A NEW CRYSTAL DETECTOR :: WE PRESENT THREE WIRELESS SETS

Amateur Wireless and Electrics

WELL ILLUSTRATED

No. 3 SATURDAY, JUNE 24, 1922 Price 3d

CHIEF CONTENTS OF THIS NUMBER

An Amateur's Single-valve Set; note the variable condenser underneath the panel and the slab-coil holders in front; the coils are not shown. In this issue, amateur methods of mounting slab coils are explained.

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Unexpected Causes of Weak Reception

WHEN dealing with such high-frequency currents and potentials as are used in wireless work, we shall often be led astray unless our notions of inductance and capacity are enlarged to take in quantities which in power circuits would be completely negligible. We are apt to get into the habit of regarding inductance as being existent only in specially-wound coils, and of capacity as residing only in variable condensers, and to forget that, "like the poor," they are always with us. For wherever we have a conductor carrying current there is inductance, and if that conductor is insulated from surrounding objects there is capacity also. They are our very good servants if properly arranged, but if we overlook them at any point we may often be left guessing as to why signals are poor and faint.

A Classic Experiment.

Both inductance and capacity tend to impede the passage of oscillating or alternating currents, the extent to which they do so being governed by the frequency. This point is well illustrated by the classic experiment with a Leyden jar. If such a jar is charged by means of a Wimshurst machine, for instance, and then discharged by a piece of wire bent into the shape shown in Fig. 1, it will be noticed that a spark appears at G as well as at A. To a low-frequency current the circular loop would offer much less impedance than the air-gap G, which it virtually short-circuits, and its inductance would be regarded as negligible; but with the high-frequency current, which constitutes the discharge of the condenser, the matter is entirely reversed, the air-gap then offering the path of least resistance.

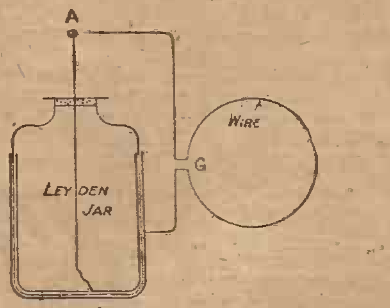


Fig. 1.—Experiment with High-frequency Current.

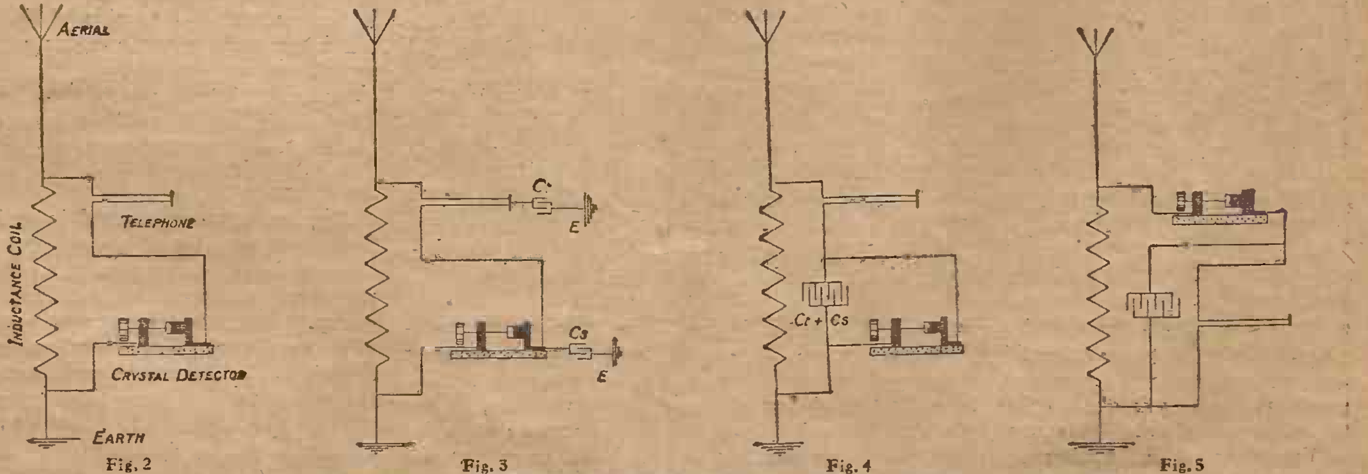
We are made aware of one of the peculiarities of our high-frequency currents in the above experiment by the outward and visible sign of the spark, but similar effects may vitiate the efficiency of our receiving sets without giving us such warning if we are not aware of the possibilities.

Generally speaking, overlooked capacities are most likely to prove troublesome, and as an example we can profitably study the effect of this on a simple crystal receiving set.

A Trouble and Its Elimination.

Supposing we have connected up such a set, consisting only of aerial, tuning inductance, telephones and silicon crystal rectifier as shown in Fig. 2. It will be noticed that the 'phones and the part of the detector in which the crystal is mounted (this usually being bulkier than the part which carries the point) are connected to the aerial end of the inductance. Now, when we place the 'phones on the head we considerably increase their capacity to earth—that is, the windings of the magnets form one plate of a condenser while the head of the operator forms the other, and this second plate is naturally, to a greater or lesser extent, earthed. In addition, the more bulky part of the detector may have a by no means negligible capacity to earth. These two incidental capacities are represented in Fig. 3 by Ct and Cs. In effect, by arranging the apparatus in this way the detector has been "shunted" by a condenser Ct + Cs in the manner shown in Fig. 4, and much of the incoming high-frequency current will take this by-pass path in preference to doing useful work in the detector.

By altering our connections to those shown in Fig. 5 the trouble is eliminated, as Ct + Cs now shunts the 'phones (where it will actually be of assistance), and the whole of the high-frequency current must pass through the detector.



Figs. 2 to 5.—Arrangements of Apparatus showing the Different Effects of Capacity and Impedance.

Another case of a stray capacity being

usefully employed is that of the flexible leads commonly used with telephone receivers. Here we have two insulated conductors twisted tightly together and having, from the high-frequency point of view, a considerable capacity between them. The effect is obviously the same as if a condenser had been connected across the receivers in shunt, and, in fact, it usually renders any additional "blocking" condensers unnecessary.

Frequently that part of the receiving circuit which contains the 'phones has to deal with both high, or radio-frequency, and low, or speech-frequency, currents. To currents of radio-frequency the inductance of the windings of the 'phones offers a large impedance, and they mostly avoid this part of the circuit and take the alternative path offered by the condenser just mentioned, whereas to currents of speech-frequency the 'phones offer by far the lesser impedance. Consequently the current distributes itself in the manner shown in Fig. 6, the radio-frequency and speech-frequency current being clearly indicated.

SIGMA.

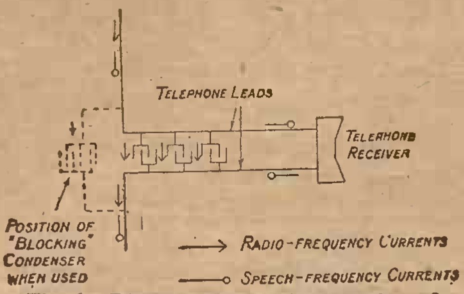


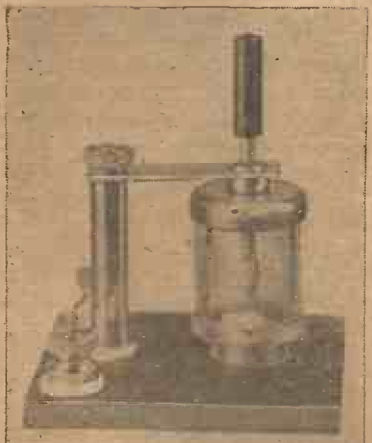
Fig. 6.—Diagram showing Distribution of Currents.

STARTING WIRELESS.—III

AERIAL AND EARTH; RECEIVING THE SIGNALS; DETECTORS.

THE object of the aerials is, of course, to pick up the signals and convey the electrical energy to the receiver. Perhaps we may best understand the action of the aerial as follows: The aerial consists of one or more insulated wires raised above the surface of the earth; this, it should be remembered, is also an electrical conductor. Hence the aerial wire and the earth form a condenser, since they consist merely of two conductors separated from each other. The aerial at the transmitting station has various electrical currents and pressures produced in it which cause the ether to become strained. This sets up waves in the ether which, falling upon the receiving aerial, cause various other electrical pressures to be produced. In practice it is usual to connect the "lead-in" from the aerial to one end of the tuning inductance, the other end being connected to the earth. It is obvious, then, that what we really have is an inductance connected across a condenser.

We have now explained the essential requirements for receiving messages, but we have not yet considered how we can utilise the electrical energy now at our disposal. However, before dealing with this point it is necessary to revert to the variable condenser previously mentioned.



Two Detector Components—the Crystal and the Valve.

Since it is possible to tune to any wave-length by varying proportions of capacity and inductance, the inductance could be fixed and the capacity be variable, or the capacity fixed and the inductance variable. Now the aerial is a fixed capacity, and therefore it is possible to tune in a station by merely varying the inductance. However, the tuning must be critical, and, therefore, if only the inductance is variable it must be very finely graded, such as would be the case with a sliding contact. With very short waves even this grading would not be fine enough, and it is therefore necessary to use a variable condenser. On the other hand, when tuning to very long wave-lengths it is equally essential to employ a variable condenser.

How the Energy is Utilised.

Suppose that we have tuned our receiver to a particular station, and that we now wish to receive the message. Every time a wave falls upon the aerial it causes an electrical oscillation to be set up across the inductance. This means that across the inductance (and therefore the capacity, whether it is the aerial alone or with an additional variable condenser) a very small electrical potential (that is, a pressure) will be set up. But since this is produced by an oscillation it will be an alternating potential, and, of course, at a very high frequency. All that it is necessary to do, therefore, is to make use of an alternating potential at a very high frequency.

If a telephone receiver was to be connected across an electrical pressure, such as a battery, there would be a little click in the receiver. An alternating current is one which is continually changing its direction, and therefore if we were to connect the telephone across an alternating-current supply we should get a series of clicks which, if they were rapid enough, would produce a musical note. Now we have an alternating potential across the receiving inductance; but even if we were to connect a telephone to this we should still be no nearer solving the problem, for it must be remembered that the potential is varying at a speed of thousands of times a second, so fast that the telephone diaphragm could not possibly move at the speed. If some device could be inserted in the telephone circuit that would only allow the current to pass one way each time a signal was sent there would be a click in the telephone, since there would practically then be a direct current.

Signals from what is known as a spark station consist of a number of little trains of waves with a comparatively long interval between each, say a thousandth of a second. Therefore each signal will produce a number of rapid clicks which will be heard as a musical note.

Detectors.

The apparatus connected in series with the telephones is the detecting device. The crystal detector can be used for the reception from spark stations and of telephony. The other apparatus now generally employed for detecting wireless signals is the thermionic valve, which has the advantage of being able to magnify the strength of the signals and also receive continuous wave signals.

PAUL D. TYERS.

"Upright Electrons."—These are not a startling discovery by the Editor of "Amateur Wireless," but simply a rather absurd mistake made by the printer. The inscription to the photograph on p. 23 of our last number should be "Thermionic Valve with *Upright Electrodes*."

WIRELESS IN THE TROPICS

LEAVING England, our first port of call was at St. Vincent, in the Cape Verde Islands, a small and uninteresting group of volcanic islands, situated some hundred miles west of Bathurst, West Africa. The only point of interest was the unusual type of wireless station which was to be seen erected practically on the seashore; this, on investigation, proved to be a British Army wagon set equipped with an 80-ft. umbrella aerial. There are few places I have visited that appeal less to me than St. Vincent, and I was not sorry when our two days' stay there came to an end.

The next town of interest, from a wireless point of view, which we called at was Cape Town. This has for its wireless work the station at Slang Kop. This station, opened in May, 1911, filled a much-needed want, as it is one of the three existing stations now open for ship and shore communication, the other two being those at Port Elizabeth and Durban, Natal. The station at Durban was removed from its original site in September, 1913, to the position it now occupies, some four miles inland near Isipingo.

Leaving Durban, we straightway headed up the Mozambique Channel, and after a further voyage of a week passed Zanzibar. The island possesses a small station open for ship and shore work, and there is also another station on the Island of Pemba.

Mombasa was next investigated after disembarking at the Port of Kilindini, and the wireless station there proved very instructive. When it is remembered that this station is only about 4½ deg. south of the equator, the reader will surely not envy the operators on duty! One set consists of a 5-kilowatt transmitter of the synchronised-spark type, having a spark-frequency of about 600 sparks per second; the note emitted is musical and high-pitched, which makes reception through the atmospheric disturbances which in this country are always prevalent easier. The station is also fitted with a 1½-kilowatt plant for shipping work; this has a range of some 350 miles. The surroundings are tropical to a degree, and from the entrance to the Harbour of Kilindini present a very striking aspect. Close by is the railway station, which is the starting-point of the Uganda Railway, which terminates at Kisumi, on Lake Victoria Nyanza, some 500 miles from the coast, the capital, Narobi, being about half-way up. The country around this district is probably one of the finest there is for big game shooting, and practically every type of African animal, reptile and bird is to be found there. One of our chief enemies was the white ant. The favourite pastime of this creature is to eat up everything it can get at, especially leather.

We had with us small portable wireless

Raising Derrick of Mast at Dar-es-salaam.

sets, both transmitting and receiving, with which much heavy work was carried out. When it is remembered we made a journey mostly on foot from Kilima Njaro, the highest mountain in Africa, to a spot some hundred miles south of Dar-es-salaam, with a ½-kilowatt spark set, through plain, bush, forest, over mountains, through

Raising a 120-ft. Steel Mast at Dar-es-salaam.

swamps, twice being almost surrounded by bush fires, and in one case even having to abandon our set and provisions, the reader will agree no doubt that wireless, under some conditions, can be as exciting as it is interesting.

Results were astonishing when it is recalled that at this particular time our set had only an input of ½ kilowatt; in one instance we were easily able to hold good communication over a distance of eighty-four miles for several days, whilst on shifting our station to a position among the mountains we were actually unable to communicate twelve miles with the same set and power.

Of atmospheric conditions I shudder to think; the sets were provided with static leaks between the aerial and earth connections, but these seemed to have little effect. On many nights, particularly in the dry season, communication was quite impossible. The best illustration I can give the reader is to ask him to imagine himself in a greenhouse and a bucketful of tintacks being poured on to the glass roof from a considerable height; he may then have some faint idea of the noise amidst which we had to endeavour to read our messages.

At Dar-es-salaam before the war there was a large wireless station capable of direct reception from Nauen, Germany. This had a transmitting range of some 3,000 miles, which enabled traffic to be sent to a station at Kamina, in Togoland, West Africa, which relaid it direct to Germany. On August 9, 1914, only five days after the declaration of war, the British forces completely destroyed the German station at Dar-es-salaam and thereby cut the colony off from the Fatherland. When the writer visited this station it wore an aspect of desolation and complete destruction, the high aerial mast being broken off near the base. What remained of the station was used later by our troops as a store for the British Wireless Section when in possession of the town itself.

Leaving Dar-es-salaam, our next destination was the Persian Gulf via Bombay; we then soon picked up the call well known to operators in that part of the world, namely, V W B, and a few days later we were living as respectable citizens of Bombay. Our stay there terminated abruptly, and we were soon away for more work. Shortly afterwards we landed at Bussara, or, as it is better known to many, Basrah. Here one at once noticed the great masts of the 30-kilowatt Marconi station that stands close to the river. This station is used with low power for ship communication work and also for Press and long-distance work on full power. V T C, the call letters of the Basrah station, were always welcome to us, as later on this station proved to be our directing station after we had erected an 8-kilowatt C.W. station at Bagdad and moved some 350 miles to the north-east to a position about eighty miles south of the Caspian Sea. Here another C.W. station was erected, a few brief details of which may be of interest. The prime mover was a 14-h.p. two-cylinder water-cooled engine which drove an 8-kilowatt Newton generator at 80 volts. By this current a motor-generator set was run supplying a 400-volt direct current for a Poulsen arc, the power being delivered to a 120-ft. aerial. When the transmitting key was down energy was supplied to the aerial system, and when up the current was diverted through a balanced-capacity system, thus emitting no spacing wave. This station was a link or relay station between Basrah, Bagdad, Baku and Tiflis.

After the lapse of a few months we were again at sea, and after passing through the Gulf of Oman our course was steered for the Suez Canal. Aden was passed close by, and again our eyes were directed to the station which lies well to the west of the town, but we did not stop there. Passing on we entered the Straits of Bab-el-Mandeb and to the Red Sea. When the passage through the Suez Canal is made at night, a small steam-generating set is hoisted on board, and connected to any available steam-pipe, the turbine and dynamo are put into operation, and a powerful arc lamp swings from the mast, and a searchlight in the bows of the ship shows up the banks of the canal to the navigator on the bridge.

There are a number of wireless stations in the vicinity of Port Said, including, of course, Port Said itself, which handles the bulk of the sea traffic in that neighbourhood. Close by is the station of Abu Zabal, situated on the outskirts of Cairo, the second of the Imperial stations, which may be plainly heard in England working to Leafield (G B L), that much-dreaded high-power station near Oxford which, to coin a phrase, literally "breeds harmonics."

A. C. CHATWIN.

MOUNTING SLAB INDUCTANCES

THE method of mounting slab coils, shown in the accompanying illustrations, was originally devised in order to use these coils in conjunction with the

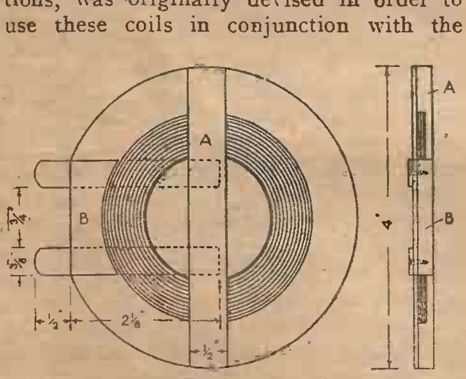


Fig. 1 Fig. 2

Figs. 1 and 2.—Two Views of Coil Mounted on Holding Disc.

apparatus described in "The Amateur Mechanic," but, of course, it will lend itself equally well to other types of apparatus. It has the great merit of requiring very few tools to carry out, and most of the work can be done with a fretsaw.

The dimensions will depend on the sizes of the coils to be used, and they must be modified accordingly. Those given were intended for coils with an inside diameter of 1⅝ in. and an outside diameter varying from 1⅞ in. to 3¼ in. The thickness varies from $\frac{1}{16}$ in. to ¼ in.

In Figs. 1 and 2 the coil is shown shaded. It is mounted on a disc of $\frac{1}{16}$ in. three-ply wood, and is held in place by a strip of wood shown by A, which will vary in thickness according to the thickness of the coil it is to hold, the strip being cut on the under side to fit the coil. Another piece of wood cut to the shape shown is attached at B. Two strips of ⅜ in. by $\frac{1}{16}$ in. brass are fixed to the back by screws passing through the three-ply into the pieces of wood A and B; A is also fixed by screws at the ends.

The ends of the coil are led through the three-ply wood, and are soldered to the two brass strips at the back. All the coils are mounted in the same manner, care being taken to see that they are central and that the brass strips are the same distance apart in every case.

Fig. 3 shows a side elevation of the stand for holding the coils, and a coil is also shown in position. The coupling adjustment is obtained by varying the angle between the A.T.I. and the reactance coil, the latter being mounted on hinges for that purpose.

The base of the stand is hollow to allow of the wires being led to the terminals. It may be made entirely of ⅜ in. mahogany. In the middle of one end is fixed an upright support for the fixed coil; this may also be made of mahogany, suitable approximate dimensions being 4 in. by ½ in. by ⅜ in. This upright is shown

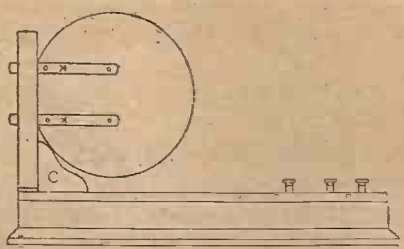


Fig. 3.—Side Elevation of Stand for Holding Coils.

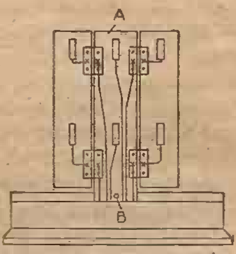


Fig. 4.—Back Elevation of Stand showing Wiring Connections.

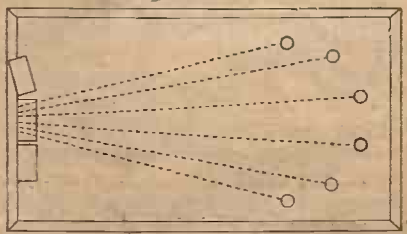


Fig. 6.—Underneath Wiring Connections.

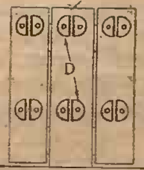


Fig. 5.—Positions of Brass Clips.

at A in Fig. 4, and is fixed by one screw B (Fig 4); it also has a strengthening support C (Fig. 3). The upright should have two slots mortised in it, into which the brass strips on the coils are a loose fit. Small brass strips (these may be cut from flash-lamp battery contacts) bent at right angles are fixed by small screws in the slots as shown at D (Fig. 5); when these are fixed the coil should be a spring fit into the slots between the brass clips. Wires are then led from the clips down the back of the support to the two middle terminals.

Two other supports are made exactly similar to A, and are attached to it by hinges through which the electrical connections are made, all joints being soldered at the points marked X in the drawings. Figs. 4 and 6 show the wiring connections. No. 28 gauge d.c.c. wire will be suitable for these; the stand is shellac-varnished after the wiring is fixed.

If desired, the stand may be made to hold only two coils, but it is worth the extra trouble to make it for three, as it is then possible to experiment with various circuits.

B. M. W.

ELECTRONS AND WIRELESS

NO one has ever given a clearer explanation of the modern uses of wireless than Professor Fleming gave last Christmas-time to an audience of children at the Royal Institution. He devoted one of his six lectures to a careful explanation of what is sometimes called the electron theory of electricity, but it was very noticeable that he did not treat it in the least like a mere theory. He stated it quite simply as an answer to the question, "What is electricity?"

Anyone who heard those lectures and thought about them afterwards must have wondered whether the veteran electrician could possibly have made all those children understand the experiments he showed them if he had not started by telling them about electrons. There was another thought that would keep on intruding itself, and that was, Could Dr. Fleming have made his wonderful "valve" if the electron had not been as real to him as he made it to the young people?

It is not given to all of us to be mathematicians, so the writer of this article has no intention of trying to explain the methods by which the size and weight of an electron have been measured. He would make an awful mess of it if he made the attempt. He wants rather to say something about how the discovery was made, to say what an electron is thought to be, and to tell a little of the way it explains some of the otherwise mysterious phenomena of electricity. The example of Dr. Fleming is so good that we may all be sure that amateur students of wireless telegraphy and telephony will understand what they are doing none the less for a little electron lore.

Electron Lore.

First of all, then, what is an electron? It is a particle of electricity. It bears the same relation to an electric current that a molecule of water does to the river Thames. It has been described as the smallest thing on earth. Before its discovery, the smallest or, at any rate, the lightest thing we had any knowledge of was an atom of hydrogen, whose diameter has been estimated as about one twenty-fifth millionth of an inch. A hydrogen atom weighs about 1,600 times as much as an electron. So much for weights and sizes. It is right that we should know them, but such figures are so far beyond the grasp of human thought that we shall not refer to them again.

One thing has not yet been mentioned, the most important thing of all. The electron is a particle of negative electricity. This is rather curious. We are not in the habit of considering negative quantities as very real things. The difficulty arose in this way. Somewhere about 600 B.C. Thales of Miletus wrote that the substance called amber (*elektron*) had the power, after it had been rubbed, of attracting dust and other light particles. About A.D. 1600 Dr. Gilbert found that many other substances had the same property. He called them, after the Greek name for amber, electrics. Hence the word electricity. Symmer and Du Fay, working independently, a century or so ago found that there were two kinds of electricity, positive and negative, but it was Franklin who decided which was which. He called the charge of electricity excited on glass by rubbing it with silk positive, and that produced on amber or resin by rubbing it with fur negative. Franklin knew nothing about electrons, so when he suggested that electricity was an imponderable fluid he thought only of positive electricity. The negative state was a deficiency of positive fluid. These facts are well known, but we must keep them in mind if we are to realise how great a change was made by the discovery that the "corpuscles of electricity" or electrons were negative.

About forty years ago the late Sir William Crookes began his famous series of experiments on the structure of matter, or rather on the structure of material atoms. The original Crookes tube was simply a

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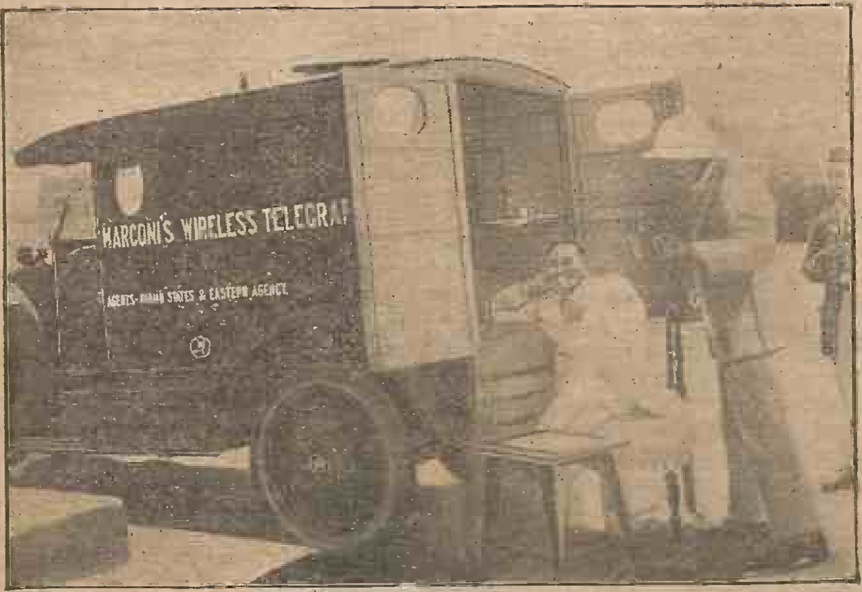
WIRELESS BETWEEN INDIAN SAHIBS



Photographs by permission of Marconi's Wireless Telegraph Co., Ltd.

His Highness the Maharajah Ranjitsinhji, Jam Sahib of Nawamagar, speaking by wireless telephone from Jamnagar to Mandvi across the Gulf of Cutch, a distance of 70 miles.

His Highness Maharao, Sahib of Cutch, receiving the message.

tube of glass with metallic electrodes fused through its ends. Before using it the air was pumped out of it as completely as possible. This exceedingly high vacuum ought to have formed an insulator, but when he joined up the metallic ends with an induction coil he obtained a remarkable set of effects. Some kind of radiation was set up, but, strangely enough, all the rays started from the negative pole and none from the positive. One of the effects of these rays was that they made the glass of the tube glow with a dim light where they struck it. He then made similar tubes of various patterns. Most of these had the positive electrode placed at one side instead of at the end. This made no difference to the direction of the rays. They ignored the positive electrode altogether and flew straight across the tube to the glass opposite, making it glow as before.

Crookes Tubes.

Two of his patterns of tube are of special interest. First is one in which two horizontal glass rails were placed. The rails, as he called them, were like thin glass wires stretching from one end of the tube to the other, and on them was balanced a wheel, like a minute model of the paddle-wheel of a steamer. The negative electrode was placed in such a position that its rays fell on the upper vanes of the paddle. The object of this tube was to discover whether the rays consisted of material particles or not. If they did, they would have enough momentum to turn the wheel. The experiment was brilliantly successful, so much so that the spinning wheel, moved by flying electrons, was exhibited on many occasions, and hundreds of copies of the apparatus have been made.

The second pattern was of quite a different kind. The electrodes were placed at the ends of the tube, but a glass partition with a small hole in the middle of it was placed across the inside of the tube just in front of the negative electrode. This prevented all excepting a thin stream of rays from finding their way into the main part of the tube. Inside this main part of the tube, right along the path of the stream of rays, Sir William placed a piece of card that had been coated with luminous paint. When the rays were allowed to pass, their path along the card was marked by a luminous line. Now, if the rays were of the same nature as a current of electricity they would be deflected by a magnet, and, as was expected, the streak of light could be bent about, attracted or repelled exactly as though it was a current flowing in a wire.

Sir William Crookes did not call his discovery by the name of electrons. He preferred to speak of his rays as radiant matter, but in using the word matter he was careful to point out that he got exactly the same effects whether the gas which had been in the tube before it was exhausted was oxygen or carbonic acid or any other gas instead of air. It might be thought that a few particles of the original gas were left behind and were the material part of the rays. If so, then all gases must have been resolved from the same substance in his tubes

Electrons and Atoms.

In the forty odd years that have passed since the Crookes tube was devised a great swarm of investigators has pounced down on the original idea, and our knowledge has advanced steadily. For the greater part it has gone along two lines. One of them has been to find out what part the electron takes in the constitution of a material atom, and the other has been concerned with the part it plays in the phenomena of electricity. The two are so close together that it is difficult to separate them. The discovery of radium solved many problems with regard to the first, but that is such a fascinating story that it is best, in this short article, to let it alone, with the remark in passing that radium, as it decays, gives off rays that answer all the magnetic tests of Crookes's radiant matter. It gives off electrons.

Material atoms, then, contain electrons. Some of these are quite loosely bound to the central part of the atom, so they are easily passed on at times from one atom to the other. When the old Greek philosopher rubbed his bit of amber on what passed in those days for a shirt-sleeve some of the electrons passed on to his shirt. Somewhere inside each molecule of the amber there were corpuscles of positive electricity that had kept the electrons in position by their attraction until they suffered violence. When the amber lost some of its electrons it became positive in its nature, and attracted the electrons in the dust to such an extent that they carried the dust with them back on to the amber.

This is the first mention of positive corpuscles that has been made here. They are slowly unfolding their properties, but, excepting in a remote way, they have very little to do with the science of electricity, so they will not be mentioned again.

How Electrons Behave.

When electrons are crowded together their mutual repulsion is gigantic, so it is no wonder that, when they get the opportunity, they fly apart with enormous velocities. When they move they cause disturbances in the ether. As a rule, they are moving in tiny orbits around the centre of a material atom, but their paths may be changed in many ways. One of these ways has been used in the thermionic valve. It has been found that when a metal is heated strongly electrons escape.

Now see how readily this fact explains one of the commonest of natural phenomena, that is, the earth's magnetism. The sun is at a very high temperature. Electrons are flying out from its atoms into space. Constant streams of them must be passing through the outer parts of our atmosphere. Now, these streams do not pass the earth so rapidly that the spinning motion of the earth is negligible.

The course of the electrons as they pass us is therefore a spiral one. If the electrons are units of electricity, then we have a spiral current of electricity continually running, always in the same direction, round the world, and everybody knows that when a current is sent through a wire spirally round a piece of iron an electromagnet is formed. Is it any wonder the earth behaves like a magnet?

Electrons and Wireless.

Go back again to the remark made just now that when electrons move they make disturbances in the ether. It is one of the commonest ways of explaining the transmission of messages by waves to make an analogy between the ether and a still pond. Float a cork at one side of the pond and float another on the other side. If you hit one of the corks it will bob up and down, ripples will be formed in the water, and in a little while the ripples will make the other cork keep time with the one you hit. It is dangerous to follow an analogy too far, but it is fairly safe to believe that the electrons pulsing rhythmically backwards and forwards in the aerial of, say, the Eiffel Tower send waves through the ether that will make the electrons confined in any distant conductor bob up and down like the distant cork. Of course, the conductor in which they are confined may be out of tune. When they rise with the wave they may get a check by the wave beginning to fall before they reach the end of their tether. Then the response of the distant aerial will be next to nothing.

FRANK T. ADDYMAN.

New Wireless Bill

SOME further proposals concerning wireless telegraphy and telephony have been framed, and under the name of the Wireless Telegraphy and Signalling Bill have been introduced in the House of Commons.

The Bill authorises the Postmaster-General

> To make regulations regarding the granting of licences;
>
> To require persons engaged in the working of wireless telegraphy to be provided with certificates;
>
> To provide for preventing interference with the working of wireless telegraphy by the generation or use of etheric waves for any purpose other than the transmission or reception of wireless messages.

The Bill makes it an offence to send or attempt to send a message or communication of an indecent, obscene, or offensive character; or send or attempt to send a signal of distress of a false or misleading character, or a false or misleading message as to a vessel in distress; or improperly to divulge the purport of any message sent or proposed to be sent by wireless telegraphy.

ELECTRICAL BENCHWORK

Ebonite Grinding, Lapping, Burning, Finishing and Engraving

Grinding.

THIS process is very useful for making rectangular panels, such as panels and bases. As an example, Figs. 5 and 6 show the method of making small rectangular switchblade holders. The blanks are cut up about $\frac{1}{16}$ in. larger than required from sheet of the required thickness with a circular saw (which, by the way, should be of a coarse cut and not the same as that used for brass). Then a lathe or lapping machine is set up with the table and dish-shaped emery wheel as shown in Fig. 5. One long side of all the blanks is first ground off, using a fence or guide as shown. Next, the guide is set so that the parts are nearly to size, allowing for lapping, when the other long side is ground. The ends are treated in a similar manner, but by using a cross guide, set at right angles, as in Fig 6. The wheel should be perfectly true, or the edges ground will be ribbed, necessitating much more lapping afterwards.

It is hardly ever necessary to grind on the flat, as ebonite sheets of the required

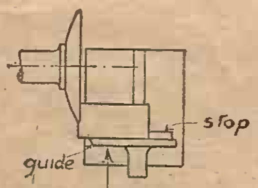


Fig. 6.—Grinding End of Piece of Ebonite.

thickness are usually procurable, but if so the dish-shaped wheel may be mounted in the chuck of an end-milling machine, or profile, and the parts held in the vice. A rather coarse wheel should be used for this work, as a fine one soon gets clogged. The speed should be fairly high, as for tool grinding.

Lapping.

Flat surfaces may be lapped on either an ordinary circular lap or a finisher, in a similar manner to brass. Sometimes lapping is used as a finish, in which case a straight "grain," such as obtained with the finisher or roll-type lap, is desirable, the surface being oiled. All surfaces that have been ground, as just described, have to be lapped (as in Fig. 7) before finishing.

Burning.

A useful process which is applied specially to making square holes in ebonite is burning. An iron or steel drift of the required size is made, with a blunt point. This is fitted to the tail stock of a small lathe, as shown in Fig. 8, and a suitable stove rigged up for heating it. A bunsen burner enclosed in a tin box will do for this. The parts to be drifted out have previously been drilled out to the

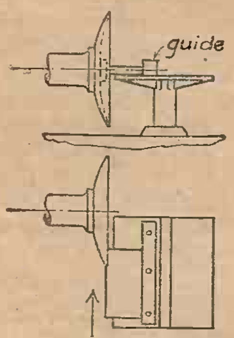


Fig. 5.—Grinding Side of Piece of Ebonite.

same size as the square to be cut, and are placed against a flat plate with a hole in the centre fixed in the chuck of the lathe, while the tailstock head is pushed up so that the drift enters the hole and burns its way through, as shown in the figure. Too great a force is liable to split the work, but the process should not be unduly prolonged, otherwise the hole will be made too large. The best temperature for the drift is found by experiment.

The only disadvantage of this process and that of grinding is that they both make a horrible smell (burning sulphur and burning india-rubber being combined), which to those unused to it is unbearable. The writer practically lived in such an atmosphere for many months at one time, and almost began to like it, but to most people it is highly offensive. The best plan is to work near a window when grinding or burning ebonite, and arrange an electric fan to carry out the dust and fumes.

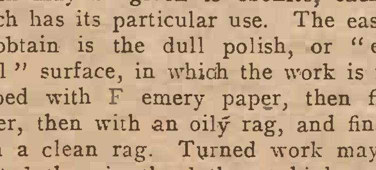


Fig. 8.—Drifting a Square Hole.

Finishing.

There are several kinds of finishes which may be given to ebonite, each of which has its particular use. The easiest to obtain is the dull polish, or "egg-shell" surface, in which the work is first rubbed with F emery paper, then flour paper, then with an oily rag, and finally with a clean rag. Turned work may be treated thus in the lathe at high speed, while flat surfaces are best rubbed with a rotary motion on emery paper on a surface plate. For the edges of panels, etc., the most convenient method is to place a sheet of emery on a surface plate, and on top of this a block with a straight-edge, against which the work is held, the edge of the latter being rubbed to and fro on the emery; a straight "grain" is produced by this method.

To produce a high polish bath brick and water is used, on a lap made of thin felt for flat surfaces, or in the lathe for turned work. A high speed is maintained, and the work should never be allowed to become dry. This gives a polish sufficient for most purposes, but, if desired, a still higher finish may be obtained with rottenstone and water. The best way of applying the abrasives is to keep them in a flannel bag (which effectually sifts them) and dust them on to the surface of the work. This bright finish is the best and

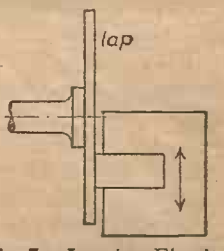


Fig. 7.—Lapping Ebonite.

most lasting surface, and looks well for all panels, knobs, pillars and scales which are exposed to view.

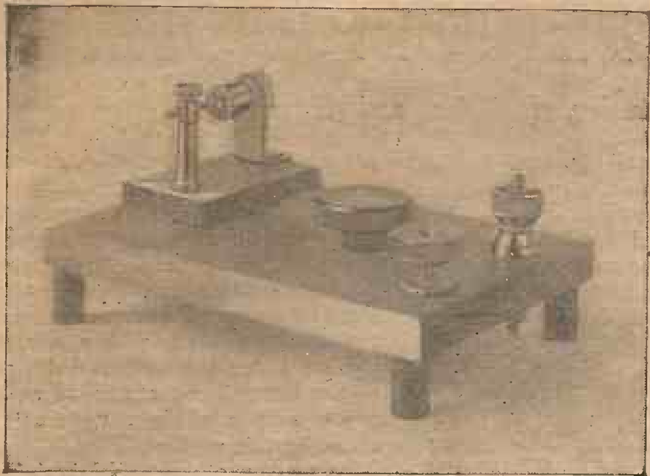
Another method sometimes employed to give a finish to ebonite is to lacquer the surface, a process which is not to be recommended except for small or intricate parts which are difficult to polish.

Engraving.

The amateur cannot hope to produce the beautifully regular lettering seen on ebonite instruments, for this is accomplished by engraving the letters with a pantographic machine, and afterwards filling them with white or coloured paste. The nearest approach to this to be obtained without a machine is arrived at by painting the letters in white enamel with a fine brush, but this process is extremely laborious and seldom gives good results.

M. S. S.

Every Reader of "A.W." should have at hand for reference a copy of the "Work" Handbook, "Wireless Telegraphy and Telephony: and How to Make the Apparatus," 1s. 6d. net.



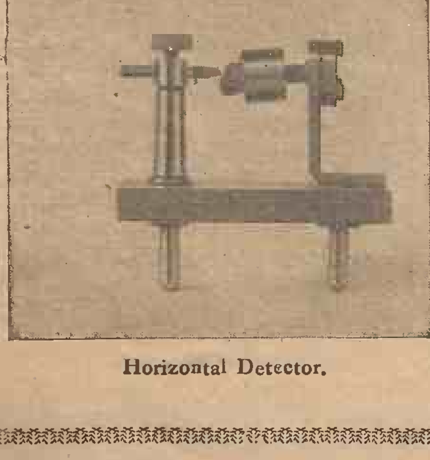
Photograph of Complete Detector and Potentiometer.

SOMETHING NEW CRYSTAL DETECT

IN spite of the fact that valves are becoming widely used by amateurs, crystal detectors still have their uses, especially in small sets where low cost is the first consideration. One of the objections to crystal detectors is the fact that when it is desired to change the crystals or experiment with new combinations quite a considerable time is lost in getting the new crystals in position. With the instrument described in this article the time lost in changing is reduced to a minimum, while the appearance, if carefully made, will enhance the value of the most expensive set. With regard to the cost of material, the only item worth mentioning is the ebonite for the base; ebonite is getting cheaper, however, so that the cost of the whole instrument should not exceed 7s. 6d.

The instrument consists of a main ebonite base, carrying an adjustable resistance and a pair of plug sockets. The crystal combinations are mounted on small subsidiary bases fitted with special plugs which fit into the sockets on the main base.

Figs. 1 and 2 show the general design of the main base, Fig. 3 being one of small detector stands fitted with the plug connectors. The reference letters refer to the same part in each case.



Horizontal Detector.

Commencing with the base B, in the case of the writer's instrument it measures 5 in. long by 3⅜ in. wide by ½ in. thick. This should be carefully cut to size, and if the reader has access to a milling machine the appearance of the base can be much improved by having all the sides and angles of the corners milled dead true. Failing this, the sides should be filed true, a set square being used to get the job as accurate as possible. The surface of the ebonite should be finished off as described in the latter part of this article and the position marked (on the under side) for the holes to take the terminals T, the potentiometer knob K, and the plug sockets PS.

It might be as well here to remind the reader that the appearance of the nicest piece of apparatus may easily be spoiled by having a terminal on a knob mounted out of truth. Many amateur mechanics use their eyes too much in this respect; the result of guesswork is seldom satisfactory. A pair of engineer's dividers are the things required for accurately marking the holes for drilling, and a little care exercised will materially add to the appearance of the finished instrument.

The terminals T fitted at one end of the main base B in Figs. 1 and 2 are a standard pattern, and may be purchased from advertisers of electrical sundries ready polished and lacquered. The writer has improved his by drilling a hole in the screw portion and fitting a small ring made of german silver wire as shown in the sketch. This prevents the terminal nut from being screwed right off, although allowing it sufficient play to clamp the connecting wires, etc.

The plug sockets PS which carry the crystal sets are mounted on the opposite end of the base, the dotted lines in Fig. 1 indicating the space occupied by the small ebonite blocks carrying the various crystals. Small plug sockets of a suitable pattern, together with a supply of the necessary plugs for the crystal sets may be purchased from large dealers in electrical and telephone supplies, the usual finish being a dull nickel. This can be removed from the flange of the plug socket, however, by polishing with fine emery cloth while the socket is revolved in the lathe. It may then be lacquered to make it in keeping with the finish of the terminals T.

A nut on the under side of the base keeps the plug socket in position, a few threads being left to enable the connections to be soldered thereto. On the question of soldering care should be taken to see that all joints are soldered quickly and properly the first time, so that no undue heat reaches the ebonite.

Four small ebonite feet are required, and these should be turned up on the lathe and drilled and countersunk to take small screws which secure the feet to the base B. If they are made ¾ in. long by ½ in. diameter they will raise the base sufficiently to enable the fittings on the under side to clear the table by ⅛ in.

The potentiometer (Fig. 4), consisting of the resistance R, the contact finger C, and the knob K, should now be constructed, its purpose being to vary the potential or voltage across the crystal. The knob K is turned up from ebonite and polished with

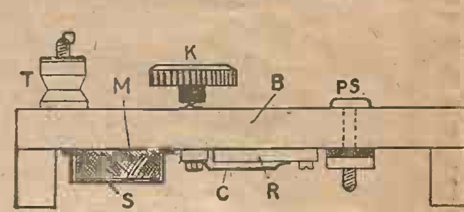


Fig. 1

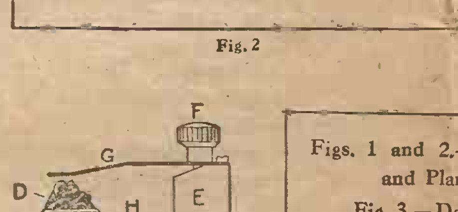


Fig. 2

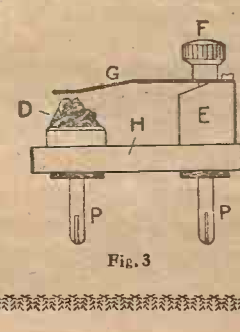
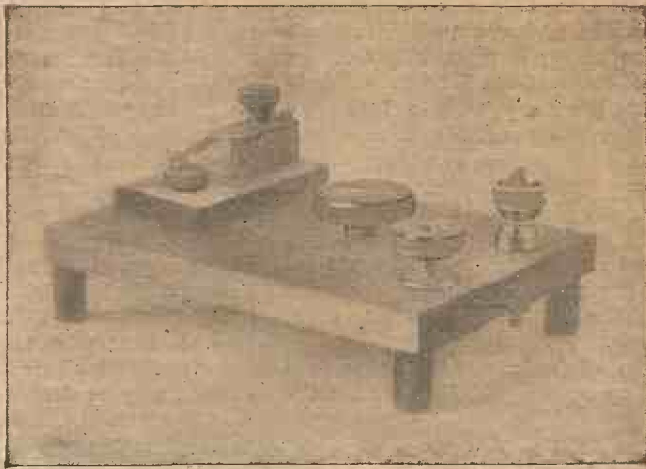


Fig. 3

Figs. 1 and 2.—
and Plan
Fig. 3.—De
Fig. 4.—Po
Fig. 5.—Mo
Fig. 6.—Diagram

… IN … ORS

Making a Novel Instrument with Quickly-removable Crystals



Another Photograph showing Different Detector in Place.

turps and fine emery cloth while in the lathe. If desired, the knob may be purchased ready-made quite cheaply.

The complete moving contact is shown in Fig. 5, the plate RP serving as a terminal for connecting up in addition to providing a smooth surface for the contact C to move on. Before the movable portion of the potentiometer is fitted to the base a spring washer should be slipped on directly under the knob K, as shown in Fig. 1; this has the effect of making the contact more firm over the resistance and remaining in place after the adjustment has been made. The contact C should be made of phosphor-bronze strip if this is obtainable, as it retains its springiness for a considerable time and thus provides a good contact with the resistance.

The resistance R is built on a strip of ebonite measuring 3 in. long by 1⅛ in. wide by $\frac{3}{16}$ in. thick. Four holes are drilled in the extreme corners to provide means of fixing to the base B. The resistance consists of No. 36 S.W.G. enamel-covered resistance wire, wound closely on the ebonite former, the ends of the wire being secured by slipping them through holes in the ebonite and pressing two small metal strips, bent up to form clips, over to further secure them. The whole coil should then be soaked in shellac varnish in order to keep the turns of wire firmly in position. The insulation must now be carefully removed where the contact C is to touch the turns of wire; this can best be done with a small piece of emery-paper or by gently scraping with a penknife, great care being taken to ensure that no turn of the resistance coil is damaged or broken during the operation. It will, of course, be understood that it is only necessary to remove the insulation from the wire where the contact C is arranged to pass over. The potentiometer battery is mounted on the under side of the base B, as shown in Fig. 1, M being the battery and S the strap which holds it in position. As the current required is exceedingly small, a battery such as is used in the very small type pocket lamps will be quite suitable.

In order to avoid the complication of a switch to control the battery and prevent it running down through the resistance R, a small clip should be made to clamp on one of the battery contact strips and to easily be recoverable when it is required to break the circuit. The next point for consideration is the question of crystal combinations. As explained in the commencement of this article, the idea is to provide a means of rapidly changing from one combination to another. The combinations may consist of zincite-bornite, carborundum-steel plate, galena-graphite, etc., all mounted on small blocks as shown in Fig. 2, fitted with plugs P for the purpose of rapidly connecting the crystals to the main base B.

The crystal set shown in Fig. 3 is a carborundum crystal D set in a cup in direct contact with one of the plugs P, screwed through the ebonite base H. The other plug has an extra long thread on the upper portion which passes through the small ebonite block E and the steel plate G into the adjusting knob F. It will be noticed that the ebonite block E is filed off at an angle under the plate G, and it will be obvious that any pressure applied by screwing the knob F down will cause the plate G to press on the crystal, the amount of pressure being instantly variable. The adjusting knob F is of polished ebonite, and the plate G is a piece of clock spring softened at one end for drilling, and polished with fine emery paper.

Various other crystal sets should be made up, the crystals being mounted in small brass cups and provided with means of adjustment. The point requiring most care will, of course, be the position of the plugs in the base H. Unless these are all exactly the same distance apart it will be impossible to make them fit nicely into the sockets on the main base B. The most effective plan is to make a small metal template with two holes, the correct distance apart, accurately drilled in it. The small bases carrying the crystals should all be made the same size, and the template be used to guide the drill for making plug holes.

It is a good plan also to make up a small cabinet of polished wood to hold the various crystal sets and keep them free from dust and damage. The bottom of the

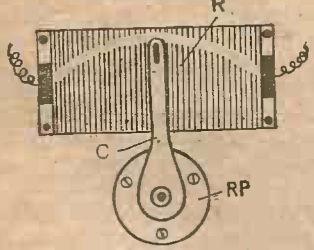


Fig. 4

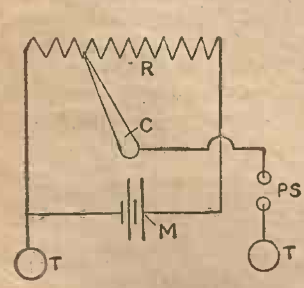


Fig. 6

—Side Elevation
n of Base.
etector Unit.
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m of Connections.

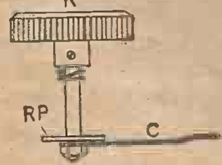
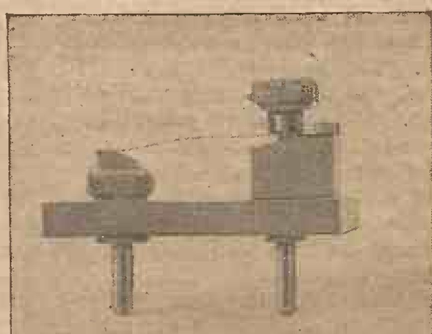


Fig. 5



Vertical Detector.

cabinet should have a block with a number of pairs of holes drilled in it to take the plugs P. The diagram of connections is shown in Fig. 6, where it will be noticed that all the wiring is practically confined within the limits of the base B, the only connections necessary outside being by means of the two terminals T, thus considerably simplifying the connecting-up to the other apparatus.

It is a good plan to solder all connections where possible; the work is then permanent and more satisfactory in every respect. A few notes on finishing the main base B and the smaller bases H may be of use to many.

The sides of the base, after being filed or milled up square, should have all file marks removed by drawing the file along the surface, the file being held at right angles to the direction of movement. A piece of F F emery cloth, wrapped round an old file, or a piece of smooth wood, should now be used to produce a grain on the ebonite. It is most important that the emery cloth should be continually moistened with turps, otherwise the heat generated will draw the sulphur in the ebonite and cause a pitted surface to appear.

The finishing should be done with very fine emery cloth. The top of the base may either be left as originally purchased, with a highly polished surface or a matt surface obtained with turps and fine emery paper. Another finish, having a matt surface, may be obtained by laying a sheet of fine emery cloth on a small flat surface, wetting it with turps and rubbing the base round and round, constantly changing the direction.

The final finish is given by means of a polishing cloth and a little tallow, care being taken to ensure that no metal dust has been picked up by the polishing cloth off the bench.

The knobs K and F should be polished while still in the lathe, practically the same process being used, with the exception, of course, of the fact that they will be revolving at a high speed in the lathe. Excessive heat must be guarded against by using plenty of turps all the time, and not allowing the work to revolve at too great a speed. A. W. HULBERT.

"AT THE CALL OF GNF"

HOW time flies! On a rainy and altogether miserable night in March, 1920, when behind a pipe of favourite baccy we had become reminiscent, my friend, with sudden inspiration, said, "Let's build a wireless receiving station." Just one of those happy spontaneous ideas to make one feel eternally grateful. We were enthusiasts from that moment, being in an excellent position to put the idea into effect. But a few months before we were Service operators, my friend in the R.A.F. and I in the Signal Service. The ensuing days, pending official sanction to erect the station, produced many an interesting hour while we pegged away at a design for the receiver.

We decided to use a circuit employing a crystal rectifier, the possibilities of which, with efficient handling, we considered excellent. On an auspicious night the official permit arrived and our real operations commenced. The aerial was our first consideration, and on the Sunday morning we allotted to the erection of the mast, stays and aerial, much interest, and probably a good deal of speculation was aroused in our neighbours.

We were very modest with our aerial, erecting a single wire 60 ft. long, plus insulators. The house end was attached to the roof, and the other to a mast only 18 ft. high. The mast was a present from an interested friend. In those days, before the advent of multi-valve amplifiers, rendering the use of outdoor aerials optional, a high aerial was a great objective, but never a complaint have we lodged against our diminutive antenna.

Came the great day to "listen in," and in passing I will remark that our station was in part purchased from a manufacturer and in part made up at home, a method which saved us quite a considerable outlay, wireless gear in 1920 being at a prohibitive price.

We surveyed the set with much satisfaction. Indulging in a little self-praise, we commended ourselves on the neatness of the arrangements, but—would it give signals? Theoretically, yes; but might there be some minor detail hidden from our eyes which would cause negative results? Aerial and earth leads connected and head 'phones on, we sat down, half expectant, half doubtful. I moved the slider of the tuning inductance over a wide wave-length range, but not the faintest buzz of a Morse signal, not even a crackling atmospheric gladdened our ears. Readjustment of the crystal detector to a point of good sensitivity with the aid of our buzzer brought no results. Fifteen minutes passed and the ether remained silent, as silent as we ourselves were.

We overhauled the set, suspecting a faulty connection. The result was an O.K. report. We donned the 'phones again, hardly with optimism. A minute or two elapsed while we were jumping to anything that (in our imagination) resembled a signal. Suddenly—and it is impossible to describe the feeling of elation and success—deep-noted signals became clearly audible. A handshake, a mutual word of congratulation, and we read the call sign of the station transmitting GNF, GNF, GNF. A hasty reference to the call letters list gave it as the North Foreland station. With the advent of one, other stations, both ship and shore, graced our aerial with their signals, till in the evening we culminated our success with the reception of the famous Paris station FL and the great Marconi station at Poldhu.

Since that memorable occasion we have made GNF our pet station in deference to our initial success, but, like other things wireless, GNF has changed with the passing months. The old deep spark note has given way to a sharper, more musical one; it provides excellent practice for Morse code enthusiasts when transmitting navigation warnings. Likewise our original simple set has given way to something more pretentious, but with many of the old parts embodied in the new.

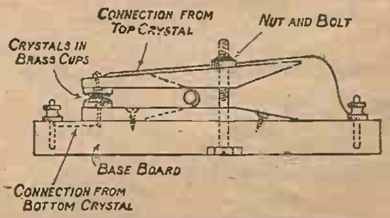
Added zest was given to our experiments when we succeeded in hearing a faint voice emanating from Croydon aerodrome, the only wireless telphony we heard for many months. What a comparison with to-day, when any evening provides its quota of interesting telephony transmissions! Now London is to have its own "broadcasting" station.

But in spite of all that is new and welcome, a memory of a great day in 1920 will be rekindled at the call of GNF.

SPARKKS.

A Detector that Costs a Shilling

A READER sends a sketch of a novel detector made from a domestic clothes-peg. He avers, from practical experience,



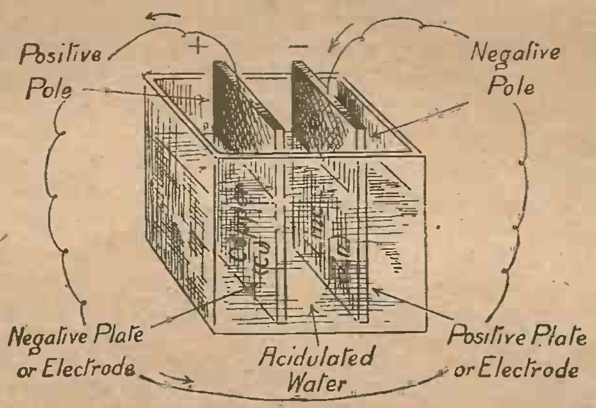
Detector made from Clothes-peg.

that it works exceedingly well. The drawing reproduced is sufficiently explanatory not to require further description.

The Economic Electric Co., of 10, Fitzroy Square, London, W.1, sends us an excellent catalogue of wireless supplies.

The Primary Battery and Current Flow

THE commonly understood meaning of the word battery in connection with electrical apparatus is that it is an arrangement for producing electricity by chemical means. There is another word, however, used in the same connection, and the indiscriminate use of either is apt to lead to confusion in the minds of some people. This word is cell, and, obviously, when a single unit is referred to it is the more correct, for actually the term "battery" implies two or more cells connected together. However, now it frequently means nothing more than a single cell. The primary battery or cell is the most easily available source of electricity, and in its simplest form it consists of a sheet of zinc and a sheet of copper placed a little distance apart in a vessel containing dilute acid, as here illustrated. When the two plates are connected by an external wire a current of electricity will flow along the wire.



A Simple Primary Battery.

The copper plate is termed the negative electrode and the zinc plate the positive electrode, and in theory the current always flows from the copper to the zinc outside the cell, and from the zinc to the copper inside, thus completing the circuit as shown. The parts of the plates outside the liquid are referred to in the reverse sense to what the immersed portions are, for the copper or negative plate is spoken of as having the positive pole or terminal, and is always indicated by the positive (+) sign, whilst the zinc plate provides the negative (−) terminal.

There are hundreds of different types of primary batteries and many different electrodes are used, but the same principle holds throughout.

When a cell has been working for some time, the "couple," the as the two different metallic plates are known, is no longer what it was at starting. The zinc and copper have become changed, more or less, to zinc and hydrogen, with the result that the difference of potential (otherwise the pressure of the current) drops by about 25 per cent. In addition, the presence of the hydrogen increases the resistance to the passage of the current, and the yield of energy is stll further reduced. This deterioration of the cell is known as "polarisation," and in the many attempts made to eliminate or, at least, minimise it have been produced most of the great variety of primary batteries known to-day.

There are certain elementary matters regarding the flow of the electric current that have a distinct bearing on the use of any type of battery or other source of electric current. Although not accurate in the light of present-day knowledge, it is convenient to assume that electricity flows in a metallic conductor somewhat in the sense that water flows through a pipe.

An electrical conductor is any substance that offers but a slight resistance to the passage of an electric current. There is no perfect conductor—that is, there is no substance that is entirely without resistance. In general, good conductors of heat are also good conductors of electricity. The conductivity of a substance is its capability of conducting an electric current.

An insulator is any substance that offers much resistance to the passage of an electric current. Theoretically there is no substance that is a perfect insulator—that is, there is none that offers so great a resistance as to obstruct entirely the passage of a current of electricity.

The amount of current that flows through a conductor is measured in amperes; the pressure, difference of potential, or electro-motive force (E.M.F.) is measured in volts; and the resistance which it has to overcome is measured in ohms. Thus, the ampere is the (practical) unit of quantity; the volt, of pressure or E.M.F.; and the ohm, of resistance. Any one of these three can be determined when the two others are known by a simple rule known as Ohm's Law, which is not in the least formidable and may be expressed in the following way:

Amperes = volts divided by ohms.

Current = E.M.F. ÷ *resistance.* It follows from this, that

Volts = amperes multiplied by ohms.

Ohms = volts divided by amperes.

A simple method of committing this important rule to memory is to let the letter E represent volts (E.M.F.); C, amperes (current); and R, ohms (resistance). Then memorise the following simple expression:

$$\frac{E}{C \times R}$$

(E divided by C R multiplied together). If any two of the above factors are known, the third is obtained by simple division or multiplication; cross out the required factor, and the remainder of the expression indicates the quantity.

VOL.

WHAT WIRELESS TERMS MEAN.—III

Some Technical Words Explained as Correctly as Popular Language Allows

MICA.—A common insulator used in the making of small condensers. It is a mineral substance, semi-transparent, and is obtainable in sheets which can be split up into a number of thinner sheets. It is placed between the plates of the condenser in order to insulate them from one another.

SLAB COILS.—A closely wound, circular coil of very fine wire, having a high self-capacity, and therefore of considerable utility on long wave-lengths. These coils are not efficient on short wave-lengths on account of self-capacity.

POLARITY. — Electricity is said to "flow," and that flow is said to take place from one pole through the circuit and back to the other pole.

JIGGER.—A term seldom used now. An arrangement of coils taking electricity in at one end and passing it out at the other at a different pressure. So called because it "jigs" up the current.

AERIAL (*or* ANTENNA).—A system of wires (usually elevated in the open air) used for the radiation or reception of wireless waves. There are various types of aerials. With modern high-power valve receivers the aerial frequently consists of a few turns of wire wound on a frame. Trees have been successfullv used as aerials.

INSULATOR.—A term applied to all materials which prevent the passage of electric currents. Ebonite, porcelain, distilled water, air, rubber, glass and similar substances are insulators. Electric wires covered with rubber or tape are said to be "insulated" There is no such thing as an insulator of magnetism

Making Telephone Receivers Super-sensitive

IT will have occurred to many who have dismantled a pair of receivers and studied the action that the nearer the diaphragm is to the magnets without actually touching, the more sensitve the receivers will be.

This is correct up to a certain point; at the same time, there is a certain critical position where the instrument works most satisfactorily under all average conditions. It may be mentioned here that the following remarks refer to telephones of the ordinary pattern, not to the adjustable patterns.

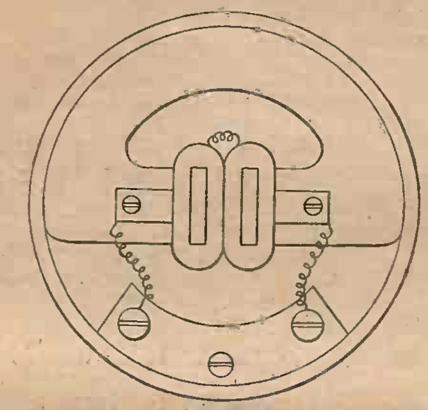
The thickness of the diaphragm is a most important point, and one upon which the whole success of the instrument depends. If the receivers have been specially made for wireless work they will be fitted with diaphragms of much thinner sheet than those in ordinary commercial telephones, which are designed to work with a comparatively large current.

The diaphragms of wireless 'phones vary slightly in thickness from No. 31 Brown and Sharpe gauge, which is .010 in., to No. 35 B.S., which is .005 in. If the reader has rewound his own 'phones (a somewhat troublesome operation), he would do well to fit diaphragms of the gauge mentioned above in order to reduce the effort required to set the diaphragm in vibration. It might be as well here to explain the action of the wireless 'phone before proceeding further. If the earpiece is unscrewed and the diaphragm lifted off it will be found that the permanent magnets endeavour to hold it tightly in place. It will also be noticed that the extensions on the poles of the magnets form a cone on which the fine windings are wound. Now, when no current is passing the permanent magnets will tend to draw the diaphragm towards them, so that, were it possible to look at it sideways through a magnifying glass, it would appear to sag towards the centre.

When a current flows round the coils, according to the direction, so will it either assist or neutralise the effect of the permanent magnets, so that the diaphragm will either sag more or fly back to its normal position. The effect of the current being intermittent will cause the diaphragm to vibrate at a certain period, the sound emitted being given out through the earpiece either in the form of speech or spark signals.

Now, the strength of these sounds will depend entirely on what force is used to attract the diaphragm. As magnetic attraction falls off quickly when acting through a space, however small, it will be seen that it is an advantage to keep the distance between the diaphragm and the poles of the magnets as small as possible.

The writer experimented with several methods of adjusting telephones in this way, and the most successful is described here. A sheet of glass, some 2 ft. square, was obtained, and a piece of FF emery-paper stuck on with seccotine. The 'phones are now connected up to a set for test and the earpieces and diaphragm removed. One of the receivers is now held in the hand and rubbed, with a circular motion on the emery surface, on the edges carrying the diaphragm. This process will naturally reduce the height of the case by a small amount, thus bringing the diaphragm a shade nearer to the magnet poles. The receivers should be replaced on the ears and tested frequently, only one receiver being connected up at one time. This process should be repeated in turn with the other receiver until it is considered that they are as sensitive as it is possible to make them. Should it happen that one of the diaphragms is found to be too near the magnets the distance may be increased again by taking a small amount off the tips of the pole-pieces with a file.



Internal Diagram of Ordinary Telephone Receiver.

With a little practice it will be possible to get both receivers extremely sensitive, so sensitive, in fact, that they must never be directly connected across a battery, otherwise there is a chance of buckling the diaphragm.

One method of testing 'phones is to get a sixpence and a penny, lay them on a sheet of glass and put a drop of water between them, touching the edges of both coins. If the flexible leads from the 'phones are placed on the coins a distinct click will be heard, the two dissimilar metals and the water acting as a battery.

It might be as well to mention here that the above remarks regarding the thickness of the diaphragms only applies to high-resistance 'phones; in cases where low-resistance 'phones are used in conjunction with a telephone transformer a diaphragm of thicker metal can be used, as the instrument is then more or less current-operated. H.

A BRIEF HISTORICAL NOTE

JUST eighty years ago (in 1842) the first wireless message was sent. Morse was able to signal without any connecting wire from one side of a river to the other, but this was not wireless as we know it to-day. He used the water as a conductor for the current. The same idea served other experimenters. Still others used the induction method, and strung up a mile of wire on one side of a stream so that current flowing through it would induce a current in a similar range of wire on the opposite side of the stream. Scores of experimenters contributed to the problem of electrical communication between places not metallically connected, and among them: Clerk Maxwell, Hughes, Hertz, Lodge, Fleming and Branly, are great names.

In 1895 Marconi, the greatest of them all, experimented in Italy on the Hertzian-wave principle, his object being to transmit wireless signals by means of electric oscillations of high frequency. He was encouraged to come to London, where, in the following year, he lodged what is generally regarded as the first British patent for wireless telegraphy.

By 1900 so great had been Marconi's success that the use of wireless telegraphy was becoming general. In that year Marconi took out the most important of his early patents, No. 7,777 of 1900, the Poldhu high-power station was begun, and wireless messages had been sent by this time over distances as great as eighty-five miles. Two years later Marconi introduced his moving-wire magnetic detector, which was a very great improvement over the coherer as used by Branly and other experimenters; on board the *Philadelphia* the great Italian inventor received signals from Poldhu, 2,099 statute miles away. Since that date the development has been amazing, particularly since 1914, when the military needs of so many nations gave wireless telegraphy a fillip.

Last year messages were sent from Carnarvon to Australia, a distance of 12,000 miles, and a sensational achievement of amateur wireless was to transmit messages from the United States and to receive them in Great Britain and in Holland.

One of the greatest factors in modern wireless has been the use of the thermionic valve invented by Dr. Fleming in 1904.

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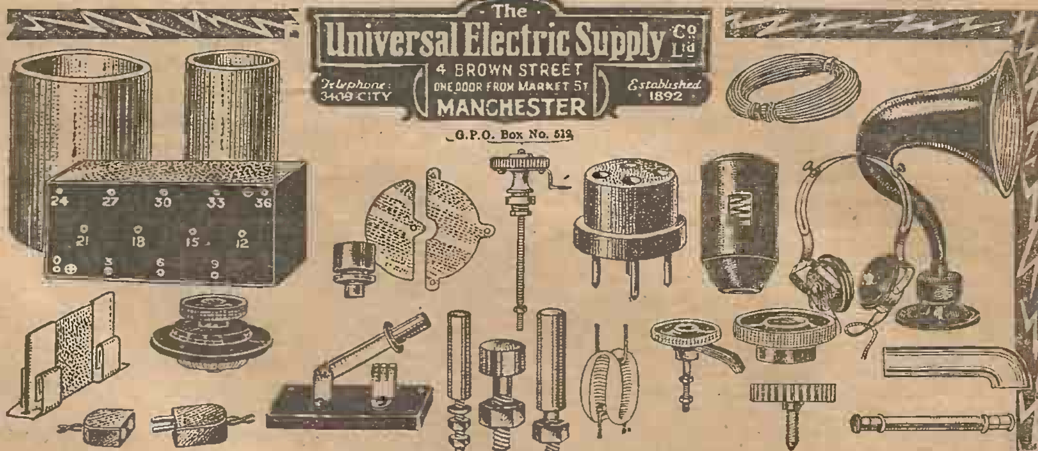

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Failure to Obtain Signals

Q.—I should be glad of advice concerning my wireless receiving apparatus, from which I am unable to obtain a signal.—A. D. (90)

A.—The following items should be carefully attended to. (1) Dismantle apparatus and carefully inspect for (*a*) corrosion due to being stored in a damp place; (*b*) broken leads or other disconnections; (*c*) bad connections of wires at terminals or contact studs, and (*d*) faulty insulation. (2) Reassemble set and test by means of a buzzer in series with a cell, for (*a*) continuity of windings; (*b*) switches or sliders making good contact at all points; (*c*) short-circuits in condensers; and (*d*) general insulation between various points and circuits. For the last-named item, the 220-volt. house supply and an 8-candle-power lamp are most useful, care being taken always to have the lamp in series with the supply and one of the testing leads. The aerial described by querist should give quite good results, especially on the shorter wave-lengths, but the aerial lead mentioned should be removed from close proximity to the wall. Presumably the 6-ft. galvanised earth plate is buried in a damp situation. A direct connection to a water-main or house-supply pipe would improve matters. If this latter is unobtainable, bury another similar plate at some distance from the first one and measure the resistance between the two through the earth (so as to indicate if the resistance is high) by means of a 4-volt. accumulator and a small lamp.—Capacity.

Interference

Q.—How can one be sure of not causing interference with other stations?—F. E. M. (95)

A.—There is, of course, no possibility of interference being caused by a receiving station which employs either a crystal detector alone, a crystal detector with additional amplifiers, or even with a valve detector, provided the receiving set is not made self-heterodyning by introduction of a reactance coupling between the anode and grid circuits of the valve. Reception of continuous waves is carried on by the interference-beats set up between two independent oscillatory currents. That is to say, the received waves set up oscillations in the receiving aerial and aerial circuit, which oscillations are, as it were, superimposed on other oscillations generated in the set itself. So that when the receiving set is "oscillating," as it is called, the aerial is actually radiating C.W. at the particular wave-length to which the aerial circuit is tuned. If when this is the case the tuning switches, etc., be moved so as to vary the wave-length of the aerial circuit possibly over wide limits, the emitted wave varies accordingly. A second receiving station, especially if near by, would, if the receiver were also "oscillating," receive the transmission from the first station; also, when this occurred, the first station would hear the beat note due to the radiation from the second. At each station the sound would be similar to, though probably not so strong as, a distant transmitting station "tuning up." Therefore, if such a note is heard when varying receiving adjustments, listen carefully and refrain from further adjustments for a time. If the note varies up and down, the other station, now identified as a near-by receiver, is endeavouring to tune querist's C.W. either in or out, and this particular adjustment had better be abandoned for a time. On no account chase the note up and down the scale, a most annoying performance indeed to the operator to whom interference is being caused.—Capacity.

SHORT ANSWERS

J. F. J. (Wavetree).—(1) The apparatus described in the Handbook "Wireless Telegraphy and Telephony" represents the latest practice, and, moreover, it has all been constructed and used, and you could be quite sure in making any of it that it would work. (2) Outside aerials are always advisable whenever possible, though with such a set as you contemplate you would still get good results with an indoor or even a frame aerial. The roof has a screening effect. A few feet will not make any appreciable difference.

E. C. (Dublin).—An advertisement in this journal would no doubt secure you a purchaser for the wireless books, etc.

F. C. L. (Balham).—We are obliged for your suggestion, though we regret that we cannot adopt it at present.

L. H. (St. Albans).—An article on the construction of a single-valve receiving set will appear in an early issue.

W. J. M. (Co. Down).—In succeeding issues you will find that all the information you require and as outlined in your letter will be given.

A. G. E. (Shepherd's Bush).—An article on rewinding ordinary watch-type receivers will appear in an early issue. The usual resistance is 2,000 ohms each; we do not consider that the construction of 8,000-ohm receivers is within the capabilities of an amateur.

Receiver (Earl's Court).—An article on rewinding receivers will appear in an early issue.

RADIOGRAMS

An American bootblack has installed a wireless receiver, together with a large sound magnifier, on his stand. Customers are entertained with concerts and news.

■ ■ ■ ■ ■

In order to eliminate head resistance and produce a clearer and more constant tone for transmission from aeroplanes, a generator driven by a single-blade propeller has been tested. This generator is carried on a special mounting on the side of the fuselage, and preliminary trials indicate that better results may be had with this type.

■ ■ ■ ■ ■

A musical programme has recently been heard about 2,800 miles from the sending station.

■ ■ ■ ■ ■

Anent the supposition that fairy stories will be broadcasted at the children's bed-time someone asks: "Who is going to answer all those questions which make the telling of a fairy story such an exercise in patience and ingenuity?"

■ ■ ■ ■ ■

Marriage by wireless is the latest "stunt" in the American radio world.

■ ■ ■ ■ ■

In the States it is possible to hear a church service on a Sunday—the sermon, the congregational singing and the organ. One can almost hear the money rattling on the collection plate.

■ ■ ■ ■ ■

More "freak" receiving sets are announced, the latest being contained in a coconut-shell.

Experiments with the employment of wireless telephony between moving trains and between a moving train and a fixed point are being carried out in many countries. One method is to fix antennæ on to a coach, and also between two telegraph poles by the side of the line.

■ ■ ■ ■ ■

For those who desire to practise the Morse code, gramophone records are available which dictate the code, the abbreviated figures and punctuation signs.

■ ■ ■ ■ ■

It is, of course, well known that until recently wireless conditions in the States were very chaotic. As an example, a sermon which was being broadcasted from a church to some smaller missions was deliberately jammed by an atheist.

■ ■ ■ ■ ■

A reduction in the rate for deferred wireless messages viâ Marconi, from Great Britain and Ireland to the Eastern zone of Canada, from 4½d. to 4d. per word, is announced. At an early date the reduction will also apply to messages handed in at post-office counters.

■ ■ ■ ■ ■

According to a recent statement of the Postmaster-General, there is no reason why a beginning with broadcasting should not be made this summer.

■ ■ ■ ■ ■

It is possible in Leeds to-day to sit in the barber's chair, and while having a hair-cut or shave to listen to the scattered wireless messages of England and the Continent "caught" on the red and white pole poised outside the shop.

(*Continued on page* 58)

(*Continued from page 56*)

A conference of linguistic experts from the various universities in the United States has been summoned to consider the advisability and practicability of establishing a universal language for the purpose of international communication by wireless.

■ ■ ■ ■ ■

Already in the back gardens of the London suburbs one may see aerials of all kinds.

CORRESPONDENCE

Who Will Recompense the Broadcasters?

SIR,—Having become very keen on wireless matters, I fail to see who is to pay for the broadcasting. I note in your first number you mention that the firms broadcasting will be recompensed by the amount of apparatus sold. This does not seem to me to be an ideal arrangement. What about all the small firms making fittings and the amateurs who make their own sets? Unless we get a huge combine (which does not seem possible) it will fall to the lot of the large firms to find thousands of pounds every year, which expense will have to be added to the selling prices of sets and fittings, while the firms not sharing this cost will be able to sell at a cheaper rate. Would it be possible to add a fixed amount to the cost of the licence—say 5s. or whatever is necessary—which amount to be paid over by the G.P.O. to the firms broadcasting, the firms on their side to guarantee a certain amount of news, etc., weekly at fixed hours?—F. W.

London, S.W.

FORTHCOMING EVENTS

West London Wireless and Experimental Association. June 22. Demonstration by Mr. F. D. Reed of the "Ultra IV" Receiver.

Liverpool Wireless Society. June 22, 8 p.m. General exhibition and discussion on home-made wireless apparatus.

Wireless Society of Highgate. At the Highgate Literary and Scientific Institution, June 23, 7.45 p.m. Lecture and demonstration by Mr. F. L. Hogg: "The Construction of a Valve Receiving Set." June 24, Field Day, outing to Ken Wood. 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."

Leeds and District Amateur Wireless Society. June 23, 8 p.m. Discussion on Direction Finding.

North Middlesex Wireless Club. At Shaftesbury Hall, Bowes Park, June 28, 7.30 p.m. Elementary lecture for beginners. 8.30 p.m. Lecture by Mr. W. Gartland: "The Miscellaneous Applications of the Thermionic Valve."

Lowestoft and District Wireless Society. The society proposes to hold an exhibition of wireless and other gear on August 3 and 4 of this year. Hon. Secretary, L. W. Burcham, Gouzeaucourt, Chestnut Avenue, Oulton Broad.

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

CLUB DOINGS

Brighton Radio Society

Hon. Sec.—MR. D. F. UNDERWOOD, 68, Southdown Avenue, Brighton.

AT a meeting of this Society recently held at the residence of Mr. Magnus Volk, vice-President, a most interesting and instructive paper was read by Mr. Norman R. Phelp, entitled "Inductance and Methods of Tuning," during the course of which the lecturer lucidly explained the various methods adopted to receive short-wave telephony, etc.

Many useful diagrams were given on the blackboard for the benefit of members.

North Middlesex Wireless Club

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

THE 93rd meeting of the Club was held on Wednesday, June 14th, at Shaftesbury Hall, Bowes Park, N., the chair being taken by the President, Mr. A. G. Arthur. The Secretary announced that it had been arranged to hold elementary classes for beginners, commencing at 7.30 on ordinary meeting nights, for one hour. Mr. L. C. Holton read a paper on "The Townsend Wavemeter and How to Use It." He explained how waves were produced in water, and compared these with those produced in the ether in wireless work. He made clear the fact that wave-length is independent of range of transmission. He also explained the meaning of the terms frequency and amplitude. The lecturer explained that the wavemeter was used in a number of ways, but one of its chief uses was to measure the incoming waves at a receiving station. He gave a demonstration of this, and explained how to use the charts supplied with the meter.

The Wireless Society of Dorsetshire

Hon. Sec.—E. T. CHAPMAN, "Abbotsford," Serpentine Road, Poole, Dorset.

AN interesting side show of the Royal Victoria and West Hants Hospital Pageant and Bazaar, held at the Winter Gardens, Bournemouth, on May 30th and 31st, was the demonstration of wireless telephony and telegraphy given by Mr. E. T. Chapman, A.M.I.R.E., with a Burndept Ultra IV. Receiver kindly loaned by Dr. T. Morland Smith.

The programme included special transmissions of music from the Eiffel Tower by kind permission of General Ferrie, in addition to the usual daily music bourse and weather forecasts broadcasted by the same station. The audiences were also much interested in hearing speech from Croydon, Lympne, and other aerodromes with aircraft flying to and from Paris and Amsterdam. A local amateur was kind enough to transmit music by kestraphone and is to be congratulated upon his station (2FX), and achievements.

COMPETITIONS FOR ALL READERS

THREE WIRELESS RECEIVING SETS AS PRIZES

Closing Date, Friday, July 7th

WE offer as a prize in each of the following competitions a well-made wireless receiving set manufactured by one or other of our advertisers, the approximate value of each set to be at least seven guineas.

Rules.—The Editor's decision in any and every case is final. There is no appeal from it. The copyright of all competition efforts published by us will be ours. All entries to be in by Friday, July 7 and to be addressed to

THE EDITOR,
"Amateur Wireless,"
La Belle Sauvage,
London, E.C.4.

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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