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Amateur Wireless And Electrics

No. 4 SATURDAY, JULY 1, 1922 Price 3d

THE "LAST POST" BEING SOUNDED IN MARCONI HOUSE AND RADIATED BY WIRELESS TELEPHONY. THE OCCASION WAS THE UNVEILING IN MARCONI HOUSE OF A ROLL OF HONOUR ERECTED IN MEMORY OF THOSE OF THE MARCONI STAFFS WHO FELL IN THE WAR.

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Amateur Wireless and Electrics

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Is Mars Trying to Communicate?

THE possibility of definite attempts at communication being made from other planets is so startling and captivating to the imagination that one is tempted to dwell on the conceivable results—to let the mind wander along a vista of fascinating "might-be's"—and to overlook the tremendous scientific improbability.

When one remembers that only thirty years ago the Philosopher's Stone—to take but one of many similar instances—the quest of the ancient alchemists, was regarded as an amusing dream of a bygone age, and that to-day nothing is surer than that the transmutation of the elements is an everyday occurrence, one hesitates to dismiss any idea, however startling, without careful thought.

People of Other Worlds.

What assumptions, then, have we to make in order to justify us in assuming that the ethereal disturbances which have given rise to so many conjectures are a definite attempt on the part of the inhabitants of some other planet to get into communication with us? Firstly, of course, that the other planets have intelligent beings of a similar or higher state of knowledge of natural philosophy than our own, who are sufficiently interested in our small fragment of the universe to wish to communicate with us, or who, while attempting to talk to some neighbours, are unwittingly being overheard by us. On the face of it this is at least possible, for there seems to be no reason why our planet should be unique in possessing inhabitants. Surely other globes thrown off by our own or some other sun have been through a similar cycle of development, which in due course has led to the evolution of life and ultimately of rational thinking beings. Whether such a one actually exists and is within speaking distance of us time alone can tell, but at least the possibility cannot be ruled out.

Having granted this premise, the next point is: Is there any limit set by natural laws, of which we are cognisant, which makes the thing possible? But here we must pause to remember that, far as our scientists have taken us along the path of knowledge, there are doubtless other and greater discoveries yet to be made. There may be some form of radiation, or even some medium, of which we at present

Readers will find this an opportune article in view of the fact that Senatore Marconi, who has recently crossed the Atlantic on the steam yacht "Elletra," is credited by the American Press with having stated that he would be at work all day Sunday, June 18th (the day when Mars came closest to the earth), in the hope of receiving wireless messages from the planet. The Senatore is reported to have said: "I listened practically all the time, day and night, for the fortnight of the voyage, and had instruments ready to receive from anybody. Several times I heard mysterious sounds, which I could not understand or explain, but I don't think they came from Mars; in fact, I am not certain whether the Martians are trying to communicate. But I was there to do everything possible to record any message sent. I shall continue to try to receive communications, however slight, on the chance of success."

know nothing, compared with which the ether of space is as poor an agent for the transmission of messages as a messenger boy. We propose to weigh the possibilities in the balance of our present knowledge as well as we are able, however, and leave this promising line of speculation for a rainy day during the summer holidays.

Is It Possible?

It would appear that there is no actual impossibility implied in the idea of interplanetary conversations. Given a transmitter sufficiently powerful and a receiver sufficiently sensitive, Nature having already supplied the medium—laid the wires right up to the house, so to speak—

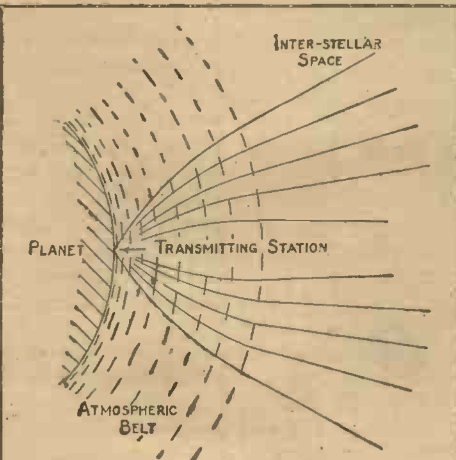


Diagram Showing the Probable Effect of the Atmosphere on Wireless Waves

there seems to be no reason why communication should not be established. The point where the first large element of doubt enters is when we come to consider what power and what sensitivity would be necessary.

As Mars is our nearest neighbour and is now passing as close to us as our respective orbits will allow, and as there seems to be some reasonable chance of its being inhabited, apart from the general considerations already mentioned, we might examine the possibilities of Mars being able to "ring us up."

Strange Phenomena

First, though, let us recall what has already happened in the way of engaging the attention of wireless men in the matter. "Signals," closely resembling certain letters in the Morse code, have been received simultaneously by stations as far apart as England and America. That they were practically simultaneously received is obviously no evidence as to their origin, as the time taken to traverse the Atlantic is only a fraction of a second. But they were of uniform intensity. This indicates either that their point of origin was somewhere on the earth on a longititude midway between that of the two stations, or that it was outside the earth altogether and a great distance away. Apparently no terrestial stations were responsible, so it seems highly probable that the latter alternative is correct.

There remain two possible explanations for the phenomenon even at that. Either it was—as most people will doubtless hope—a definite and intelligent attempt at communication, or it was some accidental ethereal disturbance, say, on the sun or other star. Knowing as we do how closely electronic disturbances are connected with other waves, and that sun-spots and the like frequently take place simultaneously with magnetic storms on the earth, we must not dismiss this second possibility too hastily.

Observation leads us to assume that the ether of space is perfectly elastic. This means that when a certain amount of energy is expended in producing vibrations none of it is frittered away as the waves pass onwards (as is the case with sound-waves in air). The only reason that their intensity decreases as they progress is that they always tend to spread out and so distribute their power over a larger area. It is only when associated with matter—as it is in the earth's atmosphere—that absorption takes place and some work is expended on the medium. If, then, we could produce a wave with either a straight or a converging front, and ensure that it keeps straight, we could transmit to any distance without limit and without losing intensity or strength.

In producing such a beam of waves the planet's atmosphere would be of some slight assistance in the manner illustrated on p. 63. The atmospheric belt would act somewhat as a convex lens and tend to refract or bend the waves, owing to the lesser density of the outer layer. However, this belt only exists for a small fraction of the distance the wave has to traverse. Even supposing the transmitting aerial could be so arranged that a parallel or only slightly divergent beam of waves was initially produced, the tendency to spread out into spherical waves would come into play immediately it left the transmitter.

Waves of short length would be most suitable for such a beam, as they do not tend to spread out and form a spherical front so much as larger ones. On the other hand, short waves spend themselves much more rapidly in passing through planetary atmospheres.

Only 2,000,000 Horse-power!

These two considerations would lead us to expect that a medium wave-length would be adopted by our Martian friends. Yet the signals so far received have been of exceptionally great wave-length.

We may be able to form some idea of the power necessary and the difficulties which our planetary neighbours would have to face in their attempts to reach us by considering the same problem on the infinitely smaller scale on which it confronts us when we wish to transmit across the 2,000 odd miles separating Ireland and America.

The wave reaching the receiving station must be of sufficient intensity to cause a current of about 30 millionths of an ampere to flow in the aerial. To do this we must construct a transmitting station having an aerial capable of dealing with, roughly, 40 kilowatts and needing generators of about 100 h.p. Supposing Mars to be 40,000,000 miles away, or 20,000 times the width of the Atlantic, we begin to see how many super-power stations they would have to link up in order to reach us; for if it be assumed that the power required increases only as the first power of the distance, 2,000,000 horse-power would be required.

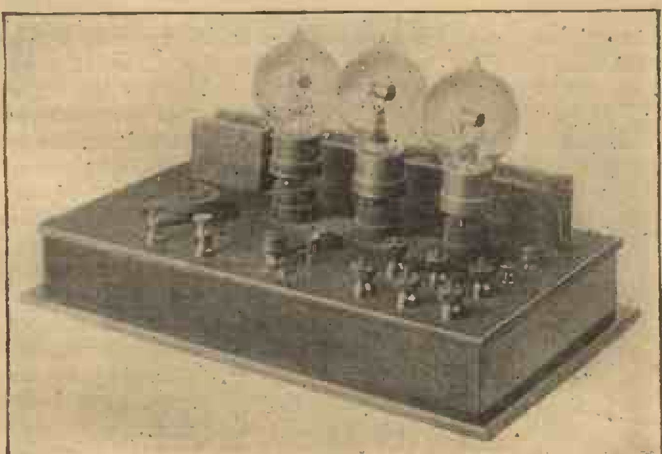
It may be objected that this is an unfair comparison, and the two cases are vitally different. It is true, as already mentioned, that in transmitting through the earth's atmosphere we have to contend with absorption, but then, on the other hand, reflection and refraction by the rarefied upper atmosphere assists us. The Martians, too, would probably be faced with much greater difficulties than we are in handling the necessarily high voltages, owing to the rarefied nature of their whole atmosphere.

S. W. G.

FAULTS IN VALVE CIRCUITS

FAULTS may be broadly divided into two classes: (*a*) noises; (*b*) failure of the set to give signals. The first-mentioned trouble is probably the more assertive, and it is with this class that this article chiefly deals.

When an amateur complains that he gets noises in the telephones he is almost invariably told that the cause is a bad high-tension battery. The writer has been troubled with noises from many sources but not yet from high-tension batteries. Of course, noises are often due to bad high-tension batteries, but more often to other causes. Common sources of trouble are: (1) telephones, (2) grid leak, (3) valves.



Example of Valve Panel with Three Valves

In tracing the cause of noise it is advisable to commence by testing the high-tension battery, either by trying it on another set or by trying another battery (known to be O.K.) on one's own set.

When the insulation of the telephone winding has deteriorated, as it will in high-resistance telephones used in valve circuits, loud crackling noises result. Telephones may be tested on another set or by comparison with another pair on one's own set.

The grid-leak is often a source of noise. Once the trouble has been traced to this it is easily remedied.

The noises may be due to bad contact between the element and the terminals, with the result that any vibration of the valve panel, or even the bench, produces noises which completely drown signals. The noises produced by a faulty grid-leak greatly resemble atmospherics, that is, sharp cracks followed by long-drawn-out rustling noises.

Valves may produce noises: (1) by the legs making bad contact in the sockets; (2) by uneven electron emission from the filament.

(1) The first cause results in noises when the valve or panel is tapped or vibrated, and may be remedied by splaying out the legs of the valve.

The second effect cannot be strictly called a noise. In a two-valve set, in which one valve is rectifier and the other is low-frequency amplifier, with the 'phones in the latter circuit, if the filament current of the amplifying valve is turned on nothing will be heard (except, possibly, a slight hum due to adjacent A.C. mains). When the filament current for the rectifying valve is turned on, however, a slight hissing sound is usually audible but which does not interfere with reception. This hissing is caused by uneven electron transmission from the filament. It is difficult to obtain a valve without this effect, but the slight hissing is negligible.

A good way of tracing the cause of noise is to make up a circuit consisting of valve, telephones and high-tension battery, the valve filament being lighted as usual. If there is no sound in the telephones the high-tension battery, telephones and valve are obviously all right, and the fault must be searched for elsewhere. Other causes are faulty low-frequency transformers and condensers!

Failure of the set to oscillate may be due to: (1) insufficient high-tension supply; (2) reaction coil leads reversed; (3) reaction coil too small; (4) aerial shorting to earth; (5) no by-pass condensers provided across telephones, high-tension battery, low-frequency transformer primaries, etc.

B. J. A.

A "Rigged-up" Transmitter and Receiver

An Easily Improvised Set for Amusement and Practice

ALTHOUGH the time is fast passing when the very elementary experiments in wireless will present any novelty, quite a lot of entertainment may be secured in the assembling and working of simple apparatus such as is described in this article, and which, as will be seen, requires the minimum of outlay and trouble to construct.

The Transmitter.—Commencing with the transmitter, Fig. 1 shows the mechanism of an electric bell which has been converted in such a manner as to be capable of propagating ether waves over a distance of some thirty yards.

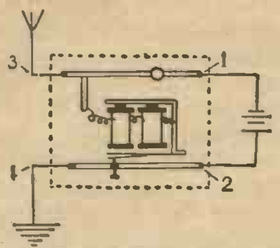


Fig. 3.—Diagram of Simple Transmitter.

The small casting carrying the electro magnets M should be removed bodily and mounted on a wood base measuring 6 in. long by 4½ in. wide. The striking knob and wire should be removed from the armature, which is then left as shown at A, Fig. 1. A bell should be chosen with fairly fine wire for the windings, as not only will this take less current from the battery, but it will have a greater inductive effect. The contact screw C S is removed from the dismantled bell and fixed in the position shown in Fig. 1. A strip of brass or copper is screwed on the base and holes drilled in it through which two terminals are screwed, as shown by 1 and 2, the contact C S being screwed through the third hole.

A sending key is made up as shown in Fig. 2, and serves the purpose of making and breaking the battery circuit operating the buzzer mechanism. It consists of two brass strips D and E, D being drilled to take the terminal 3 at one end and a small knob K, of wood or ebonite, at the other.

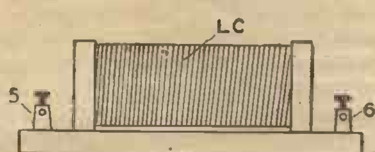


Fig. 4.—Loading Coil.

It will be noticed that the brass strip D is cut so as to form a lug F at right angles to its length. This serves the purpose of a connection for the end of the winding on the magnet M. The second strip E is shorter than the other and also carries a terminal, shown at 1. At the opposite end is a screw with the head filed flat to form a contact C, the screw on the knob K being treated in the same way. A small strip of paper may be gummed on the base, between the terminals 1 and 2, marked "battery," a second strip marked "aerial" being placed by terminal 4, and a third marked "earth" by terminal 3.

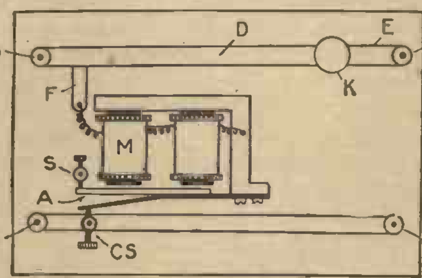


Fig. 1.—An Electric-bell Transmitter.

A small adjusting screw S is mounted on the base on the opposite side of the armature A to the contact screw C S. This screw S serves to limit the amount of play on the armature and also to prevent it sticking on the poles of the magnet.

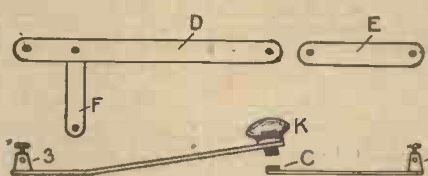


Fig. 2.—Sending Key.

A two-volt battery or accumulator is now required, and the transmitting set is complete, the electrical connections being shown in Fig. 3.

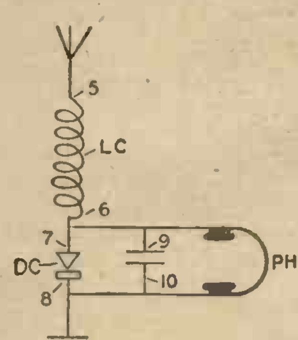


Fig. 7.—Diagram of Simple Receiving Circuit.

The Receiver.—The receiving station is a little more complicated than the transmitter, a reference to Figs. 4, 5, and 6 showing that the apparatus consists of the loading coil (Fig. 4), the detector (Fig. 5), and the telephone condenser (Fig. 6). The loading coil (Fig. 4) consists of a wood base on which is mounted the inductance L C, wound with one layer of No. 28 S.W.G. cotton-covered wire on a wooden bobbin measuring 2 in. diameter by 4½ in. long and thoroughly soaked in shellac varnish after winding.

The ends of the wire are secured to terminals at either end of the coil L C, marked 5 and 6 respectively. The detector (Fig. 5), consists of two essential parts, the crystal and the copper point, the latter being provided with a means of adjustment. The crystal is a standard galena element and may be purchased for 1s. 6d. mounted in a brass cup.

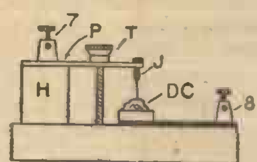


Fig. 5.—Detector.

The brass cup D C is mounted on the base, as shown in Fig. 5, and connected electrically with the terminal marked 8 by means of a brass strip as used in the transmitting set. A small block of ebonite or fibre H is mounted on the base as shown and carries a strip of springy phosphor bronze P, which is fixed to the block H by means of the terminal 7. A small hole is drilled in the spring strip P about half-way between the extreme end and the inside edge of the block H. A screw, either 4 or 6 B.A. thread, is screwed through the bottom of the base and passes through the hole in the spring strip P. A terminal nut T is screwed on about the the spring strip, as shown in Fig. 5, and serves to adjust its position within certain limits. A short length of No. 36 copper wire is soldered to a small screw J, which, in turn, is carefully soldered to the spring strip P. The copper wire should be arranged to just rest lightly on the surface of the galena D C, the fine adjustment being effected by means of the terminal nut T.

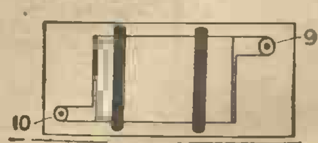


Fig. 6.—Telephone Condenser.

The telephone condenser is made up of

twenty-five small sheets of tinfoil measuring 1½ in. by ¾ in. with a small strip left at one corner to form a lug, as shown in Fig. 6. It is built up by placing the strips of tinfoil, with pieces of waxed paper in between, with the lugs alternately at one end and then at the other, as shown. It is most essential that the adjoining pieces of tinfoil do not touch each other electrically, and the waxed paper should therefore be cut larger all round than the tinfoil.

When the condenser has been built up the ends of the tinfoil should be carefully sealed together by means of a blob of solder, two pieces of cardboard being placed on either side of the condenser and a length of linen tape wound round to keep the whole together. The condenser should then be immersed in the melted paraffin wax and allowed to set in a solid block. It may then be mounted on a small wood base and the ends of the tinfoil plates connected to terminals 9 and 10. The condenser is mounted on the base by means of two strips of fibre sheet, which have holes drilled at each end to take small wood screws.

The only remaining portion of the set required is the telephone head-gear, and the reader must decide whether it will be best for him to purchase a head-gear ready made or rewind a pair of ordinary receivers himself.

Assuming that the reader has a pair of wireless receivers in his possession the receiving set should be connected up as shown in Fig. 7, the numbers on the connections corresponding to the numbers in the sketches, while P H represents the telephone head-gear.

It is a good plan to mount the whole instrument on a wood base or in a small wooden containing case, terminals being fitted to the outside for connection to the aerial and earth, as shown in Fig. 7.

To test the apparatus, the transmitting set should be taken out in the garden, the terminals marked 1 and 2 being connected to a battery or accumulator. The earth terminal 4 is connected to a short length of wire, the other end of which should be soldered to a piece of brass strip measuring 12 in. long by 2 in. wide. This serves as an earth connection, and should be buried in some moist earth.

The aerial is simply a 10-ft. length of bell wire, one end being connected to terminal 3, the other being joined to a short length of cord and suspended from a tree.

A similar aerial should be rigged up at the opposite end of the garden or some thirty yards away, connection being made to terminals 5 on the loading coil. The earth connection is made to terminal 8 on the detector, the remaining portions of the apparatus being wired up, as shown in Fig. 7.

The transmitting buzzer should now be adjusted, by depressing the key K and manipulating the screws S and C S until a high-pitched note is obtained. If the ground is damp and the aerial wire be touched with the bare hand a slight shock should be felt.

An assistant should now be obtained to operate the sending key K, while the receiving set is tuned up. The telephone receivers should be placed over the ears, the tension screw T on the detector rotated slightly to vary the pressure of the copper point on the crystal, and the clear note of the buzzer should then be heard clearly in the 'phones.

By the way, the lightest possible contact is all that is necessary for the detector, the most delicate contact giving the loudest signals.

The receiving set can now be moved farther and farther away from the transmitter until the results obtained get unduly faint. A. W. HULBERT.

Machine for Winding Honeycomb Coils

THE fiddling operation of winding honeycomb coils is reduced to a mere mechanical operation by means of the Lokap coil-winder, made by Mitchell's Electrical and Wireless, Limited, which imparts a neatness and precision to the convolutions of the coils entirely unattainable by hand methods (see Fig. 1).

The mechanical principle of the instrument is briefly that of a drum rotated through bevel reduction gearing by means of a cranked handle. The shaft to which the handle is attached carries an eccentric or cam. This cam actuates a feeding device or finger which guides the wire across the face of the drum on which the coil is being wound, and to ensure that the follower rod mantains contact with the cam a return compression spring is fitted to it. It is clear that a different cam is necessary for each width of coil, and a set of three cams is provided for this purpose.

Fig. 1.—Honeycomb Coil in Process of Winding

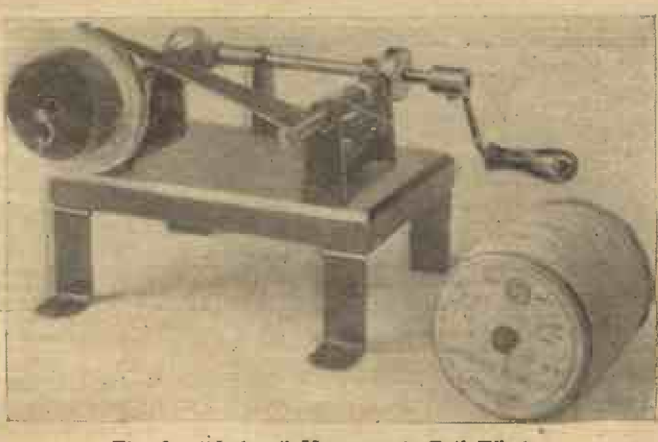


Fig. 2.—"Lokap" Honeycomb Coil Winder.

Fig. 2 shows the method of using this instrument. Having secured the machine to the bench, and arranged the bobbin of wire so that it may easily unwind when the drum is in motion, the end of the wire is passed through the eye of the feeding finger and secured to the pin on the drum. The fingers of the left hand should place a tension on the wire to avoid kinks and to lock each layer to the one beneath it. One finger of the left hand must also be pushed against the follower rod to make sure that "jumping" on the cam does not take place. Upon turning the handle it will be found that the wire is fed across the face much in the same way as cotton is fed across a bobbin on a sewing machine, except, of course, that the coils follow a wavy path.

When the coil has been wound to the size required, a blob of sealing-wax should be dropped on to the end of the wire and the end then cut off.

To remove the coil from the drum, pieces of twine are passed through the four slots in the face of the drum and tied round the coil. Unfasten the wire from the driving pin and slide the coil off. For safety, coils should be steeped in shellac and then dried.

LICENCES

AT present it is not possible to obtain the necessary licence for wireless receiving at the local post office. Before very long, however, it will be obtainable without much formality.

HOW THE "VALVE" WORKS.—II

By Means of the Water Analogy We Further Explain Its Action

IT may be objected that the water analogy used in the first article to illustrate the working of the three-electrode valve did not take account of some of the properties of the valve; for instance, the so-called

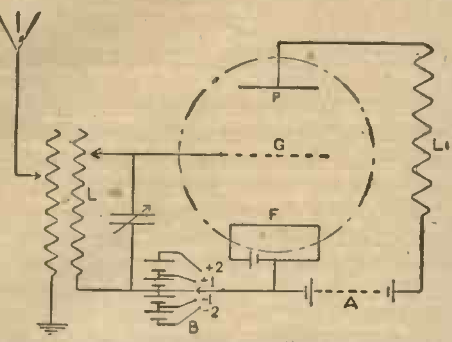


Fig. 2.—The Electrical Circuit for Amplification.

"space charge." This is, of course, true. It must be borne in mind, however, that an analogy, however useful it may prove in assisting us to take a first grasp of a complicated technical matter, has completed its purpose when that understanding is attained and should then be dropped. If we attempt to push the comparison too far we are more than likely to get confused or even erroneous impressions. When a man has obtained the necessary confidence in the water which it is the purpose of swimming floats to give him, he casts them aside as a hindrance rather than an assistance.

Three Important Functions.

Wherever we erect an aerial, signals passing in all directions immediately cause a number of high-frequency currents to rush up and down it, and if we wish to interpret them we must install apparatus to sift these currents out and reduce them to air-vibrations of audible frequency. The frequency of the currents is so high that even if they could be made to pass through a pair of telephone receivers at all they would be without effect on the diaphragm. The process of obtaining vibrations of speech-frequency from currents oscillating at radio-frequency is known as rectification, and the three-electrode valve may be made use of as a rectifier. Some of the high-frequency currents may be so weak as to fail to operate the receiving apparatus, however, and these must be magnified before use can be made of them. As an amplifier of weak currents, both of radio and of speech frequency, the valve has been found to be so well adapted as almost to revolutionise wireless in the last few years. In addition to this, it may be used as a generator of electric oscillations of almost any frequency.

Naturally such an adaptable piece of apparatus opens up a field of tremendous possibilities, and already there are many different ways in which it is being used either in its original simple form or in some development worked out to fit some special purpose.

The three important functions mentioned above may, perhaps, be very simply explained along lines similar to those adopted in the previous article.

Amplification.

In Fig. 1 the key X is so arranged that a brake is kept lightly pressing on a drum carried by the shaft of the small variable speed motor B. By raising or depressing the key the friction on the drum, and therefore the speed of the motor, may be increased or decreased at will. The key Y is attached to a vane inserted in the piping of the water circuit. The vane is hinged at the bottom of its container in such a way that the flow of water when circulating in the system tends to depress the key, but is just balanced by the spring. If the flow decreases, Y is raised by the spring, while if it increases Y is depressed by the increased pressure on the vane.

Let us set both motors running and adjust the speed of B by electrical means (not shown) until the fan G does not interfere with the flow of water across the valve. If now X is alternately, and very slightly, raised and lowered, the speed of the fan G will be decreased and increased in time with the alternations of pressure. This, by varying the rate of circulation of the water, will in turn raise and depress the key Y. Only very slight movement of X is needed to control the speed of G,

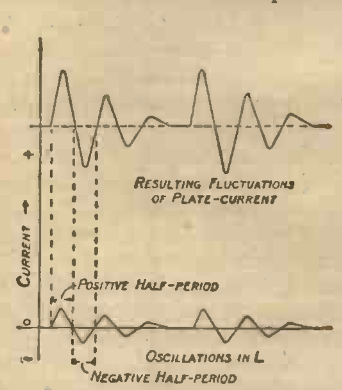


Fig. 3.—Diagram showing Current Fluctuations.

a movement many times smaller in extent and power than the resulting movement of Y.

It will be noted that the effort required to vary Y is drawn from the large motor A. This is an important point, and enables us, by making A sufficiently powerful, to reproduce the original alternations on a much larger scale and to operate instruments which those alternations would be incapable of doing if applied direct. So small, too, is the strength of the original effort required at X that it is very little exhausted, and the extent or amplitude of the variations is very little reduced when that effort is put forth.

In the equivalent electrical circuit shown in Fig. 2 the varying potential of the grid has the same effect on the flow of electrons as the varying speed of G has on the flow of water in Fig. 1. It is first set at such a value as will not affect that flow by means of the battery B. Subsequently it will be subject to slight variations above and below this value, imposed by the high-frequency currents oscillating in the inductance L. These faint oscillations will be faithfully reproduced on a much larger scale across the inductance L_1 in the plate circuit, the necessary additional energy being drawn from the plate battery A.

We may represent this process by the diagrams in Fig. 3, which also serve to

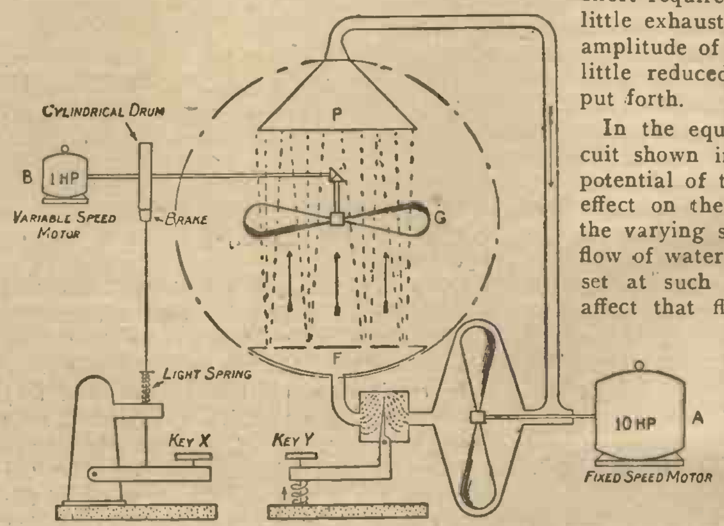


Fig. 1.—A Water Analogy of Amplification.

draw attention to the fact that, whereas the incoming currents are oscillating (that is, they flow one way round the circuit for half a period and then reverse and flow

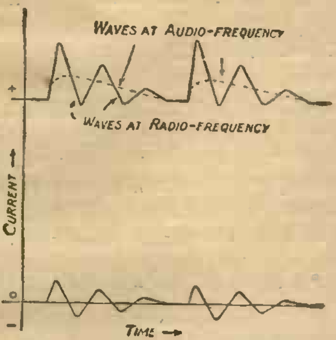


Fig. 4.—Effect of Rectification.

the other way for the next half period) the resulting fluctuations of the plate current are unidirectional.

Rectification.

Leaving A (Fig. 1) running as before, let us decrease the speed of B by its electrical control till G is only just revolving. With this adjustment any additional friction on the drum will stop the flow of water in the main circuit altogether, whereas a decrease of friction will increase that flow as before. Consequently only the positive halves of the alternations of pressure on the key X will be reproduced on the key Y. This is known as rectification, and is brought about in the electrical circuit in Fig. 2 by turning the selector switch till contact is made at -2 on battery B, just as in the case of the hydraulic analogy we reduced the speed of the fan G by means of the motor B.

The effect on incoming electrical oscillations is illustrated in Fig. 4. The essential difference between the resulting fluctuations in Figs. 3 and 4 is that, whereas in the former the average plate-current is practically constant and may be represented by the dotted straight line, in the latter it increases slightly for each train of values, as is shown by the curved dotted lines. Thus the incoming currents oscillating at radio-frequency are rectified into fluctuations of plate current at audio- or speech-frequency.

Reaction.

Having set our device running, as described under amplification, let us link up key Y mechanically with key X, so that when Y is depressed by an increase in the flow of water, X is depressed in turn by it. Thus the fluctuations in the main circuit react sympathetically on the control and render the model to a certain extent automatic. When once it has been set going it will continue to work indefinitely, the necessary energy being derived entirely from the motor A.

The electrical equivalent of the mechanical link between X and Y is the reaction coil L_2 in Fig. 5. This forms one winding of a transformer, L_3 being the other. Oscillations set up, say, in L_3 cause corresponding and magnified varia-

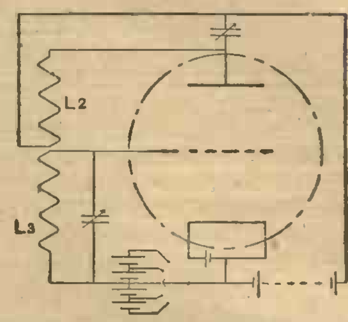


Fig. 5.—The Electrical Circuit for Reaction.

tions of the current in the plate circuit, of which L_2 forms a part. These in turn react on L_3, and so the whole circuit becomes the seat of a continuous oscillation, the plate battery supplying the requisite power. The applications of this principle, however, are beyond the scope of this article.

As mentioned in the first place, we cannot claim that the hydraulic analogy is a working model. It will have served its purpose none the less if it has enabled readers to form a conception of the fundamental principles underlying an extremely useful piece of apparatus. SIGMA.

The "Official" Receiving Set

ITS RANGE; SPECIAL SWITCHES; OTHER DETAILS.

A NUMBER of queries has been asked concerning the receiving range of the "official" receiving set described in the first number of "Amateur Wireless." It is impossible to state offhand what the range of a set will be, for there are different factors that govern the operation. Briefly these are as stated below:

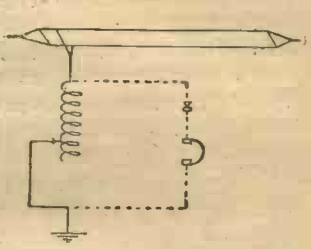


Fig. 1.—Diagram of Oscillating Circuit.

(1) The distance of the transmitting station and its direction.

(2) The power used by the station; this, of course, varies enormously.

(3) The height and length of the receiving aerial.

(4) The position of the receiving station. If it is on a hill or a level plain, and is not sheltered by trees or neighbouring houses, these conditions confer great advantages.

(5) The efficiency of the receiving set. This depends on (*a*) good insulation, (*b*) proper adjustment of detector, and (*c*) good telephones.

The only sound answer one can give is: Erect a set and discover for yourself what the range is. The knowledge that will be gained by experimenting will always be of value.

One or two correspondents have had difficulty in understanding the operation of the tens and units switch on the tuning inductance. In order that signals may be received, it must be remembered that the receiving set shall be in "tune" with the vibrations in the ether set up by the transmitting station. Assuming that the reader has a grasp of the meaning of the terms "inductance" and "capacity," which have been explained in the elementary articles that have appeared, he will know that to tune in stations of different wavelengths either the inductance or capacity, or both, of the oscillating circuit (see Fig. 1) must be altered. The method adopted in a simple set is to vary the inductance.

Now inductance necessitates a length of wire, preferably in the form of turns; two turns, provided they are close together, give four times the inductance of one turn; three turns give nine times the inductance, and so on. Also the inductance increases in proportion to the

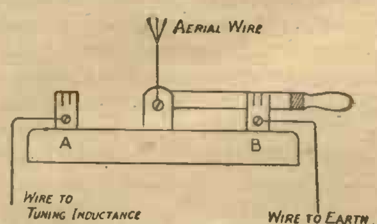


Fig. 2.—Details of Lightning Switch and Connections.

square of the diameter of the turns in the same way. By having, say, 100 turns of wire in a former (each turn being close to its neighbour but well insulated from it), and having a slider, we can vary the inductance over a wide range, increasing by a single turn at a time. The slider has certain disadvantages. It wears the wire by constant rubbing and is liable to short circuit two or more turns, which will waste some of the energy. In order to overcome these objections, and also to make an inductance suitable for panel mounting, the turns are brought out to two switches, one called the "tens switch" and the other the "units." Each stud on the tens switch has ten complete turns connected to it, so that by moving the knob of this switch the inductance is varied by comparatively large amounts at a time. To tune more closely the units switch is used, ten studs being connected to the last ten turns on the coil.

By using both switches together it is possible to include any number of turns varying from one to the greatest number on the coil.

The lightning switch is shown enlarged by Fig. 2. A single-pole change-over switch is used. The aerial wire is connected to the arm. The lead to the tuning inductance is connected to A and the earth wire to B. When the set is in use the switch should be over to the left (A), and when out of use it should be over to the right (B), thus earthing the aerial.

ELECTRICAL BENCHWORK SIMPLE SOLDERING

THE simple operation of soft soldering enters largely into the construction of wireless apparatus, and this article explains how it is done. It is only necessary to follow one or two simple rules, and anybody can do it straight away. There is no need to bother with the theory of the subject.

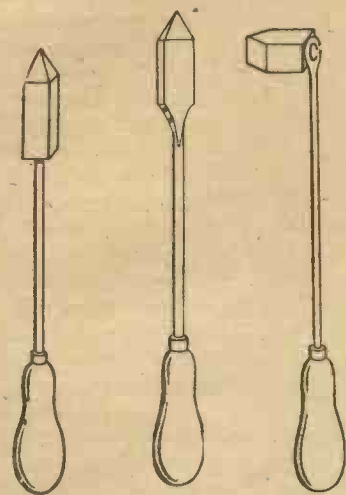


Fig. 1 Fig. 2 Fig. 3

Figs. 1 to 3.—Three Types of Soldering Bits.

Tools.

Nothing much in the way of tools is required; a soldering-bit and an old pocket-knife are all that are necessary, and as there are no large pieces to be soldered a small bit can be used; mine weighs about 3 oz., and with this size several joints can be made with one heat. For getting in awkward places a hatchet bit will be handy, but most jobs can be done with any of the bits shown by Figs. 1 to 3. I use the old pocket-knife for scraping the parts bright and clean, because solder won't "take" on greasy or dirty metal. A scraper can also be used for this purpose. A piece of clean tinplate for use in retinning the bit should always be handy.

Flux.

A flux is necessary when soldering to make the metal chemically clean and also to cause the solder to "flow" well into the joint. Spirits of salts is the best flux, but it cannot be used in electrical work because it corrodes quickly, and, moreover, any spilt on the ebonite or wood will partially destroy their insulating properties. You will find resin a safe flux, but Fluxite may be used. Resin should be powdered and sprinkled on the article.

Solder.

Any very soft solder will do. I always use blowpipe solder because it melts at such a low temperature, and there is thus less risk of melting the shellac, etc., or charring the wood or other parts of the work. It is quite strong enough for the purpose. Certain combined solders and fluxes are on the market; and these are just as good.

Heating the Bit.

The bits may be heated in the kitchen fire, or, if the bit is quite small, even on a gas-ring. A gas-iron makes an ideal stove for heating the bit. The bit must not be allowed to get red hot, because the copper burns away as well as the tinned face. With a little experience you will be able to judge the correct heat.

Tinning the Bit

Before we can actually solder it will be necessary to tin the faces of the bit. This only takes a minute or so, and it is effected by heating the bit to the temperature at which it will be used, filing the faces bright, and then melting a bead of solder on to a piece of bright tinplate on which some flux has been spread, and rubbing each face of the bit on the tin so that a film of solder is spread on them.

Some Examples.

Suppose you want to solder the ends of two pieces of wire together, all that it is necessary to do is to scrape the ends with a knife (even new wire must be so cleaned), and twist the ends together as shown in Fig. 4. Sometimes the ends are bound together with fine wire, as shown at A (Fig. 5), but this method is rarely, if ever, adopted with instruments. Another method rarely used and not generally adopted is as shown at B, which is self-explanatory. When the joint is twisted up simply spread some flux on it, heat the bit, and melt a little solder on to the joint. Then "draw" the solder through and round the joint by keeping it pressed on to the work for a second or so..

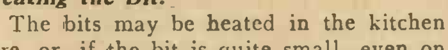


Fig. 4.—Simple Twisted Joint.

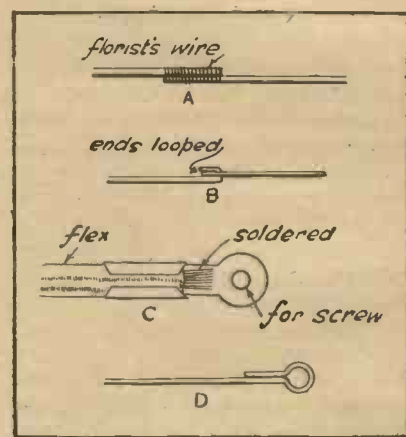


Fig. 5.—Various Joints and Terminals.

I always like any terminal connection to look neat, and instead of just twisting the wire round the contact screw I make up terminal ends as shown in C (Fig. 5). They are easily cut out of flat copper of about 26 gauge and bent to encircle the flex; the end is, of course, stripped of insulation and the wires scraped bright with a pocket-knife. These ends are then soldered to the flat part of the terminal, as shown. Plain wires may have terminals formed on them as shown by D (Fig. 5).

To solder the edges of two sheets of metal together, each of the contacting edges must be tinned. If the edges are to overlap for 3/8 in., the edge must be tinned for 3/8 in. This is done by cleaning the edges with emery cloth, spreading flux along them, and melting a blob of solder on to the point of the bit. This is then rubbed up and down the edges until a thin film of solder is spread along it. Having tinned both edges, they are fluxed and pressed together with the heated soldering-bit, when the solder will "sweat" through and make the joint.

ERECTING AN AERIAL

Fig. 5.—Photograph showing Aerial Described in this Article.

EVERYBODY now is putting up aerials, and if everybody demands fir poles there will not be enough fir poles available for immediate needs.

The writer has used and advocated something cheaper, lighter, and easier, and the photographs show that the height doesn't suffer; in fact, a 35-ft. length of 2 in. by 2 in. is longer than the usual fir pole, and is also considerably easier to erect.

The Wood to Use.

First of all with regard to the wood: Go to a timberyard and ask to see some long lengths of 2 in. by 2 in. wood without knots. Explain what you want it for and why knots are not desirable.

Pick out your piece of wood, but be careful to see that the knots are very few, very small, and that none of them comes on the corners. Plane it up, or get it planed just enough to get it smooth and take off the sharp edges. Give three coats of good paint, and you will have a cheap and durable pole.

Twenty-five to thirty feet in length is all you are likely to get in one good piece, so if you want a greater length two pieces must be joined. This unfortunately cannot be done by placing two ends together and gluing them. You will want about 3 ft. overlap, and two 3/8-in. bolts to bolt the two lengths together, as shown in the sketch, Fig. 1.

What looks particularly swagger up in the air is to plane off the edges of the top length gradually from bottom to top till the top is octagonal, that is, all the eight sides you have made are of equal width. This gives it a graceful taper, makes it lighter at the top, and does not much reduce the strength.

If you are setting this in the ground, don't put it in the ground, to use an Irishism. Make a tabernacle, as it is called. Any well-appointed flagstaff will show what that is, but in case such a thing is not in sight, it consists of three thick planks of hard wood fastened together to form a box without ends. Bury this half-way down in an upright position, and bolt the pole into the part which rises above the ground, keeping a clear 6 in. away from the surface of the soil with the foot of your pole (see Fig. 2).

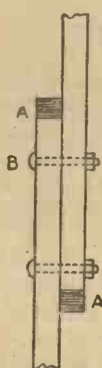


Fig. 1.—Method of Joining Masts.

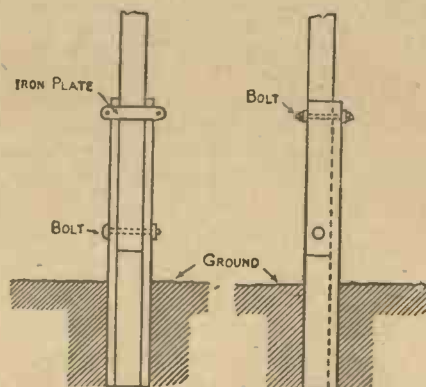


Fig. 2.—Mast in "Tabernacle" on Ground.

If your pole is to go into a wall or a chimney you make your tabernacle of iron and cement; that is all the difference, and the photograph (Fig. 3) shows an example of this construction. As it was original, so far as the writer is concerned, and has stood the test of time, he proposes to describe how it is done.

Other Materials.

The materials must be good portland cement and the best washed builders' sand. The cement should not be too new and fiery, and certainly not too old and partly slaked. The sand should be "sharp," that is, gritty, clean and sharp to the touch, and not powdery and dusty when dry.

Take equal parts of cement and sand and mix them intimately while quite dry, that is, so that no streak of sand or streak of cement shows if the heap is cut into anywhere. Builders say, turn it completely over three times dry (perhaps if I say, shuffle the cards three times dry I shall be understood); moisten sparingly and gradually with cold water, mixing the while and only giving enough water to make it cling together—the less water the better, so long as it just keeps from crumbling. In this stage it should get two or three times as much mixing as it had before the water was added. As you take away a supply from the heap beat it up again; it can hardly get too much of this treatment.

Thoroughly wet the wall that you are going to work upon. Take a length of wood very slightly larger than the pole at the foot, and tack oiled paper, American cloth, or even thin roofing felt, closely down on to it so that it will not draw moisture from the cement when it is being plastered in. This piece of wood is the "pattern" of the foot of the pole, and then when the cement is set it is to be removed and leave a place for the pole to be set in.

Fasten this wooden block on to the wall in the exact position that the bottom of the pole is to occupy when erected. Take great care that it is perfectly upright all round. The block of wood should carry a bolt, the latter well greased to prevent the cement sticking to it, and threaded through it near its end where its counterpart, the pole, will be hinged, so that when the bolt is withdrawn from the block and inserted into the pole in position, the weight of the pole will come upon the bolt and be held by the cement tabernacle.

Small Insulator.

Several dozen 9-in. nails should be worked into the brickwork of the wall on each side of the wooden block and lubricated, so to speak, or, in technical language, grouted in, with some of the cement mixture, so that, rather than force the bricks apart when weight comes upon them, the cemented nails will tend to hold them together more firmly when set. Keep the work well wetted all the time, so as to wash the cement between the bricks (see Fig. 4).

Get some stout iron wire, galvanised or plain will do, and interweave it in any pattern in and out amongst the nails, which should only project from the wall far enough to be flush with the front of the pole when in position.

Take the cement mortar and work it in amongst the nails and wirework and the wetted wall till it is a solid mass, and trowel it off so that it is level with the front of the dummy pole. Make the

BY THE "TABERNACLE" METHOD

cement wall thicker at the bottom where it will carry the long bolt and have to support the weight of the pole. Be careful not to get the cement in front of the pole, or you will not be able to take the dummy out and fix the permanent one in. When this stage is finished you must leave it alone for at least fourteen days—a month is better—cover it up so that neither sun nor frost can get at it, though rain and moist air will do no damage.

Two bolts, "rag bolts" for preference, should be set well into the wall and the cement, near the top of the tabernacle, so that an iron strap may be bolted over the pole to secure it when in position.

Staying the Mast.

The photograph (Fig. 5) shows a 30-ft. pole 2 in. by 2 in. with a small 18-ft. fir pole bolted to the top. Make a lead or zinc cup to put over the top of the pole to keep the wet out. You have already given the pole three coats of paint. Get a well-made galvanised iron pulley block with as large a pulley as possible —3 in. in diameter is not too large—so that the halyard shall not be strained round too small an arc. Wire it firmly to the top of the pole with stout soft copper wire, but not so tightly that it cannot accommodate itself to the strain when the halyard pulls the aerial up tight. Now attach stays at every 15 ft. all the way up, four stays at each point. Two or three turns of thick soft copper wire round the pole will do to secure the stays, and then, if there is a chance of them slipping, a small tack or staple will make them secure.

Shell Insulator.

No. 16, 18, or even 20 S.W.G. bronze wire will be quite heavy enough to hold against any strain, and will not rust as might galvanised-iron wire. Be careful not to "kink" the wire or it will break. If a little more expense is not objected to, the top stays, particularly the one which sets against the pull of the aerial, may be stranded with a carpenter's brace from three lengths of single stay wire. To do this measure off, say, 10 per cent. more than the length the stay is to be and fasten one end of these wires to a nail. Now run the three wires parallel and with the same tension on them in a straight line. The free ends should now be bunched together and screwed up in the chuck of a carpenter's brace and twisted together while a fair tension is kept on the wires. If this is done carefully and the twisting slightly overdone, it will untwist a little on being released, but exhibit no further tendency to come undone. Four stays—back, front, and each side—should be provided.

Draw the pole to scale on a sheet of paper and measure along the base line the distance to the anchorage of the stays. This will give the length of the latter to scale.

Anchorage.

All sorts of devices are recommended for anchorage for stays, but in London and most big towns it is very unlikely that a convenient fencepost or garden wall will not present itself. In the case illustrated all the stays are attached to the house, except the long one in front, which takes the strain against the aerial and is made off on to an old tree stump. A hard-wood stake driven into the ground à la tent-peg will take a lot of beating.

It is the writer's opinion that a 100-ft. single-wire aerial is the best to use. Short spans may make a double aerial desirable, but a spreader thrashing about in a gale might do damage. If you use rope halyards hang a weight at one end so as to keep the aerial taut and yet permit the wet rope to contract without endangering the structure. GAMMA.

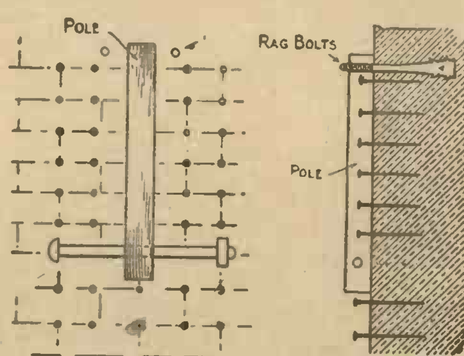


Fig. 4.—Method of Making Tabernacle on Wall.

Materials for the Erection of Aerials.

Wood for Mast.—(*a*) Ash, (*b*) fir, (*c*) bamboo.

Spreaders.—(*a*) Ash, (*b*) bamboo.

Aerial and Lead-in Wires.—(*a*) Stranded phosphor-bronze, say three to seven strands of No. 20 gauge; (*b*) stranded copper wire; (*c*) No. 14 to 18 gauge single phosphor-bronze or copper wire.

Aerial "Don'ts"

DON'T run your aerial over a public highway; you will probably have to take it down.

Don't allow it to cross overhead wires; there is always a risk of its falling on to them, with perhaps disastrous results.

Don't neglect to include a lightning protector or an earthing switch that will put the earial to earth.

Don't forget that the insulation of the aerial is one of the most important points if efficiency is desired.

Don't use insulators that are unnecessarily heavy.

Don't use any common bit of rope to support the ends of the aerial.

Don't omit to make some provision for the contraction of the aerial ropes that will take place in wet weather.

Don't forget that soot on an insulator makes an excellent conductor and that the efficiency of the set will suffer as a consequence.

Don't contemplate using a frame aerial if you only have a crystal receiving set.

Don't try to economise by using a thin wire for the aerial.

Don't omit to clean the insulators occasionally, especially if the installation is near the sea or in a smoky atmosphere.

Don't forget that the earth connection is an important adjunct to the aerial.

Don't use very light supporting masts; they bend too easily.

Insulators.—Porcelain or ebonite. Quite good results are obtainable with insulators made of hard wood soaked in melted paraffin wax.

Mast Stays.—Galvanised-iron or steel wire, stranded or single.

Leading-in Insulator.—Ebonite.

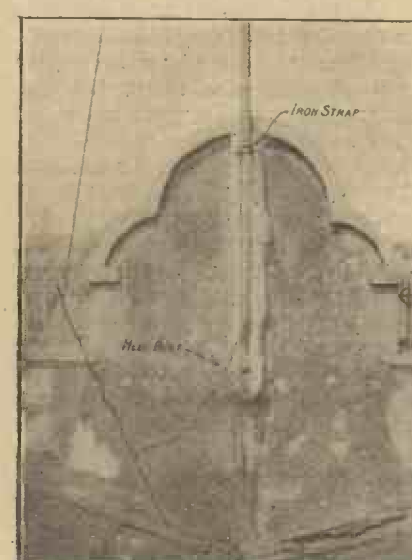


Fig. 3.—Photograph of Mast in Tabernacle on Wall.

PROBLEMS YET TO BE SOLVED

Captain J. Hollingworth, M.A., indicates in this article what great fields of investigation still remain for the wireless experimenter

IT would probably not be far wrong to describe the difference between an engineer and a layman by saying that the latter is one who is aggrieved when a piece of apparatus does not work, whereas the former is agreeably surprised when it does. Instances of this could be multiplied from any of our present-day mechanical aids to civilisation, partly, no doubt, due to a flattering belief in the omnipotence of the "expert," but much more to a lack of appreciation of the complex problems involved. Even among technical men themselves, the field covered by their individual experiences can only be so small that they do not always fully appreciate the problems confronting their colleagues.

In a comparatively young subject like wireless telegraphy such ideas are very prevalent; in fact, when discussing wireless work with non-technical people I have heard the opinion expressed that since it is now commercially possible to send messages by wireless, what is there in the subject to bother about further? Of course, even the barest acquaintance with this fascinating subject soon dispels such ideas, but even then it is difficult for anybody who is not devoting his whole time to it to appreciate the magnitude of the problems still awaiting solution.

Leeway To be Made up

Wireless telegraphy (including, of course, telephony), besides being a youthful subject, has, due to outside circumstances, had rather an abnormal adolescence. Its prime importance during the war caused a forced development, in which the principal object was the production of sets which worked rather than the investigation of underlying principles, the latter only being touched where essential to the former. Consequently there is now a considerable leeway to be made up on the theoretical side, or, in other words, the reduction of the whole subject to a systematic form. Conditions very much resemble the early days of electrical engineering before the theory of magnetic and electric circuits was fully understood, and when the chief object of each maker of dynamos appeared to be to produce something as unlike any of his competitors' machines as possible.

Broadly speaking, an important problem of modern wireless is to reduce the subject to systematic and numerical form and eliminate as far as possible the "trial and error" factor. Here we are at once met by two difficulties. The first is that our fundamental principles are not in all cases fully and accurately defined. The electron theory has been of enormous and vital importance, but there are many points, especially in the operation of a valve, not yet answered. The problem of radiation through space and the effects of absorption and reflection are not yet understood.

Complexity

The second general problem is one of complexity. Unlike ordinary electrical practice, in which in most cases a definite circuit with only one degree of freedom is being dealt with, practically all wireless problems are three-dimensional, and as such lead to the most elaborate mathematical treatment. Simplification, adopted to abbreviate the mathematical work, often leads to results so different from practice as to be nearly worthless. To take an example, the "simple oscillating circuit," as generally dealt with, is supposed to consist of a "pure inductance," a "non-inductive resistance," and a "pure capacity" all in series. In this form it yields to very simple analysis. But, as anybody who has actually dealt with such circuits knows, the inductance possesses both self-capacity and resistance, the resistance possesses inductance and capacity, and so on. The behaviour of the circuit is also influenced by the proximity of other circuits, by the earthing effects and many such details. So that while the simple circuit provides a fair description of the action taking place, any effort to base numerical results on it may easily lead to errors.

Overall Efficiency

Another problem is that of overall efficiency. In a big transmitting station we think nothing of plant of several hundred kilowatts capacity, and are quite satisfied to receive at the far end about one millionth part of a watt. Compared with this, the steam engineer with his boiler losses, his condensation losses and his other losses, usually considered so serious, appears a genius. A large amount of the loss in wireless work is, of course, inevitable from the nature of the case, but not all. A considerable porton of the energy produced is used up in heating the transmitting inductance, the aerial stays and masts (if of metal) and the ground in the immediate neighbourhood. The last-named is now being tackled by the use of the counterpoise earth, a frame of wires stretched under the aerial; since it is now concluded that the majority of earthing losses are due to eddy currents surrounding the feet of the lines of force, rather than to anything of a purely ohmic nature at the earth plates.

High-frequency resistance is another big problem. It is not generally known that an inductance, especially a multi-layer one, may easily have a high-frequency resistance of twenty times its continuous-current resistance.

"Harmonics"

Two problems brought home very strongly to the amateur are "jamming" and "harmonics." About the former there is no need to say anything; the latter is yet another reminder of the fact that the aerial circuit is not a simple one, but that it contains inductance and capacity distributed throughout its length in varying degrees. Such a circuit, when excited, may respond not only to the harmonics of the exciting source, but also to the free periods of various sections of itself.

As soon as the energy gets into the ether, it passes more from our control. Even if we knew, which we do not, the factors governing absorption and reflection, it is difficult to see how we could control them. It is generally held that the electrical state of the upper layers of the atmosphere have a great bearing on these points, and, as we cannot get up there to investigate them directly, it has to be done in an indirect manner. One such method, now being employed, is to investigate the abnormal variations sometimes occurring in directional wireless telegraphy, and, if possible, to deduce from these the nature of the electrical state in the upper atmosphere capable of producing results like those actually observed. We have to deal with the ether as it is, not as we should like it to be, and must hope that, even if we cannot control the ether, we may be able to foretell its effect. Atmospherics, X's, or strays present another big problem now being attacked.

Problems at the Receiving End

At the receiving end, the problems again become more of an instrumental nature, and are concerned with the design of efficient receivers and amplifiers. Here, probably the chief enemy is stray capacity. With the enormous frequencies used in radio work the smallest capacity imaginable makes itself felt; a mere rearrangement of the apparatus is often enough to change completely the working. Mathematical treatment is here of little help, and one can only fall back on experience. It is, in fact, a moot point how much of the energy of a radio-frequency transformer is transferred from the primary to the secondary electro-magnetically and how much by capacity coupling.

In valves themselves, grid current is a

potent source of trouble. If, as suggested in many text-books, the grid current be actually reduced to zero by making the grid sufficiently negative with regard to the filament, the valve generally stops working altogether. It is one of the reasons why the actual amplifying power of an amplifier is frequently not more than 1 per cent. of its amplification deduced from simple theoretical grounds. Although the losses in a valve may be microscopic, the power available in the aerial is correspondingly small, and none must be wasted.

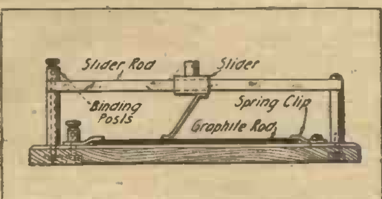
In wireless telephony there appears again the fundamental telephonic problem, namely, the undistorted transmission and reception of the highly complex forms of speech waves. It also causes somewhat greater jamming than telegraphy, owing to the high damping of the oscillations forming the carrier waves of the speech. For this reason short waves are the most suitable for telephonic purposes.

Instances of smaller problems connected with the pure technique of the subject could be multiplied almost indefinitely, but while extremely interesting and important to those who are daily "up against" them, they do not possess the same importance for people concerned with the more general lines of the subject. Detailed description of them is also very lengthy. Reviewing the subject as a whole, one cannot but be led to the opinion that a vast amount of work lies in the consolidation of the ground gained, and this will elucidate many outstanding problems. J. H.

SOME AMERICAN IDEAS

A Non-inductive Potentiometer

A NON-INDUCTIVE potentiometer may be simply constructed in the manner shown in the accompanying illustration. The base is a neat piece of hard wood approximately 12 in. by 2 in. by 2½ in. The slider rod is made from a piece of ¼-in. square brass rod, and is 10 in. in length. Holes are drilled near each end so that brass screws will pass through, as shown. Two pieces of square ¼-in. brass tube, each 1 in. long, are used as the supports for the slider rod, as



A Non-inductive Potentiometer.

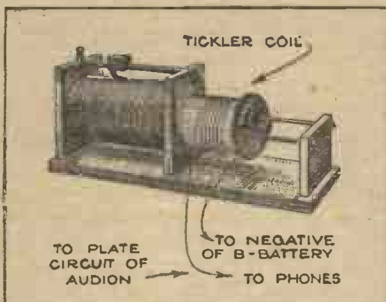
shown. The resistance rod is a piece of graphite obtained by soaking a 4H drawing pencil in hot water to loosen the glue and removing the wood protection. Two small spring clips hold the graphite rod securely in place under the slider rod. A slider is made in the usual way.—*Radio News.*

A New Indoor Aerial

ACCORDING to Walter G. Voss in *Radio News* a simple substitute for those amateurs who are unable to erect a suitable aerial is simply to connect a wire to one of the terminals of the door bell. This, he states, provides an aerial extending through the house which really gives results.

Increasing Loose-coupler Efficiency

THE efficiency of the familiar loose coupler can be increased measurably by a simple dodge. Wind some No. 28 or No. 30 gauge wire into a coil sufficiently large to fit loosely over the secondary of the coupler, as indicated in the drawing.

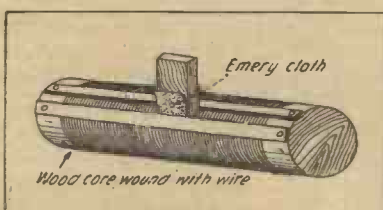


Increasing Loose-coupler Efficiency.

The number of turns can best be determined by experiment. Connect the ends of the coil to the plate circuit of the valve, one wire to the negative pole of the high-tension battery, and the other to the receivers. Application of this idea to the loose coupler really turns it into an inductive regenerative set.—*Popular Mechanics.*

Tuning Coil Hints

To remove the insulation from the wire fasten two laths on one side of the tuning coil, spaced ½ in. apart, and scrape the



Tuning Coil Hints.

insulation away by rubbing a wooden block covered with emery-cloth up and down in the groove formed between the two laths.—*Radio News.*

Starting Wireless.—IV

The Receiving Circuit.

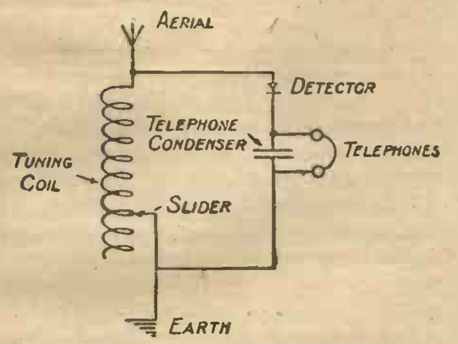
FOR the moment let us assume that our aerial has been erected and the earth connection made. We can connect up our tuning device. The simplest form of tuner consists of a single-slide tuning inductance as shown on p. 74. It will be noticed that the slider end of the coil is connected to the earth. This is a most important point, because when only a portion of the coil is in use the unused part should always be left nearest the earth end rather than the aerial end of the circuit.

We will remember that when we tune in a signal we find that a very rapid alternating potential is set up across the inductance. However, this is not continuous when it is produced by a spark station or telephony, and, therefore, we found that if we rectified this alternating potential and passed this energy on to a telephone receiver and obtained an audible note.

As previously mentioned, one method of detecting or rectifying this potential is by the use of a crystal detector. Perhaps the simplest type is the Perikon Detector, which consists of two crystals, a piece of zincite and a piece of bornite or copper pyrites. Each crystal is mounted in a small metal cup by means of solder or Wood's Metal. One cup is fixed and the other is movable, so that the pressure between the crystals can be varied. The crystals are only sensitive at certain pressures, and therefore before it is possible to receive a signal the detector must be in a sensitive condition.

The telephones are connected in series with the detector, both being shunted across the active portion of the tuning coil (see p. 74). It will be noticed that a condenser is shown connected across the telephones. This is not really an essential, but it is a great improvement. It is usually known as a telephone or blocking condenser; we may best understand its action by considering it as a kind of reservoir which stores up electricity during a signal. The condenser is usually made of either alternate sheets of tinfoil and paper or copper foil and mica.

The telephones are the only component of the receiver not yet considered. Telephones for use with a crystal detector should be of the high-resistance type. A very good value for general use is 4,000 ohms, but higher values may be used if desired. Results will be very poor if the value is much lower than about 2,000 ohms. High-resistance telephones are more expensive than those of lower values, and they are usually more delicate. As an alternative to high-resistance telephones, those of lower value may be used if they are connected through a transformer. A very usual value is 120



Connections of Simple Receiver.

ohms connected to a suitably designed telephone transformer, the high-resistance winding of which is connected in the position usually occupied by the high-resistance telephones.

Adjusting the Detector.

A detector is usually adjusted by a testing buzzer. This is exactly like an electric bell with the hammer removed. Any ordinary buzzer will answer the purpose, but it is much nicer to use one giving a very high note, that is, one with a very small and light armature. The buzzer is connected to a battery and put some distance from the receiver, preferably near the earth lead. The telephones are then put on and the slider is moved to the bottom of the coil so that nearly all the coil is in circuit. The pressure between the crystals is varied until the note of the buzzer is heard in the telephones. The buzzer is switched off, and everything is then ready for receiving signals. These are tuned in by simply moving the sliding contact up and down the coil. When a signal is properly tuned in it is advisable to readjust the crystal detector, as sometimes a slight alteration will give a louder note than would be obtained with a buzzer on that setting. PAUL D. TYERS.

Choosing Your Amplifier

AMATEURS are frequently at a loss to decide what kind of an amplifier they shall use. They may have had some experience with crystal or single-valve working and wish to have louder signals, or they may be beginners who are puzzled by the variety of apparatus offered for sale.

Three kinds of amplifiers are in common use—low-frequency, high-frequency, and resistance—and very often these are combined in a single receiver.

Low-frequency.

A low-frequency amplifier entails the use of an iron-cored transformer for each stage of amplification, and is only of use in a circuit after the received aerial current has been rectified either by a crystal or a valve. Its main advantage is that a single transformer is suitable for all wavelengths; adjustment of the apparatus is thus fairly simple. If the rectified received current is weak, a L.F. amplifier is not very advantageous; loud signals are magnified more (proportionately) than weak ones. Also a L.F. amplifier has a tendency to pick up stray outside noises—both electrical and mechanical. No one living near an electric tramway, or railway, or near a road over which there is much heavy traffic, should use a L.F. amplifier

High-frequency.

A high-frequency amplifier is used to magnify the received current before it is rectified. It does not pick up stray electrical disturbances unless the latter are of high frequency, such as those caused by your neighbour's valve receiver when it is oscillating. The great disadvantage with H.F. amplification is that it only works over the comparatively small band of wavelengths for which the air-core transformer is designed. This trouble can be overcome by having the transformer windings tapped and the tappings taken from the switch, the latter being varied to suit the wave lengths being received. A better method is to have a separate transformer for each band of wave-lengths and plug in the one required.

Resistance.

The resistance amplifier is used like a H.F. amplifier for magnifying the received current before it is rectified. It is very useful because it is suitable for all wavelengths over about 1,000 metres. It almost equals the L.F. amplifier in simplicity of adjustment.

A very good combination for long waves is a three-valve receiver having one resistance amplifier, one detector, and one L.F. amplifier. Probably the best and simplest single-valve amplifier to add to an existing crystal or valve receiver is the L.F., providing the disadvantages mentioned are not experienced.

For the enthusiastic instrument-maker and experimenter the H.F. amplifier will undoubtedly prove the most interesting. L. A. W.

"Marconi House 2LO Speaking!"

HULLO! Hullo! Hullo! Marconi House 2LO speaking. Hullo! Caxton Hall! Hullo! 2BP. Marconi House speaking. I have here a message from the Archbishop of Canterbury to the Bishop of Willesden for transmission by wireless telephony from Marconi House to Caxton Hall on the occasion of the Actors' Church Union annual fête in aid of the children of travelling actors. The message is as follows:

MY DEAR BISHOP,—Please convey the warmest expression of my goodwill for your efforts, and my hopes that, by the blessing of Almighty God, they may be abundantly fruitful.

Hullo, Caxton Hall! Marconi House speaking. We now propose to give you a few musical items. The first is a 'cello solo, by W. H. Squire.

[*Here followed a remarkably clear gramophone record of W. H. Squire's solo.*]

Hullo, Caxton Hall! Our second item is a cornet solo, by C. Laycock, entitled "Robin Adair."

[*This was equally clear and beautiful.*]

Hullo, Caxton Hall! Our third and last item is "Dreamy Paradise," played on Hawaiian guitars.

[*This item was as unique as it was melodious.*]

The message from the Archbishop of Canterbury to the Bishop of Willesden was repeated, and after wishing everybody "Good night" the speaker finished, and the ether was still save for one or two solitary "spark" signals. Our home-made crystal set had done well.—H. L. S.

Testing Your 'Phones

THE test commonly used in the early days for receivers was made by means of the handiest and weakest of batteries—a penny and a two-shilling piece, between which a bit of moist paper was placed. The end of one wire from the 'phones was connected to the "copper," and then the silver coin touched lightly (and repeatedly) with the end of the other wire.

Nowadays a similar test is made with a single piece of sheet aluminium which should be damp. Simply connect one wire of the 'phone to one end of the aluminium plate, and then touch the plate with the other wire, when, if the 'phone is properly adjusted, each contact will cause a click in the 'phones. W. W. D.

RADIOGRAMS

WOMEN are eligible for the Postmaster-General's certificate in wireless telegraphy.

■ ■ ■ ■ ■

In recent tests on the *Elletra* a transmission speed of 100 words per minute was attained.

■ ■ ■ ■ ■

Obviously the future of the industry depends to a great extent upon the steps which are taken to regulate it.

■ ■ ■ ■ ■

A report is to hand that a Hungarian engineer has invented a device for printing at limited distances by current or wireless.

■ ■ ■ ■ ■

One result of the experiments conducted on board Senatore Marconi's yacht the *Elletra* is considerable progress in the way of eliminating static disturbances.

■ ■ ■ ■ ■

The Federation of British Industries has had under consideration for some time the scheme for wireless broadcasting recently outlined by the Postmaster-General.

■ ■ ■ ■ ■

Wireless telephony has been established in the British West Indies between the Turks and Caicos Islands. Grand Turk is now connected up with South Caicos and Salt Cay, distant twelve and eight miles respectively.

■ ■ ■ ■ ■

The Postal Authorities in this country have decided to follow the example of the Washington Conference held recently. A meeting of experts is to be called in London to settle the question of wave-lengths, limitation of power and control generally.

■ ■ ■ ■ ■

According to reports there is a "space of territory" in California inside of which wireless telephone messages absolutely disappear. So far as wireless is concerned it is a region of eternal silence. Some sort of invisible barrier in the ether seems to barricade the wireless waves.

■ ■ ■ ■ ■

A system of "ringing up" a station has been invented by a French engineer. It consists of sending a certain number of signals in proper sequence which actuate relays in the receiving station, these relays being such that they only respond to signals of correct sequence and intervals.

■ ■ ■ ■ ■

Messrs. Walturdaw have secured the rights of installing the "Marconiphone" in any place of public amusement in the United Kingdom. By a loud-speaking device the audience will be enabled to obtain all the advantages attaching to a wireless installation. It is hoped to give a public demonstration within the next few weeks.

■ ■ ■ ■ ■

It is stated that a German scientist has discovered a new attractive force which is non-magnetic, and yet which causes attraction between all metals and even minerals. If any credence can be attached to the report it would seem that such a discovery will find immediate application in wireless telegraphy and telephony.

■ ■ ■ ■ ■

The papers say that a communication has been forwarded to the Postmaster-General suggesting that the interests of this new industry can best be safeguarded by applying a condition, already required in all existing contracts under the Post Office—that only British-made apparatus will be utilised in its expansion.

■ ■ ■ ■ ■

Wireless receivers in newspaper offices are not of much value, says a correspondent of the *Newspaper World*, the trouble being the conflicting electrical currents caused by the presence of electric motors. When the mechanical work of the office is finished for the day excellent wireless results can be obtained, but of course that is not when they are wanted.

■ ■ ■ ■ ■

At a meeting of Hastings Town Council a proposal for a wireless set to be installed on the front was considered. It was estimated that the cost would be £100 to £300. The mayor said that he thought it would be a good advertisement for the town and they might be able to make money out of it. The motion that the set be installed was adopted.

■ ■ ■ ■ ■

The English wireless concerts transmitted each Tuesday evening from Writtle, Essex, now take place at 8 P.M. British summer-time, on a wave-length of 400 metre; not at 7 P.M. on a wave-length of 700 metres, as hitherto. Amateurs throughout the country are invited to send reports on their reception, with criticism of the individual items, to the Writtle station.

■ ■ ■ ■ ■

A special type of gramophone has been developed for producing music to be broadcasted. The tone chamber is larger than that of the ordinary gramophone, and is supported on three posts which rest on a sound box similar to the body of a guitar. It is claimed that this machine is not only louder than the regular gramophone, but produces its tones more clearly and free from foreign vibrations.

■ ■ ■ ■ ■

Little or no information is yet available as to when the inception of the broadcasting will take place. Apparently the cause of the delay is because manufacturers of instruments have not yet agreed upon a scheme which is to be submitted to the Postmaster-General. The suggestion has been made that the manufacturers are unwilling to bear the annual cost of the broadcasting stations, as it is estimated that the upkeep of each will be about £20,000 a year.

■ ■ ■ ■ ■

The proprietors of a well-known make of cigarettes, in order to improve the condition and comforts of their workers, have installed a fully-equipped receiving apparatus. Some years ago this same firm erected a wireless installation on their factory and on one of their motor cars in an endeavour to obtain direct communication from traveller to factory at any and all times. The war prevented them pursuing this idea to a successful conclusion, but it is a development that is nowadays quite practicable.

■ ■ ■ ■ ■

In the wireless station at Lyons two systems of receiving high-speed messages are to be employed. One is the method of making a photographic record on a strip of sensitised paper, and in the other method the message is taken on a special high-speed gramophone. After the message has been recorded on the disc the latter is placed in a machine running at much lower speed, and can then be transcribed by an operator. The reverse of this system can also be used in transmitting messages at speeds up to 150 words per minute.

■ ■ ■ ■ ■

The most famous wireless station in the world has been closed. Poldhu has sent its last message, and MPD, the famous call sign that has been heard for close on twenty years, is to be heard no more.

The historical side of wireless telegraphy will ever be concerned with Poldhu, for it was the first high-power wireless station to be built, and from there the first wireless message was sent across the Atlantic on a 2,000 metres wave-length on December 12, 1901, to St. John's, Newfoundland.

It has been found that the station has several disadvantages, chief among them being its inaccessibility and the necessity of having long telegraphic lines over the most exposed parts of the Cornish coast.

The future uses of the station, it is expected, will be for experimental purposes, though this has not been definitely decided up to the present. Its work is to be taken up by Clifden (on the west coast of Ireland) with its call letters of MFT.

OUR INFORMATION BUREAU

Expert Replies to Readers' Questions. All Readers in Difficulty should Avail Themselves of This Free Service. Replies sent by Post when Stamped and Addressed Envelopes Accompany Queries

Q.—I desire to know how to wire a single valve, L.F. amplifying panel so that it can be used in conjunction with an existing detector panel of usual design without additional batteries.—R.H. (11)

A.—The accompanying diagram shows a suitable circuit arrangement for the L.F. amplifying panel. T represents a step-up iron-core transformer (of the type known as intervalve transformers), having its primary winding connected to the two terminals marked "input" and shunted by a small fixed condenser having a capacity of, say, .002 mfd. If the detector panel itself is already provided with a telephone condenser, this ·002 mfd. condenser may be omitted. The "input" terminals are to be connected to the telephone terminals of the detector panel. When the amplifying panel is in operation, the telephones (preferably having a resistance, of say, 4,000 ohms) are to be connected to the two terminals marked "output," across which it will be noticed there is another small fixed condenser of similar or slightly smaller capacity to that across the input terminals. R represents the usual filament rheostat and G and A the grid and anode sockets respectively of the valve-holder. In order to permit the use of common L.T. and H.T. batteries it is necessary that the telephone terminals of the detecting panel are between the positive of the H.T. battery and the anode. As many detecting panels are wired up with the telephone terminals on the negative side of the H.T. battery, the present panel should be examined and the connections modified if found necessary. The alteration in question will not interfere with the subsequent use of the detecting panel alone if desired.—CAPACITY.

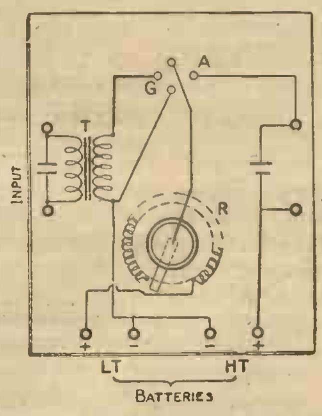


Diagram of Connections for Low-frequency Amplifying Valve.

People who are partly deaf can in some cases use the telephone with ease. Wireless telephony is bringing a new hope to the deaf. A case is mentioned in the *Medical Press and Circular* by Dr. Dan M'Kenzie of a man to whom the ordinary electrical hearing aids were useless but who by wireless can hear the Dutch concerts more plainly than can an ordinary person.

QUERIES!

SPECIAL ANNOUNCEMENT OF AN EXPEDITED SERVICE

ALWAYS mindful of our obligations to our querists (and we hope that every reader will occasionally become a querist), we have made special arrangements with a view to the improvement of our Information Bureau, and we are now able to announce that, dating from the publication of this issue, the bulk of the queries that reach us will be answered on the day of their receipt. Putting it more definitely, our special aim will be this: In the case of queries that reach us by the first post each day we shall do our best to send out expert replies by the evening of the same day. We know that readers will greatly appreciate this improved service, but its success will largely depend on them. Let them write their queries as briefly as possible consistent with supplying all the details required by our experts; let their writing be plain and easily read; let the questions be written on one side of the paper only; and let a stamped and addressed envelope for the reply accompany each query.

CORRESPONDENCE

Freak Results

SIR,—I consider F. H. M.'s results, as related in "Amateur Wireless" for June 17, very good. Perhaps a few of my own experiences may be of interest.

Using a wire-bed mattress rolled up in a corner and a good crystal, I have no difficulty at night in copying many 600-metre stations. At times even St. Maries de la Mer, F F S (Marseilles), comes in quite readable.

My outside aerial is a 40-ft. twin about 28 ft. high. On this, using the crystal, Madrid (E G C), Petrograd (P T G), and Posen (P S O) are readable. Six hundred-metre traffic comes in extremely well; all the British shore stations can be heard, nearly all of the French, Norwegian and Danish, most of the German, Spanish, and one or two Italian stations. The longer ranges are, of course, only obtained at night.

There is no need to possess a valve amplifier to get stations on one's body. By disconnecting the aerial and applying a wet finger to the aerial terminal F L can be heard. With the crystal these "freaks" are, of course, much more pronounced during the hours of darkness, results at times being scarcely believable. —H. G. S. (Wakefield).

SIR,—Having read with much interest the letter of F. H. M. (Bexhill-on-Sea) in the issue for the 17th ult. I think that some of my reception results might be of interest, though I should hardly call them freak results. For some months past I have been using a single-valve circuit on the regulation double-wire aerial.

The four large American C.W. stations—Tuckerton (W G G), New Brunswick (W I I), Annapolis (N S S), and Long Island (W O K)—can nearly always be read at night under favourable conditions.

Tuckerton comes in strongest, and on one occasion when they were working Rome I read them for half an hour without interruption.

I was once able to receive New Brunswick after P O Z (with whom they were working) had asked them to send v's because they were receiving them badly.

The Dutch concerts are clearly audible, and on the new 400-metre amateur wave-length telephony from at least six of the London amateur stations can be heard.

The valve I use is of the "soft" variety, and in my opinion is equal to two of the hard R-type.—F. D. C. (Cambridge).

CLUB DOINGS

Wireless Society of Highgate

(*Affiliated with the Wireless Society of London*). *Hon. Sec.*—MR. D. H. EADE, "Gatra," 13A, Sedgemere Avenue, East Finchley, N.2.

THE second of the series of elementary lectures on wireless was given at the Highgate Literary and Scientific Institution on Friday evening, June 16th, by Mr. J. Stanley, B.Sc., A.C.G.I., to an audience which again comprised a large number of visitors, including several ladies.

Mr. Stanley went briefly over the theory of the ether, showing that it possesses the properties essential for wave motion-elasticity and inertia—and then took his hearers carefully over the important subject of wave-motion generally, showing exactly what is meant by wave-length and frequency. He illustrated his remarks by analogies derived from the action of water waves, and led up to the fundamental equation for all wave motion, that is, velocity = frequency × wave-length. He then took up the question of oscillating current, showing how oscillations could be produced by the discharge of a condenser through a circuit containing inductance, and how trains of oscillatory discharges could be produced by the inclusion of a spark gap in such a circuit. The lecturer followed by showing what was meant by the "impedance" of a circuit, and gave the formula for this quality, and went on to point out how it followed from this that the wave-length of a circuit was dependent upon the inductance and capacity in that circuit.

Finally he showed how, by application of oscillating currents to open radiating circuits, such as ordinary wireless aerials, electromagnetic waves were set up in the ether and sent out into space. In conclusion, he showed how the different forms of aerials affected the shape of the waves produced and the directional properties of the aerials. Mr. Stanley's remarks were illustrated throughout by excellent diagrams thrown on the screen, and this added considerably to the interest and clearness of the lecture.

(*Continued on page 78.*)

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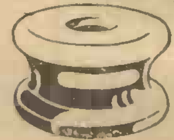

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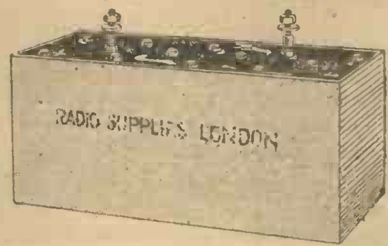

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Aerial Insulators, R.A.F., ebonite brass ring, 6d. each.
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Aerial Lead-in Wire, rubber covered, 35/40, 12 yards, 1/-.
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H.T. Battery Boxes, polished mahog. 6 plug sockets, **7/-**.
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Wireless Head 'Phone Sets, Ex W.D. L.R., **10/-** per pair, with head band and cord. Single receivers L.R., 4 6. New delivery Marconi-Brown head 'phones H.R., **51/-** pair, 2,0000 or 4,000 ohms.
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Receiver Amplifiers (Mk. 2 B) 2 valve Amplifiers, quite new, guaranteed, **£7 10/.**
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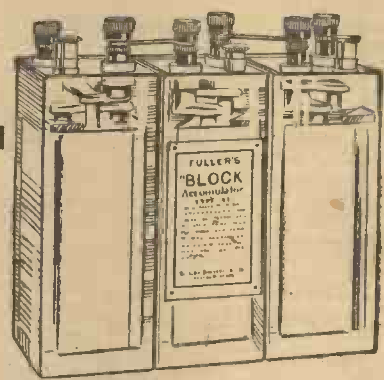

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AGENTS WANTED IN ALL PARTS.

CLUB DOINGS (*Continued from page 76*)

The Hon. Sec. will be pleased to hear from anyone interested. The Society has made arrangements to receive the Marconi concert at the Highgate Literary and Scientific Institution on Tuesdays at 8 P.M. during July, and anyone interested will be welcome on these occasions.

Bradford Wireless Society

(*Affiliated with Wireless Society of London*).
Hon. Sec.—MR. J. BEVER, 85, Emm Lane, Heaton, Bradford.

A MEETING was held in the clubroom, at 7.45 P.M., on Friday, June 16th, when Mr. J. Bever gave his lecture on "General Wireless Matters." This consisted in the main of a description of his own four-valve set. During the course of his remarks Mr. Bever made several references to the increasing number of people using valve sets, who not having the necessary knowledge to operate them, cause interference by allowing their apparatus to oscillate unnecessarily. Mr. Bever's set was on view and was connected to the Society's aerial. Excellent signals were obtained on short wave, including telephony from a local station. The signals were easily readable with the telephones lying on the table.

Sheffield and District Wireless Society

CHANGE OF ADDRESS

ON and after June 23rd, 1922, the address of the Hon. Sec. will be: 18, Linden Avenue, Woodseats, Sheffield.
Hon. Sec.—LEONARD H. CROWTHER.

Crosby, Waterloo and District Wireless Society

Hon. Sec.—S. FRITH, 6, Cambridge Road, Crosby, Liverpool.

THE association invites application for membership.

Stoke-on-Trent Wireless and Experimental Society

(*Affiliated with the Wireless Society of London*).
Hon. Sec.—F. S. JONES, 360, Cobridge Road, Hanley.

ON Thursday, June 15th, Mr. J. Gaskell gave a lecture and demonstration on X-rays. Questions were asked and answered regarding the relation of X-ray waves to wireless waves, and comment was made upon the similarity of X-ray tubes and the thermionic tube.

A corresponding section for members unable to attend the ordinary meetings has been formed.

The Leicester Radio and Scientific Society

(*Affiliated with the Wireless Society of London*).
Hon. Sec.—J. R. CRAWLEY, 269, Mere Road, Leicester.

THE monthly meeting of the society took place on Monday, June 19th, at headquarters. The lecturer for the evening was the president of the Society, Mr. Cyril T. Atkinson, and the subject "Short-wave Reception." Mr. Atkinson first of all pointed out the reasons for the special measures necessary for receiving short ether waves of below 300 metres, and then described step by step the various classes of gear and methods of construction. The lecture was illustrated by a number of pieces of apparatus of the lecturer's own construction.

The Wallasey Wireless and Experimental Society

(*Affiliated to Wireless Society of London*).
Hon. Sec.—C. D. M. HAMILTON, 24, Vaughan Road, Wallasey.

AT the meeting of the society held on Thursday, June 15th, Mr S. J. Martin gave a most interesting lecture on the "Theory and Construction of Simple Valve Sets."

FORTHCOMING EVENTS

Wireless Society of Hull and District. July 10, 7.30 p.m. Annual meeting for the election of officers. After the conclusion of the business the rest of the evening will be devoted to questions and answers.

Wireless Society of Highgate. June 30, 7.45 p.m. At the Highgate Literary and Scientific Institution. Lecture (part III) by Mr. J. Stanley: "Elementary Theory of Wireless Telegraphy and Telephony."

Newcastle and District Amateur Wireless Association. July 3, 7.30 p.m. Annual general meeting for election of president and officers.

Ilkley and District Wireless Society. July 4, 7.30 p.m. At the Regent Café, Cowpasture Road. Lecture and demonstration on short-wave telephony reception.

Leeds and District Amateur Wireless Society. July 8. Field day.

Catalogue of Wireless Apparatus and Parts.—The Economic Electric Limited, 303, Euston Road, London, N.W.1, has just issued a new catalogue devoted entirely to wireless apparatus and parts. The catalogue will provide a useful reference for all those who are constructing apparatus, in addition to those who are interested in complete sets, for every part and material used in wireless work is listed. In addition, the catalogue contains a series of crystal and valve receiving circuit diagrams, and some general information on matters wireless.

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Competition No. 2. — Another set is offered for a brief description (with illustration if necessary) of the *most novel and useful* item in wireless apparatus—in its design, material, make, electrical connections, etc. etc. The novelty must be original—not copied from any source whatever.

Competition No. 3.—The third receiving set will be presented for an ideal broadcasting programme of twelve items. You can enter for this competition on a penny postcard. Simply write down in column form twelve items that you consider would make an ideal programme.

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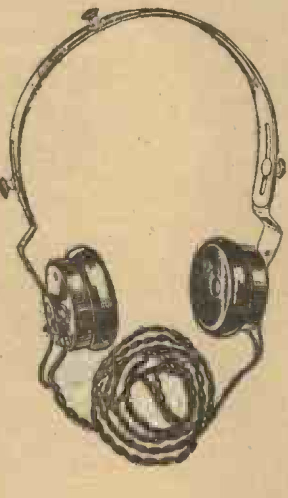

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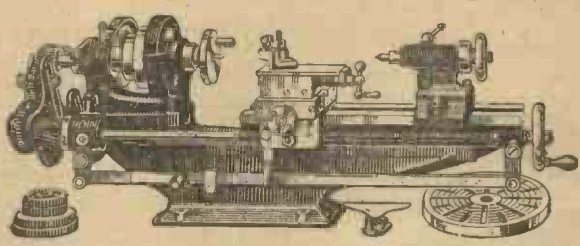

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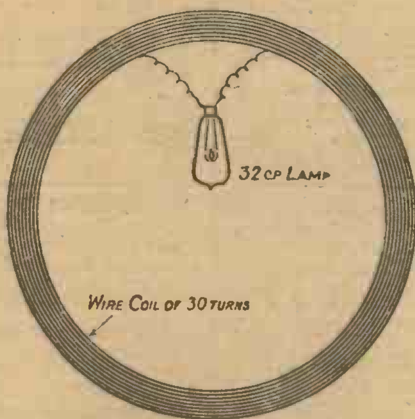

MAKING THE" WAVE VISIBLE
(See p. 89)

CHIEF CONTENTS

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Amateur Wireless
and Electrics
No. 5 July 8, 1922

WIRELESS AND TANKS

ONE of the greatest problems of the war was to find a reliable means of communication between the front lines and the rear during an attack, and until the advent of the wireless tank in early 1917 it was usually quite impossible to tell how an attack was progressing until after the inevitable counter-attack had quietened down. With the ever-increasing number of British offensives from early 1917 onwards it became essential that headquarters should know immediately of every fresh development in the attack in order to make preparations for further advances or to repel counter-attacks. It was this need for reliable information which led the authorities to instruct Captain W. R. H. Tingey to make experiments to ascertain if it was possible to employ tanks as wireless station carriers.

There were many difficulties in the way of their successful use, amongst them being the impossibility of using the high aerials which were necessary with spark transmitters; the large mass of metal surrounding the apparatus and in close proximity to the aerial; the difficulty of receiving wireless signals on account of internal noises in the tank; the supply of power to the transmitter; and the danger that the sparks from the transmitter might ignite the petrol fumes.

Six tanks were fitted with wireless at the tank workshops in France in May, 1917. The cabin was rendered almost soundproof by making its walls of two thicknesses of wood four inches apart, the space between being filled with sawdust and other packing. A small door led into the interior of the tank for direct communication with the observation officer, who had a table and chair, together with maps, telegraph forms, etc.

Aerial Systems.

The aerial consisted of eight strands of insulated electric lighting cable, arranged in sets of four on cross-shaped spreaders as shown in the illustration. It was about 20 ft. long, supported at the front by a 10-ft. steel mast which could be raised or lowered from inside the tank. The aerial was let down to supports at the back and thence to the instruments by means of heavily-insulated high-tension cable. The earth used was the tank itself, which, of course, did not make for efficiency.

Transmitter.

At this time continuous-wave or valve transmitters were not very efficient, and were found to be useless for tank work. The Wilson transmitter was used, which has a high spark-frequency and emits a high, musical note. The make and break of 36,000 per minute was driven by a small motor running at about 4,000 revolutions per minute. The normal input of this transmitter, using 30 volts, was about 150 watts, but it was often necessary to transmit straight from the 80-volt dynamo, and the input in this case was 400 watts. This 80-volt dynamo, driven off the tank engine, was normally used for charging two sets of accumulators for the transmitter and two sets for the lighting of the cabin and the electric fans.

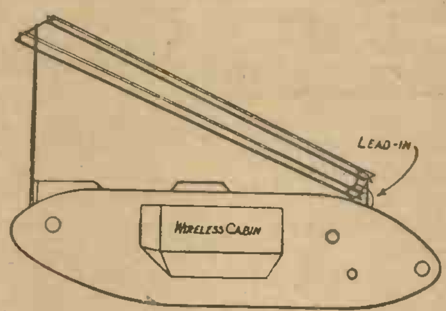


Diagram showing the Method of Erecting the Aerial on a Tank.

Receiver.

The receiver was a Mark III tuner with valve attachment, with internal alterations to bring the wave-length up to 900 metres and also to permit of reaction being used. A three-valve low-frequency amplifier was used in conjunction with the tuner, and both amplifier and tuner were run off the same high-tension battery.

Charging.

Charging was a very difficult operation. The useful life of a tank engine is limited, and it was therefore an uneconomical scheme to run a 150-horse-power engine for several hours solely to drive an 80-volt dynamo for charging accumulators, so the charging had to be done while the tank was moving up the line to go into action. A large charging board was fitted in the wireless cabin, with switches for changing over from one set of accumulators to the other, and for cutting out the current from the dynamo. There was also an automatic mercury-cup cut-out, but owing to the rolling of the tank this was never satisfactory, and it was necessary for one of the operators to keep one hand on the dynamo switch and an eye on the voltmeter. It was never possible to charge for more than a few minutes at a time, because the tank was constantly stopping and starting, speeding up and slowing down. Each time the speed was reduced, and the needle of the voltmeter came near the safe charging point, the dynamo switch had to be opened and then closed again as soon as speed increased. The result of this was that the accumulators were never properly charged, and it often became necessary to run the transmitter straight off the dynamo with the risk of burning out the spark coil or puncturing the condensers.

Working Range.

In spite of the large power employed, it was not possible to exceed about ten miles range owing to the smallness of the aerial and absorption of the transmitted power by the tank itself. At that time high-frequency amplification had not come into use in the army; the low-frequency amplifier used on the first wireless tanks hindered, rather than helped, the reception of the rather weak signals picked up on the small aerial of the tank.

Portable Installations

These tanks did good work at Ypres in July to September, 1917, but it was soon found that the wireless apparatus became useless when the tank itself was put out of action. The remedy was to make the wireless apparatus portable, so that it could be removed from the tank when necessary and installed in a handy dug-out or under any available cover. Portable installations were made in wooden cupboards, using the same apparatus as described above. A large supply of ready-charged accumulators were taken on board the tank before going up into action. Two 30-ft. masts and several spare aerials were carried, and these were erected when the tank had gained its objective. Naturally, the masts were very conspicuous, and the station came in for a lot of shelling in consequence.

The usual procedure was for one operator to put the messages into code and another to send the messages and keep an eye on the aerial ammeter. When the needle of the ammeter dropped to zero he knew that the aerial had been shot away, and operator number three had to attend to the repairs to the aerial under very great risk. The average life of an aerial under these conditions was about ten minutes, and the masts after a day's work looked very weird in their splints made from barbed-wire stakes and telephone cable.

Valve Transmitters.

In the following spring valve transmitters were installed, continuous-wave work having made great strides in the preceding months. These C.W. sets simplified matters very much; not only was the apparatus much smaller—both the transmitter and receiver were confined in one box 15 in. square by 6 in. deep—but there was no necessity for a large supply of accumulators. Six or eight accumulators for the valve filaments were sufficient for an action lasting three days. These sets employed one valve for transmitting and two for receiving, the receiving valves being low-frequency transformer-coupled. They were very efficient. Using 600 volts high-tension, a range of nearly 200 miles was obtained with a set which followed the German retirement after the armistice, the apparatus in this case being carried in a light car attached to the Armoured Car Squadron. P. S. B.

The "Hon. Sec."

WHATEVER competition there may be for positions on the committee of any wireless club or society, it is perhaps not a very remarkable fact that there is never any great rush when nominations are invited for the position of hon. sec. Two years' experience in such a position have revealed the reason. Consider what is required of this (to himself) important person.

In the first place, a secretary of a wireless society must possess a full knowledge of everything appertaining to the science from "How many turns on a honeycomb primary" to "the wave-length and call sign of Honolulu." If shaky on any query put before him, he must have the capacity of making his questioner feel sure that the answer given is quite correct and not to be challenged.

He is expected to have the finest receiving set of the club, and his door must be ever open to any member who cares to walk round at any time to see why his one valve set will not get the Dutch concert.

He must be ready every club night to hear, "Oh! my set will not do anything but crackle; can I bring it round on Sunday morning so that you can have a look at it and put it right for me?" Of course he can, and Sunday morning comes and so does the aforesaid member with a home-made set with loose wires and shaky connections, the whole held together with sticky tape and Chatterton's compound. You start tracing connections, eventually finding, say, the primary of the intervalve transformer has ceased to function. Well, then the favourite stand-by transformer you have been saving for a rainy day is rooted out and screwed and soldered into position, and the signals roll in. Perhaps a valve filament is touching the grid in the aforesaid member's set. He brings his panel, but no valves, and the set works, using the secretary's. Back home goes the member and still no results.

Then the requests for wiring diagrams and the numbers of turns; and "Why will not a resistance amplifier work on short wave-lengths?" and "Is the three-coil system better than the two-coil?" And so on, day after day and week after week.

Then there are the lectures. How many members realise the work behind the neatly printed little syllabus issued at the beginning of a session, the difficulties to find men to fit dates and dates to fit men, when you must meet the second and fourth Wednesday? Do they realise the correspondence involved in fixing up the lecturers, and later on in finding out the apparatus required, the begging, borrowing or otherwise acquiring such apparatus without expense (for most wireless societies have to watch this), and the avoidance of the hundred and one hitches which always crop up on lecture nights?

Then there is the tradesmen's association which wants a free lecture, or the bazaar committee who want a free side show. They suddenly realise that a wireless society exists in the town and decide to approach the secretary. For the credit of his club he decides to give the lecture or run the side show, and it gets through. He has the pleasure and privilege of carrying his apparatus to and from the lecture or bazaar room, generally assisted, of course, by one or two members of the wireless club. When he gets his apparatus back home he finds that a couple of valves have passed their last electron. The nicely written vote of thanks he gets about a fortnight later he frames, and privately thinks that next time it will be cheaper to give a donation!

Of course, in addition to all this, there is the usual routine work, such as writing up minutes, circularising members (some job!) and general correspondence.

And yet the secretary seems to thrive on it. The Sunday morning visitor is greeted with a smile, and *after treatment* is sent away with a "Come again as soon as you like." Lecturers still continue to be worried and cajoled, the wiring diagrams still get out, and the queries are answered, and that special little job you have assigned for to-night is cheerfully put on one side when a member brings his set which is on strike.

It is little wonder that there is no competition for the position of "hon. sec."

L. J. W.

Coil Mounting Simplified!

THE sketches, Figs. 1 to 4, show a simple method of mounting coils of the basket type. An ordinary ebonite valve holder is used as a support, this being fitted to the panel in the ordinary manner.

The leads from each of the coils are soldered to two thick pieces of copper wire, and the latter are then put through the "spider holes" and twisted round, as shown, so as to form plugs to fit the valve sockets. The wire supports of the variable coils are bent round and two other pieces attached to form a stiff hinge. K. U.

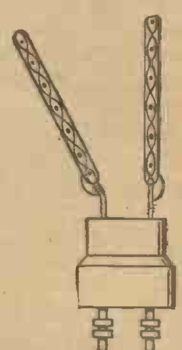


Fig. 1.—Coils on Holder.

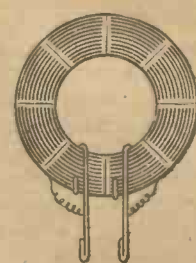


Fig. 2.—Mounting for Fixed Coil.

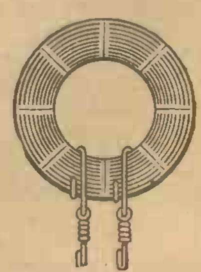


Fig. 3.—Coil on Hinged Supports.

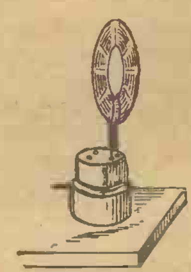


Fig. 4.—Holder with Coil on Base.

TAPPING THE INDUCTANCE COIL

THE following description, together with the illustrations, should enable the amateur to make his own variable inductance at a very small cost. A is a stiff cardboard tube about 4 in. in diameter and 10 in. to 12 in. long. B is a strip of ebonite, or even of hard wood, the same length as the tube, and about ¼ in. by $\frac{3}{16}$ in. cross section.

Fig. 1.—Photograph showing Method of Making Tappings.

The tube is wound with No. 22 gauge copper wire, either enamelled or double-cotton-covered, the winding being started about ½ in. from one end. The first two or three turns should be neatly secured by means of narrow tape tied in two or three places. After five turns lay the strip of ebonite on the coil so that the end just projects beyond the last turn; the sixth turn obviously will be brought over the strip. After another five turns on the tube the strip should be pushed along so that number twelve will again come over the end of it. This procedure is continued until the tube is fully wound to within about ½ in. of the other end, when the last few turns must be secured with narrow bits of tape in exactly the same manner as at the beginning.

The next thing is to scrape the insulation from each of the raised turns of wire just where they lie on the ebonite strip. To each of these bare spots a short length of well insulated wire is soldered (as well as to each end, of course, of the whole winding), and these connections are taken to a stud-switch, of which a very good pattern is shown in Fig. 2. The number and positions of the "tappings" can be varied according to individual requirements, there being no hard and fast rule.

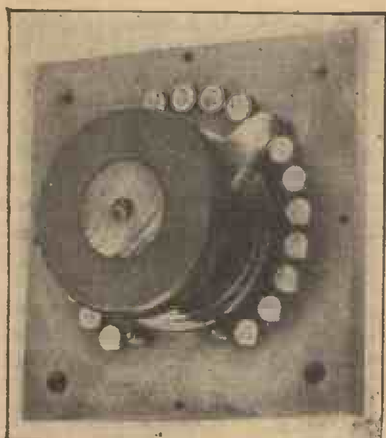


Fig. 2.—The Tuning Switch.

Fig. 3.—Photograph of Wound Coil.

This form of inductance will be found to have great advantages over the sliding contact form when home-made, as the latter is liable to give a lot of trouble in the way of faulty contact unless the workmanship is perfect. The method of mounting the tube is shown in the first illustration, the ends being of ebonite and hard wood. When screwing the parts together the narrow strip, with its connections, is turned underneath, and the wires are taken through holes in the base, so that the appearance of the finished inductance is very neat, as in Fig. 3. The switch can, if desired, be attached to one end of the completed inductance. PHEAUX.

WHAT WIRELESS TERMS MEAN.—IV

Some Technical Words Explained as Correctly as Popular Language Allows

VALVES, SOFT.—The type of valve used for reception does not need to have so high a vacuum, and such valves are called "soft." The glass of these valves is clear, but appearance does not always indicate a hard valve.

VALVES, HARD.—The glass chamber in which the parts of a valve are enclosed has nearly all the air removed. A hard valve implies a very minute amount of residual air. A very hard valve is necessary in transmitting owing to the high voltage applied to the plate. Such valves are not so suitable for reception, though they can be used for the purpose. A hard valve is frequently very black.

MUTUAL INDUCTION (*See* Induction). — The resulting effects of induction by which the induced current throws back and produces an effect on the first coil and so on, thereby producing a "swinging" backwards and forwards of current from coil to coil. This effect is present whenever two coils are in electrical relationship.

GRID.—A mesh or spiral of wire surrounding the filament of a valve. It is connected to the leg of the valve usually marked "G." The aerial circuit of a receiver is connected to the grid of the first valve in a circuit. Currents striking the aerial are thus conveyed to the grid, the potential of which is thereby constantly in a state of change, these changes being reflected in the plate circuit.

PLATE.—A small cylindrical plate of metal surrounding the grid and filament of a valve. It is connected to the leg of the valve marked "P" opposite to "G." The leg "P" is always set out of square with the other legs to prevent any possibility of the valve being wrongly inserted in the holder. The plate is connected in the high-tension circuit of the receiver, and is supplied with current from the high-tension battery. The changes in potential of the grid are reflected in the plate circuit, and the telephones being also in that circuit are thereby affected.

DRY CELLS AND THEIR WAYS

WHEN the dry cell was invented, and there were many inventors, not one of the inventors imagined that it would be used for the variety of purposes that it is to-day. The chief use of the dry cell is to give little flashes of light, sometimes for a second or two, sometimes for a little longer, and it is also largely used for wireless receiving sets.

Most readers have bought one of those little three-celled batteries that are used to give the energy for lighting up flash-lamps. For a little while all has gone right. Then, perhaps a week or so after the original purchase, the need for the light, or perhaps the interest in the thing, has gone for the time and it has been put away. When it is taken out again, it refuses to work.

The "refills," as they are called, cost very little, so as a rule you just buy a new one and take no further trouble about it. Perhaps that is the best thing to do.

Bubbles.

But the dry cell is a great device. There is no need to call it an invention. The invention came a century or so ago, when men set themselves to clean up the defects of the original voltaic cell. Volta never dreamed of electric lights or wireless. He was happy enough with his own discovery that a piece of zinc and a piece of copper, when dipped into a solution of salt or acid, could send a current of electricity through a wire that connected them. All the cells that have been made since then are the descendants of the original one of Volta. The first users of the voltaic cell soon found out its great defect. They found that the copper pole began to bubble all over with hydrogen gas. Sometimes the zinc pole got frothy as well, and the froth consisted of hydrogen bubbles, just like those on the other plate. The hydrogen bubbles proved to be exceedingly bad conductors of electricity. They have other evil properties which were not discovered until later, and their power of stopping the current from flowing through the cell was quite enough to set inventors the problem of getting rid of them.

There is no need to tell of all the different cells that were devised immediately. Most readers know quite a number of them, but for the most part they are only historical curiosities. They have nearly all been superseded by cells of the secondary or accumulator type.

The Mother of Dry Cells.

One, however—the Leclanché—remains in constant use. In the early days it was considered to be a feeble thing compared with the powerful nitric acid cells of Bunsen and Grove, but they are almost forgotten, whilst thousands of Leclanché cells are used every day.

Just as the original voltaic cell was the mother of all the group that followed, so the Leclanché cell is the mother of all dry cells. It is just as well, therefore, to examine some of the excellences and defects of the mother before discussing the uncertain temper of the daughter.

A Leclanché cell has one pole of zinc and another of carbon, and the liquid between the two is a solution of ammonium chloride in water. The solution has a slow action on zinc, but a coating of mercury prevents the zinc from wasting away on this account. When the poles are joined up the zinc decomposes the ammonium salt, forming zinc chloride, which dissolves at once, ammonia gas, which likewise goes into solution, and the old enemy hydrogen, which forms little bubbles on the carbon plate.

Getting Rid of the Bubbles.

Of course, there is a device for getting ride of these bubbles. It consists of a coating of manganese dioxide around the carbon. Manganese dioxide, however, is but a poor conductor itself, so the coating of the carbon plate is never made of the pure substance, but has an admixture of something such as finely divided carbon to make it conduct. Whatever the compound may be, it is the dioxide that burns up the hydrogen bubbles. Unfortunately it does this rather slowly, and if the cell be worked for more than thirty seconds or so at a time, the hydrogen will form faster than the dioxide can deal with it and the current will begin to die away. It only needs a moment or two of absolute rest to allow the destruction of the hydrogen to catch up, and the cell is as fresh and ready for work as ever.

This property of quick recovery is what makes the Leclanché cell so perfect a source of power for electric bells. Its other property of needing frequent rests rules it out from all such sustained efforts as are needed for keeping a small bulb constantly alight.

All that has been said so far is common knowledge, or at any rate most of it is to be found in the text-books, but we must look a little more deeply into the working both of the mother Leclanché and the daughter dry cell before we find out the cause and cure of the daughter's ailments.

Reviving Dry Cells.

One of the worst defects of many dry cells is that they will not keep. It frequently happens that cells that have been quite carefully stored for six months refuse to work. A friend of the writer of this article found a way of making such cells return to better ways. He simply warmed them for an hour or two. He put them in the kitchen oven after the fire had gone low and the oven was cold enough for his hand to bear and left them there for the night. In the morning they worked. At first he did not recognise what had happened inside the cell, so he tried the same treatment with some cells that had become exhausted by use in a flash-light. They refused to start working again.

Before trying to understand the effect of heat on the cells we need to know exactly what the cells contain. The case of the cell is made of zinc, and this forms the negative pole. In the middle of the cell is a rod of composition, mainly carbon with the necessary dioxide. The space between the two is filled with a paste of some kind, flour paste, wood pulp, plaster-of-paris, sawdust—anything, in fact, that will absorb the solution and prevent it spilling. The paste is, of course, saturated with ammonium chloride solution, and usually a little zinc chloride is added to keep the mass always damp.

It was said somewhere near the beginning of this article that zinc and ammonium chloride have a slight action on one another, even when no current is running. This is negligible in the mother cell, where the solution is free to move, but in the dry cell the layer of paste next the zinc gradually loses all its ammonium chloride and, although there is plenty of it left in the cell, it diffuses so slowly that the cell will not start. When the cell is warmed the paste is liquefied to some extent and the ammonium salt finds its way back to the exhausted layer and the cell is once more ready to start.

Worn Cells.

It is very different with a cell that has seemingly been worn out. Most of us have had a battery in this state, and most of us have at some time or other pulled one to pieces. We have seen the three small zinc cases inside and, as likely as not, we have found one or more of the zinc cases punctured as though it had been eaten away by the chemical inside. Quite naturally we have put down the failure of the cell to the giving out of the zinc.

But a moment's thought ought to convince us that there is plenty of zinc left, and a very slight knowledge of chemistry enables us to calculate that for every grain of zinc we need nearly two grains of ammonium chloride. As a matter of fact we use a great deal more, because the solution refuses to act when it falls below a certain strength. FRANK T. ADDYMAN.

Converting 'Phones for Wireless

WITH a few exceptions, it is necessary that the telephone headgear for wireless work be wound to a high resistance, anything from 500 to 3,000 ohms per receiver being general. The statement "high resistance" is perhaps apt to mislead the reader; what is actually meant, of course, is that the magnet coils must be wound with a great number of turns of fine wire in order to produce a maximum magnetic effect with very little current. The resultant resistance is, therefore, merely a necessary evil, unavoidable in all magnetic devices which are more or less voltage operated.

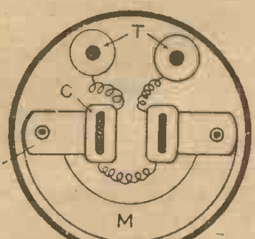


Fig. 1.—Diagram of Interior of Receiver.

Another point about wireless 'phones is that the diaphragms are much thinner than those used on ordinary commercial telephones. This makes them more sensitive to small variations in the magnetic force from the coils. At the same time, the diaphragms are more easily damaged, an excessive current causing them to buckle.

Construction of Receivers.

Second-hand receivers, of the type known as watch-pattern, may be picked up very cheaply at most large dealers in electrical sundries; many of these are surplus Government instruments and well made. The general arrangement of a receiver of this pattern is shown in Fig. 1, the ebonite earpiece and diaphragm having been removed. A permanent magnet M of semicircular shape is screwed to the outer containing case, and mounted on the poles are two pole-pieces P, which are bent at right angles and carry the magnet windings C. The ends of the windings are connected direct to the terminals T, which pass through insulated bushes in the metal case and serve to connect the coils C with the main receiving instruments.

The coils C when removed from the ordinary receiver will be found to contain fairly thick wire, the resistance being about 30 ohms. The task, therefore, is to strip them and rewind with much finer wire to a resistance of 2,000 ohms each receiver. Fig. 2 shows the general appearance of the coil when wound, the figures in the sketch corresponding with the reference letters in Figs. 1, 3, 3a and 4.

It will be seen that with such a small coil and with only a bent strip of metal P to hold, winding the empty bobbin by hand would be an extremely awkward job; in fact, it would be almost an impossibility to wind the wire with sufficient evenness to get anything like the required amount on the coils.

Again, the wire being so fine it is necessary to use great care to avoid breakage, which would mean starting all over again, and also the coil being so small, it would be almost impossible to hold it without getting cramp long enough to get all the wire on at once.

Fig. 2.—Wound Coil on Magnet.

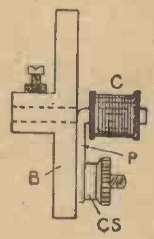


Fig. 3a

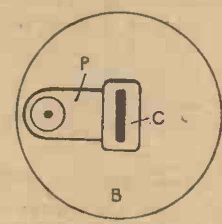
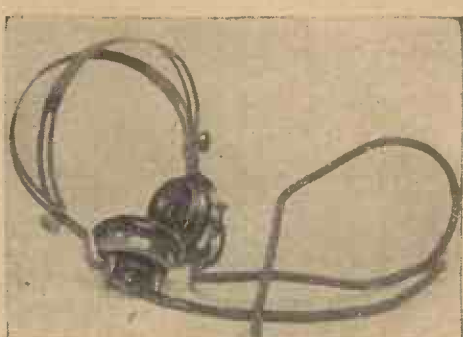


Fig. 3

Figs. 3 and 3a.—Magnet and Spool Mounted for Wind ng.

There are several ways of getting over this difficulty, with winding machines of various types, and the writer has tried them all with varying degrees of success. Most of them had the disadvantage that it was necessary to have an assistant, either to turn the handle or to guide the wire; the time taken to wind, even with practice, was considerable, and the result not entirely satisfactory. Some little time ago, however, the idea occurred of using a small-power electric motor with the coil directly mounted on the armature shaft. The result was entirely successful, and from that day the writer's circle of wireless friends has increased considerably, at least amongst those with receivers to wind. The arrangement is clearly shown in Fig. 4, E being a small electric motor 4 or 6 volt, using current from an accumulator and having a variable resistance in the circuit to regulate the speed. Clamped to the end of the armature shaft is a circular block of ebonite or fibre B on which the telephone coil C is mounted, being secured in position by means of the clamping screw C S, which passes through the holes in the pole-piece P. It will be noticed that the coil C is arranged to rotate as near as possible in the line of the armature shaft, so that, in spite of the coil itself being rectangular in shape, it will revolve with as little wobble as possible. This is very necessary, as any tendency of the coil to revolve eccentrically will tend to break the very fine wire. The ebonite block B is turned up in the lathe and a hole bored through whilst still in the chuck to take the armature spindle; this can either be a good tight fit in the first instance or the block may be clamped on the shaft by means of a small set-screw, shown in Fig. 3a. A second clamping screw C S is fitted, to hold the coil C in position for winding. This screw must be accurately positioned to ensure the coil C running true. The best plan is to hold the coil in position and then mark the place for the screw by means of a scriber passed through the hole in the pole-piece P.



Complete Double Head-set.

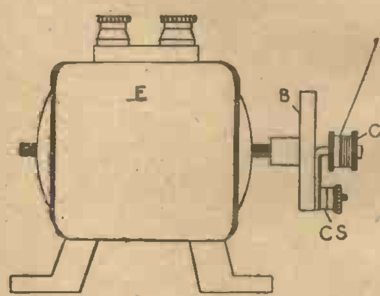


Fig. 4.—Motor with Magnet Mounted.

Revolving the Magnet.

Returning for the moment to the question of true and steady running, it is most important that the hole to take the armature spindle is accurately bored, and also that the armature spindle runs absolutely true, otherwise the coil C will wobble and difficulty will be experienced, not only in the wire continually breaking, but also in getting it to fill in close to the cheeks of the coil. If the motor E is of the type in which the armature shaft extends at both ends, the opposite end to which the block B is mounted may be used to carry a small knurled knob fitted with a short piece of brass wire about 1/8 in. in diameter to form a handle. This will prove particularly useful for controlling the motor or for winding certain portions of the coil by hand.

Winding.

With regard to the most practical method of winding the coils, the following procedure is considered by the writer to be the most satisfactory:

The motor should be connected up to the accumulator and regulating resistance and tested to see that it is in running order. The block B is then permanently fixed to the armature shaft and one of the coils to be wound clamped in position and trued up. Some fairly thin shellac varnish should be near at hand, together with a strip of silk ribbon, this latter cut to the width of the inside of the coil.

A single layer of silk ribbon is stuck on the core of the coil with shellac varnish, one layer of wire is then wound on and covered with a second layer of ribbon soaked in shellac. The free end of the wire is then carefully brought outside the coil and secured to the clamping screw C S for the time being. It is taken for granted, of course, that the sides of the coil C are already insulated with varnished ribbon or paper; at the same time it is a good plan to stick a small piece of varnished ribbon over the free end of the wire, to insulate it from the subsequent layers of wire when these are wound on. The main winding is now ready to start. The bobbin on which the wire is purchased should be mounted on a small brass rod so that it is free to rotate, and with the wire resting lightly across the second finger of the right hand, the motor should be started on the first speed, gradually increasing the speed of the motor as confidence is gained.

It is far better to go slow at first than to risk breaking the wire when the coil is partly wound and having to commence all over again. Naturally, a little practice is needed at first, but the knack of holding and guiding the wire is soon acquired, and after a time it will be possible to wind a coil and finish it off in fifteen minutes.

When the coil is almost full a single layer of silk ribbon should be put on, the last layer of the wire being wound over this, leaving about six turns from the end empty. The top layer is then held in position with the thumb and finger, while an assistant quickly soft-solders a short length of double-silk-covered No. 28 S.W.G. wire to the winding. The last six turns will consist of thick wire, when the coil should then be covered with two layers of ribbon and the whole thoroughly soaked in shellac varnish and allowed to dry before touching again. The second coil should then be treated in the same way.

Assembling.

When both coils are perfectly dry they may be remounted on the magnet poles in the receiver case, and the winding connected to the terminals.

It is a matter of opinion as to whether the inside ends of the winding should be connected to leading-in wires of a stouter gauge, some contending that the heat used in soldering tends to make the fine wire brittle and liable to break. Having finally connected up to the terminals T the whole of the case should be filled with melted paraffin wax up to the level of the top of the coils, the loose connecting wires will thus be firmly embedded and a break in the wire rendered almost impossible.

Diaphragms.

A special thin diaphragm should be purchased in place of the comparatively thick one originally fitted. The ear-piece is then screwed on, clamping the diaphragm in position, and the receivers are ready to be fitted with the headgear. This can easily be made from a length of old clock main-spring, the ends being softened, holes being punched or drilled in to take small screws, with which to secure the spring to the back of the cases. With a little trouble the ends of the spring can be slotted to take the screws, so that an adjustment is possible to make the receivers adaptable to heads of various sizes. The only remaining thing to be done is to attach the flexible leads to the instruments. These leads may be ordinary silk flex of good quality. The wires should not be twisted together, however, as in ordinary practice, but should be quite separate. The two receivers should be wired in series and the two ends of the flexible leads can be soldered to terminal tags or plug connectors.

With a little adjustment, the 'phones should be as sensitive as a specially constructed pair of wireless receivers purchased in the shops, and will well repay the trouble involved. A. W. H.

STARTING WIRELESS.—V THE AERIAL AND EARTH

Designing and Erecting the Aerial.

SPEAKING generally, in order to receive the most energy from an aerial, it should be as long and as high as possible. However, at the time of writing there are certain restrictions and regulations with regard to aerials. The Postmaster-General states that an amateur aerial must not be more than 100 ft. high and not more than 100 ft. long. If a double-wire aerial is used, the length of wire allowed is extended to 140 ft.; this, of course, includes the total length of wire—that is, two wires 70 ft., spaced some distance apart. It should be remembered that these measurements include the length of the down lead to the receiver.

Speaking broadly, one type of aerial is just as efficient as the other, and therefore the form adopted will depend upon the available space. Fig. 1 shows one of the best arrangements for a single-wire aerial, and Fig. 2 a similar scheme for a twin-wire aerial. When determining the position of an aerial, remember to keep it away from trees as much as possible, and do not let it run by the side of a building, as both these conditions tend to screen the aerial, thus decreasing its efficiency. It is not advisable to run an aerial parallel with telegraph wires or above a lead roof or guttering.

Insulating the Aerial.

The aerial only receives a very small amount of electrical energy, and therefore every precaution must be taken to secure the best possible insulation. A small leakage will affect the signal strength to a very marked degree. The two best aerial insulators are glazed porcelain and ebonite. Some comparative tests made by the writer showed that the best results were obtained with ebonite.

An excellent insulator can be made from a 6 in. length of ¾-in. ebonite rod. A small hole is drilled through each end for the purpose of attaching the wire, as shown in Fig. 3. Two forms of porcelain insulators are known as the reel and shell types respectively. When using these it is advisable to use two or three at each end of the aerial in order to secure better insulation. The method of joining is also shown in Fig. 3.

Referring to Fig. 1, it will be seen that at the top of the mast there is a small pulley which is used for hauling the aerial wire up or down. Rope impregnated with some form of preservative is desirable, and the rope should be about twice the length of the mast. It is slipped through the pulley before the mast is raised. In order to prevent the mast from swaying in the wind, and also to counterbalance the pull of the aerial wire, it is usual to fasten a number of stay wires to the top, and these wires are very frequently insulated by inserting a shell or reel insulator near the top and bottom of each, as shown in Fig. 1.

The down lead should be kept as far away from the wall as possible. In Fig. 1 it is brought into the house by means of a long ebonite tube, which is fixed to the top of the window-frame. When erecting

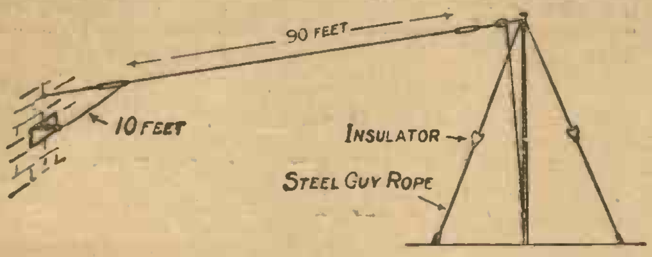


Fig. 1.—Single-wire Aerial.

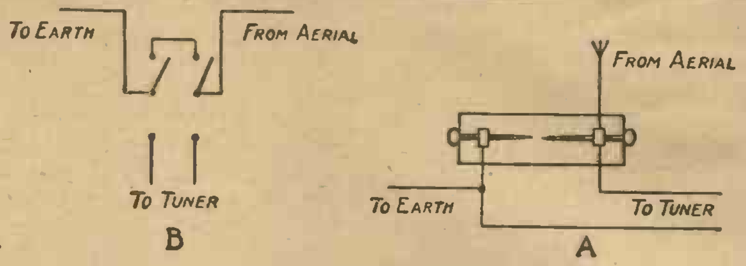


Fig. 4.—Lightning Protector.

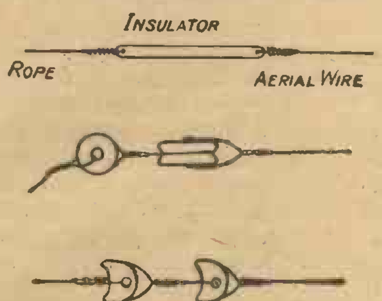


Fig. 3.—Insulators.

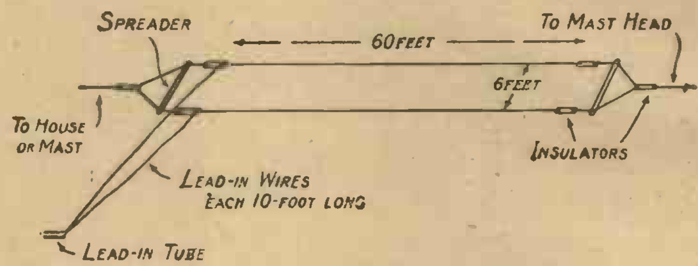


Fig. 2.—Double-wire Aerial.

an aerial the angle between the down lead and the main part of the wire should be made as large as possible. Another point to bear in mind is that if one end of the aerial has to be higher than the other the distant end should always be made the higher.

A Twin Wire Aerial.

To gain the advantage of two wires they should be spaced apart, at a distance of at least 6 ft. The spreaders are best made of bamboo on account of lightness. It will be noticed that the two wires must be insulated from each other until they merge together at the end of the down lead. The method of insulation should be apparent from Fig. 2.

Aerial Wire.

Copper, phosphor-bronze, silicon-bronze, or aluminium wire may be used for an aerial. The wire should be of a fairly large gauge, say No. 16 S.W.G. Stranded wire, such as 5/22, is the most suitable. Aerial wire of this description may be purchased in lengths of 100 ft. or 140 ft.; this is very often enamelled, which serves as a protection against corrosion.

The Earth Connection.

It is important to obtain an efficient connection to the earth, and usually a main water-pipe can be employed for the purpose. Connection should never be made to a pipe containing screwed joints, such as a branch pipe to a cistern, neither on any account should a gas-pipe be employed for the purpose. In arranging the position of the receiver, it should be placed as near the earth connection as possible. A very long earth lead should be avoided. Preferably it should not be more than about 20 ft. to 25 ft. Stranded copper wire may be used for the purpose, and it should be connected to the pipe as follows: The ends of the wire are opened out and well tinned. A small part of the surface of the pipe is scraped clean, and the ends of the wire are soldered to the pipe.

Earth Plates.

If a water pipe is unavailable, a metal plate should be buried at least 4 ft. below the surface of the earth, and if possible directly under the aerial. Wire netting, copper gauze, and copper and zinc plates are all equally useful for earths. The plate should be at least 6 or 7 ft. long and about 2 or 3 ft. wide. A number of thick (say No. 12 or 14 S.W.G.) copper wires are soldered to the earth plate, being twisted together and brought to the receiver. Since the plate is to be buried in the earth, the soldered connections are liable to corrode owing to electrolytic action. To prevent this it is essential to protect the connections by well covering them with paint or some insulating compound. It should be remembered that the more moisture there is in the ground the better will be the connection to the earth.

Protecting the Aerial from Lightning.

It will be obvious that an aerial will act more or less as a lightning conductor, and therefore it is advisable to protect the receiving apparatus during a storm. This is best accomplished by connecting a "micrometer spark gap" across the aerial and earth. The arrangement is shown at A (Fig. 4), and it will be seen that it consists of two very fine points separated by a very short distance. One is made adjustable, and the gap is set by screwing the points together until they just touch, when the movable one is given a fraction of a turn back until the connection is broken.

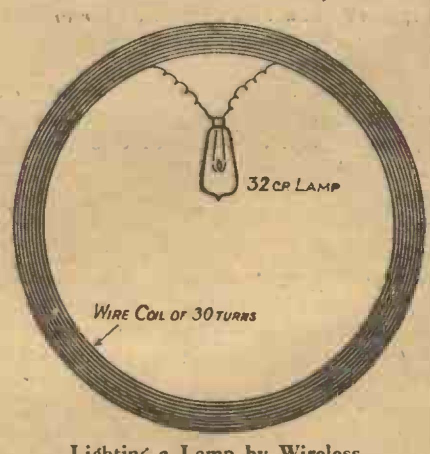
An alternative plan is to use a double-pole two-way switch. The aerial and earth are respectively connected to the blades of the switch, as shown in Fig. 4 at B. The upper contacts are short circuited and the lower ones are connected to the tuner. When the receiver is in use the switch is put into the lower position, thus connecting the aerial and earth to the tuner. It will be seen that when the switch is in the upper position the aerial is connected directly to earth, and at the same time the tuner is absolutely isolated.

PAUL D. TYERS.

Making the "Wave" Visible

AN interesting experiment for those who possess a spark coil is momentarily to light up an electric lamp by wireless, that is to say by a wave from the coil situated at the far end of a large room.

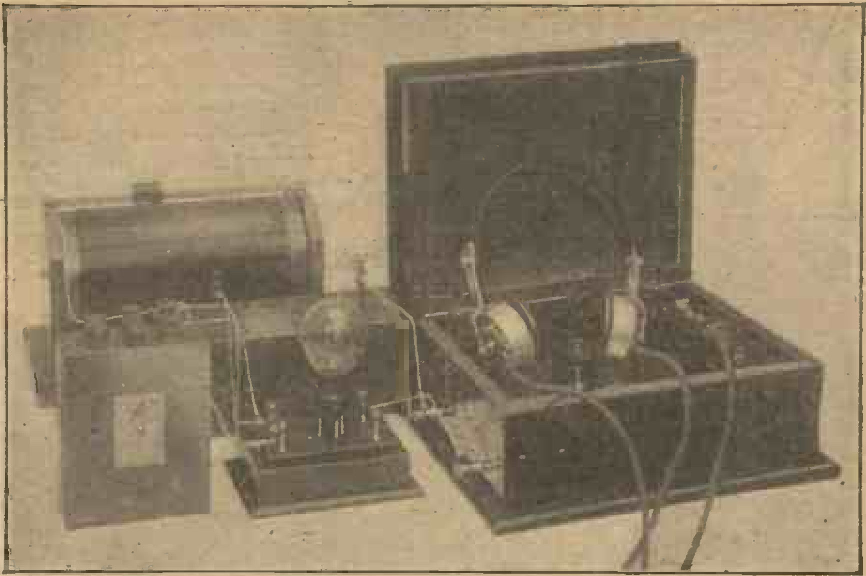
The ends of a coil of wire, consisting



Lighting a Lamp by Wireless.

of about thirty turns, 20 in. in diameter, are connected to a 32-c.p. lamp as shown in the illustration. When the coil is operated and suitable adjustment made, the wave passing into space will cause the lamp to light up.

W. W. D.



Photograph of Receiving Set with Crystal Detector and High-frequency Amplifier.

A SINGLE-VAL
SET AND HOW

THE EDITOR'S

THIS one-valve set has been specially d "Amateur Wireless") to follow on from and illustrated in the first number of this, hundreds of our readers, and we trust tha apparatus will be as welcome and as succ readers (1) who live at some distance fro space for aerials happens to be restricted advanced type of receiving apparatus t

AT the outset it may be remarked that to make everything which appears in the accompanying drawings from the rough material would require a well-equipped workshop, but most, if not all, of the parts which require special machining can be bought ready made. Those who have already made a crystal set will not have had their labour in vain, for most of the apparatus can be used in the set to be described. Those who have not made or used a crystal set are advised to do so before they attempt the valve set for two reasons. The first is that it needs a little experience to know how to get the best results from a home-made set, and the second that the mere use of a crystal set will thoroughly instil into the mind of the amateur that he must have all his apparatus thoroughly efficient.

One can sometimes afford to be a little wasteful when signals are amplified, but when it is impossible to put more energy into the telephones than is received by the aerial, which is the case of the crystal set, much will be learnt of the advantages of keeping insulation and apparatus up to the mark.

The Circuits.

Figs. 1 and 2 show alternative circuits which will give good results if the instructions are carried out in full. In both these circuits the valve acts as an amplifier. In the first it amplifies the radio-frequency currents which oscillate in the aerial circuit, and these magnified currents are passed on to the detector circuit on the right.

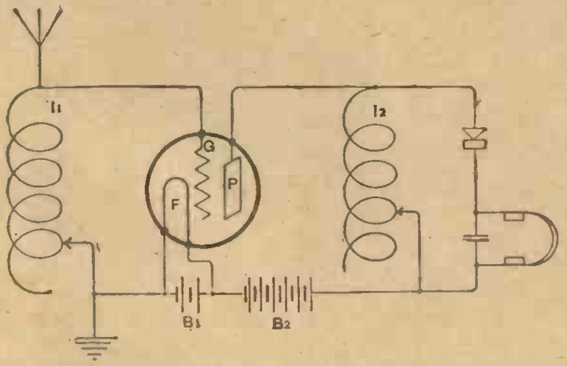


Fig. 1.—Valve as High-frequency Amplifier with Crystal Detector.

Fig. 3 may help to explain the meaning of the terms used. The top line represents two groups of high-frequency oscillations in the aerial circuit. These may be supposed to have been considerably amplified (increased in strength) by the valve. On passing through the detector circuit they are deformed in shape to be something like the second line, and the effect produced in the telephone may be likened to the third line oscillations, hence the term audio-frequency. In Fig. 1 the valve magnifies the radio-frequency current and allows it to pass on to the detector, and in Fig. 2 the valve performs the two operations of amplifying and rectifying together.

Apparatus.

The apparatus needed for circuit No. 1 comprises:

1. A complete receiving set.
2. An additional aerial tuning inductance.
3. A valve holder.
4. Battery B1 of 4 volts and battery B2 of 30-40 volts.

For circuit No. 2:

1. Aerial tuning inductance.
2. A valve holder.
3. Batteries B1 and B2.
4. Telephones with condenser.
5. Grid condenser C and grid leak L.

If the amateur has already two tuning inductances it would need less work to fit up circuit No. 1, but if he has not, it might be easier to adopt circuit No. 2; the latter also has the advantage that it can be very easily converted to a "regenerative circuit."

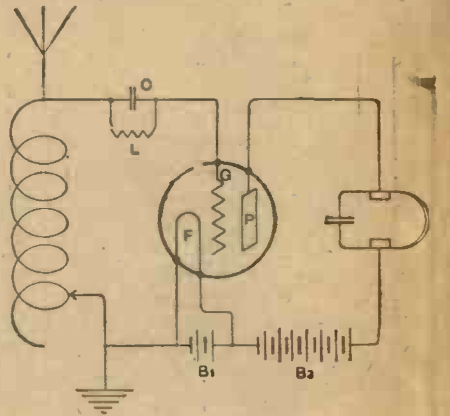


Fig. 2

Fig. 2.—(*above*) Valve as Detector and Low-frequency Amplifier Combined.

Fig. 6.—(*right*) Layout of Valve Panel.

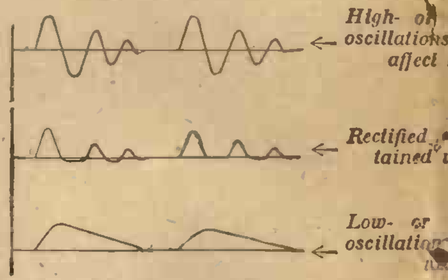


Fig. 3.—Diagrammatic Representation of Oscillations.

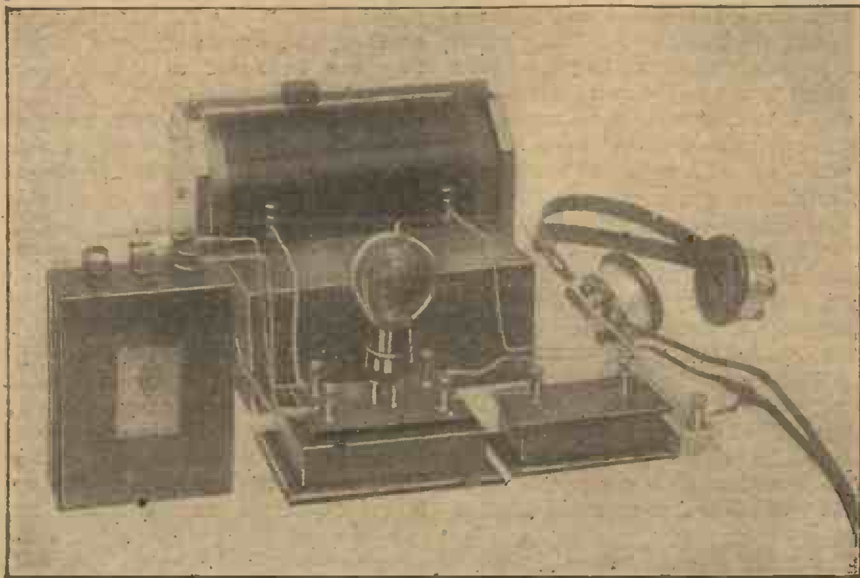
Valve Panel.

The valve panel is illustrated by Figs. 4 to 8. The top is made of a piece of ebonite 4 in. by 2½ in. by 3/16 in. thick; ⅛ in. thickness would do, but the thicker material will be stronger. The edges can be trued up

VE RECEIVING
V TO MAKE IT

NTRODUCTION

designed (at the request of the Editor of the "Official" crystal set fully described journal. The crystal set is being made by t the present and rather more ambitious essful. It will answer the needs of those m the broadcasting stations; (2) whose ; or (3) who in general desire a more than the crystal set above referred to.



Photograph of Receiving Set with Valve as Detector and Low-frequency Amplifier Combined.

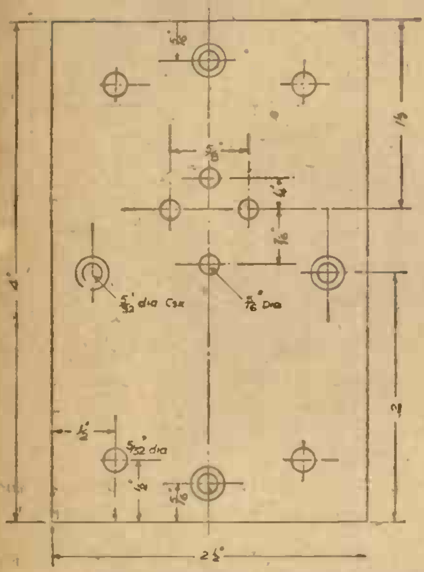


Fig. 6

radio-frequency (too rapid to telephones).

oscillations ob- with detector.

audio-frequency produced in ephones.

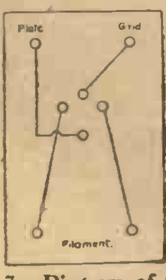


Fig. 7.—Diagram of Connections of Valve Panel.

and finished off smooth with an iron smoothing plane set very fine. Failing that, a "dreadnough" file will cut it better than any other. Fig. 6 shows the layout of the holes. The four holes for the valve legs should be marked out very carefully; they are drilled $\frac{3}{16}$ in. in diameter so as to allow a little play for adjusting the valve legs, which are screwed No. 4 B.A. (see Fig. 8A). They can be adjusted by placing them in position and pushing a valve right home. The nuts are then tightened up. If the valve legs cannot be made at home they can be bought for a few pence.

The legs and terminals should be polished and lacquered or they will quickly get dull on account of the sulphur in the ebonite. After the holes have been drilled the top can be finished off smooth with fine emery cloth, and a little oil rubbed over the surface will give a good colour.

The wooden part is made out of two solid pieces of mahogany or teak (or soft wood wil do) $\frac{7}{8}$ in. and $\frac{1}{4}$ in. thick respectively. Some of the thick piece has to be carved away to leave room for the terminals, valve legs and connecting wires, this, of course, being done when all the parts are assembled on the ebonite panel. If the maker is good at engraving he can mark the letters to the terminals of the plate, grid and filament, but otherwise they should be stamped on or marked in ink on the wood underneath. The connections of the terminals to the valve should be made with No. 20 gauge bare copper wire. A little piece of rubber tubing should be slipped over the plate connection which has to cross one of the filament wires.

Grid Condenser and Leak.

The next piece of apparatus is the grid condenser and leak, which will be needed for circuit. No. 2. These are shown in the diagrams Figs. 9 to 13, and also in the photograph. The condenser is made up of copper or tinfoil, both of which can be purchased from any electrical stores. There are six pieces of mica $1\frac{7}{8}$ in. by 1 in. and about 0.003 in. thick. The mica can be bought in thick pieces and is split with a sharp penknife. The thickness should be checked with a micrometer if possible, otherwise the only way to measure the thickness is to cut up a piece into $\frac{1}{4}$ in. squares with a sharp pair of scissors and pile thirty-four of these little squares together, when they should measure $\frac{1}{10}$ in. total thickness.

A little over or under will not matter very much. Care should be taken to obtain the mica as clear as possible. It can usually be obtained in 2 in. squares, and two of these should be ample for the purpose. The tinfoil is cut up into six strips 2 in. by $\frac{3}{4}$ in. and a hole punched $\frac{3}{16}$ in. from the end of each one. Copper foil is better than tin because it will not tear so easily, but tinfoil will answer quite well.

The "leak" is made of a piece of sheet fibre or ebonite $2\frac{5}{8}$ in. by $\frac{3}{4}$ in., with two holes made at each end $2\frac{1}{4}$ in. apart. Fibre is preferable; if ebonite is used it must be roughened with emery-cloth. A thick line with an H B pencil is drawn from one hole to the other, and the pencil is well rubbed in round the holes, as shown in the drawing, to make good contact with the clamping nuts. The

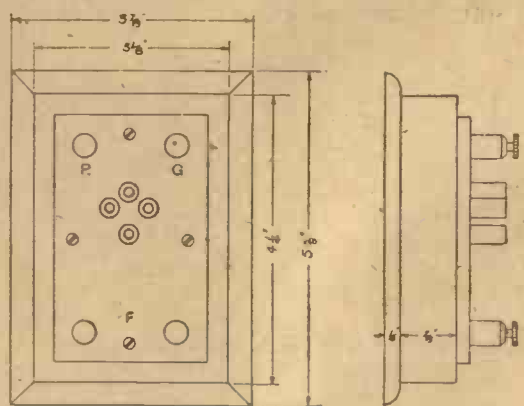


Fig. 4 Fig. 5

Figs. 4 and 5.—Plan and Side Elevation of Valve Panel.

box for the leak should be made of hard wood if possible. It is easiest to make it solid and carve the centre out like the valve panel, the bottom piece being glued on. A piece of wood or, better, ebonite $\frac{3}{16}$ in. thick is cut to the same size as the leak; this is to clamp the condenser down with. The terminals should be as shown in the drawing, with nuts and washers.

The condenser can now be assembled. First the terminals are pushed through the holes in the lid of the box, then the condenser is assembled in the following order: a piece of copper foil on one terminal, a piece of mica, a piece of foil on the other terminal, a piece of mica, and so on. These must be carefully laid on, one exactly over the other. When the last piece of foil is in place the ebonite strip should be pushed over the terminals and then the fibre with the pencil mark outwards. Washers and nuts are used to clamp the whole tightly together. The capacity of the condenser should be about .0003 microfarads and the resistance of the leak 2,000,000 ohms. The condenser will not need any adjustment once it is put together, as it will be approximately of the stated value if it has been made properly, but the leak will have to be adjusted when the set is in use. The method will be described later.

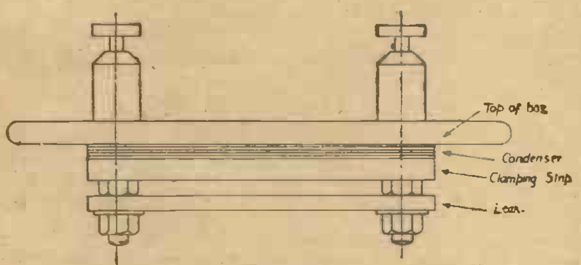


Fig. 11

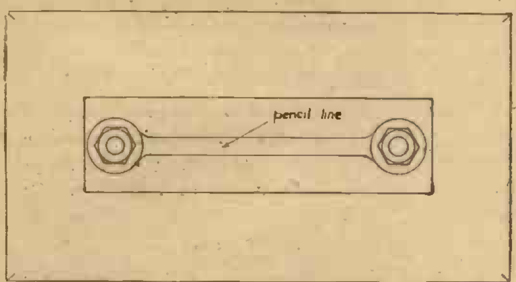


Fig. 12

Figs. 11 and 12.—Elevation and Under Plan of Grid Leak.

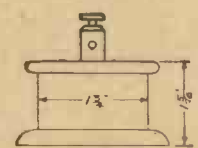


Fig. 9

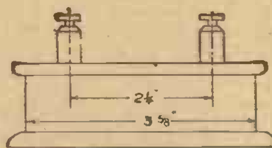


Fig. 10

Figs. 9 and 10.—Case for Grid Leak and Condenser.

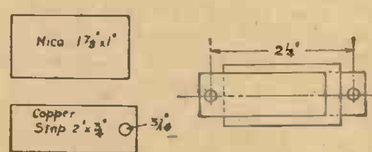


Fig 13.—Constructional Details of Condenser.

Batteries

The low-tension battery next claims attention. This is needed to light the filament of the valve, which may be an M or R type. These valves take a current of about ¾ amp. The two most suitable sources of current are accumulators or dry cells, and if there is any difficulty in getting accumulators charged, the writer would certainly recommend dry cells. The initial cost of four good cells (they must be large ones) will be about 12s. These should easily have a life of about fifty hours; a good cell has a total capacity of 70 ampere-hours. If not used too often they would perhaps last for three months or more, and when unfit for this purpose they can be added to the high-tension battery.

A 40-ampere-hour 4-volt accumulator will cost about 25, and must be charged every month whether it is in use or not. The cost of charging usually depends on the conscience of whoever does the job. It will probably be about 2s. per time. Of course, if more than one valve is used it would pay to have the accumulator because of the extra current consumed. A big disadvantage of accumulators is that they are messy and not easily portable.

It will be noticed that no filament resistance is included in the apparatus or diagram of connections. When using accumulators the writer considers that it is not worth the extra cost and trouble to have a 6-volt battery and variable resistance. A 4-volt battery can be connected straight on to the filament of the valve without the least danger of burning out, whereas one has to be careful with a 6-volt battery. When using dry cells it would be worth while including a rheostat, but instead a short piece of resistance wire could be inserted as a connection to get over the difficulty.

In this connection the writer would emphasise the need for a voltmeter if valves are used. It should preferably read up to 6 volts. It should also be used to check the voltage across the filament in order to see that it never exceeds 4.5.

The high-tension battery may be obtained in a number of ways. In the writer's case it consists of about thirty discarded electric-bell dry cells. When the voltage of a cell drops below 1 a hole is drilled in the top and a little water added; this usually freshens it up. Very little current is taken from the high-tension battery, so that there is no need to have new cells for the purpose if old ones can be obtained. An alternative is made up of three units of eleven cells; these units can be purchased for about 5s. each. Also twelve to fifteen pocket lamp batteries (3½ volt) might be used. It has already been stated that if dry cells are used for lighting the filament they can be passed on for this service when they are too old for the former.

When using old cells care should be taken from time to time to see that the voltage of any cell does not fall below 0.7 volt. The battery should be carefully insulated. It may rest upon glass plates, such as old photographic negatives, and preferably it should be enclosed in a box.

Operation.

Having now described all the apparatus which is needed, a few words on the working of the set may not be out of place.

Always take the valve out of the holder when making connections. If you accidentally connect the high-tension battery across the filament it will be a costly mistake.

To further obviate accidents a piece of ½ ampere fuse wire may be connected in series with the H.T. battery. No. 1 circuit will need two inductances; these should

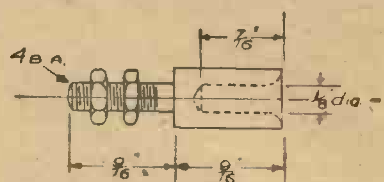


Fig 8a.—Valve Leg.

be about the same size, and when everything is connected up and you are listening for signals you should tune both circuits at once.

In circuit No. 2 only one inductance is used. The grid condenser is taken out of its box. When signals are heard thicken the pencil line on the grid leak and the signals should gradually become stronger. If too much pencil has been added it can be rubbed out. As it may take a little time to adjust the leak it should be done when a station is transmitting for a long time; for instance, the Paris weather report or the Admiralty signals. When the leak is finally adjusted it is put back in the box and the edges are sealed round with paraffin wax to prevent the ingress of moisture.

J. F. S.

A perhaps unusual source of noise in a receiving set was the presence of spiders' webs on the aerial. This particular aerial was low at the house end, and during last August a quantity of spiders' webs appeared on the insulators, etc. The first intimation of these was that signals were very weak, and the set would not oscillate above about 1,200 metres. Eventually this was found to be due to the webs, which caused fiendish noises in the telephones when the aerial swung about at all.

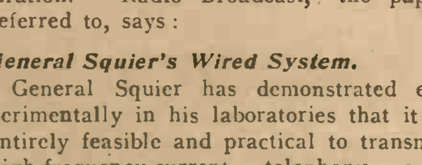
ELIMINATING THE AERIAL

The Squier System of "Wired Wireless"

IT is evident even to those who up to the present have only taken a superficial interest in wireless that one of the most desirable objects to be achieved is the elimination of the aerial. The aerial is the one inconvenient component of the receiving set. True, with a valve amplifying set frame aerials can be used, but then not everyone can afford such sets, and, moreover, many would not have the technical ability necessary for their operation. Obviously, the type of instrument that would be ideal for those whose chief interest in wireless telegraphy is simply the broadcasting reception would be one of the simplest nature and would not require an aerial.

To this public wireless is a means to an end and, providing that broadcasted programmes could be received successfully, their care is not whether the ether is the conveying medium or whether wires are used for transmission. In the latter case the installation of transmitting wires or lines is, of course, out of the question. But if use could be made of existing wires, say the lighting mains which are now general in all towns of any size, and this without affecting their ordinary use, a very useful object will have been attained.

That this is a possibility of the near future is proved by a demonstration recently given in America by General George O. Squier, Chief Signal Officer U.S.A., of the application of his system of "wired wireless." An American contemporary gives an account of the demonstration. "Radio Broadcast," the paper referred to, says:



Suitable Connections for the "Wired Wireless" System.

General Squier's Wired System.

General Squier has demonstrated experimentally in his laboratories that it is entirely feasible and practical to transmit high-frequency-current telephony over power lines and electric light circuits, and for it to be received by a large number of people by connecting receivers at various points on the line, the connection being made by a suitable plug in any light socket.

The transmitters or receivers are of the usual types now employed for wireless telephony and may be connected to the power line in various ways; the preferred arrangement used at present is shown in the illustration. In this method of connection the danger of short circuiting the mains is entirely avoided, the condensers between the mains acting as a by-pass for the high-frequency currents only, permitting the power current, direct or alternating, but of low frequency, to flow along the mains. For the wireless currents the two mains are connected in parallel and used as one conductor, the ground being the return conductor. Good results are also obtained by connecting the transmitters and receivers between the mains, suitably protected by condensers to keep the large power current from passing through the wireless apparatus, but the arrangement indicated above is more suitable.

Its Advantages.

The advantages of the line wireless method of broadcasting are many. In the first place, the ether channels used for wireless broadcasting are limited, and even the few wave channels which are available for broadcasting can be more profitably employed for such wireless activities where ether wireless is the only or best method of communication. Also since there is no wireless interference caused by broadcasting on power or lighting circuits, any number of wave channels may be employed and, therefore, multiplying the possible number of stations that can be operated on the same line. It is conceivable that in every community we may have several transmitting stations operating at the same time, but each on a different wave-length and supplying different services. One might be used exclusively for music, another for current news, and still another for educational information, etc.

A suitable plug connection in the light socket is all that will be required, so that wherever the light circuits extend, which is nearly universal these days, "wireless" broadcasting may be received.

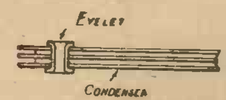
It is hard to realise at this moment the vast possibilities of this method of broadcasting, but judging from the universal interest in the preliminary announcement in the press, it is a fair guess that the system will come into general use very quickly.

There is nothing new in this idea; it occurred to many people years ago, but its fulfilment was just out of reach. For instance, it was found that if telephone currents were passed through an electric arc the original sound would be reproduced audibly, just as the old-fashioned alternating-current arc-lights would "hum" at the pitch of the circuit which supplied them. Someone proposed that a telephone transmitter should be connected to a city's arc-lighting system to broadcast police calls, news of robberies, etc. The difficulty, however, was that the arc-light was not a sufficiently "loud-speaking" receiver to be heard above street traffic, so nothing ever came of the idea. The problem of putting on another stream of "talk" without interference was only solved when a reliable method was found for using a high-frequency electric current as a "carrier."

TWO KINKS

A CONDENSER HINT

IN the construction of small fixed condensers difficulty is often experienced in making connection to the tinfoil sheets. A simple and effective method is to use ordi-



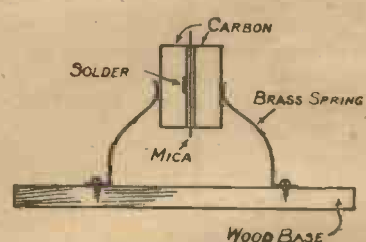
Condenser Plates Held by Eyelet.

nary eyelets to fasten the plates together. If several condensers are made of uniform dimensions they are easily interchangeable. The method of application is illustrated above. A. M.

LIGHTNING PROTECTOR

A VERY efficient lightning protector can be made from a thin sheet of mica and two discarded carbon brushes such as are used on electric motors and dynamos.

Drill a hole in the mica about $\frac{1}{16}$-in. diameter and one in a brush the same



Lightning Protector.

diameter but ⅛ in. deep, and fill this hole with soft solder. Then place the brushes together with the mica between, care being taken to ensure that the hole in the mica is opposite to the solder. Mount the protector on a well-varnished board, and fasten with clips. One of the brushes should be connected to the aerial, the other (containing the solder) should be connected to earth. J. L.

RADIOGRAMS

Wireless parties are being organised now.

■ ■ ■ ■ ■

One broadcasting station in New York sends out no fewer than ten musical programmes a day.

■ ■ ■ ■ ■

Three Continental wireless services are now being conducted simultaneously from the Ongar Marconi stations.

■ ■ ■ ■ ■

The European wireless weather report, transmitted daily at 11.30 a.m. (Greenwich Mean Time) from the Eiffel Tower, is now being supplemented by data from America.

■ ■ ■ ■ ■

The *Almanzora* recently, when sixty miles north of Fernando Noronha, exchanged wireless signals with Cape Town, a distance of 3,457 miles, thus constituting a wireless record for the South Atlantic.

■ ■ ■ ■ ■

Radio House, Wilson Street, Finsbury Square, E.C., is the newest sending station of the Marconi Company. The station is for the control of the new station at Ongar. A continuous wave is sent out from Ongar, and that wave is interrupted at Radio House.

■ ■ ■ ■ ■

"Fire" in an editorial says: The fire hazards of the country are likely to be considerably increased by the broadcasting of wireless news and the installation of thousands of receiving sets by amateurs. It is well to be forearmed, because carelessness or ignorance in the setting up of an installation and use thereof may cause much fire damage, and at the least interfere with fire-alarms that have aboveground wiring.

■ ■ ■ ■ ■

Considerable acceleration of the commercial wireless service existing between England and Spain has been secured by the recent transfer of this service from the Poldhu station to a new Marconi station at Ongar. Under the new conditions messages to Spain, marked "Via Marconi," instead of being relayed by long land line circuits to Cornwall, are transmitted direct by distant control from Radio House, Wilson Street, E.C., to the receiving station in Spain.

■ ■ ■ ■ ■

An entirely new automatic receiver is claimed to have been invented by a Newcastle engineer. The apparatus is tuned to a certain station, and it switches itself on at certain times of the day in anticipation of scheduled transmissions, and afterwards switches itself off until the next one is due. Of course, time switches are not new, for they have been in use for electric lighting, etc., for some time, but this appears to be the first attempt to apply them to wireless.

■ ■ ■ ■ ■

A great number of schools are taking up the subject of wireless, and are accordingly installing suitable apparatus. Two recent additions are the Lowestoft Central School and the school at Grayswood, Surrey. In the latter two pupils are detailed each morning to take the time signal from Paris, and to adjust the school clock accordingly. The daily weather report is also received each day from the Air Ministry's station at Kingsway House. A wireless lesson is given each week to a large class of scholars, all of whom can "listen in" simultaneously by means of a loud speaker.

■ ■ ■ ■ ■

According to the latest reports broadcasting is delayed for three reasons which may be summed up as follows:

Differences have arisen in regard to the erection of the broadcasting stations.

Manufacturers desire protection for British-made wireless sets. They argue that hardship will be involved if, after they have incurred heavy expenses in the erection of the broadcasting stations, foreign manufacturers are allowed to flood the market with receiving sets.

The special machinery and apparatus require a considerable time for construction and installation.

It is thought improbable that there will be much further delay.

It is understood that the majority of the broadcasting firms are in favour of an increase in the cost of the licence, and it is proposed that the suggestion should be put before the Postmaster-General. It is suggested that the extra fee should be 10s. 6d., making the total yearly cost to the amateur £1 1s.

■ ■ ■ ■ ■

Some little time ago a technical journal devoted considerable space to a method of transmitting photographs by wireless. In its present form the system is rather involved; at the same time, considering the vast strides made in the past few years it is quite within the bounds of reason that a method of broadcasting photographs may be evolved shortly which will enable pictures of, say, a big fight, race meeting or other public function to be flashed from the nearest broadcasting station to be picked up by any private station equipped with suitable reception apparatus.

It only needs a small flight of the imagination to see a future Derby photographed, wirelessed from the course by a super-directional transmitter, received and projected on the screen of a cinema ten minutes later!

■ ■ ■ ■ ■

Speculating as to the future of the wireless industry a writer in the "Sunday Chronicle" uses the gramophone for purposes of comparison. According to this writer there are roughly two million gramophones in use in this country. Every year about 150,000 gramophones are sold to the public, of which roughly 25 per cent. are made complete in this country, 50 per cent. contain foreign mechanism, and 25 per cent. are imported from the Continent. The capital employed in the industry is about £5,000,000 for manufacture and £1,000,000 for wholesale distribution. The number of people employed in the industry is, roughly, 10,000, and the number of dealers who handle gramophones 8,000. Every year about £10,000,000 worth of gramophones are sold throughout the land.

Assuming, therefore, that there are as many people willing to buy wireless sets as there are to buy gramophones, this country ought to be able to absorb two million sets. If the average investment on every set were only £5, the total investment would be £10,000,000. If the country could absorb these two million receivers in a period of five years this would mean an average of £2,000,000 of new business each year with employment for several thousand people, and that is a very moderate estimate.

"Wireless in the Tropics."—With reference to the photographs used in a recent issue to illustrate this article, Mr. Chatwin asks us to state that these were taken by Mr. J. A. Cooper, A.M.I.E.E., who has a collection of photographs illustrating the East African campaign from 1916 to 1918.

CORRESPONDENCE

Can any Reader Kindly Explain?

SIR,—In all the text-books I have read I have been informed that the medium through which the electro-magnetic waves (used in wireless) travel is the same as that of light. This medium is called ether and is all-pervading. Below is a rough table of wave-lengths radiated in this ether.

X-rays, about 2.5 millionths of an inch.

Actinic rays of maximum intensity, 10 millionths of an inch.

Heat rays of maximum intensity, about 15 millionths of an inch.

Electric rays, shortest measured, 0.24 in.; as used in wireless, about 300 ft. to 50,000 ft.

It is quite commonly understood that the velocity of the above waves are all the same, namely, approximately 186,000 miles per second, hence the argument that the medium must be the same for each. Now, the velocity of sound is much smaller, being 11,120 ft. per second, the medium for sound-waves being air. An experiment proving that the medium for sound waves and the medium for waves of light are entirely different is easily demonstrated by the classical experiment of placing an electric-bell under the bell-jar receiver of an air pump and removing the air. Upon the circuit being closed the trembler of the bell is seen to vibrate, proving that the medium of light which allows us vision still exists within the bell-jar; also that the sides of the vessel are transparent to the waves of light. One cannot, however, hear the action of the trembler because, the air being withdrawn, there is no medium for the sound-waves to travel in.

My difficulty, which I would like explained, can be very clearly presented by changing the substance of the bell walls. Instead of glass let it be porcelain (an insulator), or any substance opaque to light waves. We can now neither hear nor see the action of the trembler blade, but if we have a sensitive detector of electrical oscillations placed outside of the jar we can easily detect these oscillations caused by the spark at the trembler blade. I think this proves that electro-magnetic waves do not follow the laws which govern light waves. By this experiment it is shown that electro-magnetic waves will pass through intervening objects which are impervious to light waves. My difficulty is in satisfying myself that the medium for light and wireless transmission is the same. At present I cannot believe it and wish it could be made clear.

Referring to the table of wave-lengths, I can understand X-rays passing through substance because they are so minute. All substances, it is generally agreed upon, are made up of molecules separated by spaces which are filled with ether. If this is so one has no difficulty in realising the probability of X-rays waves creeping through these spaces between the molecules. However, wireless waves are very large and could not possibly creep through. I am aware that wireless waves can be distorted, but even this fact does not help us to an easy solution of the above experiment.

At the present day when signals can be readily heard without an outside aerial, the apparatus being totally enclosed within four walls of a room in the centre of a house, it is not to be wondered at my doubting the assumption that the medium for light waves and the medium for electro-magnetic waves are identically the same.

The waves of light from the sun do not travel all around the earth's surface. In the case of wireless transmission, however, the electro-magnetic waves are well known to follow the earth's surface.

All this may be very easily explained. I have never had it made clear to me, and upon asking quite a number of wireless enthusiasts I find they are just as much in the dark. I would be greatly obliged if you would insert this query in your most helpful journal and let myself and others have the benefit of other readers' scientific knowledge.—G. B. (Sacriston).

Freak Results

SIR,—F. H. M.'s letter on freak results has greatly interested me, as only the other day I had a similar experience of receiving signals without an aerial. I use a one-valve set, and was in the act of disconnecting the outside aerial and changing over to a home-made frame inside when I heard signals, my hand touching the end of the aerial wire (not the terminal). This so interested me that I called my friend in, and signals were still heard when he touched the aerial wire. This seems remarkable, as neither of us had any connection with the apparatus. Can anyone account for this? Another little experiment was receiving telephony from Marconi House with a simple crystal set, using the above-mentioned frame aerial. My station is only about 2½ miles from Marconi House, which may account for this, but the frame is a very primitive affair, consisting of two pieces of wood (4 ft. by 4 in. by ¼ in.) made in the shape of a cross and wound with fourteen turns of No. 28 enamelled wire. No other insulation is used. The frame is hidden away in a dirty little office in the city, with high buildings all round and a P.O. telegraph pole on the roof.

I may say that my valve set works very well on this small frame.—L. P. S. (City).

CLUB DOINGS

The Hackney and District Radio Society

Hon. Sec.—E. R. WALKER, 48, Dagmar Road, South Hackney, E.9.

THE third meeting of the above Society took place on June 22nd at 111, Chatsworth Road, Clapton, at 8 p.m.

A meeting, to be held on July 7th, will be open to the general public. An elementary lecture on the "Principles of Wireless" will be given, terminating by the reception of telephony and music. The apparatus to be used will consist chiefly of units made by members.

Birmingham Experimental Wireless Club

(*Affiliated with the Wireless Society of London*). *Hon. Sec.*—MR. FRANK S. ADAMS, 110, Ivor Road, Sparkhill, Birmingham.

AT a meeting held at Digbeth Institute on Friday, June 16th, a lecture was given by S. H. V. Abbott, Esq., on "Wireless at Sea"

Mr. Abbott described wireless systems and methods since the earliest days of marine wireless. An interesting programme of lectures, discussions, and demonstrations has been arranged for the summer months.

Leeds and District Amateur Wireless Society

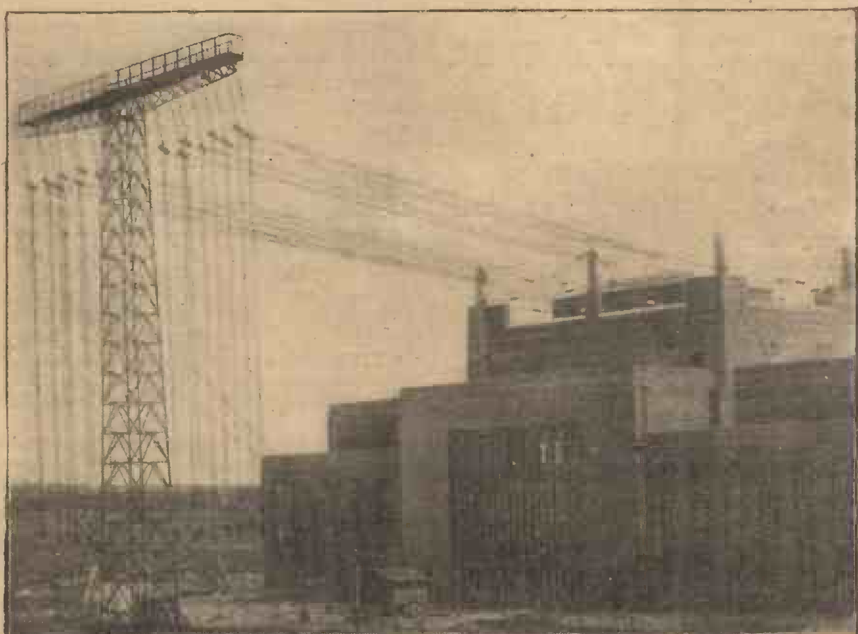
(*Affiliated with the Wireless Society of London*). *Hon. Sec.*—MR. D. E. PETTIGREW, 37, Mexborough Avenue, Chapeltown Road, Leeds.

A GENERAL meeting was held on Friday, June 23rd, at the Leeds University. It had been found impossible to arrange a discussion on "Direction Finding," as scheduled in the syllabus, but Mr. G. P. Kendall, B.Sc. (Vice-President) had offered to describe his four-valve receiver.

This set, Mr. Kendall explained, was still in the experimental stage, being assembled in the well-known 50-watt trench-set cabinet, and

(*Continued in second column of next page*)

"POZ"



One of the great German stations which amateurs are constantly hearing. In addition to much Press work it transmits time signals and weather observations.

OUR INFORMATION BUREAU

Expert Replies to Readers' Questions. Hundreds of Replies are sent by Post.

TO ENSURE A PROMPT REPLY PLEASE OBSERVE THE FOLLOWING RULES

Write distinctly, give all necessary details and keep to the point. Ask one Question at a time—never more than two. Send a Stamped and Addressed Envelope. Send the Coupon cut from page 98.

Range of Apparatus

Q.—Please say what signals could be received by means of the receiving apparatus as described on p. 10 of the first issue of AMATEUR WIRELESS if erected at Luton. —F.H. (26)

A.—The receiving set referred to, when used in conjunction with the usual "amateur" aerial should prove capable of tuning in wave-lengths from about 150 to about 700 metres. Therefore, in the first instance signals can be received from stations which employ waves between these limits. These will include ships and coast stations (on 600 metres), amateur transmitting stations (180 metres), telephone stations (amateurs on 180 and 440 metres, proposed new broadcasting stations on 350 to 425 metres), and a few ship and shore stations working on 300-metre waves. This is quite a fair selection, but it must be remembered that the question of range must be considered, and this is a most difficult matter to estimate, depending upon several factors such as (1) the power employed by the distant transmitting station; (2) the height and efficiency of the receiving aerial; (3) the efficiency and sensitivity of the receiving apparatus; and (4) the very important question of the skill of the receiving operator. It is considered, however, that, with a good aerial, average care in the construction and use of the apparatus and the use of really good telephone receivers, the signals receivable should include "spark" telegraphy from shipping and several English coast stations as mentioned above, together with telephone (speech, music, etc.) from one or two of the nearest of the proposed new broadcasting stations. With regard to this latter, however, it must be understood that until the stations actually commence operations it is impossible to state with any degree of accuracy just at what distance their transmissions should be receivable upon a crystal receiving set.—CAPACITY.

Gauge of Wire for Inductance

Q.—(1) Would it be possible to use No. 36 S.W.G. bare copper wire for the "Official" receiving set described in No. 1, as I have plenty on hand? (2) The method of wiring up the crystal detector is not quite plain to me. Will you kindly give me some information, and also, what is the best crystal to use?—A. E. S. (194)

A.—(1) No. 36 S.W.G. wire is too small to use as a single wire for an inductance coil of low wave-length. No. 26 wire has a cross sectional area of .00025 sq. in., whereas No. 36 has an area of only .000045 sq. in. However, if five strands of No. 36 were twisted together they would give the same area as one strand of No. 26. Stranded wire has the advantage over single wire that there is greater surface for the same cross-sectional area, and as high-frequency currents flow chiefly at the surface of a wire, and not uniformly all through as direct currents do, the stranded wire will offer less resistance. To strand the wire a clear space of about 100 ft long will be required. The wire should be laid out straight on the ground in five pieces of exactly the same length. The ends are twisted together, and one end is fastened to a firm object. The other end is then twisted. This may be done in various ways, the best being to fasten it in the chuck of a drill brace, and rotate it until it is evenly twisted all the way along. The wire should be pulled tight all the time. When finished, unwind a little to take the spring out of the wire, and coil it up carefully. The stranded wire may now be wound on the inductance. To keep the turns from touching one another, a ball of fine string is wound on at the same time side by side with the wire. The whole can then be varnished with shellac and baked dry. (2) The connections to the crystal were quite clearly shown in the drawing. The aerial wire is connected to one switch arm and the crystal itself. The pointer touching the crystal is connected to one terminal of the telephones. The other telephone terminal is connected to the other switch arm and to earth. Use silicon or French galena.

SHORT ANSWERS

Amateur (Cheshire).—(1) Coloured polish may possibly act as a conductor and "short" your detector. Use insulating varnish over wood. (2) One layer only. (3) Clean off insulation only on the surface edge of the wire; brush the coil in the direction of the "lay" of coil afterwards to remove dust, etc. (4) A pocket-lamp battery will last longer than a Leclanché cell, and would not run down so quickly owing to high resistance of potentiometer. Voltage is required, not current. (276)

W. H. H. (Macclesfield).—You should certainly be able to receive over a longer range of waves, but it would not increase or decrease your reception of signals over long distances. Wave-length has nothing whatever to do with distances in miles. Other instruments do not need altering. (166)

CLUB DOINGS (*continued from page 95*)

utilising some of this set's components. The first valve functions at radio frequency having potentiometer grid control, and is directly coupled by means of reactance-capacity or resistance-capacity methods to the grid of the rectifier, which functions on the grid condenser system. The set is provided with magnetic regeneration taken from the plate side of the rectifier to the aerial circuit, which will provide for the reception of continuous waves if the coupling be tight enough to set up self-oscillation or autodyning. Two stages of low-frequency magnification follow, and by means of a plug-and-jack combination, the telephoner or loud-speaker may be placed in the plate circuit of either the rectifier, the first L F valve or the second L F valve. The receiver uses valves and will function on all wave-lengths, being very useful for telephony reception. Theoretical and practical diagrams of the scheme of connections were explained briefly but clearly by the lecturer.

Wireless Society of Hull and District

Hon. Sec.—H. NIGHTSCALES, 16, Portobello Street, Holderness Road, Hull.

THERE was a large attendance of members at the monthly meeting of the above Society, held on June 10th at the Signal Corps Headquarters, to hear a paper by Mr. W. J. Featherstone, entitled "Miscellaneous Subjects Relating to Wireless." The lecturer gave a clear description of the various detectors (past and present), and explained the various uses to which a relay could be put. He exhibited a good type of this latter piece of apparatus. Mr. G. H. Strong (President), who occupied the chair, proposed a vote of thanks, which was seconded by Mr. C. Dyson (another pioneer). Fourteen new members were elected. Intending members should get in touch with the Hon. Sec.

Stockton-on-Tees and District Amateur Wireless Society

Hon. Sec.—MR. W. F. WOOD, 4, Birkley Square, Norton, Stockton-on-Tees.

THIS society is only a month old, but is one of the largest in the district, having close upon eighty members. Permanent rooms have been taken in the Malleable Workmen's Institute, Norton Road, with the use monthly, for lectures, etc., of the large concert hall. An aerial is being arranged for, and considerable apparatus has been placed at the disposal of the members.

A Club official will be in attendance in the rooms every evening.

The membership is open to persons of any age, including ladies. The general meetings take place on the second Thursday in every month.

Wireless Society of Highgate

(*Affiliated with the Wireless Society of London*). *Hon. Sec.*—MR. D. H. EADE, "Gatra," 13A, Sedgemere Avenue, East Finchley, N.2.

MR. J. STANLEY, B.Sc., A.C.G.I., gave the third of his series of lectures on the elementary theory of wireless telegraphy and telephony on Friday, June 23rd. After briefly alluding to the different types of aerials and indicating the functions of the earth connection, Mr. Stanley went on to deal with tuned circuits He showed how, by coupling a coil in an oscillatory circuit with a coil in another circuit, oscillations could be induced in the second circuit, and that these oscillations would have maximum strength when the natural frequency of the second circuit was the same as the natural frequency of the first circuit. He pointed out that by this means energy could be transferred from one circuit to another, the amount of energy transferred being largely governed by the tightness of the coupling between the coils. Mr Stanley showed that the closed circuit coupled to an aerial circuit is such an arrangement, and, since in this case it is desired to radiate as much energy as possible from the aerial, he dealt with various methods employed in practice to prevent the energy transferred from the closed circuit to the aerial circuit being re-transferred back to the closed circuit, mentioning in particular the rotary and quenched spark gaps. He then passed on to consider the receiving station, and showed how electro-magnetic waves impinging on the receiving aerial produced oscillations in the aerial circuit, and that these oscillations would be of maximum strength when the receiving aerial was tuned to the same frequency as the trans-

mitting station. He pointed out the various methods of increasing or decreasing the natural frequency of an aerial by suitable combinations of inductance coils and condensers. At the conclusion of the lecture, the whole of which was followed with great interest by the audience, a cordial vote of thanks was given to Mr Stanley.

The South London Wireless and Scientific Club

(Affiliated with the Wireless Society of London)
St John's Institute, Larcom Street, S.E.17.

RECENTLY Mr. Walsh gave a very interesting lecture on high frequency, accompanied by practical demonstrations with a 10-in. spark coil, glass-plate condensers, Oudin coils, etc., besides furnishing very interesting data regarding the construction of this type of transmission apparatus.

This lecture was followed by one by Mr. Wilkinson on "Cinematography," with special reference to kinematics. Having dealt with the projection, manufacture, and taking of the cinematograph film, he then dealt with the theory of light rays.

FORTHCOMING EVENTS

Ilkley and District Wireless Society. July 5, 7.30 p.m., Committee meeting; 8 p.m., lecture and demonstration on "Short-wave Telephony Reception."

Leeds and District Amateur Wireless Society. July 14, 8 p.m. Lecture by Mr. D. E. Pettigrew on "Maritime Radio Communication."

TELEPHONY TRANSMISSIONS

The Hague, Holland (PCGG). 1,070 metres. July 9, 3 to 5 p.m.

Writtle (2MT). 400 metres. July 11, 8 p.m.

Eiffel Tower (FL). 2,600 metres. Each afternoon (Saturdays and Sundays excepted).

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Competition No. 1.—A wireless set is offered for the best article of about 1,500 words, written from your own personal knowledge and experience, and calculated to help or interest your fellow amateurs. Illustrations will in most cases be regarded as a feature of merit. Articles should be written in simple language and be as bright and informative as possible, and the subject may be anything that you think wireless amateurs would care to read about. Should we publish any article that does not win the prize we shall pay for it.

Competition No. 2.—Another set is offered for a brief description (with illustration if necessary) of the *most novel and useful* item in wireless apparatus—in its design, material, make, electrical connections, etc. etc. The novelty must be original—not copied from any source whatever.

Competition No. 3.—The third receiving set will be presented for an ideal broadcasting programme of twelve items. You can enter for this competition on a penny postcard. Simply write down in column form twelve items that you consider would make an ideal programme.

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Do., Egg Insulators (high insulation) 9d.	Inductance Tubes 12" × 3" ... 6d.
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How Wireless Telephony is Made Possible (Pages 110-112)

Amateur Wireless And Electrics

No. 6 SATURDAY, JULY 15, 1922 Price 3d

Wireless at the Westminster City School, where messages from Belein, South America, 5,000 miles distant, have been received.

The Apparatus here shown is used in conjunction with a Frame Aerial 40 inches square wound with 60 turns of wire.

Wireless Class at Westminster City School

NOTE THE CONTENTS OF THIS NUMBER

Plenty of Illustrations

Amateur Wireless and Electrics

No. 6 July 15, 1922

Fortunes Awaiting the Inventor?

Substitute for the Valve :: New Circuits :: Loud Speakers, etc.

MANY of the epoch-making inventions by which the world has benefited have been due to the efforts of dabblers in science. The prizes in the field of invention are always more plentiful when a subject is in its infancy, and in this respect wireless is peculiar, for few subjects have had such rapid development. At the same time, however, it is evident to the most casual observer that only the fringe has been touched upon.

Discovery is not always the perquisite of the highly-trained mind, as a study of many of the important inventions of the world will show, and it is the purpose of this article to indicate to the ordinary amateur some matters that require elucidation and improvement which are quite within his scope and, possibly, capability.

A Substitute for the Valve.

Perhaps the most imperative need is the discovery of an efficient substitute for the valve detector, or, failing that, a substitute for the incandescent filament which is the all-important part of the valve. The valve itself, wonderful though it is, is really a very inefficient device studied from the point of view of energy consumption or the relationship of the input to the output. There are, no doubt, many substances yet to be discovered suitable for the purpose of detection in wireless receivers beside which the valve will be a puny implement.

But to take the valve as it is, the question of a substitute for the electron-giving filament commands the attention of all, particularly from the point of obtaining something which would give off electrons without the relatively huge consumption of electrical energy as in the present valve.

It has to be admitted that research on these lines is limited to a very few, but there is every chance of the amateur lighting on some substance or combination of substances which will give the desired result.

New Circuits.

Another good field for the efforts of the fortune-hunting amateur is that of devising new circuits by which the sensitivity or the amplification properties of the valve can be increased. This is a line which will appeal to many since it involves very little expense; the cost is a vast amount of patient endeavour.

Atmospherics.

The elimination of atmospherics also requires much research and offers great reward. Everyone who has used a receiver knows of the disturbing effect of the various cracklings, etc., caused by atmospheric disturbances. In commercial wireless, particularly in tropical countries, these disturbances necessitate the expenditure of a vast amount of energy in order to communicate over short distances. The atmospherics are a terrible inconvenience, and a great reward awaits the inventor of a device that will entirely eliminate them.

Telephony.

Then in the matter of telephony there is a number of devices required, the inventing of which will undoubtedly be to the pecuniary advantage of the inventor.

Firstly, there is duplex telephony. In wireless telephony it will have been noticed that "cross talk," such as takes place on the land-line telephone, does not occur. If two stations are working one with the other, the first station has a few minutes' talk, changes over from send to receive (the same aerial is used for sending and receiving, the connections from the transmitter and the receiver being effected by switches or other means as desired), and the other station makes whatever reply is necessary. This from a commercial point of view is a great disadvantage; it is often very necessary that one should be able to interrupt a conversation, apart from the time which is lost.

The present line of research on this subject runs on what is known as the "quiescent aerial," that is, an aerial from which radiation only takes place when speech or sounds are made in the microphone and which eliminates the carrier wave sent out by many of the present systems. Another method involves the use of relays automatically to change over the connections of aerial and earth when it is desired either to send or receive.

Secrecy.

A further necessity to the commercial development of wireless telephony is some method of making conversation unheard except by the person to whom it is addressed, or, in other words, attain the same amount of secrecy as is obtainable on the land-line telephone. A great deal of research is going on with reference to the directing of ether waves to definite points so that unauthorised persons may not listen in to any communications.

A necessary corollary to this secrecy is a device which will enable any definite wireless station to be called up at will. At present there is no device in existence which will enable an exchange to operate with a number of subscribers on its switchboard. The method now involves either a constant watch being maintained or attention at definite times when stations can communicate. It is quite obvious that a simple device is necessary that will enable either a wireless exchange to be operated or at least which will enable two stations to work without the danger of signals from any other stations operating it and causing false alarms.

Loud Speakers.

From the amateur point of view the invention of a good cheap loud-speaking device is a great necessity. There are, of course, a number of such appliances on the market, but few of them utilise any of the well-known acoustic effects whereby amplification of sound can be obtained at little or no cost. The present devices are, in the main, large editions of ordinary telephone receivers, or they operate on a system that simply eats up energy with no corresponding increase in the volume of sound. Few of them are anywhere near acoustically perfect.

There are, of course, one hundred and one devices which are necessary and to which the budding inventor can apply his talents. The few particularised in the foregoing remarks are matters requiring the urgent attention of every investigator and experimenter.

A final word. Protect all ideas which you think are of any value at all after they have received the consideration of a good reliable patent agent. T. B. T.

A Well-made Crystal Detector

THE detector shown by the photograph (Fig. 1) and in elevation and plan by Fig. 2 will interest those who have the time and inclination to make apparatus of the best materials and pleasing design. Doubtless a detector giving just as good results as the one here described could be made in half the time, but there is a good deal to be said for making something that is worth looking at when it is finished.

Every amateur has his own particular crystal or combination of crystals that he swears by, and this detector will work equally well with silicon or treated galena, and with a little modification it could be used with zincite and bornite. The writer has always used silicon, chiefly because it is easy to obtain a good sample and because it does not need a potentiometer and dry cell.

The base of the detector in the writer's case was made from an iron chuck plate casting which happened to be about the right size. A brass casting would do equally well, or better, and could be finished all over and polished. It is advisable to have a heavy base as it prevents the detector getting out of adjustment owing to vibration. The iron casting was turned up to the dimensions shown in Fig. 3 and polished only on the boss, the rest being enamelled black; three small ebonite studs were fastened in the bottom for it to stand upon. The two holes for the terminals are made 1¼ in. apart. One is drilled and tapped No. 3 B.A., and a short stud projecting $\frac{7}{16}$ in. screwed in. The other is drilled ¼ in. and fitted with an ebonite bush at the bottom (not shown in the drawing) for the terminal which is connected to the crystal cup. The terminal base of ebonite (Fig. 4) is held in place by the two terminals, the left hand one being screwed on to the stud.

Fig. 5 shows the arrangement of the crystal cup. It is insulated from the base by two ebonite bushes which are clamped together with the nut and washer at the bottom, a short piece of copper strip being soldered to the washer and carried under the right-hand terminal. The cup is made from a piece of ½-in. brass rod drilled out as shown, and the crystal is fixed in place with Wood's metal.

The pillars (Fig. 6) are made from ⅜-in. brass rod. It is probably quicker to drill out holes in the end and solder pieces of No. 3 B.A. tapped rod in place than to turn the screws down from the solid.

The bridge for the ball and socket joint (Fig. 7) is made from ½-in. by ⅛-in. brass strip, drilled out with a ¼-in. hole in the centre, and countersunk with a larger drill to take the ball. The strip which holds the ball in place must be very carefully bent so as to get the holes in the correct position. It is best to turn the ball first and fit the joint to it afterwards. A gauge for testing the roundness of the ball can be made by drilling a ½-in. hole in a piece of sheet metal and cutting out a section of the curve. As will be seen from the assembly view a small terminal nut is used finally to adjust the tightness of the joint.

Fig. 8 shows the construction of the "point." It is made from No. 3 B.A. tapped rod, and has a ½-in. ebonite sphere at one end. The other end is drilled out with a $\frac{1}{16}$-in. hole for a short distance. The rod should be a fairly tight fit in the hole through the ball, but not too tight or the ball itself will turn. A gramophone needle is then soldered in position as shown. A piece of fine steel wire is wound on the end of a $\frac{3}{64}$-in. drill, and when this is allowed to spring it will be found to make a good tight fit on the needle. The end of the wire can then be bent to point along the axis of the needle. The object of the needle is to prevent the coiled spring being damaged if it is screwed down too far. Very good results can be obtained by bending the point of the spring back on itself, that is, U-shaped, as a very sharp point is not the best for a silicon detector.

Fig. 1.—Crystal Detector Complete.

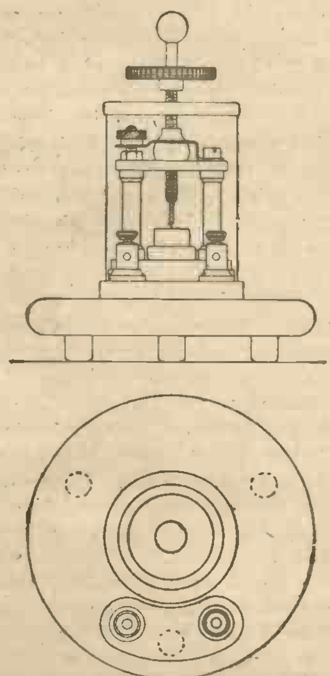


Fig. 2.—Elevation and Plan of Detector.

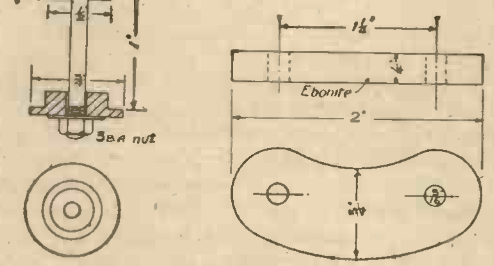


Fig. 5 Fig. 4

Figs. 4 and 5.—Details of Terminals, Base and Crystal Detector.

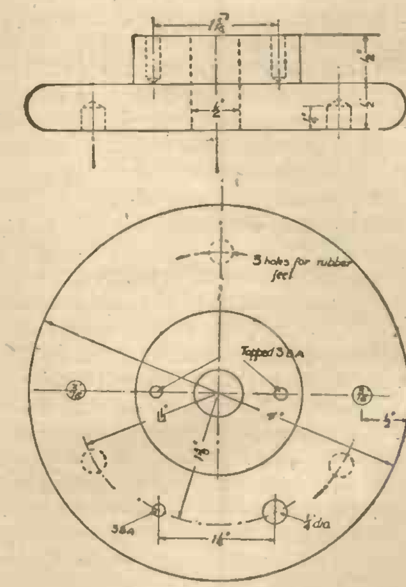
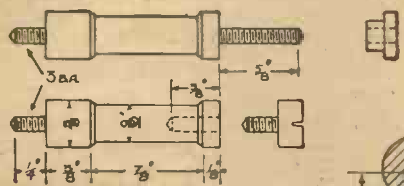


Fig. 3.—Details of Cast-iron Base.

The bridge and crystal cup are all enclosed in a clear celluloid cover. This can be made by bending a piece of 1/32-in. sheet celluloid round a 1¾-in. diameter former, allowing a ¼-in. overlap which can be cemented up with celluloid solution. The side is made of a piece of celluloid 2¾ in. by 6 in., and the top is a 1⅝-in. disc with a ½-in. hole in the centre. The side and top are cemented into a brass ring (Fig. 9). It is possible to make quite a good ring by bending a piece of 3/16-in. square brass rod round a former and making a lap joint. The joint should be bound up with wire and well soldered.

J. F. S.

Fig. 6


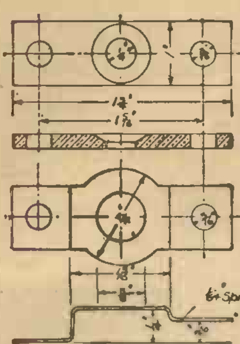


Fig. 7

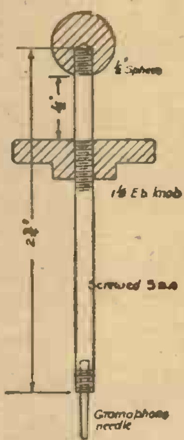


Fig. 8

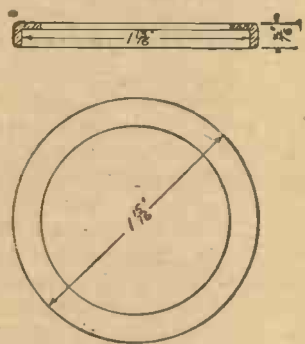


Fig. 9

Figs. 6, 7 and 8.—Details of Pillars, Framework and Point.

Fig. 9.—Brass Ring for Cover.

PRACTICAL WORKING WITH VALVES.—I

HINTS AND USEFUL NOTES

THE wireless amateur is a person who dabbles more or less sincerely with an art which is extremely complex and needing much knowledge, experience and patience. The word "amateur" covers many kinds of experimenters, from the university professor down to those who do not know the elementary principles of a most fascinating and instructive hobby. All classes of experimenter are useful to the community and should be encouraged as much as possible, but it should always be remembered that those who do not fully understand the apparatus can cause considerable annoyance to others in the district through allowing their receiving instruments to approach the oscillation point.

"Swishing" of a 12-mile Distant Station.

As an example covering this point, a recent experience of the writer's may be mentioned. A portable set was fixed up in a position about twelve miles from a large town which, of course, had its amateur wireless society, and an attempt made to hear "The Dutchman" with a seven-valve receiver. No difficulty was experienced in hearing our good friend, but, in spite of our nearest wireless neighbour being twelve miles away, the "swishing" due to oscillation was distinctly audible.

Even those experimenters who have a fair knowledge of physics and electricity should not attempt to walk before they can crawl. The writer found this out to the cost of much material and wasted labour and strongly recommends anyone commencing first to work with a one-valve set. After a few weeks further valves can be added without having to scrap parts.

Adding Valves.

It is a recognised fact that any addition of amplifying valves should at first be made as note magnifiers. The reason for this is that note-amplifying valves have the transformers constructed with iron cores, and then windings have no need to be tuned to any frequency or wave-length, whereas radio-frequency transformers are almost invariably arranged effectively to transfer the energy at one wave-length only. Little difficulty is experienced in adding two valves to the initial rectifying valve, but the addition of a third stage is sometimes difficult owing to howling of the valves, which is often caused by inter-oscillation between the valves.

It must not be forgotten that note amplification is useless as an attempt to make extremely weak signals audible, and unless their initial value is such that they can be heard with one valve the note amplification will not help matters much. The function of a note amplifier is to increase the value of signals which are already strong enough to be audible in the telephones and to enable a loud speaker to be used. The construction of an amplifier for radio-frequency currents—that is, the magnification of extremely weak and otherwise inaudible signals—is a difficult matter. Here again one stage of radio-frequency amplification is usually not very difficult, but two or more stages involve much patience and experimental work to obtain balance between the valves.

A Simple Valve Equipment.

A very suitable equipment may consist of a set comprising one radio-frequency stage having a tuned plate circuit, one rectifying valve with magnetic reaction circuit, and one note magnifier. A set of this description, when using transformers of the plug type, is capable of giving results which are quite loud enough for all practical purposes when used with head telephones, and without the many difficulties experienced when many valves are used.

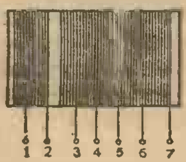
The writer has experimented during the last few months with an amplifier which has four radio-frequency, one rectifying, and two audio-frequency stages, and as a result has obtained considerable experience of what not to do in the construction and operation of such a receiver. The advantage of having three or four stages of radio-frequency magnification is that the set need not have tuned-plate circuits, and magnetic or capacity reaction is seldom necessary, although these features are an advantage sometimes and should be arranged for even if not used. A potentiometer is necessary in order to control the oscillation of the set.

An old rule, usually found to be correct, is, "Plan your work, then work to your plan," but in radio-frequency working this rule must not be too slavishly followed, as invariably a set which operates quite well when roughly coupled up on the bench entirely refuses to work when put in a neat box and decently connected up. One of the causes of this trouble is due to effects between the transformers, valves, etc., and can be overcome to a great extent by taking great care when planning to keep the many connections as far apart and as short as possible, and arranging the radio-frequency transformers at right angles to each other so that the lines of force do not intersect each other more than can be avoided.

A. F. C.

A Combined Crystal and Valve Receiver

THE receiver about to be described is not new, but is only known to the more advanced experimenter, and its many advantages are unknown to the newcomer in the wireless field. It is as easy to make as a simple one-valve receiver



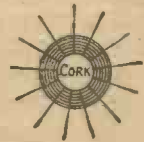


Fig. **1.—Inductance Coil. Fig. 2.—Reaction Coil**

to a person of ordinary ability. Briefly the receiver consists of a valve used as an amplifier of radio-frequency oscillations, in conjunction with a crystal used as a detector or rectifier.

The Tuner.

An ebonite or prepared cardboard cylinder 4 in. long by 3 in. in diameter is wound with forty turns of No. 20 double-cotton-covered copper wire, tapped off to a seven-point switch from the following turns: 6, 12, 18, 24, 30, 36 and 40. Between turns 12 and 13 a space of ¼ in. is left as shown in Fig. 1.

Reaction Coil.

This is a basket-wound coil of No. 26 single-cotton-covered copper wire wound on a cork 1 in. in diameter with thirteen pieces of cycle-wheel spoke or blanket pins spaced equally round its circumference.

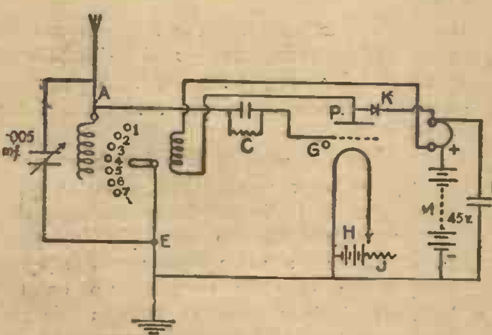


Fig. 4.—Diagram of Connections for Complete Receiver.

The wire is simply wound in and out round the spokes (Fig. 2) until the coil is just of sufficient diameter to rotate inside the inductance coil without touching. When the reaction coil is wound, leave about 6 in. of loose wire at each end for connections, and soak the coil in a bath of melted paraffin wax. When the wax is just about to set, remove the coil and allow it to harden. Afterwards the spokes can be withdrawn and the cork taken away.

A piece of brass rod 5 in. long and ⅛ in. diameter is now passed through the inductance coil in the space left between turns 12 and 13, and the coil lashed securely to the brass rod by means of adhesive tape. A hard-wood or ebonite knob is fastened to the end of the brass rod so that the reaction coil can be rotated inside the inductance coil (Fig. 3).

A variable condenser of about .0005 micro-farad capacity is connected between the aerial end of the inductance (A) and the handle of the seven-point switch, and the tuner is complete.

The complete receiver is shown in the diagram Fig. 4. It will be seen that the aerial is joined to the inductance coil at the end nearest to No. 1 tapping. The earth is connected to the arm of the seven-point switch, and the variable condenser is placed between the aerial and earth. The grid of the valve (G) is connected to the aerial terminal through a grid leak and condenser (C), which may be omitted with very little detriment to the signal strength. If used, the grid leak should be of two megohms resistance and the grid condenser of .003 micro-farad capacity.

One connection of the reaction coil (which is, of course, inside the inductance coil) is connected to the plate of the valve (P), and the other connection is taken to the telephone terminal which is nearest to the positive terminal of the high-tension battery (M). Take careful note of this part of the circuit. A connection is taken from this telephone terminal to the positive of the high-tension battery, and the negative of the high-tension battery is connected to the negative of the filament battery (H). It will be noticed that the negatives of both batteries are joined to the earth terminal (E).

The Crystal Detector.

Now for the crystal detector (K). The writer is using a galena crystal with gold point contact, but a perikon or any other crystal combination gives equally good results. It is advisable to use a crystal which does not require an applied voltage through a potentiometer. A connection is taken from the plate of the valve (P) to one terminal of the crystal detector (K). The other terminal of the crystal is joined to the telephone terminal opposite to the one which is connected to the reaction coil. A fixed condenser (N) of about .01 micro-farad capacity placed across the 'phones and high-tension battery as shown will improve results. The valve filament is supplied from a 6-volt accumulator through a variable resistance (J) of 5 ohms.

Telephones of from 4,000 to 8,000 ohms total resistance should be used, or 120-ohm 'phones will do as well if a telephone transformer is inserted between the 'phones and 'phone terminals.

When testing the receiver make sure

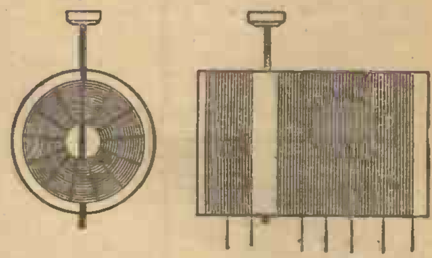


Fig. 3.—End and Side Views of Mounted Reaction Coil Fitted in Inductance Coil.

that the crystal is correctly adjusted, then rotate the reaction coil; at the same time tap the aerial terminal with the finger. If clicks are heard in the 'phones each time the aerial terminal is touched the receiver is ready to receive signals. If no click is heard reverse the connections to the reaction coil; this will give the desired result.

With careful adjustment of the crystal the strength of signals will be from 200 per cent. to 300 per cent. louder than those obtained when using the valve alone. Another advantage of this circuit is that by simply switching off the filament current signals can still be received on the crystal. This is an asset when the filament battery runs down in the middle of an interesting transmission. P. T. B.

Efficient Earth Connections

TOO great an importance cannot be attached to the earth connection for wireless work, as should this not be reliable and thoroughly well made in every respect it is impossible, even with instruments of the highest grade, to get anything like first-rate efficiency out of your station. Therefore, even as the strictest attention must be paid to the insulation of the aerial so must equal attention be paid to the good contact of the earth connection. There are several forms of earths used in wireless work, but all are not suited to the convenience of the everyday class of amateur, who naturally requires to secure the maximum of efficiency with the minimum of inconvenience and expense in the matter of installation.

Good earth connections can be obtained by spreading out wire netting over the surface of the soil, or a metal plate 3 ft. square, having the earth lead securely soldered to it, can be buried to a considerable depth in fairly moist soil.

The earth lead, which, by the way, should be as stout and short as possible, may be taken to a water-pipe, preferably to the water-main on the road side of the input tap. However, this is not essential so long as the connection is made to the cold-water pipe, and it can even be attached to the pipe over a sink or in the bathroom.

Having decided upon the pipe to be used, a portion of this, say about 1½ in. wide, must be thoroughly cleaned until quite bright by means of a piece of emery-cloth (see A, Fig. 1.). It is now necessary to ensure that the wire when twisted round the pipe will be quite tight, thus making good contact. This is very important, otherwise disappointment will arise due to noises when receiving and failure of signals in some instances. A good contact can be made quite easily by securing two pieces of flat brass, each measuring 1½ in. long by ½ in. wide and about $\frac{3}{16}$ in. thick. One of these pieces should be drilled and tapped ¼ in. from each end to take two metal screws as shown in Fig. 2. The screws need be no longer than ½ in.

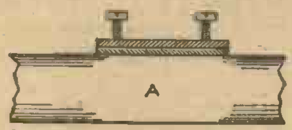


Fig. 1.—Plates on Pipe.

Fig. 2.—Component Parts of Plates.

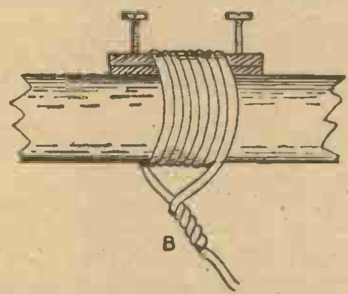


Fig. 3.—Finished Earth Connection.

Having done this, all is ready to make fast the earth lead. First place the drilled piece of brass on top of the other, then insert the two screws in the holes. Now lay the brass strips on the water-pipe where cleaned, holding them firmly in position with one hand, the piece with the screws being uppermost as shown in Fig. 1. The earth wire, after being well cleaned, should now be bound round over the brass pieces between the screws and round the pipe, say about half a dozen times, after which it should be twisted and soldered at the point B (see Fig. 3).

All that is necessary to add the required tension in order to ensure perfect contact is gently to tighten up the two screws. This will have the effect of forcing the two brass pieces apart, and as the wire passes over the top plate and under the water-pipe it will be strained and pulled tight up against the pipe. It is, of course, not necessary to put too much strain on, only just sufficient to secure good contact. The bottom plate serves to protect the water-pipe from being punctured by the screws as they are tightened up.

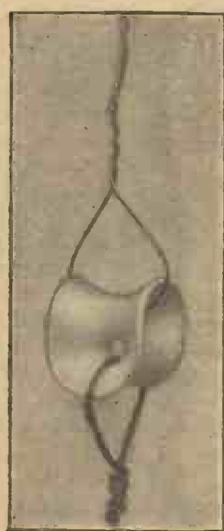
On no account should gas-pipes be used for this purpose, as apart from being inefficient they are dangerous in the event of lightning. D. F. U.

The Wiring of Aerial Insulators

THE shell-type insulator is quite a good pattern for use in amateur aerial construction, as it is light; at the same time it presents a considerable area of glazed porcelain between the wires it is desired to insulate. Further, not being "reticulated," or containing recesses, it is generally kept fairly clean by the rain when it is up in the air and out of reach of pocket-handkerchiefs and dusters.

The insulator is so simple in design that it would be thought to be obvious how to use it to the best advantage. In the photograph the first shell insulator is wired wrongly. First of all, the wires are so disposed that the insulator is under tension, and this is not the best stress for porcelain.

If the insulator were to break the construction would part and let the whole thing down. Also the single wire is shown just roughly twisted; that is to say, the main wire is twisted and contorted just as much as the tail or free end. Everyone who has had to put up thin wires under any considerable strain knows that any mechanical twist or kink is dangerous in a single wire under tension, while the slightest "nick" in the surface is fatal. The way to avoid this danger is to allow the run of the wire to remain as straight as possible, whilst the tail end is coiled round several times as indicated in the photograph next on the right. This shell insulator is here shown properly wired; the substance of the porcelain is in compression, so that even should the insulator be shattered the wires would link up together and the assembly not come down. This, if fatal to the proper use of the aerial as such on account of loss of insulation, is a consideration if stays have to be insulated by means of porcelain insulators, as the loss of a stay might result in the mast falling. It will be seen that the single wire is carried straight on after it emerges from the hole in the insulator, and the free end is brought back and coiled round this, so that all the twisting is done on the end of the wire which is not stressed. In the case of the stranded wires the wrong and the right way is shown. It is bad practice just to twist up the end round the run of the wire as shown on the left. The cable should be unstranded and each wire bound round all the rest till all the loose ends are used up. If shell insulators are difficult to obtain, a "shackle" can easily be made from small bobbin insulators as indicated in the photograph; a chain of four of these will give insulation sufficient for the most exacting requirements.



Shell Insulator Incorrectly Wired.

Shell Insulator Correctly Wired.

Bobbin Insulators.

Ebonite is sometimes used for aerial insulation, but, generally speaking, its use is not to be advocated. Eyes are provided, and it is simply a matter of passing the wire through. S. W. G.

STARTING WIRELESS.—VI

MAKING A SIMPLE CRYSTAL RECEIVER

THE reader will now understand that the essential components of the receiver are the tuning coil, the detector, and the telephones. It is not advisable to attempt the manufacture of the latter unless he is a skilled instrument maker and has a large number of tools at his disposal. The other items can be made very simply from materials in the hands of almost any experimenter.

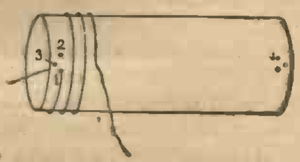


Fig 1.—Method of Fixing Winding.

The Tuning Inductance.

We will remember that the longer the wave-length the greater is the amount of inductance required to tune it in. Therefore, before we make our tuning coil, we must decide over what range of wave-lengths we desire to tune. It is impossible to wind up one coil to receive all wave-lengths. For example, to receive 400 metres wave-length we might require about twenty turns of wire on a certain size tube, while to receive 23,000 metres on the same size tube we should require thousands of turns. Obviously we must use one coil for short wave-lengths and another for longer wave-lengths, wound possibly with rather finer wire on a larger diameter cylinder. Perhaps the best range of our first coil would be from about 350 metres to 600 metres when used with the aerials previously described.

Construction of the Tuner.

The coil will be wound on a cylinder 6 in. long and 3 in. in diameter. Cardboard postage tubes are very suitable for the purpose if they are previously prepared. A 6 in. length is cut off with a saw and the surface and ends are carefully smoothed with very fine glass-paper. Three small holes are drilled in each end of the tube in the position shown in Fig. 1. The tube is then heated in an oven to drive out any absorbed moisture, and while it is still hot it is given a coat of thick shellac varnish. This is prepared by dissolving shellac in methylated spirits. The tube should be heated and varnished at least three times.

Wooden ends are fixed to the cylinder, which serve as a support for the slider, as follows: Two wooden discs about ⅜ in. thick are cut out with a fretsaw of such size as tightly to fit into the ends of the tube. This will be understood by reference to Fig. 2, and it will be seen that they are afterwards secured by small brass screws passed through the sides of the tube. The end pieces are made from any hard wood, and should be about 4½ in. square and ½ in. thick. These are fixed to the discs by brass screws after the coil has been wound.

Winding the Coil.

When winding a very large coil it is usual to arrange some form of winding apparatus, but it is unnecessary in this case. Referring to Fig. 1, about 6 in. of free end of the wire is passed down hole No. 1, up hole No. 2, and down hole No. 3, the end being put through the loop which has been formed inside the tube between holes No. 1 and No. 2. It will be found that this will fix the end of the wire quite firmly. The winding is then started, making each turn close against the other. It is essential to keep the wire fairly tight, but not so tight as to strain it. When the other end of the coil is reached the wire is fastened off in a similar manner to the first turn. The best wire is double-silk covered, but this, of course, is rather expensive, and cotton- or enamel-covered may be substituted. It should be remembered that enamelled wire is thinner than silk-covered, and therefore if this is employed more turns will be required to fill the winding space, with a consequent increase in the inductance of the coil. It is not very usual to use silk- or cotton-covered wire with a sliding contact, but this may be done if the winding is given a thin coat of shellac.

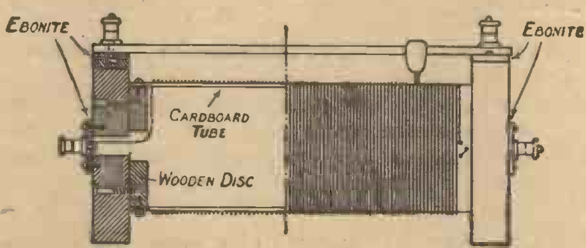


Fig. 2.—Half Section of Tuning Coil.

Mounting the Coil.

Although a connection is only required to one end of the winding, it is useful to bring both ends to terminals for use in other circuits. A hole about ¾ in. in diameter is made in the centre of each wooden disc and end piece. Two squares of ebonite about 1½ in. long are placed over the holes in the end pieces, being fixed with small brass screws at each corner. A terminal is mounted on each, and the ends of the winding are brought through the holes in the wooden disc, being connected to the back of the terminals. Thus the winding does not come into electrical contact with either the cylinder or wooden ends and discs at any point; this, of course, ensures the best possible insulation. Having reached this stage the end pieces can be screwed to the wooden discs, thus firmly fixing the coil.

The Sliding Contact.

The slider may be made if desired, but as it is a standard detail it can be purchased for about a shilling. It consists of a piece of moulded ebonite containing a spring and brass plunger which makes contact on the winding of the coil. Usually the slider is made to fit a ¼-in. square brass rod, as shown in the diagram. A piece of square brass rod is cut about 7 in. long (that is, the length of the tube and end pieces), and a hole is drilled in each end to take a small terminal screw. Two pieces of ebonite are next prepared. These should be made about 1 in. long and ⅛ in. thick. The width is that of the end piece, the ebonite being fixed to this as shown in Fig. 3. It will be noticed that a hole is drilled in the middle of the ebonite, a small part of the end piece being cut away to accommodate the head of the terminal screw. The screw is put through the ebonite, passed through the hole in the square brass, and the two parts of the terminal are screwed up tightly. The same process is repeated at the other end of the square brass, and the pieces of ebonite are then screwed to the ends.

Two terminals are connected to the slider rod, whereas only one is needed. This makes the appearance of the coil symmetrical, and the additional terminal may sometimes be of use in different circuits.

The coil is now complete with the exception of the winding contact; where the slider touches the winding the insulation must be removed. This is best accomplished by rubbing it with a piece of very fine glass-paper, using the edge of a straight piece of wood as a guide, so that a neat line of bare copper wire appears. Only just sufficient insulation should be removed to ensure the slider making an efficient contact.

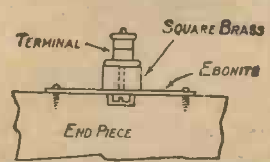


Fig. 3.—Method of Fixing Slider Rod to End Piece.

PAUL D. TYERS.

A Winder for Cylindrical Coils

THE photograph (Fig. 1) and sketch (Fig. 2) illustrate a simple machine which has been designed for winding cylindrical inductances of different sizes.

The object of having a machine for winding coils is twofold: first, it ensures a better finish, since the turns are naturally at right angles to the axis of the coil and it is easy to obtain a tight winding throughout, secondly, the time required to wind the coil is reduced to a few minutes.

Nothing elaborate is required to obtain the taut wire; a pile of books placed between the wire bobbin and the machine is all that is required.

The base A (Fig. 2) of the machine should be of soft wood, so that the spindle bearings B and C are readily screwed into any suitable position for any size of former. The bearings are made from 1-in. by ⅛-in. flat iron bent as shown and drilled to receive the screws and spindle. The spindle is a length of mild steel rod ¼ in. in diameter, screwed at the handle end ¼ in. Whitworth. The length can be made to suit the longest coil likely to be required; a good length should be chosen, say 18 in., as the extra length is not in the way. The handle is made from 1-in. by ⅛-in. iron and a knob rescued from the "junk heap"; both ends of the iron are tapped and nuts are used on both sides.

The cones D are turned in a lathe and will take any coil from 1 in. to 6 in. diameter inside. It is not really necessary to have two sets of cones as shown in the photograph; a single cone can be made to suit the diameters mentioned. It will be seen that increase in the diameter of the cones will necessitate increase in the bearing height; this explains the blocks shown under the bearings in the photograph; in the sketch the blocks are, of course, dispensed with.

A few washers at the handle end of the spindle and a fairly strong spring at the other end complete this useful appliance.

To wind a coil, first remove the bearing and cone at the end away from the handle, slip on the former on which the coil is to be wound, put the cone on again, then a washer, spring, another washer, then the bearing; push the bearing along until the spring is well compressed, and screw it down. It will be found that the former is now tightly gripped between the two cones. It should be mentioned that the cone near the handle should be a tight fit on the spindle.

A problem that soon presents itself is that of fixing the end of the wire to the former at the commencement and the completion of the winding. This can easily be accomplished by drilling a couple of holes at the point where the end of the wire is to lie. The holes should be only slightly larger than the diameter of the wire, and the wire should be passed in and out of these and then run off round the former.

If tappings are required on the coil they can be twisted loops, made as the winding is done by taking a turn round a match and giving it one or two turns. A wedge can be made to fit between the cone and base to hold the coil while this is being done. J. R. H.

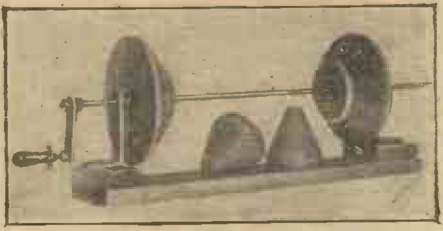


Fig. 1

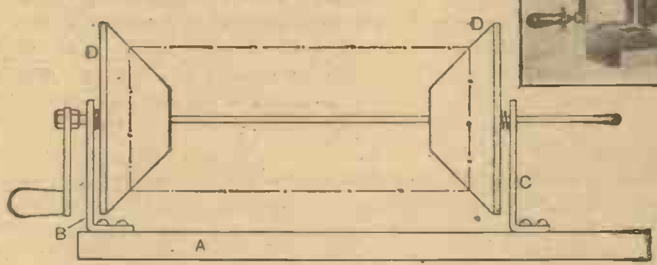


Fig. 2

Fig. 1.—Photograph of Winding Machine.

Fig. 2.—Details of Winder

A Constant High-tension Battery

THE battery to be described is designed to give about 30 volts, which is sufficient to work most valves, but it can be added to if a higher voltage is required.

Materials.

Thirty 6-in. test tubes about 1 in. in diameter (obtainable at most chemists); 30 ft. No. 20 S.W.G. bare copper wire; 30 pieces valve rubber 4 in. long; 30 pieces zinc 4½ in. long by ¼ in. wide by $\frac{1}{32}$ in. thick; a solution of zinc sulphate (as used in Daniell cells); a small quantity of sulphate crystals.

Construction.

Take a piece of the copper wire 1 ft. long and twist about half of it into a coil (Fig. 1). Insulate the straight part of the wire with a piece of the valve rubber as shown.

Bend a piece of the zinc into the form shown in Fig. 2. Solder a small connecting wire to the top. Place the wire and zinc into a tube as shown in Fig. 3. Fill the tube half-way with a solution of zinc sulphate and then put in enough copper sulphate crystals to cover the coil of wire. Treat each of the test tubes in a similar fashion.

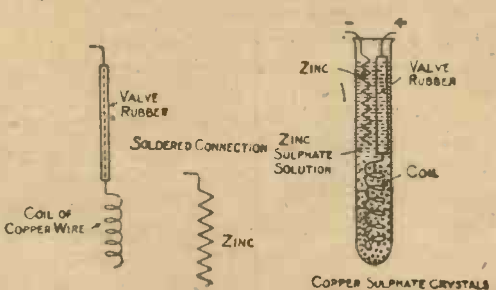


Fig. 1 Fig. 2 Fig. 3

Fig. 1.—Insulated Copper Element. Fig. 2.—Zinc Element. Fig. 3.—Complete Cell.

A stand similar to an egg-stand may be made for them, or they may be slung together with wire.

The "cells" should be connected in series; that is, the + (copper) connection of one cell joined to the − (zinc) connection of the next, and so on.

Each cell will give about 1 volt, and the current will remain constant for a long time. M. S. B.

How Wireless Telephony is Made Possible

IN attempting to set out a simple explanation of the apparently mysterious "mechanism" by means of which the human voice is transmitted through "space"—that is, without the assistance either of wires or any other obvious medium—it will be found most helpful in the first place to consider briefly other known methods of speech-transmission in order to trace step by step the progress of invention leading to the final achievement of wireless telephony.

The Link or Medium.

It is a scientific doctrine, which may safely be taken for granted, that there is no such thing as what is called "action at a distance." In other words, if a disturbance of some sort or other gives rise to a corresponding effect some distance away, there must be an intervening link or medium connecting the disturbance and the resulting effect. For example, the cause or origin of ordinary speech lies in the actions of the vocal cords in the human larynx. As the breath is expelled from the speaker's lungs it is throttled or interrupted in such a manner that it emerges in gushes or waves of differing frequencies instead of in the steady flow of ordinary breathing. These impulses or waves spread outwards from the speaker's mouth through the air and finally strike against the ears of the listener, through which they are conveyed to the brain.

In the gramophone the human voice is mechanically copied and repeated. In making a record the interrupted gushes of air from the speaker's throat are directed against a flexible diaphragm, causing it to vibrate sympathetically. A pointed needle on the reverse side of the diaphragm reflects these vibrations in the tracing it makes upon a revolving wax cylinder. In reproducing from the record a needle is forced to traverse the serrated path of the previously made tracing, and in so doing imparts corresponding vibrations to the sounding diaphragm. These vibrations are transmitted to the layers of air adjacent to the diaphragm and, spreading outwards, reach the ears of all within range of the instrument.

Air as a Medium.

In the cases so far considered atmospheric air is the connecting link between the transmitter and receiver. It is a well-known fact that if an alarm clock is carefully suspended inside a glass vessel, which is then gradually exhausted by means of an air pump, the sound of the bell grows fainter and fainter, and finally, as a high degree of vacuum is reached, can no longer be heard.

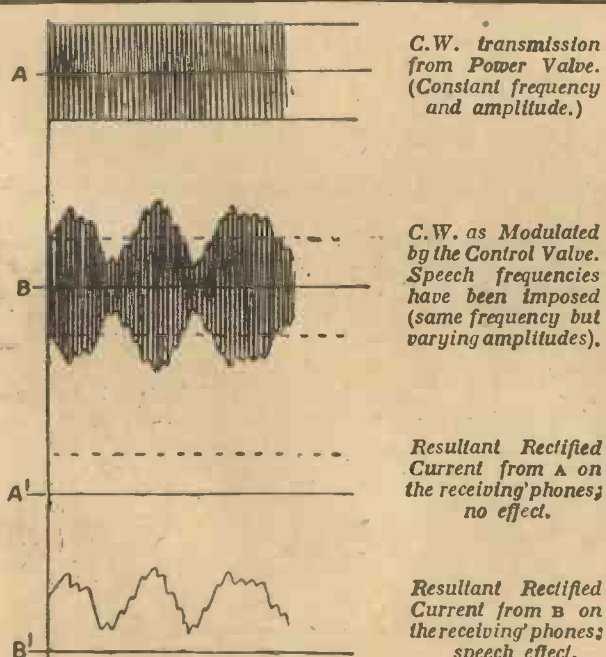


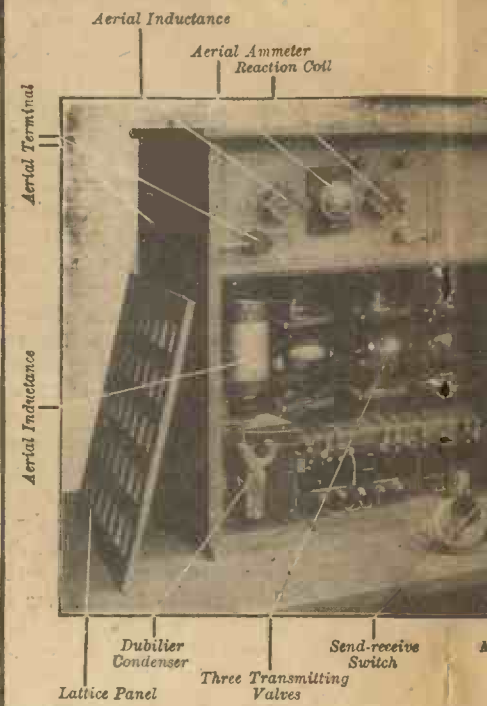
Fig. 1.—Diagrammatic Representation of Telephony Waves.

The next stage to consider is the ordinary line telephone, and here we begin to approach more closely to the conditions that exist in wireless telephony. First and foremost, we are no longer concerned with air as the medium of transmission, but instead we have to deal with electricity. Nevertheless, when we have adjusted ourselves to the new medium it will be found that the "mechanism" involved is closely analogous to that already described.

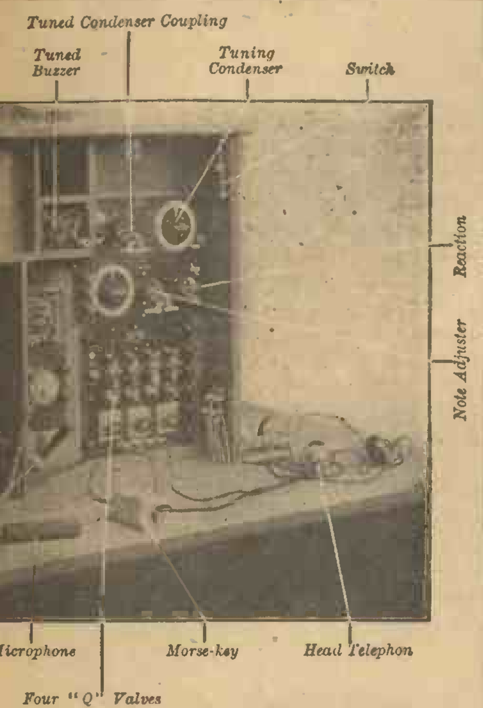
Because we are faced with the fact that light reaches us not only from the sun, which is some 90,000,000 miles away, but also from the stars, which are inconceivably more distant, and because of certain other good and sufficient reasons, we are forced to the conclusion that there must exist some all-pervading medium by means of which such light-energy is propagated. It has further been firmly established that this medium, which we call the ether, is also the vehicle whereby all electrical effects are manifested. In other words, if an electrical disturbance at any point gives rise to a corresponding effect at some distant point, the connecting link between the two is the ether.

When one is dealing with the case of a steady direct current through a wire it is true that the metallic path is the main focus of the electric energy. But the surrounding ether is also largely concerned. In the case, however, of alternating currents, particularly those of high frequency, the metallic path becomes of less importance—it is then more in the nature of a path of least resistance through the ether. In other words, the wire acts merely to focus the direction of the moving current.

Finally, if the frequency becomes high enough the electrical energy no longer finds the wire the most convenient path, and, therefore, it commences to radiate outwards in all directions through the ether itself. This is the condition that exists when an aerial is transmitting "wire-



Combined Telegraphy and Telephony



y Transmitting and Receiving Station

An article in which an expert describes clearly and explicitly the underlying principles of the telephony transmitter

less" energy. It should be borne in mind that electric effects always travel at the same speed, whether they pass over a metallic conductor of any kind or whether they are radiated "wirelessly" through the ether. This velocity of travel is 300,000,000 metres per second, and is determined solely by the inherent properties (elasticity and inertia) of the ether, and not in any degree by the properties of any particular conductor.

The Microphone.

Returning to the case of ordinary wire telephony, the action of the transmitting end is due to the effect of air waves from the throat beating upon a microphone inserted in series with an electric battery. The microphone consists merely of a box containing carbon granules, which, it is found, offer a lesser or greater resistance to the passage of the electric current according as they are pressed more or less tightly together. One end of the box is closed by a flexible diaphragm which is vibrated by the impact of the sound waves emitted by the throat of the speaker.

The result is that the pressure between the carbon granules varies with the corresponding movement of the flexible diaphragm, and the battery current reacts to the variation of resistance thus interposed in the circuit. Instead of remaining steady, the current flows in irregular quantities or "gushes" corresponding to the sound waves imposed upon the diaphragm.

The original air-pressure variations or sound-waves coming from the speaker's throat have in this way been translated into corresponding charges of electrical energy. The medium of transmission has been changed; instead of the resultant effect travelling at the rate of sound-waves through the air (340 metres per second) it moves forward about one million times faster—that is, at the velocity of the electric current, which is the same as that of light.

The current variations so created are induced into the line wire and finally pass, at the receiving end, through a coil wound round the poles of a permanent magnet, where they give rise to precisely similar changes in the strength of the magnetic field. The magnetic fluctuations in turn react upon the metal diaphragm of the telephone and cause it to vibrate in such a fashion that it creates air waves corresponding exactly to those originally applied to the microphone at the transmitter end. The receiver diaphragm is held close to the ears, which receives the air waves and interprets them as speech in the ordinary way.

We are now ready to investigate the working of the wireless telephony transmitter, and we shall find that it is a natural development of the cases that have just been considered.

It should be borne in mind that, as previously stated, an alternating electric current when of sufficiently high frequency is no longer held or bound to the metallic conductor, but spreads outwards therefrom in all directions through the ether in the form of waves or ripples of electro-magnetic energy.

If, therefore, we feed to an aerial a constant supply of such high-frequency current, that aerial will become the centre of a sphere of energy-ripples in the ether, just as a point on the surface of a pond will become the centre of an area of continuous ripples, provided that a constant supply of stones are dropped into the pond at that point.

This condition of affairs is created in the ether by means of the power valve shown on the left of Fig. 2. High-tension current at 600 volts pressure is fed to the plate of the valve from the generator. The plate and grid of the valve are retroactively coupled through the reactance coil, so that the valve is caused to "oscillate." A steady supply of high-frequency current of constant amplitude is thereby fed into the aerial, and is thence radiated outwards in all directions in the form of ether waves of constant and regular form.

We have now existing in the ether a condition that is analogous to that of a steady current flowing in the microphone circuit of an ordinary line telephone transmitter. The main difference lies in the fact that the energy concerned is in the form of high-frequency alternations, or waves in the ether, instead of being a constant and uni-directional current in a metallic circuit.

It will be remembered, however, that in order to make the direct current carry speech-form variations the microphone was used, and, in effect, this caused the sound-waves from the throat to release more or less energy or current in the whole of the circuit by varying its resistance.

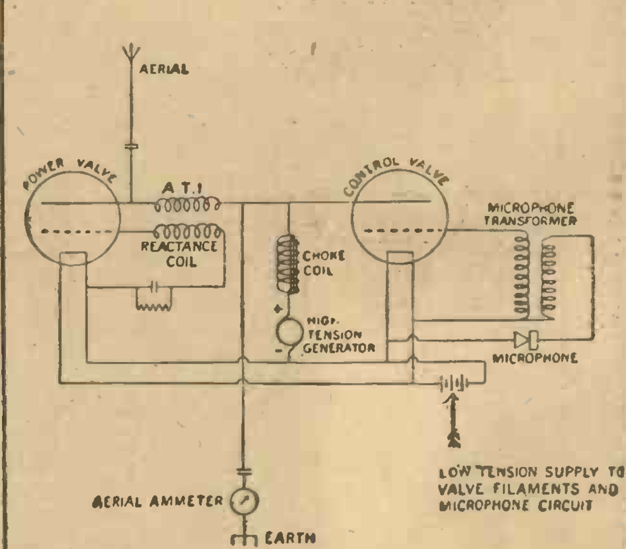


Fig. 2.—Diagram of Two-valve Telephony Transmitter as Used on Aircraft.

If one considers the nature of ether waves a little reflection will show that energy-variations can be imparted to such a "current" simply by varying the amplitude of the waves. The greater the amplitude of each wave the more electric energy it carries, and *vice versa.*

The diagram A, Fig. 1, shows a steady stream of continuous waves of constant amplitude, whilst B shows the effect of varying the amplitude of such waves by means of impressed speech, the frequency of the waves (that is, the number contained in unit distance) being the same in both instances.

At the receiving end the dictator will simply wipe out the lower half of each wave, with the result that in A1 there will exist a steady current in the 'phones as shown, giving rise to no audible effect; whilst in B1 the telephone diaphragm will be vibrated in accordance with the irregular current indicated and will produce corresponding sound-waves.

The final part of the problem then resolves itself into finding the most convenient method of varying the amplitude of the continuous waves emitted by the power valve so as to carry the sound-waves to be transmitted.

There are many ways of doing this, but in the transmitting set shown in Fig. 2, which is a simplified diagram of a two-valve transmitter, the "amplitude" variations are imposed by means of a second valve called the "control."

The Control Valve.

The message to be transmitted is spoken into the microphone, and in the ordinary way sets up variations in the steady current flowing in its circuit. These variations are applied across the microphone transformer shown on to the grid of the control valve, giving rise to corresponding alterations of the grid potential.

In the ordinary way these grid changes are reflected as current variations in the plate circuit, but on a magnified scale owing to the amplifying action of the valve.

A choke coil is, however, inserted as shown in the plate circuit of the control valve, and as a result the plate-current variations are unable to pass, but are reflected back as corresponding voltage variations, which in turn are applied to the plate circuit of the power valve, as will be evident upon consideration of the diagram.

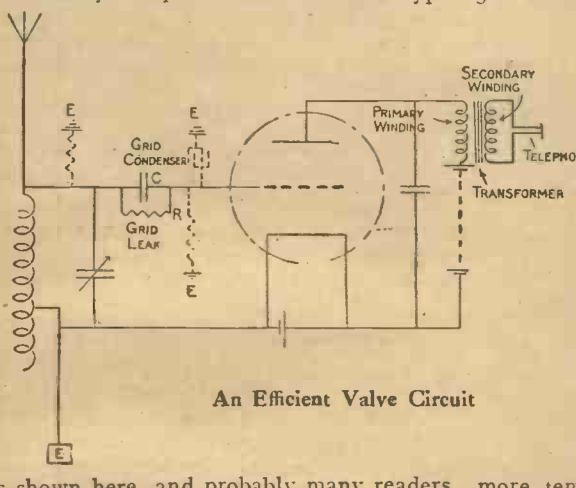
The effect of this is to vary the amplitude of the continuous waves emitted by the power valve to an extent and for a period determined by the value and duration of the extra voltages derived from the choke coil—that is, originally from the microphone.

In other words, the action of the control valve is to increase or diminish, in sympathy with the action of the microphone, the originally constant supply of high-tension voltage applied to the plate of the power valve from the generator. In consequence, the normal supply to the aerial of uniform oscillations, representing a constant emission of power at a steady rate, is changed, in sympathy with the variations of the high-tension voltage, into an irregular or modulated supply of power, which constantly varies in accordance with the air waves impressed upon the microphone. The electric power so emitted is subsequently rectified and appears as speech in the telephones of the receiving set.

J. J. HONAN.

Weak Reception :: Some Afterthoughts

IN the article on weak reception in No. 3 the effect of stray capacity on simple crystal receiving sets was considered. Most amateurs who have commenced with such a set will sooner or later wish to increase their range of reception by constructing a valve set. One of the most satisfactory simple circuits of this type



An Efficient Valve Circuit

is shown here, and probably many readers are engaged on or are considering the prospect of making such. It is now intended to point out how likely sources of trouble may be avoided.

To obtain the best results from the set shown, the grid condenser C should have a capacity of approximately .0003 microfarads, and the grid leak R should be about 2½ megohms (1 meghom = 1,000,000 ohms). So small is this capacity that large metal terminals or long wire leads may have quite considerable values, and such incidental condensers as these would form might seriously impair the operation of the valve. This possibility would be better appreciated, perhaps, if we remember that 300 micro-farads is the capacity of two metal plates, roughly 4 in. by 2 in., and separated by a piece of thick brown paper. It is unlikely that pieces of metal this size will figure in the connections between the grid and the grid condenser, where they would do most harm, but the writer has heard of a set giving trouble because the wire forming this connection was unnecessarily long and ran close to an earth wire. This point is not so likely to arise where the receiving set is permanently arranged in box form, but the amateur who prefers to make up a more temporary set, so that he may try what our American friends call a variety of "hook-ups," usually has his apparatus scattered about somewhat, and he would be well advised to bear in mind the figures given above. He should remember, too, that enamelled or otherwise insulated wire has a capacity twice or three times as great as a similar piece of bare conductor similarly situated.

Unwanted Leaks.

The grid leak should have a value not much greater or less than that already given, and care should be taken that there are no unwanted leaks on the apparatus. We are rather liable to look upon the ebonite mountings of terminals and the cotton-covering of wire, to take two examples at random, as being true insulators —that is, as offering an infinite resistance to the passage of the current. This is by no means true. Two terminals close together on a piece of moist or slightly dirty ebonite, or two cotton-covered wires lying across one another, particularly as cotton always holds a certain amount of moisture unless it has been carefully impregnated with shellac or some similar insulating varnish, may have a leakage path between them of only a few thousand ohms. This should be particularly borne in mind when arranging apparatus compactly on panels or in boxes.

In the set illustrated two or three possible sources of trouble are avoided by using the telephone transformer shown, and these should be considered when it is decided whether it is worth while constructing or buying such a transformer. If the 'phones, which should, of course, be of high-resistance in that case, had been inserted direct in the plate circuit, the comparatively large potential differences existing there might break down the weak insulation of the bobbin windings, particularly when the interior of the receivers accumulates moisture from being worn for a length of time. In addition to this, the continuous plate-circuit current may be in such a direction as to tend to de-magnetise them and so to weaken the signals.

This may be avoided by comparing the strength of the signals received when they are reversed, but it is better to use a telephone transformer, as the secondary circuit only carries current when variations occur in the plate-circuit current—that is, during the period of actual reception of signals—and so the telephones are subject to no unnecessary de-magnetisation. Another point favouring the use of a transformer is that neither the capacity nor the leakage to earth of the 'phones can disturb the tuning or potential distribution in the plate circuit when connected in its secondary.

SIGMA.

RADIOGRAMS

THE elimination of the accumulator would do much to make home wireless sets more convenient. Numerous experimeters have endeavoured to make use of the usual direct or alternating current lighting circuit. The difficulty here is the hum of the lighting circuit, which must be eliminated or at least brought down to a reasonable degree in order not to interfere with the reception. It is stated that it is now possible to operate a receiving set and amplifier on lighting current, but so far only meagre details are available. The interference has been practically eliminated by balancing resistances, grid condensers, and special grid leaks of comparatively low resistance, telephone transformer in the output circuit, and a crystal detector instead of a vacuum tube detector.

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A receiving set has now been installed in a London picture hall, and the programme includes such items as may be broadcast.

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Part of the overture and the principal items in a new musical play, which will not be seen on the stage until the autumn, were broadcast on Friday last. The transmission took place from Marconi House, the artistes being Miss Florence Smithson, who will take the principal part in this new production, and Mr. Emmett Adams, the composer of the piece, which will be known as "Lumber Love."

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In an article in "Electrical Times and Lighting" on selling receiver sets some advice is given to the retailer of the method he should adopt with the prospective customer who wishes to listen-in for too long a period. The recommendations are as follows: "(1) Give the only pair of connected 'phones to someone else to listen; (2) disturb adjustments; (3) let the customer try to adjust; (4) have a twisted connection in the aerial and earth leads, and trip over them; (5) try other pairs of headphones; (6) walk rapidly away after adjusting. The alteration of capacity will in many cases upset the tuning; (7) tap the valve or crystal; (8) make the valve oscillate, or start the testing buzzer; (9) earth the 'phones by touching one of their terminals; (10) connect a different set and repeat the performance."

The article continues. "The 'free entertainment for nothing' brigade considers these as unadulterated annoyances—they are excellent training for the ultimate customer, who will not be slow to realise how much happier he will be with his own apparatus away from your over-zealous efforts. Besides, he won't send round to have you make his set work every time one of these minor accidents has occurred."

We wonder if in No. 8 the writer means "make the valve howl."

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Wireless concerts are now becoming quite a feature of bazaars and similar organisations.

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Taxation is never equable. The position in wireless is that the person possessing a home-made crystal set with a telephony range of about fifteen miles pays the same amount as the owner of the most elaborate set with a range of 200 miles.

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A greeting was sent to all nations from the children of Wales on the morning of June 28 by wireless. It was arranged that the message should be wirelessed before dawn from Leafield Station in Oxfordshire. This station has a wave-length of 8,750 metres, and is one of the most powerful in the world.

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The post office administration of Germany has entered into an agreement with a news distributing agency for the circulation of market prices of stocks, prices of material, and so on. Subscribers to the service pay 4,000 marks per annum to the post office for installation and maintenance and a subscription for the news services to the press agency. Reception of news services which are not subscribed for is partially prevented by changing the figures, which have to be decoded by the subscribers entitled to the particular service. The apparatus consists of a single-wire aerial and a single-valve receiver supplemented where necessary by two stages of audio-frequency amplification. All apparatus is enclosed in sealed cases, inspection windows being provided so that the condition of the tubes may be readily ascertained.

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Increasing advantage of wireless is being taken by jewellers to obtain the Eiffel Tower time signals.

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There has been installed on one of the London-Paris aeroplanes a combined wireless telephone and telegraph equipment of 35 watts aerial output, with a sending range of about 180 miles at 900 metres' wave-length. The complete wireless equipment weighs only 125 lb. An air-propeller-driven generator for 6 volts and 700 volts and a 6-volt storage battery supply the necessary current. A 3-valve amplifier is used for receiving on all wave-lengths between 300 metres and 1,000 metres.

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A receiver has recently been installed in a London restaurant for the benefit of its customers. The innovation is one that might well be adopted in other places where the customers necessarily remain for some time.

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According to Dr. Charles P. Steinmetz, the chief consulting engineer of the General Electric Company, U.S.A., the ether is non-existent.

The beam of light and the wireless wave, he says, are merely due to changes in a field of electrical force, occurring at fixed intervals. A wireless station sends out a signal. In doing so it throws out a field of force which extends to the receiving station.

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Fears are expressed in the musical world that people who can listen by wireless to great singers will cease to attend their concerts. The gramophone, however, has proved that the reverse of this might be expected.

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Arrangements are being made by the Air Ministry for broadcasting meteorological reports to enable the agriculturist to plan his work in accordance with the suitability of the weather.

Three kinds of messages will be sent out:

1. General inference, which deals with the whole country. This will be wirelessed twice daily at 9.15 a.m. and 8 p.m., and will be in ordinary language.

2. Codified messages giving full detailed information as to particular areas. These will be issued three times a day, at 9 a.m., 3 p.m., and 8 p.m.

3. Synoptic messages, also in code, giving full particulars received from the seventeen weather stations throughout the country.

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An amateur at Croydon is wakened punctually at 6.30 each morning by the first call-up at the aerodrome.

OUR INFORMATION BUREAU

Expert Replies to Readers' Questions. Hundreds of Replies are sent by Post.

TO ENSURE A PROMPT REPLY PLEASE OBSERVE THE FOLLOWING RULES

Write distinctly, give all necessary details and keep to the point. Ask one Question at a time—never more than two. Send a Stamped and Addressed Envelope. Send the Coupon cut from page 118.

SHORT ANSWERS

E. I. R. B. (Liverpool).—You have sent us some crystal-detector drawings but no name or address, simply your initials. Will you kindly communicate with us?

C. M. L. (Felsted).—Yes, but the note heard will be of very low frequency. (268)

J. S. (Kilmarnock).—(1) Ear pieces of head telephones are connected in series so that each ear piece of a 2,000-ohm. pair is 1,000-ohm. (2) A crystal set will receive telephony, music, and spark signals. (3) It is best to use a lead-in wire of about the same gauge as the aerial wire. It need not necessarily be continuous with the aerial, but the joint must be soldered. (93)

H. Vic. (New Brighton).—Your oblong inductance would be quite satisfactory if the corners were slightly rounded to prevent sharp bends in the wire. (119)

W. R. (Hull).—The subject of your letter will be dealt with in an early issue. (216)

A. L. (Lampeter).—We thank you for your notes concerning electrolytic detector, and if you will complete your set and then send in a full description of the detector, and whether it compares favourably with a crystal detector, we should be pleased to consider publishing it. An article will appear shortly on the construction of telephone transformers. (217)

M. H. R. (Chester).—An article on rewinding ordinary receivers appears in this issue. (185)

G. W. D. (Liverpool).—(a) A crystal set will receive telephony within a range of about fifteen miles. (b) High-resistance-'phones are commonly used. Suitable resistances are 2,000 ohms each receiver. (107)

C. W. R. (Gillingham).—Use reaction coupling from "plate circuit" to grid circuit, as shown on p. 14 of AMATEUR WIRELESS. Grid condenser, .0005 microfarad or .5 j a r. You will require a larger aerial inductance of about 5,000 to 6,000 mics. (approx. aerial capacity .001 mf.), 5,000 mic. inductance for primary, or condenser in series up to .005 mf. Secondary will have to be greater in value, or else increase capacity across it to .002 mf. Variometer coil is not required with reactance coupling. For reception, less wires, less capacity, less atmospherics and interference from stations near at hand on other wave lengths. Aerial coil 12 in. by 6 in. 20 S.W.G. d.c.c. several tappings. Primary coil 6 in. by 4 in. 24 S.W.G. d.c.c. several tappings. Secondary coil 6 in. by 5 in. 26 or 28 S.W.G. d.c.c. several tappings. (207)

B. F. J. S. (Worcester Park).—As far as we have been able to ascertain, there is no company with the name you mention.

F. J. W. (Redditch).—The use of fir is generally advocated for wireless masts, though any straight-grained wood will serve. An important point is to use wood which is as free from knots as possible. It is quite feasible to use two pieces, and these may be fastened together with a couple of bolts, afterwards securely lashing the joint, or, in place of the lashing, iron straps may be fitted and drawn up with bolts.

S. W. (Ripley).—There is no such apparatus as you require actually on the market, but it would be quite possible to have it made. It would necessarily be costly and also delicate and, moreover, would have to be the subject of a certain amount of experiment. A valve or valves would have to be employed together with sensitive telephone apparatus. If you are likely to proceed in the matter we may be able to provide you with suggestions as to the lines it should be constructed upon.

Motors (Strathspey).—No, an ignition coil is useless, though it can be used for transmission purposes over short distances. What is generally termed the crystal is simply a crystal of a certain mineral (of which there are a number), and which possesses the property of only allowing the electricity to pass the point of contact between the crystal and some other conductor in one direction. You will find some very informative articles on the matter in current issues.

CORRESPONDENCE

Mounting Coils

SIR,—A point often overlooked by amateurs when winding and mounting slab, honeycomb or basket coils is the necessity of ensuring that all the windings proceed in the same direction. Reversed windings in a tuner result, except under certain conditions, in weak reception or total absence of signals. Unless the direction of the winding in each coil is known at the outset it is a difficult matter generally to ascertain it. The following is a simple method, however, little known to amateurs, which never fails: Attach the ends of the coil to the terminals of an ordinary flash lamp battery. Put a knitting needle or iron rod through the coil, and arrange this so that it points approximately north and south. Now push a compass under the end of the rod farthest from the battery, and the magnetism in the rod, induced by the flow of current round the coil, will cause the compass needle to be vigorously deflected to the right or left, according to which way the current is flowing in the coil. By simply changing over the connections to the battery when necessary the coils can be arranged so that the compass needle will be deflected in one direction only for each coil. When this is done the coils are all uni-directional, and a small knot should be placed in the lead to the positive terminal of the battery, so that when mounting there will be no confusion.—L. B. P. (Birmingham).

Licences

SIR,—With reference to the recent statements concerning the proposed increase of the "listening-in" licence fee, I think it would be far better to allow about five minutes' advertising at the beginning of each broadcasting programme. This would not only help to defray the cost of broadcasting, but would enable the majority of "listeners-in" to adjust their instruments before the start of the concert.

Increase in the licence fee would either spoil people's interest or incline them to install more simple apparatus. I understand that the cost of the scheme is to be covered to a great extent by the purchase of apparatus, therefore that which will bring in the bulk of the broadcasting expenses will certainly not be the simple crystal sets, as these can be quite easily constructed with the aid of the various handbooks on the subject, or, as in the writer's case, "The Amateur Mechanic."—C. H. B. (South Tottenham).

Appreciation

SIR,—I should like to take the opportunity of stating, that as one who has had no previous knowledge of electricity or wireless, how much success I have been able to obtain from the instruction given on pp. 10 and 11 of the first number of "Amateur Wireless." I have made the set as described and have had wonderful results, using a telephone receiver with a resistance of 4,000 ohms in each earpiece.—DEVON.

Interference: A Warning

SIR,—Perhaps you will allow me to say a few words to some of the newest recruits to wireless with reference to the trouble of the oscillating valve. I should like to remind them that it is within their power absolutely to ruin any broadcasting that may be done simply by the mal-adjustment of their reaction coil.

A small receiving set when it is in a state of oscillation, of course, is a small transmitter, and I shall not be accused of drawing the long bow when I say that it is perfectly possible to hear a single valve receiver at a distance of five miles, and it may very seriously interfere with telephony at a distance of two miles.

What happens when one is working to

(*Continued on page 116.*)

(*Continued from page* 114)

a faint station is this: You are straining your ears when all of a sudden it is just as though somebody had blown a loud whistle in your ear, and it is quite impossible to do any more work.

There is another side to this—if anybody will look at the licence granted by the P.M.G. he will see that one of the conditions is "that the apparatus will be adjusted in such a manner that it will not cause interference with other stations." There is also the matter of courtesy. If one saw two people talking together, it would not be considered the best of good manners to immediately make such a noise that it would be impossible for anybody to hear himself speak. Then there is the strange fact that these people who make such noises are absolutely incapable of hearing the telephony—you can't hear telephony with an oscillating valve—and yet they sit there and howl people down who are engaged on some serious experimental work.

There is just one hint—if you are unable to control the oscillations of your valve just for once let your good manners overcome your curiosity and leave the two experimenters in peace.—J. B. (Bradford).

Signals from Mars

SIR,—Commenting upon the article on interplanetary communication that appears in the issue of "Amateur Wireless" of July 1 it appears to the writer that the initial difficulty would be the practical impossibility of decoding the messages. For example, mysterious signals have already been noticed as apparently coming from space, but even supposing that they were actual communications from the inhabitants of Mars, how are we to decipher them? Their language would be "Greek" to us as ours to them.

Then again, there has always been an extraordinary predilection in the popular mind in favour of Mars as being the only planet of the solar system that could possibly be inhabited by sentient beings like ourselves. It is true that evolution on the red planet has gone forward to a far greater extent than on the earth, and this gives colour to the idea that there may be astronomers and other scientists on Mars possessing instruments of a precision and accuracy, not to mention power, far greater than any we are capable of constructing. Even so, as we said before, how are they to make us understand their messages and how are we to acquaint them with the fact that we have done so?

In the writer's opinion it is quite as possible that our other near neighbour in space—Venus—is inhabited; but as this planet is in an earlier state of evolution even than ourselves the possibility of its inhabitants (?) being able to communicate with us has apparently been ruled out. Considering, however, that Venus is almost exactly the same size as our own globe, and that she is always enveloped, as the earth also is, in such a cloudy envelope that even her rotation period remains in doubt, it seems rather premature to assume that the silvery planet is uninhabited. If it were possible for us to view our own globe from space, or from another planet, the earth would appear to be enveloped in clouds in the same way as her sister planet does to us.

The sun, the great centre of the solar system, is continually throwing out into space electric currents far greater than any signals which could be sent from another planet by man-made wireless, and these would have the effect of "jamming" any signals from Mars or Venus, even supposing we were capable of decoding them.

The agitation of magnetic needles during the "magnetic storms" which occur during sunspot maxima are only the greater and more noticeable manifestations of what is continuously going on unheeded. Indeed, there is a theory which goes so far as to assume that the sun has no real "heat rays" as we understand them, but the "rays" or "waves" when they leave the solar surface are electrical waves, that is, waves of electrical potential, quite cool in themselves, but capable of being turned into heat rays on passing through a resisting medium. This medium is found in our atmosphere, which converts electric energy into heat.

This theory is certainly borne out by the results of Véry's researches into the heat of the moon.

It is well known that our satellite has practically no atmosphere, although some recent observers claim to have discovered evidence of air in the valleys. The fact that there is no air on the moon, according to M. Véry's careful experiments with very sensitive instruments, shows that the surface temperature of the lunar rocks, even under the full rays of the sun, does not rise above about 30 deg. to 40 deg. F. Were the rays of the central luminary really heat rays, atmosphere or no atmosphere, the rocky surface of our satellite should attain the temperature of boiling

(*continued on page* 118)

(*Continued from page* 116).
water under a constant and continuous insolation of about 13½ days.

If these rays, then, emanating from the sun, are electrical, travelling through space at an enormous speed, how can we hope to pick up the comparatively small disturbances of the ether produced by the supposedly highly-developed inhabitants of Mars or the possibly less advanced dwellers on Venus?

Be this as it may, it would appear that there are very many difficulties to be overcome before we can communicate with or receive messages from possible inhabitants of other members of the solar system.

Finally, this present opposition of Mars is by no means the most favourable for making the experiment which Signor Marconi is undertaking. On August 23rd, 1924, Mars will be nearer to us than for many years past or to come, the distance of the planet from us on that occasion being only about 34,000,000 miles on some occasions, so that it will be readily understood how favourable an opportunity for interplanetary "conversations" will be the opposition of the "fiery planet" in 1924.

If Signor Marconi's experiments in the United States fail on the present occasion we must hope for better success at the nearer approach of Mars in two years' time. D. W. H.

Tunbridge Wells.

CLUB DOINGS

Proposed Durham City and District Wireless Club

WILL all interested please write to Mr. GEO. BARNARD (*Sec. pro tem*), 3, Sowerby Street, Sacriston, Durham.

Ilkeston Amateur Wireless Club

APPLICATIONS for membership of the above newly-formed club are invited. *Hon. Sec.(pro tem)*, Mr. R. W. EMINSON, 2, Station Road, Ilkeston.

Birmingham Experimental Wireless Club

(*Affiliated with the Wireless Society of London*). *Hon. Sec.*—FRANK S. ADAMS, 110, Ivor Road, Sparkhill, Birmingham.

THE monthly "General Discussions" meeting was held at Digbeth Institute on Friday, June 30th.

The discussion was opened by Mr. B. A. Matthews.

Mr. Matthews' valve receiver was criticised at length. Several other members then mentioned difficulties which they had met, and these were discussed by the meeting. Several interesting and original ideas were described by members.

The next meeting will be held at Digbeth Institute on Friday, July 14th, 7.30 P.M. The secretary will be pleased to hear from intending members.

Wireless Society of Highgate

(*Affiliated with the Wireless Society of London*). *Hon. Sec.*—MR. D. H. EADE, "Gatra," 13A, Sedgemere Avenue, East Finchley, London, N.2.

ON Friday, June 30th, Mr. F. L. Hogg, gave the first of his series of lectures on "The Construction of Wireless Apparatus" at a meeting of the society at their headquarters at the Highgate Literary and Scientific Institution.

Mr. Hogg dealt very carefully and lucidly with the construction of tuning coils and contrasted the relative merits of cylindrical, basket and honeycomb coils for various wavelengths. He showed how a simple one-valve circuit should be connected up and then dealt in detail with the assembling of the various components which go to make up such a set.

Mr. Hogg's lecture was followed with great interest by those present.

The lectures on the theory of wireless and the construction of apparatus are being continued, each Friday, until the middle of August. The hon. secretary will be pleased to receive inquiries from anyone interested and to furnish full particulars of the society.

Croydon Wireless and Physical Society

(*Affiliated with the Wireless Society of London*). *Hon. Sec.*—B. CLAPP, "Meadmoor," Brighton Road, Purley.

A MEETING of the Croydon Wireless and Physical Society was held on Saturday evening, July 1st, at the Central Polytechnic, Croydon.

Mr. A. H. Peakman, a member of the society, very kindly provided two buzzer sets for Morse practice, and the members divided into two groups, one consisting of the more advanced Morse readers who practised high speed work, and the other of the less experienced, who were desirous of improving their Morse reading. After spending a profitable hour, the members had an informal talk on innumerable wireless subjects, ranging from the harmonics of G.N.L. to the date on which broadcasting would commence, these subjects in particular calling forth some forcible remarks. The meeting terminated with a vote of thanks to Mr. Peakman for the loan of his instruments.

The secretary wishes to announce that there will not be a meeting of the society in August. The next meeting will be held on Saturday, September 2nd. He will be glad to hear from any lady or gentleman who may be desirous of joining the society.

North Middlesex Wireless Club

(*Affiliated with the Wireless Society of London.*) *Hon. Sec.*—E. M. SAVAGE, Nithsdale, Eversley Park Road, London, N.21.

THE ninety-fourth meeting of the Club was held on Wednesday, June 28th, at Shaftesbury Hall, Bowes Park. Mr. W. Gartland gave a paper entitled "The Miscellaneous Uses of the Thermionic Valve."

Those of the members who have heard Mr. Gartland on previous occasions were anticipating something interesting, but all were surprised to hear the very good and consistent results obtained by Mr. Gartland on apparatus which he had just brought to the hall, and had had very little time to adjust. Anyone who has had the unpleasant experience of bringing a lot of instruments for a lecture, and has failed to produce the results intended, will the more readily understand how gratifying it is to be able to record that Mr. Gartland's experiments did not fail, but were a great success. The chief instrument was an altered Mark III receiver, and by means of an ingenious barrel contact switch either one, two, or three valves could be used as desired. This enabled the lecturer to show the valve being used for detecting and amplifying. Speech and music were received from several stations, and by means of a simple loud speaker were rendered audible to all present. The time passed so quickly that Mr. Gartland was unable to go fully into the many other uses of the valve, but the brief outlines which he gave were sufficient to show that the applications of the thermionic valve were only just beginning to be realised.

Hornsey and District Wireless and Model Engineering Society

Hon. Sec.—MR. H. DAVY, 134, Inderwick Road, Hornsey, N.8.

A MEETING was held on July 4th when a set was "rigged up" and the concert from Chelmsford clearly heard.

Mr. H. J. Pugh demonstrated a 2-valve resistance-capacity set, the only "aerial" being one of the members standing on an insulated pedestal with one finger on the aerial terminal.

Messages were quite clear and readable, many stations being heard.

In future meetings will be held at 29, Felix Avenue, Western Park, Crouch End.

Applications for membership are invited.

Brighton Radio Society

(*Affiliated with the Wireless Society of London*). *Hon. Sec.*—MR. D. F. UNDERWOOD, 68, Southdown Avenue, Brighton.

AT a recent meeting of this Society an interesting discussion ensued, during the course of which the methods of short-wave reception were considered. Various useful suggestions were offered by different members who were present and it was ultimately suggested and decided upon that at the next meeting all members who so desired should bring their short-wave sets along for trial with a view to comparing results.

As a means of assisting the beginner as far as possible in the construction of a set capable of attaining the best possible results at the minimum cost, Mr. Magnus Volk very kindly offered to provide the funds for the construction of a set upon these lines which should be used solely for the assistance of members.

Applications for membership are invited.

FORTHCOMING EVENTS

Leeds and District Amateur Wireless Society. July 14, 8 p.m. Lecture by Mr. D. E. Pettigrew on "Maritime Radio Communication."

Leicestershire Radio and Scientific Society, July 17. General meeting, and lecture by Mr. J. W. Pallett on "Continuous-Wave Transmission."

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Marconi House (2 L O). July 12, 5 to 5.20 p.m., 6 to 6.20 p.m., and 7.30 to 8.30 p.m. July 20, 8 to 9 p.m. Transmission tests.

ANNOUNCEMENTS

"Amateur Wireless and Electrics." Edited by Bernard E. Jones. Price Threepence. Published on Thursdays and bearing the date of Saturday immediately following. It will be sent post free to any part of the world—3 months, 4s. 6d.; 6 months, 8s. 9d.; 12 months, 17s. 6d. Postal Orders, Post Office Orders, or Cheques should be made payable to the Proprietors, Cassell & Co. Ltd.

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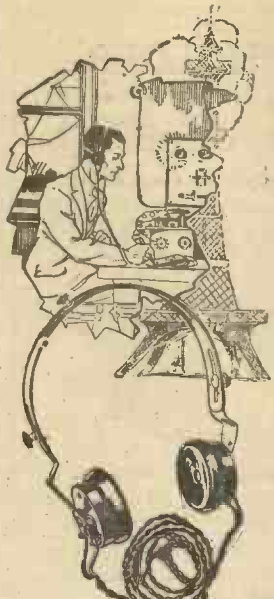

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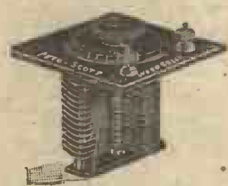

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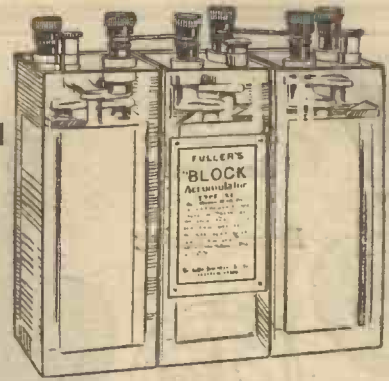

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A SIMPLE THREE-COIL TUNER

An Instrument of Wide Range Made from Oddments

UNTIL recently I have been satisfied with a tuner consisting of A.T.I. and reaction coil. But with the advent of short wave-lengths for telephony I have found it necessary to use a two-circuit set for maximum efficiency, and since it will be necessary for amateurs to discard their single circuits shortly, I think it will help them to get good results if I describe my tuner, which is made up of odd parts which I had at hand.

The base of the tuner consists of an old valve panel box 7 in. by 5½ in. by 2 in. The ebonite panel which used to form the top of this box was too badly damaged to be used again, and not possessing much ebonite I had to be content with a top partly wood and partly ebonite, both ¼ in. thick. The wood, which is fretwood ready planed, is 4¼ in. by 1¾ in. by 7½ in. The two fit close together and leave ¼ in. overlap all round the box. On the top are mounted two wood pillars ¼ in. by 1 in. by 4½ in. supporting a piece of ebonite 4 in. by 2 in., which has a projection of 1 in. towards one side of the base, preferably that side fitted with ebonite. This allows the primary and reaction coils to swing well away from the secondary, which is fixed. The coil holders are composed of three pieces of ebonite 3 in. by 1 in by $\frac{2}{5}$ in. which were cut from the top of a Mark III tuner (see Fig. 1). These are drilled at each end about ½ in. from one edge, and are tapped 3 B.A. to accommodate pieces of brass rod, which should be 1 in. long for the top and 1¼ in. for the bottom of each holder. In addition, the rods of one holder, which is to be the centre one, should be threaded for about ¼ in. of their length. Holes are also drilled right through the breadth of the holder about ⅞ in. apart to accommodate ordinary valve sockets. Next drill three holes in the top piece of ebonite ⅜ in. from the edge and ¾ in. apart to accommodate the brass rods, the centre hole being tapped 3 B.A. The bottom rods of the holders fit in corresponding holes in a small strip of ¼ in. ebonite 3½ in. by ½ in., which is supported on brass screws ½ in. above the wooden baseboard. The outer holes should be drilled not quite through the ebonite, the centre one being tapped right through as above.

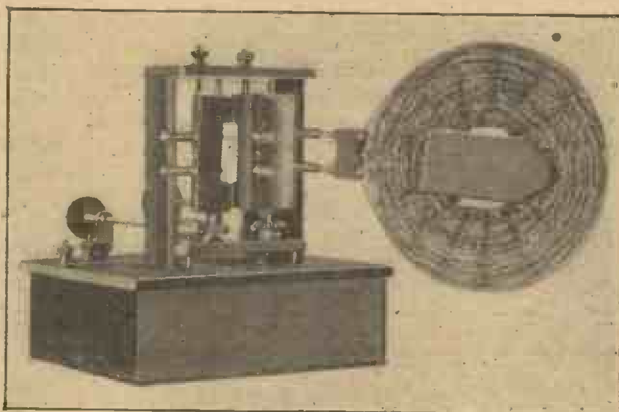


Fig. 1.—Photograph of Complete Tuner.

In order to provide means of moving the coils I have made use of "Meccano" parts. On the bottom rod of the primary holder I have clamped a bevel gear, and on the reaction holder a pinion. The holders are now assembled, the centre one being screwed into the top ebonite, then the bottom ebonite screwed on to the bottom rod. Then screw the bottom strip of ebonite to the baseboard and slip in the side holders, the rods being inserted in the top holes first. The bevel gear of the primary engages with a bevel on a "Meccano" rod, supported in rear by a "Meccano" strip bent twice at right angles. The pinion of the reaction engages with a worm gear on a second "Meccano" rod. I have fitted a slow motion gear in this case for fine adjustment, though a bevel gear may be used if preferred. The free ends of the "Meccano" rods are threaded 3 B.A. and screw into tapped circles of ebonite for handles.

The only thing remaining is to fit terminals and wire up. The terminals are in three sets of two, one set at each end of the ebonite base strip and one pair either in the middle of this strip or on the top piece of ebonite. Though I have put the strip of ebonite at the side of the base nearest the handles, it is preferably placed at the other side, under the coils, to do away with capacity effects when the hand approaches the handles. Flex should be used in the wiring of the moving coils, the wires being separated, brought through holes in the base and soldered to the terminals.

The coils used are baskets for short

Group of Basket and Slab Coils.

waves, giving better coupling than honeycomb coils. Each is clamped between two pieces of wood, one piece being sufficiently

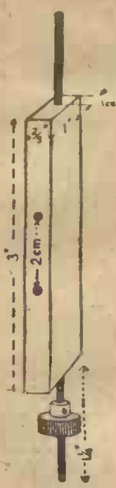


Fig. 3.—Method of Mounting Coils.

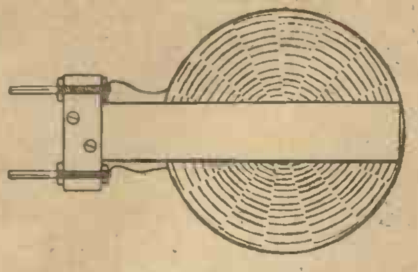


Fig. 2.—Coil Holder.

long to protrude 1 in. from the side of the coil. Small pieces of ¼ in. ebonite 3 cm. by 2 cm. are drilled with two holes 2 cm. apart, and are fitted with valve legs to plug into the sockets. These may be obtained quite cheaply. The ebonite is screwed to the wood projection and the coil ends soldered to the pins. This is clear from Fig. 3.

The following table gives an idea of the turns needed on the coils, with a .001 condenser on the primary and a .0005 on the secondary. Reaction is obtained from a coil not in use as primary or secondary.

Mean Diam. (cms)	No. of turns	Wave-length (metres)	Gauge
6	9	180-360	Primary
6½	22	320-640	22 S.W.G.
10	60	600-1,500	d.c.c.
7	36	180-400	Secondary
8	68	370-800	30 S.W.G.
12	120	600-1,200	d.c.c.

The coils are easily wound on a former consisting of a piece of curtain pole about 2 in. in diameter having fifteen holes drilled at equal distances round its circumference. Into these holes are inserted 2½-in. nails. The wire is wound round and round, basket fashion, until the required number of turns is completed, then the coil is dipped in a bath of molten paraffin wax, is removed, and when the wax has set the nails are taken out and the coil eased off the curtain pole. The photograph (Fig. 1) shows the finished instrument.

F. C.

The Nature of the Ether

THE first question to occur to those whose interest has been newly awakened in wireless matters is, "In what manner is one station in touch with another?" We may not know the technical details of the transmission of speech and written messages sent by wire, but at least there is some material connection between sender and receiver in that case, whereas with wireless there appears to be none. Modern science, though it cannot claim to have fully answered this, can yet provide an explanation which gives us a very satisfactory understanding of what takes place. Much of this explanation is wrapped up in mathematical formulæ, but a good practical conception may be obtained without making use of these by considering other similar, though more familiar, problems.

Analogy

This method of gaining an insight into the less obvious workings of nature will prove very helpful in introducing us to new ideas, but such comparisons are only for the purpose of getting a first grasp or impression and should not be carried too far. It cannot be expected that an analogy, however well it illustrates some points, will compare throughout with the problem it is intended to illustrate.

For our first analogy let us take the case of a man looking at a lamp. By some means the source of light is creating an impression on the retina of his eye,

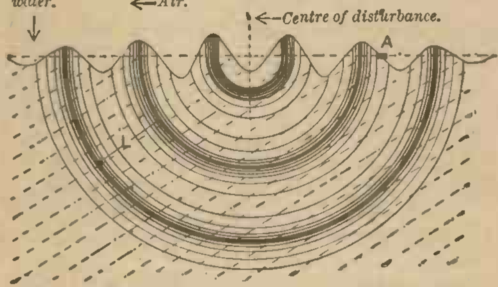


Fig. 1.—Sectional View of a Pond showing Waves on the Surface and in the Water.

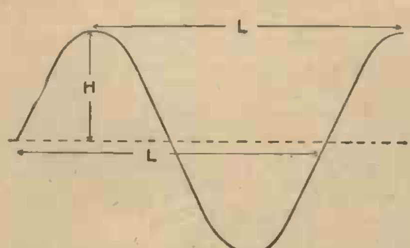


Fig. 2.—Representation of Wave Motion.

and if a second person has his hand on the light switch he may "transmit" a message to the first by turning it on and off according to some mutually understood plan or code. Yet there is apparently no material connection between the "transmitter" and the "receiver." The only alternative to regarding this as a case of action at a distance, which is irrational, is to acknowledge that the space between the lamp and the eye must be filled by some medium having definite physical properties and functions. In fact, to explain fully this and other similar problems it is necessary to imagine this medium, which is known as the ether of space, as existing everywhere, permeating even the most dense matter, as water does a sponge or a bucket of sand.

The above illustration is something more than an analogy; it is an actual case of wireless telegraphy, differing only in means, though not in underlying principle, from the system in commercial use at present.

Science has certainly discovered the existence of the ether and determined some of its properties, yet it is strangely elusive owing to its immaterial nature. It cannot be handled or examined, as, say, a newly discovered gas.

The property of the ether we are most interested in is its ability to vibrate if set in motion by suitable means.

Wave Motion

It is worth while to get as clear a conception as possible of wave-motion. It is the essential of wireless transmission, and the clearer our ideas on the point the better will be our understanding of the whole subject. With vibration or wave-motion of any sort one usually associates the ripples on the surface of a pond. These ripples are, however, only the surface manifestation of the actual wave-motion itself. Beneath the surface, waves of alternate compression and rarefaction are travelling outward from the centre of disturbance in the manner shown in Fig. 1. But for the disturbance of the surface we should be unaware of their existence. The motion we see, however, helps us to visualise and represent what takes place in the body of the water.

Before going any further we must notice one important point. It is only the wave—which is nothing more nor less than strain, or energy in tabloid form, so to speak—which moves forward. The water itself merely surges forwards and back again. This is illustrated by the effect upon a cork floating at A (see Fig. 1). As each successive wave reaches it it will both rise and fall, and move backwards and forwards, but it will not travel onwards with the wave.

In a similar manner a succession of waves or strains in the ether will travel out from a centre of disturbance (a transmitter) in spheres of ever-increasing radius without entailing any motion of the ether in bulk. From this train of waves the energy may be liberated by suitable apparatus (a receiver) placed at any point in their path and made to actuate, say, a pair of telephones. In this case, of course, there is no surface, as the ether is continuous in all directions. It is, nevertheless, still useful to represent a train of waves by a rippling line such as is shown in Fig. 2.

Characteristics of Waves

Waves differ in three important respects —in length, in intensity or strength, and in shape. The length is the distance L in Figs. 1 and 2, and the intensity is represented by the maximum height H. For the present we will neglect the equally important factor of shape and assume them to be sine waves, as are those shown in Fig. 2.

Whatever their length or shape, they travel at a constant speed in all directions, so long, of course, as they move in the same medium. This is an important point.

The speed with which they travel is dependent solely on the ratio of the elasticity of the medium to its density. Thus in a dense substance which is highly elastic disturbances will travel at the same speed as in an attenuated, inelastic substance, provided the ratio between the two properties is the same in the two cases; but if either density or elasticity changes independently of the other, it will entail a change in the speed. This fact is mentioned as it has a bearing on long-distance wireless transmission.

300,000,000 Metres per Second

The speed of wave-motion in ether is 300,000,000 metres a second, and is the greatest velocity known. It corresponds to a journey eight times round the earth in a second. All ether waves in space, of whatever intensity, length or shape, travel at this speed, but as they move outwards from the point where they are generated they decrease in intensity or height.

The number of waves which pass a fixed spot in a second is known as the frequency, and a moment's consideration will show us that this rate (measured in waves per second) multiplied by the wave-length (measured in metres) is equal to the speed of transmission (in metres per second). But we have just seen that this speed is the same for waves of all lengths, consequently we arrive at the important conclusion that the greater the frequency of a disturbance the shorter the length of wave generated, and vice versa.

The range of wave-lengths in which it is possible to make the ether vibrate is extremely wide, varying from less than a thousandth of a millimetre on the one hand to thousands of metres on the other. Naturally the properties of waves at different points on such an extensive scale vary very considerably, and the only portion of the scale which is at present found suitable for wireless transmission is that containing wave-lengths of from 30 to 20,000 metres.

Making the Ether Vibrate

The next point to consider is how we are enabled to set such an intangible substance as the ether vibrating. In our first illustration it was brought about by the heating and consequent energetic and rapid motion of the particles of which the lamp filament was composed. For producing the infinitely longer waves used in wireless a somewhat different method has to be employed. The electrons of which all matter is ultimately composed may be regarded as centres of strain or knots tied in the ether itself. The passage of an electric current consists in the handing on of some of these electrons from molecule to molecule. The process is almost as rapid as the motion of the waves of which we have been speaking, but it is slowed down somewhat by the disturbance it creates in the material of the wire or conductor. As the electrons, the motion of which constitutes the current, are thus part and parcel of the ether, their progress naturally produces an effect on the ether surrounding the wire, and if the current is made to oscillate backwards and forwards in a suitable circuit, as in the transmitting apparatus of a wireless station, waves of strain will be flung clear of the wires forming the aerial of the station and set free to travel outwards in the ether or space. SIGMA.

A Weather-proof Lead-in

A CORRESPONDENT writes as follows: "As rain is likely to be led into the leading-in tube by running down the wire and by capillary attraction, I suggest that a copper funnel be soldered in an inverted position on the down lead." This is a useful suggestion where it is necessary for the lead-in to be brought down vertically, but it is a bad way of

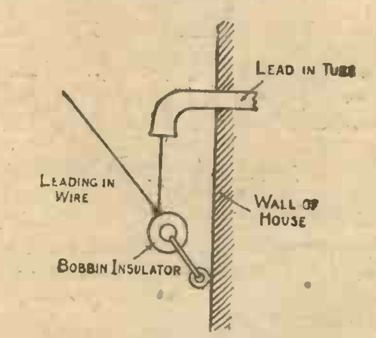


Diagram of Weatherproof Lead-in.

leading-in because any pull on the wire strains the tube. The better arrangement is shown in the illustration. In this the strain on the wire is taken by the insulator attached to the wall, and the lead-in is run upwards into the tube. However, this is only necessary for heavy wire; a light wire can easily be bent round the tube. A glass tube answers well for this purpose; it can be bent to any shape in a gas flame.

J. F. S.

A Receiver Weighing 28 oz.

THIS is a portable receiving station complete in a polished mahogany box 6 in. by 6 in. by 3¼ in., with a wave-length range of 200 to 1,000 metres. Although so small it is quite efficient. A single receiver is used in place of the usual double-headgear telephones. There

The Receiver Open.

are only three components in the set—the "figure-of-eight" variable inductance, the detector, and the telephone. A "blocking" condenser across the telephones is found unnecessary, as the difference in signal strength with and without this is almost imperceptible.

The detector crystal cup is mounted on a flat nickel silver spring, and the "point" can be moved about to touch any

The Receiver Closed.

portion of the crystal without disturbing the cup.

No buzzer is included in the set, but it is advisable to have one, as the detector can be adjusted much more easily. However, it is often found that the buzzer will automatically start the detector working.

The makers of the instrument are Mitchells Electrical Wireless, Ltd., 188, Rye Lane, London, S.E.15.

HIGH-TENSION BATTERY NOTES

ONE of the most important units of the valve receiver is the high-tension battery. The 30 to 60 volts most commonly needed must be above suspicion or the reliability of the set is very questionable.

Current Requirements

Fortunately, the B. Battery, as our American confrères call it, is not asked to provide much more than a milliampere of current, and so the size of the components need not be great. The cells must, however, be of reliable make, but this does necessarily mean high in price. The man who makes up his high-tension battery by buying up a dozen or two pocket flash-lamp batteries because he can get them for so many, or so few, pence per dozen, is asking for trouble, especially if the vendor, to convince him of the freshness of his wares, lights up a small bulb lamp with each one in turn to "test" it. One of these little lamps may easily require the best part of an ampere to light it up brilliantly, and that amount of current for even so short a flash would do even good little cells irreparable damage.

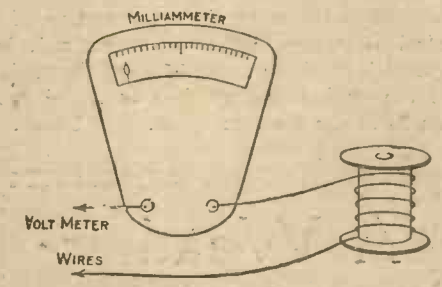
Purchase

In buying a new battery get one of a reputed make, and see that it is not tampered with by the ignorant. Above all, if you wish to test the voltage don't put a low-resistance voltmeter on it, or a high-resistance voltmeter either, for more than an instant. If, like the writer, you are fortunate enough to get hold of a lot of larger cells which have been rejected by the manufacturer for having too high an internal resistance for their intended use, you will get, at a low price, a high-tension battery, which, with proper care, will last for years.

Testing

However careful the user, there are bound to be a number of cells that will "peter out" and lower the efficiency of the battery, and the difficulty will come in weeding these out. Nowadays one ought to be able to acquire fairly cheaply a sensitive milliammeter. Choose one, if possible, that has a wide range up to two milliamperes. Now get hold of a coil of resistance wire measuring just short of 1,000 ohms. Your dealer will let you have a reel of wire of that resistance for a few pence. You can use it just as it is, on the reel, if both ends can be got at. It ought, of course, with the milliammeter in series to measure exactly 1,000 ohms, but an ohm or two more or less will not make much difference.

Connect one end of the coil of wire to one of the terminals of the milliammeter. The other terminal and the other end of the resistance coil will be the connections for the voltmeter, as shown in the accompaning illustration. If the instrument is put across a cell it will read volts, because one volt pressure applied to a circuit of 1,000 ohms will cause one milliampere of current to flow. Any cell tested this way which shows one volt or more can safely be left in the high-tension battery and others weeded out and *thrown away*. Don't play about trying to repair or recharge the cell. It is mere waste of time. A cell, when once exhausted, is only fit for the dustbin. Also, don't attempt to charge up the cell as one would an accumulator. Careful tests have proved that the result, however promising-looking, is a failure.



Method of Testing a High-tension Battery.

Reliability

The great secret of the superiority of some makes of cells is the fineness of grinding which the powdered contents receive. The "depolarising" element of a dry cell is manganese peroxide, and in either a crystalline or amorphous state it it much too hard for the cell to extract all the associated oxygen as it requires it, its funds are invested, so to speak. Ground to an impalpable powder and mixed with fine graphite and carbon dust it performs its functions faultlessly.

The active element in dry cells is a paste mixture containing flour, plaster-of-paris, and sal-ammoniac. This is smeared all over the inside of the zinc containing case. A carbon rod is supported in the centre so as not to touch the paste or the zinc case, and this rod carries the positive terminal. The space left between the rod and the paste is rammed tightly with the powdered peroxide mixture, leaving enough room to seal off the cell at the top with pitch. A cell so formed gives a small fraction over 1.5 volts when new.

The current drawn from a dry cell should never exceed one milliampere per cubic in. of the black compound—that is, the carbon rod and the peroxide mixture.

For many purposes, the life of a dry cell ends when its terminal voltage drops to one volt, but a wireless high-tension battery, if the cells are not too small, can be used until the voltage falls to .8, or even .7, provided that the internal resistance of the cell is not excessive.

The wise and careful user of a high-tension dry-cell battery insulates each cell from its neighbour so as to avoid the battery running down by leakage, or even worse, picking up stray noises from the floor upon which it stands. G. S.

Electrical Benchwork

Blowpipe
Soldering

THE process of soft soldering with the ordinary soldering iron was dealt with in No. 4. For small parts such as are required for wireless apparatus the blowpipe (a typical example of which is given in Fig. 1) is equally satisfactory.

Advantage of the Blowpipe

The particular advantage of a blowpipe is that it gives a fierce heat at a very localised area beyond which the solder does not run. You can solder spots, and also unsolder, resolder, or adjust soldered parts without allowing heat to stray and cause trouble in other places.

Operating the Blowpipe

The blowpipe needs a fair amount of knack in use, as it is no use blowing in gasps; a continuous blast is necessary. The best way to maintain a continuous blast is to breathe naturally through the nose and at the same time keep the cheeks distended (see Fig. 2). By adopting this simple dodge you will be able to keep up a steady blast of air through the blowpipe. If you are working the blowpipe flame right the flame is almost silent, whereas a roaring, irregular flame is produced otherwise.

A Lip Guard Necessary

Unless you are more careful than I am you will often carelessly place the blowpipe after use on the bench and as carelessly replace it in the mouth when it is required. The filings, dirt, etc., which the mouth end picks up are very distasteful, and to avoid this I place a thick tinplate washer near the mouth end (see

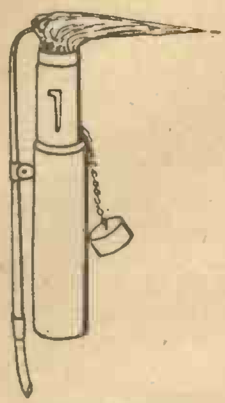


Fig. 3.—Reservoir Blowpipe.

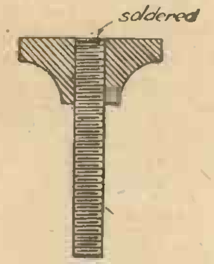


Fig. 4.—Built-up Finger Screw.

A, Fig. 1), the object being to raise that end off the bench.

Spirit Lamp and Blowpipe Is Best

There are several types of blowpipe on the market, but you will find the one shown in Fig. 1 the best for use with a spirit lamp or wax taper, whilst the combined blowpipe and spirit lamp shown by Fig. 3 is a great improvement. If you decide to have the type shown by Fig. 1, one about 9 in. long should be chosen, so that the eyes are kept well away from the flame.

The type shown in Fig. 3 has a reservoir into which methylated spirit is poured. The wick is lit and the blowpipe operated in the ordinary way.

Soft Soldering with the Blowpipe

Place the work in such a position that you can conveniently blow on the spot to be soldered. Then insert the blowpipe in the mouth, and with a stick of solder in the right hand and the taper or spirit lamp in the left, a steady blast is maintained. The joint or spot should be frequently touched with the solder (not forgetting to use sufficient flux), when the solder will soon flow into the joint.

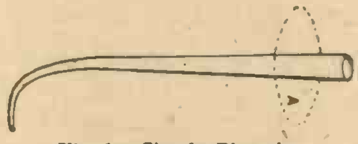


Fig. 1.—Simple Blowpipe.

If (as is likely when using a taper) soot tends to form; this must be wiped away with a cloth-covered stick soaked with flux. Smoky flames are produced when the blast is too weak; after a little ex-

Fig. 2.—Method of Using Blowpipe.

perience you will soon acquire the knack of regulating the supply of air.

Some Examples of Soldering

So far all that you need know about soft soldering in order to do it has been dealt with. Some further examples are given which show the application of soft-soldering to the building up of parts. Suppose, for example, you want some detector

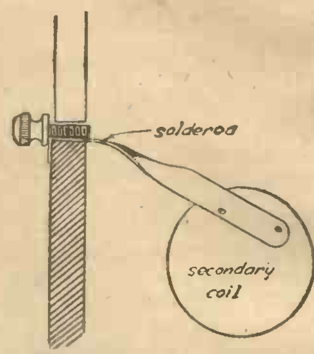


Fig. 5.—Method of Fixing Ebonite Knob to Arm.

adjusting screws. The proper way to make them (although it hardly pays, so cheaply may they be bought) is to turn and knurl them in the lathe. A simple method where a lathe is not available is to solder terminal screws to pieces of screwed rod or a piece cut off a screw (see Fig. 4).

A simple method of fixing the ebonite knob to the operating lever is shown in Fig. 5, a small ebonite knob is fitted on to a brass screw and the latter soldered to the lever.

You have probably tried at some time or other to solder connections to the mica-foil type of condenser and suffered the annoyance of melting the protruding ends of the foil! This operation cannot satisfactorily be done with the soldering-bit or mouth blowpipe. A special solder (Wood's metal, which melts at a lower temperature than boiling water) is melted, and the foil ends of the condenser, with the wire pressed into contact with them, is rapidly drawn through the solder. It will be found that a very neat connection is made by this method.

INGOT.

WHAT WIRELESS TERMS MEAN.—V

Some Technical Words Explained as Correctly as Popular Language Allows

ELECTRO - MAGNETIC INDUCTION.—The effect produced by a conductor being caused to cut a magnetic field. For instance, if a wire is passed across the pole of a magnet a current of electricity will be induced in the wire.

RESISTANCE.—The property possessed by all substances of offering in a greater or less degree opposition to the passage of electric currents. This term must not be confused with inductance or impedence. Iron and steel offer more resistance than does copper. This property is made use of when it is desired to limit the current in a circuit. The effect of resistance is to produce heat. It is a determining factor in arriving at the amount of electricity that will flow in a given circuit at a given voltage. Where a maximum flow is desired, the minimum resistance must be secured.

INDUCTION.—The effect produced upon a coil of wire in juxtaposition to another coil in which a current of electricity is made to flow, at the moment this current of electricity is started, stopped or varied.

POTENTIOMETER.—A variable high resistance, usually of the order of 200 ohms through which a current from a battery is passed and applied to some types of crystals. Also used in high-frequency circuits to apply a negative potential to the grid to stop the valve oscillating when receiving telephony.

LOADING COIL.—A coil by means of which further inductance is added to the circuit in order to enable higher wave length to be received. It is inserted in series with the tuning coil and may itself be variable. When added to a valve circuit it must always be placed below the grid connection and in front of the tuning coil. It may consist of a cylinder of cardboard wound with thick wire, or a number of slab coils.

CONDUCTOR.—The opposite to an insulator, i.e. a substance that permits the free flow of an electric current and by which it is conducted from point to point. Copper, brass and most metals are conductors in a greater or less degree, as also are water, the human body, etc.

FILAMENT.—That part of a valve to which the accumulator is connected, causing it to become incandescent, and in that state to discharge electrons from its surface (*see* Valve). It consists of very fine tungsten wire and is suspended between two supports. It is very fragile and easily broken, particularly when cold. The filament must never be in contact with any other part of the valve.

STARTING WIRELESS.—VII FINISHING THE SIMPLE RECEIVER

The Crystal Detector

THERE are a number of different forms of detectors, perhaps the most stable type being the carborundum and steel-plate combination. However, this usually requires a potentiometer, and it is therefore a little more complicated for a beginner. Another type consists of a very fine wire (called a cat-whisker in America) which bears lightly on the surface of the galena crystal. This combination is perhaps a little more sensitive than others, but at the same time it is rather erratic in behaviour. Reference was made to the Perikon detector in a previous section, and this will therefore be described. Many designs of detectors have been put on the market from time to time, each claiming some special merit. However, the reader is advised to begin with the simplest form possible, so that when he has gained more experience he will be able to judge which type he prefers.

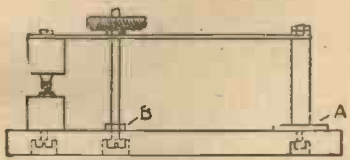


Fig. 1.—Simple Detector.

The detector will be better understood by reference to Fig. 1 than by a lengthy description. The base may be of ebonite, 4 in. by 3 in. and ½ in. thick. The crystal cups may be drilled or turned from brass rod ½ in. diameter, or they may be bought for a few pence. The success of the detector depends upon its rigidity; a weak or springy detector will never keep sensitive for more than a few minutes, and it will be found a source of everlasting annoyance. One crystal cup is fixed near the end of the base, as shown in Fig. 1, and the other is screwed to the end of a piece of brass 2½ in long, ½ in. wide, and a little less than $\frac{1}{16}$ in. thick.

A thick brass screw about 2 in. long is passed through a hole drilled at the other end of the base. A strong washer (A, Fig. 1) is put on the screw, together with a length of stout brass tube about ⅜ in. external diameter. This is followed by the brass strip, which is finally secured by two nuts. The length of the brass tube will depend, of course, upon the height of the crystal cups. A similar but longer screw is fixed to the base with a nut B, and the end is allowed to project through a slit in the brass arm. A nut to fit the screw is soldered to a small piece of thin brass, which is then screwed to an ebonite knob. It will be understood that by screwing the knob downwards the two cups will be brought nearer together, thus varying the pressure between the crystals. The crystals are set in the cups with either molten solder or Wood's metal. It is usual to employ a pointed piece of bornite or copper pyrites resting on a flat face of a piece of zincite. Two terminals mounted on the base complete the detector; connection is made, of course, to the fixed cup and the screw holding the upright.

The Telephone Condenser

This can be made very simply from tinfoil and paper. The actual value of the condenser is not of very great importance, so that the following details need not be adhered to very strictly. Eight pieces of tinfoil 3 in. by 1½ in. and nine pieces of thick writing paper 2½ in. by 2½ in. will be required. Fig. 2 illustrates the method of assembling the condenser, only four plates being shown for clearness. It is essential that the insulation of the condenser should be as good as possible, and therefore before the plates are assembled the paper should be well soaked in paraffin wax. When the tinfoil plates are assembled the four plates which project on one side are bent on to the top piece of paper, and the other four are bent on to the bottom piece of paper. The length of the projecting pieces should be a little over half an inch.

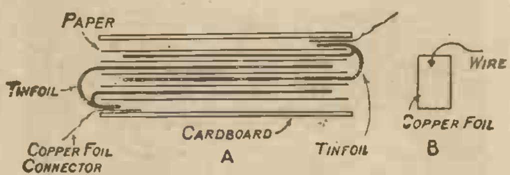


Fig. 2.—Diagram showing Construction of Telephone Condenser.

Two pieces of waxed cardboard are cut to the same size as the paper to act as a kind of cover. Connection has yet to be made to the plates, and this is best done as follows: Two short lengths of copper wire are soldered to two small pieces of copper foil. These are placed one against each of the bent pieces of tinfoil, being slipped between the top and bottom pieces of paper and the cardboard. This should be quite clear from the diagram. To ensure an efficient contact the condenser is pressed well together, and it is then firmly bound round with some tough brown paper which is secured with a little gum. To serve as a protection against damp, the finished condenser is painted with hot wax, great care being taken to cover the parts where the copper foil emerges from the paper. If desired, the condenser may be placed in a box, when the wires would be brought to two terminals mounted on a piece of ebonite on the top.

Connecting the Apparatus

Fig. 3 is divided into two parts. One part shows how the apparatus appears when it is connected up, and the other part shows the standard way of indicating the various components. It will be noticed that a switch has been included between the telephones and the detector. It is so arranged that either of two detectors may be used at will. This is a very convenient method of working, as should one detector suddenly become insensitive in the middle of an important signal it is only necessary to put the switch in the other position, thereby connecting up the second detector. As soon as the signal has finished we can immediately readjust the faulty detector. The switch is also very useful for comparing two different types of detectors, since it is possible to change from one to the other without disconnecting any of the apparatus.

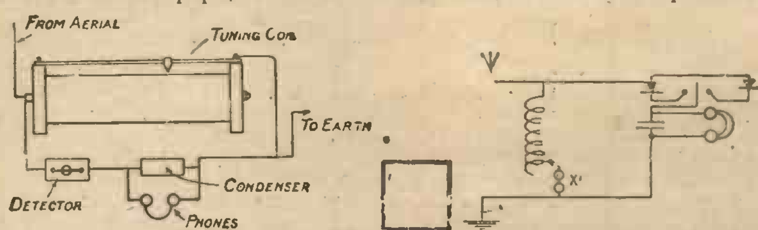


Fig. 3.—Details of Connections showing Arrangement of Apparatus and Wiring Diagram.

The tuning coil previously described was designed to receive wave-lengths up to about 600 metres. However, if it is desired to receive longer waves all that is necessary is to insert two terminals in the position marked X in Fig. 3. When receiving on the small tuning coil these are connected together with a piece of wire, but when it is wished to listen to longer wave stations simply disconnect the wire and insert another coil in its place. This coil can be made exactly similar to the other, but there is no need to fix a sliding contact since all the fine tuning can be accomplished with the original coil. It is only necessary to tap the coil at varying intervals, bringing the tappings to a multi-point switch.

A coil of this description is usually called a loading coil, since it loads the aerial to the required wave-length. PAUL D. TYERS.

Protecting the Aerial from Lightning

WHEN you arrive at the momentous decision to dabble in wireless, above all things do not make a start in construction or erection until you have schemed out

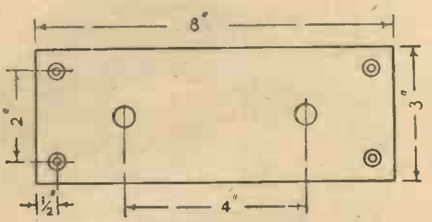


Fig. 1.—Drilled Ebonite Baseplate.

completely what you want and how you propose to set about it. You will no doubt enlarge and extend as you go on, but it is well to have something basic to work on at the outset. Having thus made your decision, be very sure that you include an efficient means of protection against lightning.

With the aerial erected and the leading-in wires brought to a suitable position, it is advisable to have a protective device installed outside in order to avoid directly bringing into the house the aerial leading-in wires with no protection. A suitable and convenient method, and one which serves a dual purpose, is to fix a well-insulated spark-gap type of lightning arrester into a suitable housing on the outside wall, and connecting the aerial through it direct to earth, thus avoiding any possibility of damage.

This spark-gap arrester can easily be made as follows: Obtain a piece of ebonite about ½ in. thick and 8 in. in length by 3 in. wide. Clean off all the polish from both sides and edges and leave a matt surface. When satisfactory drill as shown in Fig. 1. Now get a piece of brass rod 1 in. in diameter and 3 in. long, cut it in half, round off the top, and drill each piece as shown in Fig. 2.

A piece of steel rod should next be obtained ⅜ in. in diameter and 9 in. long. Cut it in half and make a nice clean point at one end and turn down and screw the other end of each piece as shown in Fig. 3.

The arrester can now be assembled. Fig. 4 is self-explanatory. The two pieces (Fig. 2) are fixed on to the ebonite base by means of 0 B.A. screws with a washer at the back. The two points (Fig. 3) are slid through these supports and clamped with 2 B.A. screws through the sides of the supports, three washers and a thumb (terminal) nut being used at the screwed end of each to clamp the aerial leading-in and earth leading-in wires in each case.

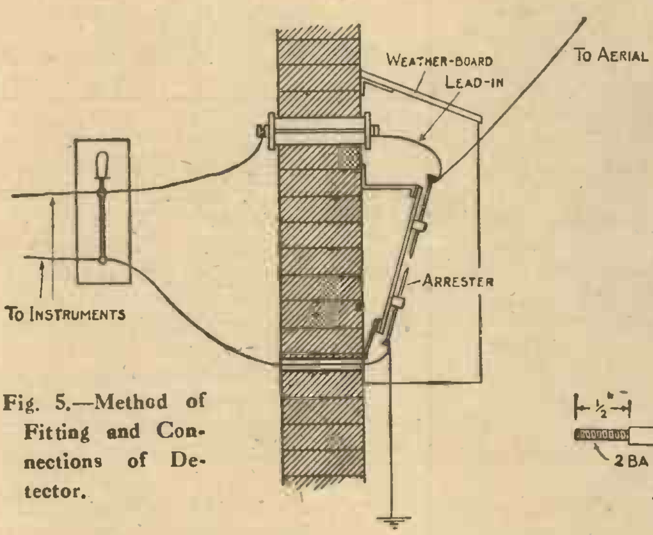


Fig. 5.—Method of Fitting and Connections of Detector.

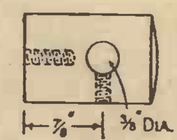


Fig. 2.—Holder for Electrodes

Fig. 3.—Electrode.

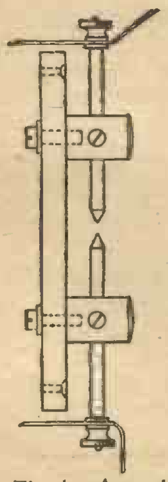


Fig. 4.—Assembly of Arrester.

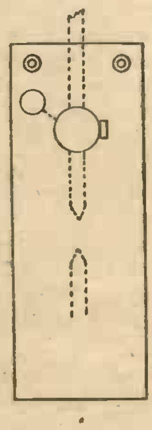


Fig. 6.—Additional Earth Terminal.

The method of attaching the arrester to the side of the house (building, shed, etc.) is shown in Fig. 5. The method can be varied to suit the conditions of the particular case and the material at hand.

The chief point about this method of fixing is that it is weatherproof. The arrester is supported by means of suitably bent-up pieces of mild steel strip arranged at an inclination outwards from the wall, with roof and sides. The inclination prevents rain from lodging, and in most cases even touching the arrester points and the small roof and sides effectively stops side and top splashing.

The connection of the aerial leading-in wires and the earth connection should be brought directly to the terminals on the pointed rods of the arrester, as shown in Fig. 5, and connection made from these points to the short-circuiting switch, which, of course, should be provided inside with the receiver. A 20-ampere lighting switch is very suitable. The provision of this switch is essential, both as an extra safeguard and in order entirely to cut off the delicate apparatus from the aerial and earth when not in use.

The further advantage alluded to with this method of protection is that by a suitable adjustment of the gap almost complete elimination of those annoying static discharges, or X's as they are called, may be achieved.

If it is found difficult to adjust the gap, which, by the way, should be about half a millimetre, a modification can be made to the arrester, which will render close adjustment more simple.

Instead of fixing the earth wires directly on to one of the pointed rods, provide a terminal as shown in Fig. 6, and make the earth leading-in connection to this, connecting this terminal by a piece of stiff wire placed under the washer to the support post, as shown by the dotted line. This relieves the pointed rod of the wires and makes it easier to adjust. Further, if it is desired a suitable screw thread can be run up the rod, and the hole in the support post similarly tapped, giving an even finer adjustment.

With regard to maintenance, paint the iron brackets and wooden housings, and occasionally polish up the steel points. If a piece of rustless steel can be obtained, use it by all means; if not, well polish the steel rods with fine emery and oil.

This arrester, of course, cannot be left in circuit when transmitting, but a simple switching arrangement would overcome this small difficulty. E. ALEXANDER.

THE Handbook on Wireless is acknowledged to be "Wireless Telegraphy and Telephony," one of the famous "Work" series of handbooks published at the offices of this journal. The price is 1s. 6d. net.

Photographic Illustrations show a Collection of the Best-known

Silicon

Galena and Special Galena

Bornite

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ALL ABOUT

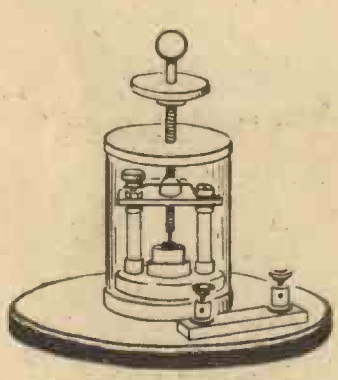
WIRELESS signals are transmitted in the form of waves created in the ether which, striking the receiver aerial, cause small alternating currents to travel up and down it. As these currents are of a very high frequency, the ordinary wireless telephone receiver cannot detect them. It is necessary, therefore, to rectify them, or, in other words, change them into uni-directional currents, before passing them through the telephones. The rectified currents produce a movement of the telephone diaphragms and thus the signals are made audible.

Certain kinds of crystals, such as carborundum, zincite, bornite, silicon, galena, molybdenite and iron pyrites, have the peculiar property of being able to rectify small alternating currents. We must explain how they do this.

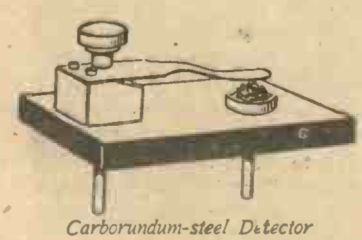
A crystal rectifies because it allows current to flow through it in one direction and does not, to any appreciable extent, allow current to flow through it in the opposite direction. It is practically a uni-directional conductor. The ratio of currents flowing in opposite directions through a good crystal should be about 40:1. It will be understood that the crystal acts electrically, very much in the same manner as a ratchet-wheel acts mechanically.

Carborundum is probably the best crystal for all-round use. It is not affected by mechanical vibration nor by fairly heavy electrical discharges across it, and it is very sensitive. This crystal has to be used in conjunction with a 4-volt battery and potentiometer, because it requires a small initial potential or voltage to be applied across it to bring it to its most sensitive point. Carborundum is used with a flat steel surface, the rectification taking place at the point of contact. This crystal is manufactured by fusing carbon and silicon together in an electric furnace. In practice three kinds of carborundum crystal are met with: (*a*) a hard dark variety, having great metallic lustre which has poor rectifying properties; (*b*) a soft crystal of a pale green colour, a colour due to the presence of copper and iron salts (this type of crystal is a very poor rectifier); (*c*) a dark grey crystal which will be found to give the best results as regards sensitivity and stability of action.

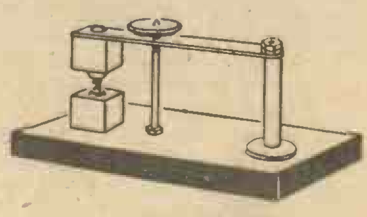
The most popular crystal detector is without doubt the perikon detector. This is a combination of either zincite and



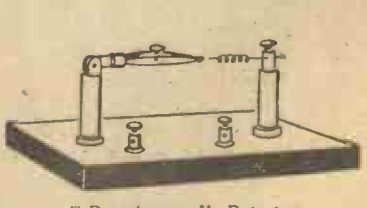
Enclosed Detector



Carborundum-steel Detector



Ferikon Detector



"Drawing-pen" Detector

Wireless Crystals Enlarged to About Three Times Normal Size.

Carborundum

Copper Pyrites

Zincite

CRYSTALS

bornite or else zincite and tellurium. The latter combination is usually found to give the better results. Zincite, or oxide of zinc, is dark red in colour; bornite is a compound of copper and iron sulphides, being bluish grey in appearance and fairly heavy. Tellurium is a light-coloured metal. The perikon detector does not require a potentiometer because the voltage of the incoming signal is sufficient to bring it to its sensitive point. It has the advantage of being fairly easy to adjust. Also when a crystal becomes slightly insensitive it can be scratched with a knife and a new surface used. To obtain the best results it is usually found that the crystals must make a light contact with each other. This detector is more sensitive in action than the carborundum type, but not so robust.

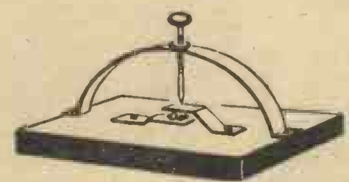
Silicon, galena, molybdenite and iron pyrites, whilst being serviceable for experimental work, do not give such satisfactory general results as either carborundum or the perikon detector. All these crystals are minerals. Silicon is light grey in colour and has not many sensitive points. Galena is very sensitive for long ranges, but strong signals destroy its sensitivity. It is bluish black in colour, has a metallic lustre, and is heavy. When using this crystal it is usual to have a graphite contact in conjunction with it. Molybdenite is dark in appearance and is suitable for the reception of strong signals; it is convenient for use in portable sets. Iron pyrites is a cubical crystal, being very metallic and heavy. It possesses many of the properties of carborundum but is not so sensitive.

The only sure way to obtain a good crystal is to search for sensitive points amongst several specimens. It is wise to remember that sensitivity is not everything; a good crystal should have the qualities of being constant in action and of not being affected by atmospheric disturbances. Such crystals as "Radiocite" and "Permanite" are usually sensitised forms of galena. They are very sensitive but not constant; a fine copper wire contact is used in conjunction with them.

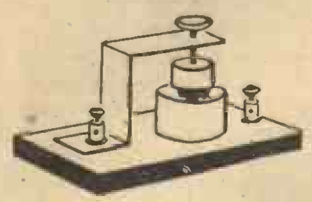
There is plenty of instruction and amusement to be had with a good crystal set. The range of a crystal set is about 300 miles for ordinary ship stations and 20 or 30 miles for high-power telephony. Several experts prophesy the return of the crystal and its ultimate triumph over the valve.

G. H. L. N.

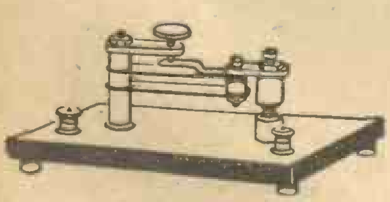
Permanite



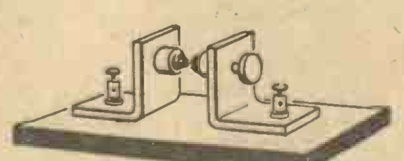
Improvised Detector



Mercury-cup Detector



Spring-adjusted Detector



Another Double-crystal Detector

Simple One-crystal Detector

Practical Working with Valves.—II HINTS AND USEFUL NOTES

THE grid leak and condenser can, with advantage, be shielded with metal foil, which should be connected to the positive terminal of the plate battery. This tends to prevent the grid of the rectifying valve from being affected by the necessary movements of the hand when making adjustments.

Sliding Contacts

A fixed condenser, having a value of from one-third to one microfarad, should be connected between the slider of the potentiometer and the negative end of the battery. This will act as a by-pass for radio-frequency currents which otherwise might have to pass through one-half a potentiometer having a resistance of perhaps four or five hundred ohms. Great care should be taken to see that the sliding contacts are good, otherwise noise may result. It is surprising how many people, including many skilled electricians, there are who take great pains to keep all oil and grease away from moving contacts. This is totally wrong, as a sliding contact if kept covered with a film of oil cannot oxidise; such a contact is also self-cleaning, due to the abrasive action of the very fine dust which forms (when absorbed in oil) a very good metal polish.

High-tension Battery

The plate-circuit battery generally consists of a group of from thirty to sixty dry cells. It is fairly satisfactory provided care is taken not to short-circuit the cells, or to attempt to discharge at a high rate. If the discharge becomes heavy the battery becomes more or less polarised, with the result that not only does the battery electromotive force fall, but considerable noise is heard due to intermittent discharge. Dry cells are cheap to renew, and after about six months—if used, say, an hour a day—are generally ready for renewal. The writer always suspects the plate-circuit battery when noises occur in the 'phones, and experience has proved that many noises are due to this cause. The battery should always be shunted with a condenser of not less than one microfarad capacity.

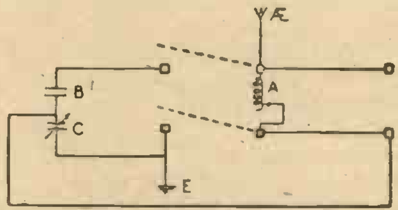
Filament Battery

A source of trouble often quite unsuspected is the filament battery. Some accumulators, if discharged at any value approaching the rated safe discharge rate, tend to give off gas, and it is often noticed that when this gas is rising noise results. On returning several cells to the manufacturers for this reason, the makers stated that had they known the cells were for wireless work they would have made them in such a way as to overcome this trouble to a large extent. They recommended that an accumulator of at least 100 actual ampere-hour capacity should be used for a discharge rate of 5 amperes.

Care should be taken that all connections are soldered, as a bad contact is often the cause of noises in the 'phones.

Dust between the plates of the variable condensers is another fruitful source of noise, but fortunately the remedy is obvious and simple.

A great many experimenters, in an endeavour to obtain a large range with a given inductance, use a comparatively large condenser in parallel. This is very bad practice, as a parallel condenser should never exceed .0005 microfarad capacity, and is even better if smaller, say .0003 microfarads. A very suitable arrangement is to use a series-parallel switch, wired in such a way that when in series with the aerial the effective capacity is the maximum, and when in parallel the maximum capacity is a much smaller amount. This result is obtained by having a fixed condenser in series with the movable condenser. The wiring for this arrangement is as shown in the illustration.



Arrangement of Series-parallel Switch.

The reference letters in this figure are as follows: A, inductance; B, fixed condenser, say .0005 mfd.; C, moving condenser, say .0015 mfd.; switch to right when in series.

A small switch can conveniently be placed in circuit to short-circuit the fixed condenser (B) if a maximum capacity in parallel is wanted. A further advantage of this arrangement is that the minimum capacity of the condenser is reduced.

Transferring Power

It is very difficult to decide which is the best arrangement to adopt for transferring the power from one valve to the next when dealing with radio-frequency currents. Three common methods of doing so are: (1) Radio-frequency transformers; (2) reactance capacity; (3) resistance capacity.

In the first case the power is probably transferred to the next valve by a combination of transformer effect and reactance capacity, and whilst very suitable for all wave-lengths is more applicable to those of from 200 to 2,000 metres, as above this the transformers become comparatively costly owing to the cost of the wire necessary for winding.

The reactance-capacity method has been found to be very good, and is somewhat cheaper and easier in construction; the windings are simple, and the question of coupling is easily controlled. The windings generally consist of slab, pancake or, better still, duolateral coils. Above 2,000 metres the simplest, and probably the best, method is resistance capacity, although it has the disadvantages that a higher voltage plate battery is required and the amplification is not so great.

A Triple-purpose Amplifier

The writer is now building an amplifier in which advantage can, and will, be taken of all three methods. It is a simple matter to arrange if four-point plugs are used to accommodate the transformers, etc. The necessary grid leaks and condensers can either be mounted on the panel with suitable switching arrangements or, as an alternative, a separate fixed condenser and leak can be provided for each coil and mounted on the same plug. The latter method is perhaps the best, as the condensers and grid leaks can be adjusted to suit requirements of the coil in question.

The writer hopes that the set he is at present constructing will be more satisfactory than the previous experiment, which had four radio-frequency tapped transformers giving a range of 300 to 15,000 metres. He also hopes that these few notes will be of assistance to earnest experimenters with more patience than money, and who prefer to make mistakes and apparatus rather than buy finished apparatus and settle down into a round of "listening in." A. F. C.

MARCONI PATENTS AND THE AMATEUR

THE Marconi Company officially announce that, far from wishing to take advantage of their patent rights to hamper and discourage amateurs, they desire to assist, rather than hinder, them in following the hobby. They state that they have no intention of taking any action against amateurs who construct for their own use wireless apparatus embodying any of the patents owned by the Marconi Company, provided that such apparatus is not offered for sale and is used only for amateur purposes. In this particular connection "construction" is intended to signify the actual manufacture, wholly or in part, of a wireless set, and not the mere connecting up of purchased instruments. On the other hand, the company intend to protect their rights when unauthorised use is made of their patents in the manufacture of apparatus for sale publicly or privately.

Radiograms

ARRANGEMENTS have been made for the American wireless station at Arlington to collect particulars of the weather conditions every morning from a number of American stations and wireless them to the Eiffel Tower. They will then be broadcast from the Eiffel Tower half an hour after noon.

An international organisation of the world's wireless operators has been formed. The federation is to have its headquarters in London.

The Middlesbrough Chief Constable has been authorised to obtain an estimate of the cost of purchasing a transmitting and receiving set and to submit the same to the next meeting of the Watch Committee of the Middlesbrough Town Council.

No official information is forthcoming as to whether either Glasgow or Edinburgh will be the selected spot for a broadcasting station. There are rumours that each city is to be permitted one.

Broadcasting is already well established in Ganada.

A system is now being perfected on the Continent by which finger prints can be wirelessed.

The synoptic weather reports and general inferences hitherto issued daily on 1,400 metres C.W. at 6 a.m., 8 a.m., 2 p.m., 7 p.m., and also at 9.15 a.m., and 8 p.m. (all hours are Greenwich mean time), in future will be transmitted on 4,100 metres C.W. The synoptic report at 2 a.m. will continue on 1,400 metres. The 8.30 a.m. report will cease. In cases of breakdown or other delay, should transmission on 4,100 metres not have begun within ten minutes of the scheduled time, the message will immediately be issued on 1,400 metres.

Wireless is to be used as a means of bringing schools lying in outside districts into touch with university life. Hitherto there has been some difficulty in inducing professors, lecturers and others to go out to them.

Authorities are of the opinion that the wireless business as it is now developing is going to be greater than the gramophone industry.

Swansea Education Committee recently passed a supplementary estimate for £50 for the purchase of apparatus to enable a start to be made in teaching the principles and practice of wireless telegraphy and telephony at the Technical College.

The more progressive newspapers in the States are already broadcasting special talks to readers, market reports, stock quotations and sporting news, in addition to complete musical programmes.

The South African Government has approved of the establishment of broadcasting wireless telephone services. As in this country the circulation of advertising matter and commercial traffic is, however, not permitted.

In the House of Commons on Wednesday last Mr. Pike Pease said the conditions for the issue of wireless broadcasting licences had not yet been settled. He hoped to make a statement on the subject soon.

A wireless theatre has been established in Southport. Sixty 'phones have been installed, and patrons will be able to hear concerts from London, The Hague, Eiffel Tower, and many other stations, general news, weather reports, lectures, etc. There is one central receiving instrument to which the sixty 'phones are connected. The theatre will be open daily from 10 a.m. to 10 p.m., the charge for admission being one shilling.

Receivers are to be installed in every village of any size throughout France. On the receipt of the official weather forecast from the Eiffel Tower it will be communicated to the inhabitants by the ringing of the parish church bell according to a prearranged code.

A wireless telephone health bulletin service has been inaugurated by the United States Public Health Service. A message of advice on how the average man and woman may ensure continued good health is broadcast twice a week.

FORTHCOMING EVENTS

Derby Wireless Club. July 20, 7.30 p.m. At "The Court," Alvaston, Derby. Lecture on "Detecting Devices," by Mr. E. V. R. Martin.

Nottingham and District Radio Experimental Association. July 27. Meeting.

Derby Wireless Club. July 27, 7.30 p.m. At "The Court," Alvaston, Derby. Lecture on "Practical Construction of a Single Valve Receiver Set," by Mr. A. T. Lee.

TELEPHONY TRANSMISSIONS

Eiffel Tower (F L). 2,600 metres. Each afternoon (Saturdays and Sundays excepted).

Marconi House (2 L O). July 20, 8 to 9 p.m. Transmission tests.

The Hague, Holland (P C G G). 1,070 metres. July 23, 3 to 5 p.m.

Writtle (2 M T). 400 metres. July 25, 8 p.m.

Broadcasting and the Public

THE newspapers tell us that the Postmaster-General and the committee of broadcasting firms are on the point of reaching an agreement, and that in this agreement two facts stand out prominently—the Government will share the licence fees with the broadcasting companies, and will, in due course, introduce legislation with a view of ensuring that only British-made apparatus shall be used in the transmitting and receiving of the broadcast messages. At the time of writing this agreement is not a fact accomplished, and we should like all concerned to look closely and anxiously into the matter before a hard-and-fast agreement on these lines is cemented.

We have long seen the very great difficulty the broadcasting firms must be in. The public calls upon them to provide amusement, and if the public calls the tune the public must also pay. There can be no two ways about that. The difficulty has been in finding a just way of making the public pay. In the United States the public has paid in one way only, that is, by purchasing the goods the broadcasting firms manufacture and sell, and a very good way, too. In this country the broadcasting firms have hesitated to start amusing the wireless public until they could be sure of their return, and that is the very core of the difficulty, but to allow a conference of broadcasting firms to settle it in secret conclave with the Postmaster-General was not ideal. The public interest was not sufficiently represented. The Postmaster-General represented, first and foremost, the official interest—the interest of a great public department in whose hands are the exclusive rights of telegraphy and telephony in this country. The broadcasting firms represented themselves. There was needed an equal representation of the public interest, a few good men of affairs who could have put the case for the people who will have to do the paying. If the suggested agreement goes through, not only will the broadcasters be given a close monopoly, but, in addition, they will be drawing a fee from every member of the public who owns a receiving set. The present nominal licence fee will have to be considerably increased—perhaps multiplied by four—and that in itself is not fair in view of the fact that the broadcasters are shutting out foreign competition, as a result of which their profits from the sales of apparatus and parts must, in due course, assume enormous dimensions. We strongly dislike the idea of a monopoly. Every true Englishman does, but if, in the special circumstances, it is agreed that a monopoly is desirable in this instance, let that be enough. Don't seek to make the public pay at both ends of its hobby—more for its licence, and inevitably more for its apparatus.

Thousands of amateurs are not interested in broadcasting. They are more or less serious experimenters to whom broadcasting as such has very little attraction. Theirs will be a very real hardship when they have to pay for something they do not want and will not have. Sooner or later the whole question of the licence and fee must be raised. Many amateurs fail completely to find any reason why the State should take a fee and do absolutely nothing for it.

CORRESPONDENCE

Can any Reader Explain?

SIR,—There are two points your correspondent should fully appreciate—firstly, that light waves are electro-magnetic in nature, differing only in linear dimensions from the disturbances which are created by oscillating electric currents, etc.; secondly, that it is of vital importance that the dielectric (in this case porcelain) should be completely taken into account and studied thoroughly, because it is the "refractive index" of the dielectric which decides whether the waves are capable of passing or not. G. B. is aware that wireless waves, also X-rays, are capable of passing, but fails to see why light waves cannot if they use ether as their medium.

If, for the sake of explanation, we say the dielectric's electrons are vibrating ten units and the light wave is vibrating at ten also, on impact the two would cancel and the light waves would not pass.

I think this is sufficient to show that it is not the ether that is responsible for the light not passing, but the electrons in the porcelain.—A. P. (Southsea).

SIR,—G. B.'s letter in your issue of the 8th inst. raises some interesting points. I think it is hardly safe to deduce any theory from the behaviour of an electric bell enclosed within a porcelain or other non-conducting receiver.

In the last paragraph but one G. B. refers to the waves of light from the sun as not travelling all around the earth's surface, while "the electro-magnetic waves, as is well known, follow the earth's surface." Is this last statement unquestionably established, or may it not be that the waves travel in straight lines through the earth to the several receiving stations? I shall be very much interested to know other reader's views.—E. W. W. (Coventry).

[We are obliged by great pressure on our space to hold over many other letters in answer to G. B. Further correspondence on the subject is not invited.—ED.].

Testing 'Phones

SIR,—Regarding the short article on testing 'phones, there is a much simpler test which I have always found to give trustworthy results, which is as follows: Place one end of one 'phone lead in the mouth, hold the other by the insulation, and touch the blade of a pocket knife with the bare end. If the 'phones are in a sensitive condition a distinct click is heard each time the contact is made.—W. B.

"Listening-in" To Be Dearer

SIR,—Under the above heading one of the daily papers published a statement of which the following is an extract:

"The cost of the broadcasting programme, estimated at £20,000 a year for each of the eight stations, has surprised those anxious to listen-in, and many have written suggesting that the price of the Government's listening-in licence, now fixed at 10s. 6d., should be increased, and the sum charged over and above the original figure placed to a common fund, out of which the programme could be provided. It is understood that a proposal on these lines has been placed before the Post Office authorities, and it is probable that a considerable increase in the licence fee will be authorised."

To the hundreds of wireless enthusiasts with money to spare for expensive valve sets the threatened increase will make little or no difference. To the real amateurs, however, who have built up their sets step by step, using home-made apparatus and inventive genius, the additional burden added to their already bowed shoulders, may, and probably will, cause the closing down of their stations.

The country has nothing to gain scientifically by thousands of "condenser wanglers" making the ether hideous with the howling of their valves; it has everything to lose by suppressing the top-attic man. Which of these two distinct sections will supply our country with wireless operators in the event of another war?

Certainly not the arm-chair enthusiasts.—J. F. G. C.

CLUB DOINGS

Proposed Central London Wireless Society

Hon. Sec.—(pro tem.).—HORACE E. HOBBS, 15, Rydon Crescent, London, E.C.1.
APPLICATIONS for membership are invited.

Proposed Clapham Park and District Amateur Wireless Club

CORRESPONDENCE is invited by Mr. J. C. Elvy, A.M.I.E.E., M.I.E.S. It is proposed that the club should include Streatham, Balham and Tooting.

The Mid West Herts Wireless Club

Hon. Sec.—MR. J. R. FRANCIS, "Ivy Cottage," Redbourn, Herts.
THE Secretary invites correspondence from all willing to assist in the holding of meetings in St. Albans, Harpenden, Hemel Hempstead and Berkhamsted.

Radio Rendezvous

709, The Broadway, Manor Park, E.12.
AMATEURS in the districts of East Ham, Manor Park, Ilford, Wanstead, Forest Gate and Barking are invited to become members of the above club. Club rooms are open every night until 10 p.m., Sundays excepted.

Birmingham Experimental Wireless Club

(*Affiliated with the Wireless Society of London*).
Hon. Sec.—FRANK S. ADAMS, 110, Ivor Road, Sparkhill, Birmingham.
A CONFERENCE of Midland Wireless Clubs is being promoted by this Club, with a view to discussing the interchange of lecturers, and other matters of mutual interest.

It is proposed that the conference shall be held in Birmingham, as early as possible in September. All Midland Clubs are invited to send delegates, and the secretary will be glad if secretaries of the wireless organizations will communicate at the earliest possible date.

Stoke-on-Trent Wireless and Experimental Society

(*Affiliated with the Wireless Society of London*).
Hon. Sec.—F. T. JONES, 360, Cobridge Road, HANLEY.
AT a meeting of the above society on Thursday, July 6th, some buzzer practice for the benefit of the new members was followed by a lecture on "A Short Wave Tuner," by Mr. A. H. Wilson.

(*Continued on page 136*)

Can You Propose a New Feature for "Amateur Wireless"?

For the Best Suggestion on a postcard received by Wednesday, August 2, a Prize of £1 will be awarded.

Amateur Wireless And Electrics

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Write distinctly, give all necessary details and keep to the point. Ask one Question at a time—never more than two. Send a Stamped and Addressed Envelope. Send the Coupon cut from page 134.

Valve Panel for Mark III Receiver

Q.—I wish to make a valve panel for use in conjunction with a Mark III receiver, and should be glad of advice.—E.E.C.C. (15)

A.—The usual type of valve panel is well adapted for this purpose, and may be constructed in accordance with detailed instructions given in Chapter IX of the new handbook, "Wireless Telegraphy and Telephony" (Cassell & Co., Ltd., price 1s. 6d.). The usual terminals as fitted will be required as follows: (1) Valve terminals on Mark III. set to be connected to aerial and earth terminals of valve panel, that is to say, to the grid (via condenser and leak) and filament of valve, which may always be regarded as the "input" circuit. (2) Telephones will require to be removed from Mark III. set and connected to telephone terminals of panel. (3) L.T. and H.T. batteries are to be connected to respective terminals on the panel. (4) Reactance terminals on panel will require to be short-circuited by means of a piece of stout copper wire, unless of course a reactance coil is made and suitably coupled to the secondary circuit of the Mark III. tuner. Though not strictly necessary for reception of spark or telephony, a reactance coil affords a means of obtaining great magnification, but the coupling should not be such that self-oscillation of the set occurs, as this distorts received speech, etc., and may cause considerable interference to adjacent receiving stations. Self-oscillation is necessary for reception of continuous-wave signals, unless a piece of apparatus known as a separate heterodyne is employed. The proposed arrangement should prove very useful, though for radio-phone reception from stations within a radius of, say, 50 to 70 miles the Mark III. set, plus one valve functioning as a low-frequency amplifier, should certainly be tried as an alternative arrangement.—CAPACITY.

CLUB DOINGS (*Continued from page 134*)

The lecturer, after outlining points which if neglected would greatly reduce the efficiency of any tuner, dealt with the construction of a short-wave tuner on which telephony from local amateur stations, and the wireless concert sent out from the Marconi station in Essex, could be received.

A home-made tuner of the variometer type constructed by the lecturer, other tuners, and a large number of tuning coils were exhibited and handed round for examination.

Walthamstow Amateur Radio Club

Hon. Sec.—R. COOK, Ulverstone Road, Walthamstow, E.17.

AT a meeting of the above club held at the Y.M.C.A., on Wednesday, July 12th, Mr. Butler gave a very interesting and instructive lecture, accompanied by diagrams on the blackboard, on "How to Construct a Crystal Set." Next week he is taking for the subject of his lecture "A One-valve Set."

The club are giving a Public Demonstration at the Y.M.C.A. on Tuesday, July 25th, when they hope to initiate a proportion of the public of Walthamstow into the mysteries and pleasures of Wireless.

All applications for membership should be addressed to the Hon. Sec.

The Hackney and District Radio Society

Hon. Sec.—MR. E. R. WALKER, 48, Dagmar Road, South Hackney, E.9.

THE above society held meetings open to the public at 111, Chatsworth Road, Clapton, on the evenings of July 6th and 7th.

The lecture given at the opening by Mr. E. R. Walker, was on "First Principles in

(*Continued on page 138.*)

THE PETOPHONE CRYSTAL SET

£3 15s. 0d.

COMPLETE WITH 4,000 OHM HEADPHONES

Comprises Double Slide Tuning Coil, 8 in. × 4 in., Crystal Detector, Condenser, High-class Sensitive 4,000 ohm Headphones. Set Mounted on Polished Mahogany Board. Carriage paid 75/-. Delivery in 48 hours. Satisfaction or money returned

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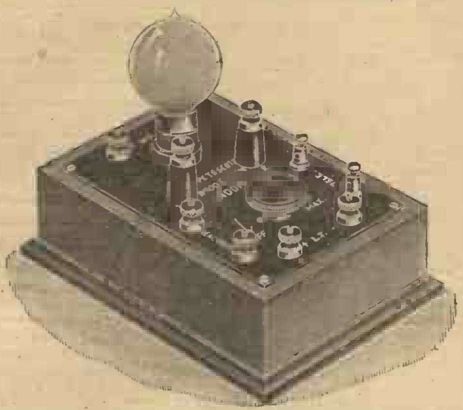

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Full Set of Parts contain Ebonite Panel, drilled and lapped, Grid Leak (Sphinx Tubular Type, guaranteed 12 months), Grid Condenser, Telephone Condenser, Systoflex, Wire, All Terminals, Set of Engraved Ebonite Tablets, Valve Sockets, Blue Print. 15/9, Post 9d. We can supply a Polished Cabinet to fit at 3/6 extra.

Get our Catalogue A. 6d. Stamp brings it to your door.

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FEATHERSTONE HOUSE, 64 HIGH HOLBORN, LONDON, W.C.1
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BROADCASTING and GENERAL RECEPTION

Single Valve Set

THE COMPLETE INSTRUMENT. Highest quality throughout. Supplied with Set of Tuning Coils, 170-2,500 metres less Valve Phones and Batteries.

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The Broadcaster

THE RADIOPHONE MONTHLY FOR LISTENERS-IN

One Shilling

Club Doings (*continued from page* 136)
Wireless Telegraphy," Mr. Walker explained how the aerial became charged so that it produced waves. After this the second lecturer, Mr. D. R. Ison, gave an explicit explanation of reception of the waves, with the aid of a Marconi 31a tuner. On both evenings various items of telephony were received. Any persons wishing to join the society should apply on Thursday evenings at the above address, or write to the Hon. Sec.

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BROADCASTING : SOME NEW FACTS (p. 152)

Amateur Wireless
And Electrics

No. 8 SATURDAY, JULY 29, 1922 Price 3d

NOTE OUR CONTENTS

We Answer Your Questions without any Delay

Operating a Crystal Receiver

Send us an Idea and Try to WIN £1

(See page 154)

Amateur Wireless and Electrics

No. 8 July 29, 1922

"ATMOSPHERICS"

ATMOSPHERICS are the bane of the wireless operator, be he professional or amateur. Their cause is well known, but their elimination is another matter.

The upper air is nearly always electrically charged with respect to the earth. Even at a height of only 50 ft. above the ground there may be a potential of hundreds, or even thousands, of volts with respect to the ground. At greater heights this potential or electrical pressure will be greater still. Clouds may be charged to millions of volts, and when these highly-electrified clouds come close to others of a different potential a tremendous spark may leap across the intervening space. Or, as is well known, a spark may leap from a cloud to some terrestrial body; this happens in a thunderstorm.

Now these discharges not only make light, which is seen by the eye, and sound waves, detected by the ear, but they also set up electro-magnetic waves in the ether which are extremely powerful but of short duration and not directly detectable by the senses. The effect is heard in a wireless receiver anywhere within many miles of the discharge as a loud crash in the telephones each time a flash of lightning occurs. These disturbing sounds are by no means only heard during a thunderstorm; they are very frequently heard when the weather is perfectly fine in the neighbourhood of the receiving station, and when there is hardly a cloud in the sky. In such cases the sounds may be due either to a distant thunderstorm or to smaller local discharges between small clouds or portions of the upper atmosphere at different potentials.

Marconi's "X's"

These disturbances were noticed by Marconi in his earliest experiments on wireless telegraphy and he called them "X's," as they were then more or less of an obscure nature. British amateurs usually refer to them as "atmospherics" or "strays," while the Americans have christened them "static."

Atmospherics are always present to a certain extent, but they vary greatly in different parts of the world, and also with the time of year. In the British Isles we are chiefly troubled with them in the summer, when we frequently get "X storms"; in the winter, however, we hear very little of them. They usually get worse at night-time. These "X storms" are manifest as a continual irregular crackling, groaning and hissing in the telephone receivers. Sometimes the disturbances are so bad that reception of distant signals is rendered impossible and radio communication is suspended until the ether is again quiet. In hot climates, as in India or Africa, the atmospherics are much worse than in this country. The disturbances are worst at receiving stations with large aerials.

Strong atmospherics are louder than normal signals, and will throw most of the usual types of crystal detector out of adjustment. The carborundum detector is the only crystal detector that will withstand atmospherics. A valve receiver does not suffer in this way, but the crashes and frying noises are amplified to an unbearable extent.

Atmospherics Cannot be Tuned Out

The worst part about atmospherics is that they cannot be tuned out in the ordinary way like signals from a spark station —they are heard on all wave-lengths. An atmospheric electrical discharge is like an explosion in the ether which kicks any wireless receiver within range into violent momentary electrical oscillation regardless of the frequency to which the receiver is tuned.

Many ideas have been proposed and tried with the object of obtaining a receiving circuit which will respond to a definite required frequency without responding to these aperiodic, or untuned, kicks. Such "X stoppers," as they are often termed, are as a rule complicated and usually weaken the required signals as well as the atmospherics. The elimination of atmospheric interference is still one of the greatest problems that faces the wireless experimenter.

Charging Up of Aerials

It has already been mentioned that the air quite a short distance above ground may be highly electrified. This was very well demonstrated in an experiment the writer was making some time ago with a kite aerial. A large kite was sent up on the end of a length of stout string and was made to carry up with it some thin copper wire, the lower end of which was retained on the ground. The lower end of the wire escaped for a few seconds, however, so that the whole was entirely insulated from the ground. When a grab was made at the dangling end of the wire a small spark passed to the hand and a shock was felt. This charging up of the wire was noticeable when the kite was only 40 ft. high. The weather was fine and there was no thunder about. (Several investigators have been killed when making this experiment.) Large aerials frequently charge up in a similar manner. In hot countries, where the effect is very pronounced, care has to be taken that the operator does not get shocks from this source. Short, low, or badly insulated aerials do not show this effect so markedly, though they are not immune from it entirely. During a fall of snow an amateur's aerial will often charge up sufficiently to give small sparks if the aerial switch is left open about a millimetre. A strong wind with fine drizzle will also rapidly charge up an aerial. Recently the writer was surprised to see a torrent of sparks rushing across the plates of a variable condenser in series with a 30-ft. aerial. A high wind was blowing at the time, accompanied by light rain.

E. H. R.

[In a concluding instalment the author will offer practical suggestions towards the elimination of "atmospherics."—ED.]

Results of Competitions

Announced in Nos. 1 to 5 of "A.W."

Competition No. 1.—An Original Article.

WINNER:—Mr. Herbert H. Dyer, 22, Leopold Street, Derby.

Competition No. 2.—Novel and Useful Items.

An announcement with regard to this will appear in next week's issue.

Competition No. 3.—Ideal Broadcast Programme.

WINNER:—Mr. B. Robertshaw, 63, Market Street, Thornton, Bradford.

In each case the prize is a well-made wireless receiver. The successful efforts will be published in due course.

A Home-made Clockwork Interrupter

Receiving C.W. Signals on a Crystal Set

IT is frequently stated that a simple crystal receiving set will enable the listener only to pick up spark stations and telephony, and that valves will have to be installed before continuous-wave (C.W.) signals can be satisfactorily received. This is true to a certain extent, but the following remarks will show how some of the louder C.W. stations can be received by means of a very simple addition.

C.W. Signals

The reason why C.W. signals cannot be heard on ordinary crystal circuits, such as have been described in "Amateur Wireless," is that when the key at the transmitting station is pressed down a continuous rectified current passes through the head telephones of the receiver, not an interrupted one as in the case of spark and telephony, with the result that no sound is heard except perhaps a faint click when the key is depressed or raised. If, however, we insert between the crystal detector and the 'phones an interrupting device capable of making and breaking the circuit at a high rate, say 500 times a second, then any continuous current in the 'phones will be broken up into a musical note which is clearly audible.

The "Tikker"

Such an arrangement is shown diagrammatically in Fig. 1. In this figure T is a rapidly rotating cog-wheel against which a light metal tongue rests lightly. The use of such an interrupter is the invention of the Danish inventor Poulsen, who used it for reception of signals from the famous arc-transmitting system which bears his name. Poulsen called the interrupter a "tikker," and this is the name by which the device is still known.

The cog-wheel T may conveniently be the fastest-moving wheel in the mechanism of a clock. It will be necessary to remove the escapement so that the wheels rotate freely. If the spring is now wound up and the mechanism allowed to run it will go at a tremendous speed and be run down in a few seconds; a governing device must, therefore, be added, and this can easily be done by soldering, or otherwise fixing, a small vane cut out of thin sheet brass to the most rapidly revolving spindle as shown in Fig. 2. Owing to the friction of the air with this vane the mechanism will not be able to "race," and will run nicely for a considerable time. The actual size of the vane for best working will depend on the nature of the clockwork and will have to be determined in individual cases by trial; the larger the vane the slower the mechanism will run. In the writer's own tikker the vane is only ¾ in. across and ¼ in. wide, but it is sufficient to ensure a steady run of about twenty minutes. The only other thing that remains to be done is to fix a light tongue which has to make contact with the cogs of the fastest wheel in the train.

The method of mounting is shown in Fig. 3. A is an ebonite strip, sufficiently thick to be rigid, through which a hole has been made at each end. By means of a bolt and fly-nut one end of the ebonite strip is fixed to a point C in the frame, and that at the other end will come near the wheel T, a hole being made at C to accommodate the bolt. The tongue B is cut to the shape shown in Fig. 4 out of springy sheet brass about the thickness of drawing-paper. An ordinary pair of scissors will cut the brass quite easily, and the hole shown in the wide end may be pushed through by any sharp tool. The tongue is fastened to the upper end of the ebonite strip A by means of a nut and bolt through the hole which has been made there, and the thin part of the tongue is given a twist through a right angle so as to bring the free end square with the teeth of the wheel T. A piece of flexible wire is connected to the clock-frame and another to the tongue; one of these wires is connected to one of the 'phone leads and the other to one of the detector terminals as shown in Fig. 1. The condenser C, having a capacity of about .01 micro-farad, is shunted across the tikker and telephones, as it greatly improves the signals. Some little adjustment of the speed of the tikker and the pressure of the contact tongue may be necessary before good results are obtained. When a C.W. station is tuned in (by means of the variable inductance L, Fig. 1), the detector carefully adjusted and the tikker set in motion, the signals are heard as an intermittent musical note or a hissing note, usually the latter.

Other Methods

As a matter of fact, Poulsen did not use a crystal detector at all in his receiver. The tikker is put in place of the detector as shown in Fig. 5. This arrangement is extremely reliable, but, in the writer's experience, is not quite so sensitive as when a crystal detector is included. However, as crystal detectors are very liable to go out of adjustment the writer would recommend the method shown by Fig. 5.

Where a crystal detector is to be used, either a good piece of zincite touched by a sharp piece of bornite or copper pyrites, or a piece of galena touched by a small spiral of 40-gauge copper wire, will be the most suitable. Crystals, like carborundum, which require a battery and potentiometer, cannot be used satisfactorily in conjunction with a tikker. Much depends on getting good specimens of crystal.

A gramophone can be used as a tikker by connecting one wire to the works and allowing the other to rub lightly against the edge of the revolving turntable.

E. H. R.

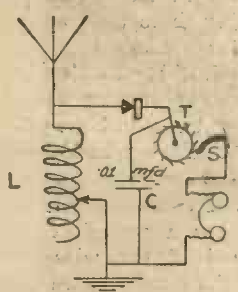


Fig. 1.—Circuit Diagram of Interrupter.

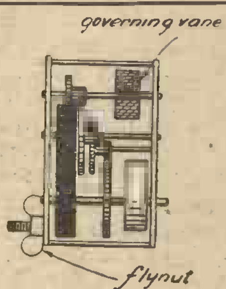


Fig. 2

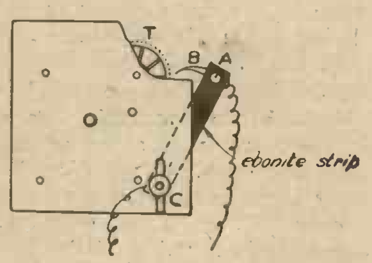


Fig. 3

Figs. 2 and 3.—Front and Side Elevations of Interrupter.

Fig. 4.—Metal Tongue

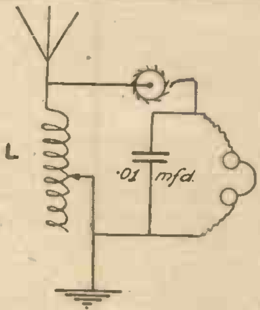


Fig. 5.—Poulsen System of C.W. Reception.

TELEPHONY TIPS

THESE notes are primarily addressed to those amateurs whose valve receivers employ reaction (either magnetic or capacity) to boost up the incoming signals. If carefully followed the best results will be ensured.

Oscillating Receivers

The reception of wireless speech and music calls for very careful adjustment if one is not to be a nuisance to any wireless neighbours, for it must be remembered that valve receivers of the reaction type are in themselves transmitters of small power. The waves radiated from the receiving aerial, although very weak, are capable of travelling several miles, and consequently will affect all valve receivers in that radius. Valve receivers only act as transmitters when the set is "oscillating"—that is, when the reactance coil is so tightly coupled to the inductance that the valve generates oscillations which are passed into the aerial. When the set is in this condition it is impossible to receive telephony at its best, although it is as well to let the set oscillate while searching for the carrier wave of the station transmitting telephony.

The best way to find out if the set is oscillating is to tighten the coupling between reactance and inductance coils, at the same time tapping the aerial terminal with the finger. If the set is oscillating a loud click will be heard in the telephones each time the terminal is tapped. If capacity reaction is used, rotate the reaction condenser until clicks are heard in the telephones when the aerial terminal is tapped.

The Carrier Wave

Having got our receiver into an oscillating condition, we will tune in some telephony and make the necessary adjustments which will give us the speech and music at their best. By means of the aerial tuning condenser and inductance tapping switch, search for the carrier wave, which will come in with a loud howl. Now rotate the condenser until the howl dies out, and it will be found that a still further rotation of the condenser will bring the howl in again. The dead spot between the two howls is the correct position. If telephony is going on it will be very distorted and indistinct because our set is oscillating. To correct this, loosen the coupling between inductance and reactance until the set just stops oscillating, then finally tune the station by means of the aerial tuning condenser. The telephony will now be very distinct, and if the foregoing instructions have been properly carried out, there will be no trace of distortion. In addition to getting the telephony at its best, we have the satisfaction of knowing that we are not interfering with our neighbours.

Other Adjustments

There are other factors which make for the correct reception of telephony. The filament and high-tension current must be adjusted to their best values, and it will be necessary to experiment a little with the filament resistance until the best point is found, always remembering to keep the valve filament as dull as possible consistent with good signals. There is a correct proportion of high tension to low tension for telephony, and to find this proportion make the following test: Get the set into an oscillating condition, then loosen reaction until oscillations just cease. This point can be found by tapping the aerial terminal while reaction is being loosened. Note the position of inductance and reactance (or reaction condenser if this is used) when the oscillations cease. Now tighten the reaction and notice if oscillations commence exactly at the spot where they stopped. If this is the case the proportion of high tension to low tension is correct, and the set is in its most sensitive condition for receiving tele-

(Continued on next page)

St. Pancras Cadets' 1½ Kilowatt Set

IT is quite a common thing nowadays for cadet corps and scout organisations to possess a wireless outfit; few, however, can claim to be so completely equipped as the No. 1 Aircraft Construction Wing of 25, Camden Road, London, N.W.1, which is allied to the 19th London Cadet Organisation.

The installation consists of a 1½ kilowatt Marconi transmitting set as used on ships, and a number of receiving sets of various types, including a trench receiver and a three-valve set specially designed for use on aircraft.

Mounted on the wall are the high- and low-tension switchboards and the A.T.I. of the Marconi transmitter. In order to control the heavy current in the low-tension circuit a magnetic switch is used, operated by means of an ordinary Morse key by the telegraphist.

The instructor seen in the photograph is Lieut. A. W. Hulbert, late R.A.F., whose articles on the practical construction of wireless apparatus appear frequently in "Amateur Wireless."

It is understood that an assistant wireless instructor is wanted who would be willing to give one evening a week to the work. The whole thing is quite voluntary, but the applicant, if accepted, is granted an honorary commission. It might be mentioned that only ex-R.A.F. or R.E. officers are eligible.

phony. If, however, there is an overlap of the points where oscillations cease and where they commence—that is, if they do not cease and commence at exactly the same spot—it is necessary to adjust the high-tension supply until the two points coincide.

If the aerial tuning condenser has a greater capacity than .0005 micro-farads, it will be found an advantage to connect a small three-plate variable condenser across the aerial and earth terminals of the set. This small condenser permits of much sharper tuning than is possible with the larger capacity alone.

Always bear in mind that if your set is oscillating you cannot be receiving pure telephony, and, furthermore, you are in all probability causing serious interference to everybody for several miles round. As soon as you have picked up the dead spot between the two howls of the carrier wave get off the oscillation point and enjoy the transmission which you have tuned in.

Using Crystal Parts with Valve Receiver

IT will, no doubt, be of interest to readers who have been working with crystal sets to know how they can utilise the old parts with a valve. Furthermore, the component parts of an old crystal receiver can very often be picked up for quite a low figure, and such parts are well worth buying by those who are desirous of constructing a valve set at moderate cost. The necessary alterations are quite simple, and practically the only part of the crystal set to discard, at any rate for the time being, is the crystal detector itself, this piece of apparatus being replaced by the thermionic valve. All the remaining parts can be utilised on the valve panel.

The first point to receive consideration is the valve panel. This need not be very large, and can best be made up from a piece of ebonite sheet measuring 10 in. by 8 in. by $\frac{3}{16}$ in. thick, or in the absence of ebonite a piece of well-dried hard wood could be used, but it is absolutely essential to ensure that the wood is quite free from moisture, otherwise losses due to leakage will occur. This panel should be marked

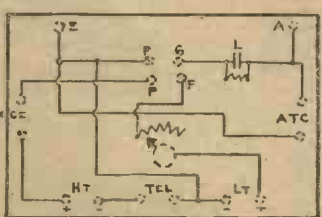


Fig. 1.—Diagram of Valve Panel.

out and drilled as shown in Fig. 1 to take the necessary terminals, etc.

The following accessories will be required: a grid leak with condenser L, valve holder A, filament regulator of about 6 ohms resistance, one dozen brass terminals, and a few small screws, all of which can be procured for a few shillings from any manufacturer of wireless apparatus. The type of valve holder recommended is that shown in Fig. 2, as, by drilling a hole sufficiently large to take the portion marked A, this can be readily mounted and screwed down to the panel from the back. Similarly, the filament regulator and grid leak with condenser are mounted on the back by means of small screws. In the case of the filament regulator, however, it will first be necessary to drill a hole large enough to take the short stout spindle which supports the ebonite knob, the latter being temporarily removed whilst mounting the regulator. The terminals should then be inserted into twelve holes round the edges of the panel, after which the connections between the various pieces of apparatus, etc., should be made as shown by the dotted lines in Fig. 1.

These connections should, of course, be made with insulated wire or bare copper wire passed through insulating tubing known as "Systoflex" sleeving, which can be purchased for a few pence per foot.

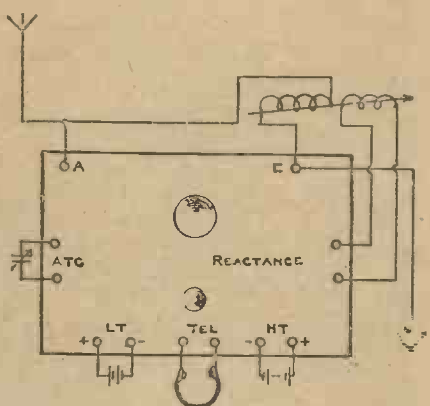


Fig. 3.—Diagram showing Connections for Crystal Parts.

This latter method is preferable, and is that usually adopted by manufacturers in the trade. The connections to the points marked PG, FF in Fig. 1 on the valve holder should be made by neatly soldered joints. In order to complete the panel it should be mounted upon a shallow box just sufficiently deep to contain the different parts mounted underneath it.

The crystal receiver parts can now be utilised as shown in Fig. 3, with the addition, of course, of a suitable thermionic valve, a 4-volt accumulator, and a high-tension battery of from 40 to 60 volts. The latter can consist of a number of ordinary pocket lamp batteries connected up in series.

Assuming that a loose-coupled tuning coil is not available, but only a simple loading coil having no secondary, this can readily be adopted for use on the panel by the addition of a pair of honeycomb or similar coils as shown diagrammatically in Fig. 4. Instructions upon the winding of honeycomb coils appeared in No. 2 of

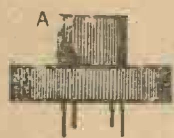


Fig. 2.—Valve Holder.

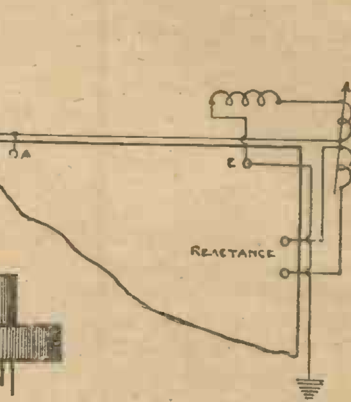
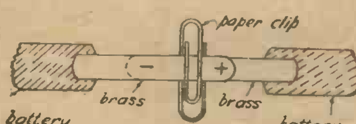


Fig. 4.—Method of Using Honeycomb Coils.

"Amateur Wireless." These coils can, if desired, be used equally well without the loading coil, as will be found from experiment. The insertion of a small variable condenser across the reaction coil, although not essential, will be found considerably to facilitate tuning. D. F. U.

HIGH-TENSION BATTERY CONNECTIONS

THE reproduced sketch shows a simple method of connecting small batteries of the flash-lamp type together. The



Simple Method of Connecting Flash-lamp Batteries.

sketch is self-explanatory, and it will be seen that a paper clip of the sliding type is used.

How to Make an Amateur's Transformer

TRANSFORMER construction offers little difficulty to one who is prepared to approach the task with determination to use skill and patience. The writer gives from his own experience details which, if followed carefully, cannot but eventuate successfully.

In the first place it will be advisable, however, to go over a little of the theory in order that the practice may be the more intelligently followed.

If two coils of wire are lying one on the top of the other, eye to eye so to speak, but having no metallic connection between them, then a varying current circulating in one of them will cause a varying magnetic field to be set up in its neighbourhood. This varying magnetic field will link up with the other coil and set up in it another varying current.

Lines of Force

The voltage driving these currents in the second coil will vary with the number of lines of magnetic force causing it and the rate at which they vary in a unit of time. Thus 10,000,000 lines of force would need to link up with one coil of wire in one second in order to produce one volt, or, conversely, one line of force would link up with 10,000,000 turns of wire in one second to produce the same voltage.

If the path provided for the lines of force is of iron the number of lines of force would be increased enormously, even using the same magnetising current. In the case we are considering we use flat circular rings of soft iron, so that the whole path of the lines of force may be provided and the lines of force not have to leave their comfortable quarters during any part of their course.

If any were to get out into the air during any part of their circuit their mutual repulsion would at once assert itself, and we should have difficulty in getting them back again into their "straight and narrow way." Therefore, in order to avoid an otherwise inevitable and continuous loss, we take more pains in winding our wire—that is, we thread it through the closed iron ring rather than wind it on a bobbin and then build up the iron into it. This is usually done in big commercial transformers, where the "air gap," which is the part of the path in the open air, is made necessary by cutting the iron and building it up in segments. Perhaps the diagram Fig. 1 will make this clearer.

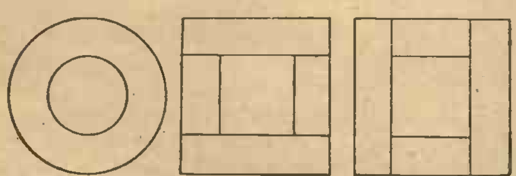


Fig. 1.—Different Types of Core.

In this figure the ring A is continuous, and once we have set up a magnetic field in it the lines of force have little temptation to leave the iron. In B, which is built up of strips, the lines of force have to leap the gaps in their race. In order to reduce the difficulty of the lines of force getting back the strips are laid like B and C alternately—that is, the butting gap comes at a different point each time and is overlaid each side by a flat plate. This construction allows the coils of wire being wound by machinery.

Fig. 2.—Photograph of Complete Transformer and Parts Used for its Construction.

In order to avoid troublesome calculations for allowance of the magnetic leakage at these joints a jointless ring has been adopted here, and the photograph (Fig. 2) shows a transformer so made. The iron rings and double-cotton-covered copper wire are also shown (Fig. 2).

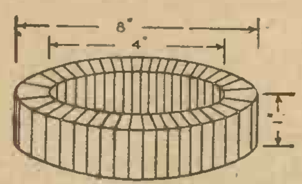


Fig. 3.—Core Taped for Winding.

The thin flat rings of iron are about 8 in. over-all diameter and about 2 in. wide, with a hole in the centre 4 in. in diameter. You will want enough to assemble and build up 2 sq. in. of cross sectional area—that is, if the rings are 2 in. wide as suggested you will want a pile 1 in. high. If the rings are not 2 in. wide they must be piled up higher so as to make the 2 sq. in. of cross section—that is, if they are only 1 in. wide they must be piled up 2 in. high (see Fig. 3).

This 2 in. must be solidly packed iron sheets, so if the rings are each .01 in. thick you must have 100 of them for a height of 1 in.

The closer the rings lie together the less wire will be needed to wind on the correct number of turns. Pinch the rings up together in a vice, and bind them together with dry cotton tape, while still pinched up tight, until all the iron is covered. The danger point in this construction is the sharp edge at the top and bottom of the pack of ring stampings, which may cut through the tape and the cotton coverings of the wire and spoil all the work. If a piece of tough but not too stiff paper is cut into two rings slightly larger than the stampings and placed on the top and bottom of the piles it will form a protection for the tape.

Primary

For the primary, or that circuit which is connected with the mains 2¼ lb. No. 20 double-cotton-covered wire will be required, and 880 turns of it must be wound on to the ring if the transformer is intended for a 220-volt circuit.

Take the coil of wire as purchased, and make the round coil into a very flat oval by squeezing in from opposite sides, and then tie it round the middle with an odd bit of tape to keep the flattened coil together. This will thus form a shuttle which can be passed through the taped up ring of iron stampings. With a needle and thread sew the commencing end of the wire on to the tape to make it secure, leaving a piece long enough for subsequent connections. A piece of thin rubber tubing should be slipped on this free end to further protect the cotton covering. Now proceed to thread the formed shuttle of wire, through and through in the same manner that the tape was wound, pulling up each turn tight as made until the 880 turns are all on. Count after each layer, and make a note on a slip of paper so that the number of turns can be checked. You may, if you so desire, check the efficiency of the work in the following manner:

Testing

With a 220-volt lamp in series with the winding you may turn on the current, as the lamp will protect the circuit. If the lamp glows anything like as brightly as it would without the transformer primary in circuit with it, there is something wrong with the winding; probably some turns are short-circuited. It will be necessary to find out what the trouble is, if any exists, and remedy it before the secondary is put on.

Supposing, however, that the lamp, if it glows at all, is a very dull red. If no indication is given by the lamp, put one turn of insulated wire through the eye of the transformer and connect the ends of this one turn by a piece of .25-ampere fuse wire or the fuse wire generally used in the lamp circuit. If this flashes your work is so far successful, and the secondary winding can be proceeded with.

Before winding the secondary, however, tape up the primary with dry cotton tape as you did the iron rings before the primary was wound on. For the secondary $2\frac{1}{4}$ lb. of No. 14 S.W.G. double-cotton-covered copper wire will be required. One volt, or a very little less, will be obtained for each four turns of wire wound over the primary. No. 14 wire will carry 10 amperes at 2,000 amperes per square inch, the same rating as the primary, and if you desire 40 volts on the secondary 170 turns of wire will be necessary. This figure is adopted as a convenient one.

It may perhaps be an advantage to bring out a tapping at the eighty-fifth turn and so have two circuits available, each giving 20 volts, or it might be even more handy to have a range of voltages to select from, in which case it is only a matter of counting the number of turns of wire put on and bring out tappings where desired.

This is a transformer capable of carrying half a kilowatt, and would do admirably for any purpose needing that amount of energy. Also it would not be wasteful on any smaller amount. The sizes are given so as easily to permit of threading the wire through the centre without much risk of damaging the covering of the wire.

Smaller Sizes

A smaller transformer might be preferred, and if so it is only a matter of varying the proportions. Thus if it is desired to cut down the iron to 1 sq. in. of cross section twice as many turns of wire on the primary will be necessary, or eight turns per volt. It would not be advisable to carry this reduction *pro rata* much lower than ½ sq. in., but to this limit the rule will answer.

It is advisable to protect the transformer when finished, and it may either be treated with insulating varnish and taped over and again varnished, or it may be placed in a box and the box filled up solid by pouring in molten resin.

In assembling the iron stampings any burrs left by the die might be removed from the edges, and even the stampings themselves might be prevented from making electrical short circuits by varnishing, though this latter precaution is very rarely necessary, especially if the iron is left dirty on the faces, as the dirt will prevent eddy currents. GAMMA.

You Heard It On the Crystal?

A Plea for the Cheap and Simple Crystal Receiver

"YOU heard it on the crystal?" On many occasions has this remark been addressed to me by fellow wireless enthusiasts, devotees of the valve, while comparing notes on the reception of some particular transmission. Although a keen admirer of the thermionic valve and its uses in application to wireless, I must confess to an ardent enthusiasm for crystals, based upon the excellent results obtained with a crystal set since its erection two and a half years ago.

The proposed broadcasting scheme has rekindled an active interest in crystal receivers, and as it is probable that many would-be "listeners-in" are sceptical as to the results likely to be obtained with such sets because of the comparative cheapness, these notes are intended primarily to establish their confidence in crystal receivers by a description of my set and what it has done.

As the aerial is an important consideration I will describe that first. I am using a single wire 50 ft. long, and it is fastened to the window frame of an attic 40 ft. high, sloping down to the mast 18 ft. in height erected in the garden. The lead-in is 20 ft. long. The tuning inductance consists of three single-layer coils giving an approximate wave-length of 4,500 metres. Tuning is effected with a four-point switch

Operating a Simple Crystal Receiver.

to bring in or cut out the coils as required, with a slider on one coil and also a variable condenser. I have worked with two crystals, one zincite-bornite, the other carborundum. The advantage of having two detectors is that with the aid of a small switch comparison of sensitivity can be made one with the other.

The 'phones are of the S. G. Brown type, each earpiece being of 4,000 ohms resistance with a small blocking condenser connected across them.

The whole apparatus is mounted on a varnished wooden base, and is very compact. The earth lead is taken to a convenient water-tap. Situated in a populous district in N. London, I am surrounded by houses, and my aerial is below the level of them all. I mention this fact in order that readers can make a comparison of their surroundings with mine.

As the reception of wireless telephony is the primary aim of most newcomers I will first mention the telephony stations I have received. Croydon aerodrome provides a constant programme in controlling the London-Paris airway, the speech being very clear and strong. Reception of 2MT (Writtle) is good, with a slight decrease of signal strength since the wave-length was shortened. The Marconi House station, 2L O, is the "star" telephony transmitter, speech being of extreme clarity and the strength surprising. On a recent evening a musical programme was sent out from Marconi House station 2L O in connection with a fête in progress at Caxton Hall, and to those who "listened-in" it must have aroused the keen hope that the day when broadcast stations commence operations is not far distant.

Amateur Telephony

Amateur telephony stations come in well on short wave-lengths, but not very strong, and I have had much gratification in hearing several good transmissions from 2ON, Walthamstow.

When the late Sir Ernest Shackleton sailed in the "Quest" several months ago a telephony test was carried out between a station at Chelmsford and the ship while on its passage down the Thames. My reception of the speech was excellent, even the sound from the noisy sirens of shipping in the river, caught by the transmitter, being heard to add to the pleasure of listening to the famous explorer's farewell message. At various times during tests music and speech have been heard, reception being very good.

Morse

Morse signals will not interest the beginner at first perhaps to a great extent, but I feel sure that it will be a natural sequence of events to learn the code and copy the messages.

The North Foreland station comes in well, as does Niton, Harwich, Sheerness, Ostend, Scheveningen, Boulogne, Le Havre, and Dunkirk, to mention but a few of the English and Continental stations. On an evening months ago (and on many evenings since) I heard clear signals from a station whose call was F F S. Reference to the call book was necessary, as I was unfamiliar with it, and was considerably surprised to find that the station was S. Maries de la Mer, situated in the South of France on the Mediterranean. A few evenings later I heard Toulon (F U T) in the same locality, transmitting a navigation warning. This could be called "freak" reception, but it is the common experience of most amateurs to receive at night distant stations that are quite inaudible during the daytime.

Ships

Ship stations come in by dozens, some when in the neighbourhood of the many docks between Southend and the Tower Bridge providing signals with a density sufficient to please any loud signal enthusiast. I have attempted on several occasions to log the ship stations received on crystal with the view to recording the greatest distance from which signals have been received, but unless one hears the ship actually open communication with the shore station, giving her name, position, etc., it presents much difficulty. Good signals, however, have been received at night from ship stations at 150 miles; but as the ship to shore traffic, and *vice versa,* is usually very heavy, with consequent jamming, it is only occasionally that circumstances are favourable for reception of the naturally weak signals emanating from ships many miles away.

Commercial Stations

Paris (F L) is the regular "big noise" of the few high-power spark stations now working, signals always being very loud and clear. Poldhu (M P D) is nicely readable, and on occasions when I have burned the midnight oil the C Q press at one a.m. B.S.T. has always been copied with crystal reception. I have never yet found it necessary to switch over to my valve set. S A J, the Swedish station which transmits press messages, can always be read, as can the time signals from Nauen (P O Z). The Air Ministry station (G F A) is received loudly, the system used being interrupted continuous-wave, and therefore receivable on crystal. The weather reports issued from this station are very interesting and useful, especially so when one is considering an outdoor week-end.

A Few Hints

There are one or two hints in connection with the use of crystal sets which, although often quoted, can never be emphasised too often. The crystals themselves should receive the maximum of care in being protected from dust, dirt, and anything likely to impair their efficiency, and if an especially good crystal comes along put a great value on it. Keep all connections clean and tight, and if the set is to be self-made take the greatest care with its construction, and remember patience is a virtue.

C. G.

Simple Aerial Erection

ERECTING the aerial is a bugbear with most amateurs, but the following method of erection will prove of interest to those who wish to do the work with a minimum of trouble and expense.

The only aerial masts that were at the writer's disposal was one of bamboo 25 ft. long and a Disposals Board mast of 16 ft. in three sections.

The bamboo was erected at the end of the garden with little or no trouble, and, in passing, it may be said that, up to a height of about 25 ft., a bamboo has been found to be ideal for wireless purposes on account of its strength and extremely light weight.

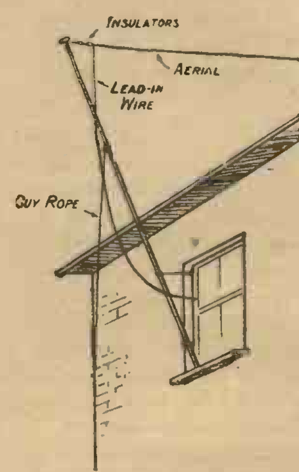
When considering the house end of the aerial, however, a less easy problem was encountered. It was not desired to go to the trouble and expense of erecting a mast on the chimney or roof of the house, and when viewing the site it was thought that instead of erecting it on the top of the house it might be an easier job to fix the mast to the side of the building and so obviate the necessity of obtaining the assistance of the local builder.

The room in which the wireless gear was housed was on the upper floor of a two-floored house; the eaves of the roof were about 1 ft. above the top of the window and projected 2 ft.

Upon these facts being noted the mast was assembled upstairs. Next two large screw-in hooks were fixed into the top and bottom of one side of the outside of the window frame and a supply of stout line obtained from the local store.

The mast was then erected in an upright position outside the window, with its foot resting on the inside corner of the window-sill farthest from the direction of the pull of the aerial, and was lashed up tight against the eaves of the house by means of the hooks and line. A guy rope taken from near the top of the mast to a point on the wall of the house, to counteract the pull of the aerial wire, completed the job. The mast, as finally erected, is shown in the sketch.

It may be added that the writer had no assistance whatever in the erection of the mast, and it would appear that if any amateur does not desire to go to the trouble of fixing a mast on the top of his house, the method just described is a very good substitute. The window sill on which the mast rests is 14 ft. from the ground, making the top of the mast 30 ft. high, which is a useful height for all ordinary purposes. Apart from the cost of the mast itself the expense was negligible.



Simple Aerial Erection.

As regards the actual aerial, which is 60 ft. long, this consists of a single wire

(*Continued on page 152*)

Side View of Variometer.

Simple Crystal Receiver.

Underneath View of Crystal Receiver.

Underside View of Valve Panel.

THE BEGINN

SOME ELEMENTARY FACTS

IN the following articles the elementary principles of wireless telegraphy and telephony will be explained in as simple language as possible, no reference being made to technical formula, which is both confusing and unnecessary to anyone taking up wireless as a pastime pure and simple.

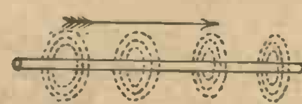


Fig. 1.—Magnetic Field Around Current-carrying Conductor.

Electricity and Magnetism

The uses to which electricity is put are being continually demonstrated all day long. The telephone, the tram, and the electric light are such common examples that few even trouble to "wonder why."

In order to make the theory of electricity and magnetism as simple as possible, the reader is asked to accept for a fact that electricity is something which flows along a metal conductor such as a telephone wire, much the same as water flows along a pipe. By means of a tap the flow of water may be stopped; in the same way the switch in the electrical circuit controls the flow of electrical current.

It is generally known that in order to force a certain quantity of any liquid through a pipe a certain pressure is required; the smaller the bore of the pipe the more resistance is offered to the flow of liquid and *vice versa*. In a similar fashion, a wire of small diameter will offer resistance to the electrical current, and a greater pressure or voltage will be required than if the same volume of current were passing through a thicker wire. Also the pressure or voltage at the end of a long thin wire will not be as great or capable of producing the same effects as the pressure at the terminals of the generator.

Certain terms are used in electrical work to express the properties and effects of electricity, the most common being volts, amperes and ohms.

The pressure or voltage, which is equivalent to the head of water in the previous examples, is measured in "volts," while the current, which may be likened to the flow of water in gallons, is measured in "amperes."

The resistance which the wire or metal conductor offers to the flow of current may be compared to the friction of a pipe; the smaller the pipe the greater the opposition to the flow of water.

How these three main electrical terms are combined in a very simple and very useful equation will be explained later; at the present time it is only necessary to think of them in the way described above.

In order clearly to understand the most simple theory of electricity it should be

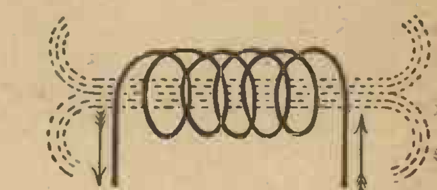


Fig. 2.—Magnetic Field Around Coiled Wire Carrying Current.

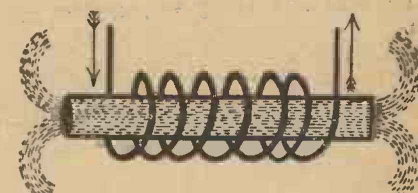


Fig. 3.—Increased Effect by Use of Iron Core.

taken for granted that electricity exists everywhere, in everything, but at rest. When certain effects are produced it simply means that a certain amount of electricity is in motion. That is to say, a dynamo does not make electricity, it simply creates a pressure which causes a current to flow from one point to another.

Just in the same way, a battery or accumulator is very much like a tank full of water with the tap turned off. The water is in the tank, but at rest. If the tap is turned on the water will at once begin to flow; in a similar manner, if the terminals of the accumulator are joined to a small lamp with a piece of wire a current will immediately flow from the accumulator, causing the lamp to light.

If a large pipe is connected to the tank a large quantity of water will flow from the tank in a short time, and in a similar way if a thick wire is connected to the accumulator a large current will flow with very little loss of pressure, technically known as voltage drop. If a thin wire is used, however, the quantity of electricity flowing in a given time will be less, and the pressure or voltage available to do work will also be smaller.

Heating Effects

Having grasped these simple facts, the

NER'S PAGE

CONCERNING ELECTRICITY

other effects of an electric current flowing in a wire should be considered. One of the most common, the heating of the wire by the passage of the current, is made use of commercially in electric heaters, electric irons, and electric lamps.

It is obvious that the smaller the wire the greater the heating effects; therefore, cables carrying large currents must be made proportionally large in diameter, whereas in the case of an electric light bulb the filament is fine, so that it will be made white hot or incandescent with as little current as possible.

Magnetic Effects

The other effect of a current flowing along a wire is the magnetic effect, and this is of vital importance in wireless work, for without it wireless telegraphy would be impossible.

A glance at Fig. 1 will show diagrammatically the magnetic field around a single conductor along which a current of electricity is flowing. The dotted lines are intended to represent the magnetic field around the wire.

Now, the magnetic field produced by a current flowing along a single wire will

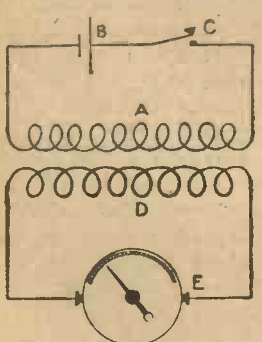


Fig. 4.—Diagram showing Induction Effects.

not be strong or intense enough to produce any appreciable effects, but if the wire is coiled up, as shown in Fig. 2, the magnetic field will be very considerably increased.

A still greater effect is produced when the wire is wound upon an iron core, and Fig. 3 in the preceding column shows diagrammatically the essential details of an electro-magnet.

One particularly useful feature of the electro-magnet is the fact that the iron core is only magnetised when a current is flowing round the coils; as soon as the current is interrupted the iron ceases to be a magnet.

Inductive Effects

In addition to the magnetic effect produced by a current in a coiled wire, there is the inductive effect of the sudden production or withdrawal of a magnetic field from the neighbourhood of a second coil of wire, which is shown in Fig. 4.

A is a coil of wire connected to a battery B and having a switch C in the circuit to switch the current on or off. By the side of the coil A a second coil D is placed connected to a sensitive galvanometer, which is an instrument for indicating the presence of a small electric current.

On pressing the switch C, it will be noticed that the needle of the galvanometer will be deflected, while on switching off the current the needle will be deflected in the opposite direction in spite of the fact that there is no electrical connection between the two coils A and D.

This is known as the inductive effect of the current, and by varying the proportion of turns of wire on the coils A and D the voltage of the induced current may be made much higher than the battery B. This property of the induction coil is made use of in medical and spark coils and transformers, and also in oscillation transformers used in wireless work.

"D.C." and "A.C."

It has been mentioned that a battery, accumulator or dynamo is a piece of apparatus for setting in motion a current of electricity, generally supposed to flow in a certain direction like the flow of water in a pipe, the voltage or pressure being at its maximum at one terminal of the battery and zero at the other. This is known as direct current or "D.C."

The other system, known as alternating current or "A.C.," is so called because the current is continually changing its direction or sign, being alternately positive or

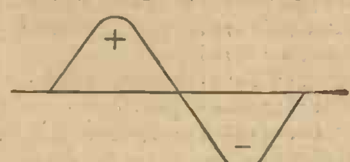
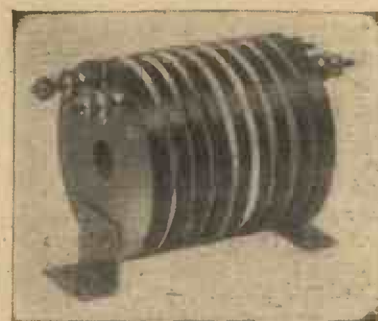


Fig. 5.—Diagrammatic Illustration of Single-phase Alternating Current.

negative every half wave, as shown diagrammatically in Fig. 5. As the whole of wireless engineering depends on alternating currents it will be necessary for the reader to remember a few of the differences between "D.C." and "A.C." A. W. H.

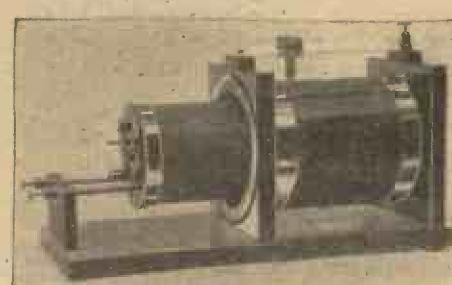
(*To be continued*)

Front View of Variometer.



High-frequency Transformer.

Simple Valve Receiver.



Loose Coupler.

Radiograms

THE organisation of commercial wireless telegraphy in Austria has been entrusted to the Marconi Company of London. This decision has met with considerable opposition from the supporters of the German Telefunken Company. An Austrian Marconi Company is to be formed with its registered office in Vienna, and half the capital is to be subscribed by the London Marconi Company. The Austrian Government will subscribe 30 per cent. The concession gives the Marconi Company the exclusive right of all wireless services between Austria and other countries for a minimum period of thirty years.

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An interesting feature of the recent political campaign of Dame Margaret Lloyd George, G.B.E. (for the Coalition), through the south-western counties was the series of demonstrations of wireless telephony and telegraphy given by Mr. D. T. Chapman, of Abbotsford, Poole, Dorset. The first and most interesting was given at the large meeting held in Clifton Zoological Gardens, Bristol, on July 10, when a special concert was transmitted from the Eiffel Tower, Paris, by kind permission of General Julien. Dame Margaret Lloyd George was an interested listener-in. Further demonstrations were given on following days at "Cambre," Pennsylvania, Exeter, by kind permission of J. W. Reed, Esq., and record signals and music were received owing to the unscreened aerial which was at a height 450 ft. above sea level. Demonstrations were also given in the Gyllyndune Gardens, Falmouth, where many people heard wireless for the first time. A 4-valve receiver was used.

▪ ▪ ▪ ▪ ▪

There has been installed on one of the London-Paris aeroplanes a combined wireless telephone and telegraph equipment of 35 watts antenna output, with a sending range of about 180 miles at 900 metres' wave-length. The complete wireless equipment weighs only 125 lb. An air-propeller-driven generator for 6 volts and 700 volts and a 6-volt storage battery supply the necessary current. A 3-valve amplifier is used for receiving on all wave-lengths between 300 metres and 1,000 metres.

▪ ▪ ▪ ▪ ▪

"Listeners-in" in Germany are required to make a yearly deposit of 4,000 marks in order to become subscribers to the German Government's broadcasting scheme. An additional fee is payable to any one of a number of wireless Press agencies which the subscriber may select. All Press messages are coded in such a manner as to be unreadable by unauthorised persons.

The wireless telephone will make the life of the lighthouse keeper less lonesome and certainly more cheerful. Some lighthouse keepers, for instance, remain at their posts for three years at a stretch, and some of them remain without mails for ten months.

▪ ▪ ▪ ▪ ▪

It is reported that a receiving apparatus many hundreds of times more sensitive than existing receivers has been invented by Armstrong, the American of "feed back" fame.

▪ ▪ ▪ ▪ ▪

Recent experiments have shown that wireless can be used quite effectively in mines, transmission being effected from one mine to another at a depth of 350 ft.

▪ ▪ ▪ ▪ ▪

The South African Marconi Company is projected with a capital of half a million, four-fifths of which is to be subscribed in London and the remainder in the Union.

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A novel feature of motor-car record-breaking by Mr. F. S. Edge at Brooklands was the installation of a wireless set in the car. The idea was to keep in touch with the ground staff during the whole attempt at making records. An upright aerial, of course, was out of the question, and therefore a trailing flexible wire was used, the "earth" being the chassis of the car.

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A firm of wireless instrument makers near Holborn (London) frequently entertains large street crowds to selections of music wirelessed from Paris.

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The makers of receiving apparatus are at present inundated with orders, and their manufacturing resources are most severely taxed. Much difficulty is being experienced in purchasing small parts, crystals, etc.

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Owing to the lack of funds there was a great probability that the Dutch concerts would be discontinued. The "Daily Mail," however, realising their value to wireless enthusiasts, has generously provided funds to ensure their continuance and also development on much wider lines.

The first concert of the new series will be on July 27 between 7 and 8 p.m. (summer time). It will be sent out on a 1,050-metres wave-length and a power of 800 watts.

On August 3 the Dutch service will be broadcast at a power of 1,500 watts, giving a range of 2,000 miles. The call, P C G G, will at first be given in Morse, then it will be repeated alphabetically with the announcement, "The 'Daily Mail' wireless concert is about to begin."

In The Grafton Electric Company's advertisement in last week's issue, some prices were accidentally omitted. The Brass Studs are respectively, 1/-, 1/3 and 1/6 per dozen, complete with nuts and washers.

Broadcasting and the Public

OUR article under the above title in last week's issue has aroused much comment, and as a result of its publication we are able this week to give our readers some information. Quite unofficially, but from a source upon which we feel we can rely, we learn that licence fees are not to be raised, but will remain at 10s. as at present. We are told that the ten broadcasting stations, which will be distributed over the country, will cost at least £250,000 per annum to install and maintain. Our authority is very certain that this apparently enormous cost will be reached, and points out that the Postmaster-General has emphasised the necessity of the broadcast programmes being on a high level and of every item being an original production—in other words, not a "gramophone" item. This quarter of a million pounds has to come from somewhere. It obviously cannot be found by the broadcasting companies unless in turn they can get the money from the public, and the arrangement proposed is that foreign apparatus shall be banned, thus giving British manufacturers a monopoly in their own country. The present intention is to charge the manufacturers a sum of money on each receiver sold, this extra payment being regarded by the broadcasting firms as a toll which the buyer will pay in return for what in a sense will be an absolutely unlimited broadcasting service. Although, as we have said, the British manufacturers will have a monopoly in their own country, our authority has taken great pains to assure us that nothing whatever in the nature of a "ramp" will be permitted, and that the toll derived from the public will be limited to the comparatively small sums which will be added to the prices of the sets sold.

Wireless manufacturers believe that, as a result of the fillip to their trade which such an arrangement will bring about, the Ministry of Labour will be able to transfer a large number of unemployed from idleness to remunerative work, and that if they can go ahead on these lines—and, naturally, not until they can see profitable business in front of them are they prepared to go ahead—the Postmaster-General will receive such a large amount of money in the form of licence fees that he will be able to restore the penny post and effect other economies! That is a very optimistic view. Let us hope it is a correct one!

We put a pointed question to our informant: What about amateur sets made at home? The definite answer was given that there is no intention whatever of doing anything to restrict their use or to make their owners pay towards the upkeep of the broadcasting stations. Whereas the purchaser of a new set will be subscribing a small amount to that upkeep, the amateur who makes his own apparatus at home will avoid any share of the broadcasting expense.

"How many broadcasting firms are concerned in the arrangement?" was our next question. The answer was not absolutely definite, but was to the effect that the broadcasting firms—two or three in number—would act in the nature of clearing houses to which members of the trade would subscribe. These broadcasting firms would install, maintain and manage the proposed stations, and would be supported financially by the whole of the trade.

And as we closed our conversation our informant gave us this parting shot: The manufacturers are out to do their utmost for the amateur public, to help them in every possible way, not to hinder them, certainly not to "bleed" them; they believe that only by mutual co-operation can success attend the very expensive experiment of initiating a broadcasting service in this country.

CORRESPONDENCE

Can any Reader Explain?

SIR,—Your reader states that the electro-magnetic waves are well known to travel the earth's surface, but do they? To my mind we have the Hertzian-wave theory of to-day simply because it became popular when Marconi took up the theory and made his announcement to the world in 1896. Tesla's theory is that we do not depend on etheric space waves for transmission of electro-magnetic waves, but by induced earth currents. He also points out that the real Hertzian waves are spent after they have travelled from the sender a short distance only. I may say that I believe that we depend on induced earth transmission. Tesla also proves that Hertzian waves have very little to do with the results obtained to-day, even at a small distance. If two grounded circuits are observed from day to day the effect is found to increase greatly with the dampness of the earth. I think that there is no better conductor of electro-magnetic waves than the earth itself. Why should the electro-magnetic waves follow the earth's surface when by ordinary etheric disturbance they can propagate in all directions unimpeded? Recently we have heard of the "Roger's antenna" (burying the aerial in the ground for a short distance), also of trees acting as aerials, signals received on sets simply with a honeycomb coil stuck in position instead of an aerial connection, etc. All this, in my opinion, proves the Tesla theory.—H. P. (Stockton-on-Tees).

SIR,—Briefly G. B.'s difficulty, under the heading of "Can Any Reader Explain?" in No. 5, is that since light waves and wireless waves differ in some of their properties it seems unlikely that they can both be vibrations of the same medium, differing merely in their frequency or wave-length. If we decide that this difference is sufficiently fundamental to render the explanation offered by the present theory unacceptable, we shall have to postulate either the existence of a second and slightly modified medium or that one of the phenomena is a material emission (the old corpuscular theory of light). We must bear in mind what a stupendous difference there is between the wave-lengths of visible light and of wireless waves. The former must be measured in millionths of an inch and the latter in hundreds of feet. Compared with this the range of audible sound wave-lengths is very limited, as they vary from a few inches only up to 300 or 400 ft. The range of visible light waves is equally small in comparison. Yet in both cases there are marked differences in the properties of the waves within even those limited ranges.

We may compare G. B.'s opaque bell-jar to a receiving aerial tuned to the wave-lengths of visible light, for it is composed of molecules of matter in extremely rapid, but perfectly definitely timed oscillation. Consequently ether rays having the same frequency are absorbed, whereas those of different frequency pass through unaffected. Turning to the bending of wireless waves round the surface of the earth. There are several factors contributing to this, two of which are based directly on the great length of the waves. If we meet a drum-and-fife band playing in a main road and suddenly turn down a side street the fifes become much more subdued, in comparison, than the drums. This is because the high-frequency waves emitted by the former do not "bend" so readily as do the longer ones, which is true of all wave motion. Even visible light bends very slightly. But the enormously greater wireless waves turn corners as readily as do sound waves. The second factor is that the rarefied upper atmosphere refracts and reflects ethereal waves back towards the earth. The conductivity of the earth's surface also plays an important part in this matter.—G. W. S. (London).

ANNOUNCEMENTS

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General Correspondence is to be brief and written on one side of the paper only. All sketches and drawings to be on separate sheets.

Contributions are always welcome, will be promptly considered, and if used will be paid for.

Communications should be addressed, according to their nature, to The Editor, The Advertisement Manager or The Publisher, "Amateur Wireless," La Belle Sauvage, London, E.C.4.

SIMPLE AERIAL ERECTION (*continued from page* 149)

of 7/22 stranded copper, each strand enamelled. This wire is very efficient, especially for the reception of short waves. It has been found from experience that for reception a single wire is practically as good as a twin aerial, and, as the use of spreaders is dispensed with, it does not place half the strain on the masts.

In order to allow for contraction and expansion of the aerial, the end of the halyard on the garden mast was not firmly fixed, but was joined to a weight sufficiently heavy to keep the aerial wire taut. This allows for any variation in the length of the wire and guy ropes and prevents undue strain on the mast in wet or cold weather and slackness of the wire during dry or hot periods. E. E. H.

FORTHCOMING EVENTS

Nottingham and District Radio Experimental Association. July 27. Meeting.

Derby Wireless Club. July 27, 7.30 p.m. At "The Court," Alvaston, Derby. Lecture by Mr. A. T. Lee: "Practical Construction of Single-valve Receiver Set."

Liverpool Wireless Society. July 27. Meeting.

Hackney and District Radio Club. July 27, 8 p.m. At 111, Chatsworth Road, E.5. Meeting.

West London Wireless and Experimental Association. July 27. Lecture by Mr. F. E. Studt: "Three-circuit Variometer Tuner."

TELEPHONY TRANSMISSIONS

Eiffel Tower (F L). 2,600 metres. Each afternoon (Saturdays and Sundays excepted).

The Hague, Holland (P C G G). 1,150 metres. July 27, 7 to 8 p.m.

Writtle (2 M T). 400 metres. August 1, 8 p.m.

CLUB DOINGS

Ilkley and District Wireless Society

Hon. Sec.—E. STANLEY DOBSON, "Lorne House," Richmond Place, Ilkley.

A MEETING was held at the Regent Cafe, Cowpasture Road, at 7.30 p.m. on Wednesday, July 5th, when Mr. H. G. Evans, B.Sc., gave a lecture on "Radio-Telegraphy and Telephony." The lecturer dealt briefly with the properties of the thermionic valve, and its application to simple wireless circuits. The lecture was illustrated with lantern slides.

After the lecture, Carnarvon, Leafield, etc., were tuned in on a very fine set which the lecturer had brought with him. Unfortunately the telephony which was expected, did not come through, on account of a slight misunderstanding as regards the time.

The Hon. Sec. will be pleased to hear from anyone interested, and will furnish particulars of membership together with the objects of the society on application.

Durham City and District Wireless Club

Hon. Sec.—MR. GEO. BARNARD, 3, Sowerby Street, Sacriston, Durham.

THE above club held their first meeting on July 11th. The attendance and enthusiastic spirit quite exceeded all expectations.

Before proceeding to business, Mr. Barnard made a few explanatory remarks, and also outlined the objects and aims of a wireless club.

(*Continued in second column of next page*)

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Erection of Aerial for Wireless Receiving Station

Q.—Will you kindly advise with regard to erection of aerial upon the roof without using poles, if possible? Conditions as shown in diagram herewith.—L. M. (76)

A.—Querist's diagram (not reproduced) shows very clearly the conditions to which he must conform. But for the unfortunate presence of the centre chimney-stack it would no doubt have been possible to erect a fairly useful aerial, though, of course, the actual height above the roof would at most be but 8 ft. As the matter stands the writer regrets he cannot see how the use of poles of some description is to be avoided, and suggests that two light poles be obtained, say about 15 to 20 ft. in length, and tapering from about 3½ in. to 2¼ in. These should be well secured to the outer sides of the two outer chimney-stacks, and should each be fitted with light galvanised iron pulley block and "endless" rope or halyard, say ⅜ in. in diameter, the poles or masts to occupy a vertical position and to have an iron cleat fastened near the bottom of each, to which the halyard may be secured. The aerial itself should consist of two wires (No. 16 S.W.G. phosphor-bronze, silicon-bronze or hard-brand copper) spaced upon light ash or strong bamboo spreaders each 4 ft. long. Insert one small "reel type" insulator between each wire and the spreader at each end, and a larger size "reel" or "saddle" insulator between the bridle rope of each spreader and the halyard to which same is attached. The down-lead may also consist of two wires soldered to the wires of the aerial proper and to each other just before they reach the lead-in tube at the instrument room. The total length of wire employed will then be 86 ft. in the horizontal component of the aerial and (say) 54 ft. in the down-lead, which just makes up the regulation 140 ft. The telephone wires mentioned, unless fairly close and nearly parallel to the aerial, will not, it is thought, have any noticeable effect. Querist may possibly overhear telephone conversation, but that will be about all.—CAPACITY.

CLUB DOINGS (*Continued from page 153*)

A very interesting and lively discussion then took place which ended in the club being formed.

It was decided to hold the meetings every other Friday at 7 p.m. A committee was then elected to hold office for three months, after which time another election will take place. It was decided not to elect the President, Vice-President and Chairman, until a few weeks had elapsed.

The next meeting will be held in the Hall of the Rose and Crown Hotel at 7 p.m. on Friday, July 21st, when a lecture will be given by Mr. G. Barnard on "The Electro-magnetic Theory and its Application to Wireless Telegraphy."

Applications for membership are invited.

West Bromwich

AT present West Bromwich does not boast a wireless society, but a lecture and demonstration of telephony in the local Technical School on the 7th inst. attracted a good audience, not a few of whom were ladies.

Mr. Howard Littley was responsible for the arrangements, and a Burndept 3-valve loud-speaker set was temporarily fixed up in the physics laboratory, the aerial being slung between two beams, and the earth taken to a water tap.

Telephony and music came in splendidly from Mr. Littley's home, whence it was transmitted by Mrs. Littley, and the demonstration proved an interesting example of what can be done with an indoor aerial, for the physics laboratory is in the heart of the school. It was explained by Mr. Littley in a brief address, that in music several particular notes did not come out well, and it was curious to note that these were always the same. An advantage of indoor aerials, he pointed out, was the almost total absence of atmospherics and the smaller liability to jamming.

The gathering was held under the auspices of the West Bromwich Engineering Society.

Barnsley Amateur Wireless Association

Hon. Sec.—MR. G. W. WIGGLESWORTH, 13, King Edward Gardens.

A GENERAL meeting of the above club was held on Tuesday, July 11th, in the Guild Room of the Co-operative Education Department, Market Street.

The question of permanent headquarters was discussed, and suggestions from the members present were considered, with the result that the Association is very hopeful that at a very early date some of the proposals brought forward will materialise, and that the work of the Association will commence in earnest.

The annual subscriptions were fixed as follow:—

Adult members, 10s., Age 18 to 21, 7s. 6d., Junior Members, 5s.

The existing committee was re-elected *en bloc* with additions. The question of President, Vice-Presidents, etc., was discussed, and finally left in the hands of the committee. Applications for membership should be made to the Hon. Sec.

(*Continued on page 158*)

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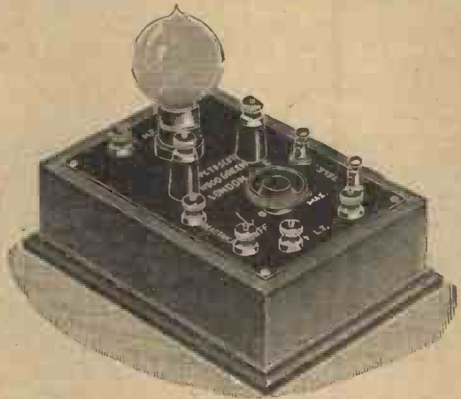

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CLUB DOINGS (*continued from page* 154)

South Shields Y.M.C.A. Amateur Wireless Society

Hon. Sec.—JAS. TEASDALE, 38, Readhead Avenue, Westoe.

The above club has now been formed, and a single valve receiver has been installed.

Intending members should communicate with the secretary or attend any of the meetings which are held every Friday at 8 p.m., in the Y.M.C.A. Buildings, Fowler Street, South Shields.

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