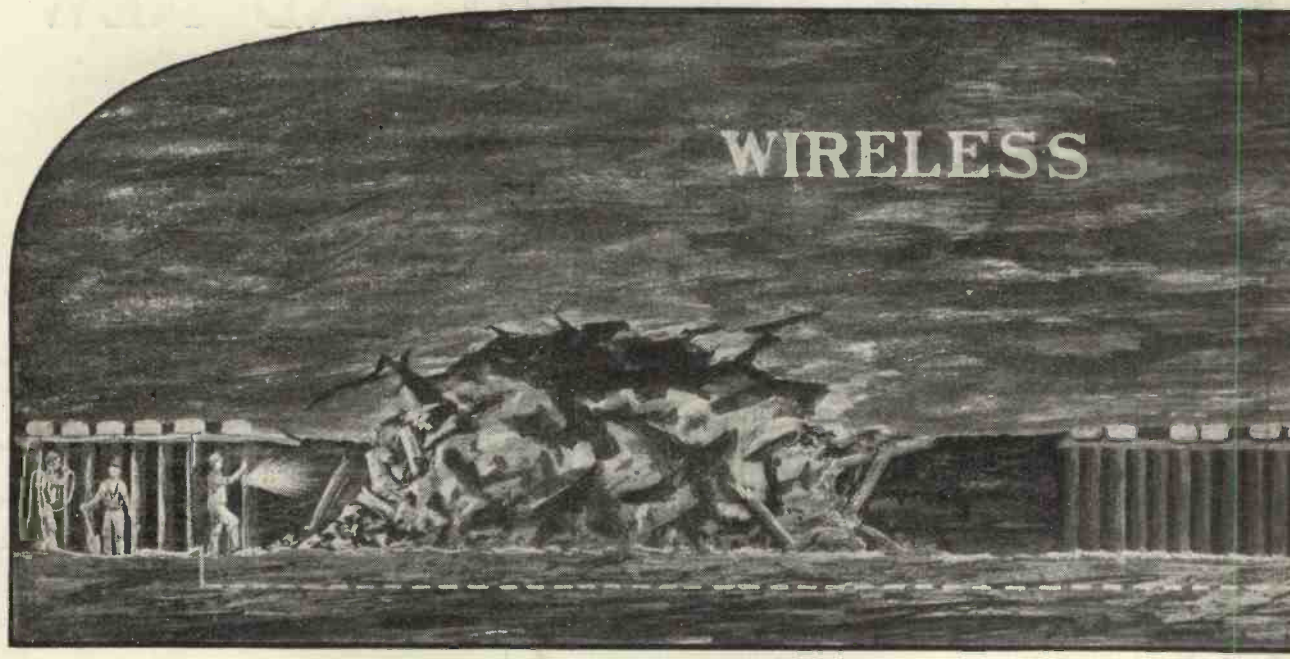
Now the good fairy in the valve provides our detector, and, however small the noise, will magnify it until the whole household can hear it from the trumpet of the loud-speaker.

In those days we depended on our skill in Morse for getting anything intelligible from wireless. The stations we heard were relatively few, punctual to the minute and, like old friends, recognisable by their voices.

There was the Eiffel Tower, gruff and growling, but none the worse for that, with a time signal vouched for by all the observatories in Europe. Poldhu, of the rolling organ pipe note, the newspaper of the ether, whose hour and a half's press message tried the Morse skill in no mean degree, and if read on Christmas Eve provided for the next day a summary of the world's news. Cleethorpes, whose weather report was much sought after when the next day's outing came to be considered. The high pitched treble of Nordeich was also a common sound, sending its weather report in German. Clifden and Coltano, twin stars of the Marconi firmament, high up the scale of wavelengths, completed the list.

Merchant ships returning from the ends of the world could be heard explaining their wants to the coast stations, and brought a breath of the sea to the listener. Then the anxious scanning of the call sign lists to establish the identity of him whom we have just heard, and the hope that this new station will establish a distance record for us.

When the pleasure of listening palled, the amateur was not at a loss. His installation, probably home-made, always needed new instruments. Half the pleasure came from making these himself. He might well have taken to himself the Royal Air Force motto, " Per ardua ad Astra."



SOME of the most useful applications of wireless seem also to be the least widely known and appreciated. We have all heard thrilling tales of SOS calls at sea, and probably most of us realise what a powerful life-saving agency wireless can be on occasions of maritime catastrophe, but how many who read these lines have any knowledge of the part which it is already playing in rescue operations in mines?

In the use of radio communication underground, as, it must be confessed, in several other branches of wireless science, American inventiveness and enterprise have led the way, for portable wireless sets have been a regular part of the equipment of the rescue parties of many of the larger mines in the United States for some time. In this country, on the other hand, colliery owners are only just awakening to the possibilities of such apparatus.

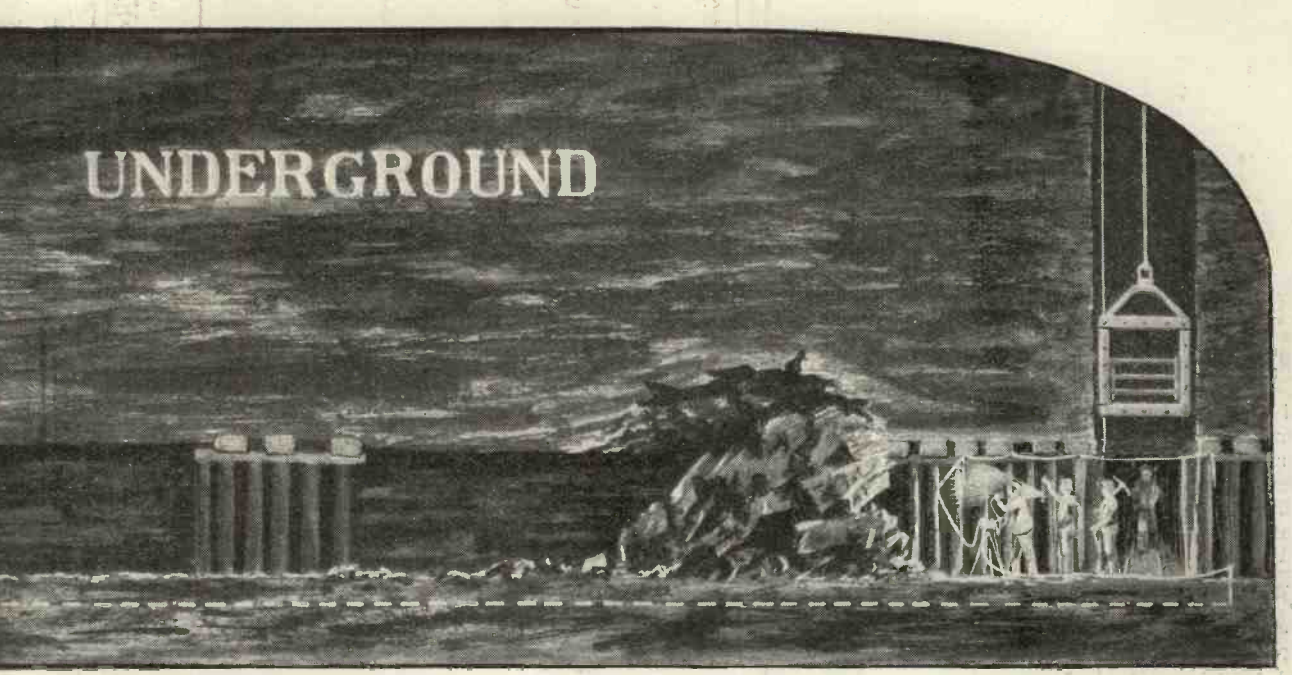
The requirements in a set for underground use are somewhat peculiar, and, indeed, difficult of fulfilment, so that the design of apparatus for this purpose is a task to try the ingenuity of the most skilled wireless engineer. First and foremost, it must be *safe*, that is, it must be quite free from any risk of the production of sparks, which might ignite a gaseous atmosphere. It follows from this that "spark" sets are practically ruled out, and the continuous wave system must be employed. Portability demands that the set shall be small and light, and thus it is necessary to use batteries for both high- and low-tension supply, which again introduces difficulties, because it is also essential that the set shall give a quite considerable power output, in view of the very adverse conditions under which it must often work.

To obtain large powers it is usually necessary to make use of a high-tension generator, and where batteries alone are available, special transmitting valves capable of working on the lower plate voltage must be used.

Finally, telephonic rather than telegraphic communication is to be desired, in order to reduce the amount of knowledge which must be possessed by the operator.

The difficulties of underground wireless work are admittedly very great. Take, for example, the matter of aerials: how can one put up an effective aerial in a space perhaps only 5ft. high, and how can its insulation be maintained in a locality where water is trickling and dripping from walls and roof, and running underfoot in a rushing stream?

The lack of height cannot be overcome, and all that can be done is to attach the aerial wire by means of pegs within a few inches of the roof, but the insulation difficulty can be fairly well met by the use of heavily rubber



covered cable, the end furthest from the set being carefully sealed with an insulating compound.

Probably the greatest obstacle, however, in underground working is the extremely peculiar and variable screening effect of the strata between the two stations. So long as the stations are both below ground little difficulty is experienced, for the waves appear to find their way through the ramifications of the mine quite easily, possibly aided by the fact that both transmitting and receiving sets are usually earthed to the iron rails of the "tub" railways which form a complex network in the roads and workings of a large colliery.

When, on the other hand, communication is attempted between a set underground and one at some point on the surface the matter is very different. Sometimes quite good results are obtained, and signals are almost as strong as they would be if both stations were upon the surface. More commonly it is found that absorptive strata, such as layers of ironstone or water-bearing rocks, are interposed between the stations and communication is extremely difficult, considerable power being required to "break through."

An instance of the screening of underground "transmitters" occurs in connection with the London Tubes. Everyone knows that tramcars can be a most serious nuisance by causing loud cracklings and hissings in valve receivers near their route, yet similar interference by Tube trains, which have much more powerful motors, only occurs in extremely rare cases. The explanation, of course, is that the steel lining of the Tubes shuts off the "radiations" of the trains in the same way that layers of conductive rocks screen the true wireless signals of an underground station.

An interesting fact that was observed during experiments at an English colliery was that in such a case of screening quite good communication could be obtained so long as the station on the surface remained in the immediate vicinity of the pit-head: when it was moved only a few hundred yards away from the shaft the signals were lost entirely.

This phenomenon would seem to confirm the suggestion that in such cases the waves travel through the workings and up the shaft rather than through the solid rocks between.

If this is a true explanation it provides a solution, also, for many puzzling features of underground wireless, such as the difficulty experienced when the stations are separated by only a short distance in the rock, but a long one in the actual workings.

FRAME AERIALS

By STANLEY G. RATTEE (Staff Editor).

So much interest lies in the direction of experimenting with frame aerials that some brief instruction on the subject should serve to aid the experimenter.

THE many stations throughout the country which have now come to be called "experimental" stations not only involve the general technicalities applicable to commercial stations, but have also special problems entirely their own, differing with each individual station.

Whereas a commercial station offers a more or less free hand to the engineer designated to erect it, yet the experimenter is forced not only to comply with the requirements of his licence, but is also governed very largely indeed by the accommodation available for his station.

Still another consideration in the case of an experimenter's receiving station is that though a commercial receiver is required to be operated invariably over a limited number of wavelengths, the experimenter wants not only an efficient receiver to tune to one or two particular stations, but as a rule desires also to be able to tune to any wavelength on which wireless transmission may be audible.

Closely connected with the efficiency of the station is the question of understanding what one is doing and accuracy in measurements. In connection with these two factors, though many readers will have used a frame aerial, there are many who have obtained indifferent results with this type of aerial.

Simple to look at, easy to construct, these aerials nevertheless have certain features about them that must be considered before anything like maximum results can be obtained.

A frame aerial may be likened unto an ordinary external aerial with its open end bent back on itself in the shape of a circle and connected to the terminal which originally carried the earth wire. In actual practice there is between the two ends a variable air condenser, put there for purposes of tuning.

When using a frame aerial the strength of the received signals may be increased by adding one or more turns of wire, though it must be borne in mind that this addition cannot go on indefinitely, or else

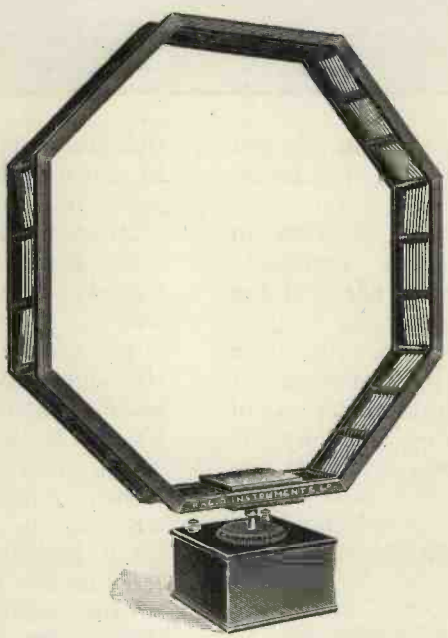


Fig. 1.—A typical form of rotary frame aerial, made by Radio Instruments, Ltd.

the number of turns will acquire a "natural wavelength" exceeding the wavelength it is required to receive.

When such a condition exists the reception of signals falls off very considerably; it must therefore be remembered when designing frame aerials that the number of turns of wire is proportional to the wavelength it is required to tune, and for accurate tuning must give a "natural wavelength" slightly less than the wavelength to be tuned. When this condition obtains, accurate adjustments can be found by manipulating the variable air condenser across the frame winding.

One of the chief attractions of a frame aerial is its directional properties, which may be used to their full advantage in the elimination of signals coming from directions other than the one wherein lies the desired transmitting station. Also, compared with the ordinary external aerial, this directional property affords purer reception when the experimental station suffers from local interference emanating from the proximity of an electric train or tramway system.

The ability of a frame aerial, in so far as "collecting" energy is concerned, is determined by the distance separating its sides, and increases with that distance until the dimensions of the frame approach half the wavelength of the received signals.

It will be understood by the more advanced experimenter that the efficiency of a frame aerial when used for reception may be calculated from the voltage to which the variable air condenser can be charged by the effective E.M.F. set up in the frame.

This E.M.F. is said to be proportional to the number of turns of wire on the frame multiplied by the area of the frame, multiplied by the total inductance, divided by the square of the wavelength, multiplied by the effective resistance of the turns; or, in other words:—

$$\frac{\text{No. of turns} \times \text{area} \times \text{inductance}}{\text{wavelength}^2 \times \text{effective resistance}}$$

In view of this, the best design for a frame to receive any given wavelength would appear to be simple, but unfortunately variation

in the number of turns with a fixed area, or *vice versâ*, does not give consistent results so far as maximum efficiency is concerned; for general purposes, however, it may be taken that, within reason, the best arrangement is a large frame with few turns for short wave reception, and a smaller frame with more turns for longer wavelengths. The wire used should have as low a resistance as possible, and so as to keep the total self-capacity of the frame low, the turns should be well spaced, which enables a greater number of turns to be employed for a given wavelength.

For those desiring to construct their own frame aerials the table given herewith indicates the number of turns required on a given frame with certain spacings, and shows the range of wavelengths covered if the frame is used with a 0.001 μF variable condenser across it.

The design or shape of the frame may be left to the reader for purposes of experiment, though a typical frame is given in Fig. 1, made by Radio Instruments, Ltd.

The wires round the frame should be insulated, the insulators also serving to separate the wires and keep them in the required positions. Pieces of bakelite or ebonite about $\frac{1}{4}$in. thick, cut as in Fig. 2, will fulfil this object. The width of the insulators is obviously determined by the width of the frame (it should be 1 to 2 inches wider than the frame), and its length governed by the spacing and number of turns of wire.

The two ends of the wire—that is, the beginning of the winding and the end—should be connected to a variable air condenser having a capacity of not more than 0.0011 μF, the two terminals of which are to be connected to the input terminals of the receiving set.

The wire used for constructing this type of aerial may be any fairly large gauge wire, the ordinary "bell" wire being quite suitable.

The useful purposes served by a frame aerial are many, and chief among its uses is that of permitting new circuits embodying magnetic reaction, or other form of regeneration, to be tried out without the fear of causing interference with local listeners.

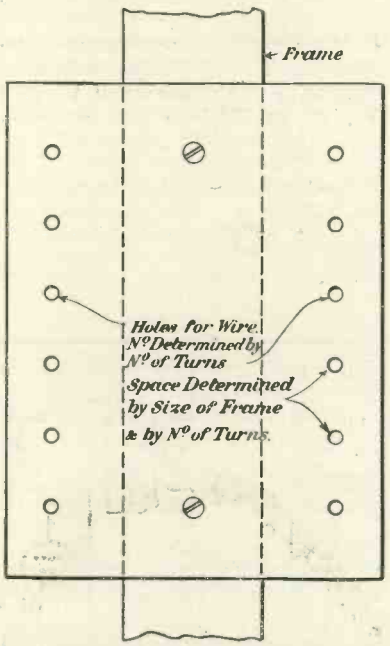


Fig. 2.—Guide and insulator for holding the windings in position on the frame.

To flat-dwellers the frame aerial opens tremendous possibilities, for without it the "indoor aerial," at all times an ugly affair, would need to be used.

When designing frame aerials it must be remembered that to obtain the best possible results tuning should be effected by means of the variable air condenser connected across the winding.

TABLE.

Wavelength in Metres.	Size of Frame. Sq. Ft.	No. of Turns.	Spacing in inches.	Capacity across winding.
300	2	9	$\frac{1}{8}$	0.001 μF variable air condenser.
300	4	5	$\frac{1}{4}$	
600	4	8	$\frac{1}{4}$	
1,000	4	15	$\frac{1}{4}$	
2,600	4	55	$\frac{1}{4}$	
300	6	3	$\frac{7}{16}$	
600	6	7	$\frac{7}{16}$	
1,000	6	11	$\frac{7}{16}$	
2,600	6	40	$\frac{7}{16}$	
300	8	3	$\frac{5}{8}$	
600	8	5	$\frac{5}{8}$	
1,000	8	10	$\frac{5}{8}$	

It is obvious from this means of tuning that there is little span between the minimum and maximum wavelengths on any given frame, and though a small loading coil may be used it is not to be recommended.

Should a broader band of wavelengths be desirable, then one may best satisfy the desire by putting a large number of turns on the frame and bringing tappings from them to a multi-point switch or terminals, thus enabling any required number of turns to be used, or in other words any number of turns required to tune a certain wavelength may be connected in the circuit at will.

This method of frame building makes the frame take the place of the tuner, fine adjustments being obtained with the aid of the variable air condenser.

Though we have so far dealt with the frame aerial for purposes of reception only, it must not be assumed by the reader that its utility does not extend to transmission. On the contrary such aerials offer considerable scope for experimental work over short distances, their advantages over the ordinary external aerial, by virtue of their directional properties, making the transmission less liable to interfere with other experimenters in the neighbourhood.

Every care should be taken when using a frame aerial for transmitting purposes that there is not a water cistern, network of metal pipes, lead roof, or other similar earthed conductor in close proximity; otherwise the radiation, which usually is only feeble, will be absorbed to such an extent that practically no distance will be covered by the transmission.

A very interesting feature to be observed when experimenting with frame aerials is the effect of height above the ground, when either transmitting or receiving. Results obtained, say, on the ground floor are very considerably improved when the apparatus is taken to the top floor.

A very suitable set for receiving purposes with a frame aerial is shown in Fig. 3, wherein is illustrated a seven-valve receiver.

The first three valves are for high-frequency amplification, the first two being transformer coupled and the third having a tuned anode coil. In Fig. 3 the high-frequency transformers and tuned anode are indicated by H_1– H_2– H_3–, whilst the fixed condensers C_2– C_3– C_4– are connected across them. The frame aerial shown varies in size and number of turns of wire according to the wavelength it is desired to receive, as previously explained.

Though H_1– H_2– H_3 are shown as variable coils with fixed capacity, this is in no way intended to imply that they must be so.

On the contrary, should the experimenter prefer to use the plug-in type of transformer, he may most certainly do so subject to his substituting the fixed condensers by others of similar capacity but variable.

The circuit formed by the frame winding and C_1 has, according to the wavelength being received, a certain frequency, to which frequency must be tuned the high-frequency circuits of the valves V_1– V_2– V_3. In order to accomplish this in the best possible manner the coils H_1– H_2– H_3 are made variable, whilst the condensers C_2– C_3– C_4 have a fixed capacity of 0.0002 μF. If, on the other hand, we use plug-in transformers, which individually are not variable, we must, so as to allow some percentage of variation in the circuits, make the condensers C_2– C_3– C_4 variable in order to tune to the frequency of the aerial circuit.

The size of the coils, or of the plug-in transformers, depends, of course, upon the size of the frame, or in other words the wavelength to be received. F_1 is a filament resistance controlling the filaments of V_1– V_2– V_3, whilst G_1 is a grid potentiometer for varying the potential of the grids of the same valves; G_2 is a fixed resistance of 2 megohms.

C_1 is a variable condenser of 0.001 μF value connected across the frame winding for purposes of fine tuning.

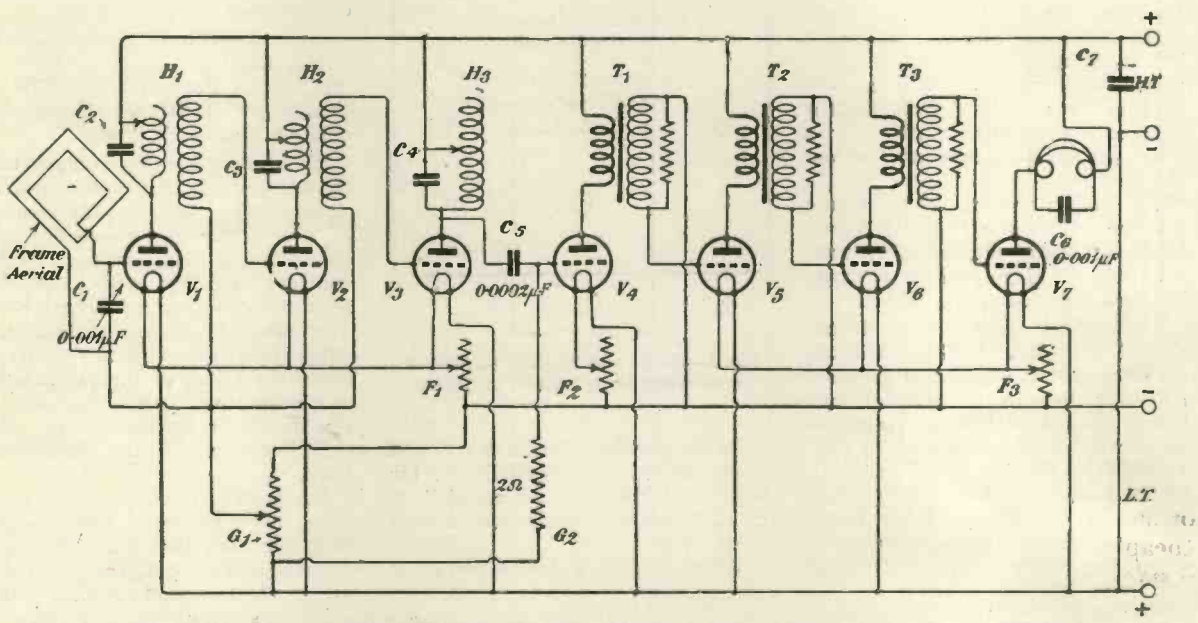


Fig. 3.—Illustrating a very suitable circuit for use with a frame aerial. If five valves only are thought best for the reader's needs, the first H.F. and last L.F. valve may be eliminated.

V_4 is the detecting valve, the filament of which is controlled by the filament resistance F_2.

V_5– V_6– V_7 are three low-frequency valves of the ordinary type controlled by the filament resistance F_3.

Across the secondaries of the low-frequency transformers T_1– T_2– T_3 are connected resistances of 75,000/100,000 ohms, and the purpose served by these is to stabilise the response of the transformers to various frequencies.* By their use a certain amount of volume is sacrificed, but with so many stages of amplification, quality rather than quantity takes precedence.

In all transformers of the low-frequency type there is what might be termed a "peak," resonance frequency which by the introduction of these resistances is smoothed out, enabling a wider range of audio-frequencies to be passed out with consistent results.

The resistance values given need not necessarily be adhered to. Other values may give improved results, by reason of the fact that different transformers have different resonance characteristics.

With a set somewhat similar to the one shown in Fig. 3 the writer has obtained very satisfactory results over considerable distances, using a frame 18in. by 18in. with 12 turns lying close alongside each other. The diagram shown, though for seven valves, can be easily applied to a five-valve receiver by eliminating the first H.F. and last L.F. valves.

Another useful circuit suitable for frame aerial reception, and one which the experimenter will find easier to construct, is the Flewelling circuit described on page 487 of No. 8, *Wireless Weekly*.

The range of this latter set is not, of course, so great as that of the receiver illustrated in Fig. 3, but for reasonable distances it is wonderfully efficient; and last, but not least, is delightfully simple, both to make and work.

* See article "Efficiency in Reception," page 530 of this issue.

AERIAL RIGGING AND MAST BUILDING

By F. H. PHILPOTT.

The second part of a practical article which will be appreciated by those who have not yet erected their aerial.

(Continued from No. 8, page 463.)

HAVING fixed a cleat or hook at the bottom of the mast, for making the halyard fast when the aerial is up, the mast is now ready for painting.

While the colour, of course, is left to the reader's taste, experience suggests that black paint or varnish is most suitable, as one coat of this colour will usually "cover," and although a second affords extra protection against the weather, it is not really necessary.

White paint will certainly require two or even three coats to cover the poles adequately, and the ironwork will probably require more. Also, white shows all the finger-marks and scratches that cannot very well be avoided during erection, and becomes soiled much sooner than black.

A cabinet-maker or polisher can supply a small quantity of black spirit varnish, which will dry with a dull finish in twenty minutes or so. It is very convenient, and should be cheap. When painting do not forget the *insides* of the ironwork, as otherwise the collars will rapidly rust away, to the possible detriment of property.

The paint having dried, the mast is ready for erection.

Before discussing the actual erection, a few practical tips may be given that will probably be very useful to the reader at one time or another during the job.

First, be absolutely certain of everything. If a 45ft. mast gets out of hand it can do a surprising lot of damage, and one guy slipping from a peg may cause you to lose control.

Place your mast and anchors by actual measurement, and do not trust to your eye. If one of the anchors is slightly out of its proper position it will cause considerable trouble in erecting, and look bad when the mast is up.

When paying out the wire for the guys, the easiest way is to hang the coil on the wrist and let out, say, five turns corkscrew fashion. Then change the coil to the other wrist and let five more turns out, corkscrewing the opposite way. By changing the wire from hand to hand in this manner, when the wire is pulled tight it will be found to stretch perfectly straight, and you will have avoided kinks and bends.

It is difficult to haul on a wire with bare hands. A good method of straining on a wire is to attach a rope to it as follows:—

Lay the wire across the rope about 2ft. from its end, slightly untwist the rope as shown in Fig. 5A, and insert the wire between the strands. Then take about six or eight

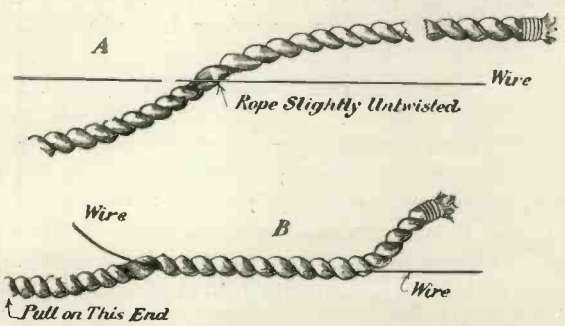


Fig. 5.—Showing a convenient form for holding rope when hauling tight.

turns with the rope round the wire, slightly untwisting the strands of the rope all the time, so that the wire will lie in the centre of the rope as a core (Fig. 5B). The wire will never slip through the rope, however much strain is put upon it, although the same rope cannot be used for this purpose very many times. This tip will be found very useful in most cases of aerial erecting.

Lastly *don't* forget to thread your halyard through its pulley, see that it runs free and *tie the ends together.*

The halyard is almost invariably forgotten until it is required to pull up the aerial.

Nothing is more exasperating than this, unless it is that, having forgotten to join the ends and having accidentally pulled slightly on one end, you watch it merrily running through the pulley, until it either stops with one end out of reach, or keeps running by its own weight and finally falls and tangles with the guys. In either of these cases there is only one thing to do, and that is lower the mast and have another try.

As a basis for discussing the erection of the mast, we will assume a perfectly open and flat space, with unlimited room and no obstructions, or in other words, ideal conditions.

Difficulties may afterwards be introduced and dealt with by compromises or additions. It will also be assumed that we are using four sets of guys.

A method of erection using only three sets of guys will be shown later.

It may be mentioned here that, should the reader decide to use only three sets of guys, and is having iron collars made, he will obviously need only three lugs (or eyes) on the two lower collars, and four (including the one for the halyard pulley) on the top.

The material needed in the case we are discussing (some of which is not usually required and can in any case be substituted) would be as follows:—

Some form of foundation for the mast to stand on.

Four anchors for the guys—some form of wire strainer is optional.

Temporarily required:—

A board about 3ft. by 9in. by 1in.; 15ft. or 20ft. of rope (a builder's scaffold rope would do admirably).

A board, pole or ladder (the latter for choice) about 15ft. long.

A mallet or heavy piece of timber for driving pegs.

The foundation may be anything that will prevent the mast from gradually sinking into the ground. A board 1ft. square, the bottom of a galvanised bucket, or bricks will serve.

The anchorage will probably be by pegs, which must be sufficiently long to drive into the ground at least 2ft. Anything shorter than this will loosen and pull out in time, particularly if the ground is soft.

The writer has made pegs of 1in. deal board, cut, notched in three places and tightly bound with wire top and bottom. The binding is necessary, as otherwise the peg will most certainly split when being driven into the ground.

Three notches are not essential, but will be found much more convenient than only one when it is required to tighten up the guys. Round pointed stakes of, say, 4in. diameter, notched and bound are perhaps the most suitable pegs to use for the purpose in mind.

To erect the mast, first measure for your length of aerial, to locate the spot where the

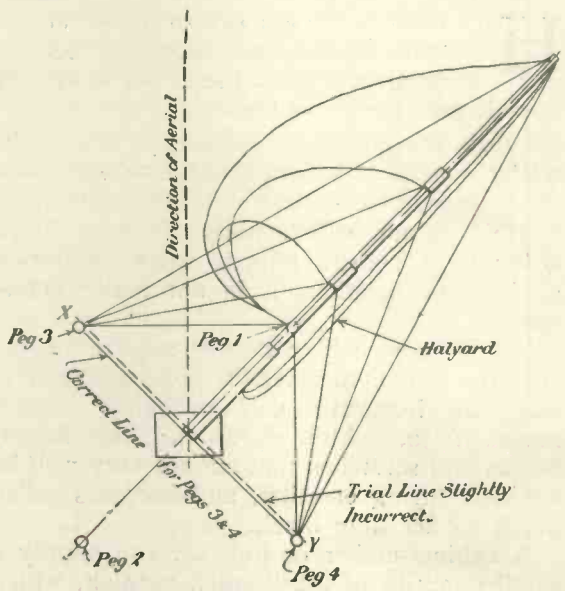


Fig. 6.—The arrangement of pegs.

mast should be. The P.M.G. allows you 100ft., inclusive of "lead in." This means that if your aerial is 45ft. high and your set is on the ground floor, the mast would apparently be 100ft.−45ft.=55ft. from the building in which you have your set. As, however, your aerial will probably slope downwards to the building, and you require room for insulators, etc., if you have the space at your disposal you should add another 5ft. or 10ft. to this, making the base of your mast, say, 60ft. from the building.

Having marked this spot, lay your base-plate or foundation, and fit the three sections of your mast together with the base in position. It is better not to attach the guys to the mast until they are actually required, as lying loosely over the ground they get kinked, and also impede operations.

The mast can be laid out in any direction which is convenient or possible, but it is preferable, and usually easiest, to lay it at an

angle of 45 degrees (half a right angle) to the line the aerial will occupy as in Fig. 6. The position of the mast at this stage determines the position of the pegs, as will soon be apparent, and laying it out as shown will bring the guys symmetrical with your aerial and distribute the strain of the aerial evenly between two sets of guys.

The correct position for the pegs, which should not be less than 10ft. from the base of the mast and should, if possible, be 14ft., can be ascertained as follows, although a geometrician will improve upon this method:

Take a piece of string, and lightly attach one end to the extreme base of the mast. At the distance decided upon, say 14ft., fasten a stick, or something that will scratch the ground. Pegs Nos. 1 and 2 (Fig. 6) can be immediately marked off. Now keeping the string straight, scratch two arcs covering the position that pegs Nos. 3 and 4 will occupy. Remove the string from the base of the mast, and after lengthening it by about 4ft., tack

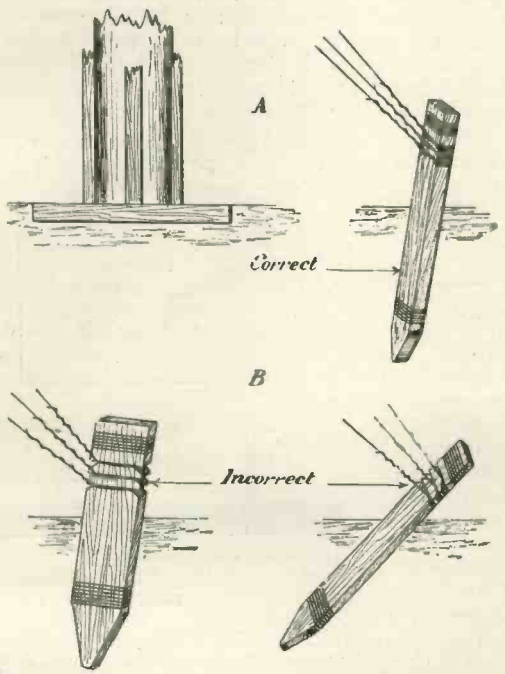


Fig. 7.—Illustrating correct and incorrect methods of driving pegs in the ground.

it to the mast at the position of peg No. 1. Keeping the string tight as before, mark the points X and Y (Fig. 6) on your scratches at 3 and 4. Using these marks as points to measure from, and by "sighting" over them and the base of the mast, the correct position for pegs 3 and 4 will quickly be found by "trial and error." It would be as well to

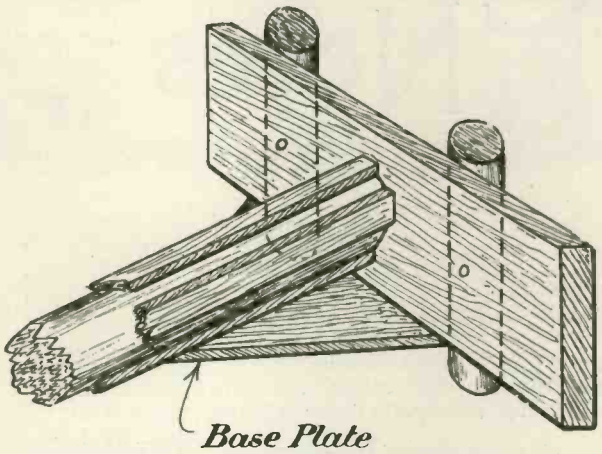


Fig. 8.—Method suggested for preventing mast from slipping during erection.

check these positions by measuring all round with your string.

The pegs can now be driven in. If flat pegs are used, drive them in with their flats *facing* the mast, and not edgeways. Also drive them in nearly vertically, as, if they are too sloping, the tendency is to lift the top earth away (Fig. 7).

Having placed your anchors, you should arrange a "stop" of some description, to prevent the mast from slipping during hauling up. A good method is shown in Fig. 8, with a short board and your two temporary pegs.

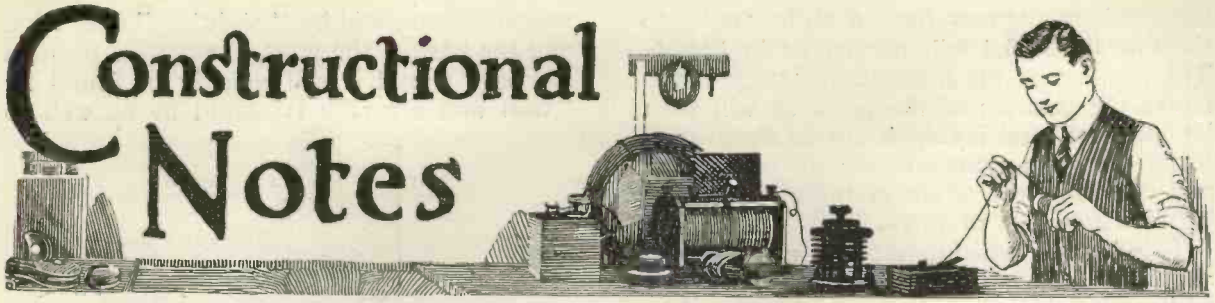
The board should preferably be "wetted" and "mudded" at the actual point of contact with the mast. This will prevent the mast from "riding" on the board, and also to some extent counteract the tendency to strip your laths from the pole.

Now fix your No. 3 and 4 (Fig. 6) sets of guys and attach them to the anchors fairly tightly, taking care not to distort your mast from the straight. You should, of course, use the thinnest wire for the top guys and the thickest for the bottom.

If your pegs have been accurately placed and the guys are carefully fixed, all of them with approximately the same degree of tightness, they should need no alteration when the mast is up.

(To be continued.)

Constructional Notes



A POCKET POLARITY TESTER.

A VERY useful little instrument can be made up from a piece of glass tubing and some odd pieces of material from the scrap-box. Its function is fairly well known. Should there be any doubt as to which is the positive or the negative pole of a battery the usual method is to place both leads in a

Fig. 1.—The glass tube

glass of water previously fouled with common salt, when small white gas bubbles will collect round one of the leads, this being the negative. The writer, being more or less particular about the appearance of his apparatus, discarded the tumbler and jam pot and devised the " instrument " to be described. The glass tubing (Fig. 1) is easily obtained from any chemist and may be ⅜in. in diameter by about 4in. long. This can be cut by making a fine three-cornered file function as a glass cutter. Two short lengths of No. 16 or 18 s.w.g. copper wire are bent as shown in Fig. 2 and pushed through two small corks which are made to fit tightly into the ends of the glass tube. There should be a space of

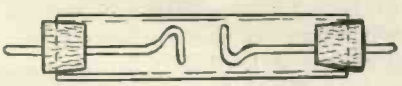


Fig. 2.—Showing how the wires are fitted.

about ½in. between the hooked portions of the wires. One of the corks is placed in position and the tube is then almost filled with water in which has been dissolved a little common salt or salammoniac. The other cork is then gently pushed into the other end of the tube and a little sealing wax is run over the ends of the corks and the edges of the tube. Two metal caps built up from two 1in. lengths of thin brass tubing and two discs with holes drilled through the centre are now slipped over the ends of the glass tube. The projecting ends of the wires are cut off, and the ends neatly soldered in the holes in the ends of the caps (Fig. 3). If the caps do not fit tightly over the ends of the tube it will be necessary to apply a little seccotine or plaster of Paris.

Though there are many methods

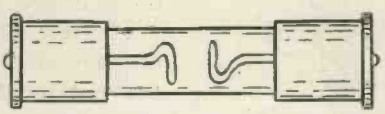


Fig. 3.—The completed tester.

of testing polarity, it will undoubtedly be found a better method to have on hand an instrument of convenience rather than employing various tests of the " water " and litmus paper types. The useful purposes served by a polarity tester when using twin flexible wire, not only justify the few minutes spent in its construction, but also permit the set to be connected in a neat and careful manner without the usual changing about of leads.

PLUG AND SOCKET FOR AN ACCUMULATOR

ALMOST convenient way of connecting up the accumulator to the L.T. circuit of the set is to attach a short length of stout twin flex, provided with a pair of sockets at its far end, to the battery, and to have a plug mounted on the set. The natural way would seem, at first sight, to be to reverse this order, fitting the plugs to the accumulator leads and the sockets to the set; but a moment's thought will show that if this were done, one would always run the risk of short-circuiting the battery when not in use, and thereby probably

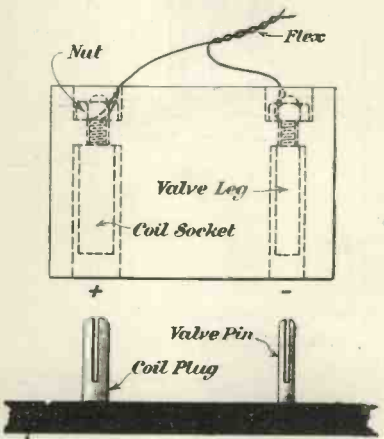


Fig. 4.—Arrangement for accumulator plug.

ruining it by carelessly placing the plug on the bench, so that its points were in contact with some metal object. With sockets designed in the way about to be described there is no danger of any such untoward happening.

It is best to use one fat plug with a corresponding socket and a thin one of each. If this is done it is impossible to connect up the battery wrongly in a moment of aberration. For these we cannot do

better than employ a plug and socket such as are used for mounting de Forest coils, with a valve pin and a valve leg for the other pair.

The actual size of the ebonite mounting for the sockets will depend upon their length (different makes of valve legs in particular vary considerably) and upon the distance apart of the L.T. connections on the set itself. Dimensions are, therefore, not given in Fig. 4. The ebonite should be ½in. thick, and its depth should be ⅝in. more than the length of socket or valve leg (excluding the screwed shank), whichever is the longer.

If we take the valve leg as being ⅞in. long and ¼in. full in diameter, the hole to receive it will be made 1in. deep with a $\frac{5}{16}$in. drill. Through the remaining ½in. of ebonite a 4B.A. clearance hole will be made for the shank to pass through. When the valve leg is secured to its nut its rim will thus be ⅛in. inside the ebonite. The securing nut is counter-sunk until it is below the level of the top.

The coil socket is mounted in the same way, its bottom being drilled and tapped to take a 4B.A. screw, which is to serve the same purpose as the shank of the valve leg.

The ends of the flex leads, having been first soldered to flat washers, are secured by the nuts which hold socket and valve leg in place. The positive lead is taken to the former, the negative to the latter.

It will be seen that, no matter how carelessly the attachment is thrown on the table, a short-circuit cannot occur, since the metal connections are effectively shielded by the ebonite mounting. R. W. H.

A NOVEL COIL HOLDER.

A SERIOUS effort to combine simplicity with efficiency is a very interesting procedure which, in this case, resulted in the production of the basket-coil holder shown in Fig. 5. A 2½in. length of brass tubing E, which is about ½in. in diameter, is slotted for a depth of a little more than 2in. to take a strip of 1-16th in. sheet brass G. A 2B.A. nut is soldered to the top of the tube, and a flange, drilled to take two wood screws, is soldered to the base as shown in Fig. 5. A short length of 2B.A. screwed rod is fitted at one end with a small knob and screwed into the nut. A piece of square wood C and one of the coil supports B are also slotted as shown in Fig. 5. The brass arm is hinged to C, which is then secured to the baseboard, and the coil support B is firmly screwed to the end of the arm. The other end of the arm passes through the slot in the tube E, so that when the knob is screwed down the end of the screwed rod engages the edge of the arm inside the tube, thus giving the desired movement to the coil. The weight of the coil and the support is sufficient to keep the arm

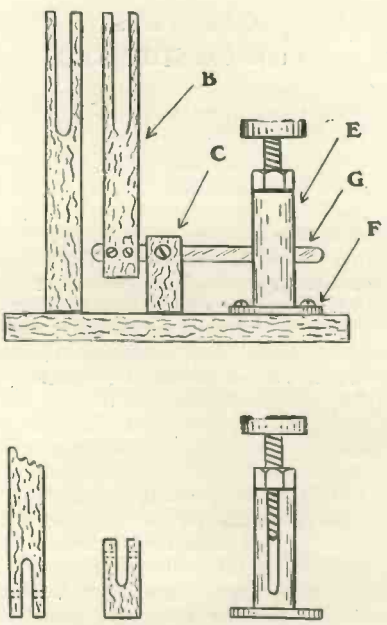


Fig. 5.—The coil holder.

pressed against the end of the screwed rod, but a small compression spring may be dropped down the tube, under the arm, if desired.

O. J. R.

NOTES ON THE CARE OF TELEPHONES.

ALTHOUGH the following remarks do not apply to the users of crystal sets or to valve sets fitted with telephone transformers, they should be of interest to those who use their telephones connected directly in the plate circuit.

In common with many other small details relating to wireless, there is a right and a wrong way of connecting up the telephones. The former leads to increased efficiency and long life, while the latter conduces to the reverse. It is rather surprising that more emphasis has not been given to this point by manufacturers in general.

The important features in any telephone receiver are the permanent magnet, the coil windings, and the diaphragm. Now if one does not allow curious people to prod the diaphragm with a pencil, and the coils do not get burnt out by lightning or other causes, there remains only one factor in regard to the useful life of the instrument, and that is the magnet.

Telephone manufacturers have devoted much research in order that a suitable steel might be found for the magnet, and it is perfectly safe to say that every good make of telephone contains a magnet which has had to satisfy very exhaustive tests covering chemical, mechanical, and magnetic qualities. Quite an interesting book could be written on these qualities alone. It is, therefore, rather a pity that the excellent work put into the instruments should be neutralised by a small oversight.

The permanent magnets, which are usually in the form of a ring or are built up from ring laminæ, carry soft iron pole-pieces on which the coils are wound, and in assembling the receiver care is taken that the coils are so connected that when a current flows through the receiver in the proper direction the permanent magnet is reinforced. One must bear in mind the fact that the diaphragm is always under tension from the pull of the magnet and is normally "bellied" towards the poles, and when this pull is in-

creased or relaxed the diaphragm is attracted or released accordingly.

Now if the receiver be connected so that the flow of current can assist in this good work, we shall be getting the maximum effect from the diaphragm, which will be operating under the most favourable conditions, and will thus respond to the most feeble disturbance in the coils. If, on the other hand, the connection be reversed, the permanent pull mentioned will at once be reduced, and further changes in the flux due to coils will reduce it still more, and, as a natural consequence, the efficiency will not be so great.

But that is not the worst of it. If the receiver be left for a sufficient length of time with the current flowing in opposition, the magnets gradually lose strength, and this can only be restored by having them remagnetised. In the course of some tests, the writer found that a certain receiver lost over 33 per cent. of the initial magnet strength after being reversed for forty-eight hours; and although this particular instrument was not intended for wireless purposes, the same applies, though perhaps in a less degree.

It is, therefore, well to look for markings on the receivers and keep them in mind when connecting up. Some makers mark the terminals with a plain + or −; others use a cord with a red spot woven into it for the positive lead. Unfortunately, there are many excellent telephones now on sale with nothing to indicate the polarity. The writer has employed the following method with some of these, and others may find it useful, but it calls for a discriminating ear.

Place a shilling and a halfpenny on a plate with their edges just touching, and put a drop of vinegar at this point. Now put the 'phones on and touch the coins, one with each lead of the 'phones. A very faint click will be heard, and the leads should now be reversed several times until it is decided which way gives the loudest click. When this has been settled, mark the cord touching the shilling, and in future connect it to the positive side of the H.T. battery. It is not much good trying this test with a dry battery, as the click is so loud in each instance that only a very practised ear can distinguish the difference.

The above remarks apply with equal force to loud-speakers when used directly in the anode circuit.

An alternative method is to find the polarity of the magnet with a compass and note how the coils are wound, but this is not always possible, as some are embedded in wax.

One other point is worth remembering. Nothing reduces the magnetism of a receiver quicker than jarring or dropping it. Good magnets are given a vibration test to find out by what amount they are weakened, but this does not help when they are dropped on to a hard surface; and until sets are "wireless" in the literal sense, people *will* trip over 'phone cords, with the usual result, so it is well to arrange convenient hooks as a form of insurance against this accident.

L. R. G.

CABINETS FOR CONDENSER.

THE experimental set has a way of straggling all over the bench and of resolving itself into an evil-looking jumble of wires and apparatus. Too much neatness is undesirable when experiments are in progress, for it usually means that connections are of a semi-permanent kind, and that certain portions of the wiring are difficult to get at. Still, one can do a good deal in this direction without making connections inaccessible.

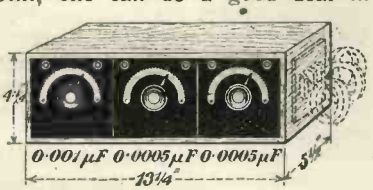


Fig. 6.—The tuner.

A condenser unit is a time-saver on the bench, and when the set assumes a more finished form it is a neat addition to the wireless table.

The design shown in Fig. 6 contains three variable condensers, one of 0.001 μF and two 0.0005 μF, intended for primary, secondary, and reaction circuits. Many other combinations are, of course, possible. One might, for instance, have one of 0·001 μF, with a vernier wired in parallel. The third condenser in this case would be for the secondary coil. Reaction and tuned anode condensers might then be mounted in a separate cabinet. If a three-coil holder is mounted at one end of a box containing the combination shown in Fig. 6, a complete and very handy tuner is made.

It is best to make up the condensers separately on ebonite top plates 4½in. square, and not to mount the trio all on one panel. The advantage of so doing is that should any condenser go wrong it can be removed without disturbing the others. If the box is to lie on its side, the spindles must be tightened up in their bushes by means of set-screws, so that the plates will "stay put" when the knobs are turned.

The effects of body capacity, which are sometimes a great nuisance, can be entirely got rid of by making a little addition to each condenser.

Before making up a condenser, give the underside of its top plate a good coat of shellac and press on, while the varnish is still wet, a sheet of tinfoil, smoothing it out carefully so that there are no air-bubbles beneath it. When nearly dry, take a scriber and mark out a circle ½in. in diameter round each of the holes that are to take the supporting rods, the terminals, and

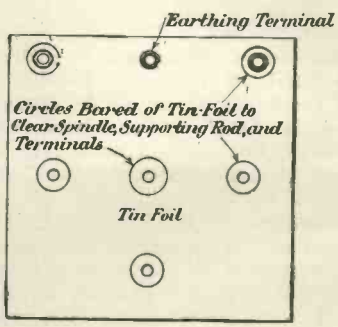


Fig. 7.—Arrangement of panel.

the spindle. If the last has a large bush, the circle will in this case be larger. Scrape away the tinfoil inside the circles.

A third terminal making contact with the tinfoil should now be mounted. Whenever capacity effects manifest themselves, they can be stopped by connecting this terminal to earth. R. W. H.

ONE often has occasion when working on the experimental set to reverse the direction of the reaction current. To do this in ordinary circumstances means disconnecting the wires and joining them up again in the opposite way. It is of no use with basket or duo-lateral coils to turn the holder bodily round, for this has no effect at all. Altering the wiring is always a nuisance, and usually entails a considerable waste of time, especially as one does not know until one tries whether the change will be beneficial or not.

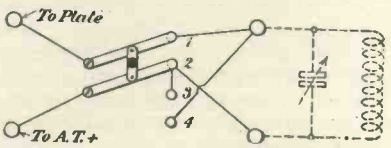


Fig. 8.—The wiring of the switch.

A neat little reversing switch is quite an easy affair to make, and it is extremely handy to use. Once it is installed, one can try the effect of reversing the reaction coil or of cutting it out altogether in an instant. The cut-out part of the switch is a great boon when searching for broadcast transmissions, since it enables one to use the set with the pleasant knowledge that one cannot be causing interference with others. As soon as the transmission has been picked up and tuned in as sharply as possible, the reaction coil is thrown in and gradually adjusted until the maximum effect is obtained. In this way radiation is avoided.

The wiring of the device is shown in Fig. 8. It will be seen that, if the parallel arms of the switch are placed on studs 1 and 2, current flows in a clockwise direction through the reaction circuit. When they are on studs 2 and 3, the coil is short-circuited, and when they cover Nos. 3 and 4 current flows in a counter-clockwise direction.

The switch is built up on a small ebonite panel $3\frac{1}{2}$in. × 3in. × $\frac{1}{4}$in.,

REACTION CUT-OUT AND REVERSING SWITCH.

which is laid out and drilled as shown in Fig. 9. The holes in the four corners are for the two pairs of terminals needed—one pair to take the leads from plate and H.T.+, the other for those running to the coil. Those marked 1, 2, 3, 4 are for the studs, whilst the remaining two take the pivots for the arms of the switch.

The arms are made of stout sheet brass. Each is 2in. long by $\frac{5}{8}$in. wide. At one end of each a 4B.A. clearance hole is drilled. The bridge which connects them is a strip of $\frac{5}{8}$in. ebonite 1in. in length by $\frac{3}{8}$in. wide. In each arm drill a 4B.A. tapping hole about $\frac{3}{4}$in. from the clearance hole previously made. The exact distance is not important, but it must be exactly the same in each arm. Drill two 4B.A. clearance holes in the ebonite $\frac{1}{2}$in. apart, and another exactly midway between them. Now tap the holes drilled in the arms and fasten the bridge in place by means of 4B.A. screws, placing a flat washer under the head of each

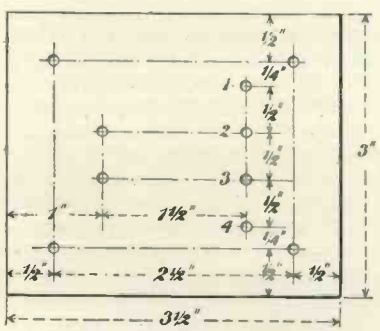


Fig. 9.—Dimensions for panel.

screw, and a second between the ebonite and the arm. Cut the screws off short on the underside and burr their ends so that they cannot work loose. The handle or knob for the arms is made of a short piece of ebonite rod with a 4B.A. clearance hole drilled right through it. It is secured to the bridge by a screw and a nut, the end of the screw being burred as before.

Fig. 10 shows the method of mounting the switch arms. The pivot of each is a 4B.A. screw. On to this is passed a flat washer, followed by a spring washer, another flat washer, the switch arm, a third flat washer and a nut. The tension having been adjusted by means of this nut, the screw is passed through the hole drilled for it, and secured in place by a nut and a lock-nut on the underside of the ebonite.

The wiring is simplicity itself. As soon as it is done, the switch

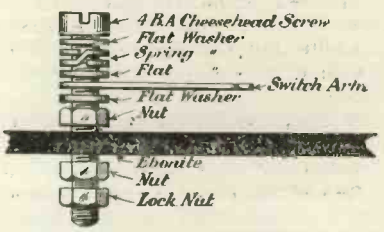


Fig. 10.—Method of mounting switch arms.

is mounted on a small wooden plinth recessed to clear the shanks of the various screws, studs and terminals, and the device is ready for use. R. W. H.

LOOSENING SCREWS.

WHEN a screw has become so set as to necessitate considerable force to unscrew it, the best method to adopt is to turn the screw in a clockwise direction, say, a quarter of a turn, before turning in the other direction to unscrew. Using force on screws spoils their heads and appearance; further, should the screwdriver slip, the material, held by the screw, is liable to be very badly scratched.

In the case of ebonite every care should be exercised in this direction on account of the ease with which ebonite can be made to split.

X. Y. Z.

Broadcasting News

By OUR SPECIAL CORRESPONDENTS

THE performance of "Twelfth Night," as broadcast from 2LO on the 28th inst., was a remarkable event in wireless history, and reflects the greatest credit on Captain C. A. Lewis, Miss Kathleen Nesbit, and the distinguished actors and actresses who assisted them. It was a little bit difficult for those behind the scenes to know how it was going over, but reports received subsequent to the performance conveyed the impression that the experiment had been a success.

* * *

One of the performers said there was no doubt at all that only those who could speak properly would be a success in broadcasting. He considered that if actors would go in for broadcasting, it would greatly improve their elocution. It seems it is quite possible to be a successful actor and fairly easy to be a successful actress without knowing how to articulate properly. So much depends on the *mise en scène*. The pretty faces and pretty dresses of the ladies, and the striking appearance of the men, all count for nought before the microphone. On the other hand, no matter what the physical disabilities of the artiste may be, if they can speak well they will be successful in broadcasting.

* * *

The intention is to give Shakespearean plays, perhaps once a fortnight, but one wonders if it would be advisable to do this so often, because, when all is said and done, however reluctant one may be to confess it, although everyone ought to be rapturously enthusiastic about Shakespeare, the sad fact remains that theatrical managers who star Shakespeare, with one or two exceptions, are not usually overburdened with much fine gold. This is a fairly clear indication that Shakespeare is not overwhelmingly popular with the masses.

A number of high educational authorities were at 2LO on the occasion of the performance. They listened first in the studio and afterwards to a loud-speaker and on head-'phones. While they were favourably impressed with the reception on head-'phones, they were not at all enamoured of the loud-speaker, and considered that its educational value was not very great at the present stage of its development.

* * *

The loud-speakers at 2LO are too near to the transmitting station to be effective. It is hoped that another test will be arranged soon and that educational authorities will have opportunities of listening-in, say, in the suburbs of London. Probably the best thing would be for distinguished actors and actresses to recite into the microphone selected passages of the bard. Loud-speakers could be installed in the various schools, and the pupils there could hear the best English as it ought to be spoken.

* * *

All British broadcast transmissions are beginning half-an-hour later and ending half-an-hour later during the continuance of summer time. It is becoming increasingly difficult to make people listen-in at nights, although a considerable amount of ingenuity is exercised in some of the suburban areas in getting the head-'phones and loud-speakers out of doors. After all, it is just as well that summer time should be utilised for the purpose for which it was meant, in healthy sport and joyous recreation. People will return with all the greater zest to the pleasures of listening-in when the days grow shorter.

* * *

Lord Knutsford's appeal for the London Hospital was one of the best speeches which have been broadcast; but probably because it was a charity appeal it received a very poor Press. It contained some most interesting revelations of the unpreparedness of Government Departments of this country in the early days of the war. The daily papers are a little bit coy in reporting items which have been broadcast because they say they have lost their first freshness. It is to be hoped that some of the addresses which have been given will be printed in some form or another. There are thousands of listeners-in who would be glad to have them for reference.

* * *

And so we are to have *another* Postmaster-General to deal with the wireless question. The holders of this office seem to change with the rapidity of electric signs. We shall need to have a new nursery rhyme running as follows:—

This is the agreement that Mr. Kellaway, the Postmaster-General made.
This is Mr. Neville Chamberlain, the Postmaster-General who signed the agreement, etc.
This is Sir Joynson-Hicks, the Postmaster - General who queried the agreement that Mr. Neville Chamberlain, etc., etc.

Let us hope that the last line of our new nursery rhyme will be:—

This is Sir Laming Worthington-Evans, the P.M.G. who settled the queries and issued the licences, etc., etc.

This is the "happy ending" which we are all most anxious should occur at the earliest possible moment.

* * *

Owners of valve sets have been anxious for a considerable time to

listen-in to as many different stations as possible, but it is rather difficult to blot out the station which happens to be nearest. However, a system of half-hour intervals for each station will be in operation by the time these words appear in print. London will close down from 7.30 to 8 p.m., Manchester and Glasgow, from 7.45 to 8.15 p.m., Cardiff and Newcastle, from 8 to 8.30, and Birmingham from 8.15 to 8.45.

The corrected time-table, with silent periods indicated, will be found on this page.

* * *

BIRMINGHAM.—The broadcasting of opera from Covent Garden was accompanied in the Birmingham area by a recurrence of the radiation evil from mishandled receiving sets, more pronounced even than on the last occasion when the National Opera Company entertained us. It is a great pity that the enjoyment of so many listeners-in should be marred to such a degree by the few. Nothing short of a combined campaign by local societies will, one thinks, diminish the evil. If one or two of the more persistent offenders could be made examples of the trouble would very quickly grow less and tranquillity in the ether would be much nearer. It is unfortunate that only an exceedingly small proportion of the many thousands of newcomers to wireless in this area have become members of local societies. The need of some kind of inspection by competent officials is obvious, for there must be many sets in use which contravene the Postmaster-General's regulations regarding the use of reaction.

Commencing from Friday last (June 1), the times of transmission from 5IT were altered as follows: 5.30 to 8.15, interval until 8.45, and continuous programme till 10.30. The extension will be welcomed, for hitherto Birmingham was first among the broadcasting stations to "pipe down."

* * *

GLASGOW.—It is understood that before the King and Queen pay their annual visit to Balmoral Castle towards the end of August a wireless installation will be placed there. If this is done it will have the effect of bringing Balmoral into closer touch with Downing Street than in the past. Last year, it may be recalled, many dispatches for the King, despite the operations of telegraphy and telephony, had to be conveyed from London and Dublin by special courier.

Mr. Herbert A. Carruthers, the Glasgow station director, is an Edinburgh man. He formerly held various appointments in the musical life of the capital, including that of sub-organist of St. Mary's Cathedral. Subsequently he held the post of organist of Park Parish Church, Glasgow. Mr. Carruthers is also well known as a concert pianist and orchestral and choral conductor.

Many tributes to the excellence of the broadcasting service from the Glasgow station have been received from people in places as far distant as Norway, Denmark, Belgium and France. Testimony is given to the clearness with which the programmes have been heard in these countries.

Despite opposition in various quarters in Scotland to the broadcasting of a Sunday programme, the inauguration of this feature has been a distinct success. The services of various clergymen have been enlisted, and people have "listened-in" to their addresses with evident appreciation.

* * *

MANCHESTER.—The wireless orchestra of 2ZY is shortly to be augmented by the addition of some "brass." This should add to the orchestra's popularity, if such a thing is possible, for it was at the top of the poll in the recent voting competition for the most popular performer, or performers, at 2ZY.

Mr. Lingard, the principal flautist of the Hallé Orchestra, has just joined the orchestra. Many listeners-in will have heard his solos the other evening.

When listening to opera broadcast from 2LO it was found that more of the opera could be heard through 2ZY's jamming than when the latter thoughtfully closed down. This kindness was misplaced, for it released all the professional "heterodyners" in the Manchester area and neighbouring counties.

(*Continued on page* 573.)

BROADCAST TRANSMISSIONS

	Call-Sign.	*Wavelength*
CARDIFF	5 WA	353 metres.
LONDON	2 LO	369 ,,
MANCHESTER	2 ZY	385 ,,
NEWCASTLE	5 NO	400 ,,
GLASGOW	5 SC	415 ,,
*BIRMINGHAM	5 IT	420 ,,

TIMES OF WORKING.

Week-day .... 11.30 a.m. to 12.30 and 5.30 to 11.0 p.m. B.S.T.

***Birmingham—3.30 to 4.30 p.m., instead of 11.30 a.m. to 12.30.**

Sundays ..... 8.30 to 10.30 p.m. B.S.T.

SILENT PERIODS.

CARDIFF	8.0 to 8.30
LONDON	7.30 ,, 8.0
MANCHESTER	7.45 ,, 8.15
NEWCASTLE	8.0 ,, 8.30
GLASGOW	7.45 ,, 8.15
BIRMINGHAM	8.15 ,, 8.45

HISTORICAL NOTES ON RADIO-TELEGRAPHY AND TELEPHONY

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

A Paper read before the Radio Society of Great Britain on April 25th, 1923.

PART II—(Continued from No. 8, page 491).

AS far back as 1864 Clerk-Maxwell, in his paper, "On the Dynamical Theory of the Electro-Magnetic Field," assuming the existence of the ether, deduced mathematically the existence of electro-magnetic waves therein. He defined the laws which would govern such waves if they existed, predicted all the properties they should possess, and even the exact speed at which they should travel. In the words of Sir Oliver Lodge, in a lecture he delivered at Finsbury Technical College on February 1st, 1923: "He is legislated for them before they were born." He also showed that conductors of electricity must be opaque to light.

In 1883 Fitzgerald, at a meeting of the British Association, surmised that the oscillatory discharge of a Leyden jar would produce etheric waves, "if only a means could be devised for their detection."

In 1888 Lodge produced stationary waves along wires by condenser discharges.

We now come to a man whose work can never be sufficiently appreciated, and, in the light of modern tendencies, it is interesting to note that he freely gave his results to the world and took out no patents.

In 1888 Hertz, in his paper, "On the Action of a Rectilinear Oscillation on a Neighbouring Circuit," gave to the world the result of his epoch-making researches, and for the first time established the existence of free electro-magnetic waves.

It is interesting to note that he described them as "outspreading of electric force"—not as waves. Kelvin, in translating his work into English, designated them "ether waves."

At this date "self-induction" was not understood. Sir Wm. Preece jocularly said it was a "bug-a-boo." Kelvin spoke of it as electro-dynamic capacity, whilst Maxwell was the first to term it self-induction. Heaviside called it induction and also pointed out this ionised condition of the upper atmosphere, whilst Dr. Eccles, in postulating his theory of the transmission of waves round the earth in 1911, gave to it the name of "Heaviside layer."

In 1889 Lodge showed the phenomenon of cohesion between two metallic spheres (see "Proceedings of the Institute of Electrical Engineers, 1890"), and later made a coherer consisting of a microphonic contact between a watch spring and a plate of aluminium.

In the year 1884 Professor Calzecchi Onesti had shown that if metal filings were placed in a tube between two copper electrodes and inserted in circuit with a battery and galvanometer or telephone, the application of a fairly high voltage across the filings caused them to stick together, or cohere sufficiently to allow a current to pass through them, and he showed that revolving the tube decohered them.

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

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

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

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

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

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

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

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

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

In 1904 Admiral Jackson took Marconi on board the battleship *Duncan* for his first long-distance

wireless telegraph test for ships, and messages from them were easily received at Gibraltar.

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

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

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

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

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

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

This little instrument was capable of resisting the comparatively rough usage of everyday work, and from that day successful radiotelegraphy became an established fact, and he set up long-distance records one after the other, so fast that he astounded the world with his results. It is interesting to note that as far back as 1892 Sir William Crookes prophesied the possibility of wireless communication as a serious factor in our lives and suggested that some day the simultaneous interchange of signals might be possible by employment of different wavelengths.

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

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

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

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

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

(To be continued.)

BROADCASTING NEWS

(Continued from p. 571.)

NEWCASTLE - ON - TYNE. — Complaints with regard to "radiation" have been frequent in Northumberland and Durham of late, and the local radio societies have been asked to endeavour to locate the offenders. An appeal to the sportsmanship of those who howl through ignorance or carelessness, together with an amusing vocal demonstration of the results produced, was broadcast by Mr. P. P. Eckersley on the occasion of a recent visit to Newcastle, and should result in a reduction of the nuisance, but we fear his eloquence will be wasted on those who make unscrupulous use of reaction.

Transmission from 5NO is really excellent since the installation of the new microphone. A sequel to the recent transmission of the North of England Musical Tournament from Newcastle Town Hall comes in the allotment of two nights to items by the prize winners of the tournament concerned. It is possible that in broadcasting we have a solution of educational problems of the future, for surely by no other means can we so directly bring the University into the home. It would almost seem as though the Newcastle station were to become a rostrum for the University of Durham, talks by professors and lecturers at Armstrong College having become a regular feature of the programmes. They are keenly appreciated, as are also the "Nights with Famous Composers" which are now being given weekly.

* * *

SHEFFIELD.—The relay station that is going to supply Sheffield with broadcast items is being erected at Sheffield University Applied Science Department in St. George's Square, and is almost completed. Delay in getting a start has been caused by exhaustive experimentation on the choice of land-lines, the desire of the B.B.C. expert being to secure the best possible results at the start. The original date of opening was fixed for May 20th, but this, unfortunately, had to be postponed. It will be possible for owners of crystal sets to listen-in to broadcast music. There seems to be a good deal of preparation in this direction, judging by increased sales and the appearance of aerials all over the city and suburbs.

The phenomenon of fading observed in Sheffield, particularly with regard to London broadcasting, is exercising the brains of experimenters and researchers, and the latest theory to account for it is that the smoke pall over London may be responsible by producing a varying condenser effect. It is noticed in Sheffield that fading is rarely present after high winds.

Radio Societies

ACTON RADIO SOCIETY (H.Q., Municipal Buildings, Winchester Street, Acton, W.3).

Hon. Sec., Mr. T. W. Hyne Jones,
208, Avenue Road,
Acton, W.3.

The status and reorganisation of the society were fully discussed at a special committee meeting held at 4a, Church Road, Acton, W.3, on May 18th; a fixed formal programme for each meeting was also arranged and apparatus was promised. The secretary will be pleased to hear from those who wish to become members.

BIRMINGHAM EXPERIMENTAL WIRELESS CLUB (H.Q., The Digbeth Institute, Birmingham).

Hon. Sec., Mr. A. L. Lancaster,
c/o Messrs. Lancaster Bros., & Co.
Shadwell Street,
Birmingham.

Mr. Towers recently gave a very successful lecture and demonstration before the club on the subject of "Receivers and Amplifiers for Broadcast Reception." Interesting results were obtained by impressing varying potentials on the grids of the valves. Information very useful to the experimenter was then given by the lecturer, after which very good results were obtained on the club's aerial.

EASTBOURNE AND DISTRICT RADIO SOCIETY.

Hon Sec., Mr. W. F. G. West,
"Bridle Gate,"
Willington, Sussex.

On May 10th Mr. W. S. Maddock gave at the Technical Institute an interesting lecture entitled "The Origin of Wireless Telegraphy," illustrated by means of diagrams.

Many novel and interesting features are being prepared in connection with future programmes. Applications for membership should be addressed to the Secretary.

GLEVUM(GLOUCESTER) RADIO AND SCIENTIFIC SOCIETY.

Hon. Sec., Mr. A. R. E. Jennings,
Caer Glowe,
Brunswick Road,
Gloucester.

This society recently held a very interesting meeting at the station of the Consulting Engineer, Mr. John Mayall, A.M.I.E.E., when his high-voltage generators were inspected. Mr. Charles Box gave a short description of his single valve "Super" circuit which receives London, Cardiff, and other broadcasting stations on a 2-ft. frame.

Applications for membership should be sent to the Hon. Secretary.

HACKNEY AND DISTRICT RADIO SOCIETY (H.Q., Y.M.C.A., Mare Street, Hackney, E.8).

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

On Thursday, May 10th, at headquarters, a special lecture was delivered to the Society by Mr. L. L. Robinson, M.Inst.C.E., M.I.E.E., M.I.Mech.E., Chief Electrical Engineer for the Borough of Hackney.

Mr. Robinson lectured on "Electric Currents, Minute and Large," and stated that it was rather interesting to consider the difference between the current he had to deal with daily and the current used in radio. His electricity depot sent out A.C. at a frequency of 50 cycles per second, so that the wavelength of his current was equal to 6,000,000 metres, compared with wavelengths of 369 metres sent out by 2LO, 2,600 metres by Paris, and up to 30,000 by the great commercial stations. The daily average load at the Hackney Electricity Works exceeded 12,000 kw. 2LO sent out 1.5 kw., yet even on this comparatively minute power many thousands of people were able to listen-in.

Mr. Robinson went on to deal with the principles of the current used, with special reference to wireless, a subject in which he had only recently become keenly interested.

On May 24th "Waistcoat-pocket Lecturettes" were delivered by members of this Society. Mr. O. Elman, a young member, asked why a horse-shoe magnet held close to the valve appreciably increased signal strength. Several opinions were expressed, but it was generally agreed that the magnet helped to attract electrons from the filament.

Mr. Bell explained various wireless circuit diagrams to enable newer amateurs to understand those appearing in papers and books.

Mr. Jenkins described with blackboard illustrations an experimental two-valve panel which he has built to test various intervalve couplings. It consisted of a wooden board on which were mounted two valve-holders and filament rheostats. Between the two valve-holders was a space occupied by six terminals which enabled a number of different couplings to be tried. Mr. A. H. Phillips concluded the evening with a short lecture on "Seeing by Wireless." In his opinion it will be many years before we shall be able to see moving pictures by wireless. Owing to a great difference of opinion, it was decided to hold a special debate on this subject at a later date.

All communications should be addressed to the Secretary.

ILFORD AND DISTRICT RADIO SOCIETY (H.Q., St. Mary's Church Schools, High Road, Ilford).

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

Mr. A. P. Welch explained the methods employed in the collection of raw rubber and the subsequent stages through which it passes before it becomes finished ebonite, in his lecture entitled "Ebonite," given on May 17th.

He stated that most ebonite sheet is finished with its surfaces in contact with tinfoil, and emphasised the necessity of removing these surfaces to take away traces of tin which adhere to it. The lecturer then gave hints with regard to the working of ebonite.

ILKLEY AND DISTRICT WIRELESS SOCIETY (H.Q., The Regent Cafe, Ilkley).

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

An interesting and instructive demonstration was given by Mr. J. J. Lancaster on May 7th, his subject being "Soft Soldering."

The "tinning" and joining of various metals with the aid of various

fluxes were shown, special emphasis being laid on the necessity for cleanliness of all surfaces and materials.

THE KENSINGTON RADIO SOCIETY (H.Q., 2, Penywern Road, Earl's Court).

Hon. Sec., MR. J. MURCHIE,
2, Sterndale Road, W.14.

At the May meeting of the above Society Mr. W. J. Henderson gave a lecture on the various types of "B.B.C." 1-, 2- and 3-valve receivers. After the main differences had been explained, he demonstrated the instruments on the Club aerials. The differences observed between the single valve detector followed by low-frequency magnification and the more sensitive but more intricate arrangement of one high-frequency amplifier followed by a detector and low-frequency magnifier were most instructive. Several members joined in a discussion concerning the effects of self-capacity and self-oscillation in such circuits and the various methods of controlling them.

The Hon. Secretary will be pleased to answer any enquiries as to membership, etc.

LAMBETH FIELD CLUB AND MORLEY COLLEGE SCIENTIFIC SOCIETY (H.Q., Physics Laboratory, Morley College, Waterloo Road, S.E.1).

Hon. Sec., MR. F. W. LING.

On Saturday, May 12th, the above Society made a break in their usual programme of lectures, and gave a wireless demonstration.

A four-valve set made on the unit system, comprising one high-frequency, one detector and two low-frequency panels, being the work of Messrs. A. E. and V. C. Percy (members), was exhibited.

Later in the evening, with the aid of a Brown loud-speaker, kindly lent by Mr. R. F. Cosser (member), those present were able to participate in the first wireless dance held at headquarters, the dance music being received from 2LO.

The Hon. Secretary will be pleased to hear from persons desirous of becoming members.

LIVERPOOL WIRELESS SOCIETY (H.Q., Liverpool Royal Institution, Colquitt Street).

Hon. Sec., MR. L. H. MILLER,
138, Belmont Road,
Liverpool.

Messrs. The Igranic Electric Co. kindly took charge of a meeting of this Society on May 10th, their representatives being Mr. Pyrah and Mr. Atkinson. A humorous reference to an objection Mr. Pyrah had to the description of the science as "Wireless" was appreciated by his audience, when he informed them that the electric wire and cable manufacturers never previously had such demands for their products from wireless manufacturers. "Radio" is in his estimation to be preferred as a title.

Lantern slides of the complicated machinery used for the manufacture of honeycomb, duolateral and gimball mounted coils were exhibited, and the ingenious method of interweaving cotton as an insulator in transformer coils was shown. Mr. Atkinson then dealt with the screening of aerials, and impressed members with the importance of eliminating this, relating his experiences with this phenomenon in Syria and his attempts to overcome it. A demonstration with a unit set tuned by variometers, and also a standard set in conjunction with the Western Electric Co.'s loud-speaker enabled the members to enjoy the broadcasting. Samples of honeycomb, duolateral and gimball mounted coils, a new type shielded transformer, potentiometers and filament resistances were examined by members.

This Society wishes to record its indebtedness to the Igranic Electric Co., and the Western Electric Co. for their enjoyable evening.

Applications for membership will be welcomed by the Secretary.

LOUGHBOROUGH AND DISTRICT RADIO SOCIETY (H.Q., Pinfold Gate, Loughborough).

Hon. Sec., MR. W. J. TUCKER,
1, Charnwood Road,
Loughborough.

"The Maintenance of Receiving Apparatus" was the subject of an interesting lecture by Mr. E. W. Plant, who gave a very clear description of a dual amplification circuit using a crystal detector. 5IT was then received very well on a set modified to demonstrate this circuit.

This Society has erected a good aerial system, and an interesting programme has been arranged, whilst the club receiving set will be designed with a view to its use for experimental purposes—testing circuits, etc.

All interesting in Radio are invited to attend the meetings of this Society which are held on Fridays, when particulars of membership will gladly be given by the Secretary.

NORTH LONDON WIRELESS ASSOCIATION (H.Q., The Physics Theatre, Northern Polytechnic Institute, Holloway Road, N.).

Hon. Sec., MR. J. C. LANE.

On May 14th Mr. F. S. Angel gave his eighth paper on the elementary principles of wireless, choosing as his subject "Rectifying and Detecting." After explaining briefly the transmission of signals the lecturer dealt clearly and fully with the following:—

1. How continuous wave are generated.
2. Crystal rectification.
3. Thermionic valve rectification.
4. The action of the leaky grid condenser.

Gridleaks were then discussed, and it was found that the experience of members with them left much to be desired. It was agreed by all, however, that makers should ensure that values marked upon such articles are correct.

Applications to the Secretary for membership will be answered by return of post.

THE PRESCOT AND DISTRICT WIRELESS AND EXPERIMENTAL ASSOCIATION (H.Q., Drill Hall, Prescot).

Hon. Sec., MR. C. E. MACANLAY,
55, Central Avenue,
The Wood,
Prescot.

On May 3rd the Prescot and District Wireless and Experimental Association held a meeting at their headquarters. It was decided that as the Association hold a portable licence, with which experiments can be conducted within a radius of ten miles, during the summer a great deal of experimental work might be done in the open air, which would provide an added attraction to the activities of the Club.

The Association have purchased the component parts necessary to assemble any receiving set, the object being to afford facilities to members who wish to construct any new circuits. None of the parts will be permanently assembled, but will be as interchangeable as a box of bricks. In adopting this method of practical instruction the committee feel sure that they will maintain the interest of the members.

Another interesting feature of the Association is "Associate Members," who are admitted at half cost of full members' subscription, i.e., 2s. 6d. The Associate Member enjoys all privileges the Association offers, except power of voting and directing the policy of the Association.

It is hoped in a short time to apply for a licence for the transmission of Wireless Telegraphy and Telephony.

ST. PANCRAS RADIO SOCIETY.

Hon. Sec., MR. R. M. ATKINS,
7, Eton Villas,
Hampstead, N.W.3.

This Society has been formed to assist all enthusiasts of St. Pancras and neighbourhood in all spheres of wireless theory and practice. The Society has secured as its technical adviser an expert of many years' experience.

Will all who desire to obtain particulars with a view to membership please communicate with the Secretary.

Mainly about Valves

The Advantage of Detuning Occasionally

IT very often happens, when receiving broadcasting, that drums are unpleasantly loud, and produce an undesirable muffled sound, which is much louder than it should be in proportion to the rest of the instruments. This trouble may be lessened by detuning from the incoming wavelength. The effect of this is not to interfere so much with the higher notes, but just to cause a lessening of the intensity of the lower notes. This, of course, is because the waveband is very much wider in the case of the higher notes than in the case of the lower notes. The notes from a drum cause only a slight change in the wavelength of the incoming signals, whereas the higher notes produce a greater change. An ordinary receiver has to be fairly flatly tuned if uniform reproduction is to be obtained. By detuning, particularly on a reaction circuit where the selectivity for a given wavelength is very high, it is possible to receive the higher notes, which really come in on slightly different wavelengths, with a decrease in the intensity of the lower notes, owing to the fact that the detuning for the waves carrying the lower notes is considerably greater.

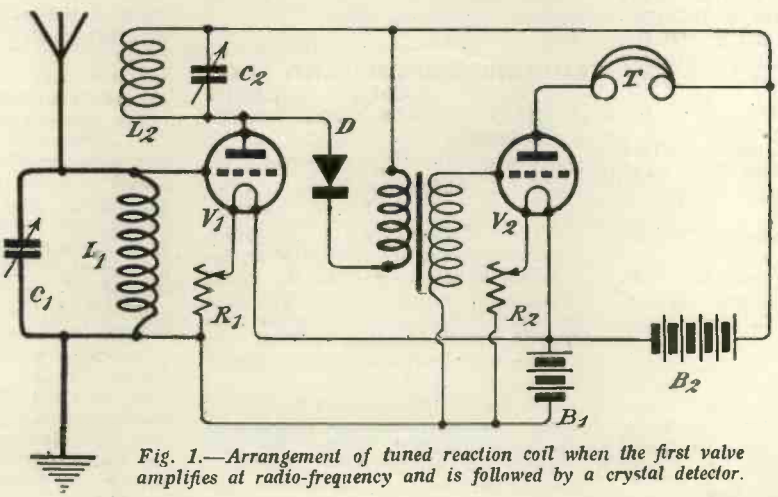


Fig. 1.—Arrangement of tuned reaction coil when the first valve amplifies at radio-frequency and is followed by a crystal detector.

More Components Required

There are several components which thousands of experimenters would like to have, but which no manufacturer, apparently, has attempted to produce. Although hundreds of thousands of gridleaks are in use, how many manufacturers produce a simple strip of ebonite fitted with two terminals and two clips to take standard sizes of gridleak?

Another component which would be exceedingly useful is an equally obvious one: a small ebonite panel, fitted with a couple of good quality terminals and a holder to take single honeycomb or similar coils. The only thing at all resembling this on the market, apparently, is a piece of moulded ebonite similar to the moulded composition on an Igranic honeycomb coil. This, of course, is not good enough. What is wanted is a proper little holder which will stand up by itself. Such an inductance holder would be invaluable for tuned anode circuit coupling, and for use when direct aerial coupling is employed.

Another useful little item is a strip of ebonite, fitted with two terminals, preferably double terminals. The terminals should not, of course, project below the surface of the ebonite strip, which latter should be provided with two screws to enable such a terminal block to be screwed on to a wooden base-board.

Personally, I am not a believer in beautiful panel sets made with an infinity of trouble and care. I would advise no one but an experienced experimenter to make up a highly finished panel receiver. If the apparatus goes wrong, or will not even work at the start, it is infinitely more difficult for the experimenter to put it right, than if he had the different components laid out on a table, or mounted simply on a wooden base-board.

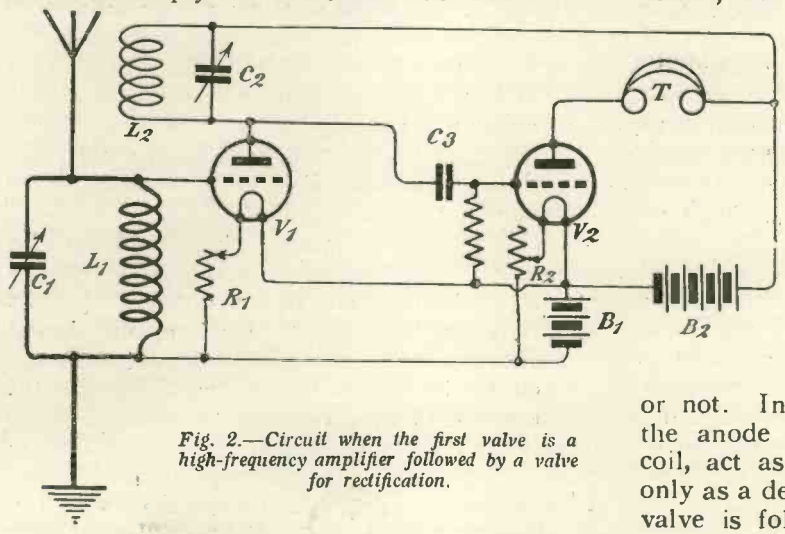


Fig. 2.—Circuit when the first valve is a high-frequency amplifier followed by a valve for rectification.

Whenever carrying out any experiments on new apparatus or new circuits, I invariably employ a collection of bought component parts, each conveniently mounted in a box fitted with terminals. When trying out a new circuit, it is essential to have each component of the best quality. A fault in one of the components will lead to entirely misleading results. If an experimenter has a couple of three-coil coil holders, two or three valve panels, two or three variable condensers, and two or three good quality intervalve transformers, he can try out thousands of different circuits and gain a great deal of valuable information. Of course, a set is very attractive, and is useful as a stand-by, but it is practically impossible really to experiment with it. Of course, many find their chief pleasure in constructing their own sets, but here again the same principle applies. It is much better, in my opinion, to make up separate components, which may be connected up in dozens of different ways, than to make up a single complete set which, once made, may give excellent results, but will not lead to the experimenter gaining any further knowledge.

Tuned Anode Reaction

In No. 5 of *Modern Wireless* I deal fairly exhaustively with the phenomenon of reaction, but anyone who works with it is bound to discover all sorts of new points which rarely seem to appear in print. Take, for example, tuned anode reaction. One rarely hears of this being discussed, yet there must be very many who wonder whether tuned anode reaction is, or is not, better than the ordinary form using an aperiodic coil.

The chief consideration is whether the tuned anode circuit is followed by a detector or not. In other words, does the valve, in the anode circuit of which is the reaction coil, act as a high-frequency amplifier, or only as a detector using reaction? If the first valve is followed by a crystal detector, as shown in Fig. 1, or followed by a valve

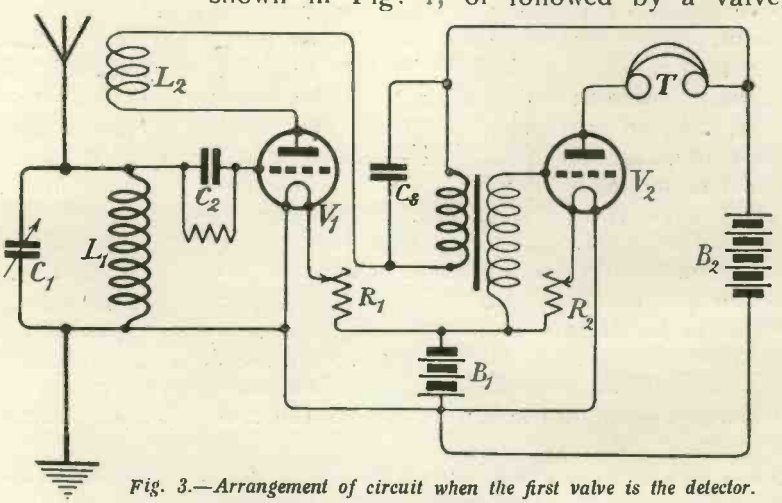


Fig. 3.—Arrangement of circuit when the first valve is the detector.

detector, as shown in Fig. 2, a tuned reaction coil will give very much better results than an aperiodic one, and in no circumstances would I advise the latter.

In the arrangement of Fig. 3, I would here suggest that the reaction coil be not tuned; only is tuning desirable if the reaction cannot be made sufficiently strong with the aperiodic reaction coil.

When the anode circuit of a valve is tuned to the same frequency as the grid circuit, a reaction effect will take place from anode circuit to grid circuit, even though there may be no direct magnetic coupling between the two circuits. The grid and anode circuits are now coupled by the small condenser formed by the grid and anode of the valve.

Looking at Fig 1, we have not only the magnetic coupling between L_2 and L_1, but also the capacity coupling formed by the condenser having the anode as one plate and the grid as the other plate. This capacity coupling exists, even though the coils are widely separated, and that is very often why the valve will even oscillate, sometimes, when there is no direct magnetic coupling.

Oscillations with Reverse Reaction

In the arrangement of Fig. 1, both forms of reaction are present, and it is sometimes a disadvantage to have both present at the same time. It is, of course, not possible simply to increase the reaction by coupling L_2 to L_1 more tightly. It is always necessary to readjust the tuning of both the condenser C_1 and the condenser C_2.

Even though the reaction coil L_2 be reversed, it is possible to obtain a reaction effect, and even self-oscillation. In such cases, this effect is due to the fact that the capacity reaction is stronger than the magnetic reverse reaction. The result is that there is a reaction effect in a direction which tends to make the valve oscillate, and sometimes makes it do so even though the reaction coil is reversed. Although the valve may not produce the reaction effect when the reaction coil and the grid coil are not tightly coupled, yet if this coupling is tightened, a reaction effect sets in, and the valve oscillates.

This, I think, must be due to the fact that, looking at Fig 1, the lower part of the coil L_2, when brought close to the upper part of the coil L_1, completes a condenser. The lower turns of L_2 form one plate of this condenser, and the upper turns of L_1 form the other, and this condenser acts in parallel with the condenser formed by the grid and anode, and, consequently, when the two coils are brought closer together, although the magnetic reverse reaction is increased, the capacity reaction is increased and swamps the other, the valve oscillating as a result.

The moral is, as a matter of course, to try the effect of reversing the reaction coil in all cases; the fact that the valve may be made to oscillate by bringing the reaction coil up to the grid coil, means absolutely nothing; the above-mentioned rather curious phenomenon may be taking place.

The great disadvantage of honeycomb and similar coils is that it is frequently impossible to obtain sufficient reaction effect. Particularly is this the case when the tuned reaction coil is shunted by a crystal detector, as shown in Fig. 1. The crystal detector increases the damping of the circuit L_2 C_2 very greatly, and, consequently, more reaction is necessary, and this cannot always be obtained when honeycomb and like coils are used.

Tuning the reaction coil, of course, always enables reaction to be obtained much more readily than if the coil is not tuned. This, naturally, is because the capacity reaction is helping the magnetic reaction. The reaction from a tuned anode circuit is always greater when the condenser across the inductance is very small. Under these conditions, the energy transferred to the grid circuit is at a maximum; and, in fact, if the inductance coil L_2 in Fig. 1 had a natural frequency, due to its self-capacity and other attendant small capacities, equal to that of the circuit L_1 C_1, reaction would very readily be obtained; even more so than if a condenser had been used for tuning.

We regret that owing to the demands upon our space, our features "Questions and Answers on the Valve" and "A Progressive Unit System" are unavoidably held over until next week

Apparatus we have tested

Conducted by A. D. COWPER, B.Sc. (London), M.Sc.

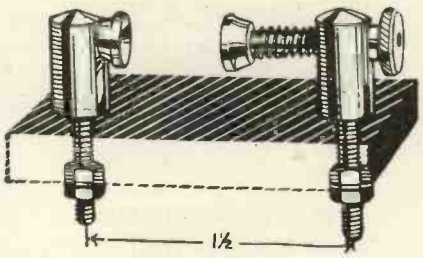
Valve Filament Fuses

UNTIL we had an opportunity of testing the type of valve filament fuse marketed under the name of "Polar" Fuse, by the Radio Communication Co., Ltd., we were somewhat sceptical as to the possibility of producing commercially, fuses that would infallibly

blow at a small marginal increment above the normal safe current in a valve filament, and yet not introduce serious resistance into the circuit, nor deteriorate rapidly in normal working.

However, in the "Polar" fuses the problem seems to have been solved; a very fine wire, apparently of a material with a very high temperature-resistance coefficient, is enclosed in a glass tube, with brass caps cemented on; these replacable units are mounted in a holder, either of the panel type, or on a separate base. Renewals, supplied at a moderate price, can be slipped in in a moment.

On careful test, the resistance of the different types—½ amp., Ora, etc., and R—was found to be very moderate under normal working load, and the fuses did not heat up unduly; on a small increase of the current, the resistance rapidly increased, and the fuses became visibly red-hot on forcing the current to what was still within the limits of a valve filament; the fuses blew at a figure sensibly uniform amongst several taken haphazard from



stock. This represents a very real advance in the application of sound engineering practice to radio; the wireless receiver is about the only piece of complex electrical equipment to which fuses have not been regularly fitted.

A Safety Wander plug

Those who have tried at some time the brief but convincing experiment of connecting the valve-filament across the high-tension battery, will be glad to know of a simple device, recently submitted to us by Messrs. A. W. Hunt, Ltd.—a combined water-plug, and fuse plus test-lamp. This uses the well-known device of a pocket flash-lamp bulb as a safety fuse, but very ingeniously incorporates it in a special wander-plug, so that by no chance can it be forgotten, or accidentally wired around. The makers claim also that it is suitable for testing individual cells of the battery.

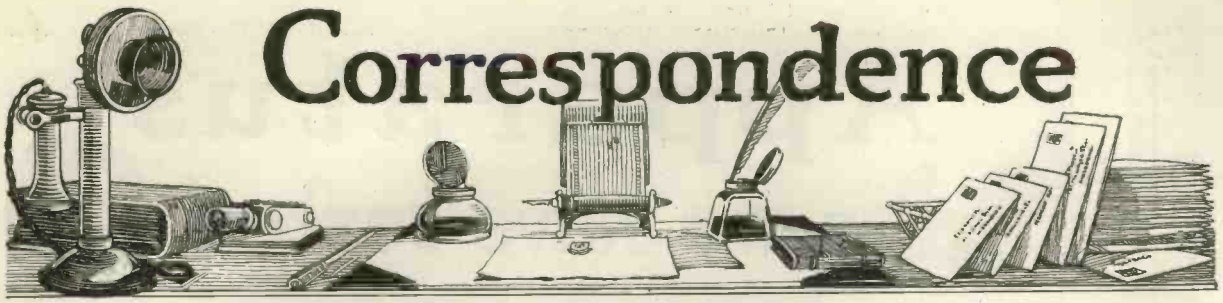
This neat and workmanlike little device will certainly make grateful friends wherever it goes.

Variable Gridleak

Messrs. A. H. Hunt, Ltd., have submitted for test an attractive little experimenter's "gadget" in the form of a variable gridleak, of range from one-fifth to approximately five megohms, together with an anti-capacity handle for operating it from a respectful distance, which will be particularly appreciated by those interested in long-range reception of relatively feeble signals. Both are well finished, practical articles, though the handle might, with advantage, be made a rather easier fit in the knob of the resistance unit. On actual trial with a one-valve set the absolute silence and smoothness of operation were a revelation to one who had used some other types of variable gridleaks, both on noisy local transmissions and on distant stations, as, e.g., the French "Ecole Supérieure" on 450 metres, the facility with which the gridleak could be adjusted to give the optimum possible results could be well appreciated. The latter came through very well indeed on the one valve with careful adjustment of the gridleak (and corresponding grid-condenser value) by means of this little instrument. It is certainly a weapon that should be in the armoury of the genuine experimenter.

A Two-valve B.B.C. Receiver.

From Messrs. The Holborn Radio Co., Ltd., we have received for trial a two-valve B.B.C. receiver, "The Deskophone," with one high-frequency amplifying and one detector valve, provision for plug-in high-frequency transformers and for loading coils for the higher wavelengths. As the name implies, the instrument is in the form of a small desk, with ebonite panels in the sloping front and on the top, where the valves and H.F. transformer are arranged, well out of the way. This arrangement makes the controls easy to operate, the scales being particularly easily readable. Criticism might be offered of the filament resistances which did not operate with that smoothness that could be desired, and were not fitted with a stop to avoid the accidental switching-on of the full voltage of the L.T. battery. A high-frequency transformer was not supplied by the makers with the instrument received; with low-resistance tuned H.F. transformer of tried efficiency the receiver gave, on a good suburban aerial, quite satisfactory results on local broadcasting, "'phones-on-the table" stage, almost too loud for one listener, and enough for a number of pairs of 'phones. In the intervals of 2LO, Birmingham broadcasting was successfully picked up.



Correspondence

B.B.C. STAMP

To the Editor, *Wireless Weekly*.

Sir,—I must, as a regular reader of this and your other helpful papers, congratulate you on the contents of your issues.

I have read with interest your Editorial remarks concerning the B.B.C. stamp on component parts for the purpose of the proposed constructor's licence.

I hasten to state that I am entirely in agreement with your remark as to protecting British manufacturers, but there is one most important fact you have apparently overlooked, the most important to my mind. The Post Office Committee is now sitting with a view to straightening the licence tangle. If it agrees to having parts marked B.B.C. I do not see how the existing tangle and forced piracy will be stopped.

As I have just said, I am all for protecting home industries, but if a new regulation is made, making the B.B.C. stamp compulsory on all component parts, this will only refer to constructors of future sets and will not remedy the existing evil, which the above Committee are endeavouring to remedy. This regulation would only refer to future apparatus and not to apparatus already constructed at home. According to your Editorial, all present home-made sets would have to be scrapped and fresh parts bought bearing the B.B.C. stamp. Do you seriously suggest that amateurs and others should scrap their apparatus, which perhaps has cost them several pounds? They would be willing to submit their apparatus for stamping with the B.B.C. stamp, but no provision will be made for this to my way of thinking, and we would still have the 500,000 listeners-in "pirates."

I would suggest that the best way would be for the Post Office to order that owners of existing home-made sets must make a declaration on a prescribed form or by letter, stating that all their parts are British made, and in the case of complete parts, bought and put together. Such a declaration to be made within one month after the Post Office calls for such declarations, any components used after that period to be stamped with the B.B.C. stamp, subject to penalty.

In the case of declarations made before the expiration of that period, an acknowledgment sent by the Post Office that such declaration has been received and is in order, to cover present sets, but not future sets. If some such method is not adopted, I am afraid that listeners-in who already have their sets made from unstamped component parts, will still be "pirates." I am, etc.,

London, E.C.2. F. W. Smith.

TELEPHONE LEADS

To the Editor, *Wireless Weekly*.

Sir.—Your publication. *Wireless Weekly*, is so full of good things that only to-day, Tuesday, have I been able to get as far as the Correspondence columns of last Wednesday's issue.

A correspondent has found that the length of the telephone leads makes no difference to the signal strength, and he has arranged matters so that he can listen-in while in bed. That is quite satisfactory with a crystal set, but with a valve set it is not much good having the 'phones on in bed if one has to get up again to switch the filaments off. My own solution is as follows:—Attached to the 'phone terminals of the set is a 36ft. length of "flex," to the other end of which is connected the loud-speaker, which can thus be carried about to any part of the house. A pair of head-'phones is connected permanently in series with the loud-speaker, but at the receiver end of the flex, so that I can tune-in in the operating room without having to switch over from 'phones to loud-speaker. If it should so happen that I want to listen-in to the broadcasting for any length of time, I run another 6ft. length of flex to the room where the loud-speaker and a comfortable armchair are situated. This second length of flex is used to control the filament current, a relay being used for this purpose. By this means the actual L.T. leads are kept short and are unaffected by the resistance of the "flex." The relay in my case is made from an old electric bell indicator coil, such as can be bought for a few pence from any electrical stores. The winding of the relay is, of course, insulated from the iron core, and should be of fairly high-resistance. The dry cell is of the type used for electric bells, and has been in use now for over six months and is still working merrily. The total cost of this arrangement, including "flex," battery, switch and relay, is only a few shillings, But the convenience of being able to switch any unwanted item off without getting out of the armchair is worth a great deal.

I might add that, in spite of this luxury, I am an experimenter, and not merely a listener-in. It is probably for that reason that I appreciate *Wireless Weekly* so fully. I am, etc.

J. F. Stanley,
B.Sc., A.C.G.I., F.R.A.

Highgate, N.6.

HEY PRESTO!

To the Editor, *Wireless Weekly*.

Sir,—I notice in your "Jottings" this week that you are troubled by a mysterious disorder of your set which you attribute to an "elemental," and suggest a search for some formula which will exorcise.

Strange to say, my own set was similarly affected one night during the present week, and as I was expecting a visitor with whom I had to do a "wireless" deal, I was accordingly annoyed. Unconsciously I muttered the whole magic phrase used by sorcerers from time immemorial, "Damman blahstit." I at once noticed a slight increase in signal strength, and a repetition of the formula resulted in a rush of sound which jerked the loud-speaker off the table. B'lieve me or b'lieve me not. I am, etc.,

R. H. Eostat.

Birmingham.

CRYSTALS

To the Editor, *Wireless Weekly*.

Sir,—With reference to A.G.'s" letter in your issue No. 6, I should like to say that I also have tried carborundum crystal without any applied potential, and that I find it, as he says, just as sensitive as any other crystal, *but only when the signals received* are loud. 2LO comes in very loud, as also does 2ON, and the tuning is far more selective. I have tried carborundum in conjunction with gold, graphite, brass, copper, steel, zinc, and aluminium, as well as with hertzite and silicon, and find that there is nothing to choose be-

tween them. I can, however, get but little Morse, and what I do get, though very loud when using silicon and gold, is even louder when carborundum is employed. The weak Morse and amateurs do not come in at all.

In conclusion I should like to congratulate you on your two papers, and to say that I have given up the three I used to take in and now only take your two most excellent ones.

I am, etc.,
F. PRIDDEN.

INDOOR AERIAL RECEPTION

TO THE EDITOR, *Wireless Weekly*.

SIR,—Perhaps it might interest some of your readers to hear of some of the results which I have obtained, using two valves and a crystal, on a 10ft. indoor aerial, in Hampstead. Fig. 1 is the circuit I employed in these experiments.

My aerial consists of four wires strerched across my room, which is on the ground floor, as high as I could get them, and running in a zig-zag fashion.

With this aerial and the afore-mentioned receiver, I could tune out 2LO and bring in Birmingham at will, and I have also received Manchester even better than Birmingham, which is largely due to the directional properties of the aerial.

I listened to the opening of the Cardiff broadcasting station, and it was, though somewhat weak, very clear; tuning is very critical, but with a little patience this difficulty should be quickly overcome. The Hague I have not yet tried, but such an arrangement should bring it in quite audibly.

I am, etc.,
C. W. BIDDULPH.
London.

ONE MAN'S FOOD IS——

TO THE EDITOR, *Wireless Weekly*.

SIR,—With regard to a correspondent's letter in this week's issue entitled "On Music," I think he has stated the only possible solution to the broadcast programme problem when he says "mix it." I am one of those unfortunate individuals who are positively frozen (which I am told is one degree beyond bored) with Chopin Etudes, Nocturnes, etc., and would much prefer brighter music, but I quite realise that there are other "listeners" who doubtless prefer more classical music, and, of course, that is where the idea of "mix it" is splendid. If we are all catered for there is little fear of dissatisfaction, but it is no use shutting our eyes to the fact that many recent programmes have been very "high-brow," with no touches of brightness or even tuneful melodies. This class of programme *must* fail to give *general* satisfaction.

I am, etc.,
H. SCRIVEN.

A "BLIND" SPOT

TO THE EDITOR, *Wireless Weekly*.

SIR,—It may interest some of your readers to know the results obtained with a home-made crystal receiver at Newbury, well known as a blind spot.

Using a good aerial and zincite copper-pyrites, I have received on several nights the Paris station at the High School of Posts and Telegraphs. Birmingham and London are received practically every evening, 5IT being very plain. With one high-frequency and one detector valve and a 4ft. aerial 2LO, 5IT, 2ZY and 5SC are quite audible, the opera from 2LO being very good.

I am, etc.,
J. BROWN.
Newbury.

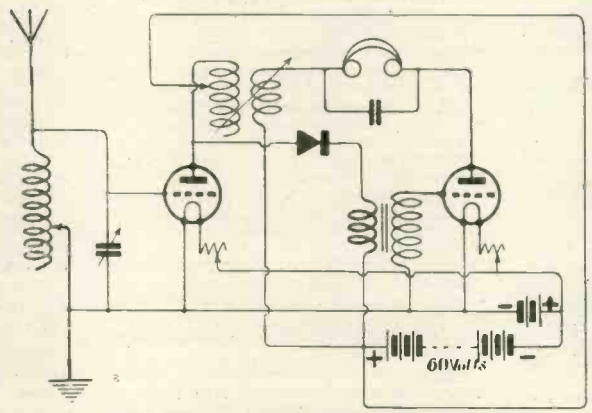


Fig. 1.—Illustrating the circuit referred to by C. W. Biddulph.

ARE THERE OTHERS?

TO THE EDITOR, *Wireless Weekly*.

SIR—I should like to draw your attention to the fact that certain four-valve broadcasting sets of reputed make, bearing the B.B.C. stamp, can be made to oscillate violently.

I am a possessor of one of these sets, and discovered the fact mentioned above accidentally.

The set consists of one H.F. detector and two L.F. valves, aerial tuned by variometer, high-frequency coupling is a variable high-frequency transformer. Normally the set will receive 2ZY and 5NO regularly, 2LO and 5SC intermittently after dark.

On reversing the L.T. leads, however, the set can be made to oscillate on certain wavelengths, with the result that 2LO comes in at loud-speaker strength, and also 5WA (Cardiff) keeping the set just off oscillation point. To 5NO and 2ZY this alteration makes no difference, except that if the set be made to oscillate, loud but distorted speech results.

The set *can* be made to oscillate so violently as to render reception within half-a-mile impossible, but, of course, I do not allow this during broadcasting hours. The results compared are as below:—

(*The set being used in N.E. Lancashire.*)

	NORMALLY.	WITH REVERSED LEADS.
2 LO (200 miles).	Headphone strength intermittently.	Loud-speaker strength with fading.
2 ZY (30 miles).	Loud-speaker strength, regularly.	Same as normally.
5 SC (170 miles).	Headphone strength, intermittently.	Same as normally.
5 WA (170 miles).	Inaudible.	Loud-speaker strength intermittently.
5 NO (90 miles).	Headphone strength, regularly but faint.	Same as normally.
5 IT (— miles).	Inaudible.	Inaudible.

I think the above forms a very interesting question for discussion.

I am, etc.,
WOULD-BE EXPERIMENTER.
Cheltenham.

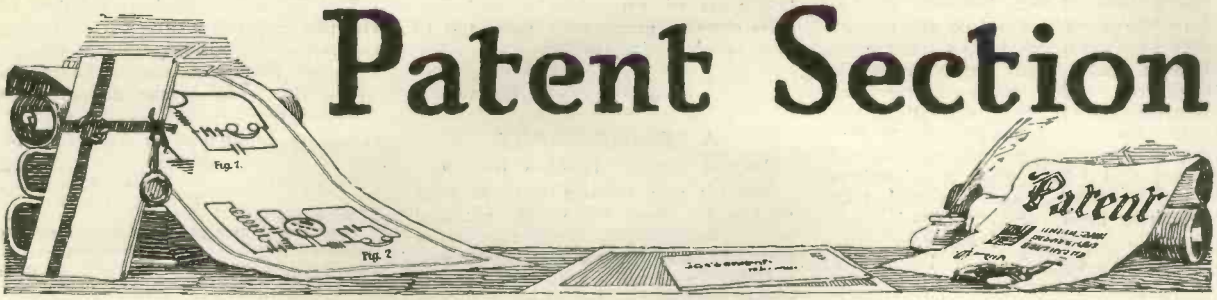
STUNT RECEPTION

TO THE EDITOR, *Wireless Weekly*.

SIR,—The following may be of interest in relation to the correspondence regarding interference by neighbouring aerials:—

I have an experimental table, also a "unit" set made up according to plans suggested by Mr. R. W. Hallows. The other evening my boy tested his ex-Army set, using our P.M.G. aerial. I had disconnected the aerial from the "unit" for him, and sat watching, retaining the 'phones. Mechanically I switched the valves on and received 2LO with only a shade less strength than when using the aerial. As the tuning on the Army set varied, mine varied with it, but when in resonance the strength of reception on both sets was increased to an extraordinary degree. No reaction was used on either set. The two instruments were at least 5 to 6 feet apart. We made a further test; one set was connected to the P.M.G. aerial, the other to a wire slung immediately under it, about 10 feet above the ground. This time the earths were quite separate. The sets were then tuned, with the same results, namely, when they were in resonance the one varied with the other in see-saw fashion, but the moment tuning synchronised, both were greatly increased in strength than when using the aerial on either set.

I am, etc.,
E. J. BRAY.
Finchley, N.3.



Patent Section

The following list has been specially compiled for "Wireless Weekly" by Mr. H. T. P. GEE, Patent Agent, Staple House, 51 and 52, Chancery Lane, W.C.2, and at 70, George Street, Croydon, from whom copies of the full specifications published may be obtained post free on payment of the official price of 1s. each. We have arranged for Mr. Gee to deal with questions relating to Patents, Designs and Trade Marks. Letters should be sent to him direct at the above address.

APPLICATIONS FOR PATENTS

(Specifications not yet published.)

12739. ALDRED, W.—Commutator for direct currents of dynamo electric generators and motors. May 12th.

12360. AMBERTON, R.—Electric controllers. May 8th.

12174. ARCY, B. N. D'.—Electric switch. May 7th.

12325. ASTLEY, A.—Device for carrying wireless valves. May 8th.

12554. BARBER, W. L.—Boxes of ironclad electric switches, &c. May 10th.

12785. BARBOUR, R. H.—Receiving apparatus for wireless signalling. May 12th.

12591. BIGNAMY, J. B.—Indoor aerial. May 10th.

12413. BINDLOSS, A. K.—Crystal-holders for wireless receiving instruments. May 9th.

12732. BRITISH THOMSON - HOUSTON Co., LTD.—Control of electric switches. May 11th.

12777. BRITISH THOMSON - HOUSTON Co., LTD.—Telephone receivers, &c. May 12th.

12778. BRITISH THOMSON - HOUSTON Co., LTD.—Insulating materials. May 12th.

12368. BRITISH THOMSON - HOUSTON Co., LTD.—Electric switches. May 8th.

12771. BURN, E. O.—Shunt regulators for electric generators, &c. May 12th.

12331. BUSBY, W. A. E. — Thermionic valves. May 8th.

12777. BUTCHER, J. H.—Telephone receivers, &c. May 12th.

12313. CATTELL, J. S.—Ear-pieces of telephones, &c. May 8th.

12217. CLIFTON, H.—Multiple wireless receiver. May 7th.

12579. CLOUD, J. W.—Electric switches. May 10th.

12328. COLEMAN, C. J.—Rectifier crystals for wireless telephony. May 8th.

12359. CREED, F. G.—Telegraphic signalling apparatus. May 8th.

12359. CREED & Co., LTD.—Telegraphic signalling apparatus. May 8th.

12702. CUTLER-HAMMER MFG. Co.—Rheostats, &c. May 11th.

12632. DANIELS, A.—Fittings for electrical apparatus. May 10th.

12632. DANIELS, H.—Fittings for electrical apparatus. May 10th.

12632. DANIELS, J.—Fittings for electrical apparatus. May 10th.

12319. DAVIS, W. J.—Rheostats. May 8th.

12319. EDISON SWAN ELECTRIC Co., LTD.—Rheostats. May 8th.

12785. ELECTRICAL APPARATUS Co., LTD.—Receiving apparatus for wireless signalling. May 12th.

12633. ENTWISTLE, A. T.—Connector box for connecting electric wires. May 11th.

12284. FIGUEIREDO, E.—Combined handle and coupler for tumbler switches. May 8th.

12528. FITZGERALD, F. W. V.—Means for reception, recording, and reproduction of telephonic signals, &c. May 10th.

12732. FITZGERALD, A. S.—Control of electric switches. May 11th.

12542. FITZGERALD, F. W. V.—Means for telephonic, &c., transmission, reception, and reproduction of drawings, &c. May 10th.

12313. FLETCHER, S. A.—Ear-pieces of telephones, &c. May 8th.

12777. FOSSEY, F. A.—Telephone receivers, &c. May 12th.

12705. FULLER, L.—Electric accumulators. May 11th.

12705. FULLER'S UNITED ELECTRIC WORKS, LTD.—Electric accumulators. May 11th.

12368. GENERAL ELECTRIC Co.—Electric switches. May 8th.

12356. GES. FUR DRAHTLOSE TELEGRAPHIE.—Telephonic transmitters and receivers. May 8th. (Germany, August 30th, 1922.)

12637. GLEDHILL, A. H.—Programme controlling device for electric current. May 11th.

12261. GOULD STORAGE BATTERY Co.—Manufacture of storage-battery separators. May 7th.

12458. GRAHAM, E. A.—Thermionic valve apparatus. May 9th.

12655. GYSBRECHTS, J. M. L.—Frame for wireless battery. May 11th.

12217. HALL, H. T.—Multiple wireless receiver. May 7th.

12427. HARVEY, T. — Wireless receiving sets. May 9th.

12331. HOLLAND, F. C. R.—Thermionic valves. May 8th.

12484. HOLWORTHY, H. F. — Portable aerials for wireless signalling. May 9th.

12667. HUGHES, E. G.—Mounting of inductance coils. May 11th.

12702. IGRANIC ELECTRIC Co., LTD.—Rheostats, &c. May 11th.

12675. JOHNSON, O. H.—Telephone, &c., receivers. May 11th.

12410. JOHNSON, H. R. S.—Thermionic valve devices. May 9th.

12410. JOHNSON, L.—Thermionic valve devices. May 9th.

12243. KATATANI, S.—Electric resistance materials. May 7th. (Japan, May 8th, 1922.)

12607. KEEGAN, C. A.—Wireless telegraphy, &c. May 10th.

12583. KOBIOLKE, A. M.—Vacuum-producing device. May 10th. (Australia, May 10th, 1922.)

12723. KUYSER, J. A.—Electric generators. May 11th.

12185. MAIDEN, A. E.—Cap for wireless valves, &c. May 7th.

12554. MIDLAND ELECTRIC MFG. Co., LTD.—Boxes of ironclad electric switches, &c. May 10th.

12689. MORCH, J. J.—Diaphragm for telephone receivers. May 11th.

12623. MURRAY, R. L.—Switch devices. May 10th.

12778. NEWBOUND, R.—Insulating materials. May 12th.

12467. OAKLEY, E. C. F.—Wireless receiving apparatus. May 9th.

12771. PHILLIPS, W.—Shunt regulators for electric generators, &c. May 12th.

12689. RICHMOND, H.—Diaphragm for telephone receivers. May 11th.

12458. RICKETS, W. J.—Thermionic valve apparatus. May 9th.

12680. ROBINSON, H. M. — Masts for aerials, &c. May 11th.

12268. STRATHDEE, A. K. E.—Series-parallel electric switches. May 7th.

12182. TAYLOR, A. M.—Electric transmission systems. May 7th.

12623. TELEPHONE MFG. Co., LTD.—Switch devices. May 10th.

12262. UNIVERSAL WINDING Co.—Electric, &c., coils, and winding machines therefor. May 7th.

12770. WARD, J. A.—Variometers for radio telegraphy, &c. May 12th.

12778. WARREN, H. W. H.—Insulating materials. May 12th.

12543. WATTS, L. B.—Combined valve holder and filament rheostat for wireless valves. May 10th.

12671. WESTERN ELECTRIC Co., LTD.—Electric discharge devices. May 11th. (United States, May 12th, 1922.)

12766. WESTERN ELECTRIC Co., LTD.—Telephone receivers. May 12th. (United States, November 17th, 1922.)

12696. WESTERN ELECTRIC Co., LTD. (Western Electric Co., Inc.).—Selecting switches. May 11th.

12453. WOODING, W. G.—Frame aerials for wireless telegraphy. May 9th.

12777. YOUNG, A. P.—Telephone receivers, &c. May 12th.

ABSTRACTS FROM FULL PATENT SPECIFICATIONS RECENTLY PUBLISHED

(Copies of the full specifications, when printed, may be obtained from Mr. Gee, post free on payment of the official price of 1s. each.)

195100. Low, A. M.—In an impulse transmitter of the type having a number of signal discs, each of which can be released from a stop by depressing a corresponding key, the disc is brought to rest by a second

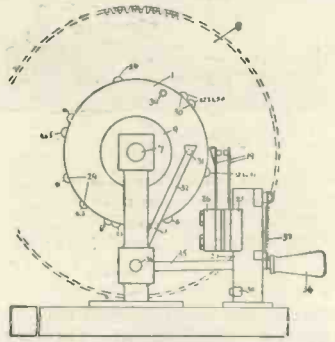


Fig. 1.—Illustrating Pat. No. 195100.

stop after sending its signal, and is again released when the key is let go, whereupon it sends an annulling signal and completes its revolution to normal position. The apparatus is particularly for use in radio-control systems. June 8th, 1917.

195134. Moody, G. H., and Butler, H. D.—A stand for use with inductance, coupling, reactance, and like electric coils for use in wireless signalling, comprises a base, and one or more insulating blocks fixed to the base or to movable arms, each block being provided with terminals and with plugs and/or sockets to engage corresponding sockets and/or plugs on coil-holders, the coils being detachably mounted on the holders, and any or all of the coils being adjustable, together with the corresponding holders and blocks relatively to the base and other coils. The movable blocks are mounted on arms turned about pivots by handles, so that the movable coils are rotatable about external axes parallel to their planes. December 17th, 1921.

195266. Goodman, W. H., and Dubilier Condenser Co. (1921), Ltd.—An electric condenser comprises sets of plates or units arranged radially around a centre or axis, each set comprising a number of plates or units mounted together in block form, and arranged substantially tangentially to concentric circles. The plates or units of high potential are preferably arranged adjacent the axis, those of low potential being arranged adjacent the periphery of the condenser. March 22nd, 1922.

195310. Hemardinquer, P.—A frame aerial is rigidly connected to a table so as to form one of the table supports. June 21st, 1922. Convention date, March 21st.

195318. Ward Leonard Electric Co. (Assignees of A. E. Waller).—The resistance elements of rheostats are formed of thin self-supporting channel-shaped strips, having flat end portions by which the strip is supported and connected. July 27th, 1922. Convention date, March 27th.

195319. Ward Leonard Electric Co. (Assignees of A. E. Waller).—Electric resistances comprise a series of copper, brass, iron, or other conducting strips attached to a base, resistance elements being supported upon and connected between adjacent strips in displaced positions so as to facilitate dissipation of heat. The resistance elements are formed of thin metal ribbon, ribbed or bent into channel form at the main portions and having flat portions at the ends and at the centre, where the element is bent into V form. July 27th, 1922. Convention date, March 28th.

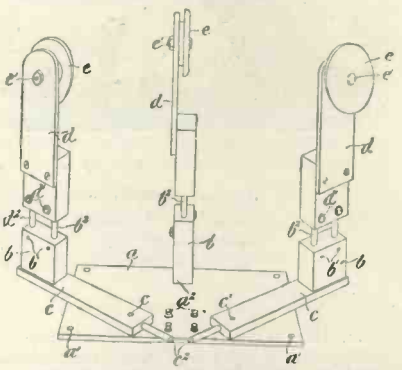


Fig. 2.—Illustrating Pat. No. 195134.

195337. Forges et Ateliers de Constructions Electriques de Jeumont.—A loading coil is placed in a recess formed by two members moulded from iron filings or magnetic powder agglomerated with insulating material. The members are connected together by means of a rod, and an air gap may be left between the central abutting portions of the members. The coil is made by binding together the wires of the various circuits and winding the cord so obtained on a mandrel to form a ring. May 4th, 1922. Convention date, March 27th.

FORTHCOMING EVENTS

June.

6th (Wed.).—Tottenham Wireless Society. Buzzer Practice. Monthly General Meeting, Lecturettes, etc., at the Institute, 10, Bruce Grove, Tottenham, N.17.

7th (Thurs.).—Hackney and District Radio Society. Debate on "Wireless." Mr. Bell will lead off for and Mr. A. H. Phillips against.

7th (Thurs.).—Derby Wireless Club. Lecture "Regenerative Circuits," by Mr. S. J. R. Allwood, A.M.I.E.E., at 7.30 p.m., at the Shaftesbury Restaurant, Tenant Street, Derby.

8th (Fri.).—Leeds and District Wireless Society. Lecture. "Elementary Theory of Transmitting Apparatus," by Mr. D. E. Pettigrew, at 7.0 p.m.

8th (Fri.).—Seaforth and District Radio Society. Visitors' night, admission free, at St. Thomas's Parochial Hall, Seaforth Road, Seaforth, Liverpool.

12th (Tues.).—Battersea and District Radio Society. Mr. G. E. Reeves will lecture at 8 p.m. on "Accumulators" at the Board Room, Lachmere Road Baths.

14th (Thurs.).—The Cardiff and South Wales Wireless Society. Experimental Work in charge of Mr. N. N. Drysdale.

14th (Thurs.).—South Norwood and District Branch of the Radio Association. Lecture by Professor P. M. Baker, B.Sc., at Stanley Halls, South Norwood.

15th (Fri.).—The Radio Society of Great Britain. Mr. J. H. Reeves, M.A., will lecture on the "Effect of Capacity in Receiving Circuits" (with demonstrations) at the Institute of Electrical Engineers. Any persons interested are cordially invited to write to the Hon. Secretary, Mr. L. McMichael, 32, Quex Road, Hampstead, N.W.6, asking for a ticket, which will be sent gratis.

16th (Sat.).—Tottenham Wireless Society. Visit to Ship Station.

21st (Thurs.).—The Cardiff and South Wales Wireless Society. Lecture, "Accumulators, Construction, Use, and Charging," by Mr. J. G. Proger.

21st (Thurs.).—Derby Wireless Club. Experimental Work with 2 H.F. valves, conducted by Mr. H. J. Kirk, at the Shaftesbury Restaurant, Tenant Street, Derby, at 7.30 p.m.

27th (Wed.).—The Radio Society of Great Britain. A paper will be read by Mr. R. A. Watson, of the Radio Research Board, on "Atmospherics," with an experimental demonstration on wave form.

We feel sure that the value of these announcements would be greatly enhanced by the inclusion of particulars regarding the place where the lecture, etc., is to be held and the time of its commencement. These details are frequently not supplied to us. Will Society Secretaries kindly note?

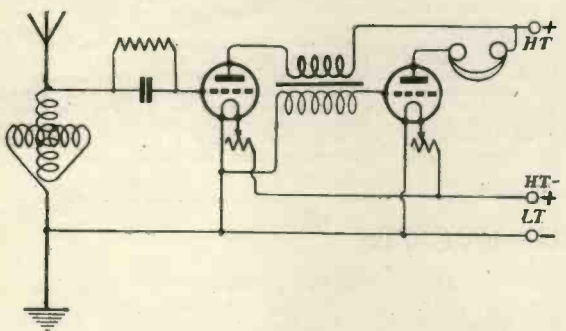
Information Department

Conducted by J. H. T. ROBERTS, D.Sc. (F.Inst.P.), assisted by A. L. M. DOUGLAS

In this section we will deal with all queries regarding anything which appears in "Wireless Weekly," "Modern Wireless," or Radio Press Books. Not more than three questions will be answered at once. Queries, accompanied by the Coupon from the current issue, must be enclosed in an envelope marked "Query," and addressed to the Editor. Replies will be sent by post if stamped addressed envelope is enclosed.

J. R. (WALWORTH) asks for a circuit diagram showing a rectifier and one low-frequency valve. He specifies certain requirements, and asks for connections to be clearly marked.

We reproduce herewith a suitable circuit diagram incorporating the features you require.



E. W. T. (MOLTON) is about to construct a 4-valve set described in "MODERN WIRELESS," and asks (1) Whether he would be able to receive certain long-distance stations provided suitable inductances were used. (2) What type of coils would be necessary for this purpose. (3) Whether special low-frequency intervalve transformers are necessary to receive long-distance stations.

(1) With suitable inductances you should be able to hear Morse messages from great distances with this set. (2) The size of coil depends entirely on the wavelength you wish to cover. (3) There is no difference in the construction of intervalve transformers for any particular wavelength. These devices function equally efficiently on all waves. Such a receiver as you describe forms a very useful all-round combination for general work.

F. L. A. W. (BRIXTON) is contemplating building the 5-valve circuit shown on page 65 of "Wireless Valves Simply Explained," Radio Press Limited. He asks for constants for the circuit.

Without knowing the range of wavelengths you propose to cover, we cannot very well advise you. If you will let us have further particulars, we will then be able to describe the values of the components in detail.

M. C. (WIMBLEDON) has constructed the three-valve broadcast receiver detailed in "MODERN WIRELESS" No. 2, and obtained satisfactory results. He now wishes to add reaction to his set so that he can hear broadcasting from other stations as well.

Reaction must not be used in such a manner as to cause the aerial circuit to oscillate when receiving British broadcasting.

R. E. W. (CAMBERWELL, S.E.5) wishes to construct the two-valve broadcast receiver in No. 1 of "MODERN WIRELESS," but finds difficulty in getting the inner tube to rotate in the outer one. He therefore queries the dimensions given.

A slight error has crept into the dimensioning of these tubes. The outer tubes should be 4in. and the inner ones 3in.

J. T. D. (LEYTON, E.10) asks with reference to the compact broadcast receiving set in the March issue of "MODERN WIRELESS" whether a clearance of $\frac{1}{16}$in. all round the rotor is sufficient.

One-sixteenth of an inch clearance is quite sufficient for this variometer, and you will find the set very satisfactory in use.

J. D. (LITTLE SUTTON, BIRKENHEAD) asks certain questions.

Grouping ten individual questions under seven headings does not constitute three questions. Before we can reply to you, we must ask you to condense your queries to the necessary number, otherwise the first three only will be dealt with.

E. G. C. (EARL'S COURT) asks the following questions: (1) The number of copper coils 1$\frac{1}{2}$in. by $\frac{3}{4}$in. and mica sheets 1$\frac{1}{2}$in. by 1in. to make a fixed condenser of value 0.001 μF capacity. (2) The same for a condenser of 0.0005 capacity.

(1) Eight coils will be required for the first condenser, and (2) four foils for the second one.

R. E. M. (FINCHLEY) is constructing the progressive unit receiver described in "WIRELESS WEEKLY," and wishes to know how the wire from T_2 is attached to the spindle of the switch so that it does not revolve when the switch is turned. He has also reversed the position of the coil on the baseboard and asks whether it makes any difference to the working of the set.

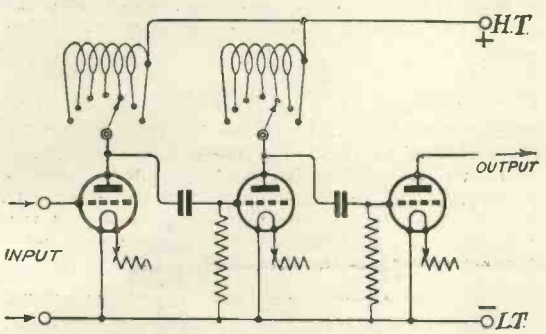
If you put a spring washer between the nut of the switch arm and the wood, you will find that there is no tendency for the wire to turn. With regard to your second question, the position of the coil makes no difference to the working of the apparatus.

R. D. (N.W.2) has made the variometer receiver described by Mr. Redpath in "MODERN WIRELESS," but does not hear any shipping. He asks if in our opinion there is anything the matter with his aerial, or if he could improve it in any way so as to obtain a greater range.

We think if you pay more attention to the insulation of your aerial, and particularly the lead-in wire, that you will have no difficulty in receiving Morse messages.

F. G. F. (CORNHILL, E.C.3) wishes to know whether it is possible to add another high-frequency valve to his reaction capacity coupled amplifier using a tuned anode coupling.

We give herewith a circuit diagram showing how two stages of tuned anode coupling circuit may be used.



A. C. (GLASGOW) wishes to know what form of inside aerial will give him the best results.

You should arrange an indoor aerial on exactly the same lines as an outdoor aerial, but it will probably be an advantage to have four wires instead of two, thus raising the self-capacity of the system. Wires should not be run round the walls of a room to form an indoor aerial.

F. H. (BIRMINGHAM) asks the following questions: (1) What size of anode coil will he require used in conjunction with a variable condenser of 0.0002 μF capacity to cover the British Broadcasting band of wavelengths. (2) Whether a similar coil might be used to produce reaction effects on to the anode coil.

(1) A cardboard tube 3in. by 3in., wound full with number 26 s.w.g. double cotton covered wires, and provided with four tappings, will be satisfactory. (2) A similar coil may be used for reaction.

Ex. W. O. (WEST HARTLEPOOL) wishes to wind a set of basket coils to cover a range of from 300 to 2,800 metres, using a variable condenser of 0.001 μF capacity, and wishes to know the number of turns of wire required.

You will require four coils, wound with the following number of turns:—(1) 70 turns; (2) 120 turns; (3) 180 turns; (4) 240 turns. This will cover from about 280 to 3,000 metres.

T. D. F. (MARLBOROUGH) is making a crystal valve circuit using certain arrangements of which he has forwarded us a sketch. He asks (1) whether the circuit is correct. (2) If his tuning coil consists of 120 turns of No. 24 d.c.c. wire on a 3½in. former, what size should the anode coil be. (3) Might basket coils be used to increase the range and if so should the same size coil be plugged in to the tuner and anode circuit.

(1) Your circuit is quite correct. (2) The same size coils might be used, or the tuned anode coil might be slightly larger. (3) Basket coils could be plugged in as desired, when they should both be of similar size.

M. D. (BIRMINGHAM) has constructed a unit receiving system as described in "WIRELESS WEEKLY," but does not obtain satisfactory results. He submits a description of how he has connected his apparatus, and asks if we can help him.

We are afraid that you have not followed out the connections quite accurately. If you will check these carefully you will find that results on this unit system will be just as good as on the slider set you mention.

D. T. N. (MERE) submits a diagram of his set, on which he hears Birmingham very loudly but complains that he does not hear 2LO.

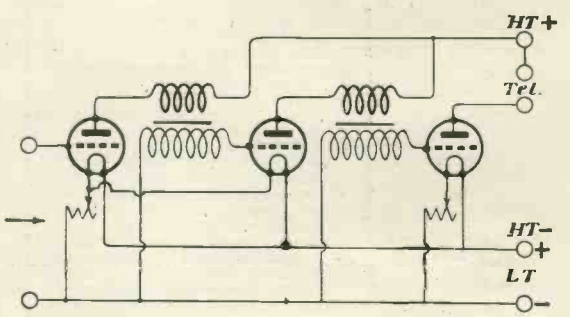
We think your aerial tuning arrangements are at fault, and suggest you experiment carefully with these. You should hear 2LO as loudly as 5IT with the apparatus you describe.

G. B. (E.16) submits a circuit diagram of his apparatus, showing switching arrangements, and asks whether they are correct.

The method of switching you suggest is quite suitable, and should be satisfactory. It would, of course, be an advantage from an economical point of view to extinguish the unwanted valve filament at the same time, but this is not necessary. There is no necessity to use low resistance telephones with this arrangement.

C. B. (MERTON, S.W.19) has certain components and wishes to know how to make up a low-frequency amplifier using them.

We give herewith a circuit diagram showing how the



various parts you mention should be connected up. 4,000-ohm telephones will be quite suitable for use with this amplifier.

A. T. (ROTHERHAM) refers to the Armstrong super-regenerative receiver described in "MODERN WIRELESS," No. 4, and asks the following questions: (1) How is the screening of the variable condenser effected. (2) Whether 3 pairs of telephones

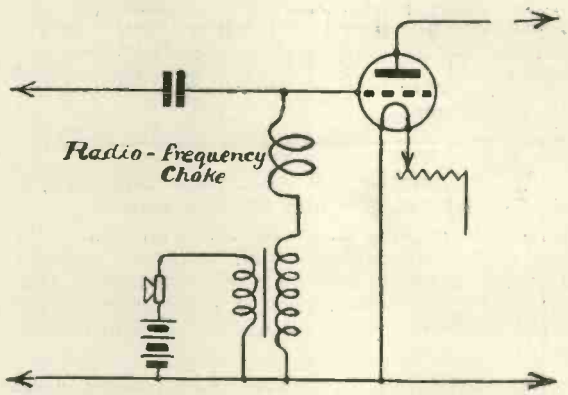
might be used with this receiver. (3) How to incorporate certain alterations which he has thought of.

(1) The variable condenser is sufficiently screened by simply enclosing the vanes with perforated zinc sheeting. A condenser in a brass case such as the Polar condenser would, of course, require no additional screening. (2) Three pairs of telephones may be used with this receiver. (3) We do not recommend any departure from the design of this instrument, which has been very carefully worked out.

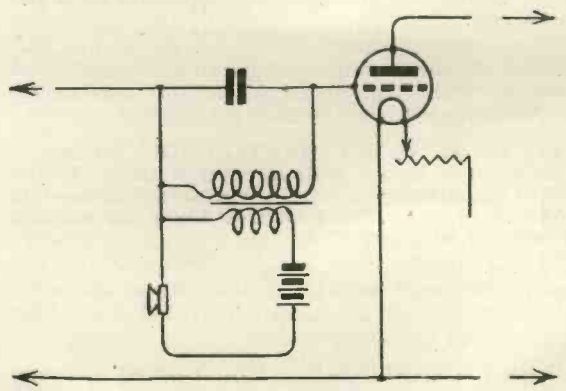
J. G. (LYNTON) submits a number of questions referring to the 2-valve Broadcast receiver described in "WIRELESS WEEKLY," No. 4.

We believe you are in rather an unfavourable spot for the reception of Broadcasting, but at the same time this receiver will give very good results. An accumulator of not less than 40 ampere-hours capacity should be used, and the high-tension voltage might be 60. Soft valves would be fairly satisfactory in the apparatus, and the full length of aerial should be employed. No variable condensers whatsoever are required for the reception of Broadcasting with this apparatus.

J. C. (ABERDEEN) asks for a circuit showing how he may effect modulation by grid control of the oscillating valve of his transmitter.



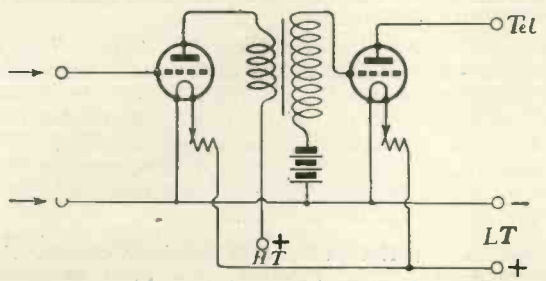
We reproduce herewith circuit diagrams showing two alternative methods of grid control.



G. A. (Nr. MANCHESTER). Please send us your address; we have a letter for you.

F. A. B. (CLAPHAM COMMON) has a low-frequency amplifier with which he experiences trouble. He submits particulars of his apparatus, and asks whether we can help him at all.

There are several reasons why your amplifier may be giving trouble. We think from your descriptions that the intervalve transformers are not well situated, as if they are too close together howling is liable to be set up. Your valve may also be too soft, the grid potential may not be sufficiently negative, and your high-tension batteries may have much too high a value. We think you should experiment with different values of high-tension voltage, and if possible different valves. We give herewith a sketch showing how to add grid cells to a low-frequency amplifier to give the grid a sufficiently negative value.



W. H. B. (CAMBERWELL) is about to construct the receiver described in "WIRELESS WEEKLY," No. 4, on page 218, and asks whether it is selective.

This device is exceedingly selective, and you should have no difficulty in tuning out 2LO.

W. W. A. (TOTTENHAM, N.17) asks (1) The number of turns for a set of lattice coils to cover from 250 to 1,000 metres. (2) What size of variable condenser is most suitable for tuning a rejector circuit. (3) Certain questions about reaction coils.

(1) A series of fixed coils having from 30 to 130 turns should be constructed. (2) A condenser having a value of about 0.0003 μF is most suitable. (3) Reaction applied to the tuned anode circuit will result in an increase of signal strength.

G. G. (EASTBOURNE) wishes to make a valve receiver for the reception of 2LO, and would like to know what parts he would require to build this instrument.

We suggest a 3-valve receiver on the lines of ST45 ("Practical Wireless Valve Circuits," Radio Press, Ltd.), for which you will require the following parts:—

(1) A 2-coil holder.
(2) 3 valves.
(3) 1 grid leak and 2 fixed condensers.
(4) 2 variable condensers, 1 0.001 μF capacity and the other 0.0002 μF capacity.
(5) 3 honeycomb coils, 2 of 50 turns and 1 of 35 turns.

Any good make of intervalve L.F. transformer, high- and low-tension batteries, and a pair of high-resistance telephones, will complete the essentials for the construction of this set. The advantage of this circuit is that whilst reaction is employed, no oscillations are transferred to the aerial circuit.

"OMEGA" proposes to build a loud-speaker on the electro-dynamic principle, and asks certain

questions as to the winding of the step-down transformer, diaphragm coil, etc.

An article dealing with the construction of an electro-dynamic loud-speaker of the type you mention will shortly be appearing in this paper. Full constructional details will be supplied.

G. T. (ST. LEONARDS). While listening-in about 11 p.m. some days ago, heard a very good concert transmitted on a wavelength of about 400 metres. He asks what station this could be.

The station you heard was probably the French Broadcasting Station of the School of Telegraphy and Telephony, located just outside Paris. This station gives very good transmissions every evening.

A. B. C. (BEVERLEY) proposes to build circuit No. ST45, and wishes to cover a wavelength range of from 200 to 1,200 metres. He asks questions as to the size of coils, etc.

The inductance L_1 should consist of 140 turns of No. 24 s.w.g. double cotton covered wire on a 3½in. tube, tapped every ½in. L_2 may be similar in construction, and should be shunted by a variable condenser of approximately 0.0003 μF capacity. The reaction coil for use on the intervalve coupling may have 160 turns on a 3in. cardboard tube, so that it may slide inside the anode coil.

W. E. C. (FINCHLEY) has a certain commercial pattern of crystal receiver, and asks questions about extending the wavelength range of the apparatus.

This could be readily done by using a series of plug-in inductances which might be connected directly between the aerial terminal of your set and the actual aerial itself.

H. T. C. (BELVEDERE) asks how to construct a paper condenser having a capacity of 1 μF.

You will find it rather difficult to make up such a big condenser for yourself, but if you care to do so you will require a strip of tinfoil 12 feet long and 1½ inches broad. This should be cut into two sections, a layer of paraffin waxed paper placed on each side, and the whole thing rolled up into the form of a cylinder. It will probably be much more economical if you purchase an ex-Government Mansbridge paper condenser. We believe these can still be had for a shilling or two.

R. M. (ROTHWELL) asks questions about a 4-valve receiver.

See reply to D. G. (Baker Street), in *Wireless Weekly* No. 5.

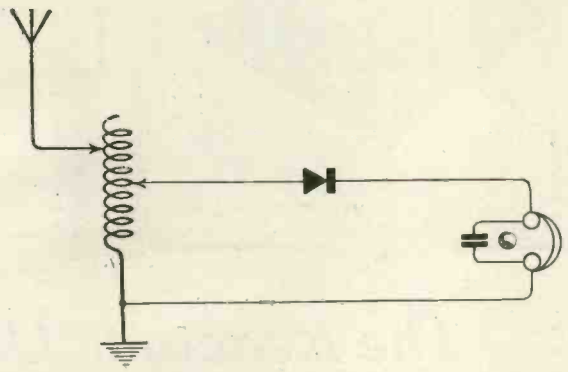
"PLANTATION" (GLASGOW) submits a large number of questions he wishes us to answer, some of which have no bearing upon wireless matters.

We have clearly stated that readers must not submit more than 3 questions at a time, which should be confined to wireless telegraphy and allied subjects. The information you require would fill a large sized book, and you cannot expect us to go into details in these columns. Your circuit diagram is correct.

L. P. C. (BANGOR, Co. DURHAM) submits a sketch of his aerial, and asks whether we consider it good. He also asks questions about a buzzer testing circuit, and wishes to know how to connect a 2-slider inductance to a crystal receiver.

(1) The single wire aerial should give you the best results. (2) The testing buzzer should be used in

the ordinary way, and we do not think you will obtain a greater output from the buzzer by using the apparatus you suggest. The whole idea of the buzzer testing circuit is to provide only weak waves so that the detector can be properly adjusted to its most sensitive point. (3) We give herewith a circuit showing how a 2-slider inductance is connected.



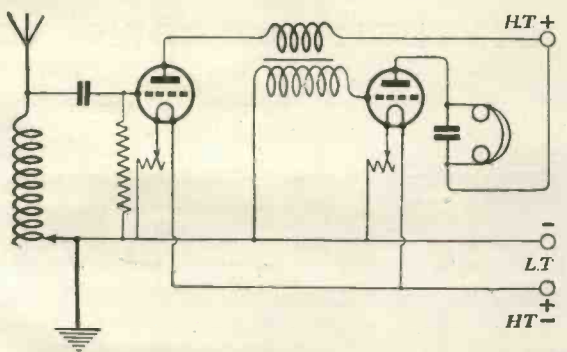
F. M. (FLEETWOOD) is using the circuit described in "MODERN WIRELESS," No. 4, page 284, and asks (1) what sort of a coil the inductance L_2 should be. (2) Whether it might be tuned with a small condenser. (3) For a good crystal.

(1) The arrangement you are using for this inductance is not at all suitable. It should be similar to the A.T.I. L_1 in characteristics, and might be a plug-in honeycomb coil. A basket coil would, of course, be satisfactory. (2) If the inductance is not variable by gradual steps, a small variable condenser across it will greatly sharpen the tuning. (3) We cannot advise as to the merits of any particular crystal, but most of the patent crystals now on the market are very satisfactory.

P. W. R. P. (S.W.1) asks questions about the construction of a multi-valve frame aerial set having a range of from 300 to 4,000 metres.

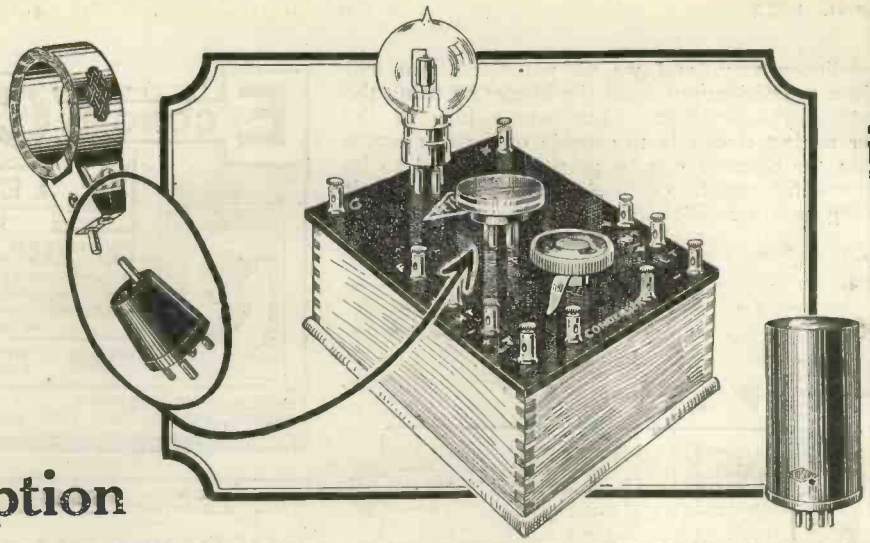
We are afraid you do not appreciate the principles governing the design of frame aerial receivers, as your letter evidently indicates that you are working along the wrong lines.

W. A. (SHEFFIELD) encloses a sketch of his crystal and valve set, and asks how he may add a valve as a detector in place of the crystal.



We give herewith a suitable circuit diagram showing how you may add a valve detector in the place of your crystal.

No. 4 of a series of talks on Peto-Scott Units.



"H.F." for long-distance reception

FOR picking up all the B.B.C Stations, you need H.F. amplification. High frequency amplification can be used on Peto-Scott Units in a variety of methods.

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By inserting a small plug-in transformer, as shown above, into the sockets on the panel and joining this No. 3 Unit up to the Detector Unit you obtain a greatly increased range of reception—possibly up to 500 miles. These plug-in transformers are tuned by the lower condenser in Unit No. 2. They are wound to various wave-lengths so that all "dead-end" effects are eliminated.

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By inserting a Multi-Wave amplifier (shown above), excellent amplification is obtained on all wave-lengths over 1,000 metres. No tuning is required and perfect results are always attained with the greatest of ease.

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By inserting a Tunode Plug and any honeycomb Coil, the famous Tuned Anode circuit is obtained. To reach any particular wave-length, it is only necessary to use coils of the correct valve.

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No. 2 Condenser Unit	42/-
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No. 4 Detector Unit	17/6
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Postage 9d. per unit extra, but paid on all orders over £2.

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Complete set of parts including 2 coil-holder, variable condenser, etc., with full instructions (mahogany cabinet to fit 3/6 extra)

28/6 postage 9d. extra.

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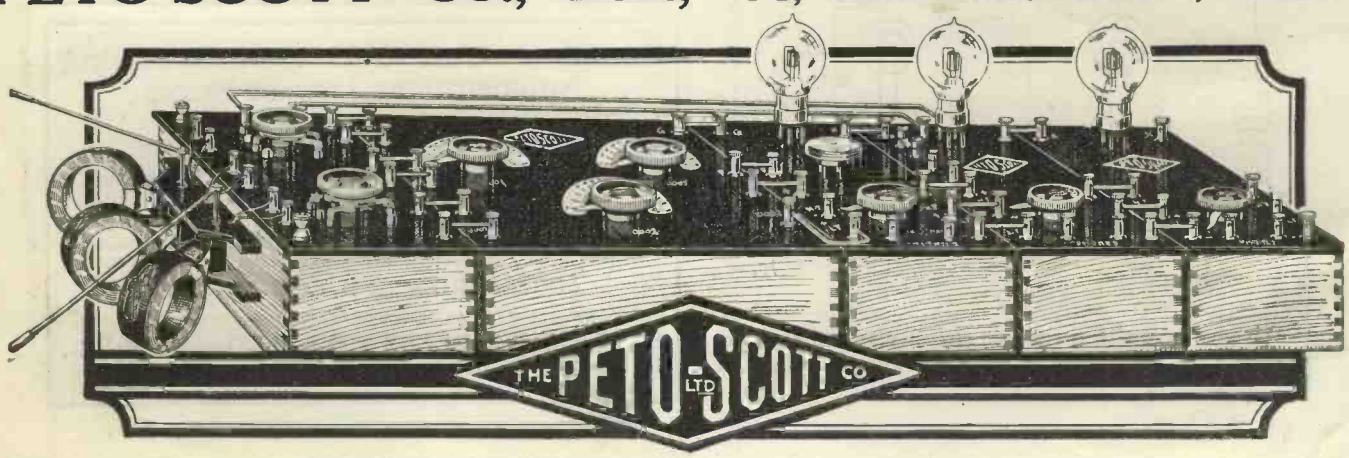

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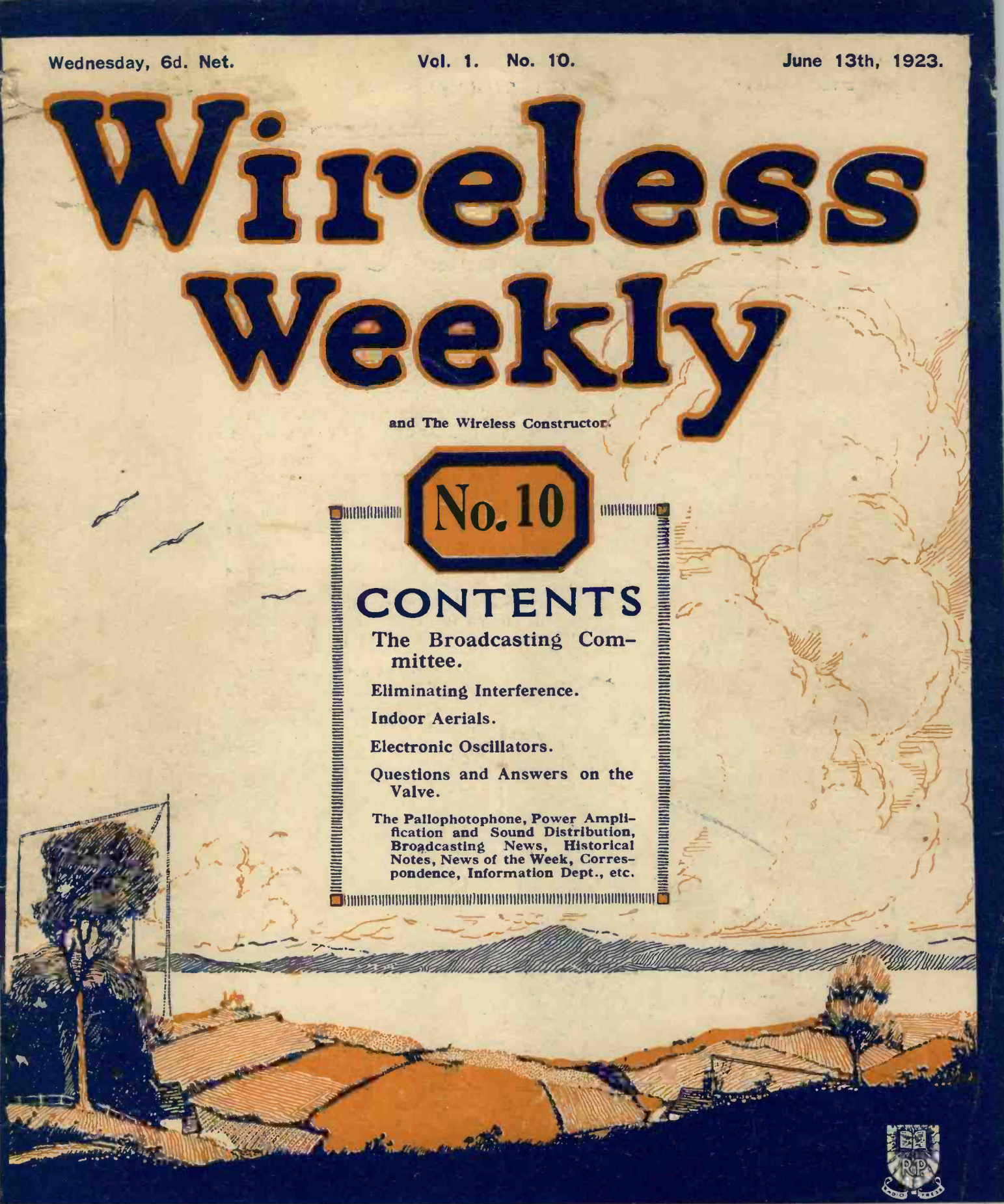

No. 10

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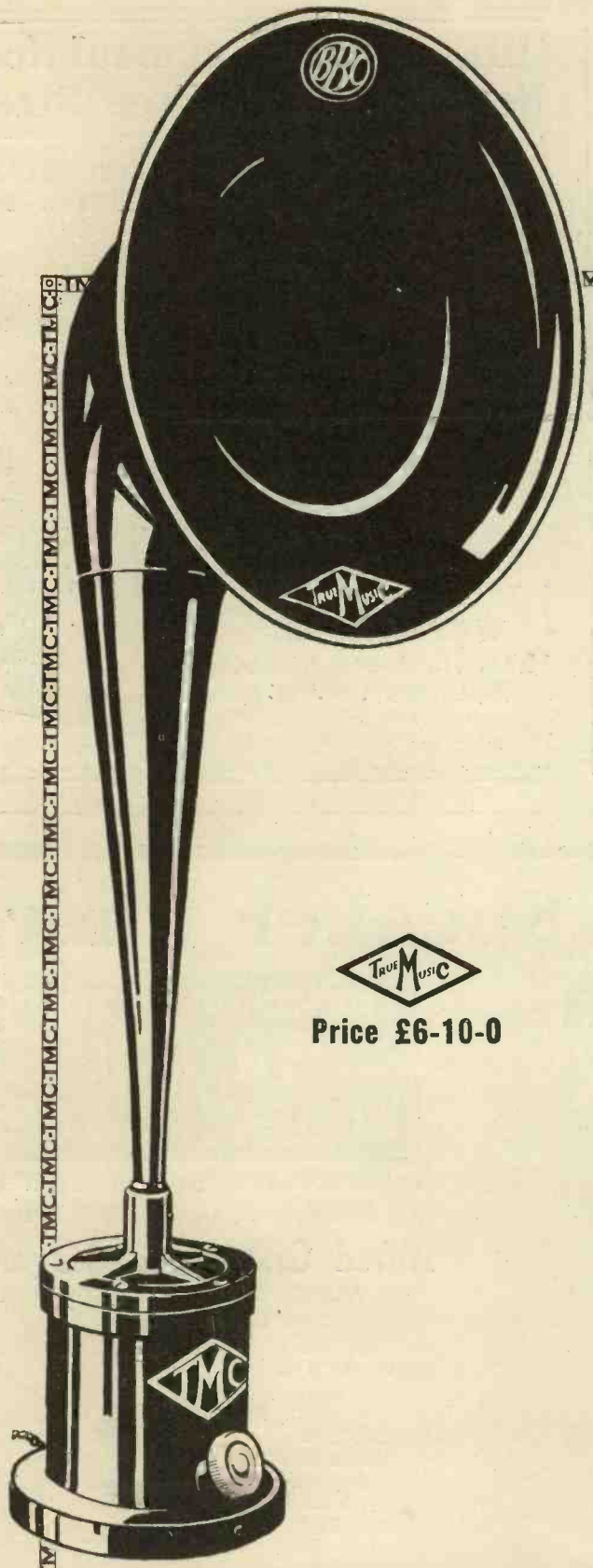
More about the "S.T.100" Circuit



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No. 510. Ethophone Popular with self-contained High Voltage Battery. Can be used with any standard accessories. - - - - - **£16:0:0**

Ethophone Popular as above, complete with 2 M.O. Valves: 1 pair 4000-ohm Telephones: Aerial Wire: Aerial Connecting Socket: Lead-in tube: 3 Insulators: Earth Wire: Earth Clip: Battery Connecting Wire. - - - - - - **£21:0:0**

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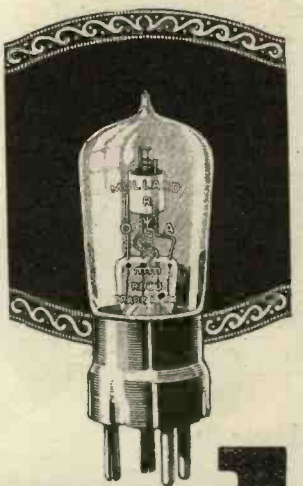

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Assistant Editor: E. REDPATH.

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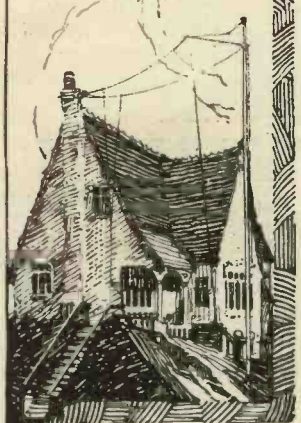


Editorial

The Silence that is Not Golden

Up to the time of going to press the Broadcasting Committee has not issued any report.

SO far as *actual results* are concerned, the special Committee appointed by the late Postmaster-General to investigate the position of broadcasting affords a striking example of the well-worn phrase "masterly inactivity."

Over six weeks ago this Committee was appointed to consider (1) broadcasting in all its aspects; (2) contracts and licences which have been or may be granted; (3) action which should be taken on the determination of existing licences of the British Broadcasting Company; (4) uses to which broadcasting may be put; (5) restrictions which should be placed on its use or development.

As far as the last item is concerned, the absence of an announcement by the Committee is unfortunately an all-sufficient restriction upon development, and, whilst fully appreciating the fact that considerable thought and time must be required before decisions can be arrived at upon *all* the points enumerated, we contend that it is the duty of the Committee to issue an interim report dealing with at least one item, namely, the licensing question.

This matter intimately concerns a vast public perfectly willing to pay reasonable contributions for the privilege of being legally entitled to do what thousands, in their enthusiasm, are now doing illegally.

With regard to the thousands who are listening-in without a licence of any description—popularly termed "pirates"—we fear that the lethargy of the present Committee, following the dilatory red tape methods of the Post Office, will, in a great many cases, find faithful reflection when the present "pirates" *can* obtain a licence upon application and payment of the prescribed fee.

Probably the greatest evil arising from the inexcusable delay in effecting a settlement of the licence question is the set-back given to a new and important British industry. Here we have enterprise which is developing something entirely new as far as this country is concerned, and, incidentally, affording employment to several thousands of British workpeople, impeded in its progress and forced to mark time—an expensive proceeding in the commercial world—simply because the Committee are straining at the bundle instead of selecting a single stick and *breaking it*.

This state of affairs must not continue. The silence must be broken. We urge everyone interested in broadcasting to write at once to his Member of Parliament requesting his assistance in obtaining a prompt settlement of the licensing question. To the industry we would say—form a strong deputation to wait upon the present Postmaster-General and request him to call for an interim report upon the licensing question from the Broadcasting Committee.

We know quite well that these things take time for mature consideration, and we are the last to call for a hasty judgment.

Nevertheless, when we see that only after six weeks is the representative of the listeners-in called to give evidence, and when we see the whole industry declining and ten thousand workers thrown out of employment while the Committee hears evidence, we feel that something must be done to remedy a scandalous position of affairs. The programmes are good, the weather is bad, and the industry should be flourishing. Through interminable delays, both the industry and the listeners-in are nauseated with the whole business. Until the licence question is decided we intend to continue calling attention to the unsatisfactory progress made by the Committee.

MORE ABOUT THE ST 100 CIRCUIT

By JOHN SCOTT-TAGGART, F.Inst.P.

It is assumed that all our readers have bought the Summer Number, No. 5, of "Modern Wireless." These notes supplement an article in which great interest has been taken.

NOTHING under the sun is new. No one appreciates this fact more than one who has been, for three years, the Patent Adviser to three of the largest wireless companies in the country.

It was, therefore, with the intention of forestalling the clever people that I personally made no claim for novelty for the ST100 circuit. It is, of course, a reflex or dual amplification circuit, and these are even more ancient than some historians would lead us to believe. The first dual amplification circuit using a valve was invented by Germans in April, 1913. The last eleven years has been spent in trying to avoid the use of these circuits.

The net sales of *Modern Wireless* are over 100,000 copies per month, and out of these 100,000 readers there are probably not more than 100 who have achieved any results with dual circuits, and most of these will confess that they (the sets, of course) howl and shriek at the slightest provocation.

I have worked fairly consistently with dual amplification circuits for over four years, and I believe I was the first British subject to obtain a patent for such a circuit, although a number of investigators such as Armstrong, De Forest, and Round, particularly the latter, have employed the principle from 1914 onwards in an experimental way.

I have experimented with every dual amplification circuit which has yet been published, but owing to their almost universal instability and tendency to oscillate at low frequency, I have never obtained sufficiently consistent and satisfactory results to warrant the recommendation of the reflex circuit for general public use.

For years listeners-in have wanted an answer to the question, "What is the most I can get out of two valves?" The practical development of the ST100 circuit was done to enable this question to be answered. I very timidly hope to receive any little credit there may be in putting forward, with full practical details, a combination of valves, inductances, condensers, resistances, transformers and batteries which will give very excellent results, which will remain stable, which is free from distortion and capacity effects, which may be handled by the novice, and which, if set up even by the beginner, will work effectively.

Working a single-valve reflex circuit is mere child's play compared to the operation of the average two-valve reflex circuit. Likewise, it is easier to use only one stage of low-frequency amplification than two, as is done in the case of the ST100. I was, however, most anxious to have two stages of low-frequency amplification, partly to simplify the tuning arrangements, and partly to enable good loud-speaker results to be obtained within a reasonable distance of a broadcasting station. The various troubles which were experienced in the experimental stages were overcome one by one. There are four or five different additions or subtractions to the ST100 circuit which, if carried out, will make the apparatus howl violently, particularly as the reaction is increased. The average circuit-monger, who imagines that design work is finished when the circuit is drawn, will receive a severe awakening when he tries to apply ordinary principles of circuit arrangement to reflex circuits.

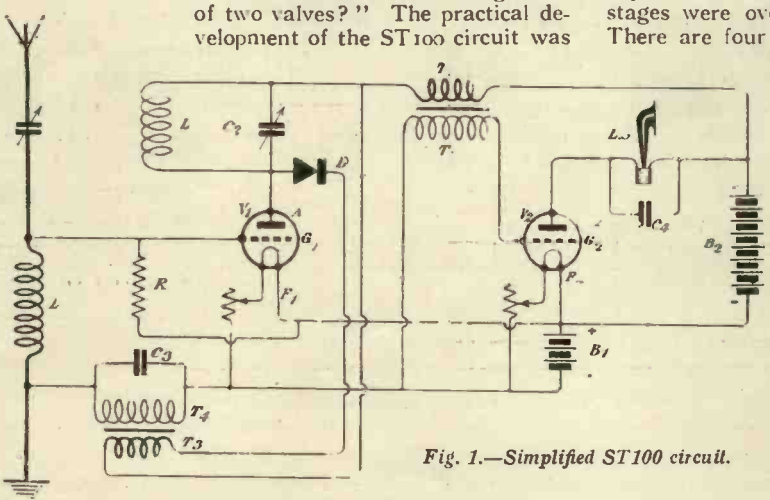


Fig. 1.—Simplified ST100 circuit.

Take, for example, the simplified ST100 circuit which I have reproduced in Fig. 1. It is standard practice, wherever the primary of a transformer is included in the anode circuit of a valve passing high-frequency oscillations, that the transformer winding should be shunted by a condenser. If, however, we connect a by-path condenser of ordinary size across the primary T_1 of the transformer T_1 T_2, in most cases the set will howl. Generally, under ordinary circumstances, a condenser would be connected across the primary T_3 of the transformer T_3 T_4, but here again it is found preferable to

omit it. Then again, we have the condenser C_4 connected across the loud-speaker L.S. This not only improves the tone, but also stops low-frequency howling. Although, therefore, it may seem easy enough on paper to work out different kinds of dual amplification circuits, yet there is far more in the practical design of the apparatus than many would think. The mere fact that dual amplification circuits have never touched the fringe of popularity is sufficient evidence that the wireless public has not had placed before them a really sound practicable proposition, in spite of the fact that dozens of different

factory results, although, owing to the howling tendency of all reflex circuits, I would not like to commit myself to the statement that all transformers would work successfully. The inductance coil L_2 is a No. 50 Igranic honeycomb coil. For the broadcasting stations using longer wavelengths, No. 75 should be tried. The condenser C_2 has a maximum capacity of either 0.0005 μF or 0.001 μF. The crystal detector D may be a Hertzite crystal, a copper spring resting on it. The condensers C_3 and C_4 were supplied by the Dubilier Condenser Company and have a capacity of 0.002 μF. An Amplion loud-speaker was found to give good results. The high-tension battery B_2

As regards the operation of this circuit, it will work quite well and there are no troubles to be encountered. The crystal detector, of course, is the vital spot in the whole system, and its adjustment is important. The contact should not be too light, particularly when reaction is applied, as otherwise, in spite of all precautions, the set may growl. Whenever juggling about with the crystal detector, have the reaction coil well away from the inductance L_1.

An important point with regard to connecting up the circuit is to see that the leads to the transformers are connected in such a way round as to obviate any tendency to oscillate. A large number

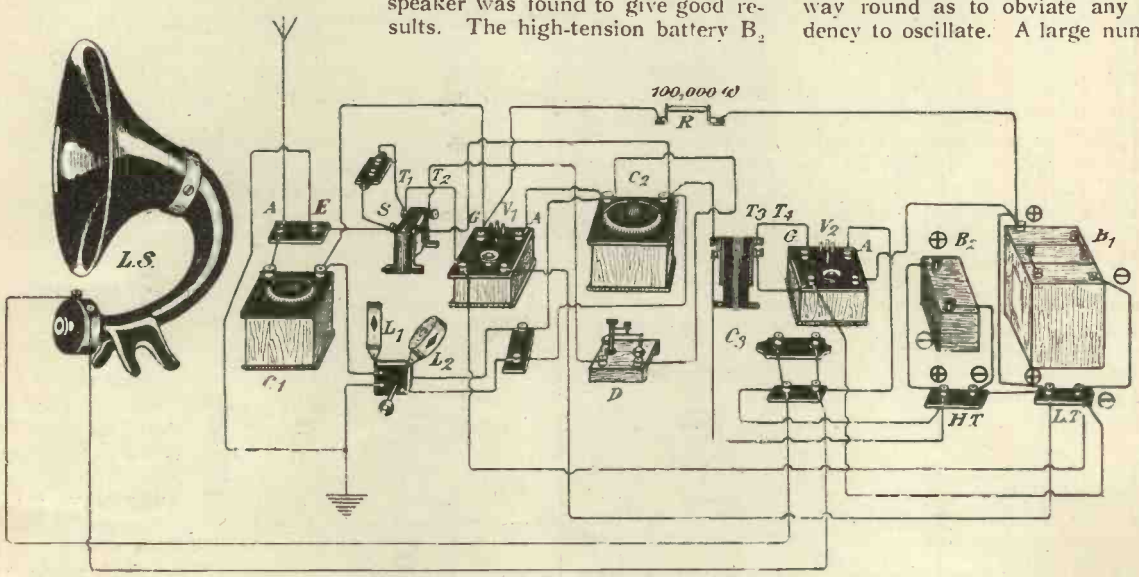


Fig. 2.—Pictorial view of components for the ST100 circuit

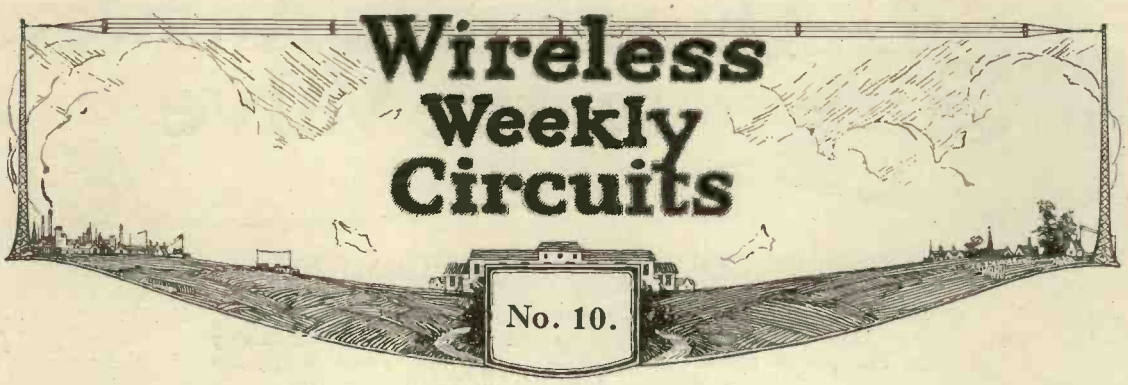
dual amplification circuits of an experimental nature have been given by numerous writers, including myself.

In the accompanying Fig. 1, the inductance L_1 has connected in series with it the variable condenser C_1, which has a capacity of 0.0005 or 0.001 μF. The inductance L_1 is a No. 50 or 75 Igranic honeycomb coil. Instead of connecting the variable condenser C_1 in series, it may sometimes be desirable to connect it in parallel with the inductance L_1, in which case the most usual size of honeycomb coil will be a No. 35 or No. 50. The two step-up intervalve transformers T_1 T_2 and T_3 T_4 are of Radio Instruments manufacture, but it is quite likely that other makes will give satis-

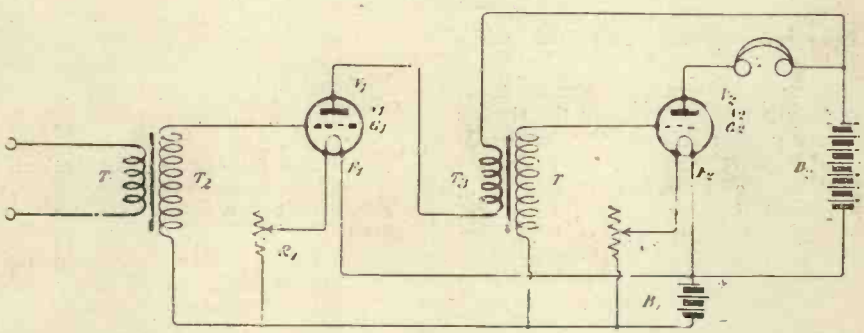
should have a value of 100 volts, although weaker signals, of course, could be obtained by using a battery of lower voltage. The valves used were of the ORA pattern, but no doubt, other types will work satisfactorily. The resistance R, which, in nearly all cases, will be essential if reaction is to be introduced from L_2 to L_1, has a resistance of 100,000 ohms, but resistances as low as 50,000 ohms may be used effectively. I cannot recommend some of the variable grid-leaks on the market, even though the makers may state that they go down to very low values of resistance. I very much question this, and therefore suggest a fixed anode resistance. An anode resistance of 70,000 ohms will prove quite effective.

of these sets were made up by different persons before the description was published, and no howling trouble was experienced. Should, however, this occur, the experimenter should try reversing the leads to the primary T_3; then try lowering the resistance of R if the change in the transformer connections does not stop the trouble. These suggestions are put forward for the benefit of those who may be using apparatus which does not conform to the kind described in the original article in *Modern Wireless*.

Fig. 2 shows a pictorial diagram of the different parts of the apparatus. This pictorial diagram has been carefully checked and is correct in all its details.



A Two-valve Low-frequency Amplifier



COMPONENTS REQUIRED.

T_1, T_2 : A step-up intervalve transformer.
T_3, T_4 : A similar step-up transformer.
R_1 and R_2 : Filament rheostats of about 7 ohms resistance.
B : Six-volt accumulator of at least 30 ampere-hour actual capacity.
B_2 : A high-tension battery of from 45 to 100 volts.
V.P.1 and V.P.2 : Two-valve panels.
T : High-resistance telephone receivers.

GENERAL NOTES.

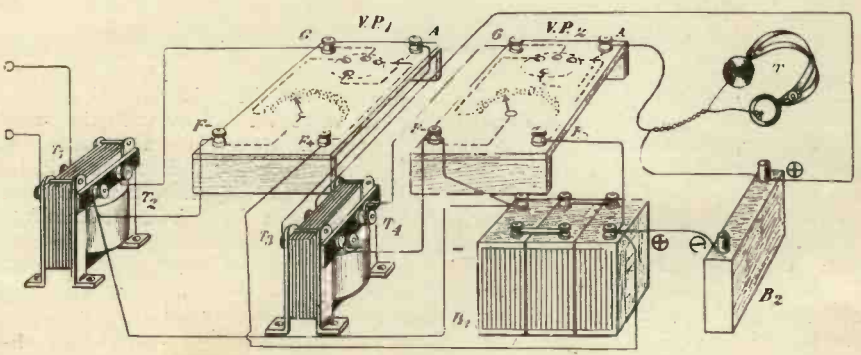
This is a low-frequency amplifier which may be applied to any type of receiver, and is particularly useful for strengthening the signals from a crystal detector, in which case the input terminals of the amplifier, i.e., those on the left, are connected where the telephone receivers would ordinarily be connected in the crystal set.

The windings T_1 and T_3 of the two transformers are primary windings and will usually, on the actual apparatus, be marked I.P. and O.P. The secondary windings T_2 and T_4 will usually each be marked I.S. and O.S.

NOTES ON OPERATION.

The only adjustments to be made are the filament rheostats R_1 and R_2 and the high-tension battery B_2. The amplifier should be so adjusted in these directions that it does not howl or produce low-frequency oscillations.

It is sometimes desirable to try connecting resistances of 70,000 to 100,000 ohms across each of the windings T_2 and T_4.



Questions & Answers on the Valve

A COMPLETE COURSE ON THERMIONIC VALVES

By JOHN SCOTT-TAGGART, F.Inst.P., Member I.R.E. Author of "Thermionic Tubes in Radio Telegraphy and Telephony," "Elementary Text-book on Wireless Vacuum Tubes," "Wireless Valves Simply Explained," 'Practical Wireless Valve Circuits," etc., etc.

PART IX

(Continued from No. 8, page 470.)

Explain how both High- and Low-frequency Amplification may be used in one and the same Receiver.

WE have already seen how a three-electrode valve may be used to amplify the signals from a crystal receiver. We have also seen how the high-frequency currents in an aerial circuit may be amplified before being applied to a crystal detector. It is, therefore, fairly obvious that this latter type of receiver might be extended by adding a stage of low-frequency amplification. All that we do is to pass the rectified currents, not through the telephones, but through the primary of a step-up intervalve transformer, the secondary of which is connected across the grid of a second valve. In the anode circuit of this valve we have the telephone receivers.

The high-frequency currents are now amplified by a valve; the amplified currents are applied to a crystal detector which rectifies them, the rectified current being now amplified by the second valve.

Practically all modern receivers use at least one stage of H.F. (high-frequency) amplification, and one stage of L.F. (low-frequency) amplification. Between these two there is always some form of detector for changing the high-frequency currents into low-frequency currents. Sometimes this detector is a crystal and sometimes a valve.

Draw and Explain a Theoretical Circuit showing a Stage of High-frequency Amplification, a Crystal Detector and a Stage of Low-frequency Amplification.

Fig. 1 shows such a circuit. The oscillations in the aerial circuit apply oscillatory potentials across the grid G_1 and filament F_1 of the first valve V_1. When the grid potential is made positive, there is an increase of anode current through the inductance coil L_2; when the grid is made negative, there is a decrease of current through L_2. The fluctuating current through L_2 is equivalent to an alternating current of exactly the same frequency as that of the original aerial current.

By shunting L_2 by a variable condenser C_2 and tuning the oscillatory circuit L_2 C_2 to the same frequency as the incoming currents, a resonance effect is obtained which results in the building up of the oscillations in L_2 C_2.

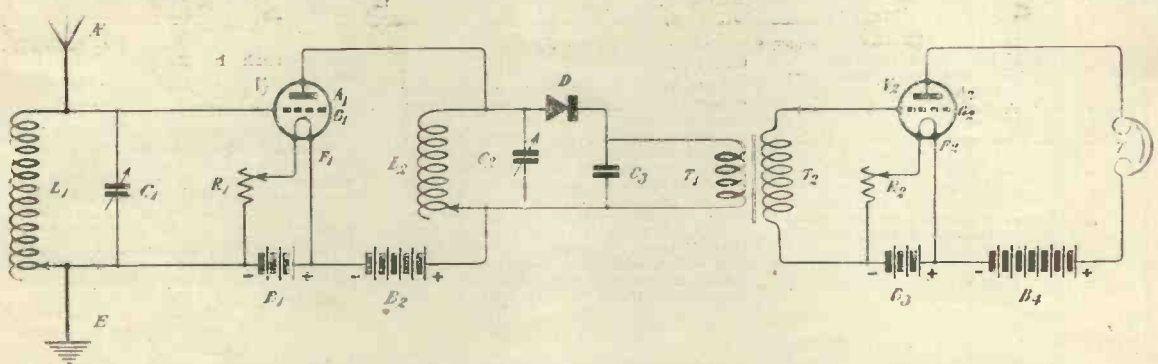


Fig. 1.—A two-valve receiver, the first acting as a high-frequency amplifier and the second as a low-frequency amplifier.

A somewhat similar effect is obtained by giving a series of impulses to a pendulum. If the "pendulum" were simply a long length of plasticine or putty hung up by the one end, the building-up effect would be missing.

The oscillations in L_2 C_2 which are several times the strength of those in the aerial circuit are now rectified by the crystal detector D, the rectified impulses passing through the primary T_1 of the step-up transformer T_1 T_2. The shunt condenser C_3 (having a capacity usually of 0.002 μF) is usually connected across the primary T_1 of the transformer T_1 T_2, although frequently it may be omitted without any loss of signal strength.

The pulsating currents through T_1 produce alternating potentials across the secondary T_2, these being of higher E.M.F. owing to the voltage step-up effect due to the secondary T_2 having usually 3 to 5 times as many turns of wire as T_1.

to the grid, while the bottom one goes to the anode. The left-hand socket is connected through filament rheostat R_1 to the negative terminal of the six-volt accumulator B_1. The right-hand socket is connected to the positive terminal of the accumulator B_1. The inductances L_1 and L_2 are tapped at, say, every ten turns. It is, of course, very usual to employ interchangeable coils of fixed inductance, such as those known as "duo-lateral" or "honeycomb" coils. Suitable coils for the wavelengths to be received are employed. Sometimes, to enable tuning to a given wavelength to be obtained, the variable condenser C_1 is connected *in series* with L_1 instead of in parallel as shown in Figs. 1 and 2.

What is Wrong with the Arrangements of Figs. 1 and 2 from a Practical Point of View?

Although this arrangement of apparatus works perfectly well, yet the objection to be raised against it is that two accumulators and two

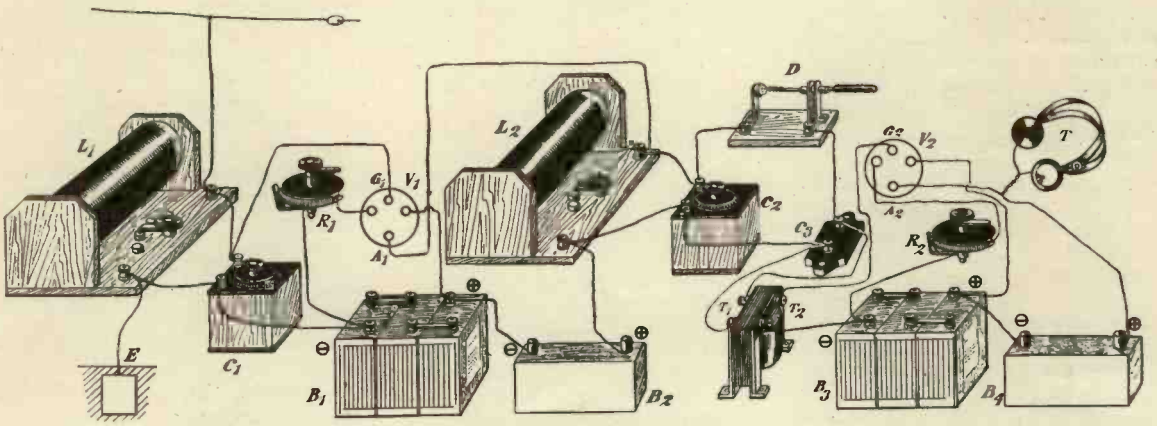


Fig. 2.—Pictorial arrangement of components to conform to circuit of Fig. 1.

The alternating low-frequency potentials, the frequency of which will usually vary between 200 and 3,000 in the case of wireless telephone reception, are applied across the grid G_2 and filament F_2 of the second valve V_2. The grid G_2 is made alternately positive and negative, causing increases and decreases of the anode current of the second valve V_2, these large current variations operating the telephone receivers T.

Show Pictorially the Arrangement of Apparatus to Conform to the Circuit of Fig. 1.

Fig. 2 shows pictorially how different components may be arranged and wired up to conform to the circuit of Fig. 1. The valve is represented in this illustration by the plan of the valve holder. The top socket, of course, goes

high-tension batteries are required. Obviously, this makes it an impracticable arrangement, and the necessity for duplicating batteries adds very considerably to the expense.

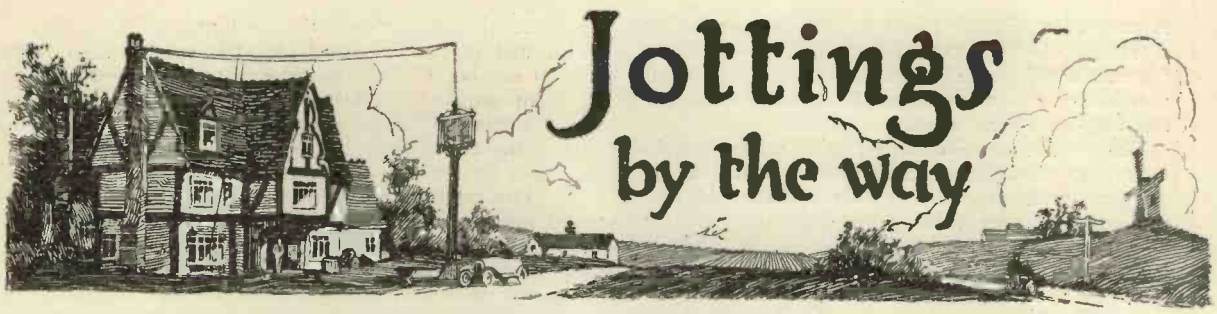
What Arrangement of the Circuit is Necessary to Enable us to Dispense with the Duplicate Batteries?

Just as thousands of lamps may be lit by current from a single source of supply, so may a single accumulator be used to supply the filaments of two or more valves. Likewise, a single high-tension battery may be used to feed the anode circuits of several valves. The circuit is made to look far more complicated by using a single accumulator and a single high-tension or anode battery, but the principles of operation remain identical.

S.T. 100

It is proposed in future issues of "Wireless Weekly" and "Modern Wireless" to give details of different sets made up in accordance with this circuit. It is however, recommended that the different parts be laid out on a table and connected up before any attempt is made to box them up. When successful results have been obtained in this way, the set may be made up in a box, taking care to keep the transformers as widely separated as possible, the different leads being kept short and separate from one another.

Future issues will contain, at intervals, further particulars of modifications and constructional details of different sets; also the experiences of our readers.



The Woman Who Did.

IN spite of the warning from one of her own sex against marrying a victim of radiomania, which I broadcast in these columns a few short weeks ago, a lady of my acquaintance has been and gone and done it. It is a very bad case, for the man is the sort of fellow who always carries four valves about with him, one in each of his waistcoat pockets. His conversation bristles like a barbed wire fence with formulæ stuffed with √'s, and π's, and ∞'s, and other cryptic things of that kind. She cannot claim to have committed matrimony with her eyes shut, for she has known the fellow for ages, and has been able to study at first hand all the dread symptoms of his terrible malady. When their future home was abuilding, his instructions to the architect were brief and to the point: "Make the chimney stacks strong enough to take aerial masts, and see that I have a good wireless room on the first floor." The house was in fact built round the aerial. When the foundations had been dug or laid or whatever one does do with foundations, all the work had to be begun over again since it was found that as things were, the aerial would not point directly away from Newark, New Jersey, U.S.A. The main water pipe, too, had to be taken through the drawing room in order to provide a handy earth in case visitors should desire to hear concerts from 2LO, or, if no music were on tap, requests from our old friend the operator at Croydon that pilots should give him their precise position.

Retaliation.

The only hope I can see for a maid who has thus taken her courage in both hands and married a man who thinks in ohms, or even at times in mhos, is to strike back by becoming herself a wireless maniac. The Broadcasting Company are doing all that they can to encourage the downtrodden wives of those bitten by the radio bug to take up a firm attitude. They have laid on a women's hour during which time no mere man, however brazen he be, can possibly wear the 'phones without blushes mantling his otherwise case-hardened cheek. Celia may learn exactly how to obtain a perfect complexion; Delia may drink in an infallible method for reducing ankles inclined to adiposity to proportions such as would win her a place in the front row of any beauty chorus. But you and I and others of the sterner sex could not possibly listen-in to these essentially feminine confidences of the ether, even on the pretence of testing out new circuits. We must surrender the 'phones to the pleadings of our better halves.

The Thin Edge of the Wedge.

The woman's hour, which, though not broadcast from Dublin or any Irish town, lasts but twenty minutes or so, is, I believe, the thin edge of the wedge. It comes, mark you, at the very beginning of the evening. It is an invitation to Amaryllis to don the 'phones directly the station signs on, and jolly well to stick to them until the men's hour (enduring but fifteen short minutes) drives her to hand them over to her lord and master. Woman is rapidly becoming infected with the radio germ. So that she may be able to hear all about next month's fashions whilst hubby is away she learns how to operate the set all by herself. This is the first stage. A little later on, hubby, on returning home, finds that she has been making improvements in his circuits. If they succeed he praises her; if they result in a holocaust of priceless valves, she apologises so prettily that he cannot be angry for long. Woman never does things by halves. If she takes up wireless she does so with a vengeance. In a little while she will be asking her helpmeet questions that cause him to fill in stealthily the "answers to correspondents'" coupon, and to temporise until the post brings him authoritative replies.

The Worm Turns.

The husband, however, has still a shot in his locker. If the steak arrives as a burnt offering cooked to the consistency of the rubber sole of a tennis shoe, he can ask sternly how this sort of thing can happen in view of the talks on cookery with which Amaryllis is supplied each evening. She will probably reply that she was so busy testing out her new tuned-anode panel that she didn't know whether it was Mrs. Beeton talking on cookery or the Foreign Secretary discussing the all-important question of the frontiers of Ruritania. But this must not be taken as a satisfactory answer; you can always put her on her mettle by saying that of course you know that she's only a beginner, and that one wouldn't expect her to be able to rig up a circuit that would make speech distinct and comprehensible. Then there is the question of dressmakers' bills. These should obviously be halved or even quartered when she receives such splendid hints on how to make frocks equal to the creations of Worth and Poiret for a matter of a few shillings. Older married men will, no doubt, encourage their spouses to take a keen interest in the new hobby. No one, not even a woman, can talk when deeply engaged in listening for the faint sounds of distant transmissions.

Tidying Up.

Cleaning, I think, should be confined to its traditional spring-tide. If one knows that it is to happen

during a certain horrid period one can pack up one's wireless gear in such a way that no harm can come to it and then go off for a week's fishing. But things come to a pretty pass when as soon as one's den has begun to get comfortably dirty after the last assaults made upon it with broom and duster it is announced that a further cleansing has been decreed. It is all very well when you have warning. Usually you have not. On previous occasions when told that such an attack was contemplated you have probably received the warning grumpily. Rather than risk another explosion the lady of the house resolves to do the thing by stealth. She waits until you go away for the day; then she lets herself and her handmaidens go. When you return everything is disgustingly clean and horribly tidy. The papers that you want have disappeared. Your pipes are standing in a neat row with mouthpieces downwards, so that when you seek to obtain solace by lighting one you receive a mouthful of juice. Then your eye falls on the wireless table. Here, again, all is decency and order. True it is that a file has been placed neatly on the top of the H.T. battery so that half of its cells have been short-circuited, and the light-hearted dusting of your most prized valves has caused their filaments to burst asunder; true that your 'phones lie upon the accumulator, the headbands bridging terminals that were never meant to be bridged. But what of that? Chaos has been changed into order; dust has been banished. You ought to be grateful. Are you? I trow not.

The Point of View.

Tidiness, after all, is chiefly the question of the point of view from which the question is regarded. A man's idea is that so long as he puts things where he can find them when they are next wanted, all is well. His bench and his worktable may not look very orderly, but he knows, for example, that both his spare set of coils and his table of regular transmissions are beneath the pile of catalogues, letters and *Wireless Weeklies* on the right. Everything, in fact, is in its place. The harsh outlines of spare condensers and other small gadgets, which are to be found in every place from mantelpiece to coal scuttle, are softened by a coating of dust. But what does a little dust matter here and there? Can it not be removed expeditiously from any bits and pieces that are wanted by blowing heartily upon them and giving them a final polish up with an antimacassar? Woman, on the other hand, thinks differently. To her, tidiness consists in putting everything behind or underneath something else. She has a perfect sergeant-major's instinct for neat rows duly arranged in order of size. That nothing can ever be found when she has had her way is of no moment to her. Her other obsession is the chivvying of dust. She can't let it rest in harmless peace. She whacks it up from the floor with carpet sweeper and broom. It rises into the air to settle upon tables and their contents. Then with the duster she sends it back again to its original lurking place. So long as she keeps it on the move very now and then she is perfectly happy.

Wireless on Trains.

We are likely to have, I see, receiving sets installed in the dining cars of our corridor expresses. The thing was done some time ago in America, and it has been tried experimentally here with great success. I trust that the managers of the railway companies, or whoever the officials are whose business it is to exact the utmost farthing from a public that has already had its pockets pretty thoroughly searched, have not read the paragraph that appeared in a previous issue about the fitting of wireless to the little steamers that ply through Paris on the Seine. So successful were the trials when an attempt was made to receive broadcast transmissions that the directors resolved to install a set upon each boat—and to raise the fares. The public has no option. It cannot say "I want to travel in the non-wireless compartment and to pay the old fare." It cannot demand its money back if the set won't work. It has simply got to pay up and to look as pleasant as may be in the circumstances.

On the dining cars of our trains wireless sets would have their advantages. Something noisy of the ragtime kind would, no doubt, lessen the horrors of the soup course, but I foresee that unless the operator is provided with a specially designed cabin with a securely locked door he is in for a nasty time. Every expert on the train will be seized with a burning desire to show him exactly what he is doing wrong and to suggest ways of improving his reception. If there are to be no cabins of refuge, then train wireless operators must either be men of sunny dispositions, beautiful tempers, and unfailing tact, or they must be of the prize-fighter stamp—men whose jutting chins and bulging biceps will awe even the most radiofanatical of passengers into silence.

Good for the Barbers.

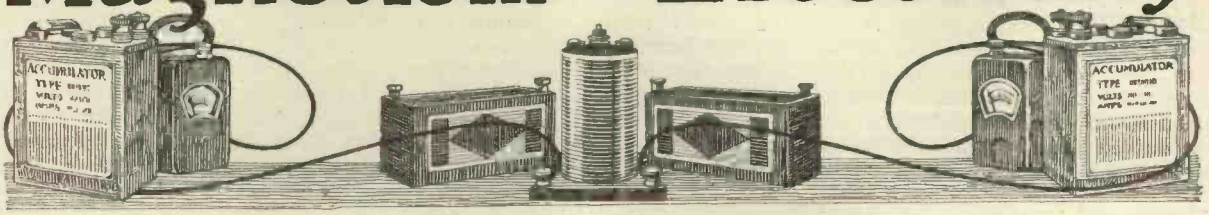
Some French musician, I forget for the moment who he is, appears to be seriously worried over the broadcasting question. There is nothing particularly extraordinary about this, for quite a number of other people are affected in the same way. But this particular worry is a novel one. He has had the Great Thought that with the onward march of wireless ten musicians blowing and scraping and thumping in the Eiffel Tower may in time suffice to provide dance and other music for the whole of Europe. This would, of course, be a terrible blow to the Pink Hungarians, Czecho-Slovaks, Jugo-Slavs and other assorted races of Central Europe who have hitherto made the production of bands and orchestras the chief national industry. It would, however, be a boon to the barbers, for it has been calculated that if this state of affairs came to pass the average number of hair cuts required would be increased by 1,019,263 per fortnight.

Overdoing Plate Voltage.

A friend called to see me the other day in distress. His telephones, it seems, have a habit of giving up the ghost. Though he uses only those of the best make, his first two pairs, wired in series, had lasted but a couple of months. They were repaired, but gave out again after a week or two. Enquiries elicited the information that he used 4,000 ohm 'phones on a two-valve set. On the question of plate potentials he was a little vague, but it appeared that when he wanted to boost up weak signals he added battery after battery until—something went!

WIRELESS WAYFARER.

Magnetism & Electricity



By J. H. T. ROBERTS, D.Sc., F.Inst.P., Staff Editor (Physics).

Readers who are taking up wireless as a hobby, and have little or no electrical knowledge, will find a careful perusal of this special series of articles of great assistance.

PART X

(Continued from No. 9, page 544.)

The Dynamo

THE production of an induced current in a coil of wire when the strength of the magnetic field through the coil is varied is the basis of the dynamo and of all dynamo-electric generating machinery. In discussing the subject so far, we have considered the

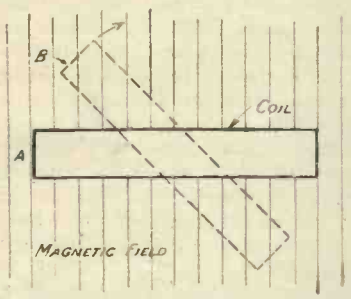


Fig. 1.—Plan of rotating coil in magnetic field.

coil to be stationary and the strength of the field to be variable. But if the strength of the field remains constant and the coil is so moved or rotated that the total number of lines of magnetic force which thread through it is varied, it will amount to the same thing as if the coil were stationary and the field were varied. In Fig. 1 A is shown a coil placed at right angles to the lines of magnetic force (the magnetic field may be supposed, for the sake of simplicity, to be that due to the earth). If the coil is rotated until it occupies a position shown in Fig. 1 B, the number of lines of force passing through it is less than when it is in the position A. Therefore, whilst the coil was moving from the position A to the position B, the "magnetic flux" (or the number of lines of magnetic force passing through it) was *changing*, and in accordance with what has been said above, whilst this change was taking place there would be an induced current flowing in the coil. When the coil reaches the position C (Fig. 2), no lines of force can pass through it. If it then continues in the same direction of rotation, the number of lines of force which thread through it begins to increase and an induced current is again produced.

It will be seen, then, that if the coil is continuously rotated in the magnetic field, the magnetic flux through the coil will increase (starting now from position C), decrease, increase, decrease, and so on

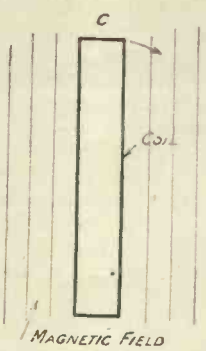


Fig. 2.—Coil in the position of maximum induced E.M.F.

The strength of the current which is induced in the coil does not depend upon the actual magnetic flux at any moment, but upon the *rate at which the flux through the coil is changing*, or, to put the matter in another way, it depends upon the *number of lines of force cut across per second* by the coil. To make this matter clearer, it may be mentioned that if instead of being rotated the coil were moved (without being rotated) in a uniform magnetic field, so that

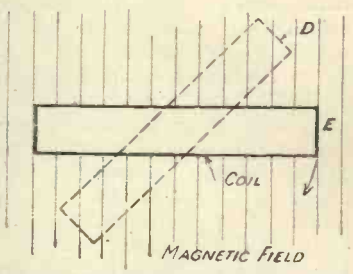


Fig. 3.—Coil in the position of reversal of induced E.M.F.

although the coil cut across lines of magnetic force, the total number of lines of force passing through the coil was never varied, no current would be induced in the coil. For the production of induced current in the coil, it is essential that the number of lines of magnetic force passing through the coil shall be *changing*.

To return to the coil shown in Figs. 1, 2 and 3, it will be seen that when the coil is in the position A the rate of change of the magnetic flux is zero, because if we imagine the coil to make an infinitesimal movement about the position A, we will see that no lines of force will be cut. The rate at which the coil

cuts the lines of force increases as the coil moves from the position A through position B to position C. In position C, the rate at which the coil is cutting the lines of force is a maximum. This will be clear if we imagine the coil to make an infinitesimal movement about the position C, when it will be evident that the smallest movement at this position will result in the maximum rate of cutting of lines of force. Another way of stating this which will, perhaps, help to make it clearer, is that in the position A the wires of the coil are moving parallel to the lines of force and are, therefore, not cutting them, whilst in the position C the wires are moving exactly at right angles to the lines of force and, therefore, are cutting them at the maximum rate.

As the coil moves on towards the position E, the flux is increasing, but the coil now has its "back" (so to speak) towards the direction in which it was originally facing. An *increasing* flux in this reverse position will produce an induced current in the coil in the same direction as a *decreasing* flux in position B. Evidently, then, the induced current in the coil will be zero in position A, a maximum in position C, zero again in position E, but will be in the same direction whilst the coil is moving from A to E.

After passing position E, the flux begins to decrease, and since the coil is still facing in the same direction as in position D, the decreasing flux will produce an induced current in the opposite direction to that produced by the increasing flux in position D. Thus the *position E represents a reversal of direction* of the induced current in the coil. From position E right round to position A again, the current increases to a maximum in position F, and falls to zero again in position A.

Thus during one complete revolution the current has risen to a maximum, fallen to zero, risen to a maximum in the opposite direction, and returned to zero. This represents what is known as "alternating current," since the current alternates in voltage or changes its direction. The complete unit of the process is that which corresponds to one complete revolution of the coil; it is known as a "complete cycle." If the coil is kept continuously in rotation and the ends of the wire are attached to two metal rings mounted upon the spindle on which the coil rotates, as shown in Fig. 4, metal strips may be pressed against these rings whilst the coil is rotating and the alternating current, produced by the coil, led away. The rings are known as "collecting rings,"

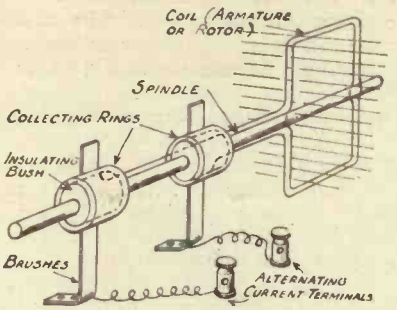


Fig. 4.—Simple illustration of principle of alternating-current generator.

and the metal strips which press against the rings are known as "brushes"; the coil is called the "armature" or "rotor."

The whole arrangement which has been described above constitutes the rudimentary alternating-current generator and represents the principle underlying all electrical generating machinery. In actual

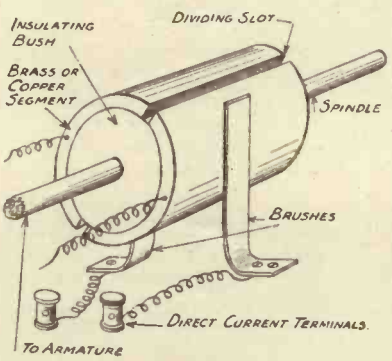


Fig. 5.—Illustrating construction of direct-current commutator.

practice, the magnetic field in which the armature rotates is artificially produced by means of a large electro-magnet, through the coils of which direct current is passed. This produces a magnetic field many thousands of times stronger than that due to the earth alone. It will be obvious that it is desirable to have the armature rotating in an intense magnetic field as, other things being equal, the rate of change of the flux will be proportional to the flux itself.

In practice, the rotor consists of an iron wheel with a number of "poles," round which coils of wire are wound.

Direct-current Dynamo

The machine which has been described above may also be used to produce direct current instead of alternating current. This is done by the employment of a simple device mounted on the axis of the armature and known as the "commutator" ("changer"). The simplest way to understand the action of the commutator is as follows:—Suppose the coil in Figs. 1, 2 and 3 is rotating slowly, say one complete revolution per second. As it passes from the position A to position E the current is in one direction, and as it passes from the position E to the position A the current is in the opposite direction. Now suppose we wish to pass the current from the machine into an accumulator which we are charging. If we place between the machine and the accumulator a reversing-key, and we change the key over every time the coil passes through the positions A and E, the current through the accumulator will always be in the same direction. It might be possible to do this change-over by hand, if the speed of rotation of the armature were only one complete revolution per second, but as the speed is usually very much higher than this, it is not only inconvenient, but impossible to make the change (or "commutation") by hand. But if a brass cylinder be mounted upon the spindle (upon an insulating core, of course) and be split into two halves by means of two cuts parallel to the spindle (see Fig. 5), the ends of the coil being connected to the two halves of the brass cylinder, this device can easily be made to effect the reversals automatically. All that it is necessary to do is to place two metal strips or "brushes" in contact with the metal cylinder on opposite sides, and to fix the cylinder on the spindle in such a position that, at the moment when the direction of the current from the armature is reversing, the cuts in the cylinder are passing the brushes, so that when one-half of the cylinder is changing its polarity it is also changing over to the other brush. Without going into

any further details, a little consideration on the part of the reader will soon show the essential principle of the commutator.

Electric generators, commonly called "dynamos," are used for a variety of purposes in connection with wireless, but the commonest use by wireless experimenters is for

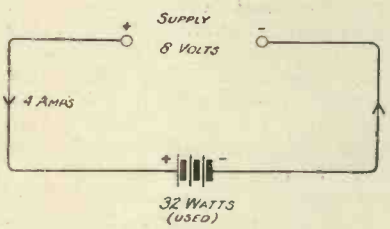


Fig. 6.—Charging accumulators with correct voltage (no energy wasted).

the purpose of charging the accumulators which are used for the heating of valve filaments. A dynamo is usually rated according to its output in amperes and the voltage at its terminals when supplying current. Of course, the voltage will depend upon the speed of rotation of the armature, and to obtain a given output at a given voltage it is necessary to drive the armature at a definite speed. For charging, say, a 2-volt accumulator, it is desirable to have current supplied at a voltage of about 2.5 volts. If current is available at, say, 8 volts, accumulators may be charged by arranging three in series, thus applying 8 volts against the 6 volts of the battery (with a resistance, if necessary). In many cases, however, the only voltage available is that of the electric-light mains, which may be 100 or 200 volts. If, say, a 6-volt battery is charged by connecting to the 100-volt mains, it is necessary to insert a suitable resistance so as to limit the current which will flow through the battery. Whilst in some cases this is a convenient method, it is a very wasteful one, for (as we saw in a previous article of this series) the energy represented by an electric current is equal to the product of the current and the E.M.F. which drives it. Suppose accumulators are charged by means of a current of 4 amperes. If this current is supplied at 8 volts, the power is 32 watts (see Fig. 6). If, however, this current is supplied from 100-volt mains, the power is 40 owatts, the rest of the energy being wasted in the form of heat in the resistances which have to be inserted in series with the accumulators (see Fig. 7).

In such cases as this it is, in the long run, worth while to install a small motor-generator set—that is, a small dynamo capable of delivering, say, 5 amperes at 10 volts—driven by an electric motor, the latter being designed to work direct from the 100-volt mains (or whatever the case may be). The current taken by the motor is correspondingly small, so that (except for certain losses, due to friction and other causes) the total power taken by the motor is equal to the power delivered by the generator, the only difference being that the motor takes a small current at a high voltage, whilst the generator supplies a larger current at a lower voltage. It will be remembered, from the remarks which have been made about static transformers, that the voltage of an *alternating* current can very simply be raised or lowered by means of an arrangement of coils upon an iron core. This method is only applicable to *alternating* current, however. For *direct* current the static transformer is of no service, and the motor generator, which we have just been considering, serves the same purpose for direct current as is served for alternating current by the transformer.

There is a considerable variety

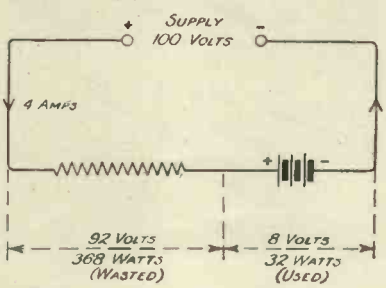


Fig. 7.—Charging accumulators with excess voltage (energy wasted in resistance).

of combination machines available for changing the voltage and output of direct current, and also for converting direct current into alternating current and alternating current into direct current, but these may be dealt with further on some other occasion.

One very simple device which may, perhaps, be mentioned here is nothing more or less than a small electric motor driven by alternating current, the motor being what is known as a "synchronous" motor (that is to say, rotating "in step," as it were, with the cycles of the applied alternating current), upon the spindle being mounted a com-

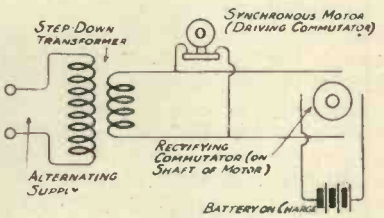


Fig. 8.—Simplified diagram of commutator-rectifier.

mutator. The current from the alternating supply is passed through this commutator, the latter being so arranged in position as to reverse the current at the right moments. A set of this kind is marketed, and may be purchased very cheaply; it is specially designed for the charging of accumulators in cases where only alternating current is available (the latter being, of course, unsuitable for use in charging accumulators).

Charging Accumulators.

Accumulators differ from ordinary primary batteries in that the action which takes place when they give out current (or are "discharged" as it is called) is *reversible*. Consequently, when an accumulator is discharged or "run down," it is only necessary to connect it to a suitable source of electric supply, and pass a current through it in the "wrong" direction (that is, the opposite direction to that in which the current flows from the cell when in use in the ordinary way), and the plates are gradually restored to their former condition. The cell is then said to be recharged, and is again ready for use as before. This is not possible with primary cells, where the chemical actions which take place are not reversible. Consequently in a primary cell, after the cell has been in use for a certain length of time, the materials (or some of them) are consumed, and the only method of re-conditioning the cell is by the replacement of the necessary parts.

SELECTIVITY

By E. REDPATH, Assistant Editor.

Those experimenters who desire to receive broadcasting over a considerable distance without interference from the nearer stations will find this article of particular interest.

ALTHOUGH excellent results may be obtained with the ordinary single circuit receiver, considerable difficulty will usually be found in receiving from distant stations when a nearby station, say up to 20 or 30 miles distant, is working.

This is principally due to the fact that the single circuit is not sufficiently selective, and, consequently, the aerial circuit is forced into oscillation by the comparatively powerful waves of the nearby station, even though the receiver may be tuned to a wavelength differing by 20 or 30 metres.

With a tuner which is not selective it will be found that considerable movement of the variable condenser, the variometer or inductance slider—according to which method is employed—is possible without any rapid falling off in signal strength.

The effect of this is shown in Fig. 1, in which the horizontal scale represents wavelength from 300 to 500 metres) and the vertical height, the current in the receiving aerial.

It will be seen that, when tuned to resonance with the 369-metre wave of 2LO, the current in the aerial circuit due to the waves from that station has a maximum value of x. This, of course, is merely an arbitrary and comparative value and does not represent any actual current value.

Note that, owing to the very gradual slope of the curve, when the tuning is varied to bring in signals from 2ZY (385 metres), the current due to 2LO's wave still has a value of about $\frac{1}{3}x$, and even when the wavelength is further altered to 400 metres the current has fallen only to about $\frac{1}{3}x$.

With such an arrangement it might be possible to receive from 5NO, but if the receiving station is fairly close to 2LO, reception from 5WA or 2ZY is out of the question.

The cause of this lack of selectivity, or "flat tuning," as it is often termed, is excessive damping. There are several factors which contribute to this damping or dissipation of energy in the aerial circuit, such as high aerial- or earth-resistance, poor insulation, high resistance of the tuning coil or variometer winding; but the item with which we are concerned at the moment is the damping due to the rapid transference of energy from the tuning coil to the valve to which it is directly connected.

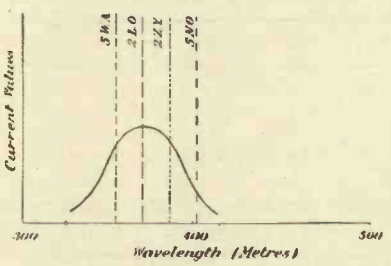


Fig. 1.—Showing the interference experienced with non-selective tuning.

The previously mentioned factors should, of course, receive the careful attention of experimenters who desire to obtain the best possible results; whilst considerable improvement can be effected with regard to the last named by the employment of inductive in lieu of direct coupling.

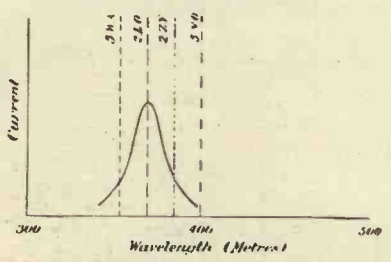


Fig. 2.—Reduced damping sharpens the "resonance peak" and reduces interference.

Fig. 2 shows graphically the increased sharpness of the resonance point, with consequent greater selectivity. It will be seen that when the receiving set is tuned to the 385-metre wave of 2ZY, the current due to the incoming wave from 2LO has fallen to less than one-third its maximum value, whilst at the 400-metre adjustment it has fallen practically to zero.

Under these circumstances, therefore, signals from 5NO may readily be received without interference from 2LO, whilst even in the case of 5WA and 2ZY, interference will be only slight compared to the case illustrated in Fig. 1. By employing an extremely loose coupling between the aerial and closed circuits the resonance "peak" may be further sharpened and the interference from 2LO be further reduced.

Readers who constructed the 2-Valve Broadcast Receiver (as described in No. 4 issue) and the Inductively-Coupled Crystal Receiver (as described in Nos. 5 and 6) may use those sets to experiment with a view to ascertaining how much may be accomplished by careful and selective tuning. Certain slight modifications are required, and these are indicated in Fig. 3, whilst, for the benefit of new readers, details of the various components are as follows.

The inductively coupled tuner is shown on the left enclosed by a dotted line, and it includes the aerial terminal A; primary coupling coil P; variometer L_1 and earth terminal E, comprising the aerial circuit. The closed oscillatory or secondary circuit includes the inductance coil S, forming the secondary of the oscillation transformer, with the variable condenser C_1 connected in parallel. Opposite

sides of this condenser are connected to the terminals T_1, T_2, which, in the original set, are the telephone terminals, the only modification necessary being the short circuiting of the crystal detector.

number of valves, a crystal detector D and an iron core transformer, M, have also been added, and, in the modified arrangement, the first valve, V_1, acts as a H.F. amplifier with tuned anode circuit L_2, C_2.

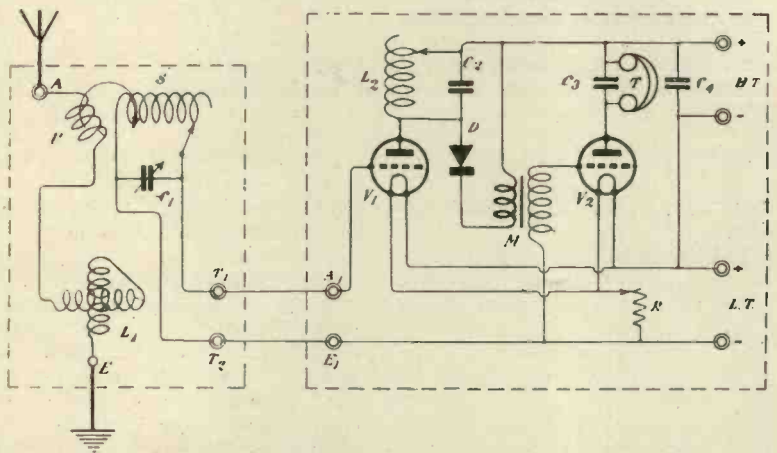


Fig. 3.—An inductively-coupled tuner (on left) used with modified 2-valve receiver.

The primary coupling coil, P, consists of a wooden former in the shape of a ball, wound with 26 turns of No. 24 s.w.g. d.c.c. copper wire, mounted upon a spindle and fitted inside the end of the secondary coil S, which consists of 200 turns of No. 36 s.w.g. d.c.c. copper wire wound upon a stout cardboard tube 2½in. in diameter by 5in. long, the winding commencing 1in. from one end of the coil and being "tapped" at the first 50 and each subsequent 30 turns, the tappings being connected to a suitable 6-point selector switch. The variable condenser C_1 should consist of 5 fixed and 4 movable vanes, and may be built up from standard parts or purchased complete, as preferred.

The variometer, L_1, may be purchased complete from advertisers in this journal or constructed in accordance with particulars given in No. 5 issue.

The modified 2-valve broadcast receiver, also enclosed by a dotted line, is shown on the right of Fig. 3. It will be noticed that the original aerial tuning inductance, with slider, has been deleted, but for a preliminary trial, at all events, it will be sufficient if the slider on this inductance is removed from contact with the winding by means of a visiting card, slipped beneath the plunger.

With a view to obtaining the best possible results with the minimum

Rectification is effected by the crystal detector, D, which, in series with the primary of the intervalve transformer, M, is connected across the anode condenser C_2. The second valve, V_2, now functions as L.F. amplifier, the telephone receivers—shunted by the usual telephone condenser—being connected directly in the anode circuit of V_2.

The anode tuning inductance L_2 consists of a cardboard former 2½in. outside diameter by 6in. long, close wound for 5in. of its length with No. 28 s.w.g. enamelled copper wire and fitted with a slider. The capacities of the various condensers are as follows:—C_2, 0·0002 μF; C_3, 0·001 μF; C_4, a large capacity reservoir condenser, value up to 0·3 μF. A_1, E_1, represent the original aerial and earth terminals of the broadcast receiver, whilst R is the filament rheostat which controls both the valves.

By the addition of a further iron core intervalve transformer and a fixed condenser (capacity 0·001 μF) the arrangement of Fig. 3 may very readily be converted into a form of the excellent "ST100" circuit, as described in detail in the current issue of *Modern Wireless*.

Fig. 4 shows the complete arrangement, the additional transformer and condenser being shown at M_1 and C_5 respectively.

Should the set have a tendency to "howl," the addition of a 50,000-ohm leak, between the terminal A_1 and the + of the filament, as shown dotted in Fig. 4, will give the necessary stabilising effect.

Referring to Fig. 4, the inductively-coupled tuner is shown upon the left as in Fig. 3, the output terminals T_1, T_2 being connected to the grid and filament of the valve V_1.

Notice, however, the connection between the terminal E_1 and the negative side of the L.T. battery is completed through the secondary winding of the low-frequency inter-valve transformer M_1. This winding is shunted by a small fixed condenser, capacity 0.001 μF, the

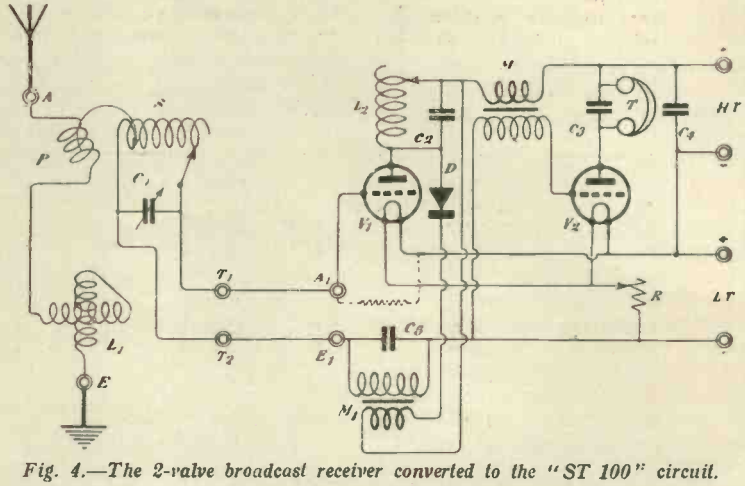


Fig. 4.—The 2-valve broadcast receiver converted to the "ST 100" circuit.

object of which is to "by-pass" the high-frequency current from the tuner.

In some circumstances better results may be obtained by using a condenser of lower capacity, such as 0.0005 μF, or even

0.0003 μF, and a little experimental work in this direction will probably be found worth while.

The object of the additional transformer M_1 is to enable what is now known as a "reflex" effect to be obtained by which the first valve V_1 is made to function as both a high-frequency and a low-frequency amplifier.

The incoming oscillatory currents applied to the grid and filament of V_1 cause amplified oscillatory currents to be set up in the tuned anode circuits L_2, C_2. These amplified currents are then rectified by the crystal detector D, and, traversing the primary winding of the inter-valve transformer M_1, are inductively applied to the grid (*via* the coil S) and filament of the valve V_1, which then functions as a low-frequency amplifier, and the low-frequency pulses in the primary winding of the inter-valve transformer M induce E.M.F.'s in the transformer secondary winding, which is connected to the grid and filament of the second valve V_2, in the anode circuit of which are placed the telephone receivers.

The selectivity obtainable by means of the inductively coupled tuner, combined with the high efficiency of the valve-crystal-valve circuit, enables the present writer, 15 miles south-east of 2LO, to obtain excellent reception from 2ZY (Manchester) and 5NO (Newcastle), without interference from the first named station.

It is of the utmost importance that the coupling between the coils P and S (Figs. 3 and 4) should be extremely loose, the coil P being rotated until almost at right angles to the coil S, under which conditions the adjustment of the variometer L_1 and the secondary condenser C_1 will be found fairly critical. The adjustment of the anode tuning inductance L_2 will not be very critical and an approximate adjustment will usually enable the desired signals to be heard, after which a final adjustment will effect improvement.

For a first trial, at all events, it is certainly advisable to tune in the desired distant station during an interval in the transmission from the nearer station. Under these conditions, the preliminary searching may be carried out with a moderately tight coupling between the coils P and S of the inductively-coupled tuner.

When the desired station is satisfactorily tuned in, the coupling should be reduced considerably. This will usually effect an immediate reduction in signal strength, and an inexperienced operator may consider that the only way to increase the signal strength to a satisfactory value is to tighten the coupling again; but, if this is done, interference will most probably be experienced as soon as the near-by station resumes transmission.

Instead of tightening the coupling between the coils P and S, the tuning adjustments of all three oscillatory circuits—the aerial circuit, closed oscillatory circuit, and tuned anode circuit—should be carefully varied, and it will be found that the signal strength can be increased practically to the volume obtained with a tighter coupling, whilst the interference from the near-by station will now be reduced to a minimum if not entirely eliminated.

POWER AMPLIFICATION AND SOUND DISTRIBUTION

Readers who heard the loud-speaking outfit at the "Daily Mail" Exhibition will find herein a description of the apparatus used by the Western Electric Co., Ltd.

A FEATURE of considerable interest at the *Daily Mail* Ideal Home Exhibition was the amplifying and distributing of the band music throughout the whole of the Exhibition.

Alongside the bandstand in the North-West corner of the Gallery was placed a small stand. This stand contained the Control Panels and electrical devices for distributing the sound telephonically to projectors placed in various positions throughout the Exhibition.

The system has been primarily designed to aid public speakers, and the introduction as a means of distributing orchestral music at the *Daily Mail* Ideal Home Exhibition was an innovation worthy of note.

We believe that never before in this country has the music of a single orchestra been so successfully distributed over so large an area, and the achievement calls for more than passing attention.

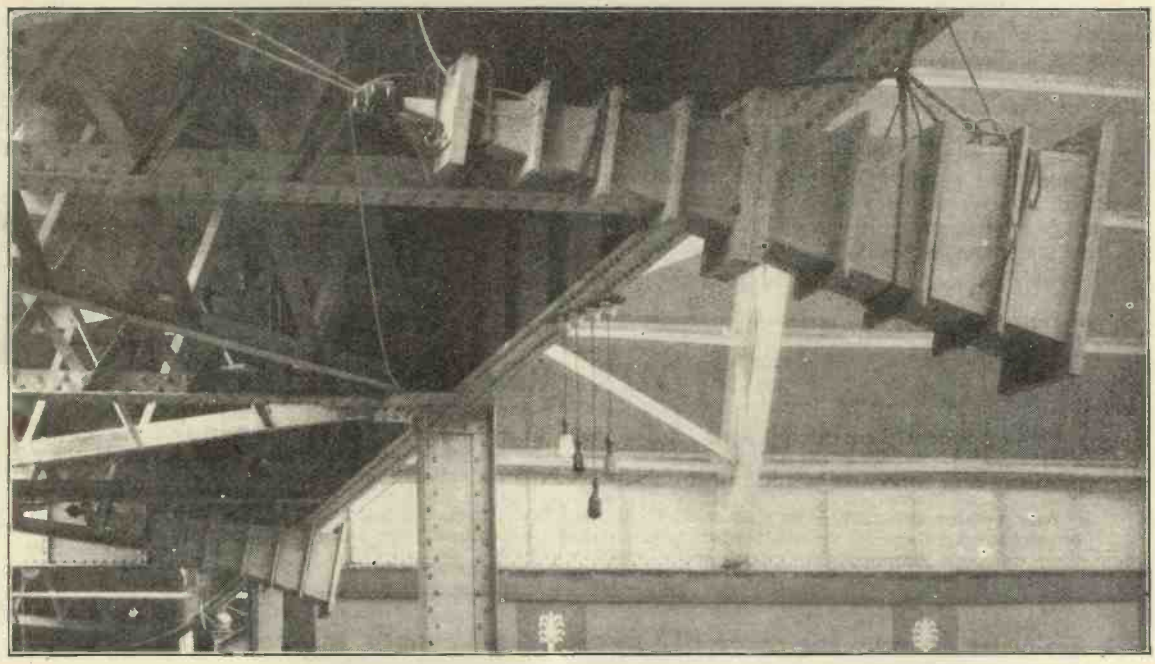
The system consists essentially of three distinct portions—the microphone which picks up the music rendered by the orchestra, the amplifier which magnifies the music current generated by the microphone, and the loud-speaker projectors which throw the required volume of sound over the area to be covered.

The microphone is an exceedingly sensitive instrument which forms the heart of the system. It is mounted on a small bracket in front of the orchestra, and picks up with great faithfulness the sound of every instrument, maintaining the exact *timbre* of each. The microphone itself is designed so that the natural period of vibration of the diaphragm is well above speech and music frequencies, so that resonance of the diaphragm at these frequencies is avoided, resulting in exceptionally pure reproduction of music or speech. The diaphragm actuates two microphone buttons connected in a special way in the input circuit so as to eliminate any distortion of the speech or music currents generated in the buttons by the vibration of the diaphragm.

The microphone is sensitive to speech at distances from three to eight feet from it. It is even more sensitive to music, owing to the fact that music, whether vocal or orchestral, is generally louder than speech, so that the microphone may be placed further away from the source of sound.

The amplifier increases without distortion the very small currents generated in the microphone so as to produce the required volume of sound in the loud-speaking projectors. The amplifier, together with the associated batteries and power board, are usually situated to the rear of the orchestra.

The amplifier consists of four stages of amplification, the first two stages being voltage amplification, the third stage current am-



Two of the loud-speakers installed at the Olympia on the occasion of the "Daily Mail" Exhibition. The design of the horn will be noted as being peculiar to the Western Electric Co., Ltd.

plification, and the final stage power amplification. The power valves in the final stage are connected in a special differential circuit to eliminate any chances of distortion.

The amplifier is constructed in panels, the cabling from the microphones being brought on to one panel which is provided with means of switching to any desired microphone. It also contains telephone apparatus to enable the operator of the amplifier to get into touch with his observers.

Another panel contains the apparatus associated with the first three stages of amplification, that is, two stages of voltage amplification and a stage of current amplification as explained above. It is on this panel that the total output from the system is regulated by means of a potentiometer situated between the first and second stages.

An additional panel contains the necessary measuring instruments, and is provided with plugs and cords so that the current in any part of the system may be measured by plugging the plug into jacks provided on the amplifier panel for this purpose.

The volume indicator is a valve detector device which measures the alternating current power in the system by means of a deflection on a galvanometer, and enables the proper transmission level of the system to be maintained.

The power amplifier receives the output from the first amplifier and increases the power available to such a value as to operate the projectors at the required volume to cover the area served by the projectors.

Finally, there is a control panel provided for adjusting the volume in the individual projectors to the desired value. This also contains keys for cutting in or out of the circuit any desired projector and a master key for switching out all projectors simultaneously.

The arrangement of the projectors for serving the *Daily Mail* Exhibition was as follows :—Four projectors served the Main Hall, these being suspended above and slightly forward of the orchestra. The two central projectors were provided with medium size wooden trumpets, the outer projectors being small fibre horns. The smaller horns were installed in these positions for the reason that the area covered was not great enough to warrant the larger wooden trumpet.

A single fibre horn served the garden and was mounted in the corner nearest the orchestra.

The New Hall was covered by two fibre horns mounted in the centre at one end.

A single projector with fibre horn served the Pillar Hall.

At the Hammersmith Road entrance, and also at the Addison Road entrance, a projector with a small curved horn was fitted, the total volume required in these cases being much less than was the case in the main buildings.

The loud-speaking projectors operate on the principle adopted by the Western Electric Company, Limited, and used by them in their wireless loud-speaking equipments. They are of the balanced armature type, combining great sensitiveness with the ability to handle comparatively large voice currents without distortion.

This system can be used to enable an audience to hear either speech or music from some distant station by introducing a telephone line such as was recently used by H.R.H. the Duke of York when speaking from Buckingham Palace to the Agricultural Hall, or the speaker may face his audience with the microphone in position some few feet in front of him. In the latter case the loud-speaking projectors would be arranged overhead or in such a manner as to produce uniform loudness of sound in any part of the area it is required to cover.

Although very great amplification can be secured it is usually not desirable, as it appears unnatural and displeasing, not due to distortion, but because the ear is not accustomed to so large a volume of speech. This is obvious, if one considers the buzzing of a mosquito which, if magnified to the loudness of a large steam hooter, would probably not be in the least suggestive of the familiar insect. It is the aim, therefore, to adjust the apparatus so that the volume at the required distance is equal to that of the normal voice weakened by an appreciable distance. Used under these conditions the sound is heard perfectly normal, and, in many instances, people have been heard to remark that the apparatus is not working. As soon, however, as the apparatus has been switched off the difference is most surprising.

News of the Week

WE note that further questions have been asked in the House of Commons with regard to Government action, or rather inaction, in the important matter of Imperial Wireless. No doubt "the matter will receive attention in due course," but whilst we are thinking and talking about it, other countries are building stations.

* * *

In certain towns blessed with enterprising local authorities wireless receiving apparatus is being fitted to bandstands in public parks. Visitors to Sefton Park, Liverpool, will no doubt heartily appreciate the two weekly wireless concerts which are to be provided.

* * *

Another example of enterprise will occur at Brighton during the Carnival commencing to-day, one of the special features being the broadcasting of music by means of loud-speakers installed along the entire sea front.

* * *

A wireless receiving set has been presented to the Royal London Ophthalmic Hospital by the Marconi Wireless Telegraph Co., Ltd. We feel sure that the patients, unable to make use of their eyes, will greatly appreciate the thoughtful gift.

* * *

A *useful* American prohibition, which forbids shipping entering American ports to transmit on an 800 metre wavelength, has just been put into force by the American Admiralty. The reason for this is very simple. The 800 metre wave was found to interfere with broadcasting. And in this country public opinion is not yet strong enough to convince some concert artistes that it is to their advantage to broadcast. The time will come, however!

* * *

In this connection the action of many of our daily newspapers in refusing to print the broadcasting programmes as news items will doubtless be remembered. The sequel—the increased sale of the papers which did publish the programmes and the rapid *volte-face* of those which did not—will no doubt also be remembered. Public opinion? Exactly.

* * *

During the course of our recent talk with Mr. Rypinski, the American broadcasting authority, we learned that they now have in America what are termed "service stations" from which anyone may broadcast upon payment of the station fee. At one station the fee is 10 dollars per minute, and large firms broadcast carefully prepared and duly censored "advertising talks." At the price, we do not think there will be many of our "three minute intervals."

* * *

There is a further possibility of our Irish readers being in a position to listen in to their own broadcasting stations in the near future, provided the authorities at Dublin Castle do *not* appoint a committee. We learn that the formation of a company is under consideration by a number of business men in Dublin, who are conferring with the Irish Post Office Authorities.

* * *

Several London clubs are contemplating the installation of wireless receiving sets. Whilst the innovation will be appreciated, it will scarcely serve as an excuse for members who already own sets.

Another photograph of that ever-popular personality, Uncle Arthur (Mr. Burrows), of 2LO.

Apparently broadcasting confers benefits which were not anticipated. According to the Paris correspondent of the *Westminster Gazette*, Dr. Henri Claude, an eminent nerve specialist, when asked if broadcasting might not be responsible for increased symptoms of nervous derangement and imaginary maladies among the general public, stated that, on the contrary, "the loosening of Hertzian waves acts on tired symptoms as antidotes to the wearing effects of civilisation." We hope the Broadcasting Committee do not hear of this!

It is reported that considerable indignation is felt by tenants on the Bellingham housing estate, near Catford, at the action of the L.C.C. in imposing what is regarded as a "tax," though officially termed a "deposit," of £1 on each wireless aerial. We understand, however, that the matter is being reconsidered by the powers-that-be.

* * *

Complaints are still received from various quarters with regard to the interference experienced from spark transmitting stations. Under the present wavelength regulation, it is feared that little can be done at present to alleviate this trouble and the only solution appears to be for the receiving apparatus employed to be made as selective as possible.

We hope to be able to publish a special article dealing with this matter in the near future.

* * *

The uses to which wireless may be put seem more than the imagination can conceive. On the occasion of last week's Derby the greatest compliment to the police traffic arrangements, was the surprise of all users of the roads at the absence of the usual traffic congestion.

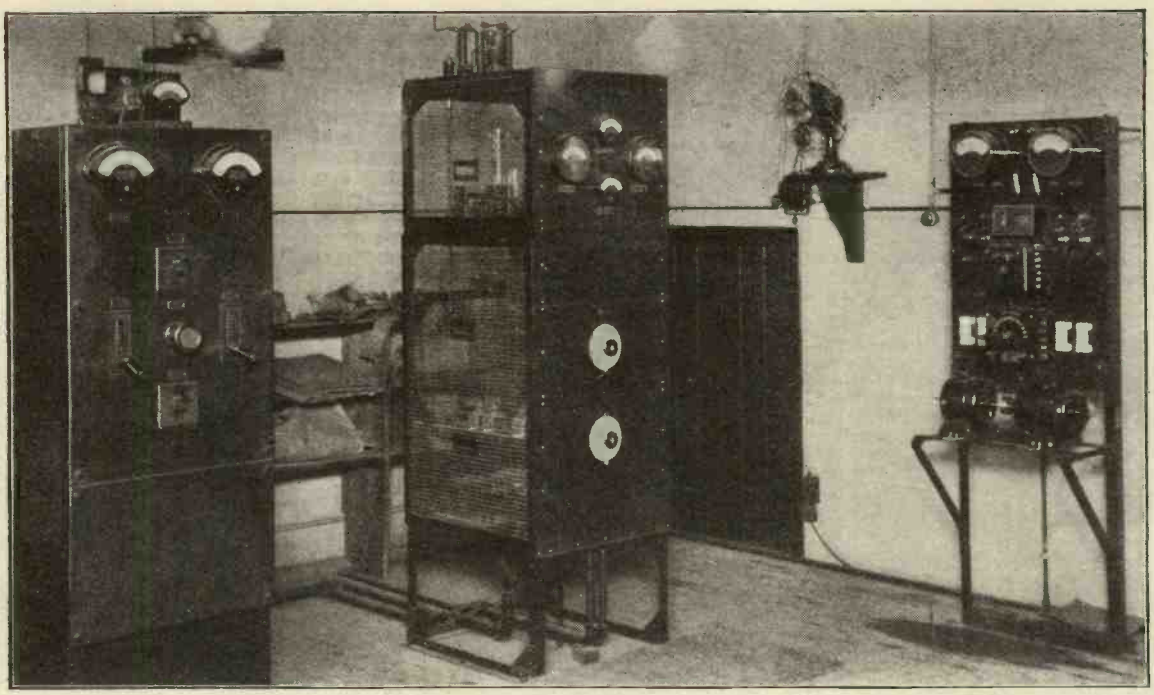
Colonel Lawrie, Assistant Commissioner of Police, established an aerial and motor patrol, linking them by means of wireless telephony with Scotland Yard. By this method information was given of a "block" in any direction and arrangements immediately made to relieve it.

* * *

We are given to understand that miners working some 300ft. below ground in the Dykehead Colliery, Larkhall, Lancashire, have enjoyed the unusual experience of listening to the programmes as transmitted from the Broadcasting station at Glasgow.

* * *

At the meeting of the Broadcasting Committee on 7th June, under the Chairmanship of Major-General Sir Frederick Sykes, evidence was given by Mr. A. A. Campbell Swinton, F.R.S., Past President of the Radio Society of Great Britain, who explained the views of his Society on the broadcasting problem, mainly as it affects experimenters, amateurs and members of Wireless Societies throughout the country.



The transmitting plant at 5 IT (Birmingham).

A new wireless journal, entitled *Radio-Amateurs*, has just been published in Paris. Its readers are asked to state whether they consider that Esperanto, in addition to the national language, should be used by the broadcasting stations on the Continent. This affords an indication of the range of the Continental broadcasting stations. We wish the new journal every success.

* * *

It is anticipated that the new broadcasting station at Aberdeen, the eighth to be installed and operated by the British Broadcasting Co., will be in working order in about five weeks' time.

THE PALLOPHOTOPHONE

The second part of an article, which began in our last issue, dealing with an important American development.

(Continued from No. 9, page 535.)

THIS means that a movement of the diaphragm of only 0.0000005in. or one two-millionth part of an inch, is necessary for the satisfactory reproduction of speech or music. Another remarkable feature in connection with the piece of apparatus is its extremely small moment of inertia. It is of interest to note that the combined weight of the diaphragm, the connecting rod, the steel shaft and the mirror is about nine milligrams, which is equal to approximately one-half the weight of the head of an ordinary pin, or to put it another way, about one-twelfth the weight of the entire pin, and has a natural period of from 4,000 to 5,000 vibrations per second. This piece of apparatus, because of its small mass, comparatively rigid construction, high natural period and freedom to move when acted upon by the sound waves, is capable of responding faithfully to not only the fundamentals and the major oscillations, but also to the numerous harmonics that are necessary to reproduce more perfectly human speech and other complex sound waves.

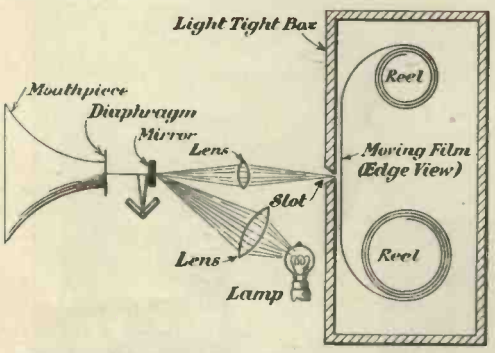


Fig. 3.—Diagram of the elements of the Pallophotophone used for making a permanent record of sound on a moving photographic film.

Another advantage possessed by this device is that its moving parts or vibrating system can be made to meet any requirements of sensitivity desired without interfering with the quality of the reproduction. It can, if necessary, be made to reproduce easily whispered words spoken fifty feet from the instrument or to operate

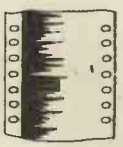
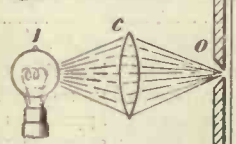


Fig. 3a.

satisfactorily even though sounds of great volume are produced in its immediate vicinity, say, such as playing by a band. Still another feature is the large range over which any one diaphragm will operate successfully. For example, if the sensitivity is such that it can easily pick up a whisper at twenty feet distant, words spoken loudly within a foot of the mouthpiece will be perfectly reproduced.

The photo-electric cell used in connection with this device was recently developed by the General Electric Company, and is extremely sensitive to slight variations of light. Unlike



the selenium cell that is so commonly known, its response to changes of light is practically instantaneous. This is due to the fact that it depends for its action upon electron emission instead of the change in resistance as in the ordinary type, there being absolutely no appreciable lag in its action.

When used as a transmitter or pick-up device, the lamp, lenses, photocell, vibrating device and detector, the diagram of which is shown in Fig. 1, are mounted upon a pedestal, the batteries, rheostats and other controls for the lamp, etc., being located in a separate cabinet, which can be located at some distant point.

The speech or music entering the mouthpiece of the transmitter can readily be reproduced, as before stated, by means of some loud-speaking device, if a suitable amplifying device be used in connection with it, or it can be used to operate the modulating tubes of a broadcasting station. An instrument of this kind is now installed at the General Electric Broadcasting Station, WGY, at Schenectady, N.Y., as part of their regular equipment.

We will now show how the voice or other sounds are recorded upon, and reproduced from, a photographic film by means of the pallophotophone.

If a narrow opening, say about 0.001in. wide, be placed in front of a photographic film, as shown

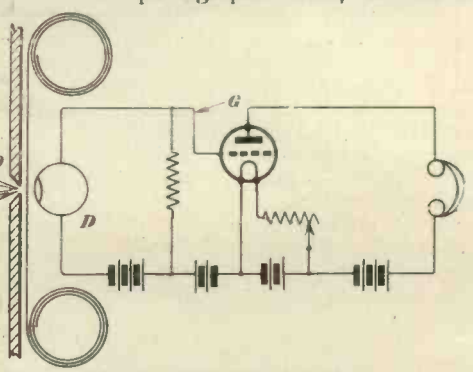


Fig. 4.—Diagram of the Pallophotophone reproducer.

diagrammatically in Fig. 3, and the edge of the light, as represented at K in Fig. 1A, vibrates to and fro along the length of this slot while

the film is running past at a uniform rate of speed, it is obvious that a sort of oscillogram or picture of the vibrations will be recorded upon the film, similar to that shown in Fig. 3A.

After the film has been developed and dried it can be made to reproduce the sounds that were used in making the record in the following manner. Referring to Fig. 4, the narrow opening before described, shown at O, is now placed in front of a sensitive light cell D, and the light of a lamp I located a few inches from this opening is focussed by means of a spherical lens C on to this opening. The film is then made to move past the opening at the same speed at which the record was made. The result is that the variation of light entering the cell, which is governed by the light and dark places on the film, corresponds exactly to the sound waves produced while making the record. In this manner the variation of potential on the grid G is an exact duplicate of that which would have taken place if the change had been produced by the actual voice as is the case when used as a transmitter direct. It might be well to state that comparisons have been made many times between the effects produced by talking directly into the transmitter and a reproduction of the same by means of the film record. This has been done by connecting the apparatus with an amplifier and loud-speaker and then first varying the light by means of the voice direct and immediately producing the same words by means of a record previously made, and it has been impossible for even experts to note any difference between the two.

When this device is used in broadcasting many people have thought that the speech from the record was reproduced by a loud-speaker and then picked up by a microphone in the usual way and thence to the modulating tubes of the radio transmitting station. This, however, is not the case.

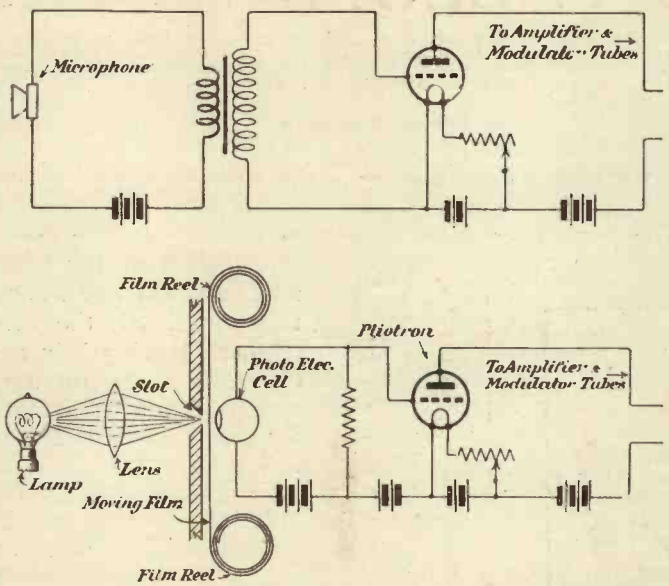


Fig. 5.—The upper diagram shows the well known connections for using the microphone of telephone apparatus for translation of sound vibrations into the form of varying electric currents. The lower diagram shows correspondingly in the Pallophotophone. the light, horizontal slot, film, and photo-electric cell which perform the same function as the combination of the voice and microphone in the familiar telephone apparatus.

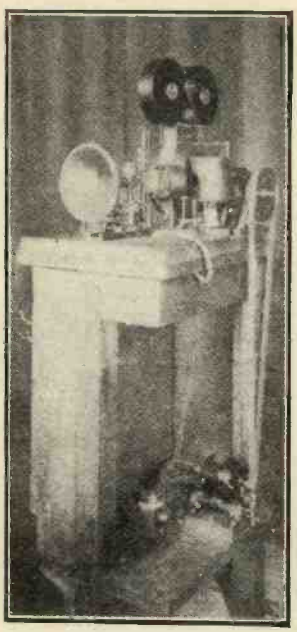


Fig. 6.—Photograph of the complete instrument for recording speech on a moving film.

Reference to Fig. 5 will show clearly how this is accomplished by the pallophotophone. The diagram shown at the top gives a clear idea of how the ordinary microphone is used in connection with broadcasting. The lower diagram in the same figure shows how the variable current from the pallophotophone is made to operate the modulating tubes. In this way it is readily seen that it is not at all necessary to convert the light waves into sound before the speech or music is broadcast, the variation of the light by means of the film serving to produce the electrical vibrations necessary to operate directly the modulating tubes of the radio transmitter.

A lecture was recorded by Dr. William Gates regarding the language of the ancient Mayas, and talks which include the phonetic sounds used in all languages, by Dr. J. P. Harrington, Ethnologist at the Smithsonian Institute. Records made by Vice-President Coolidge and Secretaries Denby and Weeks were broadcast Christmas Eve by the General Electric Company's Broadcasting Station, WGY, at Schenectady, as also was a speech by General Pershing, New Year's night, and later the talk by Dr. Gates giving a brief history of the writings of the Mayas, sometimes called the ancient Egyptians of America. This race inhabited the regions about the Peninsula of Yucatan. At the end of this lecture was recorded a reading by Cipriano Alvarado, a full blooded Kuiche Indian whose ancestors were of this race, and who has been helping Dr. Gates in his study of the Indian tongue. This reading by Cipriano was in his own tongue. Dr. Gates, listening to the radio of this speech and reading by the Indian, claimed that the reproduction was perfect in regard to faithful reproduction of the words spoken in spite of the foreign articulation.

A VERNIER FILAMENT RESISTANCE

By A. DRAKE.

Fine tuning of the modern valve receiver is greatly assisted by the proper control of the filament temperature. How this may be accomplished is described herein.

BELOW are details for constructing a simple Vernier to be used in conjunction with the ordinary rheostat. This provides a method of adjusting the filament to millivolts, consequently ensuring detector

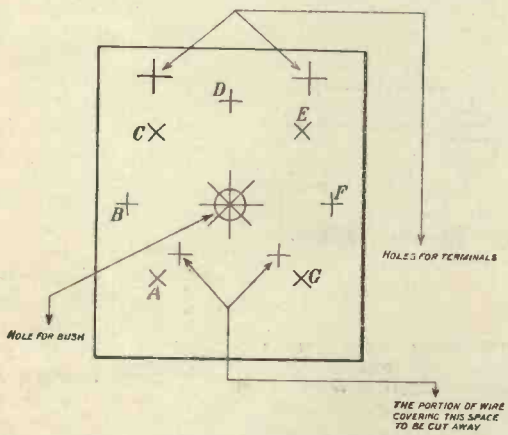


Fig. 1.—Showing the panel markings.

action at its best. Briefly, the following materials are required:—

Ebonite, $4 \times 3\frac{1}{2} \times \frac{1}{4}$in.
Two terminals.
Seven No. 5B.A. brass nuts.
6in. of 5B.A. threaded brass rod.
One laminated switch arm complete with bush and back nuts.
6in. of No. 20 Eureka resistance wire.
3in. of springy brass strip.

The first consideration is the resistance wire. This is bent to form a circle $2\frac{11}{16}$in. diameter, the most convenient method of doing this being to wind a single turn round a cocoa tin and temporarily solder the ends. The exact size is not critical, only bear in mind that the position of the holes A, B, C, D, E, F, G (Fig. 1) is governed by the diameter of the circle.

Take the ebonite, find the centre and describe a circle the diameter of which is exactly equal to the diameter of the ring just made. This is important. Point D (see Fig. 1) should be marked on the circumference, and the points A, B, C, E, F, G equidistant on either side of it. The holes may now be drilled at the points, their size being $\frac{1}{8}$in., cut from the threaded brass rod seven pieces $\frac{1}{2}$in. long, and, placing a piece in each of the seven holes already drilled, lay the ring of resistance wire on the top. Now lightly solder the wire to the centre of each stud, care being taken that the solder does not run on the top surface of the wire, otherwise this will make it noisy and destroy the smooth action; this completed, the wire is cut at A and G (Fig. 1), leaving it in the form of the letter C. Carefully screw on the back nuts until the wire is flat with the surface of the ebonite; if these are screwed too tight, however, they will break away from the wire. Should the experimenter possess B.A. taps, dies, and a little engineering ability, the rotating arm and bush (particulars of which are given in Fig. 2) will present few difficulties to him. A switch arm of the laminated type, complete with bush and back nuts, may be purchased for a shilling or two, and the laminations removed, a piece of springy brass being substituted. The two terminals may now be fitted, connecting the right-hand one to the end of resistance wire, which is at G (Fig. 1),

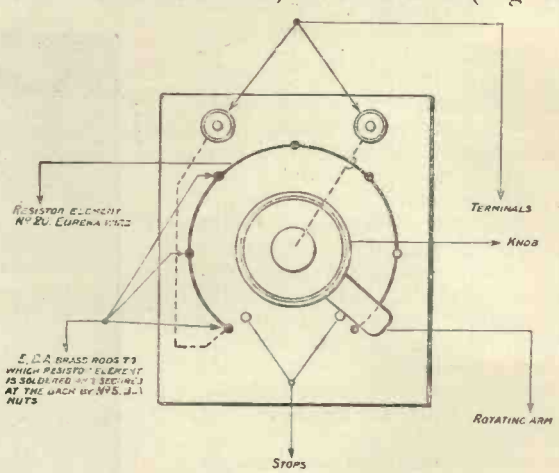


Fig. 2.—Showing the rotating arm.

and the other to the bush of the rotating arm. Two stops are made from the 5B.A. rod, each about $\frac{3}{4}$in. long, their position depending entirely on that of the arm. The instrument is now complete, and should be connected in series with the resistance already in use.

INDOOR AERIALS

By STANLEY G. RATTEE (Staff Editor).

A short treatise on the requirements and design of an efficient indoor aerial.

IN the early days of wireless when the experimenter was dependent upon relatively crude apparatus for the reception of spark signals, the aerial formed one of his chief considerations. The maximum height with minimum screening were facts that called for much thought and deliberation.

One finds to-day a different experimenter, who looks upon the valve as being a *sine quâ non* of wireless, and one which has been with us since wireless began. Because of the easy results obtained with valves he has become careless, and it is remarkable to see with what absence of consideration many experimental aerials are slung.

A train journey to-day reveals not only one but many an aerial which, governed by local conditions, such as a small garden, etc., would have been better designed as an efficient indoor device. No less than in the past, the aerial of to-day should form the subject for some thought, and though valve apparatus is capable of performing many things, in spite of adverse circumstances, with proper aerial conditions its performances are even more wonderful.

In *Wireless Weekly*, No. 9, page 560, a form of aerial known as the "Frame Aerial" was said to resemble an outdoor aerial bent back on itself so as to form a circle. Indoor aerials, on the other hand, may be said to be miniature outdoor aerials with certain special considerations.

The design usually adopted may be made up of either the inverted L or T shapes. A few yards of wire are stretched across the room horizontally and connected to the aerial terminal of the receiver; the earth connection being made in the usual manner.

The position of the aerial is dependent upon local needs, and may be inside a room, along a passage, or even in an attic or loft.

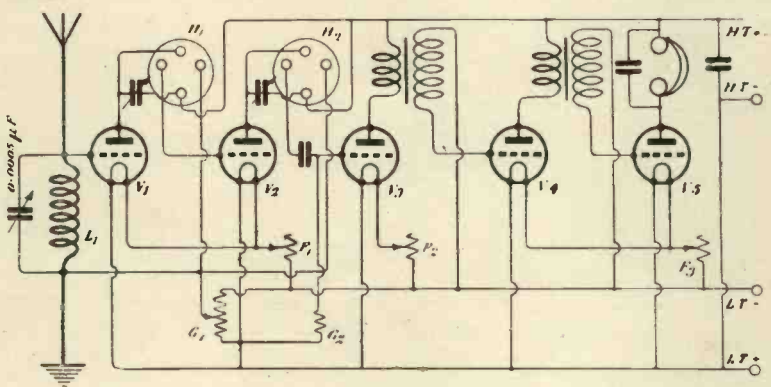


Fig. 1.—A five-valve receiver circuit suitable for use with an indoor aerial. The first two valves are for radio-frequency amplification, the last two being for low-frequency amplification. The inductance L_1 is a plug-in coil, the size of which is governed by the wavelength required.

As with the frame aerial, every precaution should be taken to see that the aerial is fitted in such a position as not to be in close proximity with a network of gas or water pipes, a metal roof, a radiator, or other similar electrical conductor to earth; unless these precautions are taken results will be very far from satisfactory.

The best method of tuning with indoor aerials is much the same as that obtaining with outdoor aerials, but with certain modifications.

It will be admitted that the best method of tuning the aerial circuit is solely by means of inductances, but when the aerial is of the indoor or small "model" type it will be found more satisfactory to connect a variable air condenser in parallel with the inductance, as shown in Fig. 1.

The aerial and earth connections are made across the inductance L_1, and therefore in parallel with the condenser C_1. The inductance L_1 should be as large as is compatible with the wavelength required, whilst the condenser should be of 0.0005 μF. The circuit shown in Fig. 1 is one that will be found suitable for indoor aerial work and consists of two high-frequency valves, detector, and two low-frequency valves.

V_1 and V_2 are the high-frequency valves, whilst H_1 and H_2 are two high-frequency plug-in transformers with 0.002 μF variable condensers connected across them for tuning purposes. The grids of the valves V_1 and V_2 are connected to a potentiometer G_1, which varies the grid potential as required. The filaments of V_1 and V_2 are controlled by the filament rheostat F_1. V_3 is the detecting valve controlled by F_2, whilst G_2 is a fixed resistance of 2 megohms.

V_4 and V_5 are two low-frequency valves controlled by the filament resistance F_3.

The wire used for indoor aerial

work need not necessarily be a wire specially recommended as aerial wire, but any wire such as that used for electric-bell circuits will be found quite suitable.

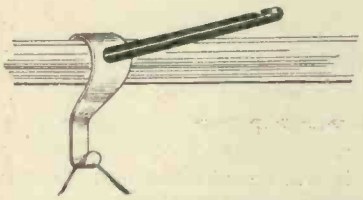


Fig. 2.—The "Ind-Aerial" support.

As a matter of fact, it is possible to use the bell circuits themselves as an indoor aerial, similarly the electric light circuits may be used, subject to proper precautions being taken.

There is a device on the market which permits of this latter arrangement without further bother, though its use and construction are beyond the scope of this article.

The form of indoor aerial adopted is mainly a matter for the experimenter to decide, and the scope afforded in this direction is of tremendous interest.

Of the forms known to the author those shown in Fig. 4 are a few. Of recent date there has appeared on the market an aerial for indoor use known as the Ind-Aerial.

This latter consists of a number of insulated brackets fitted in such

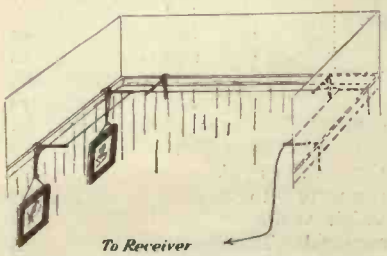


Fig. 3.—Showing use of "Ind-Aerial."

a way as to permit of their being hooked into a picture rail. On the projecting end of the bracket is fitted the aerial wire as shown in Figs. 2 and 3.

Another form of indoor aerial is that of a wire hanging from an upper floor window, weighted at one end and brought into the house through a tube fitted in the woodwork of the upper window as shown in Fig. 5.

Other indoor aerials take the shape of wire drawn up through the chimney; a length of wire taken from the basement to the top of the house along the staircases; mattresses, piano-strings, etc., make indoor aerials, and even "chicken" wire laid beneath the carpet on an upper floor may be used.

The permanent dryness of a house does everything to make the insulation of the indoor aerial a simple business, and experimenters

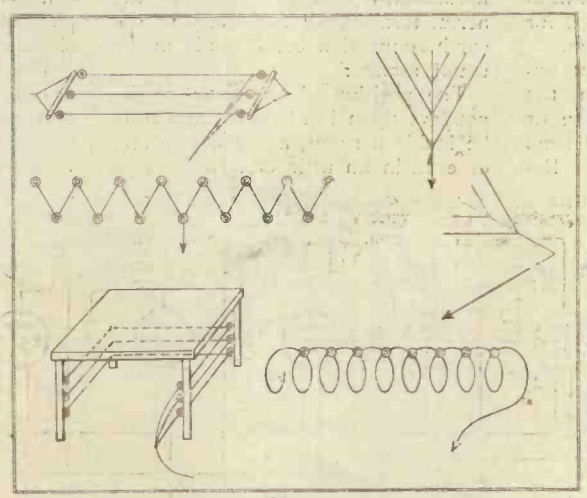


Fig. 4.—Suggestions for indoor aerials.

should experience no difficulty in this direction.

An aerial which, though not an indoor aerial, may still be used by those who are unable to erect a satisfactory outside arrangement is illustrated in Fig. 6. Here, an insulator is fixed to the end of a pole which is in turn fitted to the wall of the house at the top window. A similar pole with an insulator fitted in a like manner is arranged at the ground floor window. The aerial wire is drawn between the two insulators, the lead-in being taken from any convenient point.

The amount of experimental interest to be derived along these lines is very considerable, and where the experimenter is so inclined these aerials offer unlimited scope in their arrangement.

The type of apparatus used for the purpose of reception may be left to the choice of the experimenter, for whether crystal or valve is used,

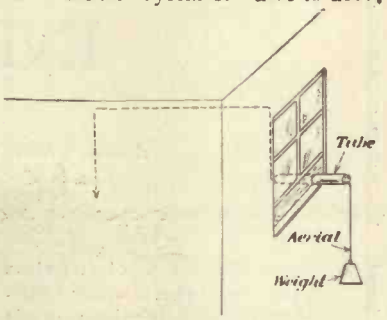


Fig. 5.—A partial indoor aerial.

subject to the aerial being of good design, average signals are obtainable with either. For loud-speaker signals one or two stages of amplification are needed as a rule, in addition to the apparatus generally used with a good outside aerial. Occasionally very noticeable interference is experienced when using two or three stages of low-frequency amplification, due to induction from the house electric-lighting installation. Particularly is this the case when the supply is alternating current.

Should this difficulty be encountered by experimenters it may usually be reduced to a minimum, if not entirely eliminated,

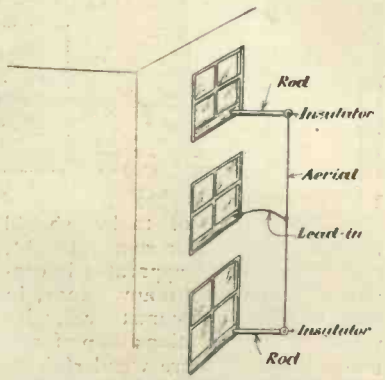
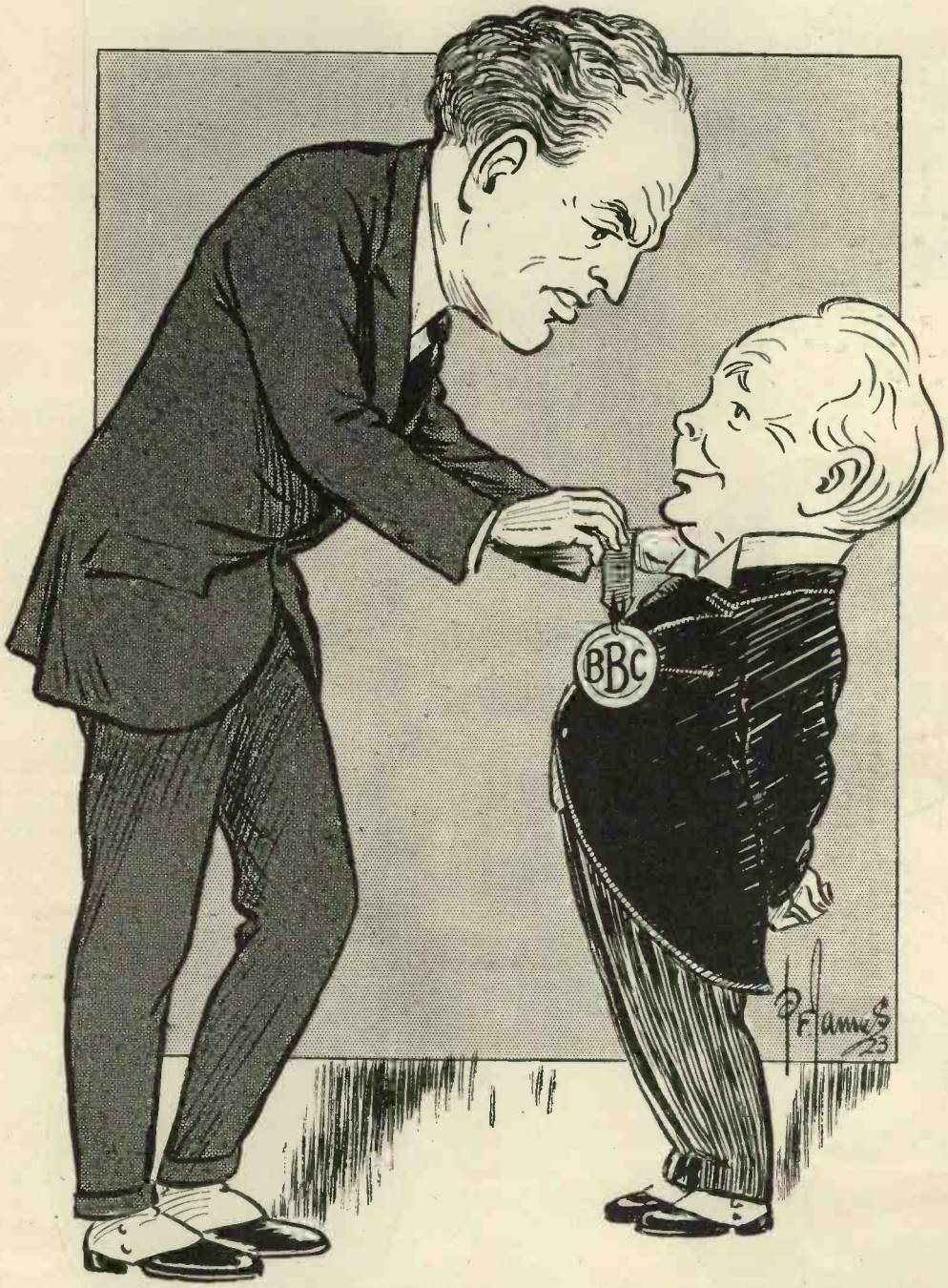


Fig. 6.—An alternative when an ordinary outside aerial cannot be erected.

by introducing into the circuit a high-frequency valve preceding a crystal detector in the usual manner.

EVENTS WE NEVER EXPECT TO WITNESS

No. 2.



The General Manager (Mr. J. C. W. Reith) of the British Broadcasting Co. stamps Sir Wm. Joynson-Hicks with the Order of the B.B.C., as a mark of affection and esteem on his promotion from the Post Office to the Treasury.

Field-Marshal Sir William Robertson, Bt.: G.C.B., G.C.M.G., K.C.V.O., D.S.O.

Mr. Charles Trevelyan.

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Sir Henry Noel Bunbury, K.C.B.—Comptroller and Accountant-General of the Post Office since 1920. Accountant-General, Ministry of Shipping, 1917.

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F. J. Brown, M.A., B.Sc., C.B., C.B.E.—Assistant Secretary G.P.O., in charge of Telegraph Branch. Representative of P.O. on Imperial Communications Committee. Technical Adviser on cable questions at Peace Conference at Paris, 1919. Member of Imperial Wireless Telegraphy Committee, 1920. Senior British Delegate at Conference on Reconstruction of European Communications, Paris, 1920, and at Conference of Principal Allied and Associated Powers on Electrical Communications, Washington, 1920. Technical Adviser on Communications at Arms Conference, Washington, 1921-22.

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Field-Marshal Sir William Robertson, Bt., G.C.B., G.C.M.G., K.C.V.O., D.S.O.—Very extensive and distinguished military record, with many decorations. Assistant Director Military Operations, War Office, 1901-7. Director of Military Training, War Office, 1913-14. Q.M.G., B.E.F., 1914. Chief of Imperial General Staff, 1915-1918. C.-in-C. British Army on the Rhine, 1919-20.

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Major the Hon. J. J. Astor, M.P.—Youngest son of the first Viscount Astor. A.D.C. to Viceroy of India, 1911-14.

J. C. W. Reith.—General Manager, British Broadcasting Co., Ltd.

Mr. F. J. Brown, M.A., B.Sc., C.B., C.B.E.

Major the Hon. J. J. Astor, M.P.

Prof. W. H. Eccles, D.Sc., F.R.S.

AERIAL RIGGING AND MAST BUILDING

By F. H. PHILPOTT.

A further article dealing with mast erection.

PART III.—(Continued from No. 9, page 565.)

TO run the guys from the coil, attach one end to the peg, leaving a foot or so to spare, pay out as previously explained, and cut off at the point of attachment to the mast. Leave plenty of spare, as it is easier to cut a piece off than to put it on! Also a long end does not tear the clothes so easily as a short one. The actual method of attaching the guys to the pegs is left to the reader, and it is unnecessary to point out that they should be secure. A good way of attaching a home-made strainer to each guy is shown in Fig. 9. It should be rather farther away from the pegs than is shown in the illustration. The strainers should be attached to the guys at different distances from the pegs, as is shown in Fig. 9. This form of strainer is very convenient and costs practically nothing.

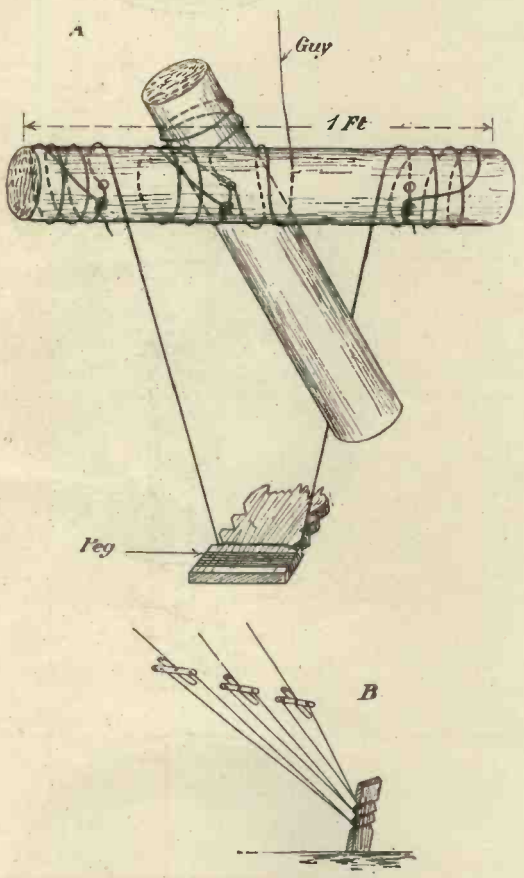


Fig. 9.—A suggestion for home-made strainers.

Presuming you have fixed guys 3 and 4, now measure the No. 1 guys to the same length as the others, and, passing them *under* the other guys, attach them to peg No. 1, spreading them over the ground as shown in Fig. 6.

There now remain the No. 2 guys. These are to be used for hauling up the mast into position. Get your ladder and lay it on the ground at right angles to your mast, and with the foot striding the "back-stop." It will then be lying over one of the side pegs, say No. 3, as shown in Fig. 10A.

Now attach your remaining guys to the rung of the ladder nearest the peg over which it lies. Having done this, fix your halyard, passing it under all the guys and fastening the lower end to the pole.

If, after erecting the mast, you find that your halyard is not clear of the guys, but is under one and over the other, it is not impossible to rectify it, but it is tedious for the reason that, looking upwards with the sky as a background, it is difficult to see whether the halyard is "under" or "over," and twisting or untwisting to find out is liable to make matters worse. The golden rule is—make sure of everything with the mast on the ground.

Now attach your borrowed rope to the ladder, as near the top as is practicable, to obtain extra leverage in hauling up. Then stand the ladder up as shown in Fig. 10. If there is any danger of the ladder toppling over sideways, or if you are using a pole, or board, instead of the ladder, you should temporarily fix light stays or guys to the side pegs. This, however, will be obvious when you come to erect. Now you are ready to haul up. It is advisable to give your rope a twist round your No. 2 peg, to hold the ladder in position, and then stroll round your pegs and mast to see that everything is safe, paying particular attention to the security of

No. 1 guys, and that you have *not forgotten your halyard.* If everything is correct and you are a fairly heavy man, you should now, by hauling on the rope, be able to pull up the mast yourself, but if you can call upon assistance you are recommended to do so at this point. The writer has managed this job by fixing the ladder with a slope towards No. 2 peg, securely fixing the rope on this peg, climbing the ladder, throwing over his weight, and hauling on the rope, with a turn round one of the rungs. I was, of course, on the side of the ladder farthest from the mast, so that I stepped from the ladder when near enough to the ground. It is not necessary to be an acrobat to perform this feat, and it is interesting to watch the expression of a listener when informing him that the mast was erected entirely by one man.

Having got the mast more or less vertical, the No. 2 guys should "arrive" very close to their own peg. Swing the ladder to one side of the peg and sit astride it (the only safe way). Then detach the *middle* guy from the ladder, and attach to the peg. Then the top one, and afterwards the bottom.

It may be here stated that if the mast has at any time to be supported by one guy only, the middle one is the one for the job, provided your sockets are good. If the sockets are weak, one guy is never enough.

Your mast is now up, and if it is not exactly vertical the procedure is obvious.

To pull it straight, slack off one guy before pulling on its opposite.

Do not trust your eye looking up at the mast, especially if there are moving clouds. In the latter case, you will find yourself continually jumping aside under the impression that the mast is falling.

To get a true idea of the vertical, get some building as a background, and, standing some distance away, align the mast against a corner of the house, or courses of bricks. Trees as a background, or even telegraph poles, will throw you out hopelessly.

An assistant watching the mast and guiding, while "the foreman" adjusts the guys, is the easiest and quickest way of getting it true.

If you obtained assistants in hauling up the mast, they could help you best, not by hauling on the rope, but by lifting the tip of the mast and walking towards the base, pushing upwards all the time.

When the mast is about a quarter of the way up, one man can then manage easily; but your assistant should *stand well clear from the mast.*

They can, however, help by keeping your No. 1 guys from fouling themselves or any other obstruction. One guy catching a tuft of grass will be sufficient to prevent you from hauling any farther, in which case—if you

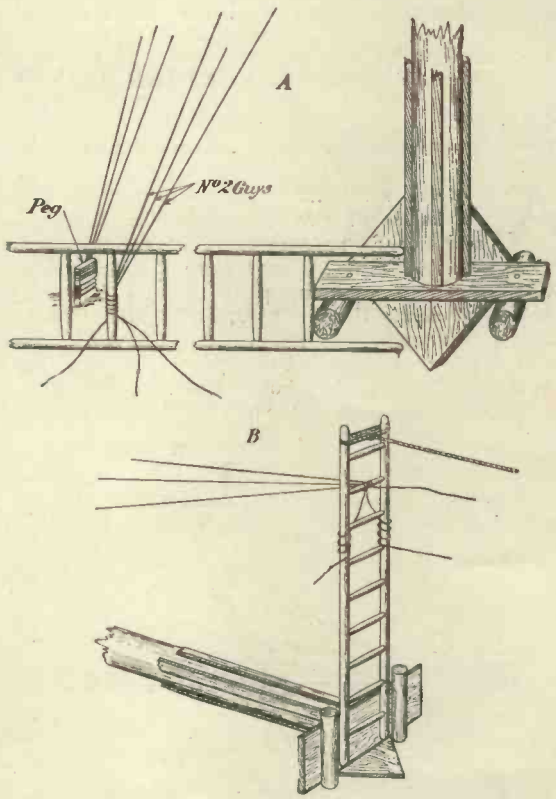


Fig. 10.—Showing method adopted for hauling up the mast by means of a ladder.

are alone—don't lower the mast, but secure your rope to No. 2 peg with the mast where it is, and clear the obstruction. You may find it necessary to do this more than once.

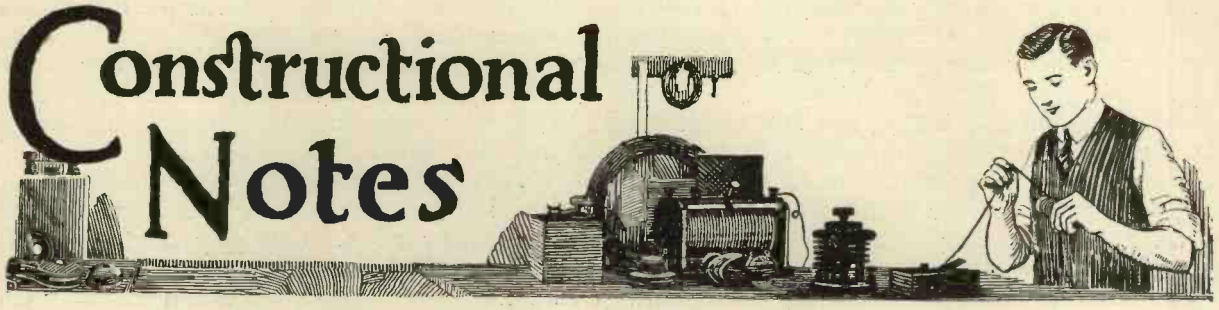
It is probably unnecessary to mention that the strain on No. 2 peg supporting the mast a short way up is considerable.

It is advisable not to walk *under* the mast.

Having made all square, and *not* having forgotten your halyard, you are now ready to haul up your aerial.

(To be continued.)

Constructional Notes



A NOVEL VERNIER CONDENSER.

A VERY serviceable vernier condenser of simple design and neat appearance is made up as follows: A fixed plate A (Fig. 1) and a moving plate B, each 2½in. across the diameter, are shaped and drilled as shown, the two small holes in each being provided respectively for bolts and screws, the other hole in the moving plate being made large enough to slip over a piece of 2B.A. screwed rod. This rod should be about 2in. long and the moving plate is soldered to this in a mid-way position as shown at X, diagram E. The plates may consist of thin sheet brass, copper, or tin-plate, and the small holes should be well countersunk to take the heads of the screws and bolts. A wooden disc D, 2¾in. in diameter by ¼in. in thickness, is drilled through the centre and recessed to take the soldered joint of the moving plate, as shown in the sectional diagram. This plate is now screwed to the underside of the wooden disc, great care being taken to see that the screwheads are quite flush. If desired a nut may be attached to the end of the spindle at the other side of the disc, but in most cases this will not be necessary. An anti-capacity handle is attached to the edge of the disc in the usual way. The panel is now drilled to take the spindle. The fixed plate is placed in position over this hole, and using this as a template the two bolt holes are marked off and drilled. The heads of these bolts should also be countersunk so that they are flush with the surface of the plate, which may now be bolted in position. A disc of very thin mica C slightly larger than the diameter of the wooden disc, is now placed over the plate and secured to same by means of some thick shellac varnish which should be allowed to set hard before attempting to assemble the instrument, the general arrangement of which should now be clearly understood. A small cardboard washer F prevents the under side of the top plate from rubbing too hard against the mica disc. The efficiency of the instrument will depend on the thickness of this washer and the thickness of the mica dielectric. Both should be as thin as possible. It is a good plan to round off all the edges of the plates with a smooth file. The connections are made one from the locknut attached to the end of the spindle and the other from one of the bolts holding down the fixed plate. If desired an ordinary ebonite knob and dial may be arranged to replace the wooden disc and handle.

O. J. R.

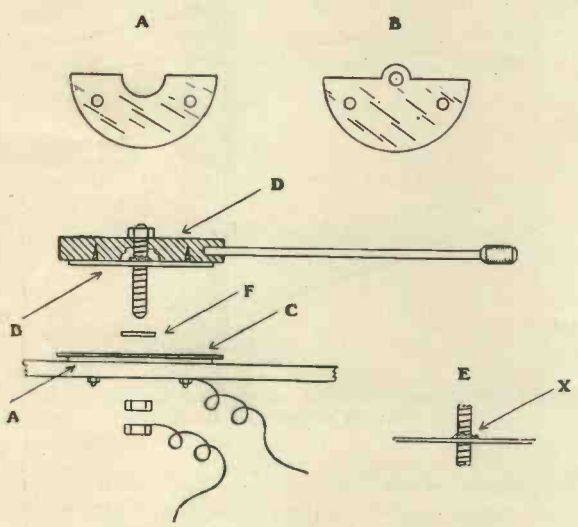


Fig. 1.—Showing parts for making Vernier condenser.

A NEW USE FOR CLOCK DIALS.

THE accompanying illustration does not, as one might imagine, represent a new design in straw hats. There is nothing with which we are more familiar than the ordinary everyday clock face, yet if we removed the figures and drew lines from each minute mark to the centre, most of us would be at a loss to know just what is represented and of what earthly use it was. No doubt it would appeal to some as a rather unique design for clock socks, but the true radio enthusiast will at once see a means of applying it to a more practical use. Here is a template consisting of a disc of paper marked off into 60 equal sections from an old clock dial in the manner indicated above, and pasted on a sheet of thin tin-plate which is afterwards cut to any desired shape. Circles of various diameters are marked on the disc and

small holes are pierced at the points where the straight lines cut the circumference. This is done by means of a sharp bradawl, and at the same time a small hole is also pierced through the true centre. We will assume that a quantity of basket coils or honeycomb coils are to be made, the hub or former being 1½in. in diameter and fitted with 15 pins. The usual method of marking off the 15 equal sections is to cut out a strip of paper just long enough to go round the periphery of the former and mark this off in a more or less haphazard way. By placing the template face uppermost on the table and by holding the former securely over the circle which most nearly corresponds to its size, the pins are pushed in, one at every fourth division, in a very short time. Being 60 sections, $\frac{60}{4}=15$.

Similarly, if ten equal parts are required we divide 10 into 60 and get 6 sections, *i.e.*, we mark off

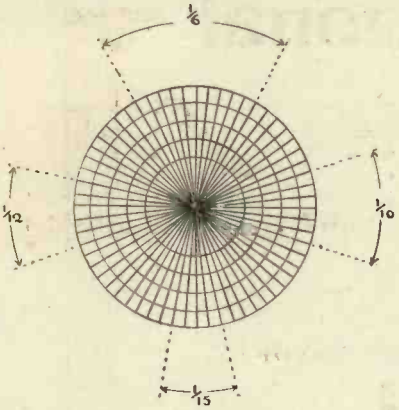


Fig. 2.

the former at every sixth section, and, again, if we require 30 equal parts we mark off at every second division. Providing the required number of divisions will divide equally into 60 the template may be relied upon to do the necessary calibrating which is otherwise such a tedious operation. When using the flat cardboard discs for the basket coil formers the template is placed on the cardboard and the required number of divisions are marked off with a bradawl, not forgetting the centre hole as it will be necessary to mark lines from this to the bradawl impressions to act as a guide when cutting the slots. A dial taken from a superannuated alarm clock is most suitable, and if this is not readily available it can be obtained for a very modest sum (and often for the asking) from almost any watch and clock jobber's establishment.

O. J. R.

A USEFUL TUNED-ANODE UNIT.

A TUNED anode unit which can be attached to almost any type of single-valve set can be made up at very small cost indeed, and no great skill is called for, since the highest flight that the constructor will have to take is no more than the drilling of 4 B.A. and ⅜in. holes in an ebonite panel. Connections should preferably be

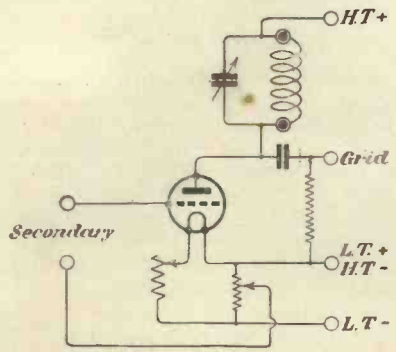


Fig. 3.—The circuit of the unit.

soldered, but if any enthusiast who desires to make up this unit is no expert with the soldering iron he can attach all his leads to terminals and valve legs by means of nuts and washers. The materials needed and their approximate cost are as follows:—

	s.	d.
Ebonite panel 9½in. × 5in. × ¼in.	2	6
Four valve legs		6
Eight terminals	1	0
Rheostat	2	6
Potentiometer (ex-Army) ...	4	6
Part of ·0002 μF variable condenser	2	6
	13	6

All of these small parts are easily obtainable from any wireless dealer, as may be seen from a perusal of the advertisement columns of this journal.

The addition of such a unit to a single valver will roughly treble the range of the set.

Fig. 3 shows the circuit, and Fig. 4 gives a wiring diagram of the panel. The panel is first laid out as shown in Fig. 5. A line running down the middle is ruled with the scriber (do not use a lead pencil which makes high-resistance leaks all over the ebonite); then two others ½in. from each of the long sides. Once these guide lines have been made the rest of the process is easy. The positions of the holes for the valve legs may be found by running a little candle wax on to the panel and pressing the pins of a valve on to it.

The measurements for the holes to take the supporting rods of the condenser are not given, since these will vary a little with different makes of parts. They can be marked out quite easily by using one of the fixed plates as a template. The potentiometer again may be one of several types, but

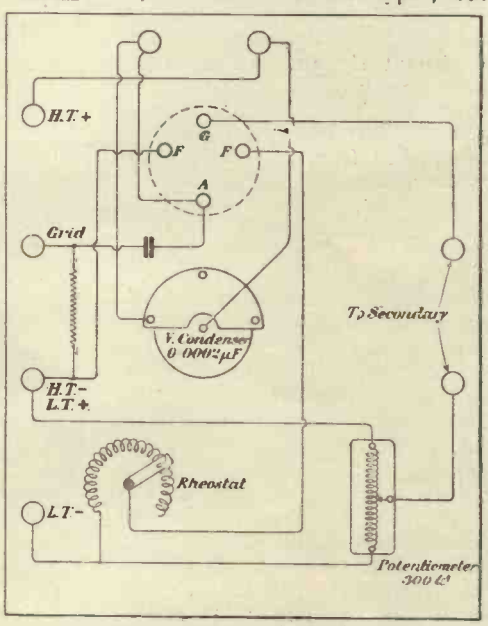


Fig. 4.—Showing back of panel.

as it stands on the upper side of the panel there will be no difficulty in finding the proper positions for the bolts which fix it in place.

Connections may be made with fairly stout copper wire, say, No. 18 gauge passed through lengths of systoflex insulating sleeving. A better method is to use stiff bare wire and to make the connections by the bridging method, bending the wires into shape on a right-angled wooden former.

The valve used on this panel should be as hard as possible. A Mullard ORA will be found perfectly satisfactory.

Those experimenters who wish to increase the range of their sets for the reception of telephony from Continental stations or far distant broadcasting stations will find that this unit will give them extra distance range at very little cost.

R. W. H.

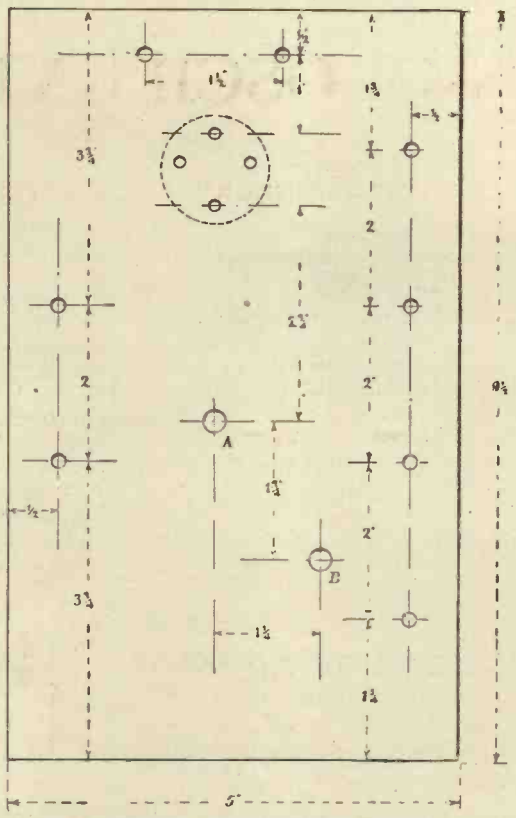


Fig. 5.—Markings and dimensions of panel.

EXTENSION HANDLES FOR CONDENSERS.

WHEN one is engaged in performing the fine tuning that is sometimes necessary in order to bring in the faint sounds of distant signals, the effects of body capacity are apt to be a great nuisance. The tuning is accomplished at last, but directly the hand is removed from the knob of secondary, reaction or anode condenser, either the signals vanish or the set begins to howl. One way of doing away with this nuisance was described in these columns a short time ago; it consists in covering the underside of the top ebonite plate of each condenser with tinfoil and connecting this to earth. This method, however, cannot be used with made-up condensers unless one has the time and the patience to take them to pieces and fit them together again. A simpler way is to fit long extension handles which enable tuning to be done without the hands being brought so near the condensers that its effects are noticeable.

Fig. 6 shows one of the most convenient types of handle. It consists of a 6in. length of $\frac{3}{8}$in. round ebonite rod, in one end of which a 4B.A. hole $\frac{1}{2}$in. deep is drilled and tapped. A similar hole is made in the edge of the con-

Fig. 6.—A simple form of extension handle.

denser knob. A 11in. piece of 4B.A. screwed rod (this is obtainable in 12in. lengths from any of the shops that deal in small parts at about 4d. a piece) is then inserted into the handle and screwed tightly home. The extension handle can then be attached when necessary or detached in a moment when not needed.

Fig. 7 shows another method

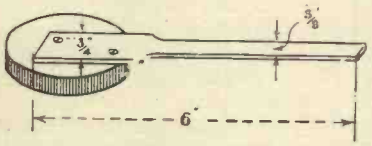


Fig. 7.—An alternative arrangement.

which is equally effective and does not require the use of ebonite rod. The handle, shaped as shown, can be cut from a piece of $\frac{1}{4}$in. ebonite, or, if this material is not available, fibre or even hard wood will do perfectly well. Whatever material is used its edges should be rounded off to make a neat job, fine emery cloth being used for ebonite or fibre and glass-paper for wood.

It sometimes pays to fit these long handles not only to condensers but also to two- or three-coil holders and to variometers. Flat handles of the type last described can, if

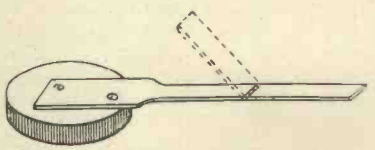


Fig. 8.—A device with folding handle.

desired, be fitted with a small hinge in the middle, so that they may be folded up and reduced to half their length if the apparatus to which they are fixed is being used on a crowded table which does not allow much room for their swing.

R. W. H.

AN ACCUMULATOR TIP.

The usual treatment of a long slow charge for a sulphated accumulator can be materially increased in effectiveness by dropping a pinch of Glauber's Salt into each cell. After charging, wash the accumulator out with distilled water to remove the sludge of detached sulphate, refill with *fresh* acid, and give a further short charge.

G. P. K.

ELECTRONIC OSCILLATORS

By J. H. T. ROBERTS, D.Sc., F.Inst.P., Staff Editor (Physics).

PART VI.—ELECTRICAL THEORY OF MATTER

IT is probably fairly well known that a large range of ether vibrations have now been investigated, and that the wireless waves used in radio-communication are of the same nature as heat-rays, light-rays, ultra-violet-rays, X-rays, and the gamma-rays from radioactive substances. These various kinds of rays differ one from another principally in the matter of wavelength; such differences of wavelength, however, give rise to a great diversity of properties in the various kinds of rays.

The long wireless waves are hardly absorbed by matter, whilst the short wireless waves may be considerably absorbed; heat waves, generally speaking, are absorbed still more; the same inability to penetrate matter continues until the wavelength becomes extremely short and we approach the X-ray region, when the waves again acquire the property of passing through material substances, though not to so great an extent as in the case of the wireless waves. The gamma-rays from radioactive substances are of still shorter wavelength than the X-rays, and of still greater penetrating power.

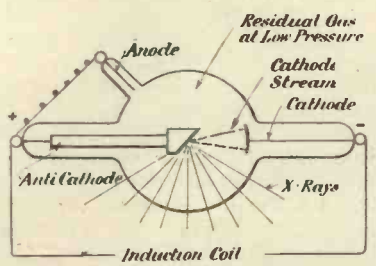


Fig. 1.—X-ray tube depending upon ionisation-by-collision in residual gas.

It will be interesting to consider the mode of production of these various kinds of rays. Wireless waves are, of course, produced by the to-and-fro surge of electrons in circuital oscillators, and their frequency can readily be controlled by the manipulation of the circuit. As we descend in the scale of frequency, however, and come to the long heat rays, we find that these are produced by the motions of atomic systems, the rapidity of the motions depending upon the temperature of the heated substance which is emitting the rays. From this point downwards in the scale of frequency, all other ether radiations are considered to be due to the vibrations of the electrical elements within atomic systems (as distinct from the motions of an atomic system as a whole).

X-rays are produced when electrons, moving with a sufficiently high velocity, strike against a material substance. The usual method of producing X-rays is by means of an X-ray tube, such as is illustrated in Fig. 1. This consists essentially of an almost evacuated discharge-tube, provided with two electrodes, across which a high-tension discharge may be passed by means of an induction coil, or other suitable source of high potential. When the current is passing, there is ionisation-by-collision taking place in the residual gas in the tube, and a stream of electrons proceeds from the cathode and strikes the anode (or the "anti-cathode," as it is more generally called); the latter is usually made of a block of tungsten. The impact of the cathode rays upon the anti-cathode causes a sudden stoppage of the electrons and considerable disturbances of the electronic systems of the atoms composing the anti-cathode. From both these causes X-rays proceed from the anti-cathode, the X-rays due to the vibrations set up in the electronic systems of the atoms being known as "characteristic" radiations and depending upon the nature of the material which forms the anti-cathode. The radiation which is produced by the stoppage of the cathode rays consists of an indiscriminate mixture of various frequencies, and by analogy with white light, which also consists of a mixture of different colours or frequencies, is known as "white" radiation. More will be said about the actual production of the rays presently.

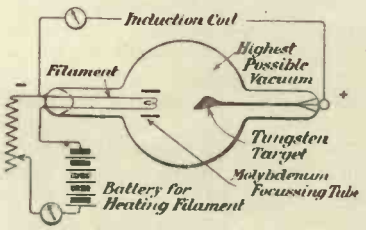


Fig. 2.—Coolidge tube depending upon thermionic emission from filament.

The older forms of X-ray tube such as that illustrated in Fig. 1, in which the current is carried by means of the residual gas, were found to be somewhat unreliable in action, and were incapable of transmitting more than a comparatively small current, with the consequent limitation of the X-ray output. Of recent years an entirely new principle has been applied to X-ray tubes by Coolidge, the tube being known after its inventor as the Coolidge X-ray tube. It will be seen, from what has been said above, that what is required for the production of X-rays is a stream of high-speed electrons impinging upon a material substance. Coolidge employed the thermionic emission from a heated filament as the source of his electron stream, and was therefore able to use a tube in which the vacuum was the very highest attainable (Fig. 2). Since the electrons are independently produced by the heated filament, there is no necessity to have any residual gas in the tube to carry the current, and thus practically all the unreliability of the older gas tubes is overcome.

It will be noticed that the Coolidge X-ray tube is, in a sense, a magnified two-electrode wireless valve, with a very high plate-potential.

When the electrons strike the anti-cathode they have fallen through a potential difference of, perhaps, 20,000 to 100,000 volts, and consequently are moving with a very high velocity. Their impact with the atoms of the anti-cathode causes violent disturbances in the electron systems, some of the electrons being displaced from their orbits. It has already been explained that the construction of the atom includes outer rings of electrons, comparatively loosely held, and electrons in association with the protons in the nucleus, the latter electrons being much more tenaciously held—that is, being more difficult to disturb or dislodge. The outer electrons are the ones which account in the ordinary way for valence and ionisation. When the cathode rays strike into the electron system, some of the electrons belonging to these systems may be permanently ejected, resulting in "ionisation" of the atoms. In addition, some, without being completely dislodged, are displaced into new orbits from which they are able, after a short interval of time, to return to their original orbits. This return is accompanied by the emission of energy. The inner electrons are more closely bound by the nucleus, and consequently the restoring forces called into play when they are disturbed are large and the frequencies of the resulting vibrations are high. This will be understood by considering a mechanical vibratory system. It is well known that if such a system be displaced from its equilibrium position and then allowed to go free, it will oscillate about its mean position, the frequency depending upon the inertia of the system and the forces which are called into play by a displacement of unit amount: the greater the latter, other things being equal, the higher will be the frequency.

In the case of X-rays, the frequency may be ten thousand times that of visible light, the latter being produced by the motions of electrons further from the nucleus. Again, it is found that when the nuclear electron system is disturbed by the ejection of a beta particle, as in the case of a radioactive atom, even higher frequencies are produced. The rays emitted under these circumstances are the "gamma-rays," and they may have frequencies from ten to a hundred times those of the X-rays. Now, in connection with the vibrations of these "electronic oscillators," as we may call the electron systems of the atoms, there is evidence of very remarkable behaviour, in that they apparently emit energy only in definite quantities. Let us consider for a moment any ordinary mechanical oscillatory system, such as a pendulum vibrating under the action of gravity. If the pendulum is gradually displaced from its zero position, energy is gradually stored up in it; the further it is displaced from its mean position, the greater the potential energy. When the pendulum is released, its potential energy is gradually transformed into kinetic energy, and apparently the transformation takes place continuously and energy is dissipated (by friction with the air, etc.) in a continuous manner. Thus both the absorption and the emission of the energy are conceived as continuous phenomena, just as though there were a flow of an infinitely divisible fluid.

Fig. 3.—The passage of X-rays through humid gas. Electrons are ejected from the gas molecules and produce ionisation trails, which are rendered visible by the condensation of water-vapour upon the ions. (Reproduced from memoir by C. T. R. Wilson.)

A simple example, to illustrate the conception of energy being emitted or expended in definite quantities, is that of the workman who is paid by the hour, the day, or the week; the employer is obliged to think of the work done in units, and to estimate the value of such units at a definite price, the latter being also expressible in definite units such as pounds, shillings, and pence or other currency. In the case of the electronic oscillators, as has already been mentioned, there is evidence that they emit energy, not continuously, but in small quantities, or, as we may say, continu*ally* but not continu*ously*. The value of the units in which the energy is emitted depends upon the frequency of the oscillation. The question naturally arises as to whether the *absorption* of energy by such electron systems takes place continuously or discontinuously: on this point evidence is at present lacking. One view is that the electronic systems absorb energy continuously and emit it discontinuously: this has been likened to the taxation of the citizens of a country and the resulting operation of battleships of the navy, the latter representing the expenditure, at each occasion, of the accumulated result of a large number of small individual efforts. This example is not a particularly apt one, however; to represent the case more properly, the contributions ought to be infinite in number and infinitesimal in amount.

According to a present view, electrons may vibrate in orbits without loss of energy to surrounding systems. This view is in some ways incompatible with the belief in an ether-medium, for, if the surrounding medium absorbs energy, it is difficult to conceive why it should not do so *continuously*. When a change takes place in the orbital motion of an electron, then a "quantum" of energy is emitted; this travels away from the system with the velocity of light. This quantum, as stated above, has a value which depends upon the frequency of the vibrations: its value is numerically equal to the frequency multiplied by a number known as "Planck's constant," so called after the discoverer of the phenomenon, and the originator of what is now called the "quantum theory of energy." For any particular type of atomic system, there are a fairly large number of possible orbits for the planetary electrons, and whenever an electron passes from one orbit to another, radiation of energy occurs.

Just as X-rays may be produced

when violent disturbances of the electron systems of atoms are produced by the collision of high-speed electrons, so these rays may act upon other atoms, ejecting electrons and disturbing the orbital motions of the inner rings. Thus when a substance is exposed to X-rays two different effects are generally produced: (1) some of the atoms are deprived of planetary electrons—that is to say, they are "ionised" (see Fig. 3); and (2) orbital changes take place, corresponding to those occurring in the atoms of the anti-cathode by which the rays were produced.

It will be evident that the latter disturbances will result in the radiation of energy, and since the substance is receiving energy and radiating energy in consequence, the radiated energy is spoken of as "re-radiation," or "secondary rays." The re-radiation will include some rays which are the same in nature as the incident rays, and some which are characteristic of the re-radiating substance: the former are said to be "scattered."

A little consideration will show that it is impossible for a substance to reflect X-rays in the same manner as light-rays or heat-rays. Regular reflection of waves by a surface is only possible when the surface is "smooth" to the waves, the definition of "smoothness" being that the irregularities of the surface are small compared with the wavelength of the incident waves. Now, the wavelength of X-rays is about half the diameter of a diatomic molecule, and therefore no material surface can be smooth to X-rays and reflecting in the ordinary sense.

By making use of the phenomenon of "diffraction," however, it is possible to obtain X-ray spectra corresponding to those obtained for visible light by means of the device known as the "diffraction grating." The latter consists of a series of obstacles, arranged in regular spacing: the distance between adjacent obstacles may be many times the wavelength of the radiation.

For use in connection with light-waves it is possible, by elaborate machinery, to manufacture a suitable grating by ruling lines, with a diamond, upon a glass surface, the number of the lines being from 10,000 to 100,000 to the inch. For

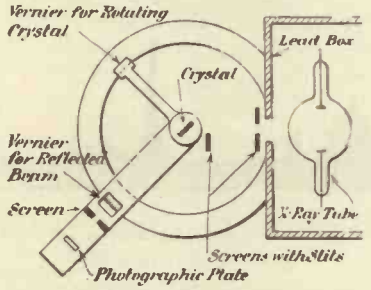


Fig. 4.—X-ray spectrometer for use with crystals, as employed by Bragg and others.

use with X-rays, however, it is necessary to employ a grating very much finer than this, and no suitable grating can be artificially manufactured. Laue, however, pointed out, in 1912, that the regularly spaced molecules of crystals might be employed as a diffraction grating for X-rays: the rays should be reflected in an orderly manner. He further suggested that such crystals might be employed for determining the wavelength of X-rays, if the distances between the adjacent molecules were known. This

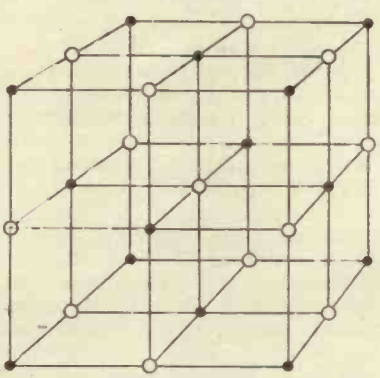


Fig. 5.—The unit cube of a crystal of the "cubic" system (sodium chloride). The black dots represent sodium atoms and the circles chlorine atoms.

work has since been very successfully carried on by Sir W. H. Bragg and Prof. W. L. Bragg, largely by means of the apparatus indicated in Fig. 4, known as the "X-ray spectrometer."

In certain crystals (called "cubic") the arrangement of the molecules is comparatively simple. In Fig. 5 is shown the arrangement of common salt (sodium chloride), the black dots representing the sodium atoms, and the circles the chlorine atoms. By simple calculations it is possible to discover very accurately the dimensions of the small cubes such as that shown in Fig. 5. These arrangements of atoms in crystals are known as "lattices." In 1914 Moseley investigated the characteristic X-ray frequencies of various substances by means of the crystal grating. It will be observed that the crystal is employed merely as a part of the appliance and re-radiates the same frequency as that which is incident upon it. Substances, however, which emit primary X-rays (for example, when used as the anti-cathode in an X-ray tube) will give rise to frequencies characteristic of their atomic structure.

Moseley took photographs of the X-radiation of various types of anti-cathodes, and found a simple relationship between the frequencies for a large number of elements. He discovered that when the elements were arranged in the order of their characteristic frequencies, each was obtainable from the previous one by a simple addition. It thus appears that each element of the periodic series differs from the element next lower by the addition of a definite amount of electricity which is accompanied by an increase in the frequency of the characteristic radiation. Apparently the nuclear charge is increased, with the production of greater restoring forces and more rapid vibrations when the inner electrons are disturbed.

This discovery by Moseley is of immense importance in the development of modern electrical theory, and it is greatly deplored that Moseley's life was early sacrificed in the war.

The developments which have arisen from this remarkable work will be dealt with in the next Article.

Broadcasting News

By OUR SPECIAL CORRESPONDENTS

THE first wireless play, "Twelfth Night," has been received with a perfect chorus of praise from the Press and from listeners-in. About five hundred letters were received by the B.B.C. couched in the most laudatory vein, all asking for more. About five communications were received stating that the senders were surfeited with the presentation of the immortal words of the glorious bard of Avon. Of course, they did not phrase their sentiments quite in this style. Indeed, one disgruntled person rudely and brusquely wrote: "I'm fed up with Shakespeare." However, five hundred for and five against is a pretty decisive indication of popular favour.

* * *

The next wireless plays to be broadcast will be "Romeo and Juliet" and "The Merchant of Venice." Efforts will be made to install really good loud-speakers in one or two selected schools, and men of renown in the educational world will be invited to listen-in and pronounce upon the merits of wireless as an aid to instruction.

* * *

There is no doubt that if any progress is to be made with the introduction of wireless telephony into schools, the only hope is in a perfect loud-speaker. If technical men wish to render a big service to wireless in the near future, they should devote all their energies to the production of loud-speakers giving first-class results at a minimum of cost.

* * *

The B.B.C. is gaining popular favour in the labour world. The National Union of Railwaymen were greatly indebted to the Company for allowing Mr. Cramp to broadcast an appeal on behalf of their Orphan Fund, and about forty London branches have unanimously and cordially passed a resolution of thanks to the B.B.C.

* * *

The B.B.C. have got into touch with the Industrial Welfare Society, and have suggested that prominent members of that body's Council should broadcast short talks on industrial subjects of a non-controversial nature. Frederick Bramley, Esq., the Assistant Secretary of the Trades Union Congress, will give a talk on "The Relief of Monotony." Frank Hodges, Esq., J.P., the Secretary of the Miners' Federation of Great Britain, will speak on "The Miners' Welfare Fund." The Rt. Hon. J. H. Thomas, M.P., the General Secretary of the National Union of Railwaymen, will talk about "The Bearing of Welfare Work on Industrial Relationship." The Rt. Hon. John Hodge, M.P., ex-Minister of Pensions, and President of the Iron and Steel Trades Confederation, may choose as his subject, "The Importance of Right Working Conditions."

* * *

Forthcoming events at 2LO include a talk by Sir Ernest Benn on "Europe" at 9 p.m. on Friday, 22nd June. Mr. Walter Ripman's subject, on 28th June, will be "Clear Speech." On 26th June the Irish Guards Band will perform. On Saturday, 30th June, Mr. Allen S. Walker will speak, his subject being "The Tower of London." This address will be the first of a series bearing the same title.

* * *

GLASGOW.—Another successful test of relay broadcasting was carried out by the Glasgow Station, when the third act of the opera "Hansel and Gretel," by the British National Opera Company, at Covent Garden, was clearly heard by listeners in Glasgow and the neighbourhood. Mr. Carruthers, the Station music director, has received messages of congratulation from Greenock, Motherwell, Helensburgh, and from city "listeners-in," who expressed their pleasure at the excellent transmission of the opera. Indeed, one Glasgow listener, using a valve set, on hearing the transmission, telephoned to the officials of 5SC to ask if they were broadcasting opera from the Glasgow Station.

* * *

The classical and dance programme nights of 5SC have been hailed with enthusiasm. For the dance music many little parties were gathered together throughout the city, and a merry evening resulted. The Scottish Eightsome Reel was one of the most popular items of the programme.

* * *

The oldest "listener-in" in Scotland is believed to be a venerable lady of 84, who lives about twenty miles from Glasgow. On her 84th birthday the other day she was enraptured at receiving a congratulatory message broadcast from 5SC. Above all things, she dearly loves to hear the "Kiddies' Corner" item.

* * *

The British Broadcasting Company's project in undertaking a new station in Aberdeen is the source of various humorous allusions in the Press to certain characteristics traditionally associated with the North-east city. One scribe in a Glasgow newspaper writes:—"If the Broadcasting Company has heard of the time-honoured reputation of that fair city, they must know that all the inhabitants will make sets out of bent pins and thimbles, purloin the receivers from the telephone call boxes, and surreptitiously listen-in with the kitchen fender as an aerial."

MANCHESTER.—Covent Garden Opera as radiated by 2ZY was an undoubted success, the only fault being that it did not last the whole evening. We wish to thank the "ether hogs" for abstaining from work during the transmission.

* * *

When the Grenadier Guards broadcast from 2ZY with such splendid and delightful results, we did not guess that the studio was so full that three members of the band sat on the grand piano while others were accommodated on the remaining pieces of music-producing furniture. The Station Director is no doubt thankful that it was not a cavalry band (spurs, you know).

Miss Ellen Terry broadcasting from the London Station.

* * *

It is unlucky for Manchester amateurs that 5IT, the broadcasting station least interfered with by 2ZY, gets so badly jammed. The other evening when listening through some slight heterodyning, interference was experienced dead on the wavelength of 5IT. Considerable patience, together with mechanical skill, was called for in order to receive Birmingham with anything like perfection.

SHEFFIELD.—"Howling" goes on apace, though it must be said that since Mr. F. Lloyd's complaint before the British Broadcasting Company of the concatenation produced by experimenters using reaction in aerial circuits during broadcasting there has been a little falling off. Probably wisdom is coming with experience in many cases, but the position is still far from satisfactory compared with the class of reception in other towns. Sheffield's geographical situation will probably always militate against reception of quality, until a full-blown broadcasting station is erected here.

NEWCASTLE-ON-TYNE.—What may be termed "Extra-mural" transmission has been repeated from the Newcastle Station this week. The Eastbourne Municipal Orchestra, under the conductorship of Captain H. G. Amers, director of music to the Corporation of Eastbourne, fulfilling a round of engagements on Tyneside, concluded on Friday with a concert at the Newcastle Town Hall, and from this various items were transmitted. The Town Hall, although the only building available for evening concerts in the city, has very poor acoustic properties, but in spite of this the transmission was quite good. Captain Amers is a Novocastrian, and his visits always prove a great attraction.

* * *

Daytime transmissions from 5NO usually consist of items by the Steinway-Welte reproducing piano. In future these will be given at 3.30 in the afternoon.

* * *

On May 30th we were treated to eight minutes of the last act of "Hansel and Gretel," relayed from Covent Garden as a test. Its only shortcoming was its brevity, for all reports are enthusiastic. There was an almost complete absence of echo, and in this respect it was a great improvement on the recent Sunday afternoon relay test from 2LO. Microphonic noises were somewhat more pronounced than in ordinary transmission, but all local listeners-in express a desire for the early frequent repetition of the experiment.

* * *

In continuation of the weekly lecture-recitals arranged by Mr. John Wyatt, L.R.A.M., lecturer in music to the Northumberland Education Committee, evenings with Gounod, Purcell, Grieg, and Tschaikowsky are to figure in the near future. The Station director has received many expressions of appreciation of the evenings with Wagner and Verdi already given.

Radio Societies

DEWSBURY AND DISTRICT WIRELESS SOCIETY (H.Q., South Street, Dewsbury).

Hon. Sec., Mr. F. Gomersall,
1, Ashworth Terrace,
Dewsbury.

This Society hopes to organise a "Direction-finding Committee" with the object of locating persons who are causing serious interference by means of oscillating sets. The Secretary proposes to commence a system whereby those who have apparatus for disposal may help those who require some particular item, and, at the same time, help their own finances. Briefly, the procedure will be:—

Members requiring any apparatus, or wishing to dispose of any, will give details which will appear in a fortnightly circular. Ten per cent. of all the sales, which is deducted from the purchase price, will go to the Society's funds.

LEEDS AND DISTRICT WIRELESS SOCIETY (H.Q., Woodhouse Lane U.M. Church Schools).

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

On May 14th Mr. A. M. Bage lectured on "Aerials, Outdoor, Indoor, and Loops." He commenced with remarks on the principles of wave motion through the ether, and showed how transmitting and receiving aerials were energised.

Mr. A. F. Carter recently lectured on "Liquid Air and Oxygen," apparatus being exhibited and experiments being shown. The process of manufacture was also explained, and the lecturer showed how liquid air could be used in vacuum valve manufacture.

On May 25th Mr. T. Brown Thomson lectured on "The Electron Theory," referring to the atomic and molecular theories of matter. The electron theory and its relationship to such forms of energy as static and current electricity and magnetism was carefully considered. The theory and action of the 2- and 3-electrode valves were then examined. On June 1st Mr. S. Kniveton gave a lecture entitled "Wireless and Weather Forecasting."

HACKNEY AND DISTRICT RADIO SOCIETY (H.Q., Y.M.C.A., Mare Street, Hackney).

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

On May 31st Mr. Cunningham, reporting on the radio demonstration which he had arranged in connection with the National Cycling Union at Woodford, stated that the demonstration was a great success.

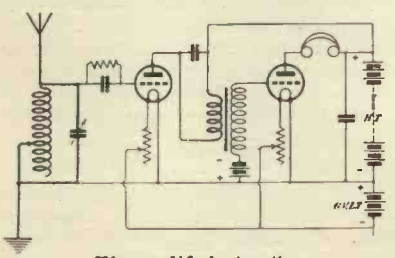
Mr. Walker stated that the Society's set was in progress of construction, and it is hoped to have it complete for a lecture and demonstration to be held in a few weeks' time. Mr. Wall gave a demonstration on coil winding with a "Lokap" machine for the benefit of those who desired to borrow the Society's coil winder for use at home.

The Secretary would like to draw the attention of those residing in Hackney to the existence of the Society, and invites everyone interested in radio to visit the Society on any Thursday evening. The fees are very reasonable and the benefits considerable.

LINCOLN AND DISTRICT AMATEUR WIRELESS AND SCIENTIFIC SOCIETY (H.Q., Lincoln Technical School).

Hon. Sec., Mr. J. T. James,
126, West Parade,
Lincoln.

Recently Mr. Bates described a circuit which he had been using, and which differed from the usual two-valve L.F. circuit, as a small 4½ volt



The modified circuit.

flash lamp battery was included between the secondary of the L.F. transformer and earth, and the L.T. leads were reversed as shown in the diagram.

It was stated that the altered circuit was equivalent to the original circuit with the addition of an extra valve. Mr. C. H. Friskney suggested the addition of extra H.T. on the last valve to increase the signal strength still more. This modified circuit, however, has the disadvantage that it is not suitable when atmospherics are present, as it is uncomfortable to wear the 'phones.

LUTON WIRELESS SOCIETY (H.Q., Hitchin Road Boys' School, Luton).

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

The third annual exhibition in connection with the above Society was held on April 28th, at the Conference Hall of the Adult School, Church Street. Local wireless traders were invited to exhibit, and a large range of receiving sets, components and accessories were displayed. The middle of the hall was occupied by the amateur section, and about thirty sets, representing the work done by members of the Society, were exhibited. These ranged from pocket crystal sets to elaborate multi-valve sets in handsome cabinets.

Two prizes were awarded for ingenuity in overcoming difficulties experienced by beginners. Signals were received and recorded on the Society's Morse inking apparatus, and demonstrations of the transmission and reception of C.W. were given.

PADDINGTON WIRELESS AND SCIENTIFIC SOCIETY (H.Q., Paddington Technical Institute, Saltram Crescent, London, W.9).

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

On Thursday, May 10th, Mr. W. Bursall, A.M.I.E.E., read a paper entitled "Flow meters."

From Mr. Bursall's remarks the meeting learned that the measurement of the flow of liquids and steam was carried out with the aid of electricity, the actual measuring instruments being, in fact, ammeters with an engraved dial in the required units.

The lecturer was able to bring to the

notice of the meeting an ingenious voltage limiting device with which he is enabled to keep the supply voltage constant. This and other devices enable the measurement of the flow of liquid through a system to be measured to an accuracy of within 2 per cent.

All enquiries regarding club membership should be addressed to the Hon. Secretary.

PLYMOUTH WIRELESS AND SCIENTIFIC SOCIETY.

Hon. Sec., MR. P. M. FOWLER,
Plymouth Chambers,
Old Town Street,
Plymouth.

On May 15th Mr. Monk gave a lecture on magnetism, particularly with regard to inductance.

The coefficient of induction and methods and effects of coupling were fully explained. In reply to questions the lecturer made various points clear with the aid of diagrams on the blackboard.

At a meeting held on May 22nd it was decided to accept the offer of the Plymouth Y.M.C.A. and to change the Society's headquarters to their building in Old Town Street, which will give more convenient accommodation and allow of the erection of a much longer aerial.

It was decided also to send a resolution *re* Plymouth Broadcasting Station to the Postmaster-General, stating that as no definite announcement has been made officially concerning the Plymouth Broadcasting Station, as suggested by the late Postmaster-General, the Society desires to have a statement from the Postmaster-General on this matter at his earliest convenience, and strongly advises the need of a broadcasting station in the Plymouth district to serve the South-West area of England.

It was resolved to address a letter to the local press on the annoyance caused by inexperienced amateurs in the district who allow their sets to oscillate, and to offer assistance by way of advice and instruction to prevent this interference, and to warn offenders that if this practice is continued the Society will take steps to track them down and report them to the authorities.

Visitors are cordially welcomed at the Society's weekly meetings, and full particulars as to membership may be obtained from the Secretary.

PORTSMOUTH AND DISTRICT WIRELESS ASSOCIATION (H.Q., John Pile Memorial Rooms, Fratton Road, Portsmouth).

Hon. Sec., MR. S. G. HOGG,
50, Waverley Road,
Southsea.

Mr. J. H. C. Harrold, M.I.R.E., gave, on May 2nd and 9th, an address entitled "Ether Waves and Wireless Telegraphy."

His explanation of the rectification of H.F. currents was of special interest to beginners, the crystal detector being chosen as an illustration. He explained that H.F. currents are rectified because the current can pass through the crystal better in one direction than the other, and the average rectified current actuates the telephone diaphragm producing audible sounds.

The Lecturer dealt with tuning, gave some crystal circuits, and showed how greater selectivity could be obtained by using inductive coupling, of which he gave two examples. One of these had the aerial tuning coil coupled to a secondary circuit, and the other an intermediate tuned circuit coupling the aerial with the detector circuit.

On May 23rd Mr. A. G. Priest gave a lecture on "Crystal and Valve Circuits," which was chiefly of a constructional nature. He described the construction of a simple single-valve receiver and gave valuable hints which were the result of practical experience. He also gave a demonstration, and displayed considerable ingenuity in assembling the components. For the benefit of advanced members Mr. W. C. Call gave a short address on "Dual Amplification," illustrated by blackboard illustrations.

At the request of members, Mr. J. H. C. Harrold gave, on May 30th, a lecture entitled "Accumulators." An old accumulator was dismantled, and, as the function of each part was explained, members were allowed to inspect it. Precautions to be observed when charging and discharging, and hints as to the care of accumulators, were given. It was generally agreed that the accumulator is a wireless component which is frequently overlooked.

Mr. Lawrence, an honorary member, has kindly arranged for a visit to an electricity power station, which should be of considerable interest to members.

RADIO SOCIETY OF HIGHGATE (H.Q., Highgate 1919 Club, South Grove, Highgate, N.6).

Hon. Sec., MR. J. F. STANLEY, B.Sc.,
49, Cholmeley Park,
Highgate, N.6.

In his lecture and demonstration entitled "Selective Tuning Circuits" given on May 18th, Mr. J. F. Stanley, B.Sc., described a series of experiments which he had carried out in order to find the most selective receiver possible without entailing the expense of a large amount of apparatus. He advised the use of:—

1. Coupled circuits.
2. One or more stages of high-frequency amplification.
3. A reaction coil coupled to the tuned anode coil of the last high-frequency valve,

and explained that although special circuits give better results, they are usually very critical to adjust when tuning in far distant stations.

The lecturer stated that a circuit tested by himself although simple to adjust had given remarkable results, it being possible to tune out the local broadcasting station entirely when receiving other stations. This circuit was then fully explained, after which a demonstration of it was given, 2ZY being tuned in whilst 2LO, 4 miles distant, was completely eliminated.

Several specially attractive features are prominent in this Society's programme for the near future, and full particulars of these may be obtained from the Secretary.

THE SOUTHAMPTON AND DISTRICT RADIO SOCIETY (Y.M.C.A., Ogle Road, Southampton).

Hon. Sec., MR. P. SAWYER,
55, Waterloo Road,
Southampton.

This Society recently arranged to increase the height and alter the direction of its aerial, and also to overhaul the three-valve L.F. receiver.

The subject of wavemeters was dealt with on May 10th. Dr. McDougall opened the discussion, exhibiting a buzzer wavemeter made by himself and favouring the members with interesting remarks on its construction and use. Mr. P. Sawyer then exhibited a Townsend wavemeter and a novel type of wavemeter of his own construction, describing and explaining the use of the former.

Details in connection with the competition for crystal receivers were settled at a meeting of this Society on May 24th. It was decided to allocate a maximum of 50 points, 25 for the best results on Bournemouth broadcasting, 15 for simplicity of handling, and 10 for simplicity of construction. It is proposed to have two sections in the competition—one confined to members only, and one for local amateurs. The circuit used in this Society's three-valve receiver was described by Mr. J. Wansbrough, and a discussion arose with regard to his suggested improvements, which include high-frequency amplification by means of the tuned anode.

Mr. W. Munn introduced the matter of local electrical interference, which will be dealt with at a later date.

At a meeting of this Society held on May 31st, Dr. McDougall gave a successful demonstration with his five-valve experimental panel and a loud-speaker constructed by himself. The set comprised 2 H.F. (tuned anode), 1 rectifying and 2 L.F. valves. Considerable ingenuity has been shown by Dr. McDougall in making various gadgets embodied in the set, and also in the method he has adopted for rapidly changing connections. The Secretary will be pleased to hear from persons who wish to join this Society.

HISTORICAL NOTES ON RADIO-TELEGRAPHY AND TELEPHONY

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

A Paper read before the Radio Society of Great Britain on April 25th, 1923.

PART III.—(Continued from No. 9, p. 573.)

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

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

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

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

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

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

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

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

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

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

In 1897 another epoch-making device was made by Sir Oliver Lodge, who took out a patent at that date, entitled "Improvements in Syntonised Telegraphy without Land Wires."

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

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

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

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

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

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

Story; also in Dr. Erskine Murray's handbook of Wireless Telegraphy.

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

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

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

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

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

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

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

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

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

An American Naval station also transmitted time signals in 1909.

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

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

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

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

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

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

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

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

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

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

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

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

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

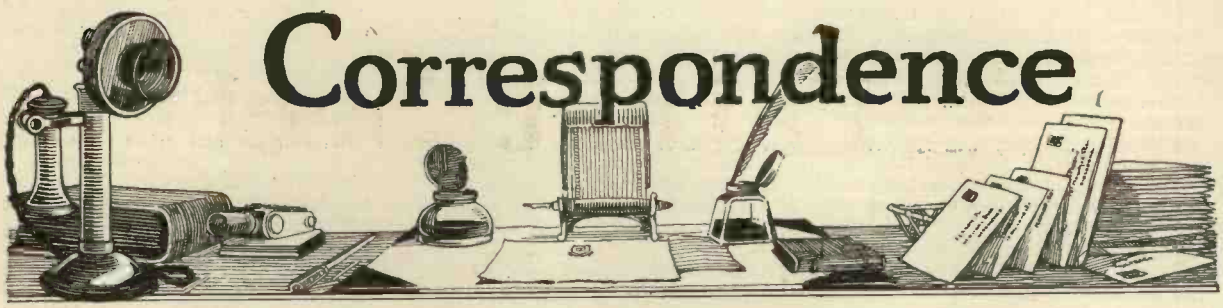
In 1897, Bell and Hayes in America, showed that if a circuit containing a battery and a microphone was coupled inductively to a D.C. arc, the arc would audibly reproduce the voice, and they applied this discovery to photophony (the transmission of speech by a beam of light).

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

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

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

(*To be continued.*)



Correspondence

ON RECEPTION

To the Editor, *Wireless Weekly*.

Sir,—With reference to a letter in No. 6 issue of your splendid paper, entitled "An Experiment," I, too, found this was the case some time ago, only I used far less wire than Mr. H. D. Hargreaves; the length was a few feet only, and splendid results were obtained on one terminal of the electric bell push; the other terminal gave no results at all. I can get London and Paris on a loud-speaker by this aerial method with four valves. It is nearly as good as my outdoor aerial. Another interesting point I would like to mention, and at the same time like to know if any other readers have noticed the same curious results, is the following:—

About a quarter of a mile from where I live there is a railway bridge, and one of the four tracks which pass over it has a join on the bridge itself.

Trains (steam and electric) passing over the bridge, on the track in question, cause clicks like atmospherics to be heard in the receivers as each wheel of the train passes over the join. These clicks, which I at one time thought to be atmospherics, are more pronounced on wavelengths of about 3,000 metres than any other. I am, etc.,

Netheravon. L. W. H. P.

CRYSTAL CUPS

To the Editor, *Wireless Weekly*.

Sir,—I have recently adopted mercury for making contact between crystal and crystal cup, and have found it very satisfactory and remarkably stable.

The cup is two-thirds filled with mercury (at a cost of 3d.). When the crystal is inserted it will float on the surface, and when pressed down and held by the fixing screws the pressure of the mercury against the crystal makes a reliable contact.

The cup should be of the vertical type, and I have experienced no loss as a result of the mercury percolating through the bottom screw of the cup. It will not spill if tilted to an angle of 60°, and does not evaporate.

When a change of crystal is desired it can be accomplished quickly and cleanly, is more economical than soldering with Wood's metal, and also obviates the risk of damaging sensitive crystals. I am, etc.,

Sydenham. H. S. Henley.

TELEPHONE BOARD

To the Editor, *Wireless Weekly*.

Sir,—In your valued paper, No. 7, Volume 1, page 437, you gave a wiring device for operating several sets of 'phones. Perhaps the wiring I have fixed up and which enables me to obtain several combinations with only three studs may be of interest.

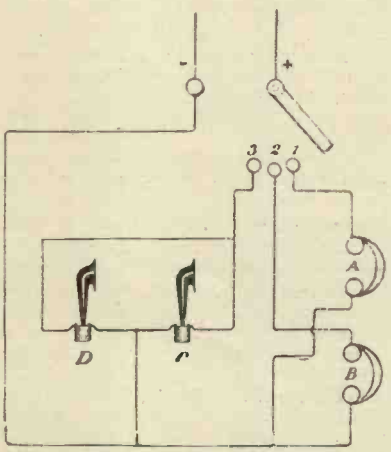


Fig. 1.—Commutator on 1, Listener A; 1 and 2, A and B; 2, B only; 2 and 3, B, C and D; 3, C and D.

Fig. 1 is a wiring diagram. The actual room taken up on panel by this attachment is 8in. by 2½in., and might be reduced. I am, etc.,

J. Yeo Thomas.

RE FLEWELLING CIRCUIT

To the Editor, *Wireless Weekly*.

Sir,—It may interest your readers to learn that I have put the Flewelling one-valve receiver to the test with quite successful results. My block condensers are the Dubilier make (capacity 0.006, *not* 0.005); the gridleaks (*variable*, ½ meg. to 5 megs.). I have tested it with outdoor aerial (single wire 95ft.) and with 4ft., 2ft., and 18in. frame aerial, and am satisfied that it will do all that is claimed, and more. I use an Ora valve and 6-volt L.T., 36 volts H.T.

One variable gridleak and one fixed (3 megs.) will give satisfactory results—the latter across the fixed condensers. I have so far only tried an 0.001 μF variable condenser, but shall test carefully with values of 0.00075 and 0.0005 μF. I have found a vernier condenser a great help in tuning.

I am, etc.,

Watford. H. G. Styles.

INTERFERENCE

To the Editor, *Wireless Weekly*.

Sir,—The article in No. 8 of your valuable paper on "Broadcast Reception and Spark Interference" fills one with a feeling of hopelessness. About 90 per cent. of broadcast reception in this district is entirely spoilt by interruption from spark stations. Some of these stations are powerful, and can be heard over the whole range, and a good deal beyond the range of British broadcasting wavelength.

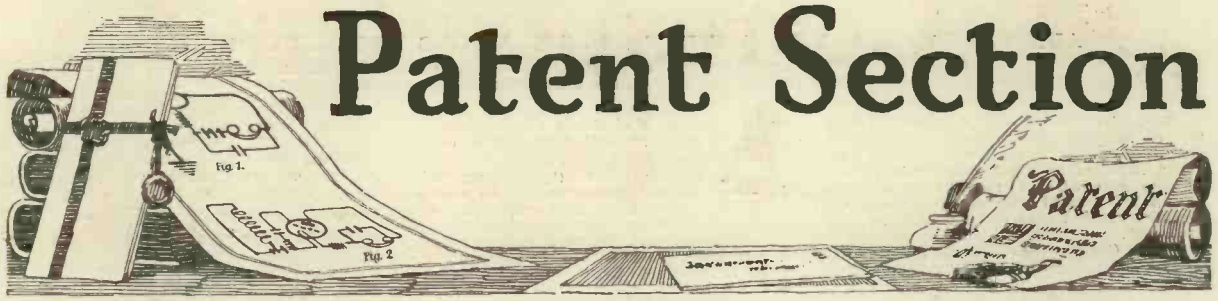
I believe I am right in stating that it is not the 600-metre spark transmissions which interfere with broadcasting, but that the interruption is due to the fact that a large amount of ships and ships' stations work on 300 metres. Also, I believe that many of the French coastal stations work on 450 metres, and between these two extremes the British transmissions take place. The result is, as I have stated, almost constant and unceasing interference.

I often wonder if the extent of this trouble is at all realised by both the Post Office authorities and those who have the future of broadcasting so very much at heart. One quite realises that the public services have a very large claim for prior consideration, but it seems perfectly certain that a large number, other than those fortunate enough to be very close to a broadcasting station, will very speedily get "fed up," and the result will tend to bring broadcasting into disrepute.

I sincerely hope, therefore, that some effort will be constantly made to, at least, get the interference lessened.

I am, etc.,

Torquay. Nearly "Fed Up."



Patent Section

The following list has been specially compiled for "Wireless Weekly" by Mr. H. T. P. GEE, Patent Agent, Staple House, 51 and 52, Chancery Lane, W.C.2, and at 70, George Street, Croydon, from whom copies of the full specifications published may be obtained post free on payment of the official price of 1s. each. We have arranged for Mr. Gee to deal with questions relating to Patents, Designs and Trade Marks. Letters should be sent to him direct at the above address.

APPLICATIONS FOR PATENTS

(Specifications not yet published.)

13344. AMOR, W.—Regenerating electric cell. May 18th.

12997. APPLETON, W. A.—Electrical apparatus. May 15th.

13218. ASTON, W. G.—Wireless tuning-device. May 17th.

13187. BACON, A. R.—Flexible coupling for sound-producing, &c., instruments. May 17th.

13131. BARBOUR, R. H.—Receiving apparatus for wireless signalling. May 16th.

13213. BARKER, W. K.—Telephone receivers, &c. May 17th.

13032. BARNETT, A. J.—Wireless receiving apparatus. May 15th.

13034. BEDDINGTON, G. C.—Thermionic valve devices. May 15th.

13128. BETTS, H. J.—Electric terminals, &c. May 16th.

12960. BLAKOE, R.—Wireless detector. May 15th.

13163. BRITISH THOMSON-HOUSTON CO., LTD.—Electric switches, &c. May 16th.

13260. BRITISH THOMSON-HOUSTON CO., LTD.—Electric switches, relays, &c. May 17th.

13116. BURNETT, J. M.—Accumulator grids or plates. May 16th.

13117. BURNETT, J. M.—Unit for accumulator plates. May 16th.

13118. BURNETT, J. M. — Accumulator plates. May 16th.

13119. BURNETT, J. M. — Accumulators. May 16th.

12910. CAEN, H.—Radio-telegraphic aerial supports. May 15th.

12911. CAEN, H.—Radio-telephonic inductances. May 15th.

12884. CLAPP, H. B.—Electric resistances. May 14th.

13106. COCHRANE, D. R.—Contacts for wireless crystal sets. May 16th.

13334. COLEMAN, C. J.—Devices for displaying and vending wireless crystals. May 18th.

12830. CONNOLLY, A.—Wireless receiving apparatus. May 14th.

12830. CONNOLLY, J.—Wireless receiving apparatus. May 14th.

12830. CONNOLLY, W.—Wireless receiving apparatus. May 14th.

13157. COOPER, M.—Transformers for telephony and wireless signalling. May 16th

13398. COOPER, T. L. R.—Electric plug and socket couplings. May 18th.

12849. COTTON, A. F. R.—Telephonographs, &c. May 14th.

13133. COTTON, A. F. R.—Means for producing variable electric frequencies. May 16th.

13401. DANIMONT, L. — Electric primary cells. May 18th.

13248. DERRIMAN, W. H. — Thermionic valves, &c. May 17th.

13403. DOBSON, E.—Electric switches. May 18th.

13196. DOCKREE, G. E.—Receiving apparatus for wireless telegraphy, &c. May 17th.

13362. DOCKREE, G. E.—Variable coupler for radio telegraphy, &c. May 18th.

12994. DORNIG, W.—Frequency multiplying transformers. May 15th. (Germany, August 9th, 1922.)

12995. DORNIG, W.—Circuit arrangements for frequency multiplying transformers. May 15th. (Germany, November 29th, 1922.)

12960. DUNCAN, H. A. H.—Wireless detector. May 15th.

13131. ELECTRICAL APPARATUS CO., LTD.—Receiving apparatus for wireless signalling. May 16th.

13394. ELSBURY, A. B.—Detectors for radio-telegraphic, &c., apparatus. May 18th.

13163. FITZGERALD, A. S.—Electric switches, &c. May 16th.

13260. FITZGERALD, A. S.—Electric switches, relays, &c. May 17th.

13337. FLEMING, J. A.—Telephone receivers. May 18th.

13344. FOSTER, H. K.—Regenerating electric cell. May 18th.

12913. FOURNIER D'ALBE, E. E. — Telegraphic transmission of pictures. May 15th.

13118. FULLILOVE, J. A. — Accumulator plates. May 16th.

13250. GARBARINI, A.—Amplifying valves. May 17th.

13006. GEE, J. W.—Undercutting electric insulators in commutators of dynamos, &c. May 15th.

13356. GIBSON, V. C. H.—Means for connecting telephone, &c., terminals. May 18th.

13113. GOOD, W. B.—Electric measuring instrument. May 16th.

13151. GRAHAM, E. A.—Intervalve transformer systems for use with thermionic valves. May 16th.

13116. HADDON, W.—Accumulator grids or plates. May 16th.

13117. HADDON, W.—Unit for accumulator plates. May 16th.

13118. HADDON, W.—Accumulator plates. May 16th.

13119. HADDON, W.—Accumulators. May 16th.

13061. HARDWARE, H.—Crystal detectors for wireless telegraphy, &c. May 16th.

13206. HARRIS, P. F.—Alternating-current electro-magnets. May 17th.

12862. HEWITTIC ELECTRIC CO., LTD.—Rectifying apparatus for alternating electric currents. May 14th. (France, May 15th, 1922.)

13006. HIGGS, W. F.—Undercutting electric insulation in commutators of dynamos, &c. May 15th.

13362. HIGHFIELD, H. C.—Variable coupler for radio telegraphy, &c. May 18th.

13380. HILL, L. D. — Wireless receiving sets. May 18th.

13362. HOGARTH ENGINEERING CO.—Variable coupler for radio telegraphy, &c. May 18th.

13157. H. T. C. ELECTRICAL CO.—Transformers for telephony and wireless signalling. May 16th.

13157. HURST, C. F.—Transformers for telephony and wireless signalling. May 16th.

13032. JONAS, S.—Wireless receiving apparatus. May 15th.

13213. JONES, F. A.—Telephone receivers, &c. May 17th.

13213. JONES, S. G.—Telephone receivers, &c. May 17th.

12997. JOSEPH, J.—Electrical apparatus. May 15th.

13084. KAHL, A. R.—Sound-reproducing apparatus. May 16th.

13344. MOORES, W. G.—Regenerating electric cell. May 18th.

13084. NOBLE, Sir W.—Sound-reproducing apparatus. May 16th.

13140. PÖHLER, E.—Method of charging electric storage batteries. May 16th.

13328. POLYBLANK, W. J.—Signalling apparatus. May 18th.

13206. REYROLLE & CO., LTD.—Alternating-current electromagnet. May 17th.

13151. RICKETS, W. J.—Intervalve transformer systems for use with thermionic valves. May 16th.

13243. ROBINS, R. W.—Leading-in tubes, &c. May 17th.

13248. ROBINSON, J.—Thermionic valves, &c. May 17th.

12814. ROWE, A. F. S.—Voltaic cells and batteries. May 14th.

12847. SANDERSON, H. F. A.—Tuning wireless receiving circuits. May 14th.

13142. SEIBT, G. (Firm of).—Variable condensers. May 16th. (Germany, May 30th, 1922.)

13382. SOC. FRANCAISE RADIO-ELECTRIQUE.—Wireless telephone receivers. May 18th. (France, May 18th, 1922.)

13383. SOC. FRANCAISE RADIO-ELECTRIQUE.—Vibratory diaphragms. May 18th. (France, May 20th, 1922.)

13233. STRATHDEE, A. K. E.—Thermionic valve holders. May 17th.

13179. SVENSKA ACKUMULATON AKTIEBOLGET JUNGNER.—Insulation for storage batteries. May 17th. (Sweden, December 12th, 1922.)

13157. TRIGGS, A. H.—Transformers for telephony and wireless signalling. May 16th.

13037. WARD LEONARD ELECTRIC CO.—Electric resistance units. May 15th. (United States, August 24th, 1922.)

12859. WIEGAND, H. J.—Resistance control devices. May 14th. (United States, May 15th, 1922.)

13180. WINFIELD BROS., LTD.—Crystal detectors for wireless telegraphy, &c. May 17th.

13180. WINFIELD, C. J. C.—Crystal detectors for wireless telegraphy, &c. May 17th.

13061. WINSTONE, F.—Crystal detectors for wireless telegraphy, &c. May 16th.

13380. WRIGHT, G. M.—Wireless receiving systems. May 18th.

12809. YOUNG, E. D.—Thermo telephone receiver. May 14th.

ABSTRACTS FROM FULL PATENT SPECIFICATIONS RECENTLY PUBLISHED

(Copies of the full specifications, when printed, may be obtained from Mr. Gee, post free on payment of the official price of 1s. each.)

195410. Low, A. M.—In a system of control of torpedoes, aeroplanes, &c., by wireless, the emitted waves are broken up into timed impulses by a rotary make-and-break switch, and at the receiver a selective switch is operated only when the received impulses are of the correct frequency. April 2nd, 1918.

195440. General Electric Co., Ltd., and Gossling, B. S.—In a device in which an

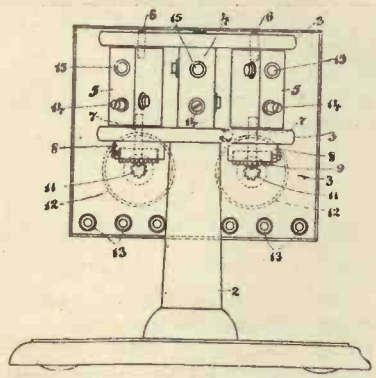


Fig. 1.—Illustrating Patent No. 195461.

electron discharge is obtained, independently of the presence of traces of gas, by means of a sufficiently steep potential gradient at the surface of the cathode, one or more cathodes are made of or coated with highly

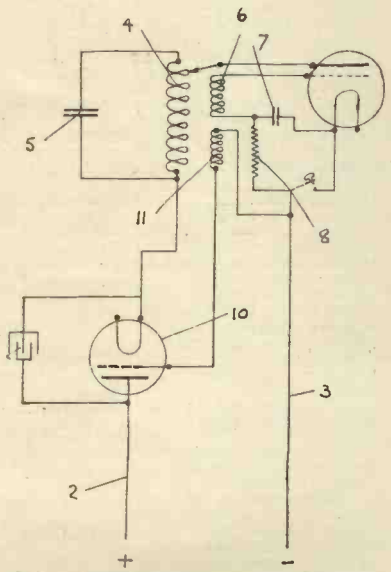


Fig. 2.—Illustrating Patent No. 195546.

electro-positive substances. December 23rd, 1921.

195453. Lorenz Akt.-Ges., C.—The electrode holder or holders of an electric arc for producing high frequency currents are formed hollow and serve to receive and guide coaxially a number of electrodes inserted one behind another, on the introduction of a new electrode all those in the holder being advanced the length of an electrode. December 29th, 1921.

195461. Beckman, O. W. C., and Alexander, P.—In a tuning inductance or an electric coupling device of the kind comprising two pivoted coils which can be moved through an angle with respect to a stationary coil, a fine adjustment of the positions of the coils is provided by a worm gearing so constructed that there is no metal or electrical connection between the coil holders and the operating buttons of the driving shafts. January 3rd, 1922.

195477. Leitner, H.—In order to assist the electrolytic reactions in storage batteries employing as active material pastes consisting of oxides of lead with glycerine, treacle, molasses, tar, &c., oxidizing or conducting substances are added to the pastes. January 21st, 1922.

195546. Hecht, N. F. S.—In order to prevent overheating of the anode of a power valve should it cease to generate oscillations, a condenser is inserted in the positive lead of the high-tension supply and is shunted by an auxiliary valve which functions to discharge the condenser periodically so long as the power valve is oscillating. If oscillation stops, the condenser cuts off the high-tension supply. May 9th, 1922.

195577. Bartholomew, H. G., and McFarlane, M. L. D.—In picture transmission by telegraphy or telephony, to obtain gradation of tone in the reproduction, a plurality of representations from the original, each corresponding with a given fraction or range of tone, are transmitted, and the corresponding received representations are used to form a composite reproduction of the original. An intermediate record of the tone variations, such as a perforated tape, may be used, and such record may be effected by the methods and means described in Specification 197402. Alternatively, the record may be formed on wax, as in making talking-machine records. The necessary current variations for transmission may be by any means, such as making the representations in insulating material upon a conducting sheet adapted to be bent round the transmitter mandrel, or slight variation may effect a selenium cell. Or the representations may be in relief and act upon a microphone. September 19th, 1921. (Cognate application, 4389/23.)

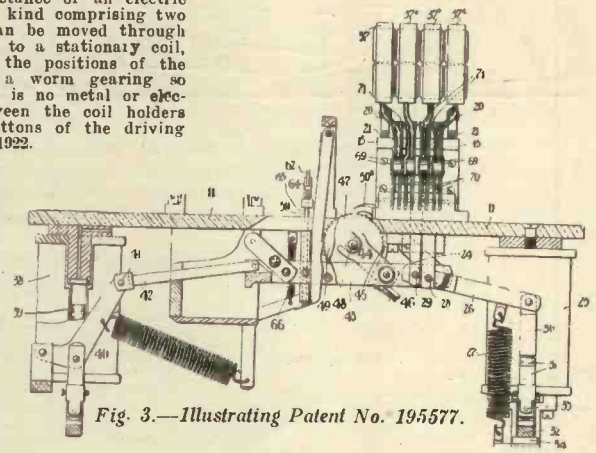


Fig. 3.—Illustrating Patent No. 195577.

195580. Nyberg, H. D.—A cell is provided with an electrolyte consisting of a solution of the hydroxide of one or more alkali metals, or of ammonium, the concentration being such that it remains practically unaltered during the working of the cell. June 12th, 1922. Convention date, March 28th.

195589. Western Electric Co., Ltd. (Assignees of Craft, E. B.).—A receiving set for wireless or line telephony is combined with an electric phonograph so that an associated loud-speaker can be actuated from either source at will. The high and low tension for the valve receivers, and the microphone circuit of the phonograph, are all fed from a motor-generator set, which, together with the other component parts, is housed in a single cabinet. September 22nd, 1922. Convention date, March 30th.

195593. Metropolitan-Vickers Electrical Co., Ltd. (Assignees of Smith, H. B.).—An insulator comprises insulating and conducting members so shaped and disposed as to distribute the electric field over a relatively large area and with less intensity adjacent to the axis of the insulating member.

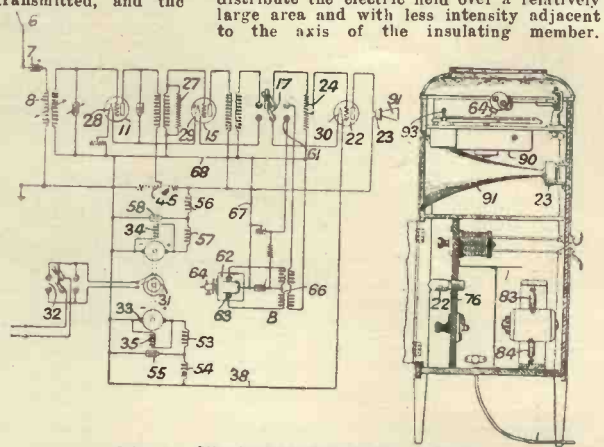
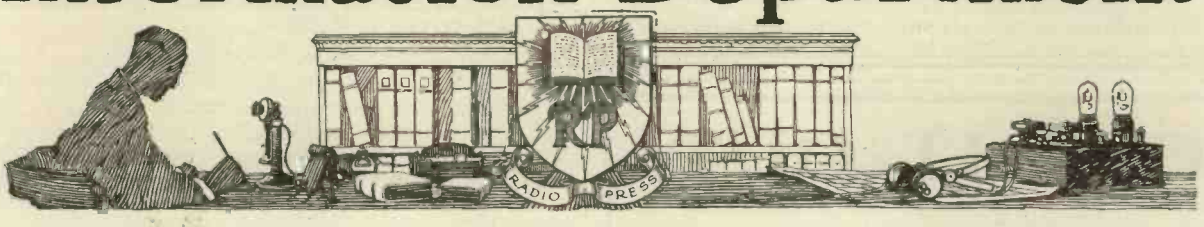


Fig. 4.—Illustrating Patent No. 195589.

January 25th, 1923. Convention date, April 1st, 1922.

195594. Metropolitan-Vickers Electrical Co., Ltd. (Assignees of Slepian, J.).—In electron discharge tubes, a varying magnetic field adjacent to the cathode controls the path of the electrons to an anode or target so as to increase their velocity. January 27th, 1923. Convention date, April 1st.

Information Department



Conducted by J. H. T. ROBERTS, D.Sc. (F.Inst.P.), assisted by A. L. M. DOUGLAS.

In this section we will deal with all queries regarding anything which appears in "Wireless Weekly," "Modern Wireless," or Radio Press Books. Not more than three questions will be answered at once. Queries, accompanied by the Coupon from the current issue, must be enclosed in an envelope marked "Query," and addressed to the Editor. Replies will be sent by post if stamped addressed envelope is enclosed.

W. J. F. (TUFNELL PARK) wishes to build a three-valve set and asks for a suitable wiring diagram.

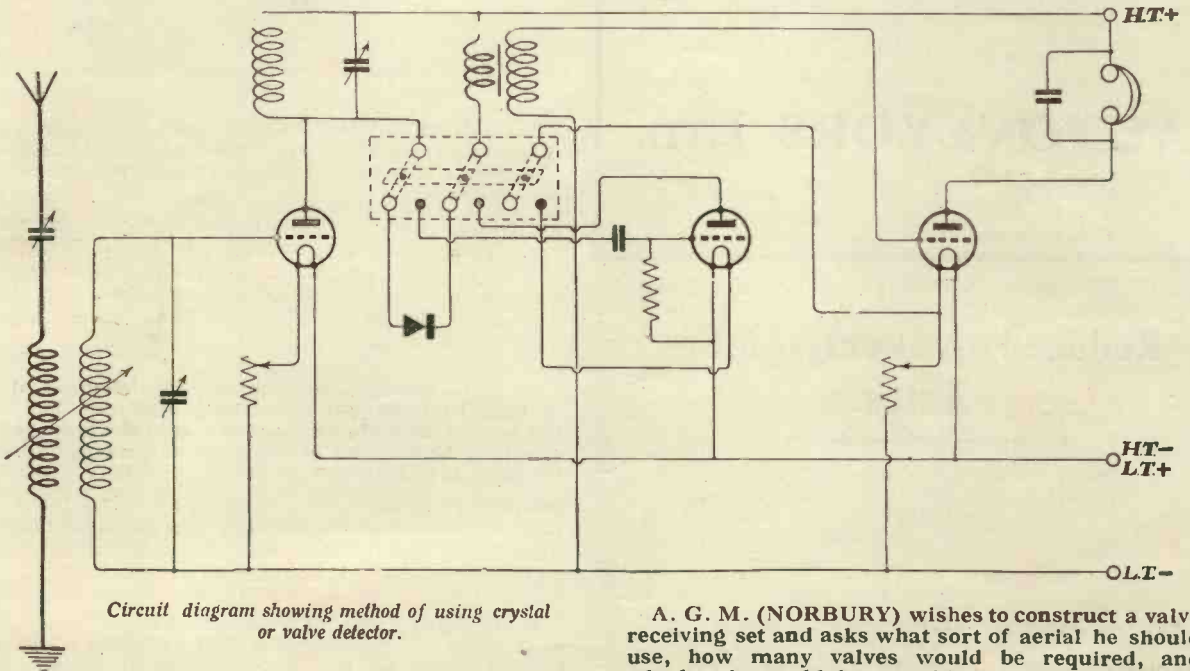
A suitable diagram for your purpose is No. ST 45 "Practical Wireless Valve Circuits," Radio Press, Limited.

C. F. S. (NOTTINGHAM) is situated about 50 miles from Birmingham and wishes to know what sort of circuit he would require to listen to the Birmingham concerts.

We recommend you to try a circuit ST 51 "Practical Wireless Valve Circuits," Radio Press, Limited. This is sufficiently sensitive to work a loud-speaker at a much greater distance than you are from any Broadcasting Station. The aerial circuit coil might have 50 turns, and the closed circuit coil 75 turns for the wavelength of Birmingham, which is 425 metres.

Experimenters.

The diagram below shows how switches may be used to control a circuit in which a crystal or valve may be used as a detector at will. As a number of readers have recently sent in queries asking how this may be effected, the attention of all interested is directed to this diagram.



Circuit diagram showing method of using crystal or valve detector.

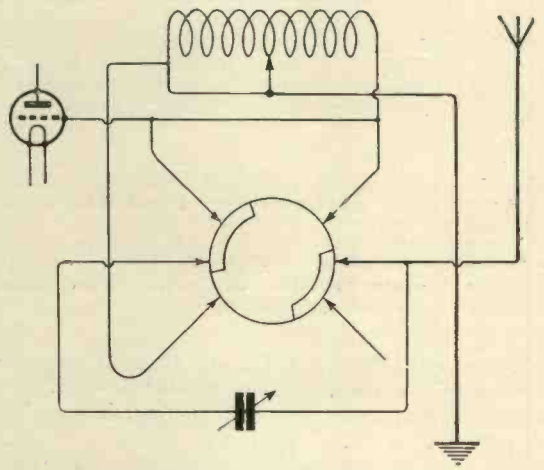
A. G. M. (NORBURY) wishes to construct a valve receiving set and asks what sort of aerial he should use, how many valves would be required, and whether it would be possible to use the ordinary electric light main for any purpose connected with this receiver.

You will require three valves arranged on the lines of circuit ST 45 "Practical Wireless Valve Circuits," Radio Press, Limited, and the aerial should, of course, be as large and as openly situated as possible. We do not think you will find any particular use

for the electric light main in connection with this apparatus, except for recharging accumulators, which would, of course, be necessary from time to time. With ordinary care valves should last twelve months.

H. H. (LAMBETH) submits a diagram of his set and asks certain questions.

We think that the set will work quite well if altered in accordance with your diagram. Basket coils will be quite suitable for tuning purposes, and the capacity you mention should give good results. A variable condenser of 0.001 μF capacity arranged with a series-parallel switch in the aerial circuit would extend the range of usefulness of this set considerably.



Arrangement of series-parallel switch.

E. B. D. (ERDINGTON) has built up a valve receiver described in No. 3 of "MODERN WIRELESS" and does not obtain satisfactory results. He asks our advice.

We suspect some wrong connection in your apparatus. Your aerial may, of course, be faulty, in which case you could not expect to receive long-distance transmissions. This apparatus if properly constructed will do all that is claimed for it, and is very satisfactory indeed.

A. W. G. has certain inductances which allow him to hear Birmingham and Glasgow loudly, but do not appear suitable for London. He asks how their size may be reduced in a convenient manner so as to allow him to listen to 2LO.

We do not think it requires very much ingenuity to tap your coil at, say, ten different places and connect these tappings to a rotary switch, so that any number of turns may be selected as desired.

H. H. (GREENLAW, BERWICKSHIRE) encloses a diagram of a two-valve circuit and asks whether it is in order and if it is as efficient as the ST 100 circuit which is to be described in No. 5 of "MODERN WIRELESS."

The circuit diagram you sent us is quite correct and satisfactory for the reception of Broadcasting. It is not, however, by any means as sensitive as the ST 100 circuit, and as full details of this are now available you will be able to make comparison.

—— (GLASGOW) submits the following questions: (1) My aerial is 70ft. long, but indoors.

Will I be able with a variometer in my possession to cover a wavelength range of from 200 to 800 metres, and if not, what apparatus would I require to extend to this range.

With the variometer you mention, the rotor and stator of which should both be wound full of No. 26 s.w.g. single silk-covered wire, you should be able to cover this range; but it will possibly be necessary to shunt the variometer by a small variable condenser having a capacity of 0.0002 μF. to extend to the upper wavelength limit.

C. A. F. (LEITH) has constructed the variometer receiving set described in "MODERN WIRELESS," No. 2, and wishes to know whether the addition of a variable condenser introduced somewhere into the circuit would increase the volume of sound.

A variable condenser will not give you a greater volume of sound, but we suggest that, with a view to raising the efficiency of the set, you should experiment with your crystal detector, trying different makes of crystal and contact point, and if possible raise the aerial somewhat.

H. A. (CAMDEN TOWN) has constructed a four-valve receiver on the lines of ST 49 "Practical Wireless Valve Circuits," Radio Press, Limited, and whilst obtaining very satisfactory results from 2LO is unable to hear any other Broadcasting Stations. He asks our advice.

We think that your tuning arrangements are probably at fault, and possibly not sufficiently selective to enable you to tune out 2LO. You do not say whether your honeycomb coils are tuned by variable condensers in the primary and secondary circuits, but, of course, these are essential to obtain sufficiently fine tuning. If you will let us have further details of your apparatus, we may be able to advise you better.

W. F. (GRAYS) asks certain questions about a set he is building.

The size of variometer you mention is rather small, but with a fixed condenser of low capacity shunted across it should cover the range required. The connections to the intervalve transformer are: IP plate, OP H.T. +, IS L.T. −, OS to grid.

R. S. (GLASGOW) wishes to know whether it would be possible to transform down 250 v. 50 cycle A.C. so that after rectification it could be used for his H.T. supply.

We do not think it a practicable proposition to use A.C. for this purpose, although if very carefully designed the circuit might be successful.

E. M. (SMITH SQUARE, WESTMINSTER) has built a two-valve receiver on the lines of ST 34 "Practical Wireless Valve Circuits," Radio Press, Limited, but whilst obtaining very satisfactory receptions from 2LO is unable to hear any of the other Broadcasting Stations. He also complains that the anode tuning is not critical.

We think you have probably the wrong size of coil in the anode and inductance circuits. The tuning of a rejector circuit such as this is very critical, and one degree movement of the condenser scale should make a very appreciable difference to the signals. You should try a No. 35 coil in the aerial circuit and a No. 50 coil in the rejector circuit.

H. F. W. (KENTISH TOWN) asks certain questions about his crystal and valve apparatus.

Unless you supply us with complete and detailed particulars of the values of the components of your apparatus, and let us know exactly what wave-lengths you wish to cover, we cannot give you any useful information. There are a number of possible variations of the circuit you suggest.

G. A. C. (BALHAM) has a 2-valve receiver of commercial make, and wishes to add the 2-valve low-frequency amplifier described in "WIRELESS WEEKLY," No. 3. He asks (1) whether it is satisfactory to do this, and (2) how it should be connected.

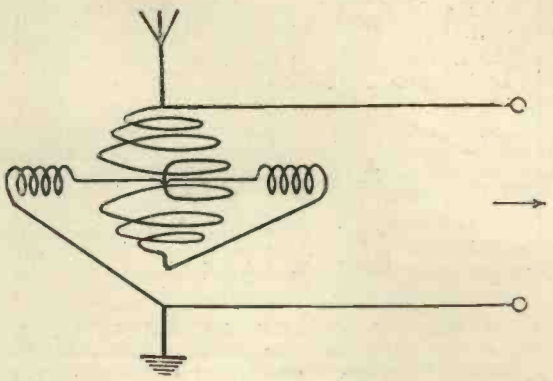
(1) This amplifier is exceedingly effective, and may be used with every confidence. (2) The input side of the amplifier is connected to the existing telephone terminals of your set. The same H.T. and L.T. batteries may be used if desired.

C. R. D. (CRICKLEWOOD) proposes to use the method of magnifying signals referred to in "WIRELESS WEEKLY" No. 4, and asks (1) whether a single earpiece of 2,000 ohms resistance would be useful; (2) whether a telephone transformer having a ratio of 1 to 250 would be suitable; (3) if this transformer is unobtainable, what would be the lowest satisfactory ratio.

(1) A single earpiece of 2,000 ohms would be quite satisfactory. (2) This ratio is much too high. (3) The correct ratio should be about 10 to 1 and a standard telephone transformer of reputable make should be used.

B. A. B. (SURBITON) wishes to know how the windings of a variometer are connected up.

We reproduce herewith a drawing showing how the various portions of the variometer are wired.



—— (WEST WYCOMBE).—You have omitted to send us your address. Please do so.

A. O. D. (KINGSWAY) encloses a sketch of his indoor aerial and asks whether he would be likely to hear anything else than the London Broadcasting Station with this arrangement.

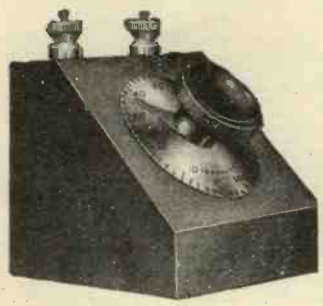
We should not imagine you could possibly hear anything else with such a primitive arrangement.

"POLAR"

PUBLIC OPINION EXPRESSED

in hundreds of congratulatory testimonials points to a highly satisfactory and quick selling article—in other words the

"POLAR" VARIABLE CONDENSER.



This unique production will give you the same satisfaction in your wireless reception.

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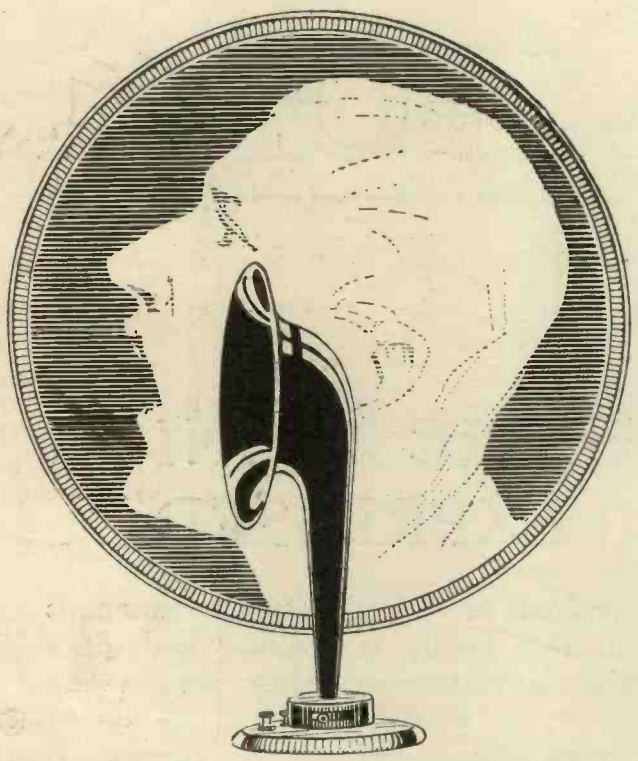
SOUTHAMPTON, 19, Queen's Terrace.

Yachting Agents: Messrs. McGruer Hollow Spar Co., Ltd., of Commercial Road, Lambeth, S.E.1.

78a



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THE purity of the tone reproduced by the **Peto-pan Super**—the clear Speaker—is a revelation to those who have only heard the distorted effects from other Loud Speakers.

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Manufactured throughout by:
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Peto-pan Super
– the clear Speaker

Introducing a new Branch:

In order to serve visitors to the West End we have opened this new Branch. A full stock of Peto-Scott Components will be carried and offered at the usual Peto-Scott low prices.

3, Wellington St., Strand, W.C.2

Special opening offer

Accumulators at less than cost

The accumulators are all filled with acid and fully charged. They cannot be sent by post.

6 volt 20 amps. . . 12/6
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HEADPHONES.
Genuine British Ericsson. Stamped B.B.C., 4,000 ohms 25/6
The LADIES' Headphones, very light, 4,000 ohms, with TORTISHELLITE Headbands 21/-
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VARIABLE CONDENSERS.
Complete with knob scale, pointer, and instructions, and TOP and BOTTOM EBONITE PLATES, ready bushed and connections made. Neatly boxed.

	Parts complete.	Assembled for Panel Mounting.
.001	7/6	12/6
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Vernier (Ready assembled)		3/-

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Reel Type ....each 1½d. Baby Shell .....each 3d.
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LEAD-IN INSULATORS.
Simplex Lead-in Patent (no more damaged window frames) 1/6
Ebonite Tube type, well made ..... from 1/-
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Intervalve Transformer, "MAX-AMP," guaranteed 21/-
High-Frequency Transformers, Broadcast wave-length 4/9
Aluminium Condenser Vanes, fixed and moving .....dozen 6d.
Spacing Washers, Small, 2d. doz.; large, doz. ..... 3d.
Valve Legs, with nuts and washers, 9d. doz.; each ..... 1d.
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Crystal Detector, fully adjustable .....each 2/6
Crystal Detector, glass enclosed for panel mounting ..each 4/-
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Filament Resistance ..... 3/- & 2/3
Fixed Condensers, in ebonite cases, tested and guaranteed correct capacity. .0002, 3 or 5, 1/3; .001, 2 or 3 ..... 1/6
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—Brass Clips for same ..... per pair 3d.
Switch Arms, complete with knob, collar washer, bush nuts, etc., best quality laminated 1/3
—2nd quality 10½d
Contact Studs, ¼in. × ¼in. ..... doz. 4d.
Contact Stops ..... doz. 7d.
"PETOCITE," the Crystal with the "Multi spots" all sensitive, complete with silver cat's-whisker 2/-

When ordering by Post, kindly send ample postage. Balance refunded. Orders over £2 post free.

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Wireless Weekly

SMALL ADVERTISEMENTS.

PREPAID Advertisements are accepted under this heading for Wireless Apparatus and Parts WANTED or FOR SALE, etc. at the rate of 1s. 6d. per line, MINIMUM THREE LINES.

Advertisements should reach Scheff Publicity Organisation, 125, Pall Mall, London, S.W. 1, LATEST by first post FRIDAY preceding date of publication.

The publishers are not responsible for clerical or printer's errors, but every care is taken to avoid mistakes.

FOR sale. New Britphone No. 4a 4 valve cabinet receiver with reaction, just delivered from makers. B.B.C. approved £32, or complete with 4 valves Brown's "D" headphone, accumulator, batteries, etc. Western Electric Loud Speaker £41. Apply Captain Clarke, Shropshire Orthopaedic Hospital, Oswestry.

PANELS engraved. No job too small. Experimenters' panels by return of post. Send your enquiries to T. R. Francis, 28, Gloucester Street, London, E.C.1.

PICKETT'S Cabinets, they're good value, 1/6 each. Highly polished. Write for lists. Works, Victoria Road, Bexley Heath.

RECEPTITE. The most sensitive crystal known. Gives loud signals with clear tones. Specially recommended for use in Mr. Scott-Taggart's new circuit. Every piece guaranteed. In boxes 1/- & 1/6 post free. Trade enquiries invited for all crystals. Cook & Co., 76, Estcourt Road, S.E.25.

SALE of wireless sets, accessories and Government Surplus. S. T. Corry, 239b, High Holborn, 3, New Oxford Street, 52a, Southampton Row, W.C.

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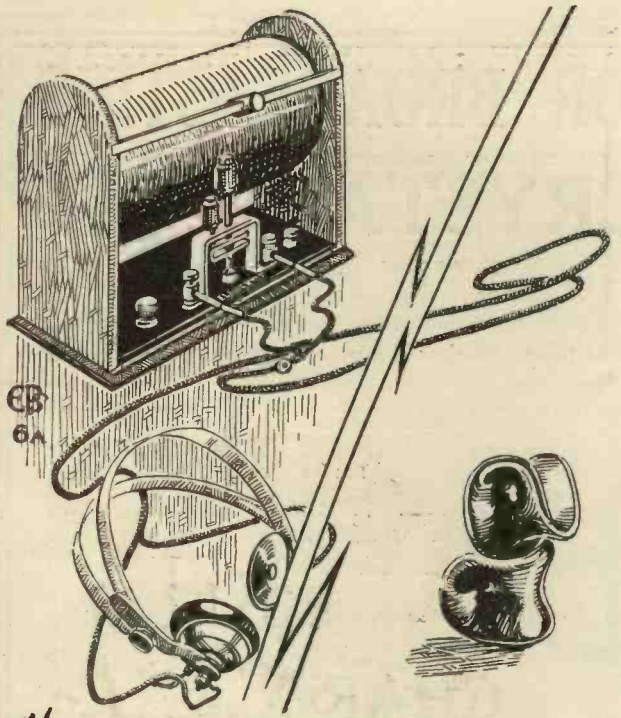
3 VALVE set complete, phones, Amplion 1. speaker, coils for Paris, etc., accumulator, H.T. cabinet, £27-10-0 Must sell. Thompson, Exmouth Road, Grays.



The FELLOCRYST

This is an excellent crystal receiving set, which gives very good results on all wavelengths from 300 to 1,500 metres, and is suitable for receiving broadcasting from ships and long-distance stations.

The adjustments are simple and easily made, and the silicon crystal detector well maintains its sensitive state.

No Batteries are required.

The set is sent out complete and includes 100-ft. coil of 7/22 stranded copper aerial wire, 2 shell insulators and one pair 4,000 ohms double headphones.
Every set is tested and guaranteed to receiving broadcasting up to 15 to 20 miles, and Morse signals from much greater distance.
The "FELLOCRYST" is British made throughout. Approved by the B.B.C. and Postmaster-General.

PRICE Complete £3 : 15 : 6
Inclusive of all taxes *Postage 1/6 extra*
Extra 4,000 ohms double headphones 21/6
Inclusive of all taxes *Postage 1/-*

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Telephone: WILLESDEN 1560-1. Telegrams: "QUIXMAG" 'PHONE, LONDON.

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MK III. 3-VALVE AMPLIFIERS. Each set has 4 high grade Transformers and all necessary fittings, complete with Headphones, all brand new. **£4 10** each set, post **1/6.**

SULLIVAN'S SINGLE PHONES. Latest pattern, brand new ex Government, with cords, highly sensitive. **6/-** each, post 6d.

FULLER BLOCK ACCUMULATORS. Brand new, 2V40 amp. ignition. **10/-** each, post 9d.

DEWAR SWITCHES. 12 leaf double pole change over series, parallel. **4/6** each, post **3d.**

DEWAR SWITCHES. 12 leaf single way. **3/6,** post 3d.

TERMINALS. Brand new, 7 piece 4 B.A. **2/-** dozen, post 6d.

LEADING-IN-WIRE. Ex Government Antena, high insulation. **2/-** per dozen yards, post 6d.

SILVERTOWN DUPLEX GALVANOMETERS. Brand new. Cost £5 each; to clear **17/6,** post free.

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ACCUMULATORS. C.A.V. and Helova, 4-volt 20 amp. **8/-** brand new, post **1/-.**

ACCUMULATOR BOXES. Brand new, in Teak, Oak, Mahogany, complete with terminals. Size 9″ long × 8″ high × 6½″ wide. Make good cabinets. Box lids and hinges **1/9** each, post 6d.

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£250 PRIZE COMPETITION

FIRST PRIZE £100

SECOND PRIZE £75 THIRD PRIZE £25

and Ten Consolation Prizes of Five Pounds each.

Entries limited to 400 in number.

Judge: JOHN SCOTT-TAGGART, F.Inst.P., Member I.R.E.

We have been successful in obtaining a further consignment of the well-known

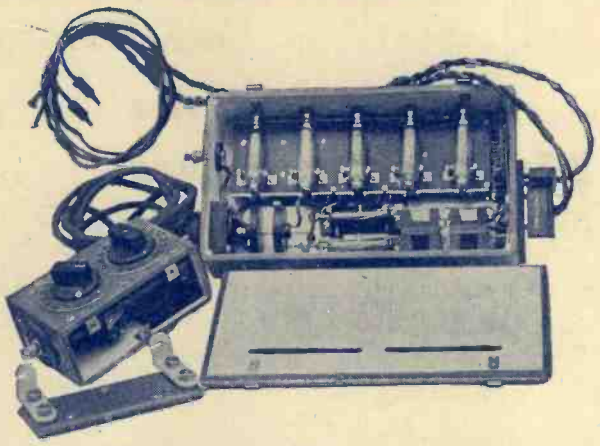
R.A.F. TYPE 10 5-VALVE RECEIVER

as supplied by the General Electric Company of U.S.A. to the Royal Air Force. These instruments are specifically designed for the reception of radio-telephony. They consist of a five-valve panel and remote control and necessary leads, as illustrated. The former contains 5 Valve Holders (for V.24 valves) 2 H.F., 1 Detector and 2 L.F., 2 Intervalve Transformers 2 H.F. Transformers, Aerial and Aperiodic Coils, Potentiometer, Variable Resistance (controlling 2 L.F. valves). The remote control contains variable filament resistance, variable condenser and small vernier condenser. We are offering the above prizes for the best reconstructed sets, according to the conditions set out below.

R.A.F. Type 10 Receiver, Remote Control H.T. and L.T. Leads (as illustrated) £10

5 V.24 Valves at 26/- . . £6 10 0

Complete : £16 10 0



RULES AND CONDITIONS.

The number of entries is limited to 400.

Set must be capable on a P.M.G. Aerial of receiving signals on all wavelengths between 300 and 3,000 metres. **(N.B.—The H.F. Transformers incorporated in the set are embedded in paraffin wax and, as the result of their high self-capacity, possess a clearly defined peak frequency corresponding to the wavelength for which the set was designed, viz., 440 metres.)** In some cases, also, it may be found that, owing to the exceptionally delicate nature of the windings of these transformers, the joint has been disconnected. This in no way affects the ultimate results, however, as to bring the set within the range of wavelengths mentioned above, these H.F. Transformers will, in any case, have to be eliminated.

On the shorter wavelengths the set must be capable of receiving any B.B.C. Station within 250 miles without interference with any other station. **(This test, in the final selection, would be made at the Company's laboratory, Stratford, where it would be required to receive, say, Manchester or Cardiff, with the minimum interference from 2 L.O. London, 6 miles distant.)**

All entries must be received on or before the 30th June, 1923. Competitors will be required to furnish the following:—

(a) A complete diagram of connections of their apparatus, together with a brief technical description.

(b) The Sales Receipt from the City Accumulator Company or their advertised agents for the purchase of the set and 5 valves.

(c) An Autograph Certificate stating that the competitor is not in any way connected with any person or firm engaged on the manufacture or sale of wireless telegraphy apparatus for commercial purposes.

Circuits employed must strictly conform to the Postmaster-General's restriction, "that no oscillating valve or valve circuit employing magnetic or electrostatic reaction may be directly coupled with the aerial or aerial secondary circuit over the range of wavelengths between 300 and 500 metres."

The prize-winning sets will remain the property of the competitors. Full particulars and photos will be published in "Wireless Weekly" during July or August. (Copyright of all published details remain the property of the City Accumulator Company, also the Company reserves the sole right to manufacture or to alter design for manufacturing purposes of any prize-winning Set. No prize will be divided.

In the event of a tie in technical design and actual reception, the prize will be awarded to the set showing best workmanship. The compactness and portability of the set will also be taken into consideration.

The decision of Mr. John Scott-Taggart and The City Accumulator Co. must be regarded as absolutely final.

FILL IN THIS COUPON AND POST TO US AT ONCE.

To THE CITY ACCUMULATOR CO.,
Competition Department,
79, Mark Lane, E.C.3.

Entry No......

I enclose herewith.....*for £16 . 10 . 0 in payment of 1 R.A.F. Type 10 Receiver and five V.24 Valves Please enrol me as a competitor for your £250 Prize Competition, according to the published conditions.*

NAME.....

Please write distinctly in BLOCK letters.

ADDRESS.....

Printed for the Proprietors, RADIO PRESS, LTD., Devereux Court, Strand, W.C.2, by THE CORNWALL PRESS, LTD., Paris Garden, Stamford Street, London, S.E.1. Published on Wednesday of each week at 3, Bolt Court, Fleet Street, London, E.C.4. Address for Subscriptions and Editorial communications:—Devereux Court, Strand, London, W.C.2. Advertisement Managers:—THE SCHEFF PUBLICITY ORGANISATION, LTD., 125, Pall Mall, London, S.W.1. Registered as a newspaper and for transmission by Canadian Magazine Post. Subscription rates:—32/6 per annum, 16/3 for six months, post free. Sole Agents for Australasia:—GORDON & GOTCH (Australasia), LTD. For Canada:—IMPERIAL NEWS, LTD For South Africa:—CENTRAL NEWS AGENCY, LTD.

Wednesday, 6d. Net. Vol. 1. No. 11. June 20th, 1923

Wireless Weekly

and The Wireless Constructor

No. 11

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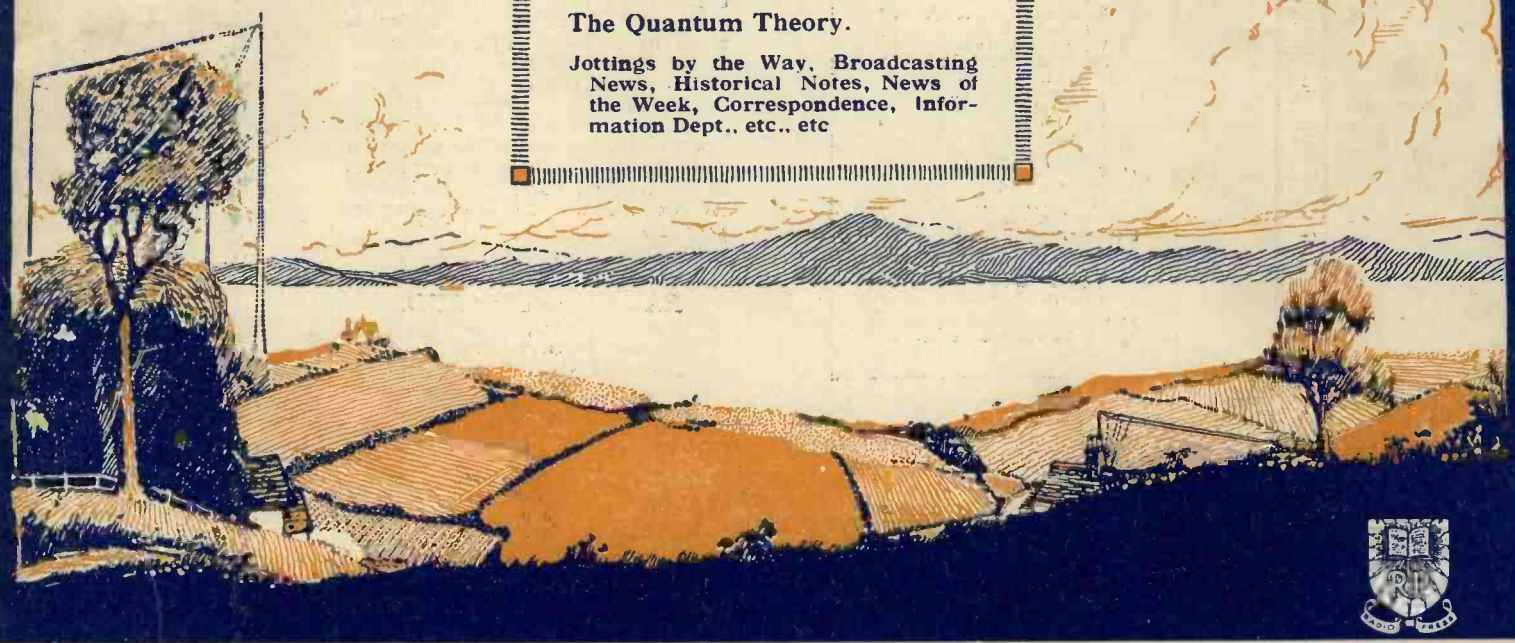

"How I Invented the 3-Electrode Valve"—By Dr. De Forest

Wireless Weekly

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Editor: JOHN SCOTT-TAGGART, F.Inst.P.
Assistant Editor: E. REDPATH.

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Advertisement Managers { SCHEFF PUBLICITY ORGANIZATION LTD., 125 Pall Mall, London, S.W.1. *Tel.—Regent* 2440.

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All correspondence relating to contributions is to be addressed to the Editor of "Wireless Weekly."

Editorial

And Time Goes On

(Up to the time of going to press no announcement has been made by the Broadcasting Committee.)

SO far there is no news regarding the interim report the issue of which we have consistently advocated. We have always thought, and still think, that the licensing question could be dealt with separately. A report and a recommendation from the Committee would enable constructors' licences to be issued by the Post Office, the effect of which would be to considerably relieve the present deadlock both with regard to public interest and in the wireless industry itself.

Possibly, however, the mass of evidence to be considered by the Committee has now become so large and the questions so involved that it is very difficult to isolate and deal with any one question. If this is the case, surely the Committee can make either an announcement to that effect or, better still, a short report upon the position generally.

For instance, at the present moment there must be simply thousands of would-be listeners-in who hesitate to invest in the necessary apparatus because they entertain doubts regarding the continuance of a broadcasting service which will justify their expenditure.

We know, of course, that the British Broadcasting Co. have repeatedly announced that broadcasting will continue; but when special Government Committees are appointed to investigate the whole future of broadcasting, the public, not unnaturally, is inclined to doubt the final authority of the B.B.C. in such a matter.

Here, then, is an important point for the consideration of the Committee, which by this time is surely in a position to state whether or not broadcasting shall continue. The settlement of minor points between the various parties concerned should follow as speedily as possible, but a definite pronouncement in favour of a continuance of broadcasting would undoubtedly have a very beneficial effect.

An old story with a new setting.

Does the Committee fully realise that whilst it is meeting and hearing evidence on behalf of the various interests concerned, thousands, possibly tens of thousands, are breaking stupid cast-iron regulations which entirely fail to provide for reasonable indulgence in what is, after all, merely a hobby. The new and promising wireless industry is rapidly declining, and at a time when everything is propitious for rapid development, trade and public activities are suspended whilst the Special Committee ponderously wades through evidence in order to effect a settlement of a few points of difference between the parties concerned, who, by this time, we feel sure, are heartily sorry they did not effect a prompt settlement themselves before the Committee was appointed.

One never knows, the Committee may be on the point of issuing their final report and do not feel it worth while to issue an interim report. There has been plenty of time in which to prepare a final report; but if the dawdling is to proceed, every nerve must be strained to get them to say *something* at once. There seems to be a callous indifference to the decline of a vast industry, together with a disregard for the interests of a large public, which has been treated scandalously for twelve months.

HOW I INVENTED THE THREE-ELECTRODE VALVE

By Dr. LEE DE FOREST.

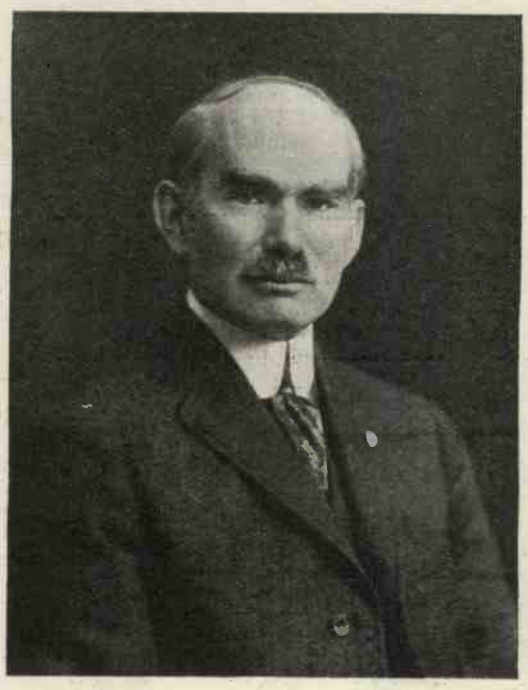
This fascinating story of the invention and early development of the modern valve has been specially written for us by the great inventor and will be followed with interest by all readers.

THE Audion—better known to British readers as the valve—bears much the same relationship to the sense of hearing as the microscope does to the sense of sight. And yet it is more than a magnifier of minute sounds electrically translated, because whereas the microscope enables us to see things of whose existence we are previously well aware, the Audion magnifies and translates into audible signals electrical energies whose existence we should never otherwise have suspected.

It is safe to say that the development of the Audion has revolutionised our ideas, if not upon electricity generally, then certainly upon that branch of electricity which has to do with signalling and communications. And it is interesting to note, in this connection, how the key to some of Nature's greatest truths is often laid into our hands as the result of an observation which, in itself, is apparently inconsequent and trivial. Newton's falling apple and Watt's trembling kettle-lid are cases in point.

Key to the Audion

It was in 1919, while experimenting with an electrolytic detector for wireless signals, that I had the luck to be working by the light of a Welsbach burner. The light dimmed and brightened again as my little spark transmitter was operated. This phenomenon was at once investigated and my disappointment was not small at finding that acoustic rather than electrical properties were responsible for the effects observed. However, the illusion had served its purpose, for it left me convinced upon the point that, in the gases enveloping an incandescent electrode, there resided latent forces or phenomena not fully understood but which could be utilised in a detector of Hertzian oscillations and which would prove far more delicate and sensitive than any form of detector known at that date.



Dr. Lee de Forest, the inventor of the three-electrode valve.

The Bunsen Flame

I next proceeded to investigate the properties of the Bunsen flame, using two platinum electrodes held close together in the flame with an outside circuit containing a battery of some 18 volts and a telephone receiver.

From the outset I was obsessed with the idea of discovering a detector-relay in which the current derived from the oscillations received on my aerial should, like a telegraph relay, liberate energy from a local battery, which energy would in turn operate a telephone or other receiving device.

When the apparatus was connected up to the aerial and earth as shown in Fig. 1 signals were clearly received from distant wireless telegraph stations, but the current which caused signals in my telephones originated in the 18 volt battery, the incoming oscillations serving merely to liberate this current by altering the electrical resistance of the heated gases between the platinum electrodes.

The First H.T. Battery

At this date, it may be said, there was brought into existence the first relay battery in Audion working. As the result of later experiments, instead of using platinum electrodes heated by flame, I employed an incandescent electric lamp filament to supply the electron stream, and the battery above mentioned was called the "B" battery to distinguish it from the "A" battery which merely lit the filament. The "B" battery is frequently spoken of as the high-tension battery, but its use marked a distinct era in the development of Audion reception.

A complete record of the experiments of those pioneer days can be found by the enthusiastic reader

elsewhere,* but it will suffice here to say that the Audion developed along logical lines, each experiment serving to bear out the ideas which I had already formulated. The Bunsen burner and the platinum electrodes gave place to an electric lamp with two filaments, which, in turn, was supplanted by a further electric lamp with an incandescent filament and a cold plate positively charged. But in each and every case the high-tension or "B" battery was employed, and this was the real source of energy which caused audible signals, the received impulses serving merely to switch this energy on and off, more or less.

The Audion in its two-electrode form was then developed and brought to a considerable degree of perfection, but it had limitations which must obviously be overcome before a thoroughly reliable com-

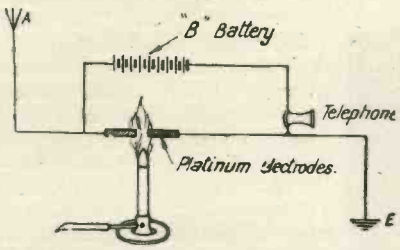


Fig. 1.—The first stage of the invention.

mercial article could be put on the market.

During my earliest experiments I had considered it very desirable that the impulses received from the aerial should, if possible, be confined to a circuit of their own, while the local battery and the telephones should comprise a second and separate circuit. I was convinced, in other words, that a "trigger" must be discovered which could, by a comparatively small pressure, be made to liberate vast quantities of energy yet without upsetting the delicate trigger action. Fig. 2 shows how I attempted to tackle this problem in the days of my Bunsen flame experiments.

After having developed the two-electrode Audion as far as was possible, I next cast round for a means of improving the results obtained, one of my objects being to keep the aerial circuit, which carried the high-frequency currents, apart from the telephone circuit, which carried the low- or audio-frequency currents, thus obtaining a much greater degree of control over the highly sensitive electron stream. Bearing in mind my experiments with the Bunsen (Fig. 2) I applied the principle to my two-

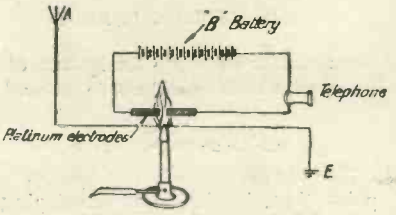


Fig. 2.—The second stage.

electrode Audion. In the first place the third electrode—which carried the aerial currents and was to act as the trigger—was placed outside the cylindrical wall of the Audion. This is represented in Fig. 3, which is interesting from a historical point of view, as will be seen shortly.

This simple arrangement proved a distinct advance upon the two-electrode device, and I at once concluded that if the third electrode were placed *within* the lamp, the charges impressed on it from the aerial would be even more effective in controlling the electronic current passing from the filament to the plate. The next arrangement was one in which I had two plates, one attached to the telephones and on one side of the filament, the other attached to the high-frequency circuit and on the other side of the filament.

This, again, was an improvement upon the external electrode, but I felt that still better results

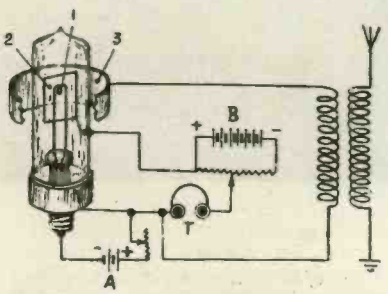


Fig. 3.—The third step towards the modern valve.

could be obtained if it were possible in any way to place the third electrode in the direct path of the carriers, *i.e.*, between the filament and the plate. But, obviously, another electrode placed thus in the path must not be a plate, as if it were the electronic stream would be cut off entirely. If the third electrode were perforated, however, there would then be no reason why it should not be placed between the other two; in fact it would probably exercise so great a control over the stream that a wire bent back and forth in the form of a grid would be all that was needed. Such a circuit (Fig. 4) was promptly made up and the results obtained surpassed all expectations.

That the three-electrode Audion would revolutionise all methods of telegraphy and telephony was apparent from the first, but it would be idle to say that I foresaw at this moment all the vast possibilities which have opened out for us as the result of its development. Even to-day, scientists are bringing forward fresh and ingenious applications of this principle—not only in the sphere of radio but in the

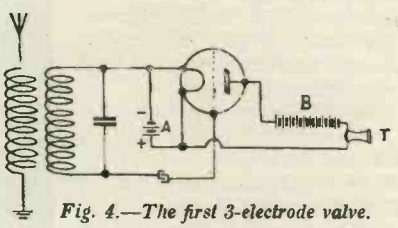


Fig. 4.—The first 3-electrode valve.

branches of science which have not hitherto been even remotely connected with electricity.

Inside the Audion

As it is, and drawing upon all our modern resources, we are only able to represent by somewhat lifeless mathematical formulæ and curves the intense action which takes place within the vacuum space of an Audion.

No curves or equations can convey adequately an impression of the seething millions of electrons hurled from the white hot filament; of their meteoric journey through space, now led on—now repulsed by the grid, now colliding with and smashing up stray molecules of gas.

All this we are obliged to supply from our own imagination, but there is much that can be indicated by means of curves, and it is possible for the behaviour of an Audion in any given circumstances to be predicted from a glance at its "characteristic curve."

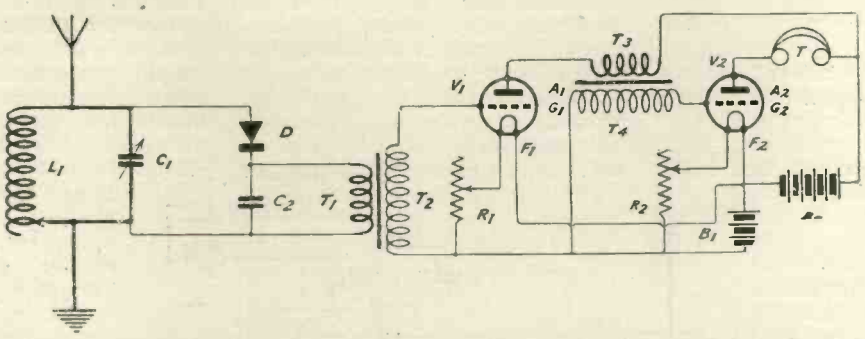
(To be continued.)

* *Journal of Franklin Institute*, July, 1920.—ED.

Wireless Weekly Circuits

No. 11.

A Crystal Receiver with Two-valve Low-frequency Amplifier



COMPONENTS REQUIRED.

L_1 : A fixed or tapped inductance.
C_1 : Variable condenser of 0.0005 μF or 0.001 μF maximum capacity.
D : A crystal detector.
C_2 : A fixed condenser of 0.002 μF capacity.
T_1, T_2 : Step-up inter-valve transformer.
R_1 and R_2 : Rotary filament resistances.
T_3, T_4 : A step-up inter-valve transformer.
B_1 : Six-volt accumulator.
B_2 : High-tension battery of from 45 to 100 volts.
T : Telephone receivers.

GENERAL NOTES.

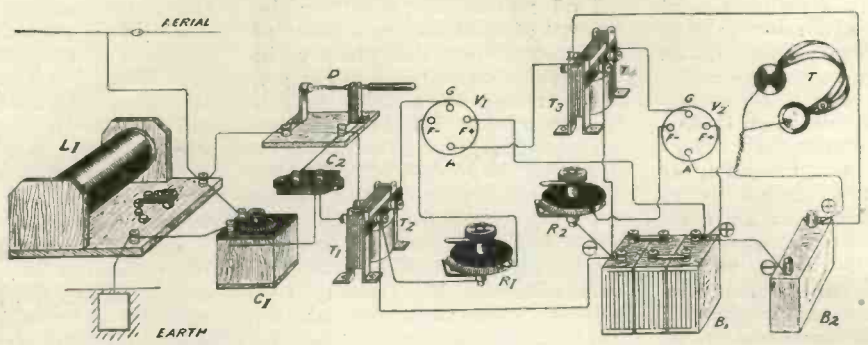
This circuit is suitable for short range broadcasting, and the circuit will work a loud speaker if the range from the broadcasting station is not too great (above about 6 miles).

VALUES OF COMPONENTS.

The inductance L_1 will either be a No. 25, 35 or 50 Igranic honeycomb coil, or an S_2, S_3 or S_4 Burndept coil. The condenser C_1 should be tried also in series with the aerial. If the inductance is a slider and no variable condenser is used, use values given with circuit No. 9.

NOTES ON OPERATION.

The tuning is done on the inductance L_1 and condenser C_1. The detector, R_1, R_2 and B_2 should be adjusted to give loudest signals. The condenser C_2 may often be omitted without effect.



SHORT-WAVE RECEPTION

By H. C. BARKER.

On account of the efficiency and selectivity obtainable, the method described in the following article is becoming increasingly popular.

MOST experimenters who have studied high-frequency amplification of the tuned anode variety have found an increasing interest in the subject, and it is hoped this article will be a help to some of those about to experiment with this circuit.

Since using this type of H.F. almost exclusively, the writer has found his interest very largely shared by his "wireless" friends, and from some questions that have been asked and the experience of others, it would appear that some of the essential points that make for the successful use of this circuit are not well known.

Perhaps the reason for the extraordinary interest in this circuit is the fact that reactance can be used when inductively coupled to the anode tuning inductance for the reception of B.B.C. transmissions, and there is no doubt that reactance with its attendant advantages is a great attraction to most of us.

The circuit is No. S.T.34 of "Practical Wireless Valve Circuits," by John Scott-Taggart, and the diagram is also shown in Fig. 7, p. 141, of *Modern Wireless* (Vol. 1, No. 2). The S.T.34 circuit diagram is shown in Fig. 1.

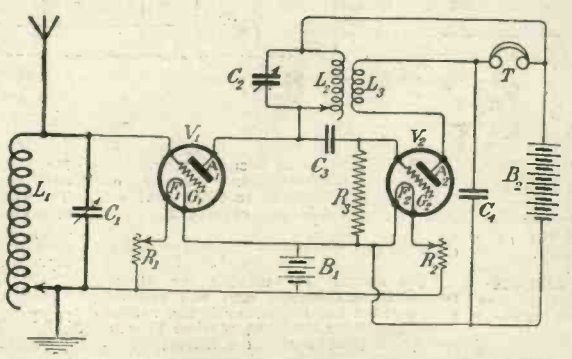


Fig. 1.—S.T. 34 reproduced from "Practical Wireless Valve Circuits."

Although this circuit is permissible for the reception of B.B.C. transmissions, it must be remembered that it is not foolproof, as would appear to be the opinion of some writers, and it is therefore absolutely necessary that all reasonable care be taken to prevent interference by oscillation. The best way to control this is probably by connecting the lower end of the aerial tuning inductance to a potentiometer with a resistance of 400 to 500 ohms connected across the terminals of the L.T. battery. This potentiometer should be disconnected whenever the filaments are turned off.

When first experimenting with this circuit the writer made use of a pancake type coil tuned by variable condenser 0.00035 μF in the anode circuit, a similar coil untuned being used as reactance. The self capacity of these coils was fairly large, and although the set worked well when very little variable condenser was in use (up to, say, 0.0002 μF) the signal strength fell off considerably whenever that amount of condenser was exceeded. It appeared doubtful whether this was due to capacity or to the condenser acting as a leak for the H.F. current. The former theory was accepted, and the following means of improvement were considered: (a) More coils of various sizes or a tapped coil, either of which would require less condenser for tuning the anode circuit; (b) coils with less self capacity used with the same variable condenser. The first alternative had the disadvantage that many coils would be required, each one tuning as near as possible to the incoming wavelength, or if a tapped coil was used there would be dead end effect. The latter experiment was tried, the natural wavelength in the anode circuit of the tapped coil being approximately 1,000 metres maximum, not a particularly large coil. This was found to be quite satisfactory for PCGG, but owing to dead end effect on the lower wavelengths it was soon discarded, and alternative (b) was examined and tried in the following manner. A coil with the lowest possible amount of self capacity was obtained, and with a smaller one which, however, had more capacity, a vario-coupler was made up. The 0.00035 μF variable condenser was shunted across the outer coil in the usual way, the inner coil being used as reactance. The vario-coupler type of reactance has been found easy to work and control, and is, in the opinion of the writer, to be recommended. On testing it was found that the inductance would tune from 180 metres to 440 metres approximately, thus covering the usual amateur and B.B.C. transmissions. A careful study of the results obtained on the higher of these wavelengths showed a slight recurrence of the old trouble—too much condenser—and although very slight, it was sufficient to show that the best results possible with the apparatus were not being obtained.

The simplest means of improvement which at the same time would permit tuning down to 180 metres appeared to be by way of a loading coil within the circuit shunted by the variable condenser, and the necessary terminals, with bridge for

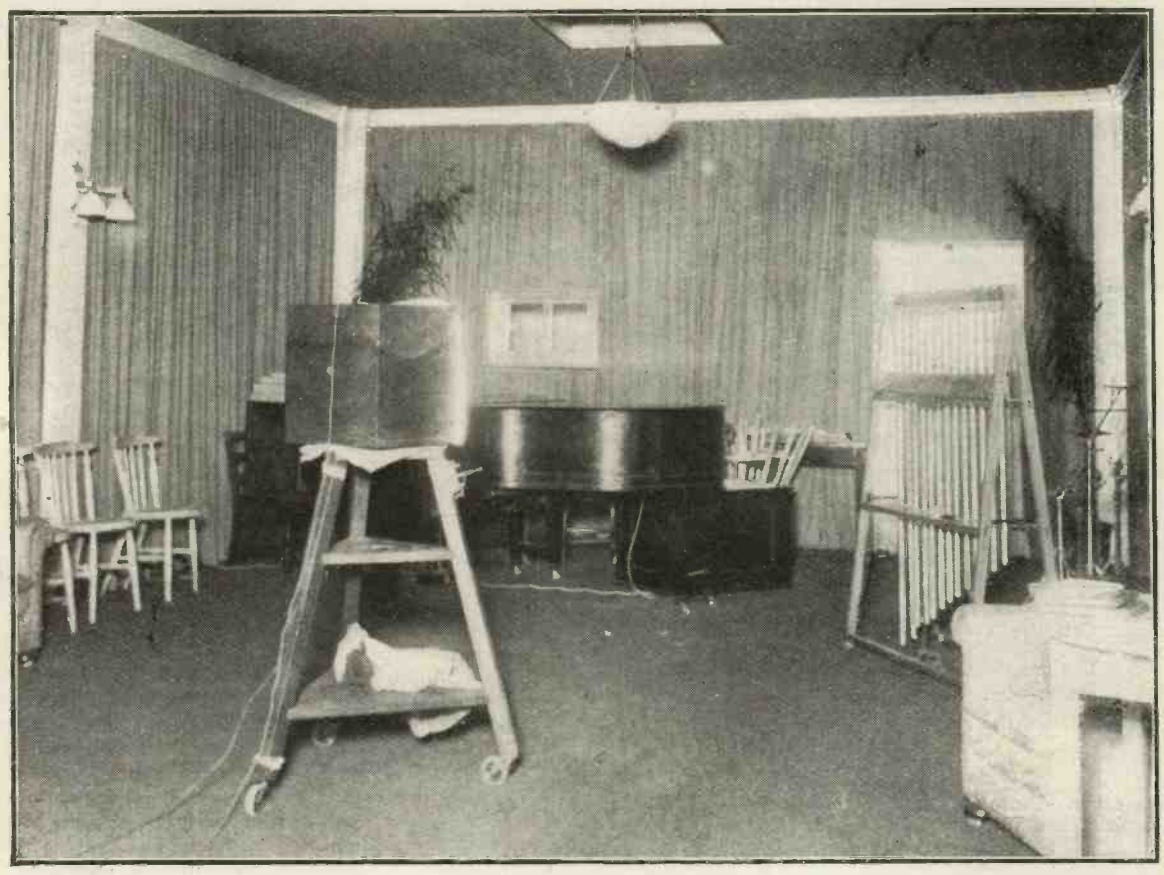
use when the loading coil was not required, were provided. It was found that this arrangement was very satisfactory so long as the loading coil was small. There was a distinct improvement on wavelengths of about 375 metres and upwards, and although a larger vario-coupler was made up and tried in place of the smaller one with loading coil, no improvement was noticeable.

The time required to insert a loading coil is only a fraction of that taken up in changing a vario-coupler, but it should be remembered that the actual range of wavelengths cannot be increased to any very great extent by the addition of a loading coil if the best results are to be obtained, and it is therefore essential to have larger vario-couplers or whatever type of inductance is used for tuning-in higher wavelengths. It might be mentioned that the effect of added capacity does not appear to have quite the same effect on the longer wavelengths.

As regards the actual working of this circuit using a single wire inverted L type aerial approximately 80ft. with 20ft. lead-in, height 18ft. at lead-in end and 30ft. at other end, direction roughly 10° (E.) from lead-in end, the B.B.C. programmes from 2ZY, 5IT, and 5NO have been received in S.E. London, also PCGG and Radiola, all except Radiola on two valves only.

One of the great advantages of this circuit is its selectivity. Using a variometer aerial tuning inductance, 5NO and 5IT have been received within 10 miles of 2LO with the latter station working. 2ZY has also been received under the same conditions with the addition of another variometer in the earth lead, but the efficiency of the apparatus is somewhat reduced by this addition.

THE STUDIO AT 2LO



A general view of the studio at 2LO. In the foreground is the microphone. On the right are the chimes.

Questions & Answers on the Valve

A COMPLETE COURSE ON THERMIONIC VALVES

By JOHN SCOTT-TAGGART, F.Inst.P., Member I.R.E. Author of "Thermionic Tubes in Radio Telegraphy and Telephony," "Elementary Text-book on Wireless Vacuum Tubes," "Wireless Valves Simply Explained," "Practical Wireless Valve Circuits," etc., etc.

PART X

(Continued from No. 10, page 597.)

Draw the Circuit of a 2-Valve Receiver, page 596 of No. 10 issue, so that One Accumulator and One High-tension Battery is Used.

Fig. 1 shows the circuit. It will be seen that a single accumulator B_1 feeds the filaments of the valves V_1 and V_2. The high-tension battery B_2 (which will usually have a maximum E.M.F. of from 45 to 100 volts) also provides the anode current for both valves.

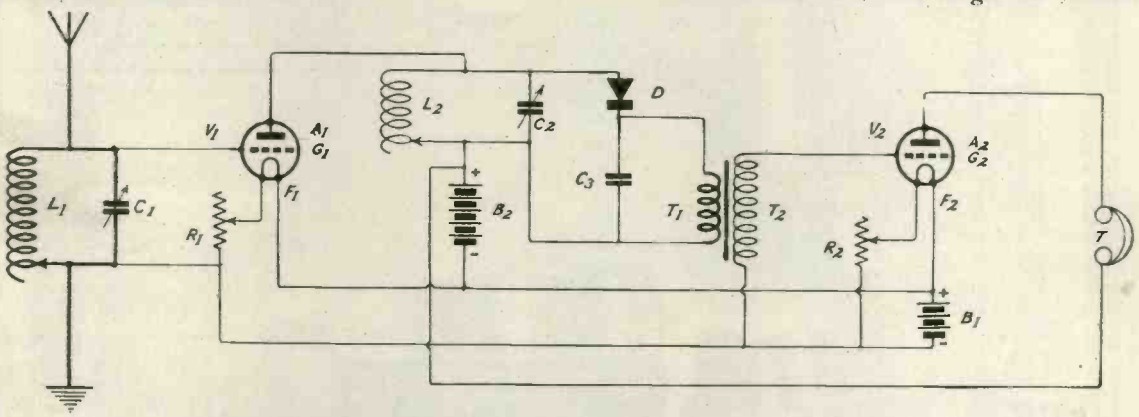


Fig. 1.—Illustrating the method of connecting one accumulator and one high-tension battery in a circuit embodying two valves.

Trace Out the Two Separate Circuits in Fig. 1.

The anode circuit of the first valve V_1 is as follows :—F_1, A_1, L_2, B_2, F_1.

That of the second valve is :—F_2, A_2, T, B_2, F_2.

Sketch a Pictorial Representation of Different Components Wired up to Conform to Fig. 1.

Fig. 2 shows how the different component parts are wired together to conform with the practical circuit shown in Fig. 1. Fig. 2 needs no further explanation as the different components have already been discussed.

In what way may the Circuit of Fig. 2 be Varied without Affecting its Operation.

The variable condenser C_1 may be connected in series with the aerial instead of in parallel with the inductance L_1. Instead of using a variable inductance and variable condenser, the inductance may be fixed, and might be a honeycomb coil.

The variable condenser might be eliminated altogether by substituting a variometer for the inductance L_1.

Similarly, the inductance L_2 might be fixed, or, if a variometer is used, the variable condenser C_2 might be omitted. This latter arrangement, however, is not to be greatly recommended, as the selectivity of the circuit is not so great. A variometer may be substituted for L_2 and a fixed condenser, having a capacity of, say, 0.0003 μF, might be connected in place of C_2. This will be found to work very well and the selectivity will remain good.

The fixed condenser C_3 should have a capacity of 0.002 μF, but this condenser may generally be omitted without affecting signal strength.

What Rules Govern the Use of Common High-tension and Filament Accumulators?

When a single valve circuit is used the position of the high-tension battery in the anode circuit is not of vital importance. It will vary the signal strength somewhat in many cases by connecting the high-tension battery next to the anode, and, moreover, there will be a leakage sometimes between the high-tension battery and earth. Moreover, the large capacity of the high-tension battery with respect to earth will be shunted across any circuit, such as a high-frequency tuned circuit. This will increase the wavelength of the circuit, and the battery, being at a high potential to earth, will be liable to reduce to a considerable extent the voltages across the oscillatory circuit.

Apart from these considerations, however, it is not a matter of vital import where the high-tension battery is placed. When, however, two valves are being worked off the same filament accumulator and high-tension battery, the position of the latter is of paramount importance. The connections from the two filaments to the common filament accumulator present no problems. If, however, we do not connect the high-tension battery in the correct position, short-circuits are liable to occur, or the valves become unstable and produce undesirable noises.

It may be taken as a rule that the negative terminal of the high-tension battery should always be connected either to the positive or negative side of the accumulator. In nine cases out of ten, the negative terminal of the high-tension battery is preferably connected to the positive side of the filament accumulator, as in that case the anodes are given an extra voltage corresponding to that across the accumulator. For example, if a six-volt accumulator were used, and the high-tension battery had a voltage of 50 volts, by connecting the negative terminal of the high-tension battery to the positive side of the accumulator, the anodes will be given a voltage of 56 volts. If the negative terminal of the high-tension battery is connected to the negative terminal of the accumulator, the voltage on the anode would be only 50.

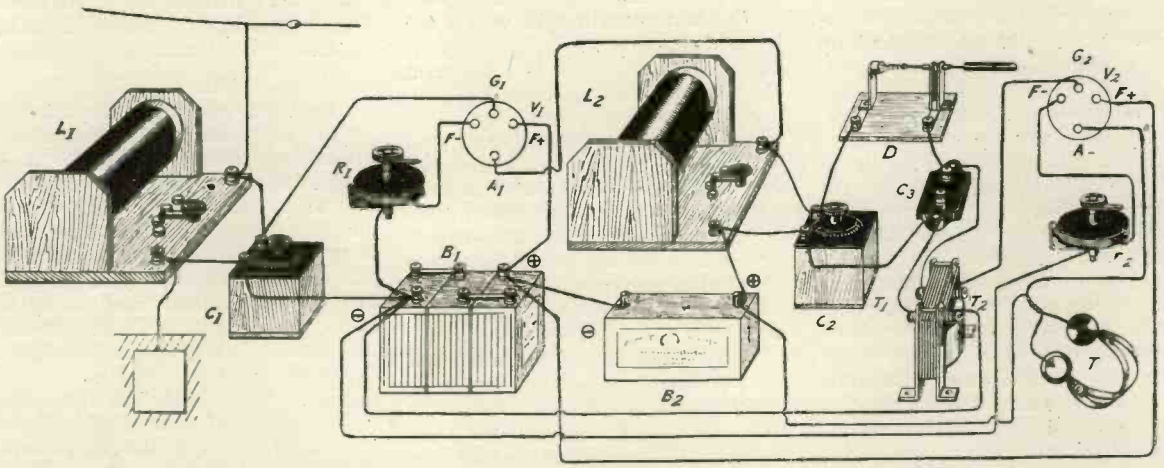
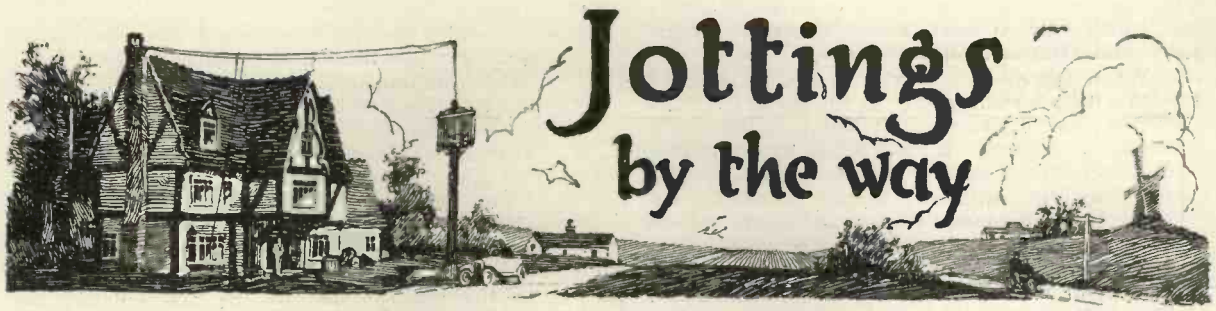


Fig. 2.—Showing the same circuit with the different components illustrated pictorially.

What is the Object of a Condenser Across the High-tension Battery?

Whenever two or more valves are fed from a common high-tension battery, it is desirable, but not absolutely necessary, to connect a condenser of large capacity (not less than 1 microfarad) across the terminals of the H.T. battery. This will lessen the minor fluctuations of the voltage of the battery, which will produce noises in the receiver, and will also make the circuit more stable, and will, to a certain extent, prevent the tendency to howl.



Grand Opera.

THOSE of us who heard the first series of operatic transmissions from 2LO linked up with Covent Garden were expecting great things from the British National Opera Company's summer season; and we were not disappointed. Captain P. P. Eckersley, the Chief Engineer, or *Ingénieur en Chef*, as he prefers to style himself when airing his excellent French before the microphone, is to be warmly congratulated on the results achieved. The transmissions made in the New Year were good; but these were, if anything, better; for numerous small points, such, for instance, as the best position for the microphone, had been duly marked, inwardly digested and attended to; any little thing that previously was not just so had received its due meed of consideration. with the result that the transmissions were really above all criticism.

It is amazing to notice how well suited such a huge theatre as the Covent Garden Opera House is to broadcasting. The slight "empty room" effect that one notices is pleasant rather than the reverse, for it gives one an idea of the size of the building, and seems to add to the sonority of both orchestra and singers. In transmissions made from smaller houses it is not nearly so noticeable, as you probably remarked when listening to the "Sleeping Beauty" from the Italian *Teatro dei Piccoli*, as sent out from the Scala Theatre. It is curious to notice how plainly audible remarks made in the stalls of Covent Garden often are. Did you hear the enthusiast, carried away by the beauty of "Faust," remark amidst and above the applause, "Well, I call it a —— good show"!

And Other Good Things.

We have been treated to some other excellent programmes besides those composed chiefly of opera during the last few weeks. One of the best was that in which the band of the Royal Air Force figured largely. They are no strangers at 2LO, and their appearance is always warmly welcomed by those who listen-in. A brass band with poor instruments indifferently played is cruelly dealt with by that most keen of critics, the microphone. The R.A.F. band is well off as regards both its instruments and those who play them, and its programmes are a real delight to hear.

There is one tip, by the way, that readers may find useful when these musicians next appear—and may that be soon. If a small-sized loud-speaker, such as those usually employed in drawing-rooms, is in use, it is apt to be a little too hard-worked by transmissions so powerful as those of a large band, especially if there is much brass. The result may be a little harshness on certain notes and during fortissimo passages. To counteract this, stop the set down a little by detuning very slightly. This may be done with the secondary condenser, or, better still, with that shunted across the tuned anode inductance. A moderate volume of pleasant sound is better than a harsh blare.

Loud Speakers.

It is only human to make other things or people work as hard as they can so long as you are doing nothing. That is probably why so many of us are apt to spoil our results by gingering up the tuning until the loud-speaker is on the point of bursting itself. A foolish policy, my masters; for, though your friends may be overcome by the amount of noise that your set is producing, no admiration for its prowess or yours will be mingled with their feelings, unless they happen to be utterly bereft of all musical instincts. The set always works best when it has something in hand. If it is going all out the results are usually far from pleasing, especially if reaction is being pushed to its limit.

The Lilies.

Have you ever tried the splendid game of visiting wireless showrooms as the idiot body? It is one of the best that I know, but it can be played with real success only in those places which harbour very young demonstrators of the lilies-of-the-field type, arrayed in gorgeous raiment and toiling no more than they can help. It was the motor industry that first gave a home to these beautiful young things. You could find them disposed gracefully about the showrooms of most of the car manufacturers, garbed in clothes that were almost incredible in their perfection, smoking unending cigarettes in amber holders of vast length. They were languid, and if they knew much about their priceless wares they were careful to conceal their knowledge beneath a bored exterior.

Still, even if they wouldn't tell you much, even if they appeared to resent your bursting in upon their repose, you felt quite sure that each of them was at least the son of a duke, and you felt duly honoured by his condescension in replying to a query here and there.

The Game.

The beautiful, bored, tired young man has now made his appearance in some of the wireless showrooms; and if, on entering, you observe one, you can proceed forthwith to beguile yourself. Assume —I am polite enough, you observe, to take it that you are not naturally gifted in this way—assume, so far as possible, the air of the most countrified of country cousins. Let your mouth gape a little if need be.

Presently one of the beautiful but languid will float towards you. "Interested in wireless?" he will

ask. You explain that you are more than interested—in fact, you have decided that you must have a set, but know nothing about it. Then follows a really funny time during which he displays his goods with a kind of pitying scorn. You ask all manner of questions; his replies are often little gems in the way of elusion. There are two ways of winding up the interview. Either you suddenly throw off the mask and explain to him just why the set he has been handling worked so badly, or you thank him warmly and say that you're not going to *buy* a set, but as your little boy is making one you wanted to see just where all the parts went.

Before indulging in this pastime make sure that your particular demonstrator really is a harmless lily. If he is, you will have provided exercise for his otherwise sluggish brain; if not, he may make a similar provision for your limbs by helping you to make a precipitate descent of the staircase.

Dud Stuff.

I believe I have mentioned already that there is a good deal of very bad stuff on the market at present in the way both of complete sets and of finished parts. Only to-day I was shown a variometer, bought by a trusting friend, which could never by any possibility have been made to work. Though advertised as just the thing for broadcast purposes its maximum wavelength was 340 metres when measured by wavemeter. The contacts were hopeless, the insulation as bad as it could possibly be.

These things come, I believe, from Austria and Germany. They are dear at any price. Another cheap line that came my way was a set of fixed condensers, also of foreign origin. The "plates" were made of the poorest lead-ridden tinfoil full of pin-holes; the dielectrics were of mica of a kind, though every sheet varied in thickness; and in no case was the actual capacity anywhere near that stated.

The Results.

To use this kind of stuff when building a set is folly of the worst kind. You will never be free from trouble of one sort or another. Those condensers will break down as sure as eggs is eggs, and anyone who fits them will spend profane hours in searching for the reasons why his apparatus refuses to do its duty. One could elaborate the list to include a huge variety of parts—gridleaks are amongst the worst; if you doubt my words, hang the expense (as I have done), and pull one of the very cheap variety to pieces.

Telephones, low-frequency inter-valve transformers, and even B.A. screws and nuts can be so bad as to be almost if not quite useless. The last are often made with worn-out taps and dies, with the result that they are neither one thing nor the other. If you want decent goods deal with reputable firms, such as those which advertise in *Wireless Weekly*. It is poor economy to buy worthless stuff at any price.

A Friend in Need.

You will, of course, have to wrestle (not always in prayer) with your set whenever friends come round to see and hear it. This is a delicate point which we have discussed before. You can lighten the labour of searching on these trying occasions very considerably by picking up a wavemeter. Many of them are to be had at ridiculous prices from those who specialise in "disposals" goods. There are two types, the humming and the squealing, or, to put it more professionally, the Townsend and the heterodyne. The former is in great demand on account of its extreme simplicity. It consists of a high-note buzzer connected with a variable inductance. You switch on the battery, set the pointer to the wavelength required, and then tune your set until the buzzing is at its loudest in the receivers.

These instruments are accurate enough for ordinary every-day use, but they cannot compare in this respect with the heterodyne wavemeter, which contains a valve provided with a tuned oscillatory circuit. With this type one connects the L.T. leads to a 6-volt accumulator (the anode potential is provided by two flashlamp cells contained within the case), and sets the indicator as before. One then tunes the set until the silent point between the squealing places is found.

The Bits and Pieces.

Besides its greater accuracy—provided that the kind of valve for which it is calibrated is used—the heterodyne wavemeter has other advantages. It can be used as a local oscillator, which is a most convenient thing to have when endeavouring to pick up faint and distant C.W. transmissions such as those of American amateurs. It can also be converted very easily, when every coil of the set has been thoroughly calibrated, into a handy little single-valve receiving outfit.

The type obtainable from "disposals" shops is worth the price asked if one takes it to pieces, buying it for its parts alone. It contains a plug suitable for connecting up the accumulator, a valve-holder mounted on springs, a rotary switch, a beautifully made variable condenser with ebonite dielectric, a mica-separated fixed condenser, and a handy galvanometer. Every part is well enough finished to delight the eye of the most critical. If you come across one of these meters going cheap, take my tip and make it yours without delay.

Too Ambitious.

Many wireless clubs make a mistake by deciding at their initial meeting to build co-operatively a vast set containing umpteen valves and every gadget that the mind of man can devise. Full of ambition they get the technical adviser to make them a series of drawings, parts are ordered in liberally, enthusiasm is unbounded. All goes well for a time. Jones undertakes the making of a trio of valve-holders, and duly delivers the goods; Smith is equally obliging in the fitting together of condenser parts; Brown mounts rheostats; Robinson concocts a wondrous switch.

But presently things begin to slacken off. Our friends Jones, Smith, Brown and Robinson, to say nothing of half the other members, are now busily engaged upon their own sets, and somehow the club giant seems a terrible undertaking. In many cases it never gets made at all. The wise secretary quells such early enthusiasm on behalf of committee and members, and plumps in the first instance for the simplest set that can be run together. The great thing is to get something working as soon as possible. Once this has been done a unit set can be designed. Even when only one panel has been made it is a working concern, and other panels can be added as time goes on.

WIRELESS WAYFARER.

A THREE-VALVE REGENERATIVE RECEIVER

By E. REDPATH, Assistant Editor.

The following constructional details of a three-valve receiving set in which the principle of reaction is employed in an approved manner will no doubt be found of service to many readers.

PRACTICALLY all wireless experimenters are aware that the principal object in employing high-frequency amplification is with a view to obtaining signals over greater distances than would be possible if a valve or crystal detector alone was used.

Low-frequency amplification, on the other hand, gives probably a greater degree of amplification, but can only be satisfactorily applied in the case of signals which are in themselves strong enough to actuate the crystal or valve detector.

In the set now to be described, and which will be found very satisfactory for all general purposes, a combination of three valves is employed, the first valve acting as a high-frequency amplifier, the second valve as a detector or rectifier, and the third valve as a low-frequency amplifier.

The increased amplification to be obtained by the use of the regenerative or reaction principle is also very well known nowadays; but, in order that its use may cause no interference with the owners of adjacent receiving stations, it is of the greatest importance to see that any reaction employed shall not be capable of causing radiation from the aerial circuit.

This matter is frequently alluded to, even in the technical wireless journals, as re-radiation. Absorption, together with re-radiation, occurs whenever the wireless waves strike any conducting body. For instance, an aerial attached to a crystal receiving set is said to be "set into oscillation" when it is tuned to resonance with the incoming wave. The oscillatory currents in the aerial circuit, therefore, due to the incoming wave, will cause a definite though very feeble re-radiation of energy. This actually is *re*-radiation.

The energy which causes the interference so much complained of comes from the receiving set itself, irrespective of any incoming wave, and is due to original *radiation*, not re-radiation.

In the present set, reaction is applied in a special manner so that, although all the benefits of the method are obtained, the radiation of energy from the aerial cannot occur.

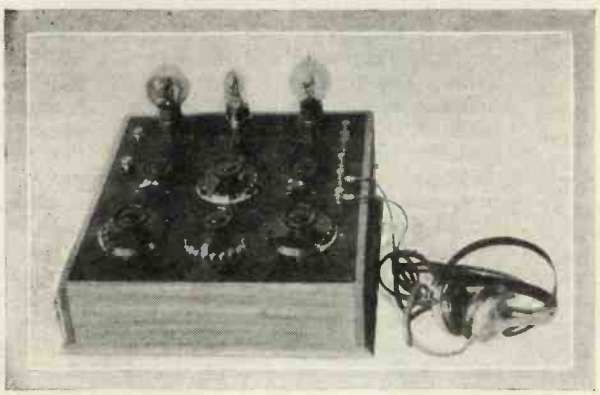


Fig. 1.—The complete receiving set.

In order to make absolutely certain upon this point, the set itself has been carefully tested, and, moreover, the design has been submitted to the Post Office authorities, and approved by them.

The general arrangement of the complete set is shown in the photograph (Fig. 1). The left-hand valve is the high-frequency valve, the centre one the rectifier, and the right-hand one the low-frequency valve. Of the two terminals on the left of the set, that to the rear is the aerial terminal, and the other the earth terminal, whilst of the five terminals to the right of the set, three are for the H.T. and L.T. batteries, and two for the telephones or loud-speaker.

The central knob and dial controls the reaction coupling. To the left and right of this central dial are the knobs for controlling the valve filament currents, the knob on the left controlling the rectifying valve only, whilst that on the right controls the H.F. and L.F. valves.

The tuning of the set to wavelengths between about 250 to 600 metres is effected by means of the 7-point selector switch and a variable condenser operated by the knob and dial to the right of it, whilst the knob and dial to the left of the 7-point switch operates a small variable condenser connected across the primary winding of the air-core inter-valve transformer between the first and second valves.

The Containing Box

The kind of wood employed and the amount of finish given to the containing box is, of course, a matter for the taste of individual readers. The inside dimensions of the box are 12in. by 12in. by 3in. deep at the front and 5in. deep at the back. Four corner pieces are glued in to take the screws which secure the ebonite top panel in place, and the height of these corner

pieces, as well as that of the four narrow strips which help to support the panel, will be determined by the thickness of the panel itself, whether $\frac{3}{16}$in. or $\frac{1}{4}$in.

Full particulars of this containing box are given in Fig. 2, and further explanation is considered unnecessary.

The Ebonite Panel

The ebonite panel measures 12in. by 12in., and, provided that reasonable care is taken in handling, drilling, etc., material $\frac{3}{16}$in. thick will prove quite satisfactory. Should the ebonite when purchased have a very glossy surface, this should be carefully removed by means of the finest emery-cloth wrapped round a flat piece of wood, a final dull-polish being obtained by brisk rubbing with a piece of flannel wrapped round a flat stick, using a few drops of sweet oil as a lubricant. The panel is then to be squared up and drilled in accordance with Fig. 3.

Materials Required

At this stage the following materials and components may be obtained and fitted in place on the panel:—

7 brass terminals, each with 2 back nuts.

12 brass valve legs, each with 2 back nuts.

2 filament rheostats, complete with knobs and pointers.

1 switch arm with spindle, bush and knob.

7 contact studs (No. 4 B.A.) and 2 brass "stops."

3 ebonite dials and knobs.

Vanes, spacing washers, etc., to make 2 variable condensers, one having three fixed and two movable vanes, and the other having fourteen fixed and thirteen movable vanes.

If these condensers are purchased complete with dials and knobs, two of the three dials already mentioned will not be required.

1 grid condenser (0.0003 μF) with 2 megohm gridleak.

1 cardboard tube, preferably wax impregnated, $3\frac{1}{2}$in. in diameter by $2\frac{1}{2}$in. long.

1 L.F. inter-valve iron-core transformer. The transformer actually used in this set is one of the Elwell ironclad type, and gives excellent service.

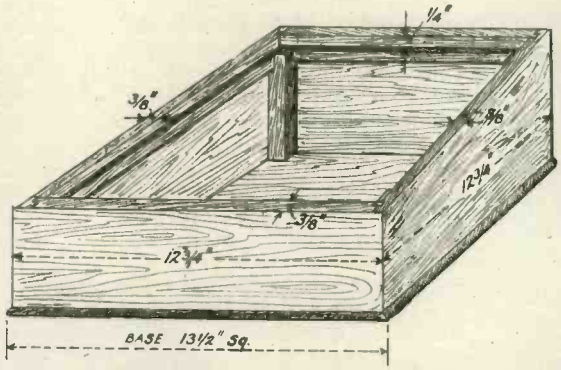


Fig. 2.—Constructional details of the containing box.

The Tuning Coil

With a view to economising space as much as possible, the tuning coil is fitted so as to surround the tuning condenser, and is, in fact, held in place by the ebonite strip across the back of the condenser.

Commencing at about $\frac{3}{4}$in. from one end of the former, and having secured the end of the wire by threading through two small holes in the cardboard tube, wind 10 turns and form a loop about 5in. long by tightly twisting the wire. Continue winding until six sections, each of 10 turns, have been wound in a similar manner. The wire employed should be No. 26 S.W.G.-d.c.c., and, when completed, the whole should be given a good coat of insulating varnish and be placed upon one side to dry. Fig. 4 will make perfectly clear the method of winding and tapping the coil, also how the coil is secured in place, surrounding the variable condenser, and the method of joining up the various tappings to the correct contact studs of the tuning switch.

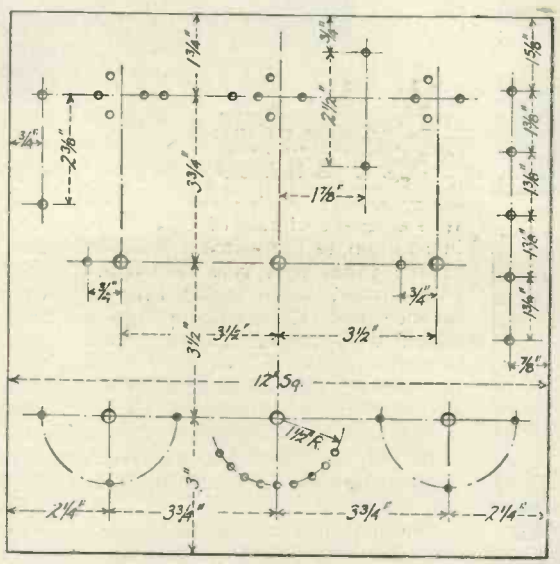


Fig. 3.—The ebonite panel marked off ready for drilling.

The High-frequency Transformer

The special form of high-frequency transformer and reaction coil combined is shown in Figs. 5 (*a*) and (*b*). It will be noted that this item is built up as a complete unit upon a separate small ebonite base, this method of construction being found more convenient than if all the parts were mounted direct on to the back of the main panel.

The actual transformer itself consists of a turned ebonite disc $1\frac{5}{8}$in. in diameter by $\frac{5}{16}$in. thick, having two peripheral grooves, each $\frac{1}{16}$in. wide and $\frac{3}{8}$in. deep. In the respective grooves are wound the primary and secondary, each consisting of 100 turns of No. 40 S.W.G.-d.s.c. copper wire, the completed transformer being secured to the ebonite base in such a manner that the secondary coil is uppermost.

The reaction coil is wound upon a similar disc to that carrying the transformer winding, though in this case, of course, there is only one groove, $\frac{1}{8}$in. wide by $\frac{3}{8}$in. deep. The winding itself consists of 100 turns of No. 38 S.W.G.-d.c.c. copper wire, the ends of which are connected to the two metal strips supporting the disc, they in turn being connected to a special ebonite-bushed spindle, and thence to the rear terminals of the transformer base.

The primary and secondary windings of the transformer should both be in the same direction, but there is no need to take any special pre-

caution with regard to the direction of the winding of the reaction coil, as, should it be found on trial to be incorrect, it is a very simple matter to reverse it.

The general arrangement of the

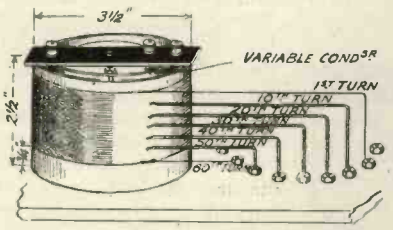


Fig. 4.—The tuning coil fitted in place with tappings connected to contact stud.

various components on the back of the panel will be seen on reference to Fig. 6. Should components be purchased or made which differ slightly from those specified and shown in Fig. 6, it is a simple matter to modify the arrangement accordingly, though this is a matter which requires consideration before the panel itself is drilled.

The Circuit Arrangement

Referring to Fig. 7, which is a complete theoretical circuit diagram of the receiving set, it will be seen that the aerial circuit comprises the aerial terminal Æ, the tuning coil L with 7-point tuning switch and

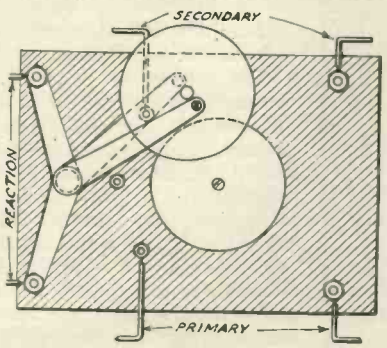


Fig. 5 (a) and (b).—The high-frequency transformer and reaction coil.

with the variable condenser C connected across the active turns, and the earth terminal E. The potentials set up across the variable condenser C due to the incoming signals are applied to the grid and negative side of the filament of the first valve.

In the anode circuit of this valve V_1 is the primary winding P of an air core transformer. Across this primary winding is connected the variable condenser C_1, so that the circuit thus formed may be tuned to resonance with the received frequency.

The secondary winding S of this air core transformer is connected to the grid *via* the gridleak and grid condenser (GL and GC respectively), and the positive side of the filament of the second valve V_2.

In the anode circuit of this valve, in addition to the primary winding of the usual iron core inter-valve transformer, is now included the reactance coil R, the coupling of which with respect to the transformer secondary S, may be varied. By means of the coil R, some of the amplified energy in the anode circuit is fed back to the input or grid circuit of the valve V_2, with consequent increase in the amplification obtained.

The amplified current in the primary of the iron core transformer M gives rise to higher voltage currents in the secondary winding, which, being applied to the grid and filaments of the third valve V_3, undergo low-frequency amplification before being passed to the telephone or loud-speaker included in the anode circuit of that valve.

R_1 and R_2 are the usual type of filament rheostats, the former controlling only the rectifying valve and the latter both H.F. and L.F. valves.

In order to facilitate the wiring up of the completed set, especially in the case of those readers who experience a little difficulty in translating a *theoretical* diagram into a *practical* wiring circuit, a complete, back-of-panel wiring diagram is given in Fig. 8.

Notes on Operation

Having connected the aerial, earth, H.T. and L.T. batteries and the telephones or loud-speaker as the case may be, to their appropriate terminals, and inserted three valves into the sockets, adjust the two filament rheostats until approximately the correct brilliancy is obtained. If a 4-volt accumulator battery is used to light the filament, and the ordinary type of receiving valves are employed, the valve may be turned up to full brilliancy without danger.

Set the centre dial so that there is practically no coupling between the reaction coil and the secondary of the air core transformer, and set the transformer tuning condenser to approximately half of its full value. Commence searching for signals, placing the tuning switch upon each stud in turn, and at the same time rotating the aerial tuning condenser through 180°.

Fig. 6.—A back view of the panel showing the arrangement of components.

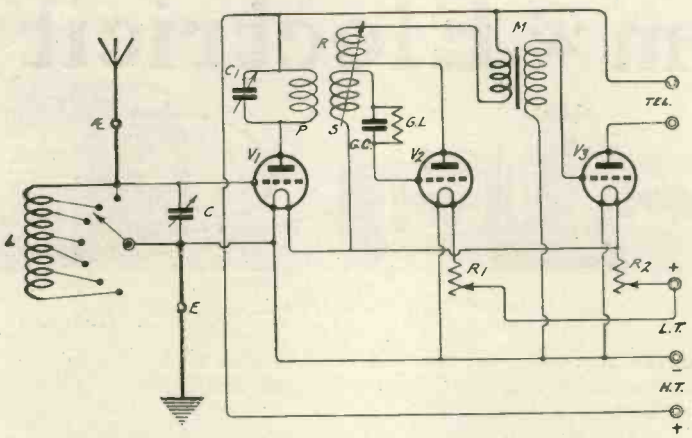


Fig. 7.—A complete circuit diagram of the receiver.

When signals are heard, first ascertain which particular stud, in conjunction with the variable condenser, gives the best signals strength; secondly, adjust the transformer tuning condenser, which should have the effect of improving signals, and, lastly, gradually increase the coupling between the reaction coil and the transformer secondary.

This last-named adjustment should give a gradual increase in signals strength until, at a clearly defined point, the signals suddenly become distorted, thus showing that the set has commenced to oscillate. The best adjustment for the satisfactory reception of good and clear speech or music is found when the reaction coupling is *just insufficient* to cause the set to oscillate.

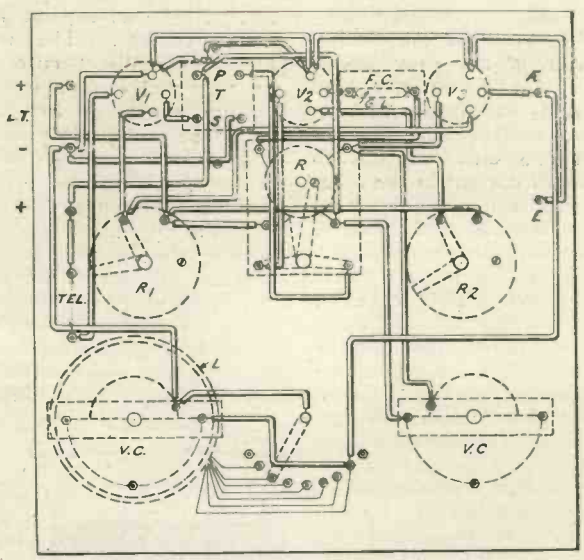


Fig. 8.—A back-of-panel wiring diagram.

TWO NEW INSTRUMENTS OF NOTE.

WE have received from Messrs. The Bowe-Lowyer Co., Ltd., a wavemeter of new design covering wavelengths from 150 to 600 metres.

By its use receiving apparatus may be tuned to the wavelength of any broadcasting station, in readiness for that station commencing its programme. This wavemeter will also prove invaluable to experimenters who design and make their own apparatus, enabling tuning coils to be wound and calibrated accurately.

The purchase of one will prove a thoroughly good investment.

* * *

Messrs. McClelland & Co. have forwarded for our inspection a valve panel fitted with a fuse for experimental work. The purpose of the fuse is to prevent accidental burning out of the valve, and is designed from a suggestion given in *Wireless Weekly* No. 7. The finish of the whole instrument is extremely neat, and a unit which we can recommend to experimenters.

FORTHCOMING EVENTS.

June.

20th (WED.).—Tottenham Wireless Society. Buzzer practice at 7.30 p.m. Mr. T. Vickery will lecture at 8.30 p.m. on "Making and Testing of Fixed Condensers, Grid Leaks, Coils, etc.," at the Institute, 10, Bruce Grove, Tottenham, N.17.

21st (THURS.).—Cardiff and South Wales Wireless Society. Mr. J. G. Proger will lecture on "Accumulators, Construction, Use and Charging."

21st (THURS.).—Derby Wireless Club. Experimental work with 2 H.F. valves will be conducted by Mr. H. J. Kirk at the Shaftesbury Restaurant, Tennant Street, Derby, at 7.30 p.m.

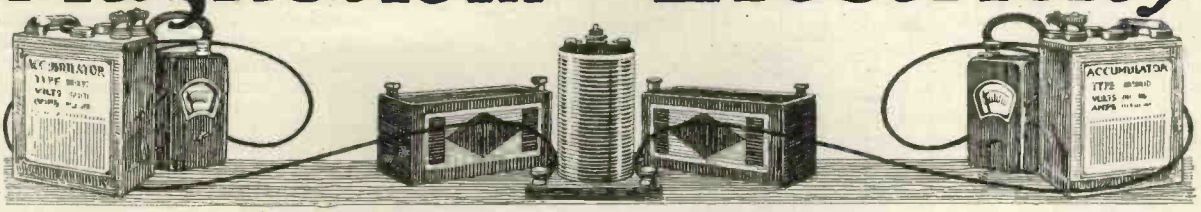
21st (THURS.).—Prescot and District Wireless and Experimental Association. A demonstration will be given in the Drill Hall, Prescot, at 8 p.m., when several sets will be on view.

25th (MON.).—Sydenham and Forest Hill Radio Society. At 8 p.m. Mr. C. A. Percival, a representative of the Ediswan Co., will lecture on the "Thermionic Valve" at the Greyhound Hotel, Sydenham.

25th (MON.).—The North London Wireless Association. Mr. E. H. Robinson will lecture at 8.30 p.m. on the "Armstrong Supersonic Heterodyne."

27th (WED.). — Tottenham Wireless Society. At 8 p.m. Mr. J. Kaine-Fish will lecture at the Institute, 10, Bruce Grove, Tottenham, N.17.

Magnetism & Electricity



By J. H. T. ROBERTS, D.Sc., F.Inst.P., Staff Editor (Physics).

Readers who are taking up wireless as a hobby, and have little or no electrical knowledge, will find a careful perusal of this special series of articles of great assistance.

PART XI

(Continued from No. 10, page 602.)

Electrolytic Rectifier

ANOTHER type of rectifier is that known as the "electrolytic" or "chemical" rectifier. This depends upon an entirely different action. The full account of its action cannot be given here, but it may be

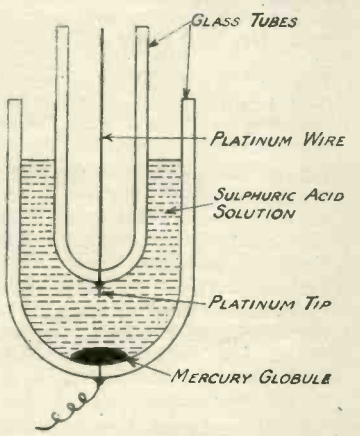


Fig. 1.—Illustrating construction of electrolytic rectifier.

stated that the appliance consists essentially of a vessel containing dilute sulphuric acid and provided with two electrodes, across which the alternating current is passed. The current sets free hydrogen and oxygen, the oxygen being deposited upon the positive electrode and the hydrogen upon the negative. When the plates are coated with the gases they are said to be "polarised"; this polarisation not only increases the resistance of the circuit, since the gases are bad conductors, but also sets up a difference of potential between the plates, which acts in the opposite direction to the applied E.M.F., and may have a value of about 1.5 volts. Thus when polarisation takes place the current flowing in the circuit is reduced; and if the applied E.M.F. is adjusted to be about equal to the E.M.F. set up by the polarisation, the current may be reduced to zero value. The action of the electrolytic rectifier is not fully understood, but it will be seen from what has been said that there will be a tendency to obstruct the flow of current in one direction and to allow a flow of current in the other direction. Thus if an alternating potential be applied to the device, more current will flow in one direction than in the other; in other words, the device will act as a "rectifier."

The reader will find later that the rectification of alternating current is fundamental to the reception of wireless telephony, and amongst the many devices which have been proposed and used for this purpose is the electrolytic rectifier which has just been considered. Its employment, however, requires a good deal of technical skill, and a fuller account of its operation will be postponed until later.

The Automatic Interrupter

A general account of the spark coil and the transformer has already been given. In one sense these two appliances are the same, but it is usual to draw a certain distinction between them. A *transformer* is generally understood to mean a combination of two or more coils so arranged that when alternating current is applied to one, alternating current is delivered from the other at a different voltage, the point for our present purpose being that the input and output are *alternating*. A *spark-coil* is usually understood to mean a similar arrangement, except that the current which is fed into the primary is not alternating current, but *interrupted direct* current. The make and break of a direct current in the primary will have a similar effect in the secondary to that which would be produced by the application of an alternating current to the primary, with, however, this important difference—that whereas with the alternating current in the primary the rise and fall of the current is gradual, with the interrupted direct current the make and break are much more rapid. Since the E.M.F. generated in the secondary depends upon the rate at which the magnetic flux through the

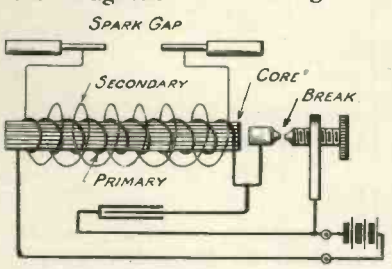


Fig. 2.—Construction of spark coil with automatic interrupter.

secondary is changed, it follows that with a very sudden break of the direct current in the primary a very high voltage may be developed in the secondary.

In using a transformer or spark coil in this way it is necessary to

have some means of automatically making and breaking the current in the primary winding. The simplest arrangement for this purpose is that which is shown in Fig. 2. The primary and secondary windings upon an iron core are indicated in the usual way, and it will be noticed that the primary current passes through a "contact-breaker" which usually consists of two

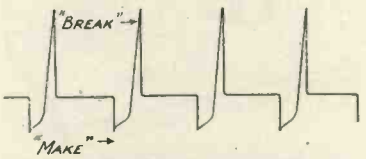


Fig. 3.—Graphical representation of potential developed by spark coil at "make" and "break."

platinum points. A piece of soft iron is mounted upon a piece of springy brass; a screw enables the pressure of the platinum points to be adjusted. It will be seen that when the primary current is switched on, the magnetic force due to the iron core will attract the armature which, in moving towards the core, will break the current at the contact. Upon the current being broken the magnetic force due to the core will vanish, and the spring will bring the points into contact again. This will re-establish the primary current, with the result that the armature will again be moved forward, the primary current will again be broken, and so on. Thus the interruption of the primary current will proceed automatically so long as the switch remains closed. It has been found that the "break" of the current is usually much more rapid than the "make," and consequently the induced current in the secondary coil is of a higher voltage when the primary current is broken than when the primary current is made. So much is this the case that we may neglect the induction effect at the "make," and consider only that at the "break" (see Fig. 3). The result is that the secondary current has a definite polarity, and it is possible to speak of the "negative" and "positive" terminals of the secondary coil. This is very important for many purposes, for example, if the coil is used to operate an X-ray tube. There are many devices designed to make and break the primary current of a spark coil, some being quite independent of the coil and positively driven by means of an electric motor. But that which has been described is a very simple one, and for many purposes quite satisfactory.

Another reason for describing this automatic "make-and-break" is that the action upon which it depends is also that of the common electric bell and of the device frequently used in wireless known as the "buzzer" (see Fig. 4). In an electric bell the armature is so arranged that it hits a bell as it vibrates (there being no secondary coil, of course). The working and the purpose of the wireless buzzer will be described later on in a subsequent issue of this journal.

The Microphone

Whilst we are dealing with the interruption and variation of currents, it will be convenient to consider the action of the device known as the "microphone." Its name implies that it is able to detect "small sounds," or, in other words, that it is a sound magnifier. The microphone is the appliance which is acted upon by the sound-waves from your voice when you speak into an ordinary telephone. An electric current passes through the microphone from a battery, and as the sound-waves set the microphone into vibration, its electrical resistance fluctuates accordingly, and the current is thereby made to vary in a manner corresponding to the sound-waves.

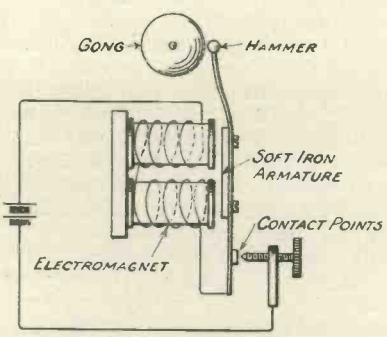


Fig. 4.—Simple illustration of construction of electric bell "buzzer."

The original microphone was invented by Professor Hughes, and took the form shown in Fig. 5. A carbon rod is pointed at both ends and rests in two carbon supports. If this arrangement were included in a simple electrical circuit which also embraced a telephone receiver, it is found that the slightest jar or vibration given to the carbon rod or its supports causes a considerable noise in the telephones. This is due to the fact that the resistance of the carbon contact varies considerably with the pressure which is applied across the points; any jarring produces variations in the pressure between the carbon rod

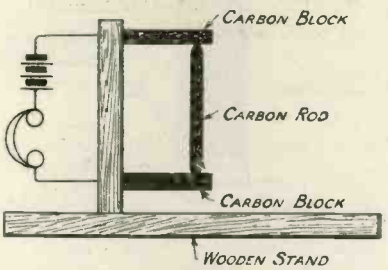


Fig. 5.—Arrangement of original Hughes' microphone.

and its supports, and thereby produces variations in the resistance and in the current flowing through the circuit. Thus a very small amount of energy in the form of vibrations applied to the microphone may cause a large amount of energy to be yielded by the battery in the electrical circuit, and hence a movement much too small to be heard directly by the ear may easily be heard in the telephones, if such movement is able to affect the microphone. For example, a fly walking on the baseboard of the microphone shown in Fig. 5 may very easily be heard in the telephones.

The microphone has been considerably improved since Hughes' day, and in its most modern form takes the shape of a small metal capsule, as shown in Fig. 6, with a mica diaphragm supporting a central metal disc, the two terminals of the microphone being the hollow case A and the metal disc B. Attached to A and B, in the interior of the case, are two plates of polished carbon, and the space between these is loosely packed with carbon granules. Thus, instead of one carbon contact, there are a very large number. This type is known as the "button" microphone, and is not only used in all telephones of the ordinary commercial kind, but is very useful for many other purposes. The microphones which have now been developed for broadcasting purposes are similar in principle to that which has been described, but have been modified to suit certain special requirements.

The fluctuating current which is obtained from the microphone circuit when sound-waves fall upon the microphone is then transmitted along the telephone line (or into the wireless transmitting apparatus, as the case may be), and at the other

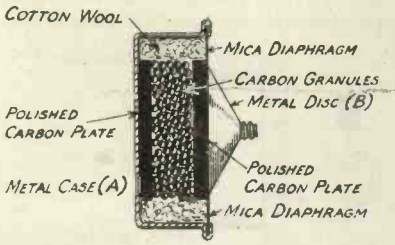


Fig. 6.—Construction of well-known form of modern "button" microphone.

end correspondingly fluctuating current eventually passes into a telephone receiver (or head-telephones or loud-speaker), where it actuates a diaphragm which produces sound-waves corresponding to those which originally fell upon the microphone.

The Crystal Detector

When we were dealing with Ohm's law and the passage of current through solid conductors, it was assumed that the *direction* in which the current flowed was of no account. In the majority of cases this is true, but there are certain cases of the conduction of electricity through solids (or, to be more accurate, through the *point of contact* between two bodies), where Ohm's law ceases to hold, and where also

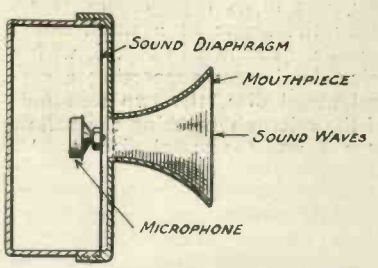


Fig. 7.—A form of telephone transmitter, showing "button" microphone mounted upon sound-diaphragm.

the conductivity depends upon the *direction* of the current. The most familiar example of this is the case of certain mineral ores, such as those of lead, copper, and zinc; if a contact is made between a piece of such ore and a metal plate (or another piece of suitable ore), it is found that the resistance of this contact is very much higher to current passing in one direction than to current passing in the opposite direction. The cause of the action is still obscure, but according to one theory it is supposed to be connected with the development of heat by the current at the point of contact. An important practical application of this fact is the making of a rectifier for alternating current. It has been found that there is extremely little lag in the effect, and consequently it is able to respond to fluctuations of extremely high rapidity, such as those occurring in the oscillatory current received from a wireless aerial. It has already been mentioned that very high-frequency alternating current cannot be detected by means of a telephone receiver, and that, in order to detect such high-frequency current, it is necessary first of all to rectify it. The crystal detector may very conveniently be employed for this purpose. All that is necessary is to mount the crystal in a suitable holder and to press against it a light metal spring, as shown in Fig. 8. The resistance of a crystal contact of this kind may be from 10,000 to 40,000 ohms.

It has been stated that such a contact does not obey Ohm's law. If the contact behaved like any ordinary solid conductor and obeyed Ohm's law, the curve showing the relation between the applied voltage and the resulting current would be a straight line. If gradually increasing voltages be applied to a crystal contact, however, it will be found that the curve showing the resulting current is that given in Fig. 9, A, B, C; thus between the voltage represented by B and that represented by C the rate of rise of the current with increase in the applied voltage is very rapid, whilst in the earlier part of the curve the rate of rise of the current with voltage is very slow. If we consider the point B on the curve, we see that a positive increase of voltage will produce a fairly large increase of current, whilst a reduction of voltage will produce very little reduction in current. Consequently, the crystal will allow much more current to pass through it when the voltage increases, in the direction indicated by the points corresponding to B and C, than when increased in the direction corresponding to the points B and A; in other words, the crystal will have a rectifying action. A fuller account of the action of the crystal will, however, be given in a later issue of this journal.

Crystals in Wireless Circuits

Some misunderstanding often exists amongst beginners as to why

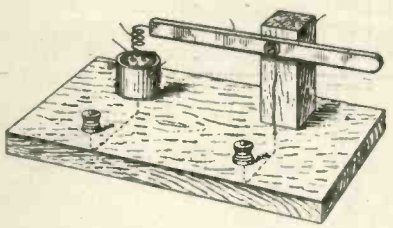


Fig. 8.—Crystal rectifier.

it should be necessary to rectify the oscillatory current received from a wireless aerial before the signals or telephony can be heard in the head-telephones.

In the first place, the natural frequency of vibration of the telephone diaphragm is usually about 800 vibrations per second, whereas the vibrations due to the oscillatory current from the aerial may be at the rate of a million per second. Consequently, the amount of the response on the part of the telephone-diaphragm is extremely small, and the sound produced would be too faint to be heard.

In the second place, the human ear is limited to a certain range of frequencies, and cannot hear sounds of frequency much above 10,000 per second; it cannot per-

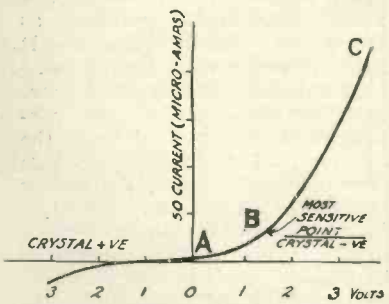


Fig. 9.—Curve showing relation between voltage applied to crystal rectifier and resulting current (carborundum).

ceive sound of a million vibrations per second. Rectified current works the diaphragm one way only, and the high-frequency waves are modulated by the speech-waves, producing audible sounds in the telephone.

A WELL-ORGANISED WIRELESS FACTORY

From time to time we purpose publishing short accounts of the works and equipment of various well-known wireless manufacturers. This will enable our readers to appreciate the care and organisation involved in the manufacture of wireless instruments and components. Other firms interested should communicate with us.

WE recently had the pleasure of paying a visit of inspection to the works of the Radio Instruments, Ltd., at 12, Hyde Street, New Oxford Street, London, W.C.1. The Managing Director, Mr. J. Joseph, M.I.E.E., is well known amongst wireless engineers, having been associated with wireless telegraphy since it was first introduced into the British Navy by Admiral (then Captain) Jackson, in 1900. In the design of new apparatus Mr. Joseph has the able assistance of Mr. W. A. Appleton, M.B.E., M.I.R.E., director of research to the company and late Admiralty technical research officer and designer of wireless apparatus.

The firm's premises have undergone considerable reconstruction, resulting in the provision of adequate floor space for the various well-equipped workshops in which some 280 workpeople are afforded employment.

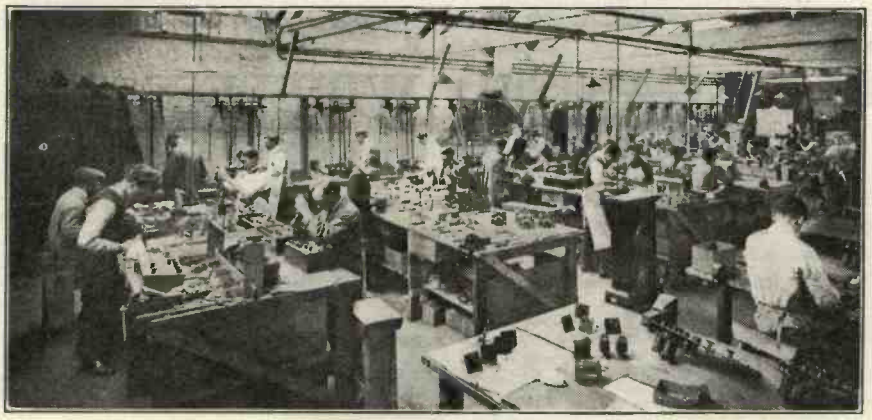
Apart from the stores, where ebonite and other materials are kept, and the offices and showroom in the basement, there are five workshops exclusively engaged in the manufacture of high-class wireless sets and components. The sections or departments are as follows:—Machine shop, assembly shop, wiring shop, transformer shop and test room.

The accompanying illustrations show a corner of the test room where every piece of apparatus is carefully tested before being passed for sale, a general view along the assembly shop, and the well-equipped showroom where all classes of apparatus made by the firm may be inspected or tried.

We found it very difficult to decide which of the three departments illustrated was the most interesting. In the assembly room we saw all types of apparatus from crystal to 7-valve receiving sets, in various stages of completion, and admired the efficiency obtained by the engineering practice of using jigs and gauges to enable parts to be made to a standard.

A corner of the room where apparatus is tested.

As the assembly of each instrument is completed, it is inspected, and, if satisfactory, is



A general view of the assembly shop.

passed along to the wiring department, where all the connecting wires are carefully fitted in place and neatly soldered with a dexterity which would be the envy of any experimenter who uses the soldering iron.

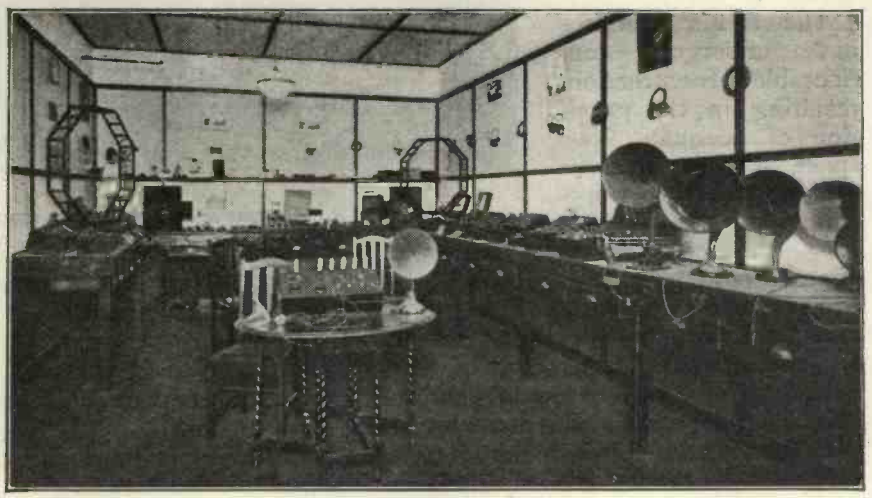
The completed instrument is then given a further inspection and passed on to the test room. The standard range of wavelengths for which the sets are designed is from 300 to 4,000 metres, and in order to give them a searching test under conditions approximating to those met with in actual practice, special instruments are provided so that, merely by moving a switch, frequencies corresponding to any wavelength within the range can be applied to the apparatus under test.

Some of these testing instruments have been specially calibrated at the National Physical Laboratory, and in this connection it is interesting to note that Mr. Joseph has been closely associated with the design and construction of much of the gear actually used in the National Physical Laboratory. For testing transformers a special form of valve oscillator is provided.

The transformer shop, in which are wound and assembled the high-frequency and low-frequency transformers and various types of reactance couplings, affords a good example of what can be accomplished in a comparatively new industry by the introduction of modern methods and machinery, the normal weekly output of H.F. or L.F. transformers from this shop being 2,500.

Similar production methods applied to other departments of the works enable some 600 variable condensers, made complete on the premises, and some 300 complete crystal and valve sets to be turned out each week, the majority of the latter being 3- or 4-valve sets.

Although we saw quite a good variety of apparatus in passing through the workshop, it was not until we arrived at the showroom that we fully appreciated the wide range of sets and components produced. Here, conveniently arranged round a spacious room, are crystal sets, amplifiers, 1- to 7-valve receiving sets, cabinet sets, loud-speakers, frame aerials, and all kinds of units and components, whilst by means of a suitable arrangement of switches prospective purchasers may hear the results obtained upon various types of loud-speakers. Anyone interested in wireless matters will find a visit to this showroom both interesting and instructive.



The showroom.

News of the Week

M. EDOUARD BRANLY, the inventor of the Branly Coherer and one of the pioneers of wireless telegraphy, was the guest of honour at the fête held at the Trocadero, Paris, recently to celebrate the jubilee of M. Branly's entry into scientific work.

* * *

M. Branly, who had an enthusiastic reception, delivered a lecture on the scientific wonders to which wireless telegraphy would pave the way.

* * *

Sir Laming Worthington-Evans recently showed in a financial statement for the year ended March 31st of the working of the Post Office Wireless Stations at Cairo, Leafield, Northholt, and Stonehaven, that these stations have made considerable losses, especially the station at Cairo, which off its own bat shows a revenue of £6,500 against an expenditure of £45,000. Sir Laming Worthington-Evans adds that Government traffic if not transmitted by means of these stations would perforce be transmitted by other routes more expensive than the wireless stations offer. Several of these services have only recently been instituted and it may be expected that the revenue accruing will increase as the service is developed.

* * *

According to the *Morning Post*, Major W. B. Zappert, of the Alexandria Fire Brigade, proposes to instal wireless telephone apparatus on each engine in his brigade. We seem to remember wireless apparatus being installed upon a fire engine in this country about 1920. Excellent results were obtained but, owing to the bulk of the apparatus, the main part of the engine had to be left behind.

A timely rebuke to the managers and concert agents is administered by *The Cinema*, which states: "To imagine for one moment, as some of those interested in the entertainment industry apparently do, that because they are frightened of wireless, its development can be artificially prevented, is as vain as to think of arresting the progress of human thought."

* * *

In the opinion of the *Leicester Daily Mercury*, broadcasting is no more detrimental to the theatre and concert managers than is the moving picture or the gramophone. There is room for all, and each has its place. The wireless receiver will eventually become part and parcel of the household equipment. Property owners in America are already advertising flats "complete with wireless apparatus."

* * *

We learn that the Radio Society of Great Britain has formed a Schools Radio Society. Mr. R. J. Hibberd, M.I.R.E., headmaster of the Grayswood Schools, and himself keenly interested in wireless experimental work, has been appointed organising secretary.

* * *

The Broadcasting Committee continue to hold meetings and hear evidence. Recently Mr. A. A. Campbell Swinton, F.R.S., Past President of the Radio Society of Great Britain, gave evidence on behalf of the Radio Society. Mr. F. Landman, Hon. Secretary, Major J. H. Beaumont, on behalf of the Radio Association, an organisation which represents the non-technical listeners, also gave evidence before the Committee.

* * *

According to a contributor to the Hull *Daily News*, the B.B.C. apparently believe that the East Coast is uninhabited, as no consideration has been given the counties of Lincolnshire and Yorkshire with regard to broadcast reception. In other words, satisfactory reception proves a somewhat costly matter, and the possibility of the erection of a relay station should certainly receive consideration.

* * *

We gather that the beneficial effects of broadcasting were promptly evident in the case of the Marionette players at the Scala Theatre, seats being booked by many listeners-in.

* * *

According to a recent visitor from America, considerable difficulty is being experienced by the various broadcasting concerns in effecting a settlement of the music copyright question.

* * *

We learn that the first provincial wireless performance of Shakespeare was given at Newcastle by the Alexander Marsh Shako-

BROADCAST TRANSMISSIONS

	Call-Sign	Wavelength
CARDIFF	5 WA	353 metres
LONDON	2 LO	369 ,,
MANCHESTER	2 ZY	385 ,,
NEWCASTLE	5 NO	400 ,,
GLASGOW	5 SC	415 ,,
*BIRMINGHAM	5 IT	420 ,,

TIMES OF WORKING.

Week-day ... 11.30 a.m. to 12.30 and 5.30 to 11.0 p.m. B.S.T.

*Birmingham—3.30 to 4.30 p.m. instead of 11.30 a.m. to 12.30.

Sundays ... 8.30 to 10.30 p.m. B.S.T.

SILENT PERIODS.

CARDIFF	8.0 to 8.30
LONDON	7.30 ,, 8.0
MANCHESTER	7.45 ,, 8.15
NEWCASTLE	8.0 ,, 8.30
GLASGOW	7.45 ,, 8.15
BIRMINGHAM	8.15 ,, 8.45

spearean Company. Scenes from "Julius Cæsar" and "Romeo and Juliet" were broadcast.

* * *

Lord Knutsford, the Chairman of the London Hospital, recently announced from 2LO that, as a result of his recent appeal, the satisfactory sum of £6,000 had been realised. We understand that a further sum of £4,000 is still required to enable the unused wing of the hospital to be reopened.

* * *

Referring to our remarks in a previous issue, regarding spark interference, it has been suggested that a great deal of this interference would be obviated if professional operators would more carefully observe the official regulations. We ourselves have frequently heard certain ships transmit the received signal (R) at least six times in succession instead of once. On other occasions stereotyped weather reports have been transmitted twice in full, and on full power, although the receiving station was not more than about twenty miles distant.

* * *

Further details of the experimental wireless reception underground at the Dykehead Colliery at Larkhall are now to hand. The test was carried out by Messrs. W. A. Smith, Limited, of Glasgow, with the hearty co-operation of the colliery management. An Ethophone V (4-valve) B.B.C. receiving set was placed upon a waggon in the cage, and lowered down the shaft. Strongest signals were received at a depth of about 180ft. At a depth of 330ft. the waggon carrying the set was run off into the working of the pit, when signals improved somewhat and the orchestral and vocal items from 5SC were clearly received.

* * *

We understand that the Prince of Wales' speech, broadcast recently from the Birmingham Town Hall, was received with great clarity.

* * *

We admire the enterprise of Mr. Ward, of the City Accumulator Co., whose Daimler car, complete with "cage aerial," 7-valve receiving set and loud-speaker, may be seen touring the streets of the City and West End each evening, broadcasting as it goes. So effective is the apparatus that the music, etc., transmitted by 2LO can be clearly heard some 200 yards away from the car. Not only will this novel advertising scheme benefit the City Accumulator Co., but it will undoubtedly do much to popularise broadcasting.

Copyright Photo. *Underwood & Underwood, N.Y.*

Miss Frieda Hempel, a famous American singer, broadcasting from the American station W J Z. How many British experimenters have heard her?

THE QUANTUM THEORY

By J. H. T. ROBERTS, D.Sc., F.Inst.P., Staff Editor (Physics).

PART VII.—MODERN ELECTRICAL THEORY OF MATTER

THE radiation of energy, whether by wireless, or by heat, light, or other rays, is considered to be due to undulatory motion in the universal medium called the ether—the word "motion" being here understood to have reference to electro-magnetic displacement. The wave-theory of energy-radiation has held almost undisputed sway for many generations, and there has been not only a growing belief in the reality of the ether, but a tendency to explain an ever-increasing number of phenomena in terms of such medium.

Of recent years, however, doubts have been thrown not only upon the wave-theory, but even upon the existence of the ether itself, and a number of important observations have been made which certainly seem very difficult to reconcile with the comparatively simple theory which has hitherto obtained. On the other hand, it must be admitted that no alternative theory has yet been put forward which can be regarded as promising completely to supplant the more conventional theory.

In Newton's time a corpuscular theory of light was developed and was commonly accepted. According to Newton's theory, light-radiation consisted of a shower of particles, which were deflected in various ways when in close proximity to material bodies. Newton spent great trouble and exhibited extraordinary ingenuity in his mathematical attempts to explain the various phenomena of light on the corpuscular hypothesis. With the advent of the wave theory, Newton's corpuscular theory was overthrown; it is, therefore, all the more remarkable that some of the most recent discoveries, both in mathematical and in experimental physics, seem susceptible of explanation on a corpuscular theory of the transmission of energy through space.

Before generalising any further, however, it will be useful to examine some of the actual experimental observations which have led to fundamental beliefs being thus called into question.

It was explained in the previous article that when X-rays fall upon a material substance, two separate phenomena usually occur: firstly, electrons are ejected from the atoms of the substance, and secondly, X-rays are re-radiated.

The radiation which falls upon the substance is absorbed by the oscillatory atomic systems and is

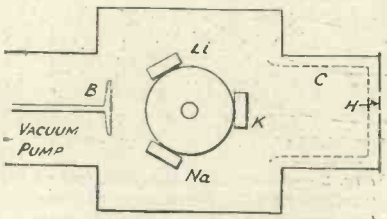


Fig. 1.—Millikan's apparatus for measurements upon the photo-electric emission from electropositive metals. By this apparatus the kinetic energy of the emitted electrons can be accurately determined.

re-radiated with or without change of frequency, change of frequency depending upon the atomic oscillatory systems and the frequency of the original vibrations. A familiar example of the absorption of energy, and its re-radiation with change of frequency, is provided by the fluorescence of certain substances which emit light of a characteristic colour when radiation of short wavelength (such as ultra-violet rays) falls upon them. When a substance is exposed to X-rays it will re-radiate its own characteristic vibrations when these are of lower frequency than that of the incident radiation.

The other effect which we have referred to, namely, the ejection of electrons from a substance by incident radiation, is also characteristic of the radiation, but the frequency of the latter must be above a certain limiting value. For example, ultra-violet light, X-rays and gamma-rays are all able to eject electrons from material substances, but the effect is less marked when the incident radiation approaches in frequency the violet and visible-light range, although the "threshold frequency" (as it is called) depends also upon the nature of the substance. A popular description of what happens when X-rays are produced by the impact of swiftly moving electrons upon an anti-cathode target, and when these rays are incident upon other substances and cause the ejection of electrons, has been given by Bragg somewhat as follows:—

"If the anti-cathode of an X-ray tube were magnified in size until it was about as large as the moon's disk (a magnification of 10^8), the atoms would be spheres about a centimetre in diameter, whilst the electrons and the nuclei would be invisible to the naked eye. The distance from the earth to the moon would correspond roughly to the distance between an X-ray tube and a substance placed near by, exposed to the rays. Let us suppose that electrons are shot at the moon with a certain velocity, and that every second each square foot receives one electron. A radiation proceeds from the moon, and will cause electrons to spring out of any bodies upon which it falls. They leap out of earth, here one and there one; for every square mile of sea and land, one a second or thereabouts. They may have various speeds, but none exceed, although some may just reach, the velocity of the original electrons which were fired at the moon. This, reduced

again to normal size, is the process that goes on in and about an X-ray tube. It is part of an universal process going on wherever electron or ray falls upon matter and is one of the most fundamental operations in the material world."

The electrons which are thrown out from a material substance by the agency of X-rays leave the atoms of the substance with energies similar to those of the cathode particles which originated the X-rays. These ejected electrons start from the atoms, initially in a direction at right angles to the path of the X-ray beam. If the substance in question is a gas, the resulting ionisation caused by the passage of these released electrons can be recorded photographically by the method of C. T. R. Wilson, which has been previously explained and illustrated.

Photo-electric Effect

When electrons are ejected from a substance by the agency of radiation within the visible or ultra-violet region, the effect is described as "photo-electric," and is probably the underlying cause of a variety of photo-chemical actions such as those employed in photography, and probably in the retina of the eye. It was discovered in 1888 by Hallwachs, that when light (of a certain minimum frequency, as has already been mentioned) falls upon a metal plate, the latter will become positively charged, or, if it is originally negatively charged, it will be discharged—in other words, there is evidence of the loss of electrons from the plate.

The "quantum theory" has already been mentioned; it was introduced by Planck in 1901, and arose out of certain observations on radiation. In 1905 Einstein made some applications of the quantum theory to the phenomenon of photo-electric emission. One of the results of Einstein's work was the prediction that the photo-electric emission should conform to a simple relation, which will be discussed presently.

Einstein assumed that an electron can only be emitted in this way after it has absorbed a certain definite amount of energy, and, further, that the amount of energy which is required for the electron to be released in this way is proportional to the frequency of the radiation. This amount of energy is called a "quantum." The quantum is not a fixed quantity, although it is a definite amount which is invariable for a given frequency of the incident radiation. In fact, if n is the frequency of radiation and h is a number known as "Planck's constant," the quantum of energy is equal to hn. It will be evident that the amount of energy which is required for an electron to get free from the atom can be expressed in terms of the quantum theory by saying that it is equal to the quantum of energy absorbed by the electron from an incident radiation of a certain definite frequency n_0. This frequency is called the "threshold frequency." If radiation of frequency n (higher than n_0) is incident upon the substance, the quantum of energy absorbed by an electron will

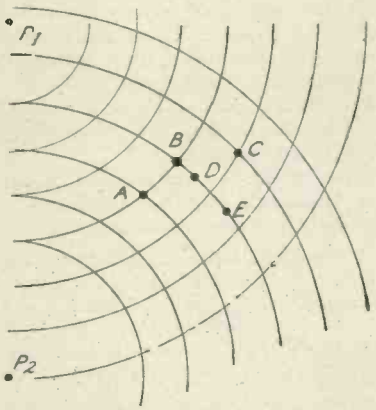


Fig. 2.—Illustrating the principle of "interference." Waves proceed from two sources P_1, P_2. At points such as A, B, C, reinforcement takes place. At certain other points, such as D, E, opposition or neutralisation occurs.

be greater than that which is required to release the electron, and the latter will proceed from the substance with a definite amount of surplus energy, which can be expressed as being equal to the difference between two quanta, namely, $hn-hn_0$, or $h(n-n_0)$.

Einstein's Relation

This is Einstein's relation, and it is interesting to remark that at the time Einstein's investigations were made there was no evidence of the proportionality between the frequency of the light and the total kinetic energy of the emitted electrons. Subsequent experimental verification of this relationship constitutes striking evidence in support of the quantum theory.

Experimental Evidence on Quanta

A careful series of investigations has been carried out by Millikan on the photo-electric emission of electrons from certain metals. Particular metals used by Millikan were sodium, potassium and lithium, these metals being chosen because of their strongly electro-positive nature; the configuration of their atomic systems is such that electrons are readily emitted. The apparatus which Millikan used is indicated in Fig. 1, where the pieces of the three metals are shown arranged upon a support capable of rotation in such a way that each in turn can be brought to face the gauze cylinder C. The radiation enters the apparatus through the holes H, and falls upon the particular metal under investigation. A rotary knife-blade B enables a shaving to be taken from the metal so as to expose a fresh surface.

The principle of the experiment is as follows:—When the electrons are emitted from the metal surface they will start away with a certain kinetic energy, represented by the difference of two quanta, as already mentioned. If, however, an electric field be established between the metal and the gauze cylinder C, the direction of the field *opposing* the motion of the emitted electrons, it will be possible to adjust the value of this field until the electrons are just unable to reach the gauze. It is then possible, by simple calculations, to determine the kinetic energy of the emitted electrons. In this way Millikan determined the value of hn, and, since the frequency of the radiation was known, the value of h, Planck's constant, was determined.

Another important matter which was investigated by Millikan was the fact that the energy of the emitted electrons depends solely upon the substance and the frequency of the incident radiation. It might at first be thought that if more intense light were allowed to fall upon the substance, the emitted electrons would depart with greater kinetic energy. This, however, is not so; if the light is more intense a *greater number* of electrons are admitted, but none leave with greater energy than that given by Einstein's relation. This is a very remarkable result. It seems to be definitely ascertained that whenever an electron strikes a substance, causing the emission of radiation, the energy associated with the ra-

diation is given by $h\nu$, and the same relation holds whenever the incidence of radiant energy upon a substance gives rise to the photo-electric emission.

The inevitable conclusion from these and such like observations is that energy is emitted in definite quanta. Certain questions naturally arise:—Is energy granular or atomic in character? Is energy transmitted through space in a corpuscular manner, similar to that conceived by Newton in connection with the transmission of light? Does an electron system expend energy only in definite amounts, and when an electron absorbs energy, does it ever absorb less than one quantum at a time? If an electron receives and emits energy only by quanta, it is presumable that its total energy at any time is an integral number of quanta. It will be seen from these questions that science is faced with an abstruse and complicated problem in regard to the proper conception of the mechanism of the absorption and emission of energy.

The photo-electric emission from a substance commences the moment the substance is exposed to light of the proper frequency. This would seem to indicate that the incident radiation had a "trigger" action upon the photo-electric emission, as otherwise it would seem reasonable to suppose that a certain time must elapse before the atomic system had absorbed sufficient energy to release the electron. The idea that the energy is already resident in the electronic system and is tripped off, as it were, by the incident radiation, is also supported by the fact that the kinetic energy of the emitted electron is independent of the intensity of the incident radiation. For example, if light falls upon an electro-positive substance, equivalent to that from a candle a mile away, the photo-electric emission can be detected, and the kinetic energy of the emitted electrons has been found to be constant (although the *number* of electrons increases) throughout the enormous range of intensities represented by bringing the candle from that distance up to within one inch of the substance.

On the other hand, there are many considerations which lead us to the conclusion that the energy of the escaping electrons is actually derived from the incident light—that is, to a view of the continuous absorption of energy, and its release only in quanta.

Again, conditions are easily arranged in which a considerable time would be required for an electronic system to absorb one quantum of energy. For example, if we have a source of radiant energy, and we calculate the amount of energy per second which reaches an atomic system placed at a certain distance from the source, on the assumption that the energy spreads out uniformly in all directions, and that the amount of such energy absorbed by the atomic system is proportional to the solid angle subtended by the system at the source, we can so arrange the values of the energy-emission and of the distance between the source and the object that a considerable time would be required for the absorption of one quantum by the atomic system. It is found, however, that, even under such circumstances, the photo-electric emission commences instantaneously.

But if, instead of imagining the radiation to proceed uniformly over an ever-increasing sphere, we think of the energy as being shot out in all directions like a shower of invisible particles, each particle comprising a *bundle of energy*, as it were, we see that certain electrons will receive, perhaps, a whole bundle of energy which will represent considerably more than would be their share according to the ordinary solid-angle theory mentioned above. Thus a corpuscular view of the emission of energy provides an explanation of certain of the observed facts. There are, however, other observations which are more simply explained on the continuous wave theory of energy emission.

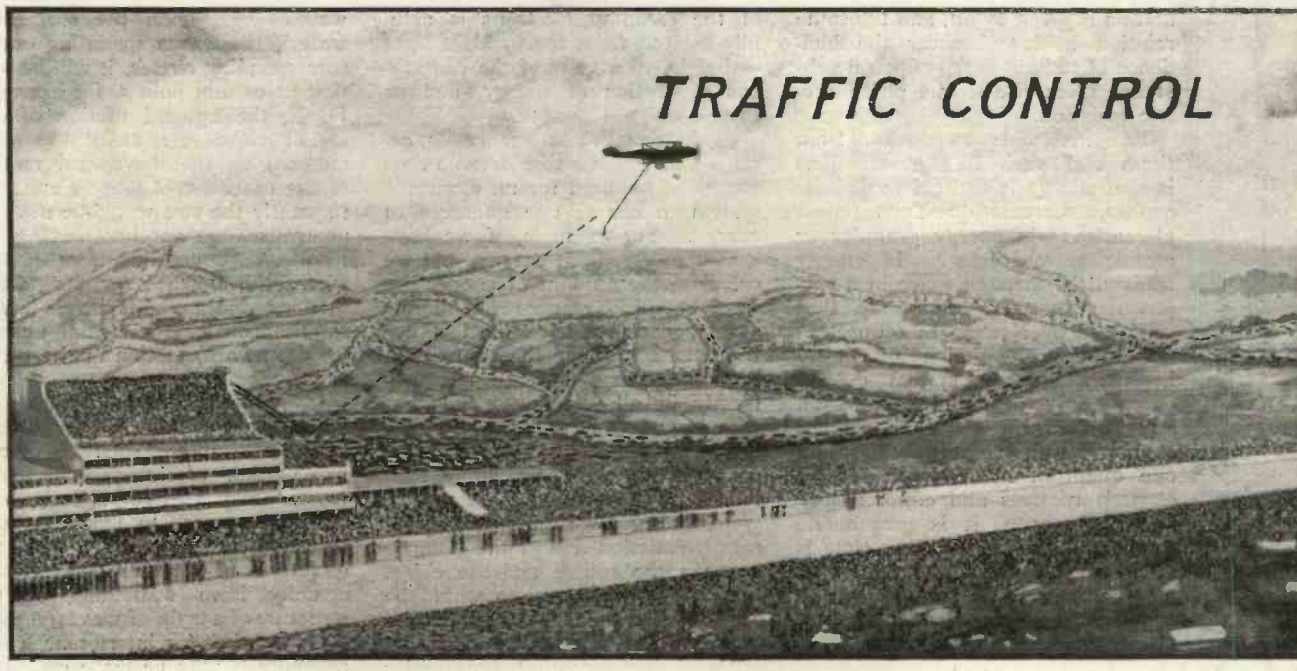
Interference

Probably the most difficult optical phenomenon to explain away by Newton's corpuscular theory of light was that of interference. This is a very simple and familiar effect which commonly occurs when two or more different sets of waves pass through the same point. A simple explanation of interference may be given by reference to Fig. 2. If P_1, P_2 are two points emitting waves (*e.g.*, upon the surface of water), the waves spreading out in corresponding circles, it will be seen that at certain points, for example, D, E, the upward motion of one set of waves arrives at the same moment as the downward motion of the other set of waves, and consequently the two would-be motions neutralise one another partially or wholly. At certain other points, where the upward (or downward) motions due to both waves arrive simultaneously, the actual upward (or downward) motion of the waves is increased.

It will be seen (points A, B, C) that a corpuscular theory does not offer such a ready explanation of interference as a wave theory. Attempts have been made, however, to overcome this difficulty by supposing that the quantum of radiant energy may actually have something of the structure of a train of waves (capable of accounting for interference), and although it may be large compared to the "wavelength," may nevertheless be small compared to the velocity (that is, to the distance travelled by the radiation per unit time), thus accounting for its corpuscular characteristics.

Conclusion

Possibly the two aspects of radiant energy ("quantum" and "wave motion") are not incompatible. Professor Eddington, in his "Space, Time and Gravitation," says:—"Physical reality is the synthesis of all possible physical aspects of nature. An illustration can be taken from the phenomena of radiant energy or light. In a very large number of phenomena the light coming from an atom appears to be a series of spreading waves. In many other phenomena the light appears to remain a minute bundle of energy, all of which can enter and explode a single atom. There may be some illusion in these experimental deductions; but, if not, it must be admitted that the physical reality corresponding to light must be some synthesis comprehending both these appearances. How to make this synthesis has heretofore baffled conception. But the lesson is that reality is only obtained when all conceivable points of view have been combined."



DERBY Day, 1923, if worthy of no special mention in other ways, will go down in the annals of that great sporting event as the one in which the streams of traffic from London to Epsom were directed and controlled by means of wireless telephony.

We are now so familiar with the use of radiotelegraphy at sea that we have come to expect wireless to play a vital part in any drama that takes place on the ocean, whether it be a ship in peril, a criminal escaping, or a person dangerously ill on board a ship which does not carry a doctor. We also know the value of wireless in connection with the navigation of aerial traffic on the Continental air routes, but it is something new and decidedly novel to see wireless brought into direct contact with one of our great national sporting events.

Statistics of the number of vehicles travelling on the roads to Epsom on Derby Day show how the volume of traffic is increasing from year to year. For example, this year's count gave a total number of vehicles 3,400 in advance of the corresponding figure for last year. This increase of traffic has called for a proportionate increase in the number of police engaged in controlling the traffic. The old methods of intercommunication by land-line telephony between various points have become inadequate, and a more centralised system of control is imperative.

When the movements of a large body of men, or the movements of traffic on a big scale, have to be controlled from a central control station, everything depends on two things, observation and inter-communication between observational points and the control station. Both of these things must not only be capable of being carried out rapidly but must be perfectly reliable.

For observation of traffic on the Epsom roads on Derby Day an aeroplane naturally suggested itself, but the authorities, evidently remembering that there are still some kinds of weather which can make flying impossible, wisely decided not to trust entirely to aerial observation, but to have also a fast motor tender equipped with wireless apparatus. It is perhaps in this motor tender, which could move rapidly from point to point in the most congested areas and *either transmit or receive while travelling at full speed*, that the chief interest lies with regard to the wireless installations employed on Derby Day, 1923.

The scheme of wireless intercommunication mapped out for use on Derby Day was based on a series of successful experiments carried out by the police authorities with the help of the Marconi Wireless Telegraph Company. These experiments were spread over a period of a few months, and the results must have been very gratifying to those who designed the apparatus.

As it originally stood, this problem of wireless intercommunication was to provide means whereby fixed control stations at Scotland Yard and Epsom could be kept in constant touch with an aeroplane flying over the Epsom area and a motor tender patrolling the roads between London and Epsom.

The conditions under which wireless telephony may be transmitted from and received by an aeroplane differ considerably from the conditions which obtain at a ground station. There are the noise of the propeller, the rush of air, and the rattle of the engine. Then again there are the complications arising from the use of a trailing aerial which is released when the machine is clear of the ground. In connection with the installation and working of wireless apparatus on an aeroplane, the Scotland Yard traffic control officers were able to draw on the almost unlimited experience of others in this important branch of wireless work. The establishment of wireless communication between two ground stations was also a matter of everyday experience in wireless, so that the chief technical interest with regard to the wireless equipment used in traffic control work on Derby Day lies, as we have already stated, in the mobile motor tender.

Two of these motor tenders were employed, but as one of them remained stationary near the Grand Stand at Epsom, its use became commonplace. Each of the two tenders used a ½ kilowatt Marconi transmitter and a 7-valve receiver. In order to avoid interference, two special wavelengths were employed.

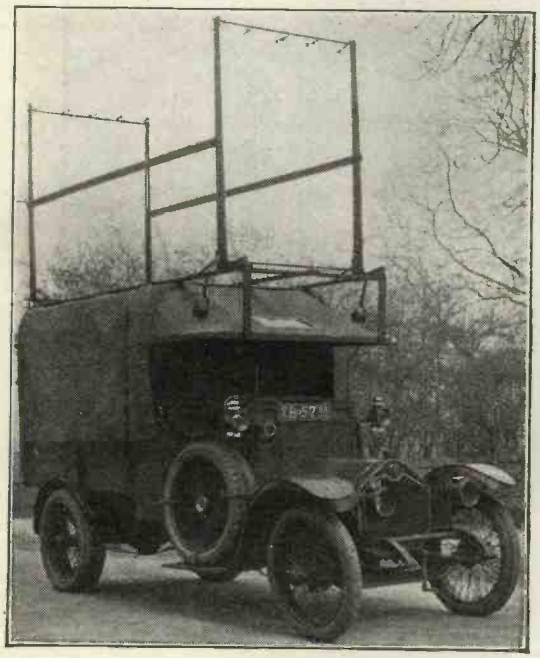
The reception of wireless signals on a fast-moving train has been successfully accomplished, and reception on a motor car moving at a high rate of speed has also been carried out, but it is one of the latest developments in wireless to be able to transmit successfully from a motor vehicle travelling along a road at forty miles an hour. This was actually accomplished by the wireless operators on the mobile tender on Derby Day, and the success obtained in this direction has caused the whole affair to be shrouded with the mystery and even the name of those famous "hush-hush" battleships of the early days of the war.

If this mobile transmission can be carried out with consistent success, the achievement is a notable one, for not long ago it was necessary for a motor tender carrying wireless transmitting apparatus to be stopped before transmitting could be attempted.

It is, of course, no new thing for an aeroplane to transmit when in full flight, but an aeroplane is provided with a long trailing aerial, and the machine is fairly steady in the air. A motor tender can only be equipped with a small aerial, and when travelling at full speed along a bumpy road one would

expect that no valve would have a dog's chance of surviving five minutes.

The aeroplane engaged on the traffic control observational work on Derby Day was the

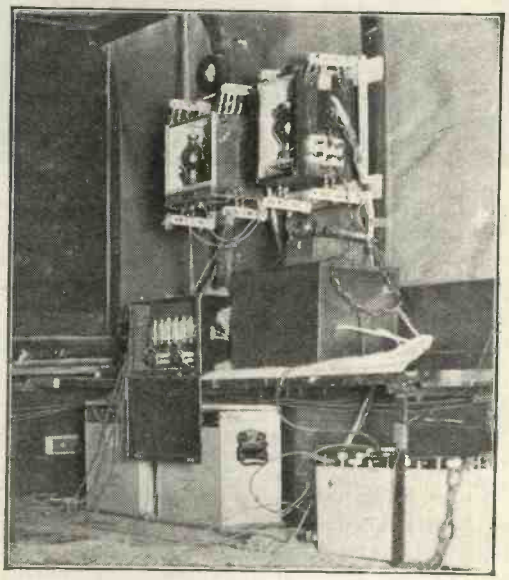


One of the Scotland Yard vans showing the collapsible aerial.

"City of Antwerp," a Vickers-Vulcan biplane of 360 horse-power belonging to the Instone Air Line, and coming from the aerial "port" of Croydon. In addition to pilot and mechanics and a police traffic control officer with attendant wireless operator, the "Antwerp" carried newspaper representatives and a cinematograph operator. The aeroplane cruised at a height of six or seven hundred feet, and at times it was possible for those on board to distinguish individual vehicles in the apparently unending flood of traffic.

If any criticism could be levelled at the traffic control scheme employed on Derby Day it is in the method of communication between the control station and the various points on the congested roads. The control officer this year relied very largely on land line telephony and motor cyclists. Effective communication with the mobile tender was also relied upon. Future developments will no doubt include the establishment of wireless receiving stations at all vital points on the roads.

Things have a way of moving so quickly in wireless that some of us may live to make our annual pilgrimage to Epsom in the days when every policeman on traffic control duty on the roads to the Downs will be equipped



The arrangement of transmitting and receiving apparatus in one of the vans.

with a wireless receiver and will have displayed on his uniform his natural wavelength in lieu of his present registered number.

T. S. F.

REPORTS ON AND DEMONSTRATIONS OF THE ST100.

Some of the excellent reports which we have received on the operation of this circuit are given in the correspondence columns. Readers will be interested to hear that Mr. Percy W. Harris, probably the most popular writer of sound constructional articles, and the author of four or five handbooks, is describing successful experiences with this circuit in the next issue of "MODERN WIRELESS" and will give full details of a simple home-made receiver embodying the circuit.

In view of the interest taken in it, Mr. John Scott-Taggart is giving a demonstration before the Ilford Radio Society of the excellent results obtainable with this circuit.

The demonstration will take place at 7.30 p.m. at St. Mary's Church Schools, High Road, Ilford, on Thursday evening, June 28th, 1923.

All interested are invited to attend this demonstration which will be the first given in connection with this circuit.

The advantage of holding the demonstration in Ilford instead of in the centre of London is that it will provide a real test, as a demonstration so close to a Broadcasting station would be of negligible value. It is also hoped that a demonstration of another circuit will be given.

In order to give the fullest opportunity for the demonstration of the results obtainable with the ST100 circuit, we shall be happy to hear from any Club Secretary who would like to witness a private demonstration, when our claims will be substantiated.

HIGH-FREQUENCY CIRCUITS IN RECEIVING WORK

By P. P. ECKERSLEY.

A further article of our series dealing with the technicalities of broadcasting.

IN my last article I dealt primarily with the chief cause of distortion in wireless reception, namely, the low-frequency amplifying circuits. It is, therefore, pertinent now to deal with the question of the high-frequency circuits

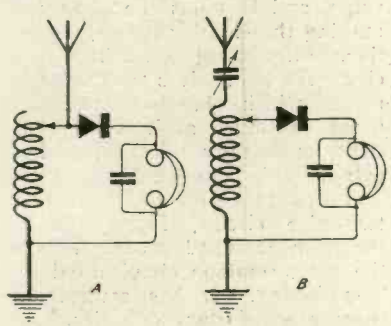


Fig. 1.—Simple crystal circuits.

in order to advise experimenters and others as to the best way of receiving broadcast.

In the first place, there is a fundamental difference between the attitude taken up by the average listener-in and the wireless professional engineer. Many experimenters look with scorn upon the instruments that are designed by wireless engineers proper, because they (the experimenters) rightly say that it is perfectly possible to get just as much sensitivity out of a given arrangement using, perhaps, three valves where the professional will use six. The professional, however, is always swayed by considerations of a large factor of safety and ease of handling.

As far as possible in the following article, the writer will try and take the point of view of the experimenter who does not look kindly upon apparatus which involves the expenditure of twice as many pounds on valves as is strictly necessary for a given performance. Thus, from this point of view, the two desiderata most to look for are :

1. Sensitivity.
2. Selectivity.

Of course, it must be understood straight away that the high-frequency circuits can very often be made very sensitive, but that their selectivity will be prejudiced thereby, and it is always a question of compromise. It is, however, rather horrifying to find sometimes that people in the South of London experience jamming from Croydon, because Croydon works on 900 metres, which is not even a multiple of 2LO's wavelength, and it shows, therefore, that in many cases the user has not got anything like a selective circuit, however effi-

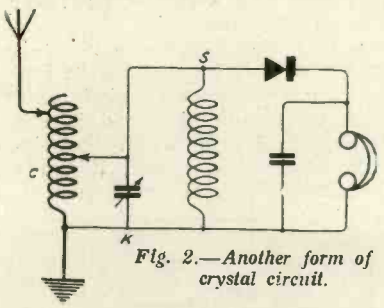


Fig. 2.—Another form of crystal circuit.

cient it may be from the point of view of sensitivity.

High-frequency Circuits—Crystal Reception

The first point to consider is the high-frequency circuit, and one may easily take the view that the high-frequency circuit includes the aerial.

There is a popular fallacy as regards the aerial which says that to get very good results, the aerial must be directional towards the station from which it is desired to receive. This is quite fallacious and it does not matter, always provided the height of the aerial is comparable with its horizontal length, in which direction the horizontal part points. Only when the horizontal part is perhaps ten times the height and when, therefore, the conditions of frame reception are approached, does the aerial system become directional.

The great point to concentrate on is getting the far end of the aerial well away from any earthed metal, while obtaining, as far as possible, a good height with a respectable horizontal part, using only the 100ft. of wire allowed by the Postmaster-General. Personally, I do not think that there is much increased sensitivity in the aerial system by using a twin aerial.

The simplest form of crystal receiver is illustrated in Fig. 1A. The great thing to realise is that a crystal is more sensitive, the more actual voltage that can be supplied to it, and therefore a lot of inductance must be included in the aerial circuit. Thus the simplest form would appear to be that of Fig. 1A.

Broadcast, however, takes place on rather short wavelengths, and

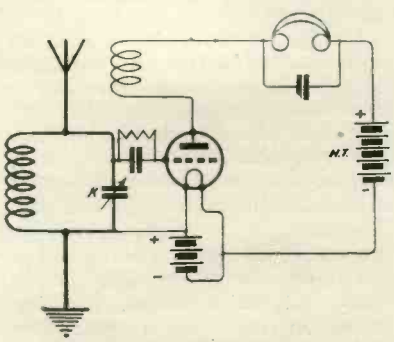


Fig. 3.—A single-valve circuit introducing reaction.

in many cases it is better to include a small variable condenser of value, perhaps, about 0.00025 μF in the aerial (Fig. 1B). A better method

is shown in Fig. 2, where in effect a coupled circuit is used.

The part C of Fig. 2 represents the tightness of the coupling, and a sensible compromise can be come to by varying the amount of C to give a respectable sensitivity and selectivity combined. The inductance S can be made very large indeed and the condenser K very small. K will tune the circuit.

The whole point in this arrangement is that considerable step-up in voltage is possible, since S can be made very large while still keeping the wavelength correct.

If it is always remembered that a crystal is a potential-operated or voltage-operated device, and it must therefore have lots of inductance connected across it, the right idea will have been obtained.

Valve Reception

The same does not apply to valve reception, because if a lot of voltage is applied between grid and filament of a valve, the same effects do not apply, and it is quite possible to get really good results by using quite a little inductance and relying upon the amplification of a valve.

A valve, as has been pointed out before, has a quality called grid current—that is to say, when the grid is made more positive than the filament, the high-frequency circuits have to supply current and are therefore loaded, and the voltage cannot exceed a certain amount.

The great point whereby a valve scores so tremendously over the crystal is that signals coming in weakly can be actually increased. A typical single-valve set is shown in Fig. 3.

In Fig. 3 a coil is shown in series with the anode circuit, which is coupled back on to the aerial. Everyone must know by this time, however, that this circuit has dangerous properties, inasmuch as it may be made to interfere with other listeners-in in the neighbourhood. Therefore, if the coupling between the anode coil and the aerial coil is too tight, the whole circuit oscillates and emits waves, and becomes, in fact, a little transmitter. The emitted waves coming from the receiver produce low-frequency beats with the incoming signal from the broadcasting station, and a howl is effectively emitted from the station.

Thus, in using the circuit in Fig. 3, the utmost care must be taken never to allow it to oscillate, and users of this circuit should exercise the utmost caution. It is quite easy to detect when this circuit is oscillating, because a howl will be heard in the 'phones. It is true that this howl may be due to some-

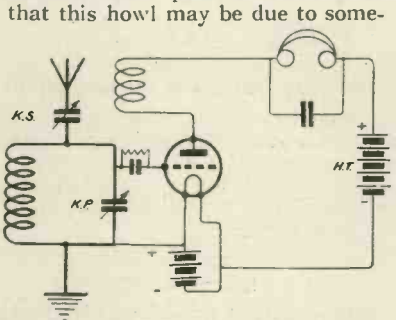


Fig. 4.—A modified single-valve circuit.

body else, but to prove whether or not it is somebody else, the best thing to do is to alter the tuning of the circuit that is being handled.

Therefore, if the condenser K of Fig. 3 is turned and the note of the howl varies sympathetically with the turning of that condenser, then the circuit is oscillating and is interfering with hundreds of other people's enjoyment. Steps should be taken immediately to reduce the coupling between the anode coil and the aerial coil, when the howl will automatically cease.

While speaking about this quality of reaction, it must be realised that when the circuit is used right up to the limit and is just not oscillating, although the signals may be very loud, they are undoubtedly, to a certain extent,

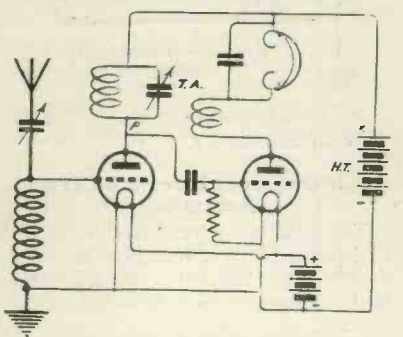


Fig. 5.—A two-valve circuit employing tuned anode.

distorted, because reaction has the quality of making the circuit very selective indeed, and a too selective circuit cuts out the higher harmonics from the broadcast.

Thus my advice to anyone using the single-valve circuit of Fig. 3 is to apply a little judicious reaction to get over the inefficiencies of the aerial and earth system, but not to arrange matters so that the circuit can ever oscillate.

The single-valve circuit of Fig. 3 is undoubtedly a good one, and if I were living, perhaps, ten miles from 2LO or any other broadcasting station and were only going to use head-'phones, I should plump for this circuit.

A slight modification is shown in Fig. 4, and this circuit of Fig. 4 has the quality of a control of selectivity. The series condenser K.S. should have a value of between 0.0005 and 0.00005 μF. When it is made very small, the condenser K.P. will have to be increased for a given inductance value, and this has the quality of making the circuit extremely selective. Introducing now a little judicious reaction, gives an arrangement which has extraordinary merit, inasmuch as it is very efficient, sufficiently selective, and is extremely easy to handle.

Let us turn now to the famous two-valve circuit, Fig. 5, using the so-called tuned anode. This is the most common circuit used for broadcasting. It has several extremely satisfactory qualities. Its *modus operandi* is as follows:—

Signals arrive in the aerial and small voltage impulses are superimposed between the grid and filament of the first valve. This results in increased impulses of current through the closed circuit T.A., and T.A. is set into oscillation at a greater amplitude than the aerial. This makes the potential at the point P vary up and down in sympathy, and in time with the arriving impulses, but with increased strength.

These increased potentials are handed on *via* the condenser to the grid of the second valve. The second valve does no amplification at all; it is merely a rectifier, but the system scores over Fig. 4 inasmuch as one high-frequency stage of magnification has been used.

Reaction can be introduced to this circuit by coupling the anode circuit of the detector valve with the circuit T.A., as shown, but here, again, great care must be taken.

A theory has been perpetuated—much to the sorrow of many listeners-in—that if reaction is used

according to the system of Fig. 5, all the beautiful qualities of reaction may be manifested without the possibility of annoying neighbours by radiation. Nothing is further

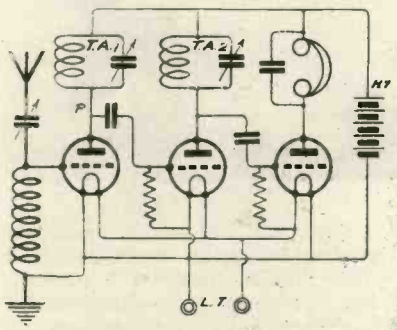


Fig. 6.—A three-valve circuit showing two tuned anodes.

from the case. It is perfectly possible to introduce reaction to Fig. 5 and annoy other users for miles around. It is obvious that this should be so, for suppose the circuit T.A. is made to oscillate, then the point P will be made to vary in potential, and the frequency of such variations is controlled by the natural period of T.A.

Now a capacity exists between P and the grid of the first valve, and the grid of the first valve is directly in contact with the aerial, and so it is obvious that the potentials of P will be handed on to the aerial circuit and the aerial will thus be set into oscillation.

Furthermore, apart from the capacity between the anode and grid of the first valve, unless very special precautions are taken, T.A.

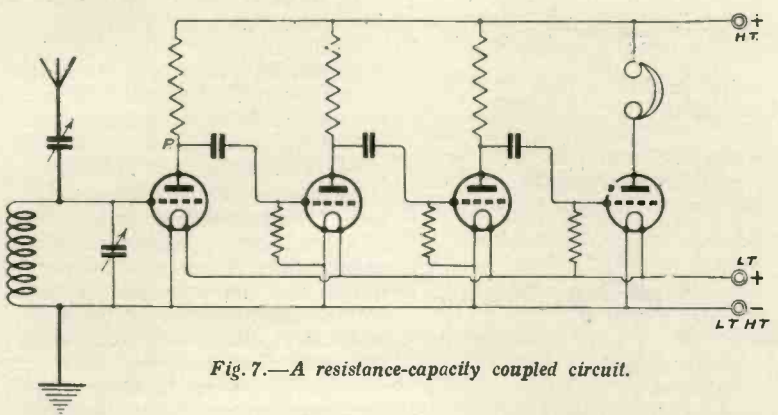


Fig. 7.—A resistance-capacity coupled circuit.

may very easily be strongly coupled with the aerial, and so any oscillations in T.A. are handed on automatically to the aerial again.

To prevent this circuit radiating, two precautions have to be taken: firstly, to neutralise the capacity effect between anode and grid of the first valve; secondly—and this is by far the most important—to prevent any coupling between T.A. and the aerial.

Many sets have been designed, as a matter of fact, and are now being sold bearing the B.B.C. mark, which do not offend in this respect, but this is only because the designers have taken special precautions, firstly, to prevent any coupling between the closed circuit T.A. and the aerial, and secondly, to neutralise the capacity effect between anode and grid of the first valve.

Unless such precautions are taken, it is extremely foolish to suggest that this circuit cannot radiate, and every amateur should be very careful to see, by actual tests, whether or not he is offending in this connection. There is absolutely no reason why a little trouble should not cure any radiation which occurs, but that trouble must be taken.

Next comes the question of how to introduce further high-frequency valves, and the first thing that leaps to the eye is the circuit of Fig. 6, in which two tuned anode circuits, T.A.$_1$ and T.A.$_2$, are employed.

Now the point is, that in using the circuit of Fig. 6 the user must be extremely careful to prevent the whole system bursting into oscillation itself, because it is so unstable that when first set up, this circuit will probably give serious trouble in this respect. The whole point, of course, is to try and arrange so that all the circuits are

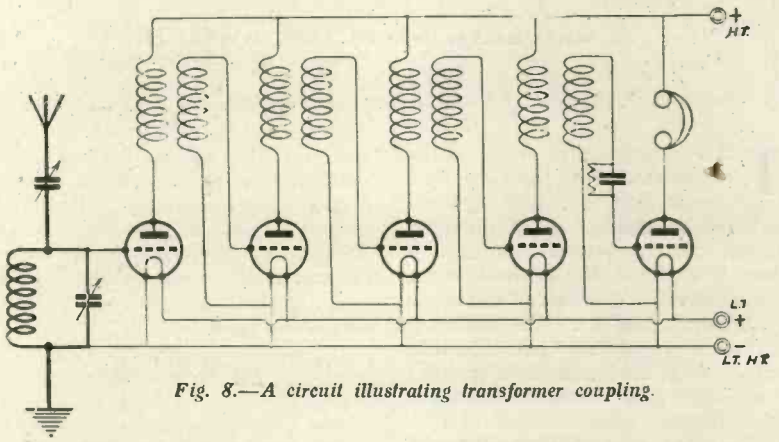


Fig. 8.—A circuit illustrating transformer coupling.

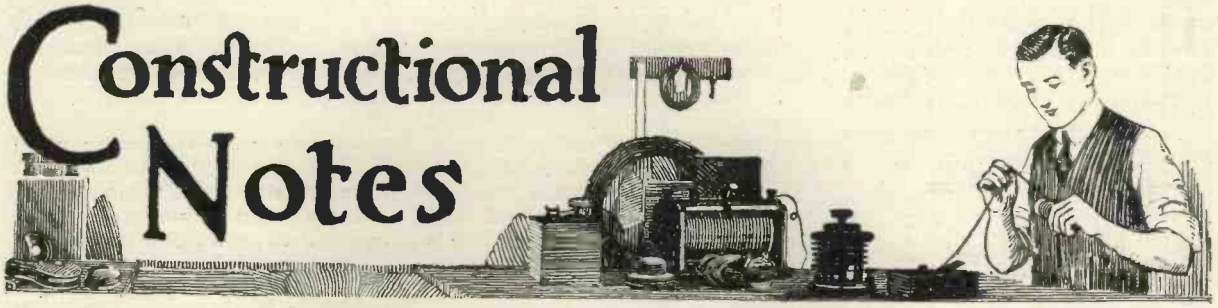
absolutely separate one from another, and cannot experience mutual couplings.

The resistance-capacity connection is shown in Fig. 7, and its action is perfectly obvious. Variations of potential come across the first valve, which make bigger changes in current in the anode circuit of that valve. By having a resistance in series with the valve, the potential of P varies, but to a greater extent than the potentials across the grid and filament of the first valve. This process can be repeated three or four times, and the circuit of Fig. 7 shows how this is done.

The resistances in series with the valve must be made absolutely non-inductive; that is to say, they must have no inductance, only resistance.

Lastly, the transformer type of high-frequency amplifier. This is obvious in principle, as shown in Fig. 8. On account of these transformers making tuning over all wavelengths difficult by virtue of their self-capacity, some are made with resistance wire in order to increase their resistance and therefore their damping.

Constructional Notes



A GRIDLEAK SELECTOR SWITCH.

THE experimenter who spends a good deal of the time that he is able to devote to wireless to the trying out of different valves and a variety of circuits, will have discovered for himself what a nuisance the gridleak of the rectifying unit can be. In ordinary transformer-coupled circuits some valves work best with it in parallel with the grid condenser, others with it connected direct to LT+, others when it lies between the grid and LT−; others again give the best results when there is no gridleak at all.

However get-at-able the connections of the panel one must make wiring changes that are a waste of time in order to try out these different connections, and the effect of constant unscrewing from and screwing up to terminals is not at all good for the leads, which, sooner or later, give way under such treatment.

The handiest fitting for the experimental set is a gridleak switch made on the lines shown in the drawings. It consists of a laminated rotary arm, mounted on a spindle provided with an ebonite knob, five studs and two stop pins. As these parts can be bought for eighteen pence, and as the fixing up of the switch needs no more skill than that necessary to drill 4 B.A. clearance holes for studs and pins, and a $\frac{3}{8}$in. hole for the spindle, the construction of this useful switch is neither an expensive nor a difficult job.

Ready-made switch arms have usually a radius of $1\frac{1}{4}$in. or $1\frac{1}{2}$in. The position of the centre of the hole for the spindle having been marked out on the panel, a segment of a circle of the appropriate radius is drawn, and five marks $\frac{5}{16}$in. apart are pricked off on its circumference with dividers. The

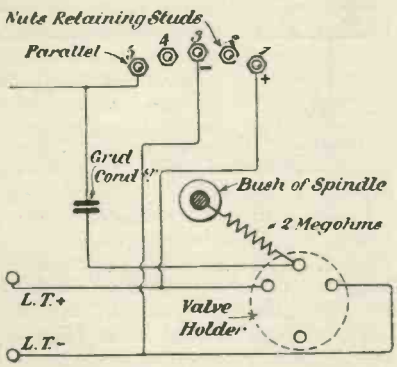


Fig. 1.—The connections of the switch.

six holes are then drilled, studs and spindle being afterwards placed in position. The points at which the holes for the stop pins will come are found by placing the arm on the two outer studs in turn.

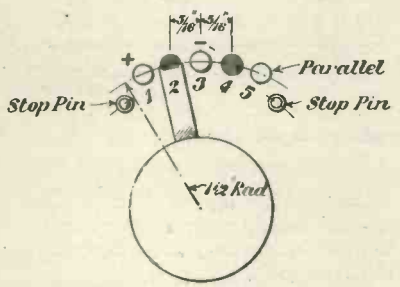


Fig. 2.—Details of the switch.

The pins should preferably be screwed into holes tapped to receive their threads; but if you have no taps they may be passed through clearance holes and secured by nuts above and below the panel. The nuts will probably have to be filed down a little in order to allow the pins to come near enough to the end studs.

Fig. 1 shows the wiring of the switch. It will be seen that if the arm is placed on stud No. 1, the leak is connected directly to LT+; No. 2 throws it out of action altogether; No. 3 connects it to LT negative; No. 4, like No. 2, disconnects it; No. 5 places it in parallel with the grid condenser. The two "out of action" studs are divided in order to avoid short circuits.

The utility of the device will be appreciated by those who use sometimes transformer-coupled H.F. amplifiers and sometimes tuned-anode or resistance capacity coupling. A slight movement of the switch enables the rectifier to function properly with any form of coupling.

In the experimental set the gridleak should be of the cartridge type, and its best position is upon the upper side of the panel. Leaks of different resistances can then be tried without the least difficulty.

This is a great advantage to all those experimenters who take pleasure in testing different types of valves, since almost every type requires a different value of leak. Not merely does the value of the leak affect the results obtained in the sense that a correct resistance is required to produce signals of maximum strength, but the quality of reproduction in the case of telephony also depends upon its adjustment. Insufficient rectification is a very common cause of distortion.

R. W. H.

CONNECTING AERIAL AND EARTH LEADS.

IT is rather a problem to find a suitable means of attaching the cabled wire of the lead-in and earth to the terminals of the tubes, fixed into wall or window frame, and provided with stout metal rods, which act as links beneath the outside and the inside of the house for the impulses received by the aerial.

Stranded wire is excellent stuff for conducting high-frequency currents, since these pass over only the outside skin of any conductor. If you look at a section of cable

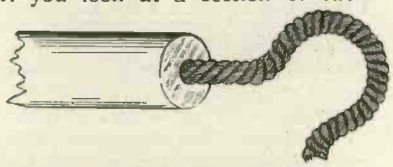


Fig. 3.—Showing the method of soldering up the ends of the wires.

you will see at once that the total skin area of all its strands is very much greater than that of the surface of a solid conductor of equal diameter.

Now it is of no use to provide beautifully free paths along aerial and earth wires themselves and to be content to have a big resistance at each of the outer terminals; and resistance there will certainly be if the cabled wires are attached to them in a rough and ready way. In this case, perhaps, only three or four of the seven strands make any contact with the terminals, with the result that the electrons, hitherto travelling over all seven strands, have to crowd at these points into about half that number.

The method which the writer uses, and which has always been most satisfactory, is as follows:—

Aerial and earth wires are treated in exactly the same way. Insulation is removed from the last two and a half inches of the cable. The wires are untwisted, and each strand is thoroughly cleaned separately with a piece of *old* emery cloth (new emery cloth would remove the tin coating); they are now twisted together again as tightly as possible with pliers. The next step is to bend them into a hook as shown in the drawing.

The hook is hammered flat, daubed with fluxite and plunged into a ladle of molten solder—the solder, by the way, must not be too hot or it will not stick. This makes the hook into a solid affair, each strand being bonded with every other, and a large contact surface for the terminals being provided. Any roughness is removed with a file.

The conductors that run through the lead-in tubes are made of 2 B.A. screwed rod. The terminals consist of large round nuts, of about the same diameter as a half-penny, which can be purchased for a penny apiece from advertisers in *Wireless Weekly*. These, as may be imagined, grip the hooks very tightly, and ensure good contact.

No earthing switch is used. When the set is not working, aerial and earth leads are detached from their terminals, hooked together and allowed to swing away clear of the house. This gives the best possible protection from the effects of lightning. R. W. H.

SERIES-PARALLEL AND EARTHING SWITCH.

MANY readers will make, or will have made, series-parallel switches for their A.T. condensers, and they will also fit aerial-earth switches to safeguard their sets during thunderstorms. These two may be quite easily and simply combined, and, in the case of panel-mounting, with considerable saving of room and corresponding increase in neatness.

Fig. 4 shows the wiring of the modified switch. 1, 2, 3, and 4 are the studs, whilst A and B are the moving parallel arms. It is unnecessary to describe the making of the series-parallel switch, as it is quite simple. For those who keep their *Wireless Weeklies* it may be said that instructions can be found in No. 3, April 25th.

The position of the 4th stud must be found by trial. The best way to do this is to stick a piece of stamp-edging somewhere near the correct place; it must be on the circle made by arm A. Move the switch, and determine if the end of arm A will touch it, and mark a pencil line on the paper. Then place B on 2 (A will be on 1, *i.e.*, the condenser will be in series), and see that the mark on the stamp-edging is clear of arm B, or the set will short-circuit to earth. Apply the punch to the pencil mark and drill a 4 B.A. clearance hole. Put in a stud and connect up with stud 3. When the set is left unattended all that is necessary to be done is to pull the series-parallel switch down until arm A connects the aerial with earth through stud 4, thus giving perfect protection against lightning discharges.

Such a method of earthing is much to be preferred from the standpoint of safety to the various arrester type of protectors. These latter are, as a rule, by no means

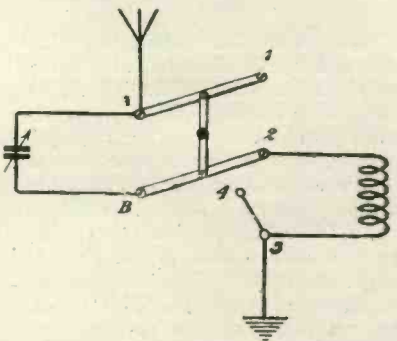


Fig. 4.—The connections of the combined switch.

such a complete protection against lightning as they seem. Although most of them are capable of shunting off a discharge so that it does not damage the apparatus, yet in doing so they may produce an arc capable of starting a fire.

J. M. T.

AN EXTENSION HANDLE.

IF an enthusiast is fortunate enough to possess a breast drill and a set of B.A. taps and dies the fitting of an anti-capacity handle to an existing ebonite knob is a fairly easy matter, but if these tools are not available it often seems that the job must be cancelled. For the benefit of those

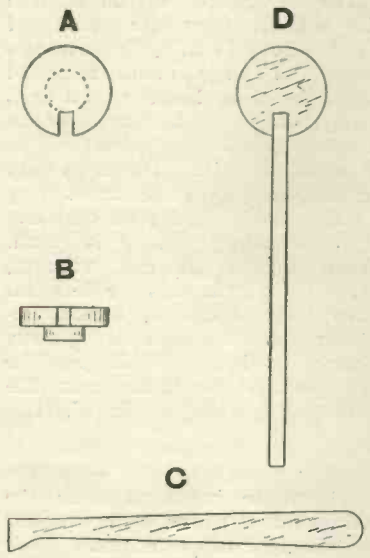


Fig. 5.—Details of the handle.

readers who find themselves thus situated the writer has devised a very simple little affair which, although possessing all the advantages of the "engineer-made" article, does not necessitate the use of the above-mentioned tools. The ordinary ebonite knob is removed from the condenser or other component and a slot is cut in the edge, by means of a saw or file, as shown at A and B. This should be cut down to the periphery of the hub, indicated by the dotted lines at A. A strip of ⅛in. sheet ebonite about 6in. long is shaped as shown at C, the length of the left hand edge being equal to the thickness of the knob and hub. This edge is smeared with a little seccotine and the handle is pushed tightly into the slot as shown at D, so that the top edge is flush with the top surface of the knob. The length of the strip is optional and, usually, the longer it is the better. In addition to being extremely simple this handle possesses a very neat appearance, and the advantages which it confers can hardly be over-estimated. In all cases where critical adjustments are required it is a great boon to be able to place all the dials in the exact positions required with the ease given by the leverage of the long handles, and with the certainty that when the hands are removed the tuning will remain correct.

O. J. R.

A HANDY CRATE FOR THE L.T. BATTERY.

AN unboxed accumulator is a nuisance, and it is something more than that, for it is really not at all a safe thing to have lying about the house. If it is accidentally upset someone may be badly burned, and any carpet with which the acid comes into contact will be ruined. But the greatest danger of all, one that probably few people realise, comes from the presence of drops of acid which have splashed out on to the top of the celluloid case at the charging station or during its journey home. If these run down the sides and come into contact with a soft wood floor, the heat generated by the action of the acid may be great enough to cause a fire.

To make everything secure, the battery should be housed in a strong crate made of teak. This wood resists the action of dilute sulphuric acid to some extent, and it can be made entirely acid-proof if it is thoroughly dressed with bees-wax.

The overall dimensions of the crate are not given in the drawing, since these will naturally vary according to the size and type of the accumulator for which it is designed. For small accumulators up to, say, 40 ampere-hours capacity wood ½in. thick is suitable; for the larger sizes the thickness should be ¾in. in order to provide a sufficient margin of strength. Ends and bottom are made solid, but the sides consist of battens 2in. broad, a wide opening being left between them so that the condition of the plates may be seen without removing the battery from its crate.

The wood, after having been cut out, should be well dressed with the wax. The crate may then be put together with stout screws, each being dipped in grease or bees-wax before it is driven home. When the ends and the two lower battens have been secured to the bottom, bees-wax should be worked into all the joints so that the tray of the crate may be water-tight. If there is any leakage or dripping from the battery, the acid will thus be confined to the waxed teak tray, where it can do no harm.

The carrying strap is of stout leather 1in. in width, and must be thoroughly greased to protect it from the action of the fumes that rise from the battery. It is fixed

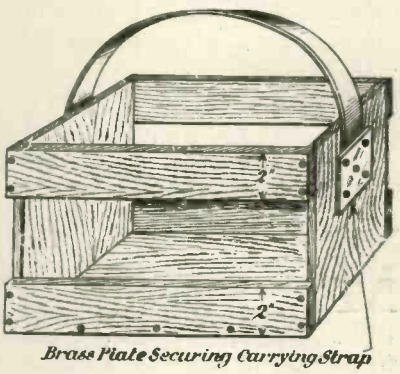


Fig. 6.—The finished crate.

in position at one end by being clamped under a brass plate screwed to the wood. To its other end may be stitched a stout spring clasp, enabling it to be attached to or detached from an eye fixed to the end piece. Or the end piece may be provided with a hook which fits into a hole punched in the strap.

Those who have to carry their own batteries to the charging station will be surprised to find how much their labour is lightened by the provision of a crate and a carrying strap.

R. W. H.

INTERCHANGEABLE FIXED CONDENSERS.

WHEN one is engaged in making up a variety of experimental circuits it is frequently necessary to spend a little time in finding the best values for the fixed condensers needed in certain positions. In most super-regenerative circuits the values of some of the condensers are quite critical, and even the most ordinary of receiving sets of perfectly normal design can frequently be improved by a little experimenting with such condensers as those used for coupling tuned-anode units, the grid condenser of the rectifying valve, the condenser which shunts the primary of the first low-frequency transformer and that placed across the telephone leads.

A most useful addition to one's experimental outfit is a set of fixed condensers of known value ranging from 0.0001 μF to 0.001 μF in 0.0001 steps, and from 0.002 μF to 0.01 μF in steps of 0.001 μF.

To buy such a set of really good make would involve a considerable outlay, but they can be made at home by anyone for a matter of a few shillings without a vast amount of trouble. Further, those to be described are designed to slip into permanent clip mountings so that any value may be changed for any other in a moment.

It is presumed that for all condensers the best ruby mica, .002in. thick, will be used. The smallest sizes have a plate overlap of one square centimetre. Two plates will then give a capacity of 0.0001 μF, three, 0.0002 μF, and so on, each additional dielectric increasing the capacity by 0.0001 μF.

For the first four of the next series we use overlaps of larger size, but keep the number of the plates constant at 11. For 0.002 μF we require an overlap of 2 cms. by 1 cm., for 0.003—3 cms. by 1, and so on, up to 0.005. We obtain 0.006, 0.008, and 0.01 μF by doubling size of the plates needed for 0.003, 0.004, and 0.005 μF respectively. For example, our 0.006 μF condenser will have 11 plates measuring 3 cms. by 2. For 0.007 we use ten plates measuring 4 cms. by 2, which give an actual capacity of 0.0072 μF. The remaining capacity, 0.009 μF, is obtained by using 11 plates with an overlap of 3 cms. by 3.

Armed with these figures, and remembering the very useful working rule: Capacity in μF equals overlap in square centimetres multiplied by number of 0.002in. thick ruby mica dielectrics, multiplied by 0.0001, we can make up fixed condensers of any desired capacity.

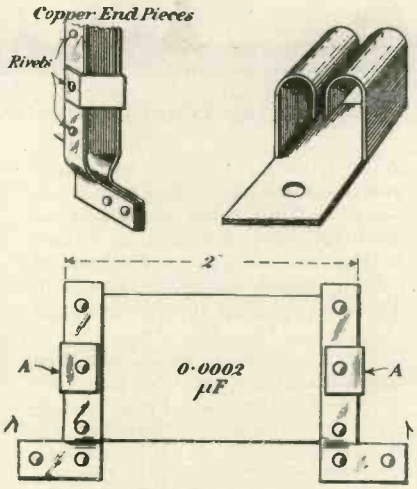


Fig. 7.—Mounting the condensers.

In order that condensers shall be readily interchangeable in clip mountings, it is necessary to adopt a standard width for all: 2in. will be found a convenient figure.

The method of putting together the alternate layers of copper foil and mica is exactly as described in these columns a week or two ago; except that the plates are cut with tangs long enough to fold right over the copper end-pieces (A.A., Fig. 7) and that the outer covering of the condensers consists of thin sheet ebonite.

The end-pieces, shaped as shown in the drawing, are cut from sheet copper. There are four of them, one pair being fixed at each end (Fig. 7) by means of rivets snipped from very soft copper wire. The tangs of the plates are also secured by rivets. The lower parts of each pair of end-pieces are tightly pinched together and fastened by rivets spaced so far apart as not to interfere with the mounting clips.

These clips are shown in Fig. 7. They can be made quite easily from springy sheet brass, or they can be bought from wireless shops at about 3d. per pair. Besides placing them wherever fixed condensers are wanted in the set, it is an advantage to mount a pair of clips on one or two of the variable condensers, connecting one to either terminal. The capacity of these variable condensers can then be increased at will by placing fixed condensers of suitable value in the clips; for since the two capacities are in parallel the total capacity will be their sum. R. W. H.

A VARIABLE GRID-LEAK.

A VARIABLE gridleak that combines the merit of extreme simplicity with negligible cost is here illustrated.

This was constructed from a broken vulcanite dark slide shutter, but stout mica, slate, or even photographic ground glass would be equally suitable.

Five pencil lines of increasing width are drawn as shown, the vulcanite having, of course, had the polished surface removed; 28 g. copper strip $\frac{3}{4}$in. wide, to which a connection has been soldered, is clipped over one edge, and five pieces of the same material $\frac{3}{4}$in. by $\frac{1}{4}$in. over the other edge, the merest smear of seccotine securing them in position. The connection on the other side is made of $\frac{1}{4}$in. brass rod about $\frac{3}{4}$in. long in which a saw cut $\frac{3}{8}$in. deep has been made. This will probably be found to be a sufficiently tight fit over the copper studs. T. H. R.

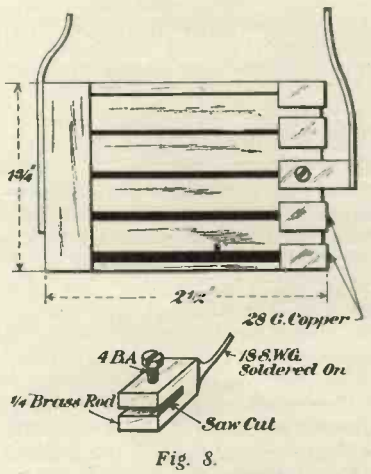
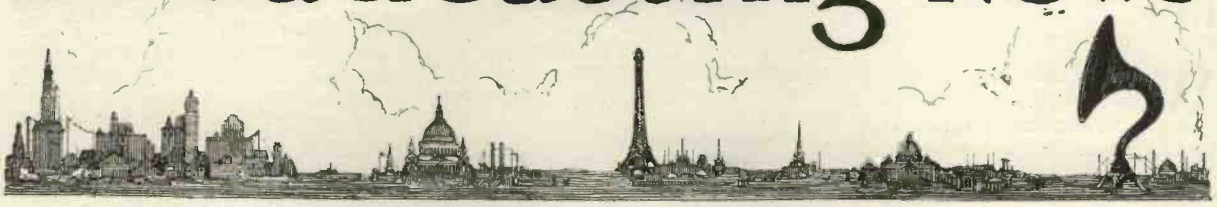


Fig. 8.

Broadcasting News



BY OUR SPECIAL CORRESPONDENTS

THE policy of the interim report which this paper has consistently advocated has the hearty support of the B.B.C. The sooner the suggestion is adopted the better, for the present state of uncertainty is paralysing trade and causing irritation in all sections of the wireless world. Besides, if something is not done quickly there may be another Postmaster General who will have to grasp the details of the subject *de nouveau*.

* * *

The hard-headed folks up Sheffield way have been impatiently wondering when their long-promised sub-station is to be established. There have been several unavoidable delays, but by the time these words appear in print a good start will have been made. It is not quite certain whether the concerts from 2LO or Manchester will be radiated, but if at all possible it will be the 2LO performances, because the B.B.C. realise that the people who live in that grimy community have a passion for the best in music, and only the best that 2LO can give will satisfy them.

* * *

This is not in the least intended to be a reflection upon the excellent concerts transmitted from Manchester, but it is an acknowledgment of the fact that Sheffield considers itself only second to the Metropolis as the hub of the musical world. Indeed, the last sentence will require qualification in the eyes of many inhabitants of the cutlery town.

* * *

The wave-band which has been allotted to the B.B.C. is absurdly inadequate, and until it is extended little development in the way of sub-stations can be expected. Indeed, it is difficult to know how Aberdeen and Bournemouth are going to be sandwiched in. However, something will have to be done, because these stations must be functioning before the autumn season commences. The broadcasting engineers are prying around Aberdeen looking for the best site.

* * *

There seems to be considerable confusion in the minds of the ready writers for the daily Press regarding the difference between the Western Electric Public Address System and broadcasting. The papers made a great fuss regarding the Prime Minister's forthcoming address to the Primrose League, which they declared was to be transmitted by wireless. Needless to say, it is the Public Address System that is to be used. The B.B.C. are most anxious to broadcast the Prime Minister's address, and it is to be hoped that their desire will be gratified, so that the whole country could listen-in to Mr. Baldwin. It is, however, all to the good that the Prime Minister is agreeable to even the comparatively small amplification of his audience which the wired method ensures. It is only a step from this until he and other distinguished statesmen broadcast properly.

* * *

The engineering staff of the B.B.C. has been augmented by the addition of Capt. A. G. D. West, B.Sc., who has been engaged on wireless research work for some considerable time. Captain West will concentrate on development and experimental work.

* * *

A central listening-in station has been installed at 2LO, but it will be impossible to say whether it is a complete success or not until the new transmitting station in Wardour Street is functioning. Incidentally, the recent speech of the Prince of Wales at Birmingham was received at 2LO on a frame aerial.

* * *

It is worth while listening-in to the daylight transmissions from 2LO at present, as some interesting experimental work is being carried out. Captain Round is obtaining some wonderful results from gramophone records, having succeeded in eliminating most of the mechanical noises.

* * *

There seems no reason why broadcasting should not prove the best advertisement imaginable for gramophone records.

* * *

The announcement has been made that the third Monday of every month is to be reserved for a symphony concert, and this was the original intention, but something topical is bound to turn up which makes it inadvisable to adhere to a pre-arranged scheme. For instance, on the third Monday of June the 200th performance of "Polly" fell due, and that put an end to the symphony concert.

* * *

The Rev. Tickner Edwards will talk on "Bee Swarming" on Monday, June 25th, at 7.15 p.m.

* * *

Mr. Tyrwhit Drake is one of the most welcome visitors at 2LO. He will give some more experiences with inmates of his private Zoo on Friday, July 6th, at 8.45 p.m.

* * *

BIRMINGHAM.—5IT has scored a distinct success in securing the services of Mr. Applebey Matthews, the well-known director of the Birmingham City Orchestra, who is to occasionally conduct a musical corner for the kiddies. Mr. Matthews has a delightful "wireless personality," and he immediately achieves an intimacy with his large audience of little folk which

imparts keen enjoyment to his talks and will make them much looked forward to. Their educational value can scarcely be over-estimated, and the children are indeed lucky in having Mr. Matthews to guide them into the fascinating realms of music.

Negotiations are still proceeding in connection with the new studio which is so much desired for this station. The problem of securing suitable accommodation near the centre of the city, so that facilities for the artistes will be more convenient, is by no means a small one, but it is hoped that ere long premises will have been secured which will be satisfactory in every way.

* * *

MANCHESTER.—2ZY's increased strength is especially noticeable when one is trying to hear London or Birmingham; perhaps this drawback is counterbalanced somewhat by the increased efficiency of the transmissions.

Listeners-in, who are desirous of acquiring a large stock of puns, should listen to the kiddies' corners as rendered by Uncle Humpty-Dumpty and Co. We were very disappointed that Mr. Burrows, on his recent visit to Manchester, did not give us a chance to judge for ourselves whether his voice is any better than our own announcers. We have often heard him speaking from 2LO, and have remarked on his wonderfully clear speech.

We are coming to the conclusion that we are never to hear broadcast opera from 2LO with any degree of success. For instance, the reception of "The Beggar's Opera" was spoiled by a loud and very persistent spark which took over the job of jamming from Oscillating Oliver & Co., who seemed to be off work for the evening.

Then again, the other evening we were enjoying some opera from 2LO through the comparatively mild jamming of 2ZY. The latter ceased suddenly, and a horde of shrieking, yelling demons descended on the music and proceeded to make the night hideous with their noise; 2ZY had closed down for the night, and, knowing well that there would be no pleasure in listening-in further, we regretfully followed 2ZY's example, with a few well-chosen words on the housing problem in the world hereafter, and so ended efforts for the evening.

Mr. K. A. Wright, M.Eng., Director of 2ZY. On the tray are perfect miniatures of all the Uncles and Aunties.

NEWCASTLE-ON-TYNE.—Broadcasting appears to be in better odour with purveyors of the "silent drama" than with other sections of the entertainment industry. In evidence of this we have the fact that selections by picture house orchestras have been relayed and transmitted from more than one of the stations. One of the most popular orchestras in Newcastle is that of the New Pavilion Cinema, and transmission from this theatre is shortly to appear on the 5NO programme. Then, again, an interesting dual attraction has been put forward by another cinema in conjunction with one of the chief wireless firms of the city. A film was shown, dealing with various methods of sound transmission, and explaining, briefly but lucidly, the theory of wireless communication. Listeners-in at home were shown on the screen, and, as the latter donned their headphones, loud-speakers in the house were switched on so that the audience were able to enjoy the Newcastle programme.

No trouble is spared by the Newcastle station authorities in making the Children's Hour a thorough success, and Uncles Will and Jack (Messrs. Fryer and Simpson) feel highly gratified by the many letters which reach them from their young admirers. On Tuesdays they have the assistance of Uncle Nick in the person of Col. Millican, and a committee of local masters and mistresses has been formed to organise a scholar's half-hour which is to be initiated shortly.

As an experiment and to test the views of listeners-in on the broadcasting of drama, "Twelfth Night" is to appear shortly in the 5NO programme.

* * *

SHEFFIELD.—Broadcast reception maintains a good standard in Sheffield, all things considered. Unfortunately the last few days has seen (or heard) an increase in the radiation nuisance. This is attributable to the large number of new sets getting into action in readiness for the proposed relay station. The expert's view of this interference, however, is that many will have learned better by the time the more intense wireless season sets in, and it is as well that they should take their noisy graduation in the science while the summer is here. Let us hope they are all experts before the winter nights set in.

Radio Societies

ACTON RADIO SOCIETY (H.Q., The Municipal Buildings, Winchester Street, Acton, W.3).

Hon. Sec., Mr. T. W. Hyne Jones,
208, Avenue Road,
Acton, W.3.

Mr. F. E. Wade gave a demonstration with his one valve experimental receiver on May 28th. Signals were received with great success, and comparisons of their strength were ascertained by using different makes of valves. Mr. R. R. Goding then added one stage of low-frequency amplification to Mr. Wade's receiver. The demonstration was very instructive and much appreciated by the members.

CAMBERWELL AND DISTRICT WIRELESS CLUB.

Hon. Sec., Mr. R. Stone,
30, Bushey Hill Road,
Camberwell.

The Secretary of this Club desires to bring to the notice of wireless amateurs residing in the Camberwell district that the entire reorganisation of this Club is now being undertaken by a "live" committee, who are arranging a series of lectures and demonstrations.

DARTFORD AND DISTRICT RADIO SOCIETY (H.Q., Dartford Grammar School).

Hon. Sec., Mr. E. C. Deavin,
84, Hawley Road,
Dartford.

On May 18th Mr. E. C. Deavin brought for demonstration a 4-valve receiver, the wiring and technical details being discussed. The H.F. valve embraced the tuned anode principle, and switches were provided to enable any number of valves up to four to be used. The set was designed for experimental purposes and gives very good results.

Good progress is being made in connection with the installation of the Club's receiving apparatus, and it is hoped that interesting and instructive experimental work may soon be commenced.

THORNTON HEATH RADIO SOCIETY.

Hon. Sec., Mr. R. S. Keeler,
72, Bensham Manor Road,
Thornton Heath.

A meeting was held on June 5th for the purpose of forming this Society, officers and committee being appointed and preliminary arrangements made. The objects of this Society are to assist and encourage members in the study of wireless and in the construction and testing of the necessary apparatus. Efforts are being made to secure a garage which could be used as a workshop to be equipped with machines and tools for the use of qualified members.

Mr. J. J. Deardon exhibited his three-valve set, and received "The Beggar's Opera" very well on a small loud-speaker, the members being particularly interested in the various switching arrangements which enable the loud-speaker to be used in almost any part of the house.

Meetings of this Society will be held fortnightly, and all interested in wireless are invited to become members. All communications should be addressed to the Secretary.

ILKLEY AND DISTRICT WIRELESS SOCIETY (H.Q., Regent Café, Ilkley).

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

On May 28th a communication from the Radio Research Board dealing with the "fading" of signals and "blind spots" was read. Several members have now undertaken research work in connection with these phenomena.

All persons interested in this Society are invited to the meetings, and dates and particulars may be obtained from the Secretary.

THE LOWESTOFT AND DISTRICT RADIO SOCIETY (H.Q., St. Margaret's Institute).

Hon. Sec., Mr. G. W. Barker.
The Cottage,
Normanston Hall,
Lowestoft.

At a meeting held on May 8th, Mr. H. C. Trent, B.Sc., conducted some experiments in wave calibration. After the Lecturer had explained the working and construction of the instrument, several stations were received and the readings of a Sullivan wavemeter were checked.

NORTH LONDON WIRELESS ASSOCIATION (The Physics Theatre, Northern Polytechnic Institute).

Hon. Sec., Mr. J. C. Lane.

Mr. V. J. Hinkley recently gave his "Practical Demonstration of Valve Characteristic Curves." Taking valves of various makes kindly lent by Messrs. G. Z. Auckland & Son, he proceeded to plot the characteristic curve of each in turn. The curves were traced upon the blackboard and, by the aid of apparatus fitted with illuminated dials, the fluctuations of milliammeter and voltmeter records were reflected upon the large calibrated scales provided. Great interest was taken in the demonstration, which was of considerable length and carefully detailed.

Applications for membership should be addressed to the Secretary.

ORMSKIRK AND DISTRICT RADIO SOCIETY.

Hon. Sec., Mr. J. Fitzsimmons,
11, Sunnyfields,
Ormskirk.

The Secretary will be pleased to furnish all particulars to anyone interested in this Society which has just been formed.

PRESCOT AND DISTRICT WIRELESS ASSOCIATION (H.Q., Drill Hall, Prescot).

Hon. Sec., Mr. C. E. Macawley,
55, Central Avenue,
The Wood, Prescot,
Lancs.

Mr. Lauder gave the third of a series of demonstrations at the headquarters on May 30th. The instrument used was a four-valve panel constructed and operated with success by the lecturer. Manchester and other stations were tuned in, and, with the aid of two loud-speakers and several pairs of headphones, the audience were able to enjoy the concert. During the intervals Mr. R. B. Broughton explained the various parts of a wireless set.

All persons interested in wireless are given a cordial invitation at the ordinary meeting of this Association on June 28th.

THE RADIO ASSOCIATION, SOUTH NORWOOD AND DISTRICT BRANCH (H.Q., Stanley Halls, S. Norwood).

Hon. Sec., MR. C. H. P. NUTTER, 243A, Selhurst Road, S. Norwood.

Mr. E. A. Saunders gave, on May 11th, a lecture entitled "A Few Considerations of Ether, Electrons and Material Phenomena." He commenced by saying that he thought every true experimenter should give a little thought to the ether and electron theories, and explained various experiments made in the past by famous scientists in their endeavour to solve the problem of the ether. He then passed to electrons and the working of the modern thermionic valve.

Mr. C. Nutter announced on behalf of the Secretary that it is hoped in the near future to arrange a visit to Croydon Aerodrome Wireless Station.

On May 31st Mr. J. N. D. Ridley lectured on "The Reception of American Broadcasting." After giving his experiences the lecturer described the apparatus used, giving hints for the benefit of those who wish to try and receive music from across the Atlantic.

SEAFORTH AND DISTRICT RADIO SOCIETY (H.Q., St. Thomas Parochial Hall, Seaforth Road, Seaforth, Liverpool).

Hon. Sec., MR. R. ROBERTS, 237-9, Crosby Road, Seaforth.

Mr. R. Roberts recently gave an interesting lecture on "Inductance, Capacity and Oscillation." Several local sets were adjusted and faults were rectified and explained. This Society is carrying out on a large scale various theories on inductive coupling, and hopes to publish the results in a few weeks' time.

Particulars of membership will be gladly sent by the Secretary to enthusiastic persons.

SOUTH DORSET RADIO CLUB.

Hon. Sec., MR. E. B. CARTWRIGHT, 18, Newberry Terrace, Rodwell, Weymouth.

It was decided to form this Club at a meeting held on April 27th at the Guildhall, Weymouth. After the business had been dealt with a broadcasting programme was enjoyed by all. Weekly Morse classes are being held, and lectures have been arranged for early dates. The membership is steadily increasing, and a hearty welcome is extended to all interested in wireless and allied subjects. Particulars of membership will be forwarded on application to the Secretary

STOKE-ON-TRENT WIRELESS AND EXPERIMENTAL SOCIETY (H.Q., Y.M.C.A., Marsh Street, Hanley).

Hon. Sec., MR. F. J. GOODSON, B.Sc., Tontine Square, Hanley.

On May 24th Mr. T. R. Clark gave an interesting lecture entitled "Adding a Valve to a Crystal Set."

He stated that the results obtained by adding an L.F. amplifier for use in this district were not satisfactory; much better results being obtained by adding an H.F. amplifier. Various methods of adding valve amplifiers to crystal detectors were explained, and a demonstration of the lecturer's H.F. valve-crystal set was given.

SWANSEA AND DISTRICT RADIO EXPERIMENTAL SOCIETY (H.Q., Y.M.C.A., St. Helens Road, Swansea).

Hon. Sec., MR. H. T. MORGAN, 218, Oxford Street, Swansea.

On May 9th Mr. R. G. Isaacs, M.Sc., of the University College, Swansea, gave a very interesting lecture on "The Elementary Principles of Wireless Telephony and Telegraphy."

The lecturer stated that he had experimented with the reaction coil coupled to both the tuned anode coil and the aerial tuning coil, and had found the audibility factor the same in each case. He also pointed out that by coupling the reaction coil to the aerial tuning coil no advantage is gained, and the set is liable to cause interference.

TOTTENHAM WIRELESS SOCIETY (H.Q., The Institute, 10, Bruce Grove, Tottenham, N.17).

Hon. Sec., MR. S. J. GLYDE, 137, Winchelsea Road, Tottenham, N.17.

On Wednesday, May 16th, Mr. A. G. Tucker lectured on "Radium and the Constitution of Matter." After detailing the recent discoveries of Radio-Activity, the lecturer explained the relation between "Transmutation and the Tapping of Atomic Energy." He pointed out that if the average quantity of Radium found in the surface rocks kept the same proportion for a depth of fifty miles, the earth must be getting hotter.

The lecture was followed by a competition for novel crystal sets. Among the many entrants were an inkstand and a book, a matchbox and a paperweight. The prize of £1 went to the owner of a handsome writing-case set incorporating special switching arrangements. The efficiency of the various sets was a notable feature of the competition.

On Saturday, May 19th, 14 members visited Croydon Aerodrome by kind permission of the commanding officer, and a visit to a ship station has been arranged for the near future.

On Wednesday, May 23rd, Mr. F. Haynes gave a lecture on "Electrostatic Loud-Speakers."

He pointed out that in electromagnetic loud-speakers distortion increases with the power in use, whereas electrostatic loud-speakers are remarkably free from this defect.

On May 30th a debate on "High- and Low-Frequency Amplification" was held, the Chairman describing various methods of obtaining H.F. amplification. Members gave their experiences as to what they considered was the best valve to use in an H.F. amplifier and the advantages and disadvantages of the tuned anode circuit were discussed.

Low-frequency amplification was then dealt with, various makes of L.F. transformer being compared, and the correct method of winding then being dealt with.

The Secretary will be pleased to forward particulars to anyone desirous of joining the Society.

UXBRIDGE AND DISTRICT RADIO AND EXPERIMENTAL SOCIETY (H.Q., Willowbank Tea Barn, High Street, Uxbridge).

Hon. Sec., MR. J. R. M. DAY, 10, Prospect Terrace, Cowley Road, Uxbridge.

Recently Mr. Bailey demonstrated with a unique pocket two-valve set of his own design and construction, which was very efficient in receiving the Radiola Concert.

By kind permission of the Marconi Co., Mr. Piper showed various kinds of valves to the members, such as are used at 2LO.

Mr. Bailey also exhibited a seven-valve amplifier, which interested all of the members present.

WIRELESS AND EXPERIMENTAL ASSOCIATION (H.Q., Camberwell Central Library, Peckham Road, S.E.15).

Hon. Sec., MR. G. SUTTON, 18, Melford Road, S.E.22.

On May 30th a long and exhaustive discussion took place on the use of low temperature emission valves.

Mr. Green described the construction and uses of the hydrometer, and Messrs. Joughin and Voigt discussed various points with regard to the construction and uses of loud-speakers.

Mainly about Valves

The ST100 Circuit

THE interest taken by experimenters in this circuit has been extraordinary, judging by letters received. The sales of *Modern Wireless* No. 5 (June) have been brisker than ever, and practically the whole edition was sold out within a few days. Those who have been disappointed must remember that the task of estimating the demand is an extremely difficult one. Radio Press, Ltd., spend at the rate of nearly £50,000 per year on *Modern Wireless*, and it is impossible to afford to print more than are actually ordered by the wholesale newsagents. It is, therefore, important to give a standing order to a newsagent, or, better still, to take out a subscription with the publishers, who will see you receive your copy on the first of every month.

Speaking about *Modern Wireless*, we invited criticisms and suggestions. The correspondence we have received has been of great interest, and will help us to improve *Modern Wireless* with every issue. We thank those who so kindly took the trouble to write to us.

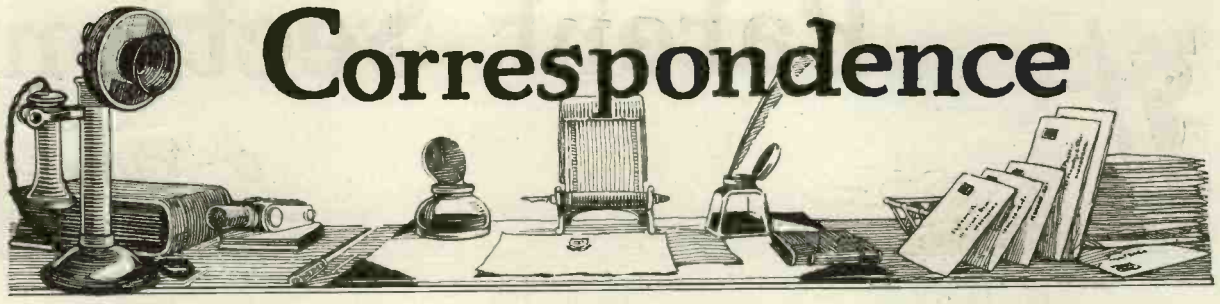
Valve and Crystal Receiver

The crystal, no doubt, is coming into its own again, and I have recommended its use time and again. The two-valve ST100 circuit uses two valves and a crystal detector. A crystal detector gives excellent service providing the high-frequency currents are not too strong. This fact does not seem to be generally known. Unless the incoming currents are very weak, I would not connect a crystal detector after more than two stages of high-frequency amplification. The application of large E.M.F.'s to a crystal detector destroys the sensitive spot. Even moderately strong signals will, in the case of many crystals, such as hertzite, wear out a sensitive spot in time, and a new spot will have to be found.

Crystal detectors have never received adequate attention from the research worker. There is a mine of information hidden in every crystal detector. The perfect crystal has not yet been evolved, although the same old mineral appears every month under some new name.

Many have a prejudice against crystal detectors when used with valves. Many have asked for an ST100 circuit using a valve instead of a crystal for detecting purposes! This is almost like asking for an Armstrong super-regenerative circuit using only a crystal. The ST100 is, of course, a particularly stable form of reflex circuit, and the object is to obtain a maximum of signal strength with a minimum of valves.

The great advantage of the crystal detector is that it saves a valve detector, which unfortunately cannot be used as an amplifier of separate currents because undesirable and practically unpreventable reaction would be introduced. Even with 99 per cent. of reflex circuits the low-frequency howling trouble is experienced, which is the reason why only a comparatively few of the 100,000 listeners-in have been able to use them successfully.



BROADCAST RECEPTION.

To the Editor, *Wireless Weekly*.

Sir,—The first paragraph of Mr. Wareham's letter in No. 8 issue of *Wireless Weekly* interests me very much. I get good reception from all British Broadcasting Stations except Cardiff, and can also get Cardiff's carrier wave, but no telephony. Perhaps some of your readers have had similar experiences and overcome same, if so, I shall be interested to know how. I use a well-known 2-valve set with 2-valve loud-speaker equipment, which is strong enough to receive 2LO, a station considerably further away from here than Cardiff. I am, etc.,

F. G. Sandison.

Port Erin, I.O.M.

COMPLIMENTS.

To the Editor, *Wireless Weekly*.

Sir,—I should like to pay a tribute to the excellence of your two publications *Wireless Weekly* and *Modern Wireless*.

Like two stars of the first magnitude they cause the lesser lights to pale into insignificance. May they always shine so bright! I am, etc.,

Southsea. Stanley G. Hogg.

PIRACY.

To the Editor, *Wireless Weekly*.

Sir,—There has been a considerable amount of discussion with regard to the question of "pirates." No one yet seems to have thought of a very simple way of exterminating them. Why not bring in the old regulation that people must show their licences before being supplied with radio gear? The following could be considered as radio apparatus:—

Valves.
Crystals.
Transformers (high- and low-frequency).
Variable condensers.
Tuning coils.
Insulators
Loud-speakers, etc.

This, I think, would go a long way to solving a problem—unfair to the B.B.C. (of which I am no friend) and the listeners-in who have bought B.B.C. apparatus. I take this opportunity of expressing my thanks to you for producing such fine papers as *Modern Wireless* and *Wireless Weekly*. Each copy gives some new problem to tackle or some new subject for experiment. I am etc.,

S.E.16. A. B. Brown.

LICENCES.

To the Editor, *Wireless Weekly*.

Sir,—In your last issue I see a letter from "Londoner" who complains about his wireless licence, for which he applied on April 19th.

I myself applied on January 11th, and have not even had a provisional licence granted me. I am a keen experimenter with a fair knowledge of wireless, and have so informed the Secretary to the General Post Office, but the only answer I can get is that my application is receiving attention.

Several friends of mine who know nothing whatever about wireless or even electricity have applied for licences and received, practically by return of post, not temporary ones but the real article. I am, etc.,

London, S.W.5. "Nomis."

ST100.

To the Editor, *Wireless Weekly*.

Sir,—I have pleasure in reporting to you my first tests with circuit ST100 as detailed in *Modern Wireless*.

Newcastle is much too loud for the head 'phones and the Brown loud-speaker (large) was easily operated.

Later, London was tuned-in, 310 miles away, and the opera, "Il Pagliacci," received perfectly but too loud to be comfortable on the 'phones, and just audible enough to be readable in a 12ft square room on the loud-speaker. This performance of the set astonished me, and bears excellent testimony to the sensitivity of this circuit.

Yours, etc.,

E. A. Deome.

Wooler, Northumberland.

MORE ST100.

To the Editor, *Wireless Weekly*.

Sir,—I was much interested in the account of ST100 in the June number of *Modern Wireless*, so, finding I had all the necessary parts, except the valve panels by me, I put 2 valve holders on a strip of ebonite and wired it up. With Burndept concert coil No. 4 as L1 and a 75 of the same make as L2, and 85 volts H.T. I tuned in 2LO at 5.30 and got the loudest, clearest and best telephony I have ever heard.

There was no difficulty in working the set at all. I am now wondering if it is possible to add a stage of H.F.

With best wishes,

Yours, etc.,

N.W.10. A. H. Atkin.

SUCCESS.

To the Editor, *Wireless Weekly*.

Sir,—With reference to circuit ST100 and your request for reports on same, I have pleasure in informing you that I have been able to hear successfully the Hague, Radiola Paris, Eiffel Tower concerts, and, of course, 2LO. Have also picked up Croydon, Lympne, and Le Bourget and local amateurs.

I am using two solenoid coils, one for A.T.I. and one for anode. These are fitted with sliders, and obviate the necessity of using large capacity condensers. I have two small variable condensers, about 0.0001 μF, which are quite O.K. for fine tuning.

Yours, etc.,

E.7. H. E. W.

BREVITY.

To the Editor, *Wireless Weekly*.

Sir,—Allow me to congratulate you on the excellence of circuit ST100.

Yours, etc.,

T. Robertson.

Southwark, S.E.17.

CONGRATULATIONS.

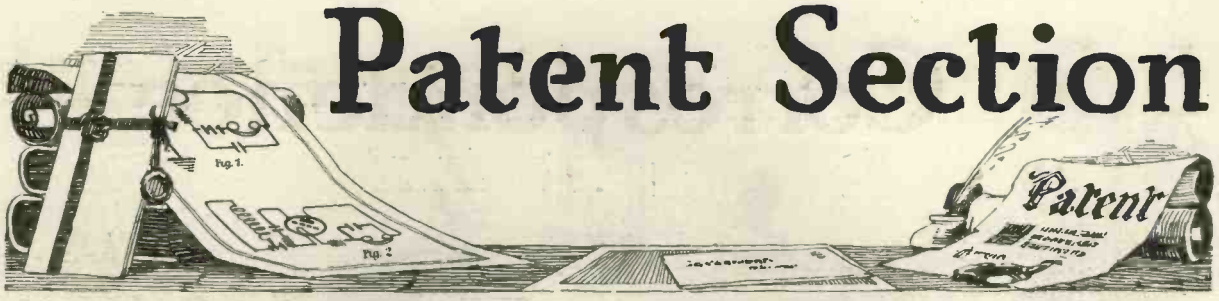
To the Editor, *Wireless Weekly*.

Sir,—I have spent some considerable time on this circuit and I confess the results are excellent.

Congratulations on the circuit.

Yours, etc.,

Salisbury. W. Ison.



Patent Section

The following list has been specially compiled for "Wireless Weekly" by Mr. H. T. P. GEE, Patent Agent, Staple House, 51 and 52, Chancery Lane, W.C.2, and at 70, George Street, Croydon, from whom copies of the full specifications published may be obtained post free on payment of the official price of 1s. each. We have arranged for Mr. Gee to deal with questions relating to Patents, Designs and Trade Marks. Letters should be sent to him direct at the above address.

ABSTRACTS FROM FULL PATENT SPECIFICATIONS RECENTLY PUBLISHED.

(Copies of the full specifications, when printed, may be obtained from Mr. Gee, post free on payment of the official price of 1s. each.)

195653. SATCHWELL, L.—In an electric resistance of the grid type, the bars of each component grid are splayed apart by and clamped upon an insulated member threaded between them at about the middle of their length. The insulated member employed consists of a strip of metal folded upon itself and arranged edgewise between strips

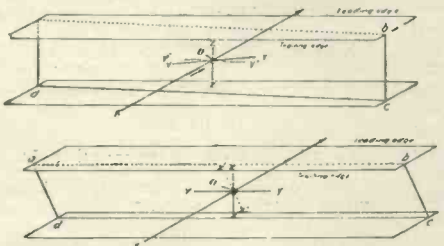


Fig. 1.—Illustrating Patent No. 195656.

of mica with flat supporting strips of sheet metal; similar members may also be used to separate adjacent grids. December 16th, 1921. Cognate application, 6467/22.

195656. CULVER, C. C.—In systems of the kind in which an aircraft is navigated with the aid of directional receiving apparatus working with a central station, the receiving loop is arranged so that its effective plane may be displaced in two dimensions with respect to the longitudinal axis of the aircraft. With this arrangement, by keeping constantly in touch with the central station, the aviator flies in a spiral to the ground. September 27th, 1921.

195657. RYAN, C. P.—In a chattering-contact device having a contact carried by one end of a balanced lever co-operating with a contact carried by a diaphragm, in electric relays, the lever with adjustable counterweights has a biassing hair-spring with a tension regulator, and is pivoted in a frame which is itself pivotally connected with a base to allow relative adjustment of the contacts and decrease of the overall height for transport purposes. The device is used to control a morse-inker in connection with a wireless receiver. April 10th, 1922.

195691. ROBINSON, E. Y.—A thermionic valve or other vacuum tube has a cathode of the type providing a concentrated source of electrons, with an anode in close proximity to the cathode so that the inter-electrode space is small, and means, such as electrostatic or mechanical shields, for confining the space current to the inter-electrode space. By this arrangement a valve having hard characteristics is obtained with comparatively high pressures of residual gas or vapour. December 6th, 1921.

195698. MOULLIN, E. B.—A direct-reading voltmeter for relatively small alternating voltages of any frequency comprises a three-electrode valve having the grid connected to the filament through a resistance so that it becomes negatively charged to about 0.9 volts, the resulting decrease of mean anode current, consequent upon the application of an alternating potential difference between the grid and filament, being measured on a galvanometer in the anode circuit calibrated to read directly in terms of the applied potential difference. A condenser is connected to the grid for the purpose of rendering the readings independent of frequency, and another condenser is connected between the anode and filament to reduce alternating fluctuations of anode potential. December 7th, 1921.

195718. LORENZ, AKT.-GES., C.—Comprises various arrangements for keying a continuous wave transmitter, the key being arranged to vary the choking effect of one or more iron-cored or other choking-coils in such a way as to suppress the emission when the key is open. December 30th, 1921.

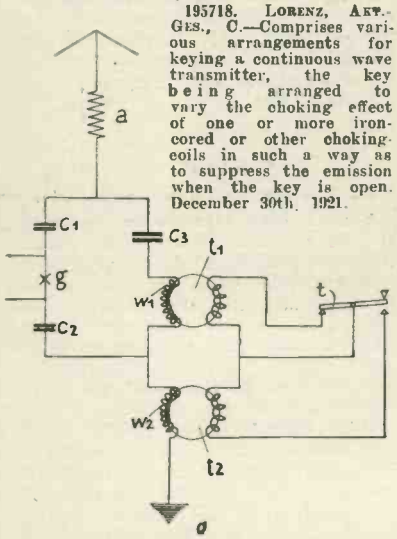


Fig. 2.—Illustrating Patent No. 195718.

195796. QUINN, E. J.—Code transmitting apparatus for line, wireless, or flashlight telegraphy, comprising one or more semi-circular members with alternate conducting and insulating strips arranged in accordance with the signal, and a roller carried on a resilient arm which is rotated by a spring-returned key connected to a rack engaging a pinion. A free-wheel clutch is arranged between the pinion and the spindle carrying the resilient arm, so that the arm may complete its rotation whilst the key is being returned by its spring. After a complete rotation of the arm, the roller rests gainst a stop. A number of such

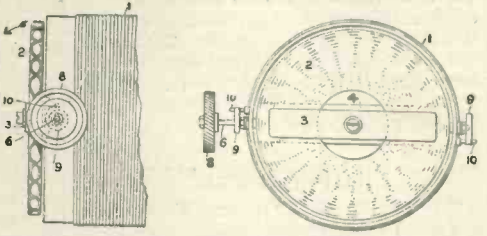


Fig. 3.—Illustrating Patent No. 195814.

apparatus may be built up to form a key-board transmitter. January 19th, 1922.

195814. CASTAGNOLI, G.—A basket coil, or a honeycomb coil, is mounted within a helical coil so as to be capable of rotation through 180° about a diameter. February 3rd, 1922.

195824. AUTOMATIC TELEPHONE MFG. CO., LTD., and HUDD, A. E.—A relay has an armature on which is pivoted a polarised armature which normally rests on the pole-pieces of an electro-magnet, and upon excitation of the latter is acted on to make one of two contacts, the armature being attracted to permit the turning movement. A non-magnetic frame supports the electro-magnet and a permanent magnet, the effective strength of which is adjustable by means of a soft iron bolt. Terminals are secured to L-shaped parts attached to the pole-pieces, and carry the adjustable contact screws, which are engaged by springs on the armature in operative position. February 13th, 1922.

195838. WESTERN ELECTRIC CO., LTD.—In order to minimise interference between signalling stations, the wave frequencies employed by the several stations, both for transmission and for homodyne reception, are compounded of a number of frequencies radiated from a central control station. February 27th, 1922.

195903. IGRANIC ELECTRIC CO., LTD.—A rheostat for panel mounting comprises a resistance element in the form of a spiral spring stretched around the circumference of a drum, which is provided with a radially offset insulating element positioned between the ends of the spiral, and a blade spring contact bearing tangentially upon the outer surface of the resistance element, the drum and contact being adapted for relative rotation by a manually operated spindle. July 13th, 1922.

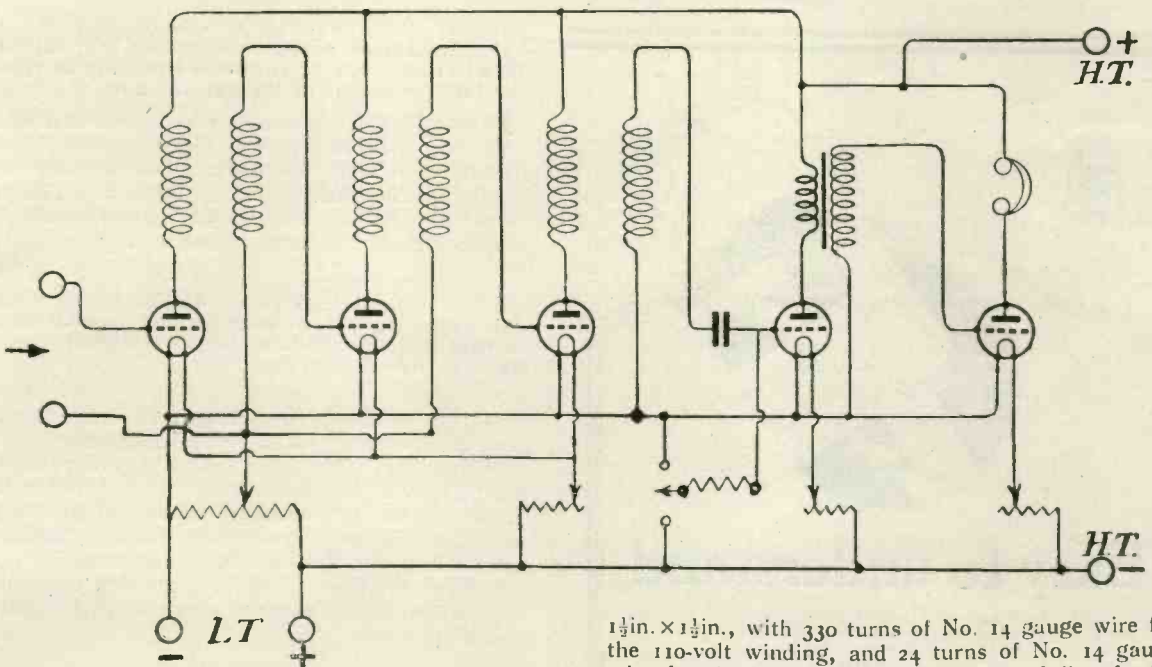
Information Department

Conducted by J. H. T. ROBERTS, D.Sc. (F.Inst.P.), assisted by A. L. M. DOUGLAS.

In this section we will deal with all queries regarding anything which appears in "Wireless Weekly," "Modern Wireless," or Radio Press Books. Not more than three questions will be answered at once. Queries, accompanied by the Coupon from the current issue, must be enclosed in an envelope marked "Query," and addressed to the Editor. Replies will be sent by post if stamped addressed envelope is enclosed.

F. L. M. (KETTERING) asks: (1) How to fit potentiometers to control the grids of various valves which he has. (2) What is the cause of crackling noises in his loud-speaker. (3) When switching off a stage of high-frequency or low-frequency amplification, what circuits are actually made or broken.

(1) We give herewith a circuit diagram showing how to add a potentiometer to your high-frequency valves. You will obtain no advantage by fitting such a potentiometer to your low-frequency valves. (2) The crackling sound you hear is probably due to a slightly faulty H.T. battery. You should shunt this battery with a condenser having a value of not less than 0.5 μF. (3) This greatly depends on the type of switch and the method employed for high-frequency intervalve coupling. The ideal arrangement would break all unwanted circuits, and, in addition, disconnect the filaments.



P. A. S. (REDCLIFFE STREET, S.W.10) asks for particulars to make a step-down transformer to reduce the 110-volt A.C. main to a suitable pressure for use with a rectifier for charging accumulators.

A suitable transformer for your purpose would consist of a closed iron core having a cross-section of 1½in. × 1½in., with 330 turns of No. 14 gauge wire for the 110-volt winding, and 24 turns of No. 14 gauge wire for the low-tension side. About 4½ lb. of wire will be required altogether, and the windings must be very well insulated from each other. This transformer is capable of giving an output of 10 amperes at 8 volts. If the current is too great, the primary should be wound with finer wire down to about No. 28 s.w.g., and the secondary in proportion. The secondary is in this case, of course, the inner winding.

N. E. L. (MANCHESTER) has made up the valve receiver described in No. 3 of "MODERN WIRELESS," on page 214, but experiences difficulty in hearing the local Broadcasting.

We are afraid you must have omitted some connection in your apparatus, or else that some component part of your set is at fault. On this apparatus the Manchester Broadcasting should be exceedingly clearly received.

E. A. P. (CLAPHAM COMMON) wishes to know what relationship exists between the number of turns of wire and the size of the formers in a variometer.

In order that the variometer may function to its best advantage, the inductance values of the two coils should be identical. This naturally means that the smaller coil must have more turns of wire.

A. B. (ASTON, BIRMINGHAM) has made the crystal receiver with a range of from 200 to 4,000 metres described in No. 1 of "WIRELESS WEEKLY" and hears Birmingham very loudly, but cannot get the Paris Time Signals. He asks our opinion.

With careful adjustment there is no reason why you should not hear the Paris Time Signals with this set. An efficient aerial and earth system is, of course, necessary; and, if you are using an indoor aerial or a very short outside one, you cannot expect to get results over such a long range.

W. B. (SHEFFIELD) is constructing the two-valve Broadcast receiver described in "MODERN WIRELESS," No. 1, and finds difficulty in rotating the inner portions of the variometers.

The attention of any readers who have sent in queries regarding this instrument is directed to the fact that owing to an error the diameter of the inner tubes is ¼in. greater than should be the case. This must serve as a general answer to all the others who have enquired about the same instrument.

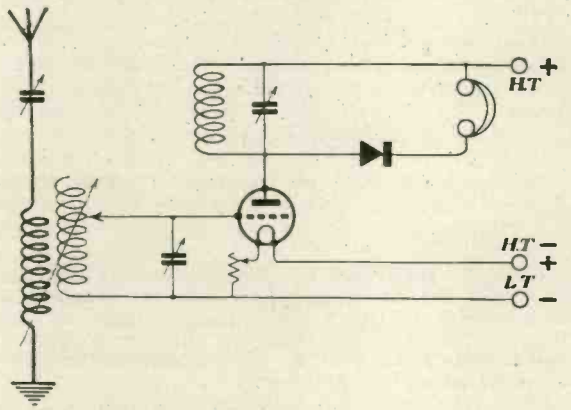
C. M. (OKEHAMPTON) wishes to construct a unit receiving set to hear all the British Broadcasting and, in addition, the Continental concerts. He asks for particulars.

We suggest you should use two high-frequency panels, a rectifier (which might be a crystal), and two low-frequency valves. The addition of a third low-frequency valve connected as a power amplifier will be useful at times. Valves of low self-capacity might be used for the high-frequency stages, a good soft valve for the rectifier (if a valve is used), and hard valves for the low-frequency amplifier For the power amplifier a small transmitting valve might be used with advantage. Separate H.T. batteries should be used.

E. J. S. (W.14) asks certain questions about a circuit described in No. 2 of "MODERN WIRELESS," page 89, Fig. 6, from which he does not obtain any results.

The values of the inductances L2, L3, and L4 may be similar. Coil L1 might be 35 turn "Igranic" coil; coils L2, L3, and L4 50 Igranic" coils. The value of the fixed condensers is not critical, but should be about 0.002 μF. for C3, C4, and C5. With proper adjustment you should obtain very good results from this circuit.

O. D. (Leamington) submits a sketch of a proposed H.F. amplifier, and asks whether it is correct. He wishes to use a vario-coupler in his possession.

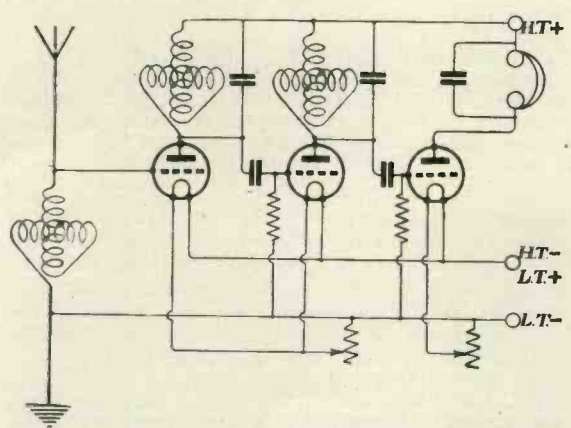


The arrangement you show is incorrect; we reproduce herewith a circuit diagram showing how a H.F. valve can be added to your crystal set using a vario-coupler.

T. O. (COUNTY DURHAM) has built a 2-valve note magnifier, and experiences trouble with it.

You should shunt the telephone terminals with a condenser having a value of not less than 0·002 μF, and it is possible of course that your H.T. voltage is incorrect. The H.T. battery itself should be shunted by a condenser of not less than 0·5 μF.

L. S. (Longton) asks how to add two stages of high-frequency amplification to his receiver, using variometers in his possession.



A suitable circuit conforming with your requirements is given *above*. This also shows how your third variometer may be used for tuning the receiver to the required wavelength.

E. T. F. M. (MAIDENHEAD) asks whether reaction applied to a single valve circuit in the manner he indicates in his enclosed diagram is permissible.

Reaction on to the aerial circuit for reception of British Broadcasting is not permissible under any circumstances. We have already dealt with so many queries with reference to this subject that we wish to draw the attention of all readers to this answer. We shall not reply to any more of these questions, as the regulations are sufficiently well defined and quite clear.

F. W. R. (BELFAST) has built a 4-valve receiver as described in "MODERN WIRELESS," and wishes to know whether he would be likely to hear 2LO in Belfast with a frame aerial, and if so what size of frame and how many turns of wire should be used.

Whilst this set is very suitable for the reception of broadcasting at your distance on an outside aerial, we do not think you would get very satisfactory results with a frame. If, however, you care to try it, you should use a frame 4ft. in diameter wound with 8 turns of stranded wire, and tuned by a small variable condenser in parallel with it. This frame and condenser would, of course, take the place of the aerial tuning inductance on your set.

C. W. S. (BARNSLEY) submits a circuit diagram and asks the following questions: (1) Whether it is advisable to use a lower plate voltage for the high-frequency valve than for the low-frequency valve, and (2) whether we can recommend a first-class telephone transformer.

(1) Your circuit is quite correct and well thought out. It is advantageous to be able to control high-tension supply to the high-frequency valve, and also to the detector valve. A little experimenting will often result in an extraordinary improvement in results from a multi-valve set if tapped H.T. batteries are used. (2) We cannot recommend any particular make of telephone transformer, but you can buy the products of any reliable firm with confidence. The make you mention is very suitable and thoroughly reliable.

T. E. W. (WANSTEAD) wishes to construct a 3-valve Armstrong super-regenerative circuit and asks for a wiring diagram.

Full constructional details for building this instrument were given in *Wireless Weekly*, Vol. 1, No. 1, to which you should refer.

C. E. D. (DRUMCHAPEL, GLASGOW) asks with reference to the fourth paragraph on page 210 of the third issue of "MODERN WIRELESS" whether it is only necessary to use a single valve amplifier in conjunction with the loose-coupled crystal set in order to receive Continental telephony.

The use of the words "valve amplifier" imply an amplifier varying in power with the work which it is required to do. You will certainly require at least two high-frequency stages and one stage of note magnification to receive PCGG, for instance, in Glasgow. You should hear 5SC well with this set, but a low-frequency valve amplifier would allow you to use a loud-speaker with this instrument.

G. C. (DEVON) asks for a wiring diagram for a receiver embodying one high-frequency valve on the anode reactance principle; a rectifier and one low-frequency valve.

The most suitable circuit for your purpose is No. ST45 in "Practical Wireless Valve Circuits," Radio Press, Ltd.

J. H. E. (CHADWELL HEATH) asks for a good 4-valve circuit for general purposes.

See page 248 *Modern Wireless*, No. 4, and circuits ST48, ST49 and ST50, "Practical Wireless Valve Circuits," Radio Press, Ltd.

R. M. (EAST BARNET) sends a list of material in his possession, and asks for a suitable circuit.

See reply to J. H. E. (Chadwell Heath) above.

£250 PRIZE COMPETITION

FIRST PRIZE £100

SECOND PRIZE £75 THIRD PRIZE £25

and Ten Consolation Prizes of Five Pounds each.

Entries limited to 400 in number.

Judge: JOHN SCOTT-TAGGART, F.Inst.P., Member I.R.E.

We have been successful in obtaining a further consignment of the well-known

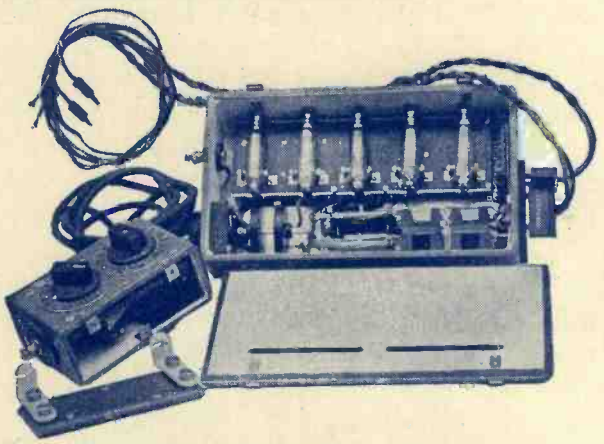
R.A.F. TYPE 10 5-VALVE RECEIVER

as supplied by the General Electric Company of U.S.A. to the Royal Air Force. These Instruments are specifically designed for the reception of radio-telephony. They consist of a five-valve panel and remote control and necessary leads, as illustrated. The former contains 5 Valve Holders (for V.24 valves) 2 H.F., 1 Detector and 2 L.F., 2 Intervalve Transformers 2 H.F. Transformers, Aerial and Aperiodic Coils, Potentiometer, Variable Resistance (controlling 2 L.F. valves). The remote control contains variable filament resistance, variable condenser and small vernier condenser. We are offering the above prizes for the best reconstructed sets, according to the conditions set out below.

R.A.F. Type 10 Receiver, Remote Control H.T. and L.T. Leads (as illustrated) **£10**

5 V.24 Valves at 26/- . . **£6 10 0**

Complete : **£16 10 0**



RULES AND CONDITIONS.

The number of entries is limited to 400.

Set must be capable on a P.M.G. Aerial of receiving signals on all wavelengths between 300 and 3,000 metres. **(N.B.—The H.F. Transformers incorporated in the set are embedded in paraffin wax and, as the result of their high self-capacity, possess a clearly defined peak frequency corresponding to the wavelength for which the set was designed, viz., 440 metres.)** In some cases, also, it may be found that, owing to the exceptionally delicate nature of the windings of these transformers, the joint has been disconnected. This in no way affects the ultimate results, however, as to bring the set within the range of wavelengths mentioned above, these H.F. Transformers will, in any case, have to be eliminated.

On the shorter wavelengths the set must be capable of receiving any B.B.C. Station within 250 miles without interference with any other station. **(This test, in the final selection, would be made at the Company's laboratory, Stratford, where it would be required to receive, say, Manchester or Cardiff, with the minimum interference from 2L.O London, 6 miles distant.)**

All entries must be received on or before the 30th June, 1923. Competitors will be required to furnish the following:—

(a) A complete diagram of connections of their apparatus, together with a brief technical description.

(b) The Sales Receipt from the City Accumulator Company or their advertised agents for the purchase of the set and 5 valves.

(c) An Autograph Certificate stating that the competitor is not in any way connected with any person or firm engaged on the manufacture or sale of wireless telegraphy apparatus for commercial purposes.

Circuits employed must strictly conform to the Postmaster-General's restriction, "that no oscillating valve or valve circuit employing magnetic or electrostatic reaction may be directly coupled with the aerial or aerial secondary circuit over the range of wavelengths between 300 and 500 metres."

The prize-winning sets will remain the property of the competitors. Full particulars and photos will be published in "Wireless Weekly" during July or August. (Copyright of all published details remain the property of the City Accumulator Company, also the Company reserves the sole right to manufacture or to alter design for manufacturing purposes of any prize-winning Set. No prize will be divided.

In the event of a tie in technical design and actual reception, the prize will be awarded to the set showing best workmanship. The compactness and portability of the set will also be taken into consideration.

The decision of Mr. John Scott-Taggart and The City Accumulator Co. must be regarded as absolutely final.

FILL IN THIS COUPON AND POST TO US AT ONCE.

To THE CITY ACCUMULATOR CO.,
Competition Department,
79, Mark Lane, E.C.3.

Entry No......

I enclose herewith.....*for* **£16 . 10 . 0** *in payment of 1 R.A.F. Type 10 Receiver and five V.24 Valves Please enrol me as a competitor for your £250 Prize Competition, according to the published conditions.*

NAME.....

ADDRESS.....

Please write distinctly in BLOCK letters.

Printed for the Proprietors, RADIO PRESS, LTD., Devereux Court, Strand, W.C.2, by THE CORNWALL PRESS, LTD., Paris Garden, Stamford Street, London, S.E.1. Published on Wednesday of each week at 3, Bolt Court, Fleet Street, London, E.C.4. Address for Subscriptions and Editorial communications:—Devereux Court, Strand, London, W.C.2. Advertisement Managers:—THE SCHERFF PUBLICITY ORGANISATION, LTD., 125, Pall Mall, London, S.W.1. Registered as a newspaper and for transmission by Canadian Magazine Post. Subscription rates:—32/6 per annum. 16/3 for six months, post free. Sole Agents for Australasia:—GORDON & GOTCH (Australasia), LTD. For Canada:—IMPERIAL NEWS, LTD For South Africa:—CENTRAL NEWS AGENCY, LTD

Wednesday, 6d. Net. Vol. 1. No. 12. June 27th, 1923.

Wireless Weekly

and The Wireless Constructor

No. 12

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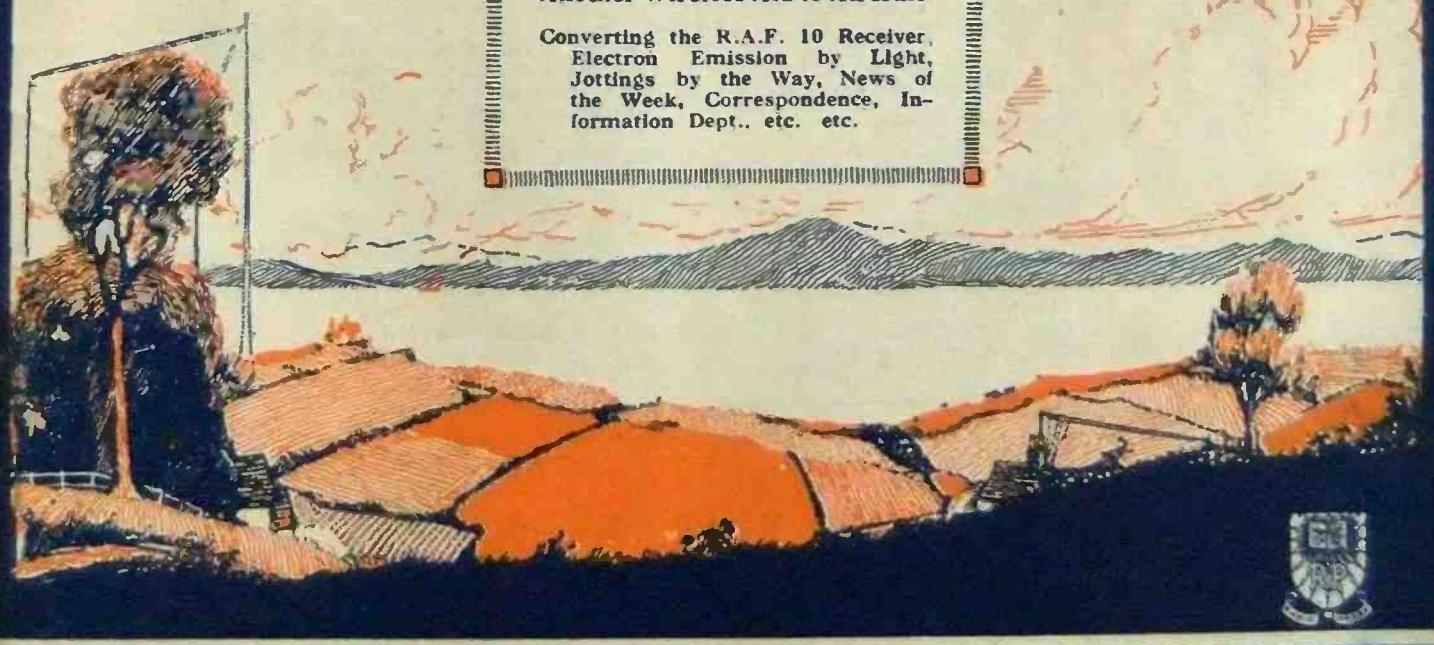

My Experiences With S.T.100.—By Percy W. Harris.

Wireless Weekly

Vol. 1. No. 12
June 27, 1923

CONTENTS

Editor: JOHN SCOTT-TAGGART, F.Inst.P.
Assistant Editor: E. REDPATH.

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Scientific Adviser:
Prof. G. W. O. HOWE, D.Sc., M.I.E.E.
Advisory Editors:
Prof. R. WHIDDINGTON, M.A., D.Sc.
Prof. C. L. FORTESCUE, M.A., M.I.E.E.

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S. G. RATTEE.
P. W. HARRIS

All correspondence relating to contributions is to be addressed to the Editor of "Wireless Weekly."

Editorial

ONE of these days, between the Wednesday of one week and the Wednesday of the next, a decision will be made by the Broadcasting Committee regarding the future of broadcasting. A whole Editorial will be wasted and a willing horse will have been beaten for one week. For all the present indications of a decision, we might confidently continue editorials in an impatient strain for weeks. Nevertheless, one cannot help but feel that some day the Committee will come to some decision. This intelligent hope is really founded on the fact that the President of the Radio Society of Great Britain is a member of the Committee, and however careless other members of that Committee may be of the interests of the listener-in, we feel sure that Dr. Eccles feels his responsibility in this matter. Representing, as he does, the listener-in, we feel certain that he is exerting every effort to hasten a decision which is holding up the development of wireless broadcasting in this country.

We feel sure that he remembers that the licence problem is not months old but years old.

Long before broadcasting was inaugurated the Post Office were checking amateur developments by holding up wireless licences, and this state of affairs became very acute when broadcasting commenced. There were tens of thousands who did not even pretend to be able to fill in correctly the application forms for an Experimental Licence. These thousands had not the least intention of buying a wireless set, although they would be prepared to buy component parts. No licence whatever could be issued to these members of the community. The result has been that during this twelve months they have either given up the idea of wireless, or else have installed apparatus in defiance of the law.

In wireless matters the conscience element, so essential to the strict surveyance of an art like wireless, is rapidly disappearing. This is a very serious matter when it comes to enforcing the licence fees. A pirate of twelve months' standing will not be likely to haul down his flag if he can help it. Meanwhile, this feeling of irresponsibility is spreading.

It is an extraordinary fact that such a large body of the British public has been suppressed for twelve months in this fashion without a remedy. This repression has had a very serious effect on the wireless industry as a whole. Not only has it caused the Press to strive to obtain freedom for the home constructor, but it has led to many serious and unfair attacks on broadcasting itself.

Public confidence needs to be restored, and the Broadcasting Company, by issuing their report, will completely alter the situation.

The manufacturers, on the other hand, the moment this report is published, can do much to popularise wireless. Really good demonstrations in different towns should be organised by the associations of manufacturers, and wireless broadcasting itself should be advertised. No doubt if the manufacturers' associations would guarantee a certain amount of advertising to the newspaper proprietors, the latter would agree to devote editorial space to popularising the new amusement and hobby. Just as electrical manufacturers and radiator makers advertise their products, so should wireless manufacturers advertise wireless.

We feel that, in spite of the severe depression, "the sun," as Mr. Lloyd George would say, "is rising over the Welsh mountains," and a period of great prosperity lies in front of the manufacturers, who should now be preparing for a boom autumn and winter. Meanwhile, let them join with the would-be listeners-in in pressing for a decision from the Broadcasting Committee.

MY EXPERIENCES WITH ST100

By PERCY W. HARRIS, Staff Editor.

So varied are the experiences of the experimenters who have tried this new circuit that some practical hints on its working should serve to assist our readers.

EVERY experimenter who has passed beyond the elementary stage is well aware of the great difference which may exist between a circuit which looks well on paper and one which will give practical results. Innumerable dual amplification circuits have been published from 1914 onwards, but it has remained for the ST100 circuit to bring the principle of dual amplification into widespread use amongst all classes of listeners-in. The main principle of the circuit, of course, is not new, but the detailed arrangement of the apparatus, and most particularly the means of stabilising the circuit, are not only novel, but effective. To obtain the maximum results these details have to be observed, and it will then be found that the circuit is both easy to handle and remarkably efficient.

I am very sorry to see that in some quarters petty attempts are being made to minimise the credit for producing such an essentially practical form of dual amplification circuit. Furthermore, I have a shrewd suspicion that many who are saying there is nothing novel in the ST100 circuit have now built a dual amplification circuit for the first time as a result of the article which appeared in No. 5 of *Modern Wireless*.

My own experiments with this circuit have been remarkably successful, and my first receiver to embody this circuit is shown in the photo on the second page of this article. Within five minutes of soldering up the last connection this instrument was filling the house with music from 2LO with the aid of a Claritone loud-speaker. Indeed, on an ordinary P.M.G. aerial, six miles away from the station, the strength of signal was so great that the circuit had to be considerably detuned to avoid the distortion due to overloading the loud-speaker.

I have built many receivers to various designs, but never yet have I found a circuit which gives such tremendous strength and purity for two valves. The circuit used is not modified in any way from that described in the original article by Mr. John Scott-Taggart, but I have found it advisable to place the aerial tuning condenser permanently in parallel and not in series. Both the aerial condenser and the anode tuning condenser have a value of 0.0005 μF, these values being large enough to give considerable range with the coils used, but not so large as to make tuning difficult.

The first experiments were carried out with my usual outdoor aerial, which is between 30 and 35ft. high and about 40ft. long. With this, as I have mentioned above, the strength of signals from 2LO is far too great to be comfortable, and distortion occurs through overloading the loud-speaker. Although the instrument is designed so that reaction between the anode coil and the aerial coil is possible, in the test on broadcasting this reaction was not used. I agree with Mr. J. Scott-Taggart that the efficiency of the circuit is greater on relatively loud signals such as are obtained at distances up to about fifty miles from a broadcasting station, but I have found that without any recourse to reaction Birmingham is comfortably audible in an ordinary living-room using the loud-speaker. Cardiff, which is not heard very well at any time with my normal apparatus, was heard quite comfortably in the telephones, using in this case a telephone transformer and low-resistance telephones. I have used high-resistance telephones without causing any appreciable interference with the circuit, but I think it is generally best to use either a loud-speaker or low-resistance telephones with the intervention of a transformer. This prevents body capacity effects giving trouble and likewise protects the telephones.

The instrument shown is remarkably stable, and whilst it will oscillate if the swinging arm bearing the moving coil is brought too close to the fixed coil, I have not found it "howl" save when one or other of the coils is withdrawn from its socket.

After testing the instrument on all kinds of wavelengths with the outside aerial, I rigged up a temporary indoor aerial consisting of electric light flex taken from the instrument round three sides of the room at a height of 7ft., the total amount of wire not exceeding ten yards. The ordinary earth connection was used. With this arrangement, using a little reaction, it was possible to enjoy 2LO's evening programme quite comfortably, with the loud-speaker. I think all readers will agree that a two-valve and crystal circuit which will give such results is remarkably efficient.

As I am sure many readers will wish to obtain equally good results, I have prepared for the July issue of *Modern Wireless* a complete and detailed description of how to make this instrument, the description being accompanied by several photographs and diagrams to elucidate the text. Meanwhile, it may interest some experimenters to know that I have worked this instrument with a number of different kinds of valves. It works quite satisfactorily with Marconi-Osram R's, the Cossor (including the new red-topped Cossor valve specially made for high-frequency amplification), Ediswan A.R., Mullard Ora, and Marconi-Osram Q.X. Whilst it will work quite well on 60 volts, 100 volts give far better results, and the additional expense for a larger high-tension battery is well warranted.

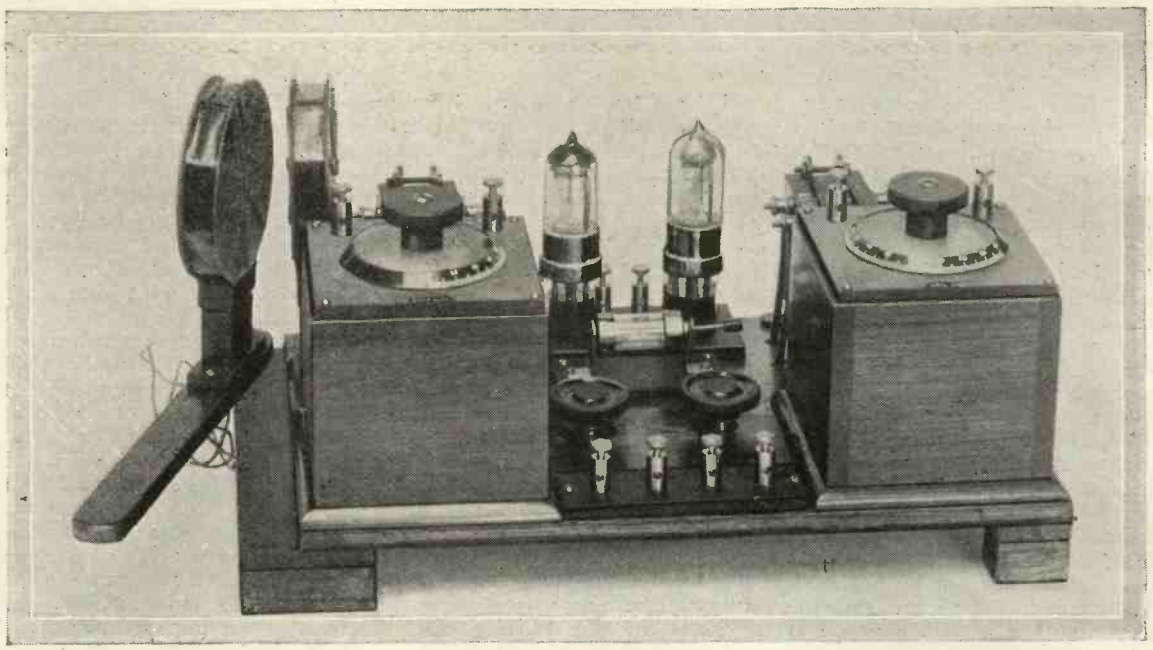
The instrument is so designed that it is very simple to disconnect the last valve and place the loud-

speaker after the first valve, thus giving an opportunity of using the set with one valve only. In this way using only one valve and the crystal, together with the loud-speaker, the transmissions from 2LO were found to be quite loud enough for an ordinary room.

The crystal detector does not appear to give any trouble, and I am using at present a specimen—quite a good one—of hertzite, with a gold "cat whisker." I would advise all experimenters who have not yet done so to fit their crystal detectors with a gold wire, as this seems to give superior results in all cases. The crystal detector is best adjusted on weak and not strong signals, for when signals are weak it is far easier to find the most sensitive point. I have not yet tried a zincite-bornite combination, but I should not be surprised if this proves superior. However, the present arrangement of hertzite and gold wire is thoroughly satisfactory in my hands, and those who are used to handling such crystals can be recommended to continue with them in this circuit.

I have not yet tried the instrument with dull emitter valves, but with such valves it should prove the most economical and efficient receiver possible for the reception of broadcasting up to 50 miles or so. For the benefit of those who are not accustomed to handling crystal receivers, and might be inclined to think that the crystal is liable to give a great deal more trouble than a valve, I may say that, when adjusted, my own receiver remains on adjustment for the whole evening without needing to be touched in any way, which fact speaks for itself.

By arranging to give a negative bias to the grids of the valves (4 to 9 volts, best found by trial) further considerable amplification is obtainable, particularly with certain valves.



An example of the ST100 circuit made up in a neat and compact form.

FORTHCOMING EVENTS.

JUNE.

27th (WED.).—2LO, Elgar Night.

28th (THURS.).—2LO, Opera, "Savitri," by G. Holst.

28th (THURS.).—Cardiff and South Wales Wireless Society. Mr. W. H. McClure will take charge of experimental work.

28th (THURS.).—Luton Wireless Society. Mr. E. Plater will lecture at 8 p.m. on "The Flewelling Circuit," at Hitchin Road Boys' School, Luton.

28th (THURS.).—Newport and District Radio Association. Mr. G. L. Green will speak on "Humours of Listening-in," at the Memorial Institute, Queen's Hall, Newport.

29th (FRI.)—2LO, Acts I. and II. of "The Meistersingers," at 7 p.m.

29th (FRI.).—Radio Society of Highgate. An exhibition and demonstration of loud-speakers to be held at 1919 Club, South Grove, Highgate, at 7.45 p.m.

29th (FRI.).—The Leeds and District Amateur Wireless Society. Mr. R. E. Timms will lecture on "Signalling — Ancient and Modern," at 8 p.m.

JULY.

1st (SUN.).—2LO, Royal Air Force Band.

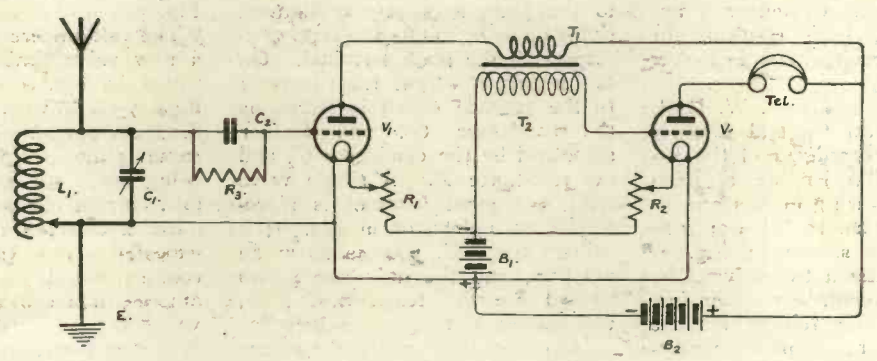
1st (SUN.).—Dartford and District Radio Society. Visit to North Foreland Wireless Station.

2nd (MON.).—North London Wireless Association. Lecture by Mr. V. J. Hinkley, at 8.30 p.m., on "Triggered Valve Circuits."

Wireless Weekly Circuits

No. 12.

A Valve Detector with Low-frequency Amplifier



COMPONENTS REQUIRED.

- L_1 : A fixed or tapped inductance.
- C_1 : Variable condenser having a maximum capacity of 0.0005 μF or 0.001 μF.
- C_2 : A grid condenser having a capacity of 0.00025 μF or 0.0003 μF.
- R_3 : A gridleak having a resistance of about 2 megohms.
- T_1, T_2: A step-up intervalve transformer.
- B_1 : Six-volt accumulator.
- R_1 and R_2 : Rotary filament rheostats of standard pattern.
- B_2 : High-tension battery of 40 to 100 volts.
- T : High resistance telephone receivers.

GENERAL NOTES.

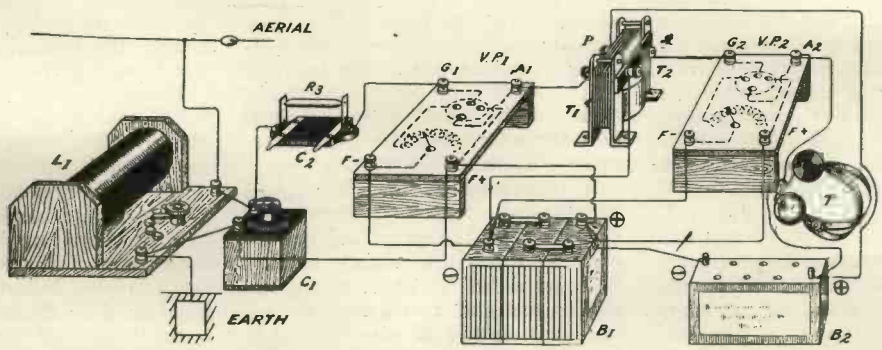
In this circuit the first valve acts as a detector, while the second one acts as a low-frequency amplifier.

VALUES OF COMPONENTS.

The inductance L_1 may be an S_2, S_3 or S_4 Burndept's coil or a No. 25, 35 or No. 50 Igranic honeycomb coil. It might also be an inductance consisting of 80 turns of No. 26 gauge d.c.c. wire wound on a cardboard tube 4in. in diameter and tapped at every ten turns. If an inductance with slider is used without a variable condenser, see values given in previous circuit.

NOTES ON OPERATION.

Try joining the lead from the earth terminal to different points on the filament accumulator. This will sometimes make a difference. Try connecting a 0.002 μF condenser across the primary T_1. Otherwise the only adjustment is the usual filament rheostat, the high-tension battery, and for tuning purposes the inductance L_1 and variable condenser C_1.



A NEW RECEIVER

The following article describes a combined kenotron and pliotron capable of operating on alternating current.

A NEW development introducing some very interesting characteristics is the combination of a kenotron rectifier (for supplying the plate voltage) and an equipotential cathode pliotron (capable of being heated by an alternating current without any appreciable A.C. hum resulting in the output circuit) in a four-electrode valve.

As described by Mr. A. W. Hull, of the American General Electric Co., in the *Proceedings* of the Institute of Radio Engineers, from which the following details and illustrations are abstracted, the principle is clearly shown in Fig. 1, which represents a two-valve A.C. receiver, the kenotron rectifier furnishing the plate voltage for the pliotron detector; the pliotron cathode-heating battery is omitted, the cathode being connected directly to the anode of the kenotron, and it is evident that the device will function equally well if the two elements are combined so that the kenotron anode can also be used as the pliotron cathode, the resulting circuit being shown in Fig. 2.

The structural features of one form of such a double-function valve are indicated in Fig. 3. The filament is a helix of tungsten wire, maintained at a temperature of approximately 2,300° C. by 2 amps. at 5 volts A.C. The cathode is a nickel cylinder ⅛in. in diameter by 1¼in. long coated with barium oxide, and the grid and plate are concentric cylinders surrounding the cathode, the grid being a helix 1in. long by ¼in. in diameter, consisting of 40 turns of 3-mil. (0.008 cm.) molybdenum wire. Fig. 4 is a cross-sectional view of a valve suitable for operation from a lamp socket, without transformers; the filament is a standard tungsten helix, such as is used in gas-filled lamps, and the cathode a nickel cylinder ⅛in. in diameter and 1½in. long.

In the typical receiving circuit (Fig. 5) incorporating a single valve of the type shown in Fig. 3, the filament voltage is obtained from a step-down transformer; one side of the 110-volt power line is connected to the filament and the other to the plate so that the filament swings plus or minus 110 volts with respect to the plate terminal. On the negative side it feeds current to the cathode which is stored by the condenser C_1, and further smoothed by the condenser C_2 and the resistance R. A single valve with a 110-volt filament is represented as a detector in Fig. 6; it utilises the A.C. power line as an antenna, and the only accessories needed are the telephones, filter, and tuning unit.

In order that rectification may result when a single valve is used as a half-wave rectifier (Figs. 2 and 5), the outside surface of the cathode is made to have a higher electron emissivity than the inside by coating it with an oxide; the necessity for unilateral electron emissivity is removed when full-wave rectification is employed, but if a single valve with a 110-volt filament be used as a full-wave rectifier (Fig. 4), the electron emission from the inside of the cathode may be the same as that from the outside, provided it is less than that of the filament; for, in this case, the cathode is always receiving electrons from one end of the filament at the same time as it is emitting them to the other end, and it is only necessary that the number received should be in excess.

A resistance-capacity filter gives satisfaction, and is lighter and cheaper than the usual inductance-capacity type; that shown in Fig. 6 consists of three 2-microfarad condensers and two 4,000-ohm resistances, and is capable of furnishing five milliamperes at 60 volts, with half-wave rectification. An earth connection is, generally, not necessary, the A.C. line being sufficiently earthed; earthing the circuit at any point does no harm, but may interfere with operation or introduce an A.C. hum; it is preferable to make the earth connection through a condenser as shown in Fig. 5.

The volt-ampere characteristics of a new valve similar to that illustrated in Fig. 3 are compared in Figs. 7 and 8 with those of a standard UV-201 amplifier valve at the same plate voltage, the former being much steeper, as is also the grid current characteristic, so that a higher detection coefficient may be expected. The values of mutual conductance, plate resistance, and amplification constant for the new valve are 1.5×10^{-3}, 18,000, and 27 respectively, as compared with 0.28, 20,000, and 6 for the UV-201 type of valve. The operating characteristics of the new valve are identical with those of standard pliotrons, but its voltage amplification is about four times that of the UV-201 type, at both radio and audio frequencies, which fact is specially significant in the case of radio frequency; at 300 metres a resistance-coupled UV-201 type amplifier gives a voltage amplification of 2 per valve, whereas the equipotential cathode valve averages 7-fold voltage amplification—a single valve of the latter type being thus nearly the equivalent of three of the former pattern.

Under normal conditions A.C. hum cannot be heard when a single valve is used; with two in series, the hum can be heard only when the telephones are pressed tightly on the head; but with three in series hum is quite noticeable; a large part of the hum is probably due to circuit induction, and can be eliminated by shielding.

An important operating feature of this type of receiving equipment is its safety; nothing that the operator can do can harm either

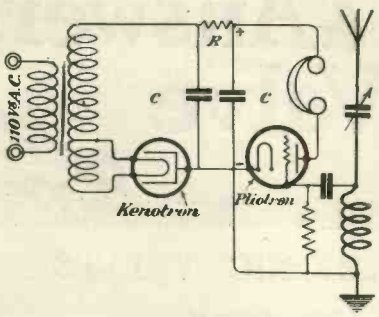


Fig. 1.—A pliotron receiver with kenotron rectifier.

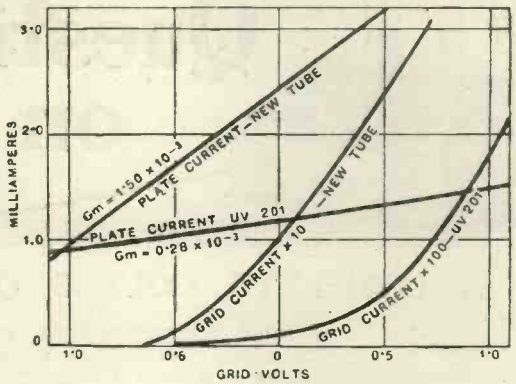


Fig. 7.—Characteristic curves.

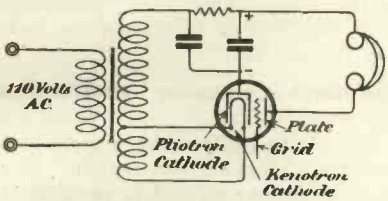


Fig. 2.—Combined pliotron-kenotron rectifier.

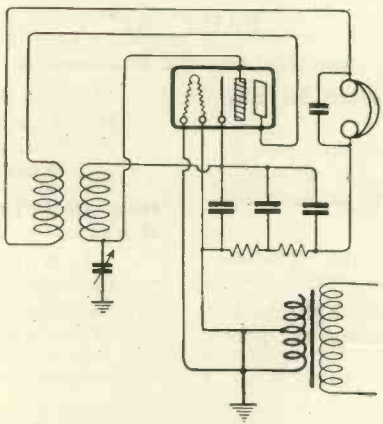


Fig. 6.—Receiving circuit for 110-volt valve with power line aerial.

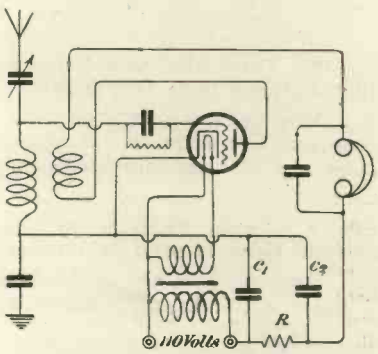


Fig. 5.—A simple receiving circuit.

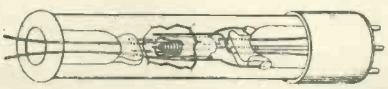


Fig. 3.—Laboratory model of the new valve.

Fig. 4.—Cross section of 110-volt filament valve.

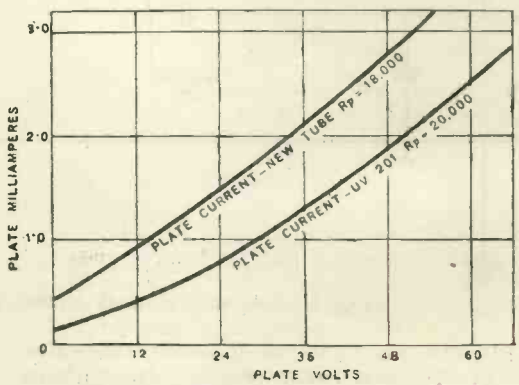


Fig. 8.—Plate-resistance characteristics.

himself, the receiving valve, or the lighting circuit. The A.C. power terminals are made inaccessible by the use of standard lamp receptacles and plugs, all exposed terminals are protected by high resistances, and no injury can be done to the valve by short-circuiting either the pliotron or the kenotron part of it.

Questions & Answers on the Valve

A COMPLETE COURSE ON THERMIONIC VALVES

By JOHN SCOTT-TAGGART, F.Inst.P., Member I.R.E. Author of "Thermionic Tubes in Radio Telegraphy and Telephony." "Elementary Text-book on Wireless Vacuum Tubes," "Wireless Valves Simply Explained," "Practical Wireless Valve Circuits," etc., etc.

PART XI

(Continued from No. 11, page 647.)

May the Three-electrode Valve be Used for any Other Purpose than Amplifying?

Yes, the three-electrode valve may be used as a sensitive detector. It changes the high-frequency currents into ones changing at low frequency.

Draw a Simple Receiver in which the Three-electrode Valve is used as a Detector.

Fig. 1 shows a simple circuit in which the oscillation circuit L_1, C_1 is connected across the grid G_1 and filament F_1 of the three-electrode valve V_1. In the anode circuit of this valve we have the telephones T and the high-tension battery B_2. In the grid circuit, next to the grid, we have a condenser C_2 having a capacity of about 0.0003 μF (the abbreviation "μF" meaning microfarad) shunted by a high resistance R_2 of 2 megohms (a megohm being 1,000,000 ohms).

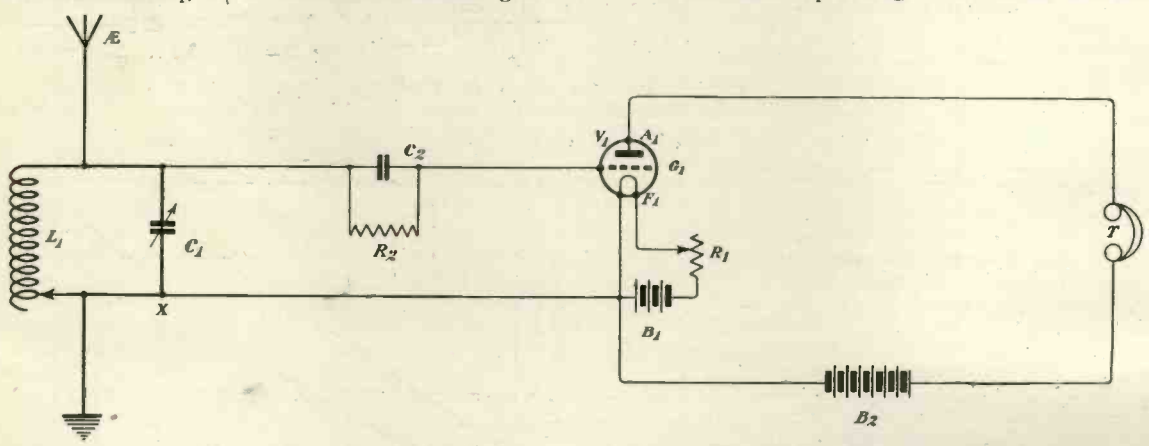


Fig. 1.—Illustrating a simple receiver using a three-electrode valve as a detector.

What is a Leaky Grid Condenser?

The condenser C_2 connected in the grid circuit of a valve for rectification purposes is called the *leaky grid condenser*. The condenser itself is called the *grid condenser*, while the resistance R_2 is called the *leak*. The whole process of rectification by this means is known as *leaky grid condenser rectification*.

How Does Leaky Grid Condenser Rectification Work?

It is very difficult to explain the process to a beginner, but the following is roughly what happens. The oscillations applied to the grid G_1 of the valve V_1 in Fig. 1 are of an alternating nature; that is to say, the grid is first given a positive potential, due to the positive half-cycle of oscillating current, and then a negative potential, due to the negative half-cycle.

When receiving wireless telephonic speech or music, or when signals are received from stations working on the spark system, the high-frequency currents are continually varying in their amplitude or strength. When the grid is given a positive potential, it attracts some of the electrons on their way to the anode; in fact, the grid and the filament act very much like a two-electrode valve under these conditions. The electrons, when

they are attracted to the grid, charge it to a negative potential. At the end of the positive half-cycle the grid is a little more negative than it was before. A negative half-cycle now comes along and causes the grid to become still more negative; but as this negative impulse on the grid does not cause any more electrons to go to the grid, the total number of electrons sticking on to the grid, as it were, remains the same. The next positive half-cycle, however, now comes along and attracts still more electrons from the filament, and at the end of the second positive half-cycle the grid is considerably more negative than before.

The ultimate result of this process is that, while the grid potential continues to vary at the same frequency as the incoming oscillations, yet, owing to the accumulation of electrons on the grid and on the right-hand plate of the condenser C_2, the grid gets gradually more and more negative.

In order to prevent this negative potential becoming too great, and therefore preventing the proper action of the detecting process, a leak R_2 is provided across the condenser. This leak has

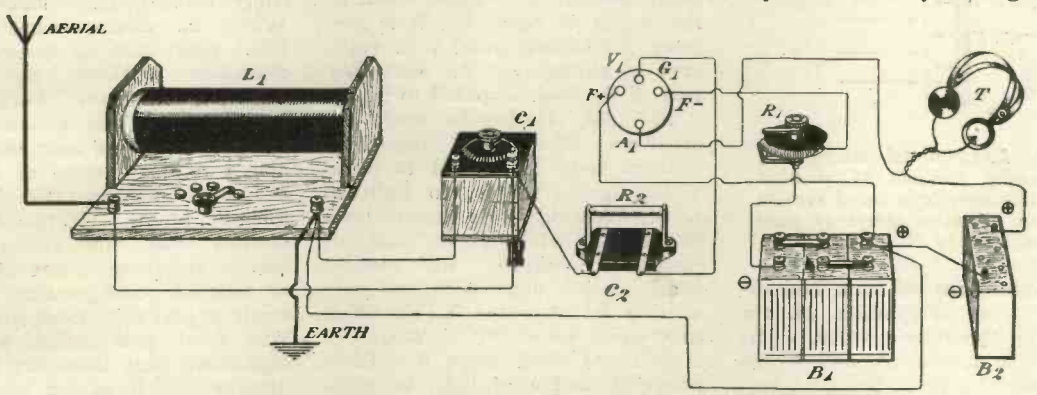


Fig. 2.—A pictorial illustration of a three-electrode valve connected in such a way as to give detection as in Fig. 1.

a very high resistance, and serves to allow the electrons to leak away slowly back to the filament from the grid and the right-hand plate of the condenser C_2. This leak is necessary, because the electrons could not, of course, pass through the condenser C_2, which, while it allows the passage of high-frequency impulses, will prevent the passage of an ordinary direct current.

While the high-frequency currents are varying in strength at what is known as an " audio " frequency, *i.e.*, frequencies very much lower than the frequencies of the oscillations, the negative potential on the grid, due to the accumulation of electrons, is varying in accordance with these low-frequency variations. When the oscillations have a large amplitude, the negative potential on the grid becomes large, owing to the fact that the large positive half-cycles produce a large accumulation of electrons on the grid, whereas, when the oscillations are very feeble, practically no electrons are drawn to the grid, and those that are already there are leaking away through the resistance R_2.

The low-frequency variations of the grid potential cause similar current variations in the anode circuit of the valve; that is to say, while the grid G_1 is becoming more negative, the anode current is decreasing.

The reader will thus see that, while the strength of the oscillations in the aerial circuit is varying up and down, the anode current is also varying in time with the other low-frequency variations, the anode current, however, always decreasing and then returning again to its normal value. One moment the anode current may be decreased by a large amount, and the next moment by only a small amount. These current fluctuations passing through the telephones T cause them to emit the music, speech or buzzing, according to whether the incoming oscillations are produced by music, speech, or spark signals.

Does the High-tension Voltage matter very much when the Valve is used as a Detector?

An adjustment of the high-tension voltage is more important in the case of a valve detector than a valve amplifier. Usually the high-tension voltage needs to be considerably less when a valve is used as a detector.

Does it matter to which side of the Filament Accumulator the bottom end of the Grid Circuit is connected?

In Fig. 1 the junction point X is shown connected to the positive side of the filament accumulator B_1. This will usually be found to be the best place to make the connection, but the experimenter, or constructor, might be interested to try connecting it to any point on the accumulator B_1, such as half-way along, or the negative terminal. The best connection depends a good deal on the type of valve used, but in nearly all cases it is not possible to improve on the results obtained with the connection made to the positive side of the accumulator.

Show the Wiring necessary of different components to conform to the Circuit of Fig. 1.

This is illustrated in Fig. 2, the different components being lettered so as to correspond to the different parts of the circuit shown in Fig. 1.

ELECTRON-EMISSION BY LIGHT

By J. H. T. ROBERTS, D.Sc., F.Inst.P., Staff Editor (Physics).

An article dealing with possible uses in wireless of electron-emission.

THE discovery and application of the phenomenon of the electron emission from a hot wire may be said to have revolutionised wireless telephony, and scarcely a week goes by without

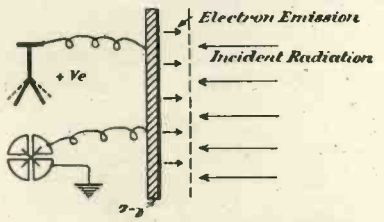


Fig. 1.—Experimental arrangement for showing emission of electrons from plate under influence of suitable radiation. Positive charge of plate indicated by electrometer.

the announcement of some new development or adaptation of the wonderful thermionic valve. Its uses are so numerous, and it has proved such a great practical success, that attention has been almost wholly focussed upon the thermionic emission, as the effect upon which the future of wireless is to be built.

Probably this is right. In any case, it is certain that the very large amount of research work which has been devoted to the science of thermionics has eminently justified itself.

At the same time, it is well to remember that the thermionic emission, although it permits a copious and manageable supply of electrons to be very conveniently obtained, is not the only known method of producing electrons under conditions suitable for manipulation after the manner of the wireless valve. Of recent years many other phenomena have been discovered which involve electronic emission, and it is not impossible that future wireless developments (at any rate in certain special directions) may be more conveniently served by some form of electronic emission other than the thermionic emission.

An interesting and important mode of electron emission is that known as "photo-electric" emission, which occurs when certain substances are exposed to particular kinds of radiation. In its widest application the term "photo-electricity" includes any electrical changes brought about by the action of light, but it is now more particularly used with reference to changes in the *electrification* of the body exposed to light.

In 1888, Hallwachs made the discovery that if a negatively charged body is exposed to ultra-violet light (that is, to light of short wavelength), it rapidly loses its charge, whilst if the body is positively charged, its positive charge is not diminished and may actually be increased. This effect may easily be shown by means of a gold leaf electroscope if a fairly powerful source of light is available, such as an electric arc. Zinc shows the effect well, and if a freshly polished plate of this metal is attached to the plate of the electroscope and is negatively charged, it will be found that when the light from the arc falls upon it the divergence of the gold leaves will be diminished (see Fig. 1). It has also been found by Elster and Geitel that the electro-positive metals, such as sodium, potassium, and rubidium, show strong photo-electric effects, even when exposed to visible light. The less electro-positive metals show the effect less strongly, but metals such as zinc and aluminium will exhibit the effect when exposed to strong sunlight.

What is the mechanism of this photo-electric emission? It is well known that, according to Maxwell's electro-magnetic theory of radiation, light consists of electro-magnetic disturbances propagated through the ether with a finite velocity. In the advancing wave-front there are periodic changes both of electric and magnetic force, the directions of these changes being at right angles to one another. The atoms of the substance upon which radiation falls consist, as we now know, of groups of electrical particles, the outer rings of particles of each atom being electrons comparatively loosely held. When an electro-magnetic wave falls upon such an assemblage of electrified particles, the electric force in the wave disturbs the equilibrium of the system, and it is easy to imagine how, under suitable conditions, some of the electrons may be separated from the metallic atoms. It has been explained that the electro-positive metals are those whose atoms are of unstable configuration and are ready to part with an electron under very small provocation, and it is significant that these are the substances which exhibit the photo-electric effect most strongly.

If the incidence of radiation produces a supply of electrons, it would seem reasonable to look for evidence that the conductivity in the vicinity of a substance emitting photo-electrons should be increased, and, in fact, Hertz, as early as 1897, observed such an effect, although its nature was not at that

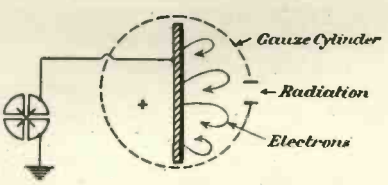


Fig. 2.—To determine maximum kinetic energy of emitted electrons.

time properly understood. Hertz found that if an electric spark circuit was so arranged that the potential difference across the spark-gap was just insufficient to

cause a spark to pass, and then the spark was illuminated by means of the light from a second spark, the spark would pass across the first spark-gap. He found that the effect was prevented by interposing a glass plate between the two spark-gaps, but if a plate of rock crystal (quartz) were interposed instead of the glass, this made practically no difference to the effect. It should be noted that glass is practically opaque to ultra-violet rays, whilst rock crystal is much more transparent to such rays. These and other experiments proved to Hertz that the spark in the first spark-gap was precipitated by the incidence of ultra-violet light upon the electrodes. In view of what we now know of the photo-electric emission, it will be seen that the effect is easily explained, for the production of only a few electrons in the first spark-gap would give rise to ionisation-by-collision, and the number of ions would increase with great rapidity and would result in the passage of the spark in the usual way.

It may be remarked, in passing, that this effect is similar, in some ways, to that which takes place in a wireless valve, and no doubt the reader will see, in the experiment of Hertz, the idea of a possible wireless valve, or its equivalent, based upon the photo-electric effect.

When the photo-electric effect takes place from a metal surface immersed in air or other gas at ordinary pressures, the electrons set free at the surface of the illu-

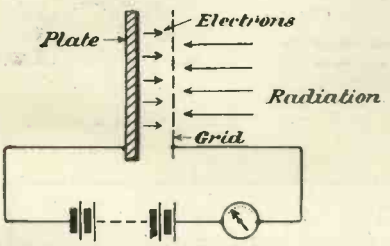


Fig. 3.—Arrangement to obtain characteristic curve for emission current.

minated plate form ions by becoming attached to one or more gas molecules, and if an electric field is applied, these electrified carriers move comparatively slowly through the gas. If, however, experiments are carried out in a very high vacuum, the conditions of the discharge are much simplified. It was found by Elster and Geitel that at very low pressures a transverse magnetic field had the effect of diminishing the photo-electric current, and later, experimenting in a somewhat similar way, J. J. Thomson, Lenard, and others were able to identify the carriers of negative electricity, from a metal surface illuminated by ultra-violet light, with the cathode particles in a Crookes tube; in other words, it was proved that the electrical particles which are ejected from the metal surface by the influence of incident radiation are *electrons*, identical with the electrons which have now been found to be produced by so many various methods.

Experiments on Photo-electricity.

The general experimental arrangement for investigations in photo-electric discharge includes essentially the plate which is to be illuminated, and a suitable gold leaf electroscope or quadrant electrometer, which is connected to the illuminated plate while all other bodies in the neighbourhood are kept at zero potential. Under these circumstances, in consequence of the emission, the plate acquires a positive charge and eventually, when its positive potential reaches a certain value, the released electrons are unable to reach the surrounding bodies, and consequently the positive potential of the plate has a maximum value (see Fig. 2). It is easy, by equating the kinetic energy of the emitted electrons to the potential energy which they would have on reaching their surroundings, to obtain a simple formula giving the maximum velocity of the electrons leaving the plate.

Another method by which the photo-electric effect has been investigated is to arrange that the illuminated metal plate forms one plate of a condenser, the other plate of the condenser being a piece of metal gauze placed opposite to the illuminated plate, the radiation passing through the meshes of the gauze and falling upon the plate which is under test. By means of a battery, an electric field is set up which drives the electrons from the plate to the gauze, and by including in the circuit a sensitive galvanometer, the emission current can be investigated for different values of the electric field (see Fig. 3). Without going into further details of such experiments (which, however, are extremely interesting to those who wish to make a serious study of special cases of electron emission), it will be seen that the method of experiment is very similar to that which is adopted in determining the characteristic curve of a wireless valve. In particular, as the potential difference between the plate and the gauze is increased

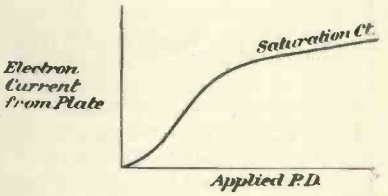


Fig. 4.—Characteristic curve for emission current. Note similarity to characteristic curve for 2-electrode valve.

(we may think of the plate as the filament of a valve, and the gauze as the anode of the valve), the emission current increases and finally attains a maximum or saturation value (see Fig. 4).

Certain important conclusions have been reached from experiments of this kind made in high vacua. It has been found that, up to about 800 deg. Centigrade, the number of electrons emitted per second, and also the velocity with which they leave the surface, are independent of the temperature. When the temperature reaches about 800 deg. Centigrade the thermionic emission begins and the number of electrons emitted per second increases rapidly. Below this temperature it is found that the amount of the emission is directly proportional to the intensity of the incident light.

A very striking result, which is of great theoretical importance in connection with the so-called "quantum theory of energy," is that the velocity of the emitted electrons is independent of the intensity of the incident radiation. It has been found that the total energy of an escaping electron is proportional to the *frequency* of the incident radiation. That is to say, the *intensity* of the radiation controls the *number* or quantity of electrons emitted per second, but the *frequency* of the radiation controls the *energy* which enables the electrons to leave the surface: the actual energy of an emitted electron is equal to hn, where n is

the frequency of the radiation, and h is Planck's universal constant (the value of Planck's constant is 6.55×10^{-27} erg. sec.). It is to be noted, however, that the energy of the electron does not all appear in its velocity of emission, for a certain amount of energy is expended in getting free from the surface, or, as it is expressed, in overcoming the "electron affinity." It is convenient for some purposes to express the energy required for the detachment of an electron as being that which it would acquire from radiation of a certain minimum frequency, n_0. This frequency is called the "threshold frequency." Thus if radiation of frequency n_0 falls upon the substance, the electrons will *just be detached* from the metal, but will have no velocity. If radiation of frequency n (greater than n_0) falls upon the metal, the energy will be hn, and the surplus energy, after detachment from the metal, will be $hn - hn_0$ or $h(n - n_0)$. The kinetic energy of a moving body of mass m and velocity v is $\frac{1}{2}mv^2$, and thus the velocity with which the electrons leave the metal is given by the equation

$$\tfrac{1}{2}mv^2 = h(n - n_0).$$

This is known as Einstein's relation, and has since been experimentally verified by a number of different investigators, including Richardson, Hughes and Millikan: it forms a very convenient method for the determination of Planck's constant. The equation which has been given above applies not only to ordinary light, but also to the ejection of electrons from a substance due to the incidence of X-rays. It is probable also that the relation applies to the converse case of the emission of radiation from a substance which is subjected to electronic bombardment. By way of example, the case of sodium may be instanced. The threshold or characteristic frequency (n_0) for sodium has been found to have the value 5.15×10^{14} sec.$^{-1}$, which corresponds to about the green light of the spectrum. Einstein's relation means, in this case that if light of lower frequency than the value given above (or, in other words, light nearer to the red end of the spectrum) falls upon the metal sodium, no photo-electric emission will take place, while if light of higher frequency (that is, nearer to the violet or ultra-violet end of the spectrum) falls upon sodium, there will be a photo-electric emission, and the maximum energy of the emission will increase in proportion to the difference between the frequency of the exciting radiation and the frequency of the characteristic radiation or threshold frequency.

According to the quantum theory, interchange of energy between matter and ether can only occur by indivisible quanta, the amount of such a quantum being proportional to the frequency of the incident or emitted radiation, and being equal, in fact, to the product of the frequency and Planck's constant. Some reference to the quantum theory has already been made in a previous article: there are some physical phenomena which do not yet appear to conform to the quantum theory, but the photo-electric emission is one which falls naturally into place as an instance in support of the theory.

Reverting again to the comparison between the thermionic emission and the photo-electric emission: it has often been remarked that a considerable waste of energy is incurred in the heating of the filament of a wireless valve, this energy being partly used in releasing electrons from the hot wire. In the case of the heated filament, the proportion of the energy supplied by the filament batteries, which is actually used in overcoming what we may call the "electron affinity," is extremely small, by far the largest percentage of the energy being wasted in the form of heat radiation. Suggestions have been made for avoiding this waste and for providing alternative sources of electrons. In the case of the photo-electric emission, although, of course, the total amount of emission is very much less than may be obtained thermionically, the method is one whose efficiency, in the sense we are considering, is worthy of investigation.

HISTORICAL NOTES ON RADIO-TELEGRAPHY AND TELEPHONY

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

A Paper read before the Radio Society of Great Britain on April 25th, 1923.

PART IV.—(Continued from No. 10, page 631.)

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

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

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

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

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

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

(A slide was shown here of a small Poulsen arc which Mr. Blake used at his station at Richmond in 1913.) We used to telephone with this to Mr. Shaw's station at Twickenham, and to the London Telegraph Training College at Earl's Court.

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

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

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

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

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

Fessenden was the first to use a microphone in the aerial circuit. In

Heinrich Rudolf Hertz, whose experiments beyond doubt must now be classified among the principal achievements preceding the actual development of wireless telegraphy.

1906, by use of telephone relays of his own design, he demonstrated the possibility of connecting a land telephone line to a radiotelephone station.

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

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

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

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

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

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

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

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

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

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

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

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

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

Petersen's frequency raiser, patented in 1912.

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

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

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

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

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

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

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

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

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

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

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

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

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

It is quite impossible for us to go into the various spark systems which have been and are still employed. I may just mention in passing Balsellie's interrupted spark gap, Fessenden's rotary spark, Marconi's disc discharger, Lowenstein's quenched spark, across which a draught of air is blown by an electric fan, the Telefunken quenched spark, Dr. Chaffee's high-efficiency spark system, which is successfully employed for radiotelephony for distances up to 100 miles, also the De Forest spark system. Then there is the Lepel transmitter, which shares the properties of a hydrogen arc and a quenched spark; this works on a 500-volt D.C. or A.C. supply, the arc is struck between a sheet of delta metal, and a water-cooled disc of copper.

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Amplification.

THERE is a legend, an outrageous libel on the noble brotherhood of Angliars, that a fish once landed may continue to put on weight and length for weeks, months or even years after its demise. Even if this were so, and as an ardent seeker after trout I deny emphatically that it is, it would be as nothing when compared with the wireless phenomenon which we may call post-receptional amplification.

Let me recount an episode to show what I mean. My friend Blinkinflatt and I succeeded a few nights ago in bringing in Radiola at moderate loud-speaker strength by means of two valves. The circuit was a perfectly ordinary one, though one of the valves—the rectifier to wit—was something rather special. He, my friend, not the valve, was no doubt a little pleased with himself. He mentioned the feat to one or two fellows in the train. It became the talk of the place. Three days ago Mubblesworth buttonholed me in the main street of Little Puddleton and said with a kind of reverential awe: "Pretty sound fellow, Blinkinflatt. Invented a new circuit that knocks everything else into a cocked hat. Gets Brussels so that you can hear him all over the house, on one valve." During the last two and seventy hours the phenomenon of which he spoke has manifested itself to an extraordinary degree in our little town. Bredsnapp told Dewnohow that the miracle was performed regularly with a frame aerial; Snarsfield has it that signals were so intense that even when aerial and earth lead were disconnected the neighbours complained that the band playing in Blinkinflatt's house was keeping their children awake. Even the one valve was lopped off by my next informant, who knew for a fact that nothing but a crystal was used. I think that there will be a rather notable meeting of the wireless club next Wednesday. Blinkinflatt is down to lecture on long distance reception, and I have just told the secretary that I was present when he performed his wondrous deed, which, I assured him, consisted really in receiving WJZ by the aid of a piece of coke and a safety pin contact.

Notoriety.

Though naturally the most modest of men, Blinkinflatt has gained a certain measure of notoriety. The local paper had a five-line paragraph on the Feat; we must give it a capital F, because the *Little Puddleton Gazette* did so; it also misspelt the word, and its heading "Little Puddletonian's Big Feet" created a record sale for the issue. No less than twenty-seven pencil-marked copies were sent to Blinkinflatt by his friends. The editor of the semi-local daily that graces our breakfast tables saw the paragraph, attracted no doubt by its headline, decided that there was something in it, and sent down a reporter. Blinkinflatt refused an interview, but the press sleuth-hound tracked down the least veracious of his acquaintances, and obtained from him sufficient "facts" for his fell purposes. Next day the *Mudshire Sentinel* starred Blinkinflatt, even as films star Douglas Fairbanks. This is sometimes called "featuring," and certainly Blinkinflatt's features in the published portrait from a snapshot made by the reporter as our friend was driving him away were sufficiently remarkable to warrant the prominence given to them. The affair next became a national one, no less an organ than the *Daily Megaphone* having now taken it up. Blinkinflatt has already received an offer of umpteen pounds a week to appear at the Vanadium in a wireless turn, and goodness knows where it will all end. The more Blinkinflatt tries to tell the cold hard facts, the more he is laughed at and told not to be foolishly modest about his epoch-making discovery. "My dear fellow," people say, "I know you're far too good a chap to swank, and it's awfully nice of you to be so diffident about it. But you needn't be so reticent with me; I know all about the whole business." What is the poor man to do?

Safety First.

You may remember that not long ago a firm of coil manufacturers advertised a warning which came as a shock to thousands of us. It appeared that by purchasing in all good faith coils of other makes we had unwittingly laid ourselves open to all kinds of fearsome pains and penalties if we were caught in the act of using them. I forget at the moment whether we were liable to be dragged on hurdles to the place of execution, there to be hung, drawn and quartered, and afterwards buried at the cross roads with a stake driven through us as a warning to others who might be tempted to offend, or whether it was that we should lose all civil rights and incur the penalty of outlawry. Anyhow it was something pretty fearsome. The only consolation was that we could expiate our crimes by sending in postal orders accompanied by humble prayers for the granting of a licence to use our unspeakable coils without further let or hindrance.

A Grievance.

The Editor and I are feeling that we have a just grievance. Thousands, possibly millions, of private experimenters are using the S.T. umpty-um and the wireless wayfarer No. 1 (my ewe lamb). Are

they licensed to do so? No! Are we drawing one bronze penny from the fruits of our cerebral labours? No! Is such a position to be tolerated for one moment? Surely as free-born citizens of this Great Empire we have our rights. We desire, therefore, to warn all and sundry that as from to-day all unlicensed users of these circuits are guilty of nearly every crime in the statute book. High treason, mayhem (whatever that is), felo de S.T. are but the least of them. The penalties are too awful to record in cold black and white. Suffice it to say that anyone caught red-handed is, *inter alia*, liable upon conviction in open court to be hanged from his own aerial after being roasted over a fire made from the components of his wireless set. Lest the nervous should take the next boat for the Argentine, let me say that we are prepared to take a lenient view of the whole affair. Upon receipt of a cheque for five guineas we will issue the necessary licence indemnifying the offender from pursuit, hue and cry, and all legal penalties. Such is our generosity that even sixpenny postal orders will not be sneezed at. Can we say more? I think not.

A Much-Felt Want.

There was in what in misguided moments we term the good old days a most useful kind of court which was held in certain towns. It was called the Court of Pie Powder, which is a corruption of the French *pied poudré*, or dusty foot. It had the right of dealing summarily with wayfarers (!), tramps, strolling players and other perambulating offences against common decency, sentencing them to periods in the stocks, to whipping at the cart's tail and other suitable punishments. These courts are obsolete now, but what is wanted is something of the same kind empowered to deal with squealers, radiators, causes of etherial cat-calls and other disturbers of the wireless peace. At present these almost unmentionable creatures pursue their nefarious pastimes well-nigh unchecked. Time was when each broadcasting station had a black list, the announcer singling out various howl-ridden localities for special mention at the beginning of the programme. I shall always remember how heartfelt were my remarks about Little Puddleton on one never-to-be-forgotten evening when I was privileged for a few moments to take the place of the announcer at 2LO. Had he not leapt to the control switch I believe that my burning words would have killed oscillation once and for all in that part of the world at any rate. But all that no longer exists. The black list has been done away with, and the offenders no doubt smile sardonically as they cause their sets to wail and whistle and scream and moan and howl and chirp. Gone is the hand, or rather the voice, that administered radio spankings. Nothing will be done until we have Courts of Squeals Overt.

Justice.

These would, I think, meet the need of the moment. Those whose peace was troubled by the nefarious activities of their neighbours would repair to the market place, where, in the manner of the citizens of Jersey, they would kneel down with palms raised aloft to the heavens, crying. "Oyez, Oyez, my neighbour oscillates." The mayor, wearing his chain of office would then proceed to the residence of the person complained against, who would be arrested and dragged before the court. Upon conviction he would be placed in a kind of cage mounted upon a dray. Telephones connected through dozens of stages of low-frequency amplifiers to a special oscillator would then be clamped about his ears, and he would be paraded through the streets of the town for all and sundry to mock as they listed. Naturally his aerial would be torn down and its site sown with salt, whilst all his valves would be burnt out before his eyes by being connected one by one to the lighting mains. The Court of Squeals Overt is the only thing that will deal with Reacting Rupert as he should be dealt with, and the sooner it is instituted the better.

Technical Terms.

For the benefit of those who find it hard to understand technical terms, and who in spite of all their best efforts cannot for the life of them see the subtle distinction between, say, a volt and a variometer, I propose to give from time to time a few short lists of explanations that will make everything plane sailing. Here is the first of them, which will enable even the most crusty expert to give soft answers to the beginner's artless questions.

Anode.—What poets write in springtime.

Accumulator.—(1) When you put all you won on the 2.30, on to the also ran in the next race; (2) the thing you have to lug round to the garage.

Coil.—Used by mortals for shuffling off.

Condenser.—The thing that makes the squeaks when you turn its knob.

Grid. — Produces the frying noises. See Plate.

Henry.—See Ford.

Microfarad.—The millionth of a farad.

Microphone.—The millionth of a 'phone.

Loud-speaker.—See Wife.

Plate.—Serves up what is fried on the grid.

Reaction.—That tired feeling after a job of work.

Super-regeneration.—Process of submitting already amplified impulses to further distortion.

Transformer. – Implement designed for producing crackling noises.

Watt.—Electrical unit of power. Power is the work done per unit time. Understand? Splendid. Nor do I.

Strategy.

These, I think, should help would-be wireless enthusiasts towards an understanding of the great science. They must not be put off if they hear others indulging in the use of long words and unpronounceable terms. The more abstruse the flora of the wireless man's vocabulary the more profound is often his ignorance. He mugs up a whole heap of difficult words simply to cover his lack of knowledge. Thus if you hear a man speaking of such things as mhos you may feel pretty sure that he is merely trying to frighten you into silence. Attack is the only method to adopt in such cases. If you don't know any suitable words, invent 'em and ask him what he thinks of Slopitoff's theory of superimposed bielectrons.

WIRELESS WAYFARER.

A CONVERSION OF THE R.A.F. 10 RECEIVER

Some Suggestions for Reconstruction

An article dealing with the five-valve receiver in connection with the competition organised by the City Accumulator Co.

THIS receiver, advertised in this journal in connection with a competition scheme, is a five-valve instrument employing two high-frequency stages and two note magnifiers, and arranged to function on a fixed wavelength. The general arrangement of the receiver incorporates high-frequency inter-valve transformer coupling by means of aperiodic resistance-wound coils, followed by rectification, which in the original instrument is carried out without either a grid-leak or condenser, whilst potentiometer control is provided for the high-frequency valves.

The tuning arrangements of the instrument comprise a small basket coil connected in the aerial circuit in series with a semi-variable fixed condenser, across which is shunted a small vernier variable condenser having a capacity of about 0.0001 μF. The value of the semi-fixed condenser is approximately 0.001 μF. The semi-variable condenser is fixed, in operation, at the point at which tuning is most sharp, and to compensate for swaying of the aerial the resonance point can be controlled by means of the small vernier variable condenser.

The secondary circuit or detector coil is aperiodic in action, and is wound in the form of a small basket coil with No. 44 S.W.G. resistance wire. This winding is so proportioned that there is the maximum step-up of potential obtainable in the circuit of the first high-frequency valve. The coupling between the aerial and secondary circuit coils is variable, and it is interesting to note that there are no condensers whatsoever in this circuit beyond the aerial circuit tuning condenser. No reaction of any kind is fitted.

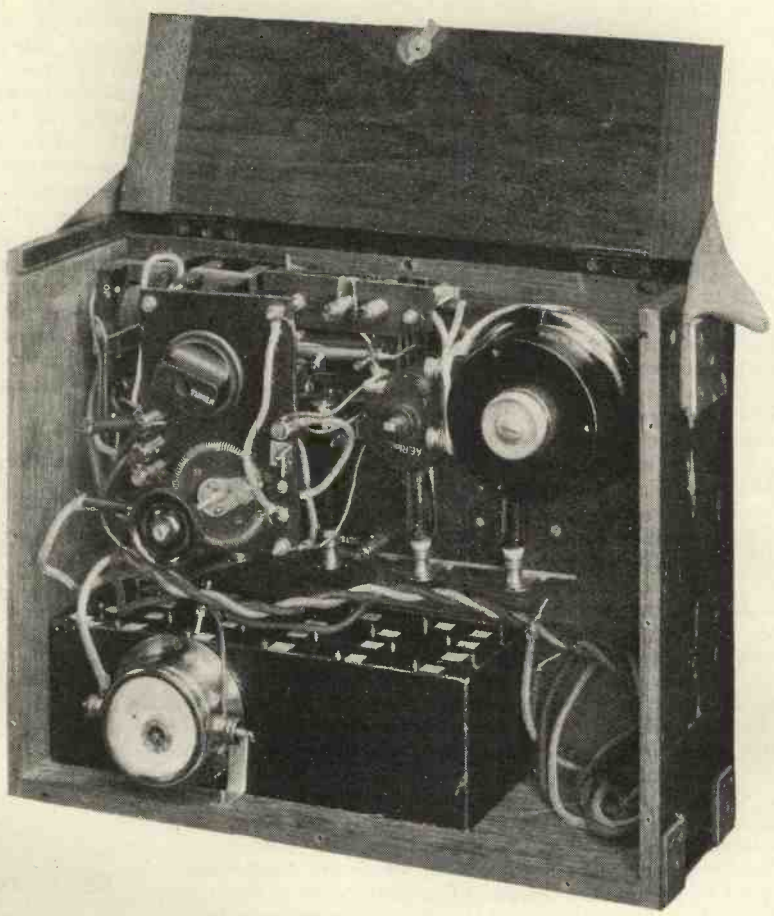


Fig. 1.—A converted receiver.

Fig. 1, which shows the complete instrument, will illustrate how, after it has been converted, it may be fitted into a small case measuring only 14in. × 11in. × 4in., and at the same time including the necessary batteries and even a loud-speaker, to which an extensible horn may be fitted. This particular instrument is capable of yielding good loud-speaker signals at a distance of 50 miles from a broadcasting station, using a loop aerial 18in. square.

The most important conversions refer to the high-frequency transformers and the tuning mechanism, which will now be dealt with. The original high-frequency transformers consist of small disc coils of resistance wire of about No. 47 S.W.G., arranged in the form of two slabs pressing against each other and embedded in paraffin wax

in an ebonite container immediately behind the valve panel.

In order to confine amplification to the British broadcasting band of wavelengths, these transformers should be removed and a fresh type substituted. It will be found that

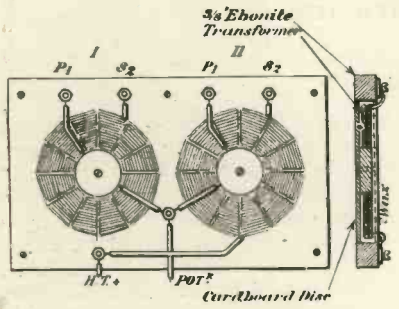


Fig. 2.—Details of the H.F. transformers.

there are two circular holes, each 1½in. in diameter, in the ebonite frame immediately behind the valve panel. These holes should be completely cleared out by scraping with a penknife, and two discs of thick cardboard pressed firmly into the back of the holes. Two circular ebonite centre pieces ½in. in diameter will then require to be turned, and these should be ⅜in. thick, less the thickness of the cardboard, so as to completely fill the centre portion of the holes as far as the back of the panel. These ebonite discs should then be attached to the cardboard by means of small screws tapped into the ebonite. Washers should be placed beneath the head of the screws so as to prevent them from pulling through the cardboard.

The basket coils may then be wound on a similar former, and for the two transformers four coils will be required, each having 75 turns of No. 40 S.W.G. double silk-covered wire wound, as already stated, on a ½in. former. It will be found that these, when in position, leave a space of about ¼in. all round, which may be subsequently filled with paraffin wax in order to hold them in position. The four coils having been prepared, attention should be paid to the small pins mounted on the transformer frame, from which the connections to the various parts of the circuit are taken. It will be seen that there is a common connection for the two H.T. positive feeds and also for the two feeds to the arm of the potentiometer. One basket coil should be placed over the core of the first transformer frame, and the beginning end of this connected to the terminal going to the anode of the first valve. The outer end of the winding may then be attached to the common H.T. positive terminal. A thin disc of cardboard, soaked in shellac varnish, and which may conveniently be of the thickness of an ordinary postcard, should then be placed upon this basket coil and the second winding placed in position. The inner end of this is connected to the arm of the potentiometer, and the outer end to the terminal going to the grid of the second valve. The connections for the second high-frequency transformer are made in a similar manner.

The coils having been pressed into position, and finally connected up, they may be secured by means of a little hot paraffin wax poured into the hole in the transformer frame, around the edges of the basket coils themselves.

The next alteration is to the tuning mechanism, and this must be entirely reconstructed. The secondary coil is contained in a small ebonite case marked "Aperiodic," and the aerial circuit coil in a similar case engraved "Aerial."

Both windings must be completely removed, and the secondary circuit coil may be replaced by a small basket coil having 60 turns of No. 32 single silk-covered wire wound on such a size of former as will just allow the coil to slip inside the original case. It will then not be necessary to tap this coil.

The aerial circuit coil may consist of a basket coil wound with a similar gauge of wire, but having 50 turns, tapped at 30, 35, 40, 45, and 50 turns. The mechanical arrangement for selecting the necessary number of turns in circuit will be evident from an examination of Fig. 3, which shows how connections are made to small 6B.A. screws inserted in the outer rim of the aerial circuit coil case, and upon which a spring plunger, removed from an electric lampholder, bears. The pattern of arm carrying this spring plunger may be of any form most convenient to the constructor, but the design shown has been found very useful. A small bridge piece of ebonite will serve to secure the lever to the coil case, which can be mounted, together with the spindle upon which the secondary coil slides, in any convenient position close to the high-frequency valves. The leads from the secondary circuit coil should, therefore, be very short.

A Polar variable condenser of 0.001 μF capacity is included in the aerial circuit lead, in series with the aerial coil. A similar condenser having a value of about 0.0003 μF can be placed across the secondary coil if it is required to obain very sharp tuning. Otherwise the secondary coil will function almost equally well at any point between 350 and 450 metres, when used with a standard Post Office aerial.

It will be observed that the clips for holding the valves in this instrument are of a pattern resembling those used for V24 valves. This type of anti-capacity fitting should be retained on the high-frequency side; but if desired other valves may be used for low-frequency amplification. If the same fitting is to be retained, Q or QX valves should be used. The transformers coupling the low-frequency side of the apparatus have a ratio of 5 to 1, and give extremely satisfactory amplification. In the existing instrument the filament rheostat controlling the low-frequency valves is so arranged that the grids of the note magnifying valves have a fixed negative potential of about 2 volts with respect

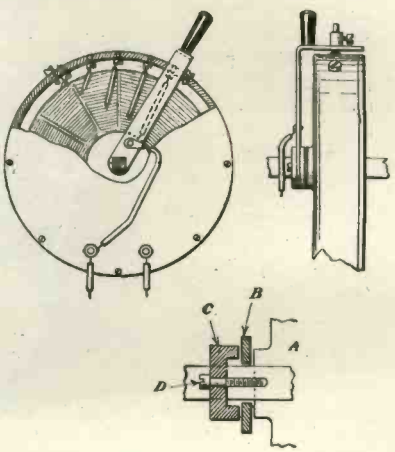


Fig. 3.—The construction of the tuning coil.

to the filament; but if greater volume of sound is required, a grid cell of about 3 volts may be placed in series with the secondary winding of the transformer, and the

(*Continued on p. 708.*)

HOW I INVENTED THE THREE-ELECTRODE VALVE

By Dr. LEE DE FOREST.

An article specially written for "Wireless Weekly" dealing with the invention of the three-electrode valve

(Continued from No. 11, page 642.)

Characteristic Curves

LET us suppose that we have an Audion working under certain definite condition of filament temperature and plate potential. Provided these two factors are kept constant, a definite, steady stream of electrons will flow from filament to plate and round through the external circuit.

If now the grid be charged sufficiently negative all flow of electrons to the plate will be stopped (owing to the repulsion of like charges). As the negative charge is reduced to zero the plate current rapidly increases. As the grid potential becomes positive this plate current increases up to a point S, after which it rapidly approaches a saturation value above which it will not rise, regardless of how high the positive potential applied to the grid. This state of affairs is shown in Fig. 5.

It will be observed that over the straight line portion of this curve (between Q and S), when the grid potential varies a small but equal amount right and left of zero, the amplitude of variation in the plate current is directly dependent on the variation of the applied grid potential. In other words, as long as the Audion is adjusted so as to work over this portion of its characteristic curve, each positive or negative charge impressed upon the grid (from the in-coming signals) will produce an increase or decrease of the plate current which is exactly proportional to that charge. In this way, whatever is impressed upon the grid circuit is reproduced, greatly magnified but without distortion, in the plate circuit.

High- and Low-frequency Amplifiers

Hence, the Audion is always worked on this portion of its curve when it is acting as an amplifier whether of high- or of low-frequency impulses. It will also be

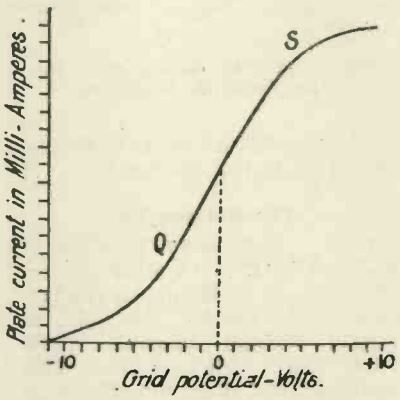


Fig. 5.—Curve illustrating the effect on plate current of grid potential.

seen that several Audions can be connected in "cascade" or "series," each one reproducing in its plate circuit the impulses which, magnified by the previous Audion, have been impressed on its grid.

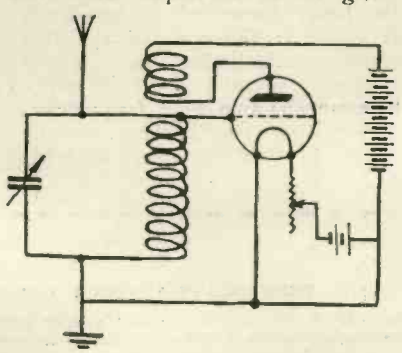


Fig. 6.—The first circuit in which the valve was found to be a generator of continuous alternating currents.

The only limitation to this is that no Audion must receive on its grid impulses powerful enough to cause it to leave the straight or symmetrical portion of its characteristic curve. Referring again to Fig. 5 it will be seen that the lower portion of the characteristic curve resembles the curve of a crystal rectifier with a critical point at −4. Rise of grid potential at this point will cause an increase of plate current, but if the grid potential falls, there is very little change in the plate circuit current. At this point, therefore, the Audion will have rectifying properties and can be used as a detector. As is only to be expected, the presence of a slight trace of gas within the Audion renders it very much more perfect as a rectifier. For this reason the imperfectly exhausted or "soft" tubes of a few years ago were very much better as rectifiers than are the "hard" Audions of to-day, but the more perfect the exhaustion process the more constant and therefore more reliable the Audion becomes.

In the early days when Audions were exhausted like ordinary incandescent lamps by simple oil pumps it was rarely practicable to use a high-tension battery of more than 80 volts, since anything above this figure produced excessive ionisation, *i.e.*, collision between the streams of electrons from the filament and the molecules of gas remaining in the bulb. This collision caused the molecules to break up and the working of the Audions became erratic.

It was necessary to use higher voltages than 80, because otherwise the volume of signals received from a cascade amplifier was very limited, and so some means had to be devised whereby the exhausting process could be improved. Such an improvement was known to the makers of X-ray bulbs, and I accordingly had my Audions ex-

hausted by the X-ray method as early as 1912. This enabled me to use a potential of several hundred volts on the plate without causing ionisation, and marked a further definite step in the progress of Audion development.

Oscillations

It was in the summer of 1912 that I first discovered that if the grid circuit was inductively coupled with the plate circuit the Audion became a generator of continuous alternating currents. Such a circuit will be seen in Fig. 6.

The explanation of the operation is simple. An initial impulse in the plate circuit, no matter how it is produced, induces a similar one in the grid circuit, owing to the inductive coupling between the coils. This, in its turn, produces a further flow of current in the plate circuit, which, through the inductive action of the coils produces a further rise in the value of the plate current. This process continues until, owing to the saturation point being reached, the final impulse on the grid fails to produce a corresponding rise in the value of the plate current. Since the grid has failed to produce an increase in the plate current, the latter, having nothing to sustain it at its high value, commences to fall again to normal. This promptly produces on the grid a negative potential—owing to the collapsing magnetic field—which in turn reduces the value of the plate current still further. Finally, a situation is reached where the grid becomes sufficiently negative to stop the electron flow entirely. The last negative impulse, therefore, does not produce any drop in the plate current, which accordingly tends to rise to normal again. The interaction of the circuits, however, forces it up to the saturation point and the whole process is repeated, the Audion acting as a generator of continuous undamped oscillations so long as the batteries remain connected and the coils sufficiently closely coupled.

The Audion as a generator of continuous waves became widely used, especially so in its smaller sizes. Considerable amounts of energy have, however, been handled by this method in long distance working both for telegraphy and for telephony.

But it was as a receiver of undamped oscillations that the Audion proved so highly successful.

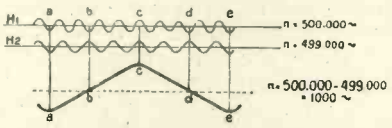


Fig. 7.—Curves dealing with the principles of the heterodyne.

The Heterodyne

It is a well-known principle of physics that if two systems are set vibrating or oscillating at slightly different frequencies, they will, at certain definite intervals, come "into step" with each other. This is represented diagrammatically in Fig. 7, where it will be seen that the two frequencies H_1 and H_2 are of slightly different periods. At the points "a" and "e" they come into step in the negative sense, at "c" in the positive sense, and at "b" and "d" they are exactly in opposition.

The result of this is shown by the lower curve, whose amplitude is equal to the sum of the two smaller amplitudes and whose frequency is equal to the difference between the two high frequencies. Now, since the Audion can be made to oscillate over a wide range of frequencies, it is very simple for us to arrange matters so that "beats" of an audible frequency are set up between the incoming oscillations and the local oscillations, and in this way continuous waves can be detected and converted into audible signals. The ordinary crystal or valve detector being, of course, quite unsuitable for the purpose.

This system, which is known variously as the "beat," "interference," "heterodyne," or "autodyne," method of reception is extremely sensitive and has the great advantage that the operator is enabled to choose his own note for reception above the noises of static and local disturbances.

* * * *

The foregoing is intended to show how the present-day Audion came into being, to indicate the observations and experiments which enabled it to be developed to its present high pitch of perfection, and to touch upon one or two of its most common applications. No attempt has been made to enumerate the various circuits in which the Audion can be employed, the subject being, I believe, dealt with elsewhere herein. That we are as yet in the infancy of the Science of Radiology there can be no doubt. Each day brings forth fresh ideas and suggestions, not from our laboratories and research departments alone, but frequently from "amateurs" who have been fired with enthusiasm by the stories of the pioneer experiments in this most absorbing science.

The field for experiment is wide, and the tillers comparatively few.

[NOTE.—The date of Dr. de Forest's first experiments with Bunsen flame relays was erroneously given as 1919 on p. 641. This should, of course, have been 1900.]

REPORTS ON AND DEMONSTRATIONS OF THE ST100.

Readers will be interested to hear that Mr. Percy W. Harris, probably the most popular writer of sound constructional articles, and the author of four or five handbooks, is describing successful experiences with this circuit in the next issue of "MODERN WIRELESS" and will give full details of a simple home-made receiver embodying the circuit.

In view of the interest taken in it, Mr. John Scott-Taggart is giving a demonstration before the Ilford Radio Society of the excellent results obtainable with this circuit.

The demonstration will take place at 7.30 p.m. at St. Mary's Church Schools, High Road, Ilford, on Thursday evening, June 28th, 1923. All interested are invited to attend this demonstration which will be the first given in connection with this circuit.

The advantage of holding the demonstration in Ilford instead of in the centre of London is that it will provide a real test, as a demonstration so close to a Broadcasting station would be of negligible value. It is also hoped that a demonstration of another circuit will be given.

In order to give the fullest opportunity for the demonstration of the results obtainable with the ST100 circuit, we shall be happy to hear from any Club Secretary who would like to witness a private demonstration, when our claims will be substantiated.

News of the Week

IT is interesting to note that evidence given before the Broadcasting Committee by representatives of newspapers and news broadcasting agencies has shown that though the broadcasting of news can be restricted in this country, there is no means of preventing the broadcasting from stations situated abroad of news cabled from England, and in all probability the question of international copyright in broadcast news will be raised.

* * *

We understand that a question in the Northern Parliament led the British Broadcasting Company to investigate the possibility of establishing a broadcasting station in the North of Ireland.

It was found that there was a great demand for such a service in Ireland, particularly in Belfast. The company is anxious to make a start, but any decision will have to be shelved until the Broadcasting Committee has made its report.

* * *

The *Petit Journal* has equipped two motor cars with wireless apparatus in order that concerts broadcast from Eiffel Tower may be heard by the French troops of the Army of Occupation.

* * *

The Deptford Borough Council has circularised the whole of the tenants on the Brockley Estate to the effect that all wireless aerials attached to brick houses must be secured by an iron staple driven between the brickwork joints.

On concrete houses, where there are no joints to take the staple, wireless aerials must be attached by the Council's own workmen, the tenant having to pay the actual cost of carrying out the work.

We understand that the *Daily Express* has fitted some of their cars with wireless in order that holiday-makers may reap the benefit of listening-in to broadcast programmes whilst enjoying the open air at the popular seaside resorts. These cars we further understand are fitted with six-valve receiving apparatus, equipped by Messrs. Burndept, Ltd., of Blackheath. It is said that the apparatus is so efficient that music may be heard plainly half a mile away.

BROADCAST TRANSMISSIONS

	Call-Sign	Wavelength
CARDIFF	5 WA	353 metres
*LONDON	2 LO	369 ,,
MANCHESTER	2 ZY	385 ,,
NEWCASTLE	5 NO	400 ,,
GLASGOW	5 SC	415 ,,
BIRMINGHAM	5 IT	420 ,,

TIMES OF WORKING.

Week-days....3.30 to 4.30 p.m. and 5.30 to 11.0 p.m. B.S.T.

*London—11.30 a.m. to 12.30 instead of 3.30 to 4.30 p.m.

Sundays.....8.30 to 10.30 p.m. B.S.T.

SILENT PERIODS.

CARDIFF	8.0	to	8.30
LONDON	7.30	,,	8.0
MANCHESTER	7.45	,,	8.15
NEWCASTLE	9.0	,,	9.30
GLASGOW	7.45	,,	8.15
BIRMINGHAM	8.15	,,	8.45

Messrs. W. A. C. Smith, Ltd., of Glasgow, by arrangement with Messrs. John Williamson & Co., were responsible for the fitting of the Clyde turbine steamer "Queen Alexandra" with an Ethophone V, coupled to an Ethophone power amplifier, with three loud-speakers, the object of their experiment being to receive the programme from the Glasgow Broadcasting Station during the cruise of the steamer at the Lochs Long and Goil. By popular verdict of all who listened-in the reception was of very fine quality, rich in tone and audible all over the saloon. Interruption by Morse was absent and the hills between the transmitting station and the steamer had no perceptible effect on the reception which, even at the head of Loch Goil where, owing to the numerous bens in the vicinity, trouble of this nature might be expected, remained unchanged.

* * *

According to the *Journal of Commerce*, people who have built their own wireless sets or who have had sets built for them, and do not hold Post Office licences, need not fear that they will be persecuted with official inquiries while the Broadcasting Committee is sitting. Until the Committee has reported, and the Postmaster-General has considered their report, the Post Office does not propose to interfere with anyone using wireless receiving apparatus.

* * *

The popularity of broadcasting has extended to the residence of the Duke and Duchess of York, on whose house at Richmond may be seen a very smart-looking aerial.

* * *

According to the *Catholic Herald* it was recently reported that Cardinal Dubois of Paris has directed attention to the fact that while broadcasting may convey the preacher's words with perfect fidelity to his invisible audience, it cannot transmit the vital factor, his personality and his magnetism. The metallic effect, the Cardinal said, robs the words of much of their fervour.

* * *

At Liverpool Police Court recently, before the Stipendiary Magistrate, John Owen Evans, master

of the steamship, "Tredenham," was summoned for not having kept a continuous wireless watch on his ship. The prosecution is interesting in that it was stated to be the first of its kind in this country.

* * *

The patient endeavours of the unfortunate blind to overcome their severe physical defects is illustrated by Mr. J. T. M'Dade, who has made several wireless receiving sets, one of which is estimated in value at £200. The apparatus comprises seven valves, three of which are for high-frequency of the tuned anode type, the usual detector and three low-frequency valves. The complete set is mounted on a stand similar in size and shape to a roll-top desk.

* * *

The following paragraph appeared in the *Meyers Enfield Observer*, dated June 15th, and in view of its wording it would be interesting to know what British manufacturers think about its advice.

"The increased effectiveness of the majority of receiving sets now on the market has made it possible to add to the number of telephones which can be used—an improvement which removes a reproach levelled at wireless in its early stages when only one pair was possible. They must, however, be of irreproachable quality, and although there are several good English makes on the market, those supplied by France can be relied upon to give the best results.

* * *

From the *Financial News* we learn that vessels attached to the Canadian Department of Marine and Fishery are to be fitted with wireless apparatus for the purpose of reporting the movement of shoals of fish. Telephone broadcasting apparatus will also be employed for the same purpose. By this means fishermen ashore who are in possession of receiving sets will be enabled to learn of the movements of fish, and so avoid fruitless and unprofitable trips.

* * *

We note a recrudescence of applauding at 2LO's studio, the applause apparently proceeding from those responsible for the item. In the circumstances it would be well to drop this custom lest a wrong impression of self-congratulation may result.

The above photograph shows the apparatus at the Glasgow Broadcasting Station.

ANOTHER WIRELESS AID TO AVIATION

By LT.-COL. HAROLD F. TOWLER

This interesting article describes how wireless serves to further assist aircraft in the landing of machines.

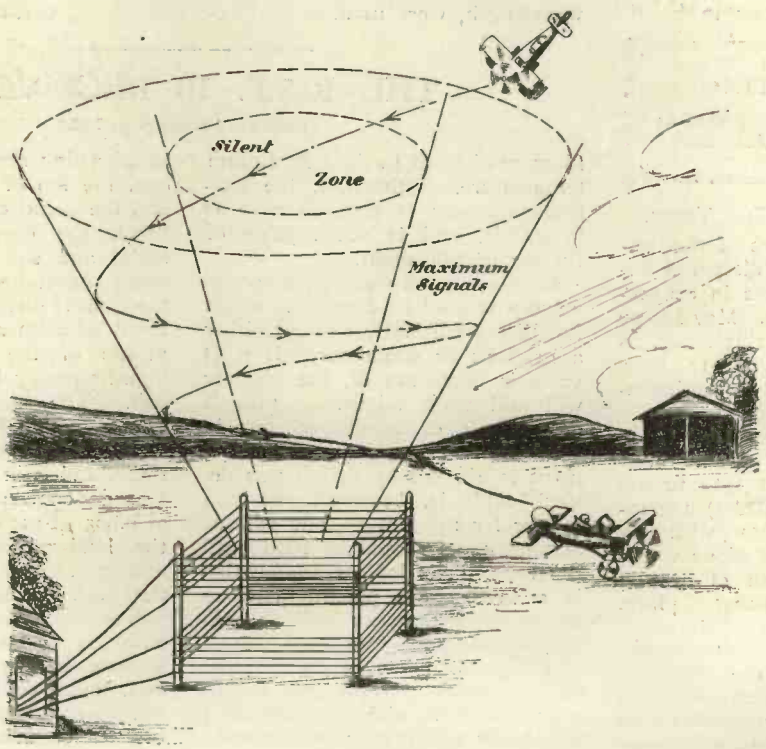
THE Post Office Department of the U.S.A. has been developing various methods to enable a continuous service of mail aeroplanes to be maintained under all weather conditions.

Like all others faced with this task they have found that fog and misty weather is the greatest difficulty they have to meet. The modern aeroplane has high enough engine power to contend with almost any wind that may be encountered, but an aeroplane depends on speed for its support in the air; therefore, unlike other forms of traffic, it is not able to slow down on approaching a danger. It has to find its landing ground with certainty; and, notwithstanding the fog, comes to the ground at practically the same high speed at which it has been flying.

The American Post Office found that the machine could easily be guided to the vicinity of the aerodrome by the use of wireless direction-finding coils, such as Dr. Robinson's. But, although the pilot of the aeroplane could be quite confident that his directional wireless would lead him directly over the field, he had no means of knowing the exact instant at which he was over the centre of it, or his exact height above it, if the weather was too thick to see the ground.

The method with which the U.S. Post Office have tried to overcome this difficulty is shown in the illustration.

Two exactly similar coils or loop aerials are placed horizontally, one over the other, and signals are transmitted from both simultaneously, but the arrangement is such that the current on each oscillation flows in different directions in the two coils. That is to say, that if in the upper coil the current were at any instant flowing in a clockwise direction, that in the lower coil would simultaneously be flowing in an anti-clockwise direction.



Illustrating the arrangement of aerials for aeroplane landing.

The result of this arrangement is that the aeroplane, receiving the signals on its loop aerial used for direction finding, hears nothing until the transmitting station is bearing in a direction nearly 60 degrees below the horizontal.

When the station is actually 60 degrees below the horizontal, the strongest signal is received, and it then fades away until a silent zone is encountered, when vertically over the station.

In other words, the signals are radiated strongest in the form of a cone, the apex of the cone being the transmitting station and the landing field. Also, as Mr. J. C. Egerton, the Superintendent of Radio to the U.S. Post Office, points out in his preface to "The Book of Radio," by C. W. Taussig, "The diameter of this cone at 3,000 feet can be about one mile."

The aeroplane on flying into this area receives loud signals which die out just before passing over the centre, and are picked up again just after passing the centre, being heard loudest again when the bearing is 60 degrees below the horizontal towards the tail of the machine.

The pilot, at a height of 3,000 feet, has a circular area nearly a mile in diameter to find. When flying right through the centre of

it, he can get an idea of his height above the ground from the time taken to fly through the central silent zone, and if the machine glides down on a spiral path whilst on the loud zone of signals, she must reach the grounds in the limits of the aerodrome.

I can well believe that, from the pilot's point of view, the most difficult task would be to maintain the correct spiral in foggy weather, and he would undoubtedly need good instruments, such as turn indicators, to help him, and also practice in clear weather.

The result of practical experience of this method has satisfied the U.S. Post Office of its utility, and it has been used considerably.

BROADCASTING.

The following letter appeared in "The Times" of June 20th.

To the Editor of THE TIMES.

Sir,—Some questions of real importance have been discussed recently in your columns in connection with broadcasting. May I hope that you will publish this letter, as it may be of interest to your readers generally, and to the listening-in public particularly?

Sir John I. Thornycroft wrote pointing out that the present range of wavelengths allotted to broadcasting (350 to 425 metres) was inadequate, since, even now, with only six out of the eight stations working, a certain amount of mutual interference is taking place. Colonel J. T. C. Moore Brabazon in his reply, however, and also Mr. L'Estrange Malone, the chairman of the Radio Association, sought a solution by asking manufacturers to design their receivers with more selectivity. It is insisted, however, that selective receivers are difficult to handle by unskilled users, and that too great a selectivity must *a priori* cut out essential components of telephone radiation. To be a real pleasure to distant listeners-in, broadcasting must rely upon robust receivers and powerful transmitters.

Inadequate as the present allotment is, listeners-in have some right to expect freedom from interference on the wavelengths allotted to broadcasting. As Colonel Moore Brabazon points out, listening-in in many coastal towns is, frankly speaking, impossible.

Here is a question that should be dealt with at once by the proper authorities, because it is undoubtedly true that broadcasting is being completely spoilt in many localities by interference from badly-adjusted spark transmitters interfering on wavelengths other than those allotted to them. It is useless to use ultra-selective receivers, since in many cases the jamming on the broadcast wave is louder than the distant broadcasting stations. This may be due to several causes, but my point is that in all cases the interruption could be avoided if modern apparatus, properly adjusted on the correct wavelength, were used.

Every day wireless communication is becoming more general, and it behoves the authorities to apply stringent supervision, so that each communicant obeys the regulations laid down, and, furthermore, uses modern apparatus for modern needs. If some action is not soon taken, wireless communication in congested areas will become more and more difficult. At the present moment engineers are adopting the crude method of trying to shout each other down; authority should surely step in to allow the users of modern apparatus free use of the ether on their own particular wavelength.

Yours faithfully,
P. P. ECKERSLEY,
Chief Engineer, British Broadcasting Company.

THE R.A.F. 10 RECEIVER

(Continued from page 702.)

filaments heated to their maximum temperature. Otherwise, the low-frequency side is very effective as it stands, and is not capable of further improvement.

In the original receiver, a special valve was used as a rectifier which functioned efficiently without either a gridleak or condenser. If a Q valve is made use of, the receiver will still work admirably without either leak or condenser, but in some cases a considerable improvement is effected by fitting this device. This is, however, purely a matter for experiment, and various arrangements should be tried until the most distortionless rectification is secured. The potentiometer is so arranged that, as well as controlling the high-frequency valves, it varies the potential on the grid of the rectifier. This grid circuit may, therefore, either be left as it stands, or a leak may be connected together with the potentiometer or, again, either across the grid condenser or to one or the other of the filament legs.

For the sake of compactness in the receiver illustrated in Fig. 1, the control unit has been placed in the actual receiver itself, and the position of the components readjusted after conversion. This enables the apparatus to be entirely enclosed, including loud-speaker, in the carrying case, and permits of complete control by the rotation of one knob only. To receive other broadcasting stations than the local one, the top of the case is opened and the aerial circuit condenser rotated, the coupling between the aerial and secondary circuit coils being simultaneously adjusted until the desired distant station is found. Final adjustment is then made by means of the potentiometer and high-frequency filament valve rheostat. The instrument shown in Fig. 1, which incorporates a loud-speaker, embodies these conversions, and is in addition fitted with a large condenser having a value of 0.005 μF across the terminals of the loud-speaker and a filament ammeter. This latter is so arranged that the correct reading for the valves when working at a normal point is visible through a small window in the front of the case, and, therefore, when the receiver is completely closed, it is only necessary to occasionally glance at the meter reading to ensure satisfactory operation when in the hands of an unskilled person. An Elwell valve window is fitted in the front of the case, so that the operator can see the filaments burning, and a small reflector is so arranged that light is thrown on to the face of the filament ammeter.

The complete receiver converted as shown weighs about 18 lb., and is sufficiently sensitive to receive a broadcasting station 400 miles away on a loud-speaker, using a small indoor aerial.

A MOTOR CAR DE LUXE

Some of our readers may have had the pleasure of hearing the programmes of 2LO filling the public highways, drowning the hum of traffic and making glad the night with music.

MANY times of recent evenings homeward-travelling business folk have been surprised to hear, above all the traffic noises of the streets, loud strains of music, interrupted at times by the familiar formula about "London, 2LO, calling." The accompanying illustration will serve to convey an idea of how this latest wireless wonder is achieved.

The photograph shows the demonstration car of Messrs. The City Accumulator Company, which has made a number of extended tours of late, going even so far afield as the mining valleys of South Wales. These tours aroused considerable interest wherever the car appeared, and the demonstration party had many interesting and sometimes amusing experiences. As may be seen, the car carries a "sausage" aerial suspended from two poles lashed to the front and rear, while upon its roof is mounted a Western Electric loud-speaker.

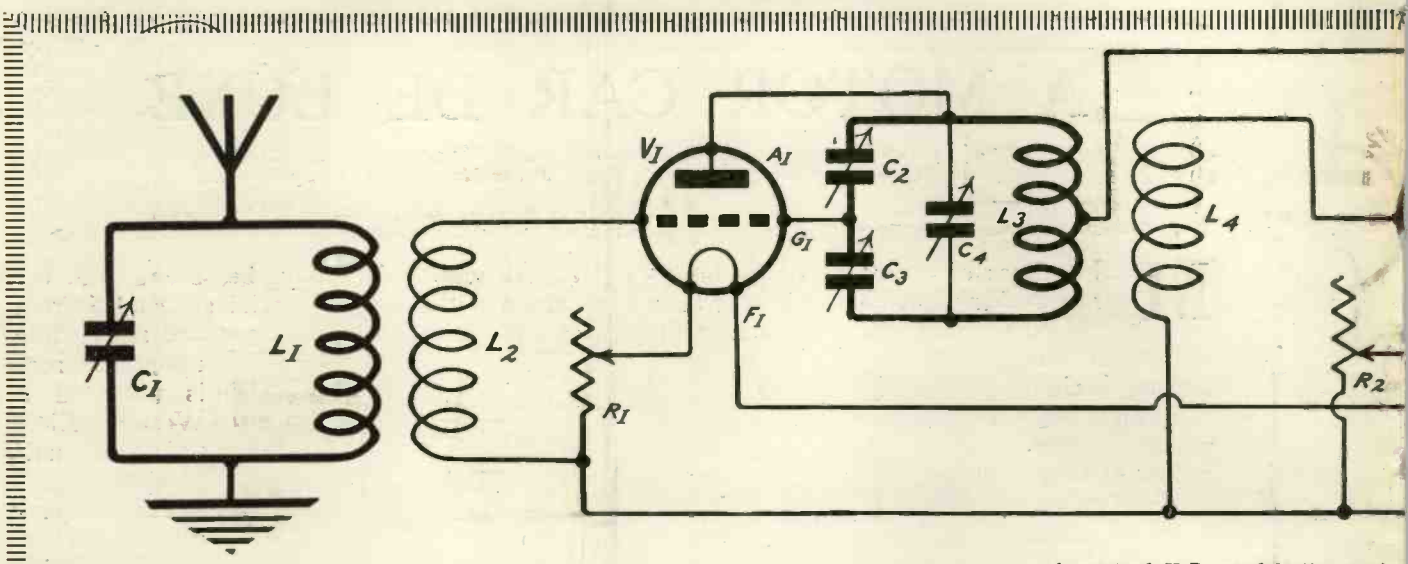
The demonstration car of the City Accumulator Co.

The set employed is a standard six-valve Marconiphone, to which is attached a two-valve Western Electric power amplifier, and the volume of sound produced when the full number of valves are in use is overpowering. For example, at a distance of 40 miles from 2LO the music can be heard 300 yards from the car, while actually in London it is necessary to cut out some of the high-frequency valves to reduce the signals to a reasonable strength, even allowing for traffic noises and shielding effects of buildings.

CATALOGUES RECEIVED

Messrs. The Sterling Telephone Co., Ltd., have published, in connection with the opera season of the British National Opera Co., Ltd., an illustrated brochure. The costume photographs of the artists are reproduced in association with their radio instruments by exclusive permission of the Opera Company. This brochure will be sent to anyone applying for same at 210-212, Tottenham Court Road, W.1.

We have also received from Messrs. Sterling leaflets describing their latest development, a smoother for use when the H.T. supply is derived from D.C. mains, and also a pamphlet entitled "Radio in Summertime."



A practical H.F. amplification receiver

A SPECIAL METHOD OF HIGH

By JOHN SCOTT-T

This bridge method of high-frequency amplification is one solution

ONE of the principal radio problems of to-day is the provision of a thoroughly effective means of radio frequency amplification. The methods at present employed are far from satisfactory when several valves are used. Inefficiency has to be deliberately introduced to prevent the valves from oscillating, and instead of obtaining a full amplification of, say, seven times per valve, the amplification in many cases is reduced to about two. Grid base-line potentiometers, resistances, inefficient transformers, and other schemes are adopted to prevent self-oscillation, but all these methods mean waste, and the effect of them may be compared to brakes applied to a high-powered motor car.

The problem is a very old one, and yet very few suggestions have been made to lessen the evil. It has been proposed to introduce reverse reaction to overcome the natural tendency for valves acting as high-frequency amplifiers to oscillate. This is not by any means a satisfactory solution of the problem, and the use of damping devices is merely a palliative, for it must be remembered that a valve will oscillate under many circumstances when the degree of amplification is only half of that which may be developed with the valve. In other words, the valve oscillates before it has had a chance of amplifying the high-frequency currents to the degree of which it is capable. Two methods of balancing out the capacity of the valve have been suggested. One of these has been proposed by the General Electric Company, of U.S.A., and the other by L. A. Hazeltine, also in America. The latter has named his arrangement a "Neutrodyne circuit," and considerable success has been obtained with it.

Of course, in all these arrangements there is a common similarity, in that undesirable capacity effects are neutralised. Of course, inductive effects are also to be partially blamed for self-oscillation, but the main trouble seems to be capacity coupling.

The arrangement about to be described is one which, whilst protected for a considerable time before the neutrodyne circuit, is now published for the first time.

The bridge method described is distinctive in many ways, and recent tests have proved so successful that many experimenters in these directions may care to carry out tests themselves.

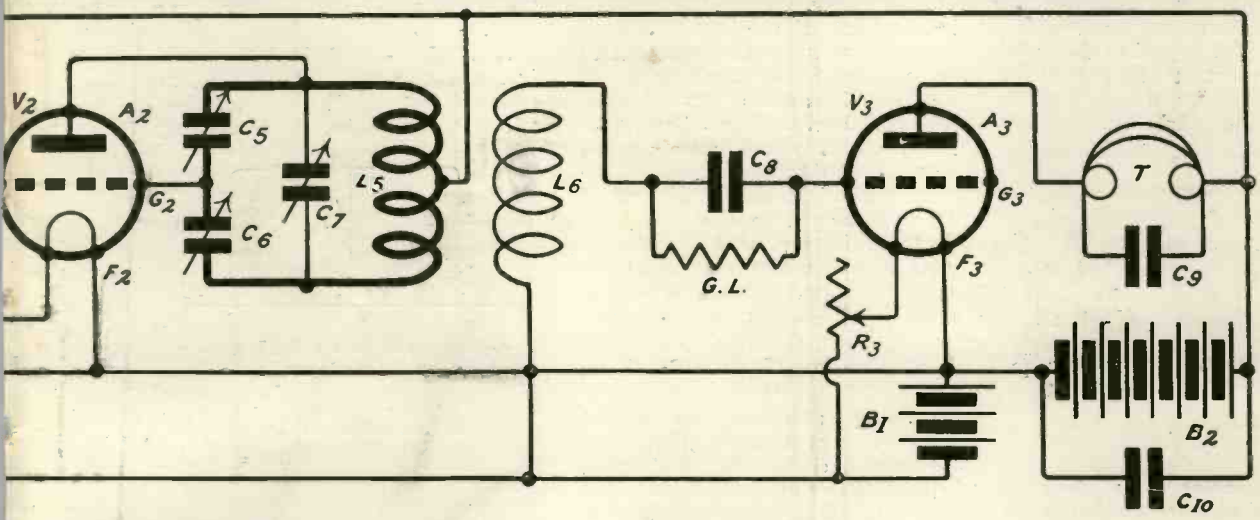
Undesirable Reaction

Undesirable reaction is the cause of self-oscillation in high-frequency amplifiers. Fig. 1 shows a simple valve amplifier. If this circuit be connected up, and the oscillation circuits L_1 C_1 and L_2 C_2 be tuned to the same frequency, it is extremely probable that the valve will generate continuous oscillations, due to the natural coupling between the two oscillation circuits. This coupling is provided chiefly by the capacity C_3 across grid and anode of the valve. This capacity acts, of course, inside the valve itself, although it is represented by a small condenser C_3 shown in dotted lines.

In the writer's bridge method of amplification, advantage is taken of the fact that if an inductance is shunted by two equal capacities in series, the potentials at the point between the condensers will be the same as those at a point half-way along the inductance.

Fig. 2 shows a single valve acting as a high-frequency amplifier, in which the capacity coupling inside the valve makes the valve oscillate. This effect is obtained more readily if the two extreme oscillation circuits are fairly widely separated from the grid and anode oscillatory circuits respectively.

Fig. 3 shows an inductance L_3 shunted by two variable condensers



using the bridge method described.

FREQUENCY AMPLIFICATION

GGART, F.Inst.P.

of the problem of effective high-frequency amplification.

C_3 and C_4. When these condensers have equal capacities there will be no potential difference, however great may be the current in the circuit L_2 C_3 C_4, between the point between C_3 and C_4 and the middle point on the inductance L_2. In other words, whatever the current may be, the points G and B_2 will always be at the same potential. If, however, the condenser C_3 is larger or smaller than C_4, the point G will have a high-frequency potential with respect to B_2, the magnitude depending on the relative values of the capacities C_3 and C_4 and on the high-frequency current flowing in the circuit L_2 C_3 C_4.

The arrangement, in fact, acts more or less as a high-frequency potentiometer. Moreover, just as in the case of a potentiometer having a middle tapping, either positive or negative potentials may be obtained by moving the slider to one side or other of the middle point, so may the nature of the potentials at G with respect to B_2 be varied by altering the relative values of the condensers C_3 and C_4. This potentiometer effect is used in a high-frequency amplifying valve to obtain the desired effect between the anode circuit and the grid circuit. Obviously, when dealing with high-frequency circuits it is necessary to have either C_3 or C_4 in Fig. 3 variable, and preferably both, as it will always be necessary to make slight final adjustments. These adjustments will vary the wavelength of L_2 C_3 C_4; and in Fig. 4 an additional variable condenser C_5 has been added for the purpose of making any slight readjustments of wavelength.

It will, of course, be realised that any variation of capacity of C_5 will have no effect whatever on the potential differences between G and B_2. If C_3 and C_4 are equal, the points G and B_2 will be at the same potential, whatever the capacity of C_5 may be.

Application of the Principle to Valve Amplification

The first step in the application of this principle to valve amplification is shown in Fig. 5. Here the valve V_1 acts as a high-frequency amplifier, the potentials to be amplified being applied to the terminals B and D. In the anode circuit of the valve V_1 we have the top half of the inductance L_2, which is shunted by a variable condenser C_5. The middle point along L_2 is connected to the positive side of the high-tension battery B_2, the negative side of which is connected to the filament. Although the whole of the inductance L_2 is not included in the anode circuit of the valve, yet if the circuit L_2 C_5 is tuned to the frequency of the oscillations applied to D B, magnified oscillations will appear in L_2 C_5. The strength of these would not be as great as if the whole of the inductance of L_2 had been included in the anode circuit, but even if only five turns of the inductance L_2 were included, oscillations would still be produced in the circuit L_2 C_5.

In an arrangement like this the capacity C_3 of the grid-to-anode space would still have an undesirable coupling effect, and to overcome this entirely the bridge method of amplification is employed, and this in simple form is shown in Fig. 6.

It will be seen that this circuit differs from Fig. 5, in that two variable condensers C_3 and C_4 are employed. These condensers are connected in series and are directly across the whole of the inductance L_2. If the capacity of C_3 and C_4 are made equal, the point between the condensers will be at the same potential as the middle point Y on the inductance L_2. However large a current may be flowing in the circuit L_2 C_5 C_3 C_4, which is simply a composite circuit, resolvable into an inductance and one condenser, the potential of the middle point between the condenser C_3 and C_4 will

always be the same as that at the point Y. We now connect the middle point between the condenser C_3 and C_4 to the grid of the valve, and this ensures that there will be no potential difference between the grid and the point Y when cur-

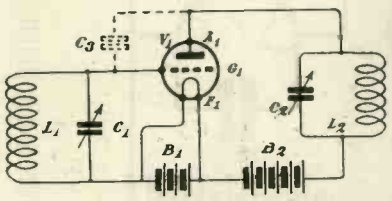


Fig. 1.—Showing how reaction is produced by capacity coupling.

rents are flowing in the circuit L_2 C_5 C_3 C_4.

Now the point Y is connected through the high-tension battery B_2 to the filament of the valve, so that, as regards *high-frequency currents,* the point Y is at the same potential as the filament. We can, therefore, now say that the grid

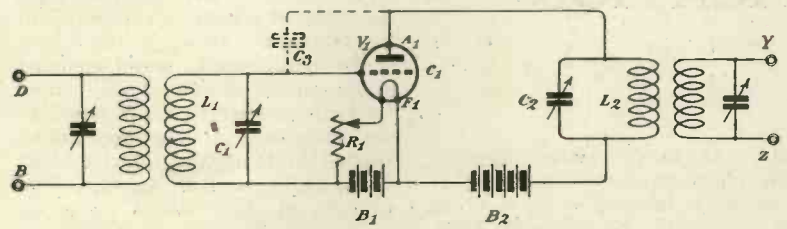


Fig. 2.—Amplifier circuit which tends to oscillate.

will always be at the same high-frequency potential as the filament. In the ordinary high-frequency amplifying arrangement the transference of energy from the anode circuit of the valve to the grid circuit results in high-frequency potentials being impressed on the grid in such a direction as to strengthen those already existing there, thus produc-

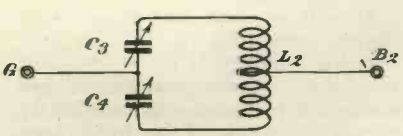


Fig. 3.—The high-frequency bridge.

ing self-oscillation; by using the bridge arrangement of Fig. 6, however, if the valve amplified a hundred times and a very heavy high-frequency current indeed was flowing in the anode circuit, the grid would remain unaffected and would be absolutely neutral with respect to the filament of the valve. Having made the grid potentials independent of the anode circuit, we can now apply the potentials to be amplified to the terminals B and D. To take an imaginary case, if high-frequency currents having an amplitude of 1 volt were applied across the grid and filament of the valve, we might obtain currents of 10 volts amplitude across the inductance L_2, but none of these 10 volts would in any way affect the 1-volt amplitude variations of the grid.

A Bridge-Amplification Receiving Circuit

Coming now to an actual example, we have in Fig. 7 a theoretical circuit in which this bridge method is employed. The incoming high-frequency signals are transferred into the grid circuit L_2 C_2, and are amplified by the valve, the amplified currents flowing in the circuit L_3 C_5 C_3 C_4. By carefully adjusting the condenser C_3 and C_4, the effect of the magnified oscillations in the anode circuit of the valve on the grid circuit may be entirely eliminated. The high-frequency currents flowing through L_3 are now transferred into the tuned circuit L_4 C_6 connected across the grid and filament of a second valve V_2 acting in the ordinary way as a detector.

Fig. 8 shows the practical arrangement of a bridge amplification circuit. It will be seen that a single accumulator and single high-tension battery are employed.

The circuit is an extremely selective one. The inductances L_1 and L_2, and L_3 and L_4 are loosely coupled; and, while this improves selectivity, the use of circuits of this kind should not be attempted by anyone not fully experienced. In the hands of an experienced worker, however, very effective results may be obtained. It is hoped in a future article to give practical details as to the best method of tuning bridge amplification circuits.

It is possible, by suitably adjusting the capacities C_3 and C_4 to obtain just sufficient reaction effects to strengthen the incoming

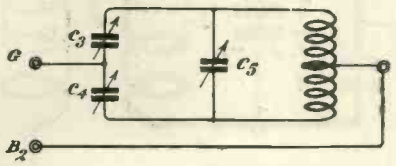


Fig. 4.—The bridge with a re-adjusting condenser C_5.

signals to the required degree. On the other hand, it is possible to obtain a high degree of amplification by balancing the condensers against each other. When previously it was stated that the capacities C_3 and C_4 should be equal, it was, of course, meant that the capacity C_3, plus the small capacity between the grid and anode, should equal the capacity C_4. By having the condensers C_3 and C_4 of, say, 0.0005 μF maximum capacity, the very small capacity between grid and anode becomes negligible, and balancing is perfectly simple. If we did away with the condenser C_3 altogether, and relied upon an extremely small variable condenser C_4, the circuit would be unworkable. By using C_3 as a ballast capacity, the process of balancing becomes much simpler.

A very important effect is that which the bridge method has on the tuning of the circuit L_2, C_2. The balance between C_3 and C_4 might be made with each conden-

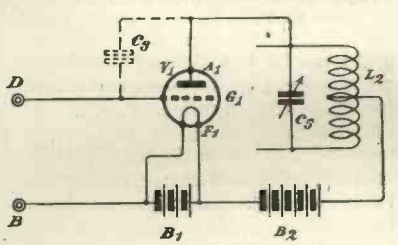


Fig. 5.—First step in the explanation of the bridge method.

ser at, say, 0.0001 μF capacity, or, on the other hand, both condensers might be balanced at approximately 0.0005 μF. Both condensers, of course, will never have exactly the same capacity, but it is

to be noticed that they have a tuning effect on the circuit L_2, C_2. Their effect on the anode circuit seems to be a much smaller one.

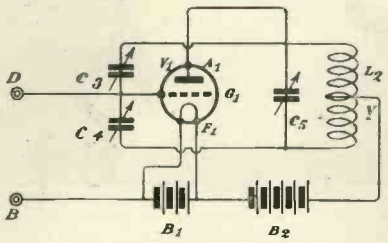


Fig. 6.—The completed bridge.

If both condensers C_4 and C_3 are adjusted to a relatively large capacity, the condenser C_2 must be proportionately smaller, and *vice versa*. Any adjustment of either C_3 or C_4 should be accompanied by readjustments of C_2, and also of C_5.

The circuit of Fig. 8 might quite easily be simplified in various ways. In the first place, the coupling between the first and second valve might be made simpler. For example, the inductance L_4 might be aperiodic, and the condenser C_6 eliminated, or one of the condensers C_3 or C_4 might be fixed. It is, however, desirable, until one is fully satisfied as regards the quantities, to use variables.

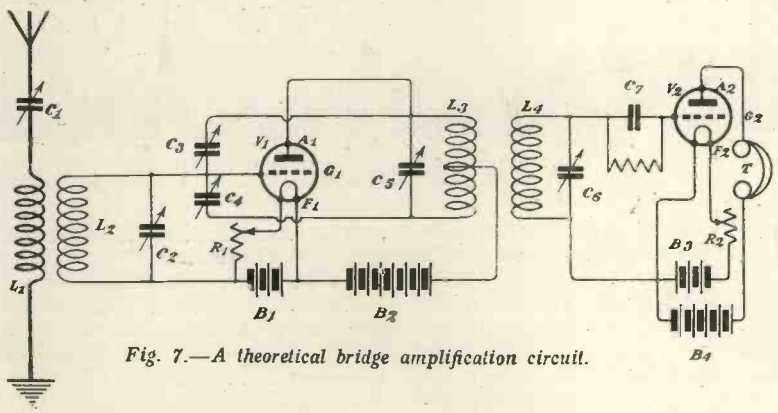


Fig. 7.—A theoretical bridge amplification circuit.

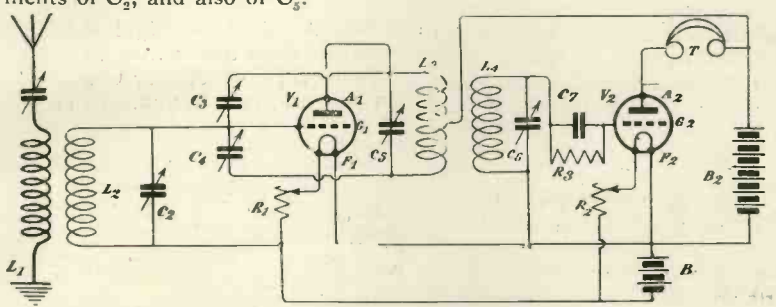


Fig. 8.—A practical bridge amplification circuit using single H.T. and L.T. batteries

While experimenting with the Fig. 8 arrangement, it was found that the condensers C_3 and C_4 had such an important effect on the tuning of the grid circuit that it was decided to try leaving out the variable condenser C_2 altogether, and to balance out C_3 and C_4 at capacities which tune the inductance L_2 to the incoming wavelength.

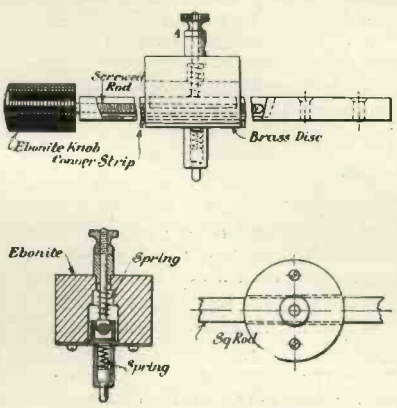
[*This article is continued in our next number, when further practical details will be given.*]

A NEW MICRO-TUNING ADJUSTMENT

THIS piece of apparatus has been designed to enable the experimenter to obtain the highest possible efficiency of tuning with any type of crystal or valve set.

With the ordinary slider bar it is difficult to adjust the slider to the exact point upon the inductance.

With the arrangement illustrated, the slider can be lifted, and so disengaged from the screw, when it can then travel the entire length of the slider bar. The moment the slider is released, a threaded nut engages with the screwed spindle, and fine adjustments are obtained by rotating the spindle by means of the ebonite knob shown on the right.



A general view of the micrometer adjusting rod.

This invention (patent applied for) should prove a great improvement upon the ordinary type of slider.

The device will shortly be obtainable from all wireless dealers.

Broadcasting News

BY OUR SPECIAL CORRESPONDENTS

THE second Shakespearean play to be broadcast was the "Merchant of Venice." On this occasion no attempt was made to boom it in the Press, but a number of high educational authorities were invited to 2LO to listen to an excellent loud-speaker. It is difficult to say what they thought about it as an adjunct to ordinary educational facilities. There was general agreement that the loud-speaker demonstration was a complete success. Further tests will have to be made in schools considerably removed from 2LO before the educationalists can be expected to become enthusiastic.

* * *

There is one possibility which must always be borne in mind, and that is that if broadcasting can be proved beyond all question to possess great educational merits, then the teaching profession will naturally view its advent with some suspicion in case it diminishes the prestige of the teachers. In these days when local authorities are searching the horizon for possible economies, the fear might possibly arise that education by wireless might mean a reduction in the number of teachers employed.

* * *

The teaching profession can rest assured that the paramount thought in the mind of the B.B.C. is that wireless should help to make the teacher's work easier, pleasanter, and, where possible, more efficient. It is difficult to imagine anything more calculated to increase the prestige of a teacher than the ability to harness the latest miracle of science to his hum-drum activities.

* * *

The dancing lessons which Madame Edith Baird gives during the Children's Hour have proved most acceptable, and not a few parents and teachers have found her hints most valuable. The same would be true of any other form of instruction, broadcast. One of the great dangers of the teaching profession is the tendency to get into a rut, and if in teaching English, History, Geography, Languages, or any other subject the teacher could enlist the help of those who are the recognised experts in their profession, the educational stimulus which this would provide for teacher as well as scholar is too obvious to need elaboration.

* * *

Although nothing very sensational is happening so far as announcements in the Press are concerned, it may be taken for granted that efforts are being made constantly to solve the various problems with which broadcasting is still confronted. At the moment of going to press the prospects of agreement with the theatrical world are more promising than at any previous stage in the negotiations.

* * *

We understand that it has been decided by the B.B.C. to commence their Sunday afternoon transmissions on July 1st from 2LO. Of course there is nothing to hinder the B.B.C. from broadcasting all day on Sunday if they like, although the amateur experimenters might have something to say on that point.

* * *

Mr. Allen S. Walker, the well-known historical lecturer, will broadcast a talk from 2LO on "The Tower of London," on Saturday, June 30th, at 9 p.m.

* * *

Mr. Frank Hodges, J.P., Secretary of the Miners' Federation of Great Britain, will talk from 2LO on "Miners' Welfare," on Wednesday, July 4th, at 9 p.m. This is not an appeal.

Mr. E. T. Williams, M.I.E.E., Assistant Director of Electrical Engineering to The Admiralty, will talk on "A Holiday on the Norwegian Fjords," on Saturday, June 30th, at 7.15 p.m., from the London Station.

* * *

Mr. A. C. Banfield, F.R.P.S., will broadcast a talk from 2LO on "Make a Friend of your Camera," on July 4th, at 8.45 p.m.

* * *

Something will have to be done about the inadequate wavelength band allotted to the B.B.C. It is quite impossible to cram eight stations and an indefinite number of relay stations into the narrow margin of 75 metres. The B.B.C. have applied to the Post Office for an extended band but hitherto with no measure of success. Perhaps someone will raise the matter in Parliament. It would be interesting also to have authoritative information regarding some of the work that is being done by Government officials.

* * *

The leopard cannot change its spots, and it is difficult for officials to get out of official ways, but one would like to know what authority a certain local government official in London has for warning tenants that aerials must not only conform to his council's requirements, but that the tenants must be prepared to remove them at a week's notice. When anyone instals a new wireless set for which a licence has been obtained, then surely they are entitled to use it for the period covered by such licence. Wireless has enough restrictions to contend with, but if it is always to be at the mercy of every zealous official, then the outlook is far from cheerful.

MANCHESTER. — The new quarters of the Manchester Broadcasting station will be ready in six weeks unless anything unforeseen happens. We understand that when this happy day comes we are to be shown what a programme *should* be like; we hope that the fact of the station being only one minute from the Hippodrome and Palace will have an important bearing on future programmes.

* * *

We are looking forward to the promised operatic evenings which are to take place on the third Tuesday in each month, for, like most listeners-in, we are very fond of opera and good singing.

* * *

The ten minutes Morse practice at 10.45 on a Monday evening should prove very useful, although the time is rather late. The ten minutes will be divided into two parts, five minutes at five words per minute and five at ten words per minute. The Morse will be on interrupted C.W. so that users of crystal sets and other non-radiating sets will be able to hear it.

* * *

For the first time since we took up wireless, we blessed a jamming spark: it jammed the "2ZY poem" so badly for listeners-in in Liverpool that they requested an encore which was immediately granted, and we were thus able to hear the delightfully amusing item a second time.

* * *

I wonder how many listeners-in on Sunday noticed announcer "B's" slip. He said that Miss Gladys Hulme would be late, as owing to the crowds at Blackpool she had difficulty in leaving the town, but that she was in all probability "in the way on a taxi."

Miss Isolde Menges, accompanied by Mr. Tod Boyd, broadcasting from 2ZY.

NEWCASTLE-ON-TYNE.— The articles dealing with selectivity appearing in the *Wireless Weekly* are proving of great interest to Tyneside amateurs in view of the proximity of the coast station at Cullercoats. Complaints as to interference are particularly common amongst experimenters living in the coast towns of Whitley Bay, Tynemouth, and North and South Shields. We have, on occasion, heard this station operating synchronously with broadcasting for two hours without ceasing.

* * *

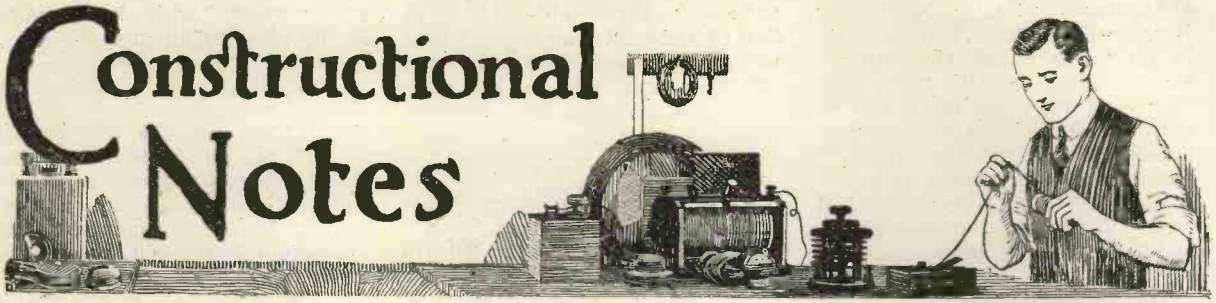
Great preparations are afoot in Newcastle in connection with the Royal Show and the visit thereto of H.R.H. the Prince of Wales. Seizing this opportunity to benefit the charities of the city, a competition has been organised, and appeals to listeners-in to purchase entry coupons for this are broadcast nightly from 5NO. The station authorities are hoping to sell tickets in excess of any of the other depots as a result.

SHEFFIELD.—In spite of light nights there seems to be a steadily growing enthusiasm for wireless, especially of the broadcasting variety. We know of half a dozen hundred-guinea sets being installed in one district alone during the past week, and dealers report a healthy state of sales.

* * *

Broadcatchers have been quick to turn the fine weather to good use. The country around Sheffield, moorland and dale, is now of an evening the pilgrimage of parties with wireless sets tucked beneath their arms.

Constructional Notes



A SIMPLE TUNING STAND.

THE average beginner generally finds that to construct a tuning stand similar to the type advertised is a little beyond him; but the accompanying sketches and description relate to a simple one, which is quite efficient, and yet easy to construct.

Referring to the sketches, Fig. 1 is the plan and elevation of the instrument, and Fig. 2 a cross-sectional end view with a coil-holder inserted. In Fig. 1 there are the usual three holders, the stationary one in the centre marked A and the moving ones B, B on each side of it. B slides in a groove which the two strips C, C provide. This is more clearly seen in Fig. 2.

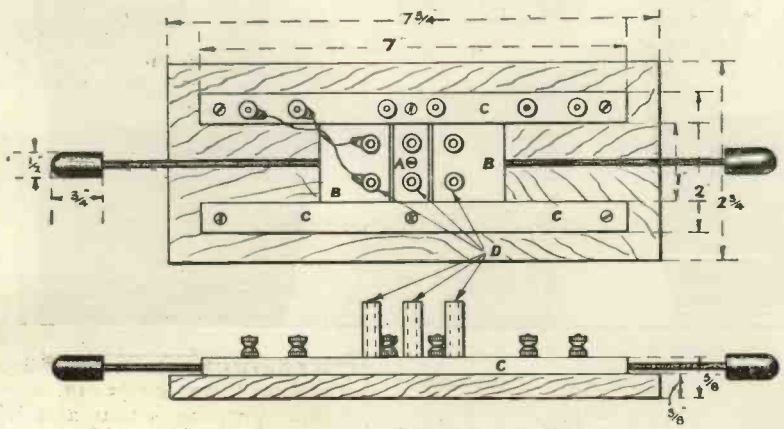


Fig. 1.—Plan and elevation of the tuning stand.

The following material will be required:—Six terminals, six valve legs, a few odd pieces of ebonite, twelve tags (these can be cut from sheet brass to the sizes given in Fig. 1), two brass rods 3¾in. in length having a screw thread at each end, and a piece of flexible wire.

The first operation is the making of A and B, B. Take a piece of ¼in. thick ebonite, file the sides to size (2¾in. × 1¼in.), and mark along each edge of one side a line ⅛in. from and parallel to the edge, as shown in Fig. 3, and then file to shape, as seen in the end view. This piece is cut into three, as shown in dotted lines, the ends made true with a file, and the holes bored in their respective positions. The holes to take the valve legs and the two brass rods must be tapped. Place a tag on each valve leg and insert them in their holes, cutting off and filing level the thread that protrudes on the other side. Screw the brass rods into the ends of B, B. The two small knobs can be made from ebonite rod ¼in. in diameter by cutting two pieces ¾in. in length, filing them to shape shown in Fig. 1, boring the holes for the rods, and finally tapping them. The three holders will then be completed.

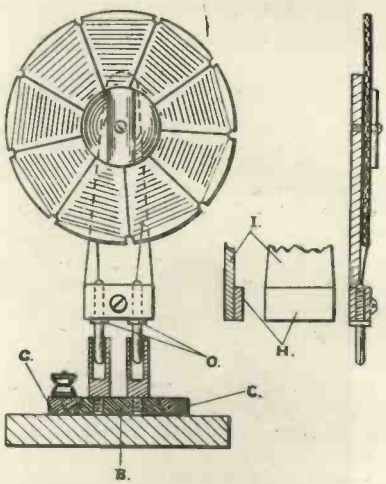


Fig. 2.—Cross-sectional view.

For C, C two pieces of ebonite 7in. × ½in. × ¼in. are required. The bevel is cut in the same way as the holders. On one, holes for the three fixing screws and for the six terminals are bored, and on the opposite side (the side on which the bevel slopes inwards) the six holes are countersunk for the heads of the terminals. The other strip will only require the screw holes. A tag is placed on each terminal before fixing it to the strip. It is best, before securing this part to the base, to solder pieces of flexible

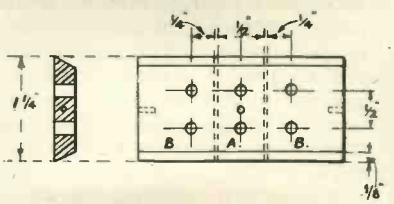


Fig. 3.—Mounts for the coil-sockets.

wire from the tags on the holders to the tags on the terminals. The right-hand pair of valve legs are connected to the right-hand pair of terminals, the centre pair to the centre pair of terminals, the left-hand pair to the left-hand terminals. Take the base (which need not be precisely of the same sizes given) and screw to it the strip containing the terminals and the centre piece A. B, B are placed in position, and the other strip placed alongside. Hold the strip firmly with one hand, and with the other move B up and down. It may be found necessary to ease slightly the sides of B, B with a file so that they will slide nicely. The strip is then screwed down, which will complete the tuning stand.

A Coil Holder.—A coil holder suitable for mounting various classes of coils such as basket and slab inductances is shown in the upper part of Fig. 2. The height of the holder will depend on the size of the coil to be mounted, but the other part has definite sizes. The material required for one holder is as follows:—Two valve pins, pieces of $\frac{1}{8}$in. ebonite, and two screws. Cut pieces of ebonite to the approximate sizes of H and I. Drill a clearance hole in H and a tapped one in I, and screw the two together tightly. Grip it with a pair of pliers, and bore the holes for the valve pins. It is important that the distance between the centres must be exactly $\frac{1}{2}$in., otherwise it will not fit into the tuning stand holder. The coil holder is then finished off with a file. The ends of the coil can be either soldered to the pins or clamped underneath washers.

A. J. R.

EASILY MADE DRILLING JIGS.

TIME is saved and accuracy obtained by the use of a drilling jig where a series of similar holes are to be drilled for panel mounting. A most useful type is a jig for drilling holes to receive valve pins, as shown in Fig. 4.

A block of any hard wood is first marked out to correspond with the pin centres of a standard type of valve. Holes are then drilled to be a "forced fit" for 4 valve sockets, and are recessed to a depth of about $\frac{1}{4}$in. on the underside to allow clearance for waste ebonite which

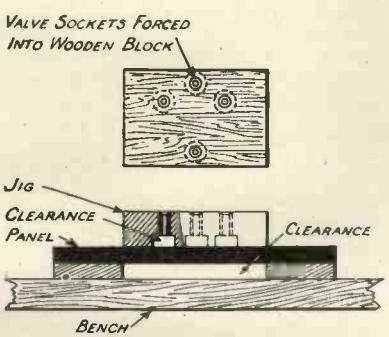


Fig. 4.—Jig for placing valve legs.

accumulates while drilling the panels.

The valve sockets are hammered in as far as the top face of the recess, and the parts protruding from the top face of the wooden block are sawn off. These sockets act as bushes for the drill. The completed jig is placed in position on the panel to be drilled, and panel and jig are clamped on to the bench, two strips of wood being

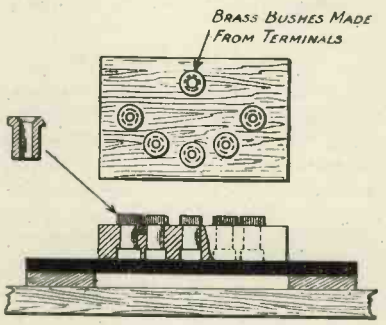


Fig. 5.—Jig for contact studs.

placed between the panel and the bench to make a further clearance.

By means of this jig any desired number of accurate drillings can be made, and there is no possibility of holes being drilled in the wrong place through a mistake in marking out.

Fig. 5 shows a jig constructed in a very similar manner, but arranged for drilling a series of holes for contact studs. In this case the top halves of standard terminals, as shown, are employed as bushes, the internal thread being removed. Similar jigs can also be made for drilling complete panels, if several similar panels are to be constructed.

An instance where a jig of this type is necessary is in the drilling of the top and bottom plates of a variable condenser. These two plates must be drilled to coincide exactly, and such accuracy can only be obtained by using a jig.

H. B.

A VERNIER SLIDER.

MANY wireless constructors who are using the sliding type inductance coil have come to the conclusion that, for fine adjustment, a vernier slider is necessary. The patterns which are at present manufactured are rather expensive, and to construct one on similar lines is a complicated task for those not possessing a full kit of tools. The diagram given in Fig. 6 shows how to make a vernier adjustment, of a very simple but efficient type, employing the ordinary slider. It has also a graduated scale bar on which the various call signs can be marked opposite the corresponding division

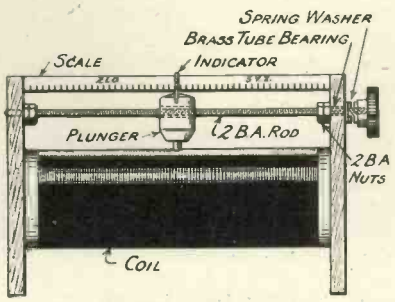


Fig. 6.—The vernier slider in position.

when the best tuning is obtained for the stations in question. This will greatly facilitate the tuning operation for any station.

Fig. 6 shows the vernier assembled. The scale may be made of brass strip or $\frac{1}{8}$in. ebonite marked along one edge in six-

teenths of an inch. The coil supports are slotted and the scale is forced into the slots. Holes are drilled in the coil supports to act as bearings for the 2B.A. rod. The left-hand end of the rod is turned down until the screw-threads are removed and the right-hand support is drilled to receive a tightly fitting brass tube or bush, having an internal diameter to clear the 2B.A. rod. An indicator is also fitted which serves the purpose of keeping the plunger vertical. This can also be made of brass strip. The slot is made to clear the scale along which it should be an easy sliding fit. A slot is also cut in the top of the plunger, and the indicator forced in and secured by means of two small brass pins. Fixing the plunger to the 2B.A. rod is a piece of ¼in. square brass rod, tapped 2B.A., and then made a tight fit into the square hole in the plunger. The other details are self-explanatory.

H. B.

TESTING HOME-MADE APPARATUS.

WHEN any piece of apparatus has been made up it is very important that it should be tested in order that any possible defects may be detected before it is mounted in the set. If apparatus is not so tried out failure on the part of the set to work properly may lead to a long and exasperating search for the seat of trouble, since there are so many places in which it may possibly lie. Here are a few simple tests that may be found useful.

Continuity of Windings

For inductances and other coils whose resistance is not very great, use a flashlamp tester. Touch the ends of the inductance wires with its contact plugs: the lamp should glow. For transformers and other windings with very high resistances use the 'phones. Join one wire from the windings to a terminal of a flashlamp battery, connecting the other to one of the telephone leads. Touch the second battery terminal with the other 'phone lead: there should be a loud click.

Tapped Inductances

Use the flashlamp tester, connecting one plug to the "in" lead of the inductance, the other to the arm of the selector switch. Move the arm round the various studs. The lamp should glow steadily when contact is made with any one of them. Its light should be brightest on the stud representing the shortest wavelength.

Fixed Condensers

A portion of the high-tension battery (say 20 volts) may be made use of for testing condensers. Connect the condenser under trial across the appropriate sockets for an instant; then place one of the 'phone leads on one of the condenser's contacts, and touch the other with the second lead. A loud click should result owing to the discharge of the condenser. If there is no click there is a breakdown in the dielectric or a short circuit between the plates.

Variable Condensers

Wire the condenser, the 'phones and a flashlamp battery in series. Rotate the knob. No sounds should be heard in the 'phones. If clicks are heard the plates are touching at certain points.

Telephones

These are very seldom home-made, but here is a tip that will be found useful if little jobs have been done on the 'phones, or if the purchase of a second-hand pair is contemplated. Place a drop of water on the surface of a penny and lay it on the table. Bring one of the 'phone leads into firm contact with the wet bronze and touch it with the other. A click should be heard whenever this is done, for the combination of the metal of the penny and that of the leads forms a very tiny cell, the water acting as the electrolyte by virtue of the impurities which it contains.

R. W. H.

DRILLING AND TAPPING EBONITE.

DRILLING and tapping, the latter especially, are jobs that the beginner at constructional work in wireless is often rather afraid of. Never having previously tackled such tasks, he is apt to think that they present great difficulty; he fears, too, that a considerable outlay may be necessary in order to provide the necessary tools.

Such fears are entirely groundless. The tools, for instance, are quite inexpensive, for there is hardly a piece of wireless apparatus that cannot be made up with three of the B.A. (British Association) sizes of screws. The writer uses hardly any size but No. 4. For very fine work No. 6 is handy; whilst the supporting rods of variable condensers and other large parts will usually be 2B.A.

Here is a list of all the drills needed to do every job with these three sizes:—

B.A.	Tapping.	Clearing.
6	No. 44	No. 33
4	,, 34	,, 26
2	,, 26	,, 12

It will thus be seen that only five drills are needed, Nos. 12, 26, 33, 34 and 44. Good twist drills of these sizes will cost about 8d. apiece.

In order to use them we require two other tools: a small centre-punch, costing 6d. or 8d., and a breast-drill of the bevel-pinion type, which will run to about 10s. To be able to cut threads in the holes, we need a set of taps Nos. 2, 4 and 6B.A., costing 8d. each, and a tap-wrench at about 1s. The beginner had better start with taper taps, which are easier to work with. Later he may acquire a further set of three plug taps.

In addition to these we shall require one more drill to complete the outfit necessary; a ⅜in. drill for making holes to take the bushes of the spindles of condensers, rheostats, variometers, and so on. This will be too large for the average breast-drill to take; it is best, therefore, to secure one with a square shank, and to use it in an ordinary carpenter's brace.

Don't make your first attempts

upon a virgin panel representing several shillings. Invest a few pence in some scrap ebonite, and get to work on this for practice. First mark out the ebonite by pasting paper upon it and ruling pencil lines. Then punch-mark the centres of the holes to be drilled. Make the punch-marks quite big and deep so that the drill will not slip. Place the ebonite on a flat piece of wood, dip the drill into turpentine and make your first attempt.

Having placed the point of the drill in the punch-mark, stand so that your eye is right over the drill; you will thus be able to guide it and to keep the hole straight. Don't press too hard. Turn the handle at a fair speed and the drill will go in almost by itself. If the ebonite shows a tendency to turn with the drill provide a stop by driving a couple of nails into the wood on which it rests.

Practise until you are able to drill a straight hole. Then tackle tapping. As ebonite is soft stuff there is no need to clamp the work in a vice. Hold it in the left hand, and with the right insert the point of the tap. Make sure that it is quite straight, then press in and give half a turn to the right. Twist back a fraction of a turn, then make another half-turn forward. Now leave the tap in place and hold the work up to the eye to see if the tap is going straight. If so, all is well, for it will continue to do so. If not, start again.

Like the drill, the tap should be lubricated with turpentine, for ebonite, though apparently very soft, has an uncanny way of removing the edges from unlubricated tools. When the tap has gone in about a dozen turns it should be screwed right out again, so that the ebonite dust which has collected on its cutting edges may be removed. This ensures a cleanly cut thread.

Here is a tip that may be found useful. It sometimes happens that you have no tap in stock for a particular screw (one of the odd-numbered B.A. sizes, for example) that must be used. Drill a suitable hole—the right-sized drill is that which will just pass through the nut—then take a screw of the same size and file three flat faces towards its end so as to make it triangular in shape with the threads remaining at the corners. Slightly point the tip. Harden the screw so treated by heating it and allowing it to cool slowly, and you have a first-rate makeshift tap for ebonite that will do any amount of good service.

R. W. H.

CRYSTAL PLUS NOTE MAGNIFIER.

IN a previous issue of *Wireless Weekly* we discussed methods of adding a high-frequency amplifying valve to a crystal set. If you remember, we saw that by so doing we increased the range very considerably, but did not greatly affect the volume of sound in the telephones. To obtain increased signal strength it is necessary to add a low-frequency amplifying valve, which deals with impulses after they have been rectified, and has little, if any, effect upon the range of the receiving set.

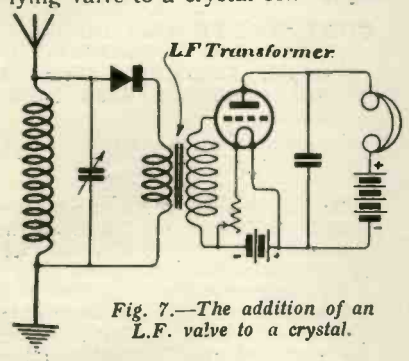


Fig. 7.—The addition of an L.F. valve to a crystal.

Those who live within five miles or so of broadcasting stations will probably obtain all that they want from the arrangement shown in Fig. 7, for signals are in this case so strong that they do not need amplification before rectification. The low-frequency transformer used should be of a reliable make, and the step-up ratio between windings should be fairly large. A transformer with a step-up of 3½ or 4 to 1 will be found satisfactory.

If, however, your receiving set is situated at some distance from a broadcasting centre, you will find it best to adopt the tuned-plate radio-frequency amplifier that we discussed previously, and add a note-magnifier to it.

One of the best ways of doing this is shown in Fig. 9, which gives a very useful circuit for all-round use. It is not permitted to use reaction coupled either with the A.T.I. or the secondary for broadcast reception, but those who desire to be able to receive C.W. signals with a crystal rectifier may make use of the circuit given in Fig. 8. Here the anode inductance is "split," a small series coil being coupled to the secondary of the tuner. This is a circuit which gives enormous amplification and has a very long range.

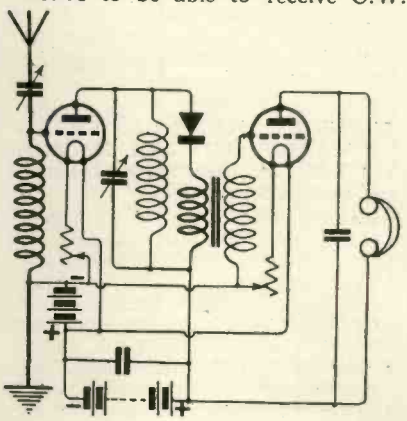


Fig. 9.

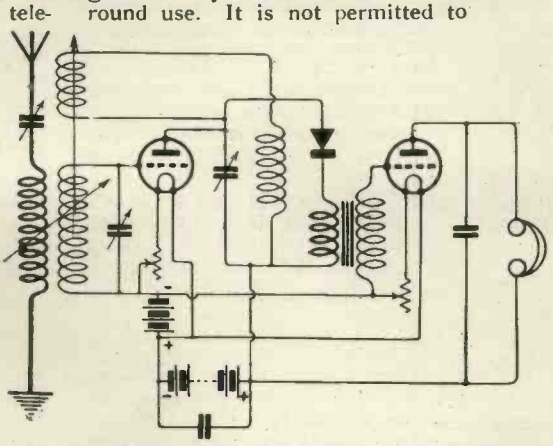


Fig. 8.—Showing both H.F. and L.F. valves with a crystal detector.

For the reception of telephony the crystal is undoubtedly better than the valve, since its rectification is more complete, and therefore leads to considerably less distortion. Hence a combination of valves and crystal detector is very hard to beat.

Radio Societies

DARTFORD AND DISTRICT RADIO SOCIETY (H.Q., Dartford Grammar School).

Hon. Sec., MR. E. C. DEAVIN,
84, Hawley Road,
Dartford.

Further additions to the Society's receiving set were brought forward on June 1st, the detector, tuner, and two-stage low-frequency panels being in operation. A crystal set with one stage of low-frequency amplification, constructed by Mr. Pernett, was demonstrated, and gave good results on the Society's aerial. A broadcast panel (1 H.F. and Det.), by Mr. Prangnell, also gave very good results.

All interested in radio are invited to communicate with the Secretary, who will send full particulars regarding membership.

HACKNEY AND DISTRICT RADIO SOCIETY (H.Q., Y.M.C.A., Mare Street, Hackney, E.8).

Hon. Sec., MR. H. A. EPTON *(pro tem.)*,
17, Chatsworth Road,
London, E.8.

At a meeting of the above Society, held on June 9th, a discussion took place on a circuit which has lately been devised by a well-known radio expert, by means of which it has been claimed that two valves and a crystal are as efficient as four valves used in the ordinary way.

Two members of the Society had experimented with this circuit, and expressed satisfaction, and one, Mr. Parry, promised to bring his set along to the next meeting of the Society, so that it may be demonstrated and examined.

THE RADIO SOCIETY OF HIGHGATE (H.Q., Highgate 1919 Club, South Grove, Highgate).

Hon. Sec., MR. J. F. STANLEY, B.Sc.,
49, Cholmeley Park,
Highgate, N.6.

Mr. F. H. Haynes gave, on June 1st, an interesting lecture, entitled "Electro-static Loud-speakers."

The principles and their applications were carefully explained, and some useful hints were given on the construction of such loud-speakers. A demonstration on a Johnson-Rahbek loud-speaker (made by the lecturer) was given, but, owing to insufficient amplification, the reproduction was not so good as it might have been; the results showed the possibilities of such an instrument under suitable conditions, however.

On June 8th Mr. G. A. Y. Sowter, B.Sc., gave the first of his lectures on "Amplification." In this lecture he confined himself to high-frequency amplification, and dealt with the theory of H.F. circuits in a clear and exhaustive manner. Figures were given showing the importance of avoiding stray capacity in such circuits. The theory of the rejector circuit for inter-valve coupling was also explained.

A full programme of forthcoming features may be obtained from the Secretary.

HONOR OAK PARK RADIO SOCIETY (H.Q., St. Augustine's Hall, Honor Oak Park).

Hon. Sec., MR. G. J. PRICE,
22, Honor Oak Park, S.E.22.

This newly-formed Society held its second meeting on June 13th.

Dr. Higson (Vice-President) said that he had spent an enjoyable afternoon in the works of E. A. Graham, Esq., where he had seen many experiments in wireless telephony carried out, and was pleased to add that at a later date Mr. Graham (President) would be able to give some very interesting demonstrations at the headquarters of this Society.

Mr. C. Watson gave an address on modern scientific theories, and concluded by advising the members to keep an open mind where these theories are concerned.

LINCOLN AND DISTRICT AMATEUR WIRELESS AND SCIENTIFIC SOCIETY (H.Q., Lincoln Technical School).

Hon. Sec., MR. R. BATES,
"Holmside,"
S. Catherines,
Lincoln.

On June 14th a test was carried out with this Society's transmitter, and as a preliminary, 2UL, a local amateur, kindly reported on the C.W. signals and telephony.

At 8.30 p.m. communication was successfully carried on with 5GS (Grimsby) on a wavelength of about 190 metres. At present the Society is using a single-valve circuit and a transmitting valve of type A.T.25. The anode supply is taken from a 230-volt D.C. main, and a smoothing unit, constructed by Mr. H. V. Found, has proved very successful.

This Society hopes to transmit on most Thursdays at about 7.15 p.m., and would like to receive a reply in C.W. from any society or amateur who picks them up, on a card in the case of those living 100 miles or more away who do not possess a transmitter.

PORTSMOUTH AND DISTRICT WIRELESS ASSOCIATION (H.Q., John Pile Memorial Rooms, Fratton Road, Portsmouth).

Hon. Sec., MR. S. G. HOGG,
50, Waverley Road,
Southsea.

On June 6th Mr. A. G. Priest continued his lecture on "Crystal and Valve Circuits," which was illustrated by blackboard circuit diagrams.

The lecturer advised the use of a micrometer spark gap or some other device for protection against lightning. He remarked that insufficient attention was paid to the importance of securing a good earth, and details such as this are often responsible for indifferent results.

On June 13th Mr. Claret described the construction of his four-valve set. Mr. Claret's initial experiments in wireless were distinctly novel, the valve panel being made of wood and the condensers of postcards and tinfoil. Notwithstanding the primitive methods adopted, the transmissions of Mr. Philip R. Coursey, Mr. Leslie McMichael, and North Foreland were heard.

THE STRATFORD-ON-AVON AND DISTRICT RADIO SOCIETY (H.Q., Public Hall, Rother Street, Stratford-on-Avon).

Hon. Sec., MR. E. W. KNIGHT,
17, Park Road,
Stratford-on-Avon.

On June 14th the new circuit ST100 was tested at the headquarters of this

Society, and the results obtained certainly justified the description " supersensitive." Using this circuit, " The Beggar's Opera " broadcast from the Lyric Theatre, Hammersmith, was received on the loud-speaker with great strength and clearness.

THE SYDENHAM AND FOREST HILL RADIO SOCIETY (H.Q., Chess Room, Greyhound Hotel, Sydenham).

Hon. Sec., MR. H. E. HAMPSHIRE,
139, Sydenham Road,
S.E.26.

Recently Mr. W. L. Woolley gave a very interesting lecture on aerials, showing by wooden models how the poles and stays should be fixed. In the discussion following many interesting points were introduced.

On May 7th a lecture on " Elementary Electricity " was given by Mr. W. V. Regden (Chairman). It is proposed that the Chairman should give a lecture on the above subject once a month throughout the year.

In a lecture recently given by Mr. S. C. Tucker the headphones of an ordinary crystal set were replaced by a galvanometer which enabled one to find the most sensitive spot on the crystal. This arrangement was also adapted to a valve set, and by adjusting the current, voltages, and grid-leak, and by working each valve at its most efficient point the results obtained proved that each valve has a point at which it will work best.

TOTTENHAM WIRELESS SOCIETY (H.Q., Institute, 10, Bruce Grove, Tottenham).

Hon. Sec., MR. S. J. GLYDE,
137, Winchelsea Road,
Bruce Grove,
Tottenham, N.17.

A demonstration of members' instruments was held on June 13th at a meeting of the above Society.

A number of sets, ranging from a one- to a five-valve set, were displayed and tested, including the Society's set. Interesting results were obtained from a Flewelling circuit and from an interference eliminator.

WEMBLEY WIRELESS SOCIETY.

Hon. Sec., MR. W. R. MICKELWRIGHT,
10, Westbury Avenue,
Alperton,
Wembley,
Middlesex.

On May 31st an exhibition of members' apparatus was held in the large hall at Park Lane School.

The President displayed a fine collection of high-frequency apparatus, including Tesla and Ruhmkorff coils, a Wimshurst machine with Geissler tubes, and his registered wireless clock tuner. These were operated by Mr. H. W. Gregory, who showed a rectifier and model electric train in operation. Matchbox crystal sets, valve sets, frame aerials, loud-speakers, and other equipment were also shown. The exhibition was organised by Mr. W. E. Meldrum, assisted by the Secretary, to whom application should be made for particulars of membership.

WIRELESS AND EXPERIMENTAL ASSOCIATION (H.Q., Camberwell Central Library).

Hon. Sec., MR. G. SUTTON,
18, Melford Road,
S.E.22.

On May 16th Mr. W. A. Knight (Chairman) described methods of providing high-tension anode supply for telephonic transmission, using a spark coil and six volt battery.

Chokes of both air and iron cored types, and condensers of various capacities were used for smoothing out the H.T. current produced.

Mr. Horwood (Assistant Secretary) exhibited a list giving the numbers of turns and wavelengths of a series of Lokap coils which he had wound and tested.

The Secretary then exhibited a variometer made up from odds and ends, and costing only sixpence-halfpenny.

On June 6th some aspects of the present broadcasting programme were discussed, particularly with regard to 2LO. The Secretary was instructed to write asking:—

(1) If it would be possible for 2LO to switch off the carrier wave during intervals?

(2) Would they consider the broadcasting of a suggestion to licensed amateurs that they should refrain from transmitting during the half-hour of broadcasting " close-down " ?

(3) Could the call sign of the broadcasting station always be used before and after each item?

(4) Would the necessary Sunday testing be kept down to a minimum?

He was also instructed to assure the B.B.C. that the communication was not sent in a censorious spirit, but with a wish to indicate a desire for more harmonious working.

The Secretary then read a circular he had received from a firm vending a type of inert battery, and had some scathing remarks to make about the misleading statements contained in it. None of the members are likely to buy a battery of Leclanche cells under the mistaken impression that they are cheaper than accumulators at the prices quoted in the circular referred to.

WOLVERHAMPTON AND DISTRICT WIRELESS SOCIETY.

Hon. Sec., MR. J. A. H. DEVEY,
232, Great Brickkiln Street,
Wolverhampton.

Mr. A. H. Watkins recently gave a lecture on " Ether Waves: A Material or a Force."

While Mr. Watkins admitted that many theories were substantially correct, he held the opinion that, in view of the fact that many of these were being reviewed, there must evidently be a necessary assumption in many respects.

WOOLWICH RADIO SOCIETY (H.Q., Y.M.C.A., Thomas Street, Woolwich).

Hon. Sec., MR. H. J. SOUTH,
42, Greenvale Road,
Eltham, S.E.

By kind permission of Captain P. P. Eckersley, the members of this Society were allowed to visit the Studio of 2LO.

The members were present whilst testing was actually taking place.

Mainly about Valves

A Novel Circuit

I WAS working with the accompanying circuit during the week-end, and as it gave very good results I thought my readers might be interested to try it. The circuit is very selective and the reaction comes up gradually—not with a *plonk* as often happens (about this plonk, by the way, I hope to say more at another time). The aerial circuit, of course, is tuned in any convenient way, but I would not recommend any material variation from the other inductance values. A No. 35 or No. 50 Igranic honeycomb coil with a 0.0005 μF or 0.001 μF variable condenser will usually do for the aerial circuit. The condenser should be connected in series and then in parallel to see which gives the best results.

The coil L_3 is a No. 35 Igranic coil shunted by either a 0.0005 μF or 0.001 μF variable condenser. The coil L_2 is a No. 50 Igranic coil. The condensers C_3 and C_4 have a value of 0.002 μF, and are of the Dubilier type in moulded composition. The reaction coil L_4 is a No. 75 Igranic coil. These inductance values are for 2LO (369 metres). The gridleak R has a value of 2 megohms.

An additional low-frequency amplifying valve was actually used, and may be added to the circuit if it is desired.

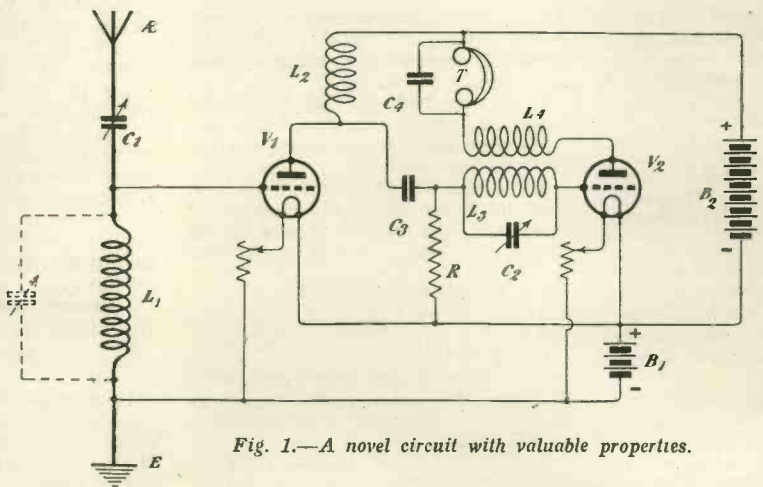


Fig. 1.—A novel circuit with valuable properties.

An Interesting Effect

An interesting but little known effect in power amplifiers is the generation of high-frequency oscillations by the valves used to amplify low-frequency currents.

I was speaking the other day to the engineer responsible for the production of a 5-kilowatt broadcast transmitter which is to be installed at Manchester in the near future. The microphone potentials are, of course, amplified before being applied to the modulating valves of the transmitter, which, by the way, is of the choke-control type. When operating this set it was found that the low-frequency amplifying valves oscillated at high-frequency and the circuit emitted powerful waves having a length of about 5 metres.

The accompanying circuit (Fig. 2) shows a simple amplifier for magnifying the speech currents. It was found that not only did the valves amplify the low-frequency currents, but as the high-tension voltage was increased, self-oscillation set in with a sudden increasing of the anode current. It was at first thought that this was due to the softening of the valves, but it was found to be due to the connecting wires to the grid and anode forming separate oscillation circuits which were coupled together by the capacity coupling inside the valve. In the figure the part of the lead to the grid marked X forms with the filament lead a capacity which completes the oscillation circuit F G X C_1 F. In the diagram the condenser C_1, of course, is to represent

the natural capacity existing between the point X and the filament. Likewise, the wire going to the anode forms one plate of the condenser, the other side of which is the filament. This capacity is represented by C_2, which completes the circuit F A Y C_2 F. These two oscilla-

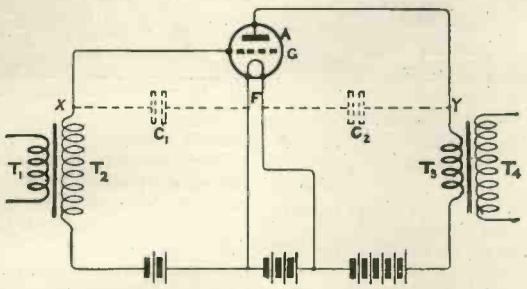


Fig. 2.—Showing how anode and grid circuits may become oscillatory.

tion circuits are coupled inside the valve, and when the anode voltage is increased to a sufficiently high value the natural reaction between the two circuits is sufficient to produce very strong high-frequency currents, and it is possible to light a lamp by connecting two loose bits of wire, one to each side of the filament, and placing the lamp near the apparatus. It was found that the effect was specially noticeable where two or more valves are connected in parallel for amplification, the steepness of the characteristic curve being thereby increased.

When dealing with receiving sets it would be as well not to overlook the possibility of a similar action taking place. It would account for distortion, and the effect might easily be present when voltages of 300 and more are used.

To prevent the valve oscillating at low frequencies the windings T_2 and T_3 are usually shunted by high resistances.

Inaudible Oscillations in L.F. Amplifiers

Speaking of undesirable high-frequency oscillations in low-frequency amplifiers, reminds me that many experimenters seem to imagine that because the low-frequency amplifier does not howl it is doing its work properly. This is far from being the case. Often a low-frequency amplifier is oscillating gently at a frequency well above the audible limit. It is quite possible for the amplifier also to oscillate below the audible frequency limit, but I doubt if this effect is often obtained. I have frequently experienced the trouble caused by low-frequency amplifiers oscillating at a frequency over 20,000. Although this does not cause any unpleasant noises in the loudspeaker or in the telephones, it will completely spoil the quality of the speech, and it is desirable to take precautions mentioned in an article on low-frequency amplification which appears in the current issue of *Modern Wireless*.

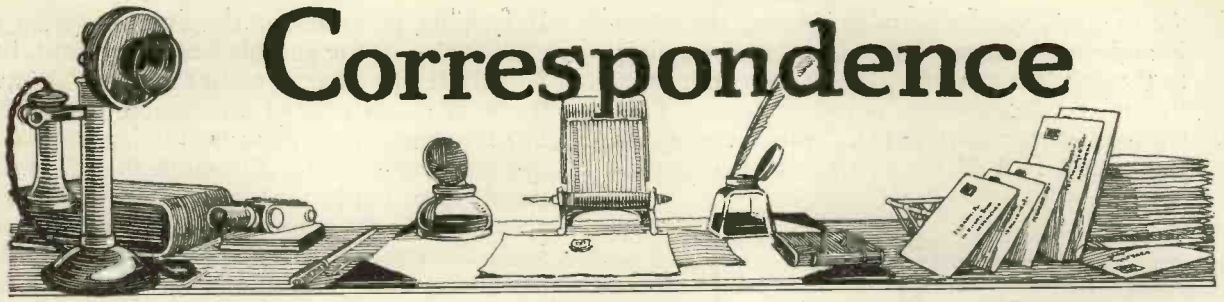
A Peculiarity of Some Intervalve Transformers

Some types of intervalve transformers have the peculiarity that it is possible to leave the secondary terminal which would ordinarily go to the negative terminal of the filament battery quite unconnected, the other terminal being connected to the grid of the valve. It will be found in many cases that leaving out this connection in no way affects the strength of signals. It is interesting to remember that Dr. de Forest, who was one of the first to use amplifying valves in series, commonly left this connection open, apparently because he found that it made very little difference whether the secondary circuit was closed or not.

In those cases where the letters IS and OS mean "inside secondary" and "outside secondary," it will be found that OS should be connected to the grid.

A Useful Valve Panel

I see that Messrs. McLelland have placed on the market at 20s. a valve panel which is fitted with a fuse, and which has several distinctive features, these being suggested in my notes of May 23rd. Such a quick response came as a surprise, and shows that criticisms and suggestions are not ignored by manufacturers. The panel is beautifully made (entirely in ebonite), and may be recommended unreservedly to all who want to carry out real experiments. I hope that someone will turn out the gridleak holders and terminals, blocks and holders for single honeycomb coils which I mentioned in another issue.



VALVE COMBINATIONS

To the Editor, *Wireless Weekly*.

Sir,—One is continuously coming across paragraphs on the lines of the following in *Modern Wireless* and *Wireless Weekly*: "The first and second valves operate as high-frequency amplifiers, the third is the rectifier, while the fourth and fifth are note magnifiers."

It appears to me that a simple method of graphically classifying multi-valve receivers as shown below might be standardised for purposes of reference, etc. It has in its favour the advantages of simplicity, and at the same time of conveying immediately to the reader the functioning of the valve combination without *further explanation*. I would suggest that the valves be divided into their functioning groups, viz., H.F., rectifying, and L.F. amplification respectively, as is done at present, but the number of valves employed in each group could be signified *by numerals* only, the numerals then being merely separated by dashes.

For example, "Type 2—1—2" would immediately convey to the reader that the valve combination comprises 2 H.F., a rectifying, and 2 L.F. valves, other combinations *ad lib.* could be similarly graphically indicated thus:—

Valve Combination.	Type.
1 H.F., 1 Rectifier, 1 L.F.	1—1—1
2 H.F., 1 Rectifier, 2 L.F.	2—1—2
3 H.F., 1 Rectifier, 2 L.F.	3—1—2
1 Rectifier, 1 L.F.	0—1—1
1 Rectifier, 2 L.F.	0—1—2
1 Rectifier	0—1—0
1 H.F. Unit, comprising, say, 2 valves.	2—0—0
1 L.F. Unit, comprising, say, 2 valves.	0—0—2
Marconi 7-valve Amplifier or similar combination	6—1—0
1 H.F. valve followed by crystal rectification	1—C—0 etc.

This suggestion is an adaptation of a system standardised for years in locomotive engineering for the purpose of graphically classifying locomotives according to the number and grouping of leading, driving, and trailing wheels respectively, and I see no reason why the same idea might not, with advantage to all concerned, be universally adopted by the wireless press.

I have religiously taken in all wireless periodicals for years past, and I take this opportunity of wishing your recent valuable additions to our wireless publications every success. Judging by the issues to date I am sure its future is assured. I am, etc.,

W. E. Dixon Bennett.

South Africa.

[When this was received an article on this actual subject was in hand. Mr. Bennett's suggestion is an excellent one, which we propose to adopt as a regular convention. What happens when a valve acts in a dual capacity? Shall we add D after the number? And how are we to denote reaction? We would like our readers' views.—Ed.]

THE PALLOPHOTOPHONE

To the Editor, *Wireless Weekly*.

Sir,—Your articles in the last two numbers of the *Wireless Weekly* on the "Pallophotophone" are undoubtedly interesting. The instrument may, too, be of commercial value, though with that matter I am not now concerned. It should, however, be made quite clear that the instrument is nothing more than a refinement of an instrument originally designed by Professor J. G. McKendrick and by Doctor J. Erskine-Murray. A reference is made to this apparatus in Doctor Barton's Text Book on Sound, and it is there stated that the first public exhibition of their instrument was made in Nottingham in 1901. The writer repeated these experiments in 1910 with a slightly different apparatus which seems to have been even more sensitive than the original; and had actually in his possession a considerable number of films and negatives showing the light pictures of various words and phrases, until a year or two ago, when they were destroyed owing to deterioration due to casual fixing.

The use of the photo electric cell is also somewhat ancient history. A full description of the method of manufacture of such a cell will be found in a paper by Kemp in the *Physical Review*, Series 2, Vol. 1, p. 274, and dated 1913. The sensitiveness of the cell used by Kemp was such that it would detect the light of one candle power at a distance of $2\frac{3}{4}$ miles, and under those conditions give a measurable current of $\frac{1}{10^{15}}$ amperes. It is thus evident that the present development has been brought about by the resources of a wealthy corporation being brought to bear upon the researches of men occupied in the pursuit of pure science. Many such developments of even greater practical use than this instrument could be brought about if business firms in this country could be made to realise their responsibilities in this direction. It is useless to expect scientific men to bring their inventions and designs to the commercial stage if, in the subsequent process of commercialisation, the inventor is to be either robbed of the fruits of his labours altogether or to receive such a mean reward that he cannot afford to continue his researches in other matters.

The upshot of all this is that if we are to have real advance in the application of scientific thought to the needs and pleasures of our everyday lives it is essential that the scientific worker shall be able to reap some reward for his labours, and that business firms who profit from a scientific development shall pay a proper proportion of those profits to the men with the brains who made their profit-making possible.

Incidentally, why is it necessary for the designer of this apparatus to desecrate a beautiful language like Greek by incorporating bits of it into the clumsy portmanteau word by which he calls his design?

Faithfully yours,

C. W. C. Wheatley,

Camden Engineering Co., Ltd.

London, N.W.1.

AERIALS

To the Editor, *Wireless Weekly*.

Sir,—I had hoped that the letter by "Pre-War" in your issue of the 18th April, and the Editorial comment on it, would have induced experimenters to put forward their views. Beyond the reply by Mr. Hogg on May 9th dealing more particularly with the transmitting effects there does not appear to be much interest taken in the point raised.

I should have thought that where reception is concerned, which so far as the majority of your readers are interested is the main thing, there could have been only one answer; closed aerials are more efficient on the facts as stated by "Pre-War," insulation resistance is doubled, and capacity of insulators is reduced by having them in series.

In view of these facts why is it that

without exception every diagram shows the aerial with the insulators in the aerial, no mention being made of any other arrangement? I am, etc.,

Harrogate. FIVENNA.

A WIRELESS CLUB AND THE B.B.C.

TO THE EDITOR, *Wireless Weekly*.

SIR,—The Wireless and Experimental Association, at the Central Library, Camberwell, on Wednesday, June 13th, received with every satisfaction the reply of the B.B.C. to certain representations. The points were dealt with by the Company's chief engineer, Capt. Eckersley, in a very businesslike manner, and after a full discussion by the meeting, point by point, it was agreed that the B.B.C. were doing their best with a difficult situation. The last paragraph of the letter deserves repetition. It is:—"You will realise, however, that our work, too, is largely experimental, and sometimes we have to do tests on a Sunday which we have no opportunity of doing at any other time. We will seriously try and use this time to the best of our ability and not jam the ether unnecessarily, and we would like to take this opportunity of thanking amateurs throughout the kingdom generally for the sporting way in which they have treated the Broadcasting Company."

The secretary of the Wireless and Experimental Association was instructed to write:—"My committee instructs me to write thanking you for the great courtesy of your reply and the meticulous attention to detail which your letters evince. We should be sorry to convey the impression that we do not appreciate the considerate use of the ether which the B.B.C. exercises, and in which it compares very favourably with other users whom we might mention. It was only natural that the old amateur should feel the loss of much of his previous freedom, but there are undoubted compensations. There is one main principle upon which the amateur associations can combine with the B.B.C., and that is in keeping the ether clean, and you may be assured that my association is 'all out' on that tack. As the last sentence in your letter of the 9th indicates that you are not averse from a wider publicity than the pages of our minute book affords, I have taken the liberty of submitting the correspondence to the press for publication."

Not to be outdone, the Company's chief engineer replied:—"It is very kind of you to write in this way, and I am glad you appreciated the correspondence and took it in the spirit it was offered. I am very glad to hear you are sending it to the press."

Which all goes to show that while the Wireless and Experimental Association will not abate their claims for the liberty of the wireless amateur, they are content to sink their individual preferences if they clash with the greater enjoyment of the greater number.

GEORGE SUTTON,
London. Hon. Sec.

INTERFERENCE

TO THE EDITOR, *Wireless Weekly*.

SIR,—The letter of your correspondent "Fed-up," in the issue of June 13th, expresses my feelings exactly. I have been experimenting for many years and am therefore constantly asked for advice. I *cannot* advise people to go in for broadcasting under the present conditions. I have used the most selective-tuned H.F. and other circuits that are within the means of most people and interference from spark stations is almost constant on the broadcast band, but especially between 390 and 425 metres, which is near the 450 French coastal work. It must be realised that we in East Anglia are over 100 miles from *any* B.B.C. station. London—the nearest—comes in with only occasional interference, but enough back-chatter of "sparks" to spoil the beauty while we are working. Nothing short of elaborate rejector circuits, such as the "Hinton," can alleviate the trouble owing to our distance from the B.B.C. stations, and this is not within the scope of B.B.C. licence holders. In the circumstances, recruiting people for B.B.C. licences is hopeless and, on top of all this trouble, is the usual summer sunset atmospheric! Why cannot spark stations be altered to a higher wavelength of about 700 metres? Also, why not a relay station at Norwich?

I am, etc.,
A. E. D. KENNARD,
Wrentham.

A SUGGESTION

TO THE EDITOR, *Wireless Weekly*.

SIR,—May I be allowed to make the following suggestion which I think will appeal to all experimenters, amateurs and dealers alike, and also indirectly to the B.B.C. It is as follows:—

> That all the six Broadcasting Stations shall each in turn replace one of their morning demonstrations by an afternoon concert between the hours of 3 p.m. and 5 p.m.
>
> By doing this I claim the following advantages:—
>
> 1. That those with valve sets will have the opportunity of testing their instruments and listening to distant stations on five afternoons of the week, whereas at present those who live near a Broadcasting Station get no chance of doing so.
>
> 2. Dealers will also have the opportunity which they have not now, of demonstrating their sets, while they will still get transmissions on five mornings and one afternoon a week from their local Broadcasting Station.
>
> 3. A considerable increase in the sale of valve sets. The public are now getting educated to wireless, and those who live near a Broadcasting Station realise that to buy an expensive valve set is useless under the present conditions, as they never get the opportunity of using them on account of interference from the near station.
>
> 4. The B.B.C. will be put to no extra expense or work, as they are merely replacing one morning with an afternoon concert. They will derive advantage from the extra sale of B.B.C. valve sets which the public will readily buy as soon as they know that they are going to be given an opportunity to use them.

I am, etc.,
G. A. BEDWELL.
Norwood.

EXPERIMENTAL LICENCES

TO THE EDITOR, *Wireless Weekly*.

SIR,—I have read of so many complaints as to the delay in issuing experimental licences that, in all fairness to the much maligned Secretary of the General Post Office, I would like to say that I posted my application by the last post from here on the 4th inst., and received a notice dated the 7th inst. to the effect that the licence would be granted me.

I am, etc.,
R. G. BURDER.
Loughborough.

THE PROOF OF THE PUDDING——

TO THE EDITOR, *Wireless Weekly*.

SIR,— I must congratulate you on your books for the beginner.

I studied magnetism and electricity at a private school as a boy, and am now on an engineering cost accounting job.

Your "Simplified Wireless" was my first insight to this fascinating hobby—and the first set I made worked excellently.

Then I bought No. 3, "How to Make Your Own Broadcast Receiver," and the variometer set (No. 2)—on an aerial of only 60 ft. total length by about 20-25 ft. high—is even better, two of my friends saying that it is better than their one-valve sets! Of course, I use good 'phones, but it is to your credit that such workable apparatus can be so cheaply made.

I might mention I take both *Wireless Weekly* and *Modern Wireless* regularly, these being the only wireless periodicals I now use.

I am, etc.,
STUART G. CAMPBELL.
Catford, S.E.6.

Patent Section

The following list has been specially compiled for "Wireless Weekly" by Mr. H. T. P. GEE, Patent Agent, Staple House, 51 and 52, Chancery Lane, W.C.2, and at 70, George Street, Croydon, from whom copies of the full specifications published may be obtained post free on payment of the official price of 1s. each. We have arranged for Mr. Gee to deal with questions relating to Patents, Designs and Trade Marks. Letters should be sent to him direct at the above address.

ABSTRACTS FROM FULL PATENT SPECIFICATIONS RECENTLY PUBLISHED.

(Copies of the full specifications, when printed, may be obtained from Mr. Gee, post free on payment of the official price of 1s. each.)

195964. BRITISH THOMSON-HOUSTON CO., LTD. (Assignees of Prince, D. C. of Schenectady, New York, U.S.A.).—A discharge device such as a thermionic valve comprises a cathode, a control grid, an anode, and a second grid interposed between the control grid and the anode and maintained at a potential lower than that of the anode so as to prevent secondary emission from the anode whilst reducing the space charge losses. March 29th, 1923. Convention date, April 8th, 1922.

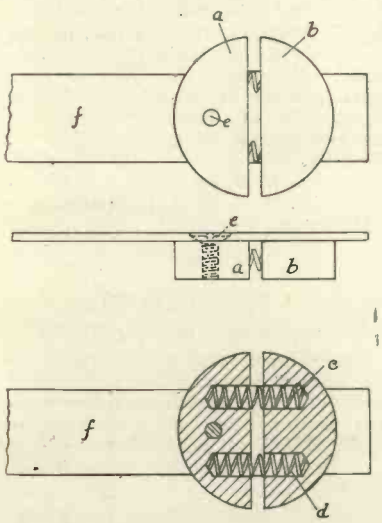
195982. INTERNATIONALT RADIOTELEGRAF- & TELEFON COMPAGNI VED WAHNOE & PETERS.—In wireless direction-finding systems, the bearings of a distant transmitter, whether at sea or in the air, are automatically shown upon an illuminated map at one of two or more fixed beacon stations by apparatus controlled by the moving coil of a Bellini-Tosi or other directional receiving set. April 7th, 1923. Convention date, April 10th, 1922.

195987. BRITISH THOMSON-HOUSTON CO., LTD. (Assignees of Alexanderson, E. F. W. of Schenectady, New York, U.S.A.).—Relates to valve generators of the kind in which oscillations of radio and audible frequency are produced simultaneously, and consists of a particular circuit arrangement in which the amplitude of the low-frequency oscillations is limited relatively to the amplitude of the high-frequency oscillations. April 9th, 1923. Convention date, April 10th, 1922.

195990. BRITISH THOMSON-HOUSTON CO., LTD. (Assignees of Alexanderson, E. F. W. of Schenectady, N.Y., U.S.A.)—A transmitting aerial is furnished with an extended earthing system, which is designed so as to collect at least three-quarters of the capacity current that normally reaches ground outside the area covered by the elevated antenna. The antenna is of the multiple-tuned type described in Specification 130064. April 10th, 1923. Convention date, April 10th, 1922.

196062. BRITISH THOMSON-HOUSTON CO., LTD.—In a high-frequency signalling system of the type in which the dots and dashes are of equal length and are transmitted by waves of different frequencies, the two sources of high-frequency current of different frequencies are connected to the transmitting circuit by transformers, and the potential of the secondary of either of the transformers can be suppressed at will to send a dot or dash as the case may be on the frequency supplied by the other transformer, while at the same time the transmitting circuit is tuned to the frequency being transmitted. January 12th, 1922.

196085. GRENFELL, G. P., and ROBINSON, J.—Approximate determinations of bearings may be made with ordinary receiving apparatus operating in conjunction with a transmitting station employing a rotating directional beam, the radiation being given distinctive characteristics only when it is in the direction of two or more cardinal points, which may, *e.g.*, be at 90° apart. Specifications 135896, 144628 and 189266 are referred to. January 16th, 1922.



Illustrating Patent No. 196188.

196126. WAGNER, H. G.—Block electrodes of galvanic batteries, made as described in Specification 196127, are separated from one another in the battery cell by insulators secured to one of the electrodes. Each electrode is formed with a recess, so that when two electrodes are placed in a cell a cavity is formed at the top to receive a testing instrument or to serve as a filling opening. February 6th, 1922.

196127. WAGNER, H. G.—Porous active material for storage battery electrodes is made by soaking sawdust in a solution of ammonium sulphate, draining off the excess solution, and mixing the damp sawdust with lead peroxide or powdered lead, then with carbon, and finally with calcined calcium sulphate. The mixture is then moulded into shape, the ammonium and calcium sulphates causing the mass to set and harden. February 6th, 1922.

196188. KNIGHT, A. W.—An inductance coil holder consists of two half-cylinders of insulating material, which are pressed apart by springs so as to grip the inside of the coil. One of the half-cylinders is fastened by a pin to an insulating strip which may be attached to a vertical rotatable pillar. Two or more holders may be mounted on a base, the coupling between the coils being varied by rotating pillars. May 3rd, 1922.

196225. BRANDES, INC., C. (Assignees of Dietrich, F., of Flushing, New York, U.S.A.).—The head-band of a telephone head-set consists of a seamless fabric sleeve covering a wire. The ends are provided with metal tips having apertures through which the wire passes. The receiver is supported by an adjusting rod, sliding freely in a chuck having means to cause the chuck to grip the rod to prevent its free movement. The rod is provided with a ball-head screwing into it, and the receiver is supported on pins in a stirrup. September 1st, 1922. Convention date, May 12th, 1922.

196231. NAAMLOOZE VENNOOTSCHAP PHILLIPS' GLOEILAMPEN-FABRIEKEN.—In electric lamps, vacuum tubes, &c., each leading-in conductor is fixed to a metal disc which is welded into a tubular extension of the glass container. The metal may be a chromium-iron alloy having a coefficient of expansion approximating to that of the glass, and when this alloy is used the parts of the conductors connected to them are preferably of nickel. October 25th, 1922. Convention date, July 28th, 1922.

196233. PETTY, A. L. A.—In a wireless receiver, the valve shunted on the aerial inductance has its rectifying power increased by a high-resistance leak connecting its grid to its plate. The leak for a common type of valve has a resistance lying between 25 and 100 megohms, and preferably amounting to 50 megohms. It may consist of a piece of wood about 1 in. long and ⅛ in. thick, having terminal pins driven into its ends to a distance of ½ in. from one another, or it may be of resinous, fibrous, or other substance. December 12th, 1922.

Information Department

Conducted by J. H. T. ROBERTS, D.Sc. (F.Inst.P.), assisted by A. L. M. DOUGLAS.

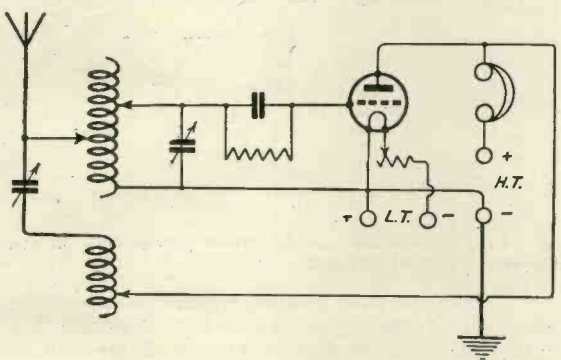
In this section we will deal with all queries regarding anything which appears in "Wireless Weekly," "Modern Wireless," or Radio Press Books. Not more than three questions will be answered at once. Queries, accompanied by the Coupon from the current issue, must be enclosed in an envelope marked "Query," and addressed to the Editor. Replies will be sent by post if stamped addressed envelope is enclosed.

F. N. (OLDHAM) asks for a suitable circuit diagram which will enable him to receive all the British Broadcasting Stations from Manchester.

If you wish to work a loud-speaker, we recommend the use of circuit No. ST51 "Practical Wireless Valve Circuits," Radio Press, Limited. This will give you reception not only from British Broadcasting Stations, but if appropriate inductances are used, from Continental stations as well.

J. F. (N.W.) asks for a circuit diagram of a Reinartz tuner.

We submit herewith a suitable circuit diagram.



F. D. B. (CARDIFF) asks questions about a suitable commercial type of receiver for certain specific purposes.

We are unable to recommend any particular manufacturer's instruments in these columns, but we should estimate the cost for a receiver such as you describe to be in the neighbourhood of £60.

P. R. L. (CHRISTCHURCH) submits a sketch of a peculiar type of variometer he has originated, and asks our opinion upon it.

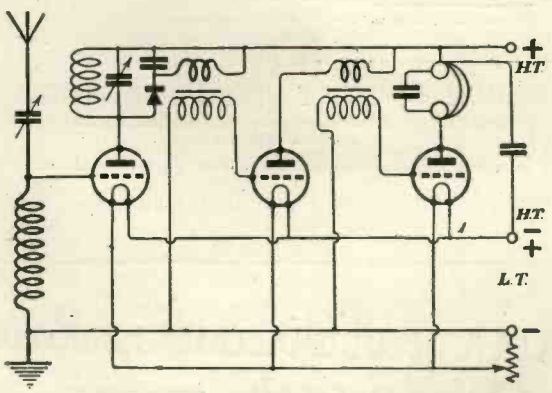
We do not quite see the advantage of this instrument; if you would let us know in what part of the circuit and for what purpose you propose introducing it, we will then be pleased to pass our opinion upon it.

C. B. (LEYTONSTONE) asks the following questions: (1) For the dimensions of a variometer to cover all the British Broadcasting Company's Stations. (2) Whether it is possible to completely cut out signals on a wavelength very close to that on which it is desired to receive. (3) Certain questions about repaired valves.

(1) A highly efficient variometer is described in *Modern Wireless*, No. 2, by Mr. Redpath. (2) If a loose coupled circuit is used it is generally possible to control interference. (3) We believe satisfactory results have been obtained from repaired valves.

J. W. (EASTHAM) has a Government Mark IV. 3-valve amplifier, and wishes to know whether this could be converted into a 3-valve receiver.

The C Mark IV. low-frequency amplifier can be readily converted by removing the earth-to-valve transformer fitted at the input side of the instrument, and which is attached to the tapping switch on the face of the instrument, and substituting a gridleak and condenser. The arrangement will then constitute a rectifier with two low-frequency stages.



W. S. (BLACKBURN) asks for a diagram showing 3 valves and a crystal detector.

A good circuit is given above.

M. F. H. (PORTHCAWL) is constructing the 2-valve Broadcast receiver described in "WIRELESS WEEKLY," No. 4, and wishes to know whether this would receive clearly at a distance of 50 miles.

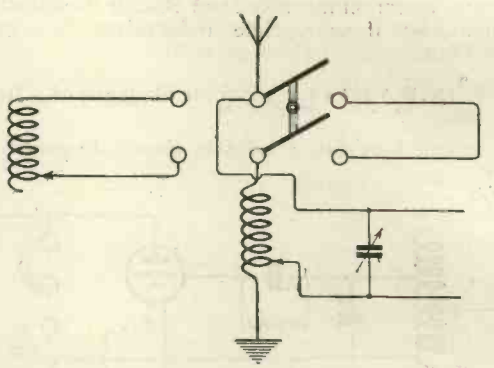
This receiver has a range of between 80 and 100 miles under favourable circumstances, and can be thoroughly recommended.

J. E. A. (BRACKLEY) asks questions about an Armstrong super-regenerative circuit, and also whether a number of functions can be performed by one valve at one and the same time.

The wire you propose to use for the winding of the Armstrong inductance and reactance will be quite suitable, and the same number of turns per slot should be used. Referring to your question about the valve, we think a 4-electrode valve would be useful to you for this purpose. The adjustment of the associated circuits with such a valve, however, is rather a tricky matter, but offers wide scope for experiment.

W. S. C. (FINCHLEY) asks how to connect a double pole switch to cut a loading coil out of circuit when not required.

See the accompanying diagram.



W. F. (BASINGSTOKE) asks questions about different types of crystals.

One of the specially treated crystals now on the market will probably give you very good results, but a "Perikon" combination is very stable as well as being sensitive. Crystals can be distinguished by the practised eye by their colour alone.

W. T. (N.W.3) asks whether it is correct to assume that there is no radiation from the aerial when telephony is received without distortion, using a circuit employing reaction. He also asks for information regarding certain amateur call signs.

Reaction effects may easily take place which cause radiation from the aerial, even although no distortion is introduced into the received speech. There is not, however, likely to be radiation if the reaction is applied to the circuit in such a manner that there is at least one valve between the grid to which reaction is effected and the aerial circuit. Referring to your question about the amateur transmitters, we regret we have no information about the stations you mention.

J. C. (FINCHLEY) has built a 2-valve note-magnifier as described in "MODERN WIRELESS," No. 2, from which he obtains excellent results. There is, however, a constant scraping noise, and he asks if we can explain the reason for this.

It is probable that either your connections are faulty or that your H.T. battery is weak. You should carefully test all the circuits in turn with a pair of telephones and a battery, and the voltage of the H.T. battery should also be tested. This amplifier should be quite silent when in use.

J. G. (HUNTSTILL) asks for particulars of an intervalve transformer.

The core might consist of sufficient laminations of No. 24 s.w.g. annealed iron, insulated on each side, to form a square of ½in. cross section. The primary winding should consist of 4,500 turns of No. 40 gauge single silk-covered wire, and the secondary winding 11,000 turns of the same wire. Half an ounce will be required for the primary and 1½ ounces for the secondary. The primary resistance will be about 1,100 ohms, and that of the secondary 3,680 ohms. The inductance value of the primary winding is in the neighbourhood of 8 henries, and that of the secondary about 50 henries. With reference to your question about Daniell's cells, we do not think they are suitable for charging an accumulator of a capacity greater than about 10 ampere hours.

W. H. R. (WALTHAMSTOW) asks questions about a receiving circuit incorporating valves and crystals.

See ST35, "Practical Wireless Valve Circuits," Radio Press, Limited. This will give you all the information you require.

E. W. J. (BROADSTAIRS) submits a circuit diagram of his apparatus, and asks various questions

We have examined your circuit diagram, and find it correct. An additional low-frequency valve will, however, greatly improve results, and to reach a wavelength of 2,600 metres, the aerial circuit coil should be a No. 200, the anode coil 250, and the reaction coil 100.

L. A. H. (STROUD) asks what type of receiver we would recommend for the reception of Broadcasting from Birmingham or Cardiff.

We think that under the circumstances you mention a four-valve receiver of any reputable make would be very satisfactory. We cannot, of course, recommend apparatus made by any particular firm.

T. K. F. (SOUTHAMPTON) asks (1) Must his circuit be oscillating to receive continuous waves. (2) Whether certain coils in his possession give as good results as could be expected. (3) Whether his tuning apparatus is interfered with by the magnetic field from generators situated 300 yards away from the apparatus.

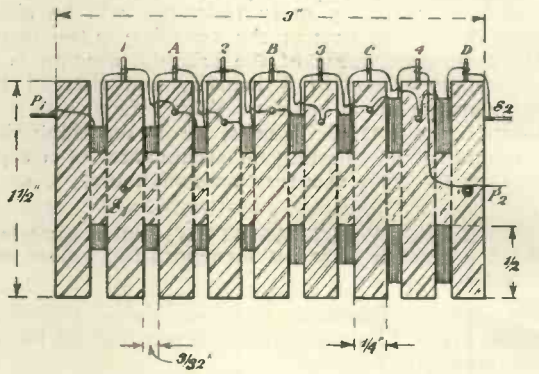
(1) It is essential that oscillations be generated in the circuit to receive C.W., but this does not mean that it radiates. This latter point depends entirely on the type of circuit used. (2) There is nothing to choose between the different types of coils you specify. (3) The field of the generators will not produce any direct interference with the tuning apparatus of your receiver.

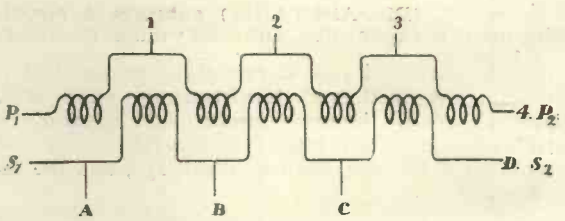
H. L. (PENRITH) proposes to make a 4-valve receiver, but cannot decide between the one described on pages 14 and 150 of "MODERN WIRELESS," and that described on page 182 of "WIRELESS WEEKLY." He also asks questions about the assembling of the apparatus.

There is little to choose between the two sets. If anything the *Wireless Weekly* one is slightly preferable. Referring to the question of filament rheostats, it is of course an advantage to have one for each valve, but on the other hand this is not necessary. We think that if you arrange the parts as shown in *Wireless Weekly*, there will be no necessity for the additional complication of separate panel mountings for the components. This receiver gives very satisfactory results, and would receive Broadcasting from Newcastle, Manchester, and Glasgow quite comfortably at your address.

EXPERIMENTERS.

The attention of the large number of readers who have sent us in questions regarding the construction





Slot 1. 100 turns, 40 s.w.g. S.S.C. wire; Slot 2. 100 turns, 40 s.w.g. S.S.C. wire; Slot 3. 100 turns, 40 s.w.g. S.S.C. wire; Slot 4. 100 turns, 40 s.w.g. S.S.C. wire; Slot 5. 150 turns, 40 s.w.g. S.S.C. wire; Slot 6. 150 turns, 40 s.w.g. S.S.C. wire; Slot 7. 250 turns, 40 s.w.g. S.S.C. wire; Slot 8. 250 turns, 40 s.w.g. S.S.C. wire.

Slots 1 and 2. 300 to 500 metres; Slots 1, 2, 3, 4. 500 to 1,100 metres; Slots 1, 2, 3, 4, 5, 6. 1,100 to 2,400 metres; Slots 1, 2, 3, 4, 5, 6, 7, 8. 2,400 to 4,000 metres and upwards.

of slot-wound H.F. transformers is directed to the diagram which shows, in conjunction with the text, how an eight-slot transformer is constructed.

H. F. B. (WESTCLIFF-ON-SEA) asks for the size of the 5 inductances shown on page 206 "MODERN WIRELESS," No. 3, for a wavelength of 400 metres.

Coil L1 should be 50 turns, L2 50 turns, L3 75 turns, L4 75 turns, L5 75 turns. L1 might also be 35 turns.

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