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THE WIRELESS WORLD

VOLUME VIII NO. 1 NEW SERIES

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THE WIRELESS WORLD

THE OFFICIAL ORGAN OF THE WIRELESS SOCIETY OF LONDON

No. 1.

APRIL 3RD, 1920

VOL. VIII

INTERPLANETARY WIRELESS?

By PHILIP R. COURSEY, B.Sc.

GR^{EAT} interest has been aroused, particularly during the last few months, by certain statements in the Press relative to the possibility or probability of wireless signals being received from places external to the earth. Mars, always popularly considered a planet of mystery and always more or less an object of popular attention since Herschel first drew attention to its nature, was naturally at once associated with the source of these mysterious disturbances of the aether, and whether rightly or wrongly the so-called "signals" were thereupon attributed to that source.

Hence such headlines as "**Morse from Mars**," "**S.O.S from the Moon**," "**Mars, Moon or—?**" were flaunted before our eyes in all directions, with the result that the popular imagination was excited to a degree rarely associated with merely ordinary scientific events and happenings.

Mars, the fourth planet in the Solar System next in order to the Earth reckoning outwards from the Sun, appears from astronomical evidence to resemble in many ways our own Earth as regards climatic and other conditions. It is smaller than the Earth, its mean diameter being about 4,200 miles, while that of our own planet is 7,918 miles. Curiously enough the Martian's day is very much the same length as ours, being on an average only about 40 minutes longer.

To what extent, however, do the other conditions on Mars resemble our own?

Firstly, has it an atmosphere capable of supporting life as we know it? Apparently it has, although it is evidently much rarer than our own. As to its actual surface temperature, however, we cannot make any very definite statement, beyond the fact that it seems to be rather colder than the Earth. Assuming that the Solar System as we know it to-day was once a nebulous formation in space, which, through gradual cooling and contraction during long ages, settled slowly down to its present definite form with a central nucleus—the Sun—and a number of independent centres of condensation—the planets—it seems obvious that Mars has proceeded further in the cooling down process than has the Earth. This may be due to one of two causes. Mars may have separated off from the parent nucleus at an earlier date in time than the Earth and therefore have been longer cooling down, or it may merely be that on account of its smaller size and volume it had both a smaller initial heat content and a proportionally larger surface for radiation. Possibly both causes have been contributory factors. If we assume that the materials composing the bulk of the planet Mars are similar in nature to our own rocks, the specific heat of such materials would be of the same order as that of the Earth, with the result that assuming equal initial temperatures the heat contents of the two planets would be practically proportional to their masses.

The above assumption as to similar constitution is not altogether unwarranted, since

the spectrum lines reveal to us the presence of a large number of materials in the Sun which we also know here, while, of course, if the whole of the Solar System once formed part of a single nebula, the materials to be found in each planet would necessarily be similar. Furthermore, modern researches into the constitution of matter all lead us to the conclusion that its various forms are all built up of the same "bricks," and that the different elements, once considered separate and immutable, are really agglomerations of two fundamental entities—electrons and atomic nuclei, the latter probably being identical with either hydrogen or helium atoms which have lost an electron. One of the most prevalent gases found in the Sun, as judging from spectrum examination, is hydrogen, while helium also occurs there, and in fact was so named on account of its first discovery in that orb.*

However, to return from this digression, the diameter of Mars is, as we have seen, approximately half that of the Earth, but its mass is only about one-tenth. Its initial heat content should therefore have been about one-tenth that of the Earth.

But the surface of a sphere is proportional to the square of its diameter, and although neither the Earth nor Mars are perfect spheres, yet we may say that the surface area of Mars is to the surface area of the Earth approximately as 1 is to 4. Hence relative to their initial heat contents, the radiating surfaces of Mars and the Earth are approximately in the ratio of $2\frac{1}{2}$ to 1, so that it is only natural to assume that of the two planets Mars would have cooled down at first more than twice as rapidly as the Earth, and would therefore be at a lower temperature at the present time. Although this must undoubtedly have been the case at the beginning the magnitude of the loss of heat at the present day is not great. Prof. C. H. Lees in his recent Presidential address to the Physi-

* Greek, Helios = the Sun.

cal Society of London while discussing the physical evidence as to the age of the Earth, stated that at the present time the average loss of heat by radiation from the Earth was only sufficient to lower its temperature 1° C in over 3,000,000 years. A further factor, however, would be the nature and conditions of the atmosphere surrounding the planet. When the temperature is high there would be a great quantity of water vapour—and possibly other vapours—in the atmosphere, which would to a certain extent act as a blanket surrounding the globe and restrict the radiation. Hence, further, if there is a less dense atmosphere on Mars than on the Earth, that planet should be in a better position to cool down more rapidly.



Mars as seen through a telescope.

A certain amount of water vapour must almost certainly be present in the Martian atmosphere as it is generally agreed that the white polar caps which are seen to grow and recede from season to season, are ice caps such as we know them in our arctic regions. The change in the seasons from summer to winter must on Mars be more pronounced than what we usually experience, as the orbit of Mars round the Sun is

more eccentric than that of the Earth. The mean distance of Mars from the Sun is 141,500,000 miles, but this figure varies by 13,000,000 miles during the revolution, which incidently takes just over $1\frac{3}{4}$ years (686.9 days to be more exact), whereas in the case of the Earth the mean distance from the Sun is 92,000,000 miles, and it varies only by about 3.1 million miles during the year.

Hence to sum up we may say that the natural conditions on Mars are somewhat analogous to our own, that the temperature is somewhat, but evidently not very much, lower, that the year is longer and consequently the seasons each longer—that is to say the winter would be long and cold—and that the atmos-

INTERPLANETARY WIRELESS ?

phere though probably similar to our own in composition is much more rarefied. It seems therefore within the bounds of possibility that some form of life may exist on Mars, although obviously we cannot make any statement as to this with any degree of certainty. Mr. H. G. Wells has given us an entertaining description of how such life, if it exists, may have developed along quite different lines to our own and how in the process it may have reached a more advanced stage of development.

As regards the possibility or otherwise of wireless signals being received from or sent to Mars, this must obviously depend upon a number of factors, chief amongst which we may mention :—

Is Mars inhabited by life at all ?

If so, does the form taken by the living organism in any way resemble ours ?

Have the organisms or animals developed to the extent of the human race ?

Are they intelligent or do they more resemble the "lower animals" ?

If they are, have they developed scientific apparatus and instruments in any way resembling our own ?

Have they discovered the phenomena of electrical currents, and of electrical waves, and have they discovered how to produce and detect such waves ?

Have they a language at all ? And have they knowledge of anything upon which a common basis of understanding could be built between the two worlds ?

Given affirmative answers to all these questions, and possibly to a few more similar ones as well, we may say that interplanetary wireless is possible ! Truly an appalling list of assumptions, a list such that if it were used as the basis of any scientific theory without any additional support or evidence would scarcely warrant us to give it further consideration, yet the modern newspaper man is prepared at the slightest hint to sweep them all aside and tell us in two-inch type that we have received **"MORSE FROM MARS."**

Let us examine for a moment the evidence

upon which such sweeping statements were based. It is a well-known fact that there exist in the aether—the fundamental uniform and omnipresent medium filling all space and all bodies—natural electric waves. These have doubtless existed in all ages but until the development of the sensitive wireless receivers which made their detection possible their presence was quite unsuspected by man. When they were first discovered they were styled X's in order to indicate their unknown origin. We now know that many of them are set up by ordinary thunderstorms, either near or distant, but of the source of some we are still not altogether sure. Nowadays they are more often referred to as "atmospherics" or "strays"—indicating their probable origin in natural atmospheric disturbances. These atmospheric may be heard on almost all wavelengths to which a receiving apparatus may be tuned, although as a general rule they are most prevalent on the longer wavelengths. The nature of the sounds which they set up in the receiving telephones takes almost every possible form, from isolated clicks and scratches to complicated sounds of almost every conceivable type. In general they have been classified into three main groups known respectively as, "clicks," "grinders," and "hisses," although very often it is difficult to assign a given sound to any one of these three types. The usual wavelengths used for ordinary commercial radio work lie between about 400 metres and 20,000 metres, depending upon the class of the service. For ordinary short distance work between ships, aeroplanes, etc., the shorter wavelengths are used, while for the long distance services across ocean and continent the longer wavelengths are more suitable. The atmospheric can be heard on all these wavelengths, but their type becomes more diverse and their number more frequent on the longer waves, and using the larger aerials customarily associated with long distance signalling.

When listening in on very long wavelengths, between 80,000 and 120,000 metres according to the reports, these atmospheric have

again been heard as was to be expected, but it was also noted that at times the sounds in the telephone receivers seemed more regular than those given by the usual form of strays. This suggested the possibility of these sounds being produced by something more than the natural atmospherics, while their regularity rather emphasised the possibility of some more "intelligent force" being behind them. These sounds were heard simultaneously at places as widely separated as London and New York, while reports have also been received from Australia indicating the receipt of similar "signals." The widely distributed nature of the signals led Senatore Marconi to suggest the possibility of the waves having originated at a great distance and possibly at even some point quite outside the Earth. This then in brief was the basis of all the fanciful tales that have been written round the subject in the columns of the Press. It is just as likely that the waves may have originated in any other planet, or in the Sun, as that they may have been set up by hypothetical Martians. It is well known that disturbances of the Sun's surface and of the Solar atmosphere influence the electric and magnetic state of the Earth, as evidenced by the so-called magnetic storms which occur from time to time, and which are generally associated with seasons of sunspot activity.

These magnetic storms cause widespread disturbances to the telegraph lines and cables, and quite powerful currents are often induced in the telegraph circuits. The magnetic recording instruments also indicate large and sudden variations during such "storms." These variations of the magnetic properties of the Earth are known in many cases to occur simultaneously over large tracts of the Earth's surface, while it is also known by careful observation that many of the atmospherics heard in wireless receivers are recorded simultaneously at stations separated by considerable distances. It is therefore quite probable that the two may have a common origin, although this has not yet been definitely proved. It is conjectured that the

cause of both phenomena may be that streams of electrified particles are shot out from the Sun's surface near or through sun spots, and that when these impinge upon the Earth's atmosphere the general electrical condition of the Earth is disturbed. The above-mentioned phenomena are also closely allied with the greater prevalence of aurora at certain times. It is not always that when sun spots are seen the Earth is disturbed and aurora are frequent, and it seems then probable that the streams of particles which appear to be shot out from such "spots" have missed the Earth altogether, and so have not produced any noticeable effect on our planet. It is perhaps not without the bounds of possibility that these streams may at times impinge upon other planets and set up surges of electric currents in their atmospheres or in their solid masses. These currents in their turn would give rise to wireless waves in the aether, and these waves might be detected by receivers on our globe. In that sense we may be receiving interplanetary wireless "messages" almost every day without our being aware of it!

On the surface therefore it seems most probable that the "mysterious signals" about which we have heard so much have been caused in some manner by solar disturbances in one form or another, although of course it is *not impossible* that some other cause may really be the explanation. It is unwise in scientific matters to say that anything is impossible.

Of course Mars is not the only planet that might have been concerned in the affair; Venus might equally have been the culprit, and many consider that the possibilities of life on Venus are quite as feasible as in the case of Mars. Venus also approaches rather closer to the Earth than does Mars.

Since the distance between the Earth and Mars differs widely during their revolutions round their respective orbits, the "signals" if they really originate in that planet should vary very considerably in intensity as the distance varies. In the case of a free aether wave in space such as we are concerned with

INTERPLANETARY WIRELESS?

in this case, the energy picked up at the receiver would vary inversely as the square of the distance traversed. This point should be capable of verification. Mars is nearest to the Earth on about April 20th next, and the signals should be strongest on that date if Mars has anything to do with them at all. The distance between the Earth and Mars varies between about 35,000,000 miles and over 200,000,000 miles, depending upon the positions of the two planets in their respective orbits. Alternatively the signal strength should vary with the Earth's distance from Venus should that planet be the source.

According to a message from Rome the Spiritualists are stated to have disclosed at a *séance* that not Mars, but Jupiter is really the source, but there seems even less evidence to be considered to support such a proposition.

Considering that in the first wireless signals received across the Atlantic Ocean in December, 1901, the Morse signal "S" was used as a distinguishing letter, it seems indeed a curious coincidence that the interest in this case should also have been stimulated by a "signal" of the same type ("S" in Morse is 3 dots). It is perhaps surprising in view of the statements reported to have been made some time ago that "wireless waves are eternal," that some enterprising reporter has not suggested that these fresh signals are really the old 1901 ones come back to us again from somewhere! Of course there is the difficulty of the wavelength being very much greater

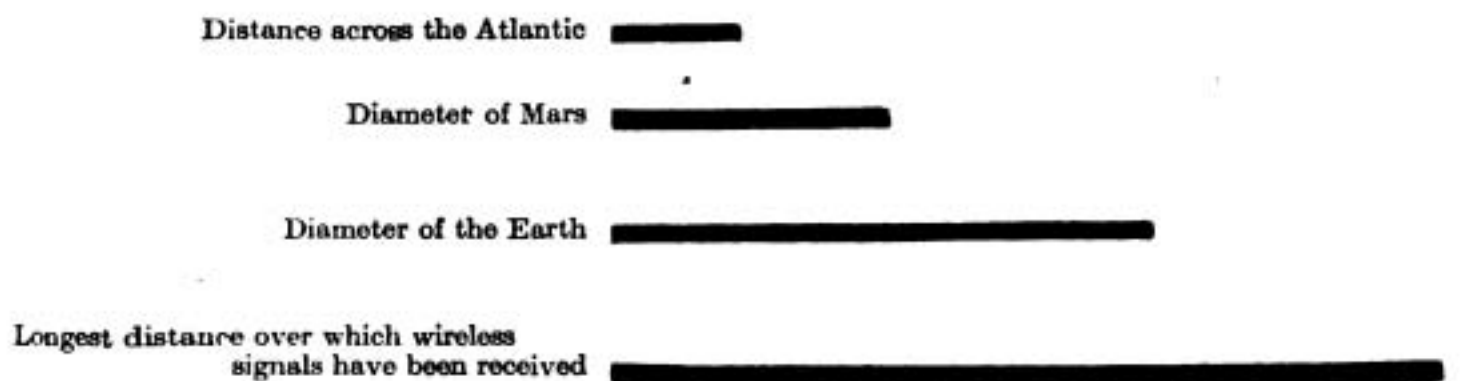
in this instance than was the case before, but that should not be an undue obstacle to overcome with such an ingenious explanation at stake.

Incidentally, neglecting this point, it may be of interest to note that in the 18 years that have elapsed since these historic signals were sent from Poldhu to Newfoundland, the waves could have travelled to a point approximately 45 billion (45×10^{12}) miles away and back again, supposing that they could live out such a journey. Is there anything, any collection of objects, any reflecting surface, at such a distance from the earth? It can scarcely be the end of the aether because many stars are estimated to be much further away than this, and light from them reaches our telescopes through the aether.

As far as the theoretical possibility of interplanetary wireless signalling goes, what energy should we require to use to produce a detectable signal on Mars, or, conversely, what energy would it be necessary for the Martians to throw off into space to give rise to a signal here that we could pick up with a sensitive wireless receiver?

This would depend very largely upon the sensitiveness of the receiver, and it seems safe to say that even with modern amplifiers with which magnifications of half-a-million times have been obtained, the power required would still be very large.

The most important question that arises is really whether this energy could reach us



On this scale the average distance of Mars would require a line approximately $\frac{1}{10}$ th of a mile long, and the distance from the Earth to the Sun by a line $\frac{1}{2}$ rd of a mile long.

Diagram illustrating comparative distances of wireless signal ranges on the Earth, and the enormous distance to be covered in trying to signal to Mars.

through the Heaviside Layer—that ionised upper layer in the atmosphere which acts as a reflector for our wireless waves which we use in ordinary radio signalling on Earth. It was once assumed that this layer acted as an almost perfect reflector, but modern researches tend rather to indicate that the mechanism of the wave bending to which it gives rise is probably more of the nature of refraction. The case is very much like that of the passage of a beam of light out from water into the air (Fig. 1). The beam

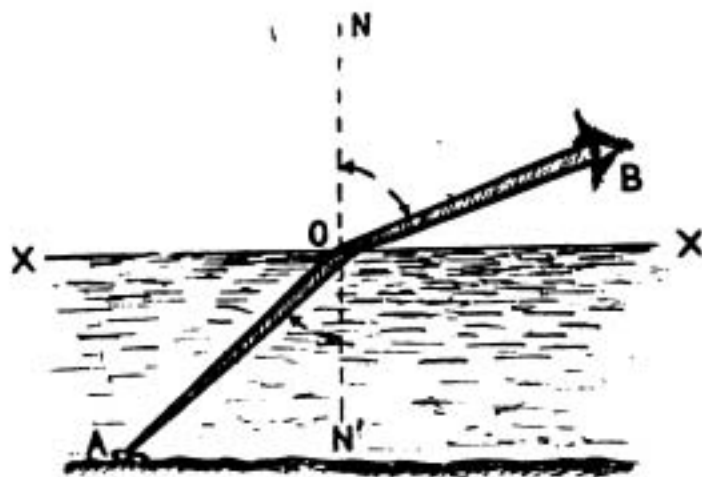


Fig. 1.

indicated at AOB is bent or refracted away from the normal ON (perpendicular to the boundary surface XX), that is the angle NOB is greater than N'OA. What happens as the angle NOB is increased is indicated in Fig. 2., which shows successive positions of the beam from which it may be seen that as the angles of incidence θ , ϕ , etc., are increased, the emergent rays CD, EF, etc., approach the boundary surface. For the angle of incidence ϕ part of the ray is reflected along EG, and part passes through the boundary and emerges at EF. For all larger angles, the ray is totally reflected at the boundary and cannot get outside of the water at all as shown at SHK. In ordinary wireless signalling owing to the small height of the ionised layer (about 60 miles) compared with the distances of transmission, the last case (total internal reflection) is the one more usually met with. Hence it would seem possible by directing

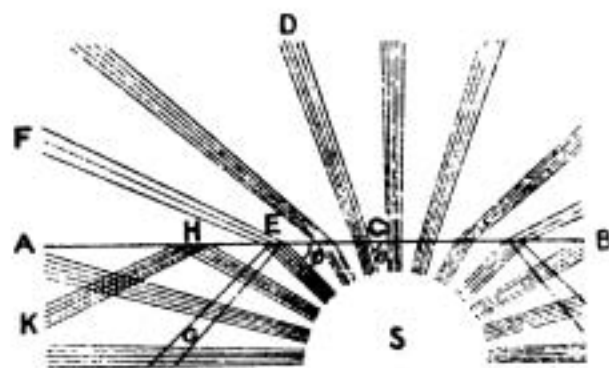


Fig. 2.

our waves nearly vertically upwards from the Earth's surface, for them to get outside of the Earth's atmosphere and then to travel on through space. As far as waves coming towards the Earth are concerned, the conditions are easier, as is evident from the diagrams (Fig. 2), although it would still be desirable to arrange special aerials capable of receiving most efficiently signals coming down nearly vertically towards the Earth's surface, instead of those reaching it from a nearly horizontal direction as is usually the case. A series of very long horizontal wires, elevated and insulated from the Earth might be a possibility.

As regards the actual transparency of the Heaviside Layer to electric waves we really know very little. We do know, however, that for the frequencies of light waves it offers little or no obstruction, but it is impossible to say at once, whether it would be similarly transparent to the waves of a frequency of the order of hundreds of thousands, as it is to the light waves having a frequency running into billions per second.

The problem of getting the waves through the ionised layer may therefore resolve itself into the possibility or otherwise of producing waves of a sufficiently high frequency as well as of a sufficient power.

The wavelengths on which these special "signals" have been received are, however, long, and therefore there is on these grounds even less likelihood of the waves having come in from outside, although it is not impossible that the layer may be selectively transparent

INTERPLANETARY WIRELESS ?

to waves of some wavelengths and not to others, just as a coloured glass transmits waves over a very limited range of frequencies, and cuts out others. It may be of interest to see what is the oscillation frequency of a wave 120,000 metres in length (which is the wavelength on which these signals have been received). Now the frequency and wavelength of an oscillation are connected by the relation

$$\begin{aligned}(\text{Wavelength}) \times (\text{Frequency}) \\ &= \text{Velocity of Light} \\ &= 3 \times 10^8 \text{ metres per second.}\end{aligned}$$

Hence we have Frequency

$$\begin{aligned}&= \frac{3 \times 10^8}{120,000} \\ &= 0.25 \times 10^4 \\ &= 2500 \text{ cycles per second.}\end{aligned}$$

This is comparatively speaking a low frequency, and the point perhaps deserves investigation as to whether there is any possibility of the occurrence of this frequency in natural oscillations of the Earth or of anything connected with it, *e.g.*, the Heavyside Layer and the Earth's surface form a gigantic condenser in space, which should promote the production of oscillations of some definite frequency if their electrical equilibrium were disturbed. It has been stated that Sir Oliver Lodge years ago searched for the presence of low frequency waves of the order of 100 per second, but found more. However, this aspect of the question is perhaps worth further investigation at the present time in the light of more modern knowledge, as it at least would explain the world-wide nature of the "signals" should they be due to such a source, in which case the disturbances may

merely arise through the ionised streams of particles from the Sun.

Many fanciful speculations have been based upon the three dots (or "S") which generally constitute these mysterious signals. One of the most favoured being that it is an indication or call meant for the third planet in the Solar System, *i.e.*, the Earth. This of course presupposes that the "signals" have been sent out by some intelligent being external to the Earth.

Again, the three dots might be an attempt to establish some interplanetary language, based upon mathematics, in which case they might represent a triangle. On the other hand we have no evidence to show that ordinary Euclidian geometry, as we know it, would be understood on another planet, where one of the other geometries might be in force—their space may be "warped" and their "straight lines" curved!

To overcome the difficulties of establishing an intelligible mechanism of communication would doubtless be the work of years, even if such a result could ever be achieved with the means at present at our disposal. In this connection a visual means of signalling might be much more convenient to work with for this purpose, as huge diagrams or lettering could be outlined in lights and form a means of indicating desired signs or geometrical propositions. The cost, however, would be enormous.

So, until the possibility of intercommunication is more definitely established either in the affirmative or negative we may well leave the subject at this point.

The next Article in this Series will be entitled:---

AETHER: THE SUB-STRATUM OF THE UNIVERSE.

THE DESIGN & CONSTRUCTION of a WAVEMETER & TUNING TESTER

By A. D. KENT.

GENERAL REMARKS.

IN this article I shall deal with an easily constructed wavemeter, an instrument which is practically indispensable in a receiving station, especially when only a crystal receiver is used, the reason being that when standing-by for a station on a certain wavelength it is essential that the receiver should be tuned to the wavelength of the transmitting station.

The method of using a wavemeter as a tuning tester is as follows: Assuming that the operator knows approximately the calibration of his wavemeter, he should set the condenser to the setting for the wavelength he intends to receive. A battery and a buzzer must be connected across the inductance, as shown in Fig. 1. The interrupted current will then charge up the condenser which will discharge through the inductance, thus causing oscillations in the circuit shown inside the circle in Fig. 1. The wavelength of the oscillations emitted depend upon the capacity and inductance in the circuit, and can be determined from the formula:—

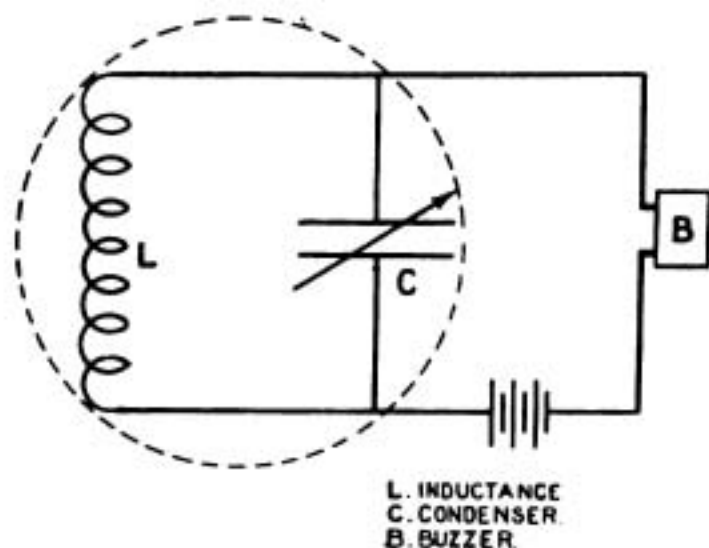


Fig. 1.

$\text{Wavelength} = 1885 \sqrt{\text{capacity} \times \text{inductance}}$,
capacity being in microfarads and inductance in microhenries.

Adjust the buzzer to give a good note—preferably using a high-note buzzer—and place the inductance of the wavemeter near the earth-lead. The oscillations will impulse the aerial and on tuning up the receiver the note of the buzzer will be heard in the telephones.

Should the oscillations be too weak to be heard in the receiver, wind a few turns of the earth-lead round the wavemeter inductance and test again.

When the receiver is adjusted correctly for wavelength, adjust the crystal to give best signals.

DESIGN.

To design a wavemeter and guarantee the values of inductance and capacity, even when instructions are carefully followed, is a very difficult matter. The inductance unit can be made very close to a given value if wound with care, but the condenser is the main difficulty.

Only a well-made air condenser can be relied on to be within reasonable limits of calculation. I am afraid that to make an air condenser very advanced workshop practice is required, and for the average amateur a well-equipped workshop is not available.

I therefore think that the best proposition is to make up five fixed mica condensers, which can be paralleled by means of a simply constructed switch (Fig. 4). By using a variable inductance we shall be able to adjust to intermediate wavelengths between those given by the fixed condensers with maximum inductance.

Fixed Condensers.

To make up the fixed condensers copper foil 0.002 of an inch thick may be used, because it is easy to solder connections on to

CONSTRUCTION OF A WAVEMETER AND TUNING TESTER

this metal. Use mica for the dielectric, 0.002 of an inch thick, and cut it with a sharp pair of scissors into strips $2\frac{1}{2}$ " long by $\frac{3}{4}$ " wide. Cut the copper foil into strips $2\frac{1}{2}$ " long by $\frac{1}{2}$ " wide. We must next make up some shellac varnish. Shellac can be obtained from a colourman. It must be ground to a fine powder and mixed with methylated spirit until it can be easily smeared over the mica with a mop; a mop will obviate the necessity for straining the varnish, and is quickly made with a piece of rag and a small stick.

The copper foils must be laid on the mica, the tabs projecting, each alternate end, $\frac{3}{4}$ ", with two sheets of mica between each foil (see Fig. 2).

The table below shows the number of foils that will give approximately the values required.

When the condensers are built up, the

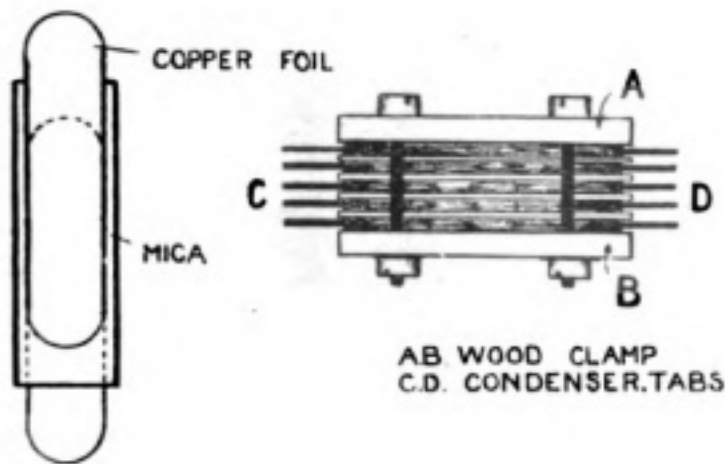


Fig. 2.

clamp as shown in Fig. 2 must be screwed down tightly and placed *en bloc* in an oven having an average temperature of about 120° F. The baking will evaporate the methylated spirit and consolidate the shellac.

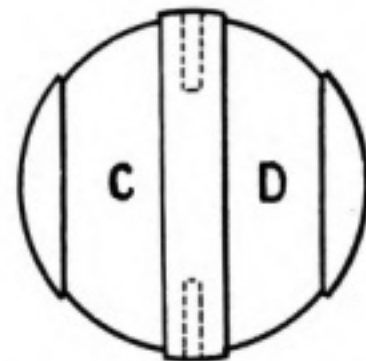
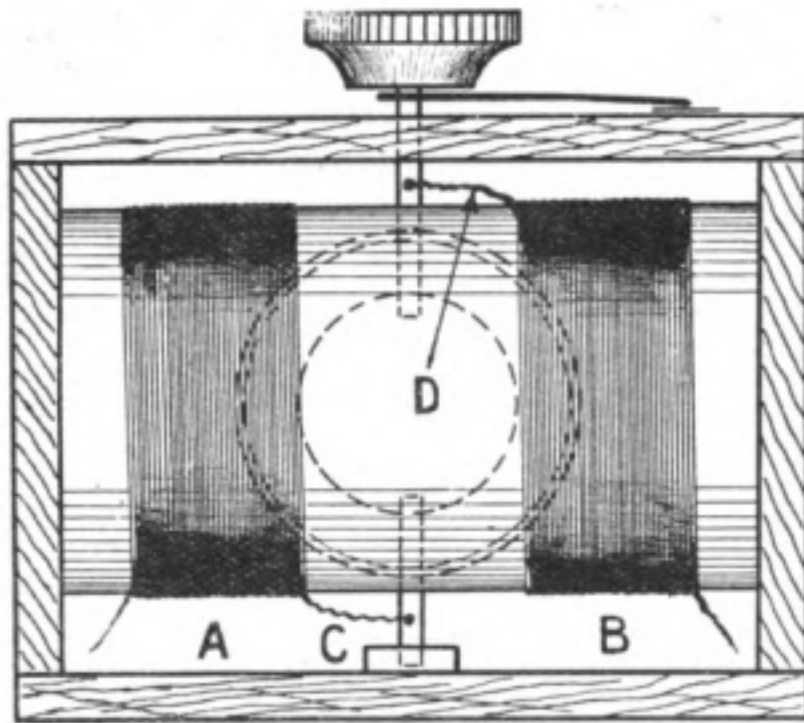
When cold the condenser should be quite rigid, and the shellac will protect it from damp and subsequent bad insulation.

The table shows the total number of foils required to make capacities as shown in Fig. 4:—

Capacity.	No. of Foils.	Arrangement of Foils.
.0001 mfd.	2	1 each side.
.00015 „	3	2 one side, 1 the other side.
.00025 „	5	3 „ 2 „ „
.0007 „	15	8 „ 7 „ „
.00018 „	40	20 „ 20 „ „

Thus, when the parallel switch is at—
 1, the condenser capacity is .0001 mfd.
 2, „ „ „ „ .00025 „
 3, „ „ „ „ .0005 „
 4, „ „ „ „ .0012 „
 5, „ „ „ „ .003 „

The Inductance Unit will take the form of a variometer or continuously variable inductance. It will be as well briefly to describe its action. A variometer is an arrangement of two inductances connected in series and so mounted, one in the other, that by moving one coil the "mutual inductance" between the two coils is varied and the inductance value of the combination is altered. Our variometer will consist of a tubular former, with a spherical former mounted inside the tube. The two windings are connected in series. When the axes of the two coils are in the same plane and the magnetic fields oppose one another the inductance value will be a minimum. As the spherical coil is rotated, the opposition of the two fields decreases, until, at 90°, *i.e.*, with the axes of the two coils at right angles, there is no mutual inductance between them, and the inductance of the combination is the inductance of the tube plus the inductance of the spherical. Continuing the rotation of the spherical, the fields of the two coils build up together, and the inductance of the combina-



SPHERICAL COIL FORMER

Fig. 3.

tion is greater than the sum of the two individual coils. When the two axes are again in the same plane—with the two fields working together—*i.e.*, after 180° rotation—the inductance is a maximum. A numerical example, taken from a model made for the present article, will clearly show the operation of a variometer and prove the statements made above.

The inductance of the tube former is 376 mhy., and of the spherical, 267 mhy. With the two coils connected in series, but widely apart so that there should be no mutual inductance, the value was 646 mhy: this equals the sum of the two separate coils. With the spherical mounted in the tube and set so that windings were in opposition, the value was 213 mhy. Set at 180°, the windings working together, the value was 1,065 mhy. At 90°—*i.e.*, with no mutual inductance—the value was 639 mhy. This is about the same as the sum of the two individual coils.

To Construct the Variometer.—The *Spherical* former should be a hard wood ball, 3½" diameter, turned as shown in Fig. 3, so that there is a raised section at each side to support the winding. If this is not done, it will not be possible to wind the coils without their

collapsing. Drill two holes in the centre of the grooved portion, one each side penetrating about a third of the way through, *not meeting in the centre*, into which two brass stems may be screwed to mount the former into the tube.

The *Tubular* former may be made of several layers of stiff paper or cardboard, wound in a circular form. It should be 4" long and have an inside diameter of 3½". The thickness will vary according to the manner in which the tube is made, but the thicker it is, the better for mechanical strength.

Drill two holes, diametrically opposite, just large enough to put the spherical spindles through. If possible, the tube should be reinforced round these holes so that the movement of the spherical will not wear away the tube, giving a sideshake to the spindles and causing the spherical to foul the tube.

Next make a hard wood stand. For this will be required two pieces for end supports, a piece for the base, and two pieces for spherical supports—one piece placed along the top of the tube from end to end and a small block for the bottom spindle.

CONSTRUCTION OF A WAVEMETER AND TUNING TESTER

The base should be $4 \times 4\frac{1}{2}$ ", the two end pieces $4\frac{1}{2}$ " square, with holes in the centre of approximately $3\frac{1}{2}$ " diameter, to slip over the ends of the tube.

The top support for the spherical should be $4 \times 1\frac{1}{4}$ ", and the block for the bottom spindle 1 " square. All to be of $\frac{3}{8}$ " wood.

Do not wind the formers first, but mount up the whole unit completely, so that all fitting and adjusting can be done without damaging the windings.

First of all, fit the tube into the end pieces and place the spherical in its position inside the tube, screwing the spindles through the holes in the tube into the spherical. The top spindle should be 3 " long and the bottom one $1\frac{1}{2}$ ", both being of $\frac{1}{8}$ " brass rod. Then mount the end pieces and tube on to the base-board, having previously placed in posi-

tion the small block with the hole through it, which is to act as a pedestal bearing for the spherical spindle. The position of this block must be accurately determined by measuring the position of the holes in the tube. Having fixed the block, the length of the bottom spindle can be adjusted so that the spherical is mounted centrally in the tube. After this put on the top spindle bearing, which is the piece of wood $4 \times 1\frac{1}{4}$ ". The position of the hole in this piece should be carefully determined by measurement. The next thing is to provide the handle, pointer and scale. The scale may be an ordinary metal protractor, fixed on the cross-piece.

The mounting of this unit requires some thought and skill on the part of the amateur, but if care is taken, a very useful piece of apparatus can be made.

To Wind the Formers.—Dismantle the unit and proceed as follows: Wind the tube in two parts, as shown in Fig. 3 at A and B, each part consisting of 35 turns of No. 22 D.W.S. The space between the two parts should be $\frac{1}{8}$ ". Wind section B, first commencing $\frac{1}{8}$ " from centre of spindle hole. Measure the distance from the centre of the spindle hole to the end of this winding, and mark it off to the left of spindle hole, to fix where to commence winding A. Then wind A, and see that both windings are in the same direction, *i.e.*, clockwise. Finish off the windings with tape, as shown in the December issue (1919) of the *WIRELESS WORLD*.

Then wind the spherical with 34 turns, each side, of No. 22 D.W.S. The method of winding is as follows. Commence at the ledge on the left-hand side, and wind 34 turns clockwise, finishing off the winding. Then turn the coil round and commence winding another 34 turns in an anti-clockwise direction, and finish off the winding.

(NOTE.—If this second half is not wound anti-clockwise, the two halves of the spherical winding will oppose one another, and give no inductance.)

Join the two inside ends together. Then, starting from the left-hand side, the winding

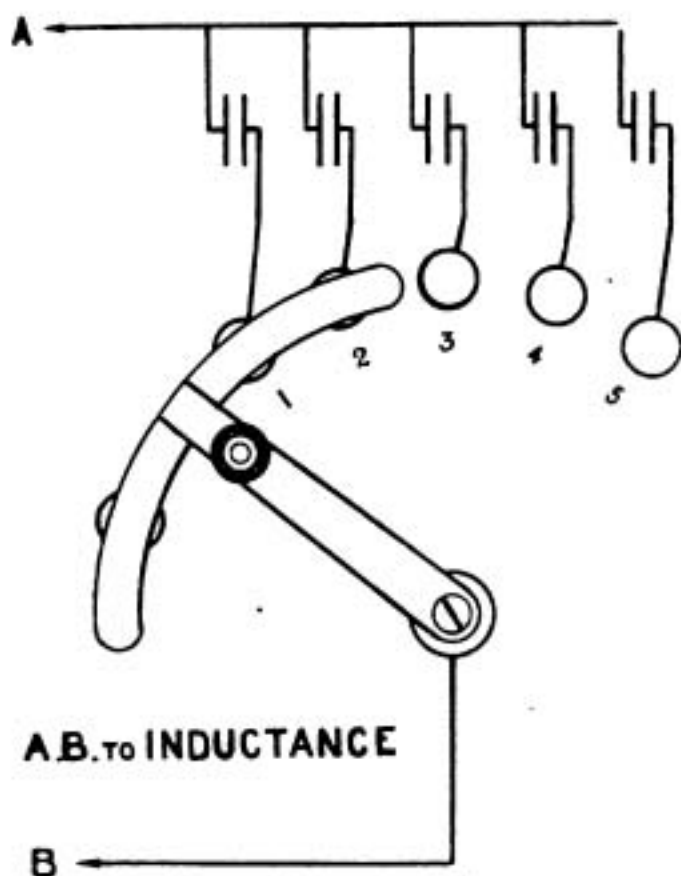


Fig. 4.

1.	.0001	Mfd	Condenser.
2.	.00015	"	"
3.	.00025	"	"
4.	.0.07	"	"
5.	.00018	"	"

will be continuously clockwise from one side to the other.

Now re-mount the whole of the unit, and make the final connections. One end of the spherical winding should be connected to the top spindle, and the other end to the bottom spindle, care being taken to see that the two spindles do not touch one another. Then connect end C of the first winding on the tube to the top spindle, and connect D of the second winding to the bottom spindle. The spherical is then connected between the two halves of the tube winding. The next thing is to "set" the pointer. It should indicate 0° at minimum inductance and 180° at maximum inductance. Turn the spherical so that the turns of the winding point to the ends of the tube—*i.e.*, the turns of spherical are at right angles to the turns on the tube. This is the position in which there is no mutual induction between the two windings. The pointer should be set at 90° and fixed to the spindle. The point 0° will indicate either maximum or minimum inductance, according to whether the coils oppose or assist one another at this point. To determine which it is, place the tube up on end and trace the direction of current-flow down through all the windings. If it goes downwards in a clockwise direction through the fixed and movable windings, then the two coils are assisting one another and the scale should indicate 180.

The inductance values previously given were taken from a unit made up exactly as described here, and they will be approximately

correct if the amateur makes his variometer as nearly as possible the same and winds his inductances tightly and evenly.

Now, if the condenser block and the variometer unit are connected together they will form the oscillating circuit.

If the condensers are accurately made the wavelengths of the five ranges will be approximately :—

Range.	Cond.	λ (Var. 0°.)	λ (Var. 180°.)
1	.0001 mfd.	320 m.	660 m.
2	.00025 "	430 "	980 "
3	.0005 "	620 "	1380 "
4	.0012 "	940 "	2100 "
5	.003 "	1460 "	3300 "

It will be seen that there is a considerable overlap in wavelength between the ranges, This will allow for inaccuracies in the amateur's set and still give him overlap.

If a buzzer and battery are connected across the inductance the circuit will oscillate and emit waves, the lengths of which will depend upon the adjustment. On the other hand, a telephone and crystal connected across the inductance will enable a wavelength to be measured.

To complete the set, it is necessary that it should be standardised against an accurately-calibrated standard wavemeter.

TO APPEAR SHORTLY

THE THEORY, DESIGN, CONSTRUCTION AND USE
OF FRAME AERIALS.

THIS ARTICLE HAS BEEN WRITTEN SPECIALLY FOR AMATEURS.

NOTES AND NEWS

The Conference of Affiliated Wireless Clubs (see page 16) held at the Royal Society of Arts on February 27th, was well attended, and we were particularly gratified to note the presence of such a large proportion of delegates from the provinces. Interest will centre around Captain Loring's speech, in which he indicated what must for the present be considered the high-water mark of amateur liberty. Yet, as one delegate remarked to us over the edge of his teacup, the new wireless bill has yet to be passed. However, the thanks of amateurs are due to Captain Loring for his frankness; he administered the *coup-de-grace* to some of our hopes with a quick and clean stroke, which is the most merciful way. It is quite certain, however, that the claims of amateurs have not been, and will not be, lightly brushed aside, and that a considerate ear will be inclined towards special applications. So our advice is, "If, bearing in mind all sides of the question, you feel that your application is reasonable, try your luck, even though the odds seem to be against you. In a short statement such as Captain Loring's six points, all possible cases cannot be covered."

New Clubs are now coming into existence very rapidly, and we shall be pleased to furnish what information we can regarding their whereabouts.

The Air Ministry Wireless Meteorological Reports are now being transmitted on 1,400 metres (C.W.) at 0315, 0745, 0915, 0930, 1015, 1100, 1200, 1300, 1400, 1445, 2015 (all G.M.T.). Call signal, GFA. The code now employed is not that which was published in our March issue, and we hope to give details of the latest code in a future number.

The R.A.F. Syllabus covering the training of Electricians and Mechanics—Operators (W/T) is now in our possession, and will be published by us in a digested form as soon as possible.

A direct wireless service between Great Britain and the United States has been inaugurated. This service marks a new departure, it being the first direct wireless link between this country and the United States.

The service will be conducted jointly by the English Marconi Company and the Radio Corporation of America. The wireless terminal stations are Carnarvon on this side and Belmar, New Jersey, on the American side. At present messages on this route can be accepted for New York, Greater New York and South America (at rates up to 4d. less per word than the existing cable charges), but it is anticipated extending the service for messages to all parts of the United States. The first messages sent over this route were exchanged between Mr. E. J. Nally, President of the Radio Corporation of America, and Mr. Godfrey C. Isaacs, Managing Director of the English Marconi Company, and between the latter gentleman and Mr. Davis, Vice-President of the General Electric Company, New York.

The steady march of wireless continues. The Swedish Authorities are anxious to inaugurate a direct wireless service between Sweden and the United States, and proposals are under consideration for the erection of a powerful wireless station in Sweden for this purpose. The promoters hope to obtain from the United States assurances that some definite hours every day will be assigned to the Swedish Station for sending messages to and receiving from American stations.

Two wireless stations have been opened in Tripolitania, at Misurata and Azizia. The tariff for these stations will be that fixed in Tripoli. The station at Thié has also commenced working, the tariff for which station is that fixed by Eritria.

The Sable Island (Canada) Wireless Station has been reopened for the exchange of public correspondence with ships at sea.

The Christiania Wireless Station was officially opened on January 10th last. The installation, the order for which was placed in Germany in 1915, and which was commenced the following year, works on the Arko system. Hydro-electric current from the power station at Kykkelsrud operates a 100 kw. motor which drives an alternating current generator of special design. The Christiania Station is used exclusively for European traffic, the Stavanger Station undertaking the American service.

Direct wireless communication has been established between Eiffel Tower and the stations of Yunnan-foo and Bach Mi. in Indo-China. Arrangements are in hand for the erection of a station at Saigon by means of which it is hoped to inaugurate a Far East commercial service.

The Paris Academy of Sciences Hebert Prize for 1919 was awarded to Raymond Jouaust for his work on Magnetism, Electrical Standards, Photometry and Wireless Telegraphy.

The Scandinavian Shipowners' Associations recently approached the Foreign Office requesting a modification or postponement of the time limit for enforcing the regulations covering wireless apparatus on all ships of over 1,600 tons, to which, however, the Foreign Office was unable to accede. The Swedish Government was informed that if technical representatives were sent all information possible on the subject would be furnished. The new regulations will come into effect in December of this year.

Prior to the entry of the United States into the War, the Lackawanna Railroad Company was completing the fitting of their trains and terminal stations with wireless telegraphy and wireless telephony apparatus in order that communication could always be established between moving trains and between trains and the terminal stations. This work, however, had to be suspended owing to wartime restrictions.

Now that the ban on private wireless has been removed, the Lackawanna Company is arranging for the completion of the work.

The French are shortly about to try the operation of wireless telegraphy in connection with their State Railways for the working of signals. The apparatus will be fixed to the ordinary signals and will actuate as soon as the signal is placed at danger. If a train passes a signal thus set an alarm will be rung in the engine cab. Experiments which have been spread over the last two years have been in progress on the line between Paris and Maintenon. The cost of introducing the new system is estimated at 20,000,000 francs.

With reference to the remarks under the heading, "The Maintenance of Mechanical Oscillations by Means of the Three-Electrode Valve," in our January issue, we learn that this subject was also discussed in a letter from Mr. H. L. Kirke (Capt. R.F. att. R.F.) which appeared in the *Electrician* of July 18th, 1918.

The *Radio Service Bulletin*, dated Washington, November 1st, 1919, No. 31, announces that effective from January 1st, 1920, the 800-metre wavelength and no other will be used by all United States Naval shore radio-compass stations.

Full reports of the heroism of the Wireless Operator, M. Mezier, of the French liner *Afrique*, which vessel it will be remembered sank in the Bay of Biscay in January last, have now come to hand. M. Mezier, true to the traditions of the wireless service, remained at his post and went down with his ship. The last message received from him read "Nothing terrifying. All is calm."

L'Electricité comments on the divergences of the Parisian clocks, stating that five minutes fast or slow is not by any means rare, and points out how easily this could be remedied through the utilisation of wireless telegraphy, as the Eiffel Tower transmits gratuitously three times per day the exact time to the hundredth part of a second. This country does

not possess a single time-signalling station. We do not deserve to be the custodians of G.M.T.

According to the *Elektrotechnische Zeitschrift*, on the outbreak of the war the Germans no longer relied on the ordinary telegraph system, but fell back upon wireless telegraphy and wireless telephony to ensure their communications.

Reference has been made in the press to the theory that the mysterious explosion of the big British dump at Bethune and the equally mysterious destruction of the French battleship *Jena* in Toulon Harbour about ten years ago were caused by the action of wireless. Much research has already been

carried out in connection with the utilisation of wireless to transmit and control power at a distance, including experiments to effect by wireless an explosion at a distance, but the tendency to resort to wireless to explain happenings the causes of which are unknown is not one to be encouraged.

The honour of being the first lady wireless operator in Great Britain falls to Miss A. C. Rainie, whose portrait we reproduce on this page. She received her wireless training at the North British Wireless School, Glasgow, and during the war carried out some important wireless duties. It is stated that Miss Rainie hopes that one day wireless operators of her sex will be attached to every steamer.



Miss A. C. Rainie.

Photo Press.

The University College, London, is seeking to effect a great extension of its engineering school, for which purpose a sum of at least £100,000 must be raised. Amongst the many contributions already received by the College are gifts of wireless apparatus valued at £500 each from Marconi's Wireless Telegraph Company, and the Marconi International Marine Communication Company, Limited. Donations should be sent to the President of the Equipment and Endowment Fund Committee, Prince Arthur of Connaught, 42, Upper Grosvenor Street, London, W.1, or to the Hon. Treasurer, Sir Ernest Moir, at University College, London.

DIGEST OF RADIO LITERATURE

AIRPLANE ANTENNA CONSTANTS. J. M. Cork, Assistant Physicist to the Bureau of Standards. (*Bureau of Standards, Washington; Scientific Paper, No. 341.*)

The author states that the purpose of this work was to obtain general information regarding the effective capacity, effective resistance, true capacity, true inductance and wavelength, as well as the transmitting directional effect of various types of aeroplane antenna. The paper deals with capacity and resistance measurements, and directional effects of both fixed and trailing aeroplane antennæ, and it is well supplied with diagrams and graphs.

PRINCIPLES OF RADIO TRANSMISSION AND RECEPTION WITH ANTENNA & COIL AERIALS. J. H. Dellinger. (*Bureau of Standards, Washington; Scientific Paper, No. 354.*)

This paper, which is largely mathematical, considers the advantages of coil aerials as compared with ordinary antennæ. The fundamental principles of design of aerials are also given. The Bureau of Standards has for some time been carrying out research work on radio communication with various types of aerial, as a result of which it is possible to calculate in a simple manner the distance a given receiving antenna will receive signals from a given transmitting antenna, when the current in the transmitting aerial, the dimensions of the aerial and the distance between the two stations are known.

DETERMINATION OF THE OUTPUT CHARACTERISTICS OF ELECTRON TUBE GENERATORS. Lewis M. Hull, Assistant Physicist, Bureau of Standards. (*Bureau of Standards, Washington; Scientific Paper, No. 355, December 1st, 1919.*)

In this paper a method of analysis is presented by means of which it is possible to design a circuit to obtain maximum output from a given three-electrode valve for generat-

ing alternating currents suitable for wireless telegraph and telephone sets, or, conversely, to select the valve which will furnish with reasonable efficiency its maximum power to a particular output circuit. The paper is partially mathematical and contains a number of graphs. It also includes however, two simple diagrams—(1) Direct-coupled Generating Circuit, and (2) Output Circuit.

THE EMPLOYMENT OF AUDIONS OR THREE-ELECTRODE LAMPS DURING THE WAR. General G. Ferrié. (*Revue Générale de l'Electricité; Paris, December 27th, 1919; pp. 933-935.*)

A recapitulation of the progress made during the war in wireless telegraphy and wireless telephony by the French Military authorities, with particular regard to the use of three-electrode valves. Such valves were used from the very first months of the war, but their employment on a grand scale was not organised until 1915-1916. The author of the article is Director of the French Military Wireless Service.

CONDENSERS. A. V. Ballhatchet, M.J. Inst.E. (*The Model Engineer and Electrician; January 15th, 1920; pp. 51-54.*)

An article dealing in detail with the construction of various types of condensers suitable for wireless. Diagrams accompany the article, which covers more than three pages.

TRIODE VALVES AS ELECTRIC AMPLIFIERS. Dr. W. H. Eccles. (*Nature; January 15th, 1920; pp. 501-502.*)

The amplifying qualities of three-electrode valves are now widely known, and the above article by Dr. Eccles is an interesting contribution to the subject. Three diagrams are given.

FIRST ANNUAL CONFERENCE OF AMATEUR WIRELESS SOCIETIES

The First Annual Conference of Affiliated Wireless Societies was held at 3 p.m. February 27th, in the Library of the Royal Society of Arts, John Street, Adelphi, W.C., The meeting was convened by, and held under the auspices of, the Wireless Society of London. Sir Charles Bright, F.R.S.E., M.I.E.E., M.Inst.C.E., officiated as Chairman, being supported by Admiral Sir Henry B. Jackson, G.C.B., K.C.V.O., F.R.S., Mr. F. Hope-Jones, M.I.E.E., Mr. Basil Binyon, O.B.E., Commander F. G. Loring, R.N., and Mr. H. L. McMichael. During the proceedings Commander Loring made a statement relative to the policy of the Post Office in regard to amateur wireless work.

At the close of the Conference tea was served, and the meeting adjourned at 4.30 p.m., and proceeded to Marconi House where, by courtesy of Marconi's Wireless Telegraph Company, Limited, the delegates were shown two cinematograph films of wireless subjects.

The following is a full report of the proceedings of the Conference.

Sir Charles Bright: There are two examples, gentlemen, that I think may perhaps be worth mentioning, of the highly advanced stage of wireless work of all kinds that we are now in. The first is that in about five hours' time, those of us who go to hear Mr. Campbell Swinton's address, will also have the opportunity of hearing wireless telephony of a very advanced kind, from the Marconi Company's works, at Chelmsford, to all manner of far-reaching points, such as Ascension. We shall all equally have the opportunity of listening in. The other example is this meeting, which I think one may say marks an epoch in wireless work. The object of this meeting, as I expect you all know, is to consider the question of the affiliation to this Society of various Wireless Societies and Clubs throughout the United Kingdom. I think the best thing I can do now is to call upon Mr. Hope-Jones, who has everything to do with our Wireless Society of London very much at his fingers' ends—a great deal more, I am afraid, than I have—to read to us a list of all the Wireless Societies and Clubs, and also a separate list of the delegates of those Societies and Clubs who have favoured us with their presence to-day.

Mr. F. Hope-Jones, M.I.E.E. (Chairman of the Wireless Society of London): Sir Charles Bright and gentlemen, the Wireless Societies of this country appear to be twenty in number, at least these are all whose existence has been ascertained by the Executive of the Wireless Society of London. I propose to read to you a list of the fifteen who at this moment are affiliated under our proposal to the Wireless Society of London. I shall mention the other five afterwards, and I dare say some information will be contributed regarding them by other gentlemen here. The order in which I shall read them is of no importance, being merely geo-

graphical. Starting at the north with the Glasgow and District Radio Club. They have not been able to send delegates to this meeting, the distance being too great. The Southport Wireless Experimental Society; the Manchester Wireless Club; the Radio Scientific Society, Manchester; the Altrincham and District Wireless and Scientific Society; the Sheffield and District Wireless Society; the Derby Wireless Club; the Burton-on-Trent Wireless Club; the Bristol and District Wireless Association; the Plymouth Wireless Society; the Three Towns Wireless Club, Plymouth; the North Middlesex Wireless Club, Enfield; the Wireless and Experimental Association, Peckham; the Woolwich Radio Society; and the Brighton Radio Society. I will now read three letters which have been sent in lieu of delegates:—

The Burton-on-Trent Wireless Club.

"This Club is of the opinion that it is highly advantageous to all Clubs in the United Kingdom to affiliate with the Wireless Society of London, in order to facilitate mutual protection and assistance for Amateurs, and especially in regard to the removal of the restrictions of D.O.R.A., which are so handicapping amateurs at the present time."

The Derby Wireless Club.

"Restrictions will tend seriously to hamper progress in this country, as compared with, say, America. We do not see why experimenters should not have a definite wavelength allotted to them, say, 200 metres. With sharply tuned valve transmitters it is most unlikely that any serious interference could occur, and the licence could, of course, be easily revoked in necessary individual cases, where complaints have been made.

As regards the matter of 'affiliation,' the club has already signified its approval by acquiescing

CONFERENCE OF AMATEUR WIRELESS SOCIETIES

in the London W/T Society's suggestion when made."

The Altrincham and District Wireless Society.

"The Society is quite young, but consists of some real enthusiasts, who are out to make the Society one of the biggest and best in the north, and they are proud to become affiliated to the London and parent Society.

They feel that the benefit obtained by being in touch with the best and latest Wireless news will be a great help in their steady progress.

They also feel a certain amount of protection in being a part of so distinguished a Society, which has the interest of their smaller brethren at heart.

They tender their best wishes for the success of the Conference, and the prosperity of the Wireless Society of London."

The other Societies I will name now. The Birmingham Wireless Association. The question is under their consideration, and I presume it is sufficient to point out that they are part and parcel now of the Birmingham and Midlands Institute, an old-established scientific society. I think they have hardly had time to consider the matter. We have received no replies to our suggestions for affiliation from the following four societies: Stoke-on-Trent Wireless Club; Leicester Radio Society; Wolverhampton Wireless Association; and Chelmsford Wireless Club. I have no doubt there is a very simple explanation for that. Probably in some cases these Societies, if they were established before the war, have not been resuscitated since. We are a little bit early, perhaps. In one case, that of Chelmsford, the proposal to form that Society is only just set on foot, and it is hardly a sufficiently active Society to adopt our proposals. The Chairman will permit me to say that it must be a source of gratification that a scheme such as we have proposed has been so rapidly appreciated and so well responded to. (Applause.)

Sir Charles Bright: First of all, gentlemen, I should like to give you a very hearty welcome on behalf of the Wireless Society of London. Besides the delegates of the Societies and Clubs that Mr. Hope-Jones has referred to, which I believe were mostly formed about a year before the war, we are honoured by the presence of Commander Loring, on behalf of His Majesty's Postmaster-General, and also other representatives of the Post Office, and although Colonel Wace, the Chief of the Wireless Board, is unable to be present, I believe there are representatives of his staff who are present. Then, again, we are also greatly honoured by one of our Vice-Presidents—a man whose name will go down in history connected with wireless work—Admiral of the Fleet, Sir Henry Jackson. (Applause.) To start the ball rolling, I think it might be well if I gave some rough idea of the main agenda of the Conference. The first object of the Conference, as I have already indicated, will be to obtain a frank and full view of the question of affiliation with the Wireless Society of London. Any recommendations that are made will be taken careful note of by our

Society, but this is not a meeting at which resolutions will actually be proposed or considered. Then the next question, and it is a very important one, will be that as to whether this Conference shall be carried on from year to year, and whether it shall be in London, and what time of the year will be likely to be most convenient for all parties concerned. Then we especially want to know what His Majesty's Post Office can do for Amateur Wireless Telegraphy and wireless work generally, in regard to the regulations governing the use of wireless in private stations. In this connection it is right that the delegates should be informed that those of us here in London who have had contact with the Post Office have always received great sympathy in connection with the work of the wireless amateur, and the fact that Commander Loring is with us here to-day gives strong evidence of that. The question that is, I suppose, of most immediate interest is as to whether there can be any real relaxation of some of the conditions that apply to wireless work, especially perhaps as to that condition which expects "some definite object of scientific value or general public utility." I have quoted the words; they are from one of the clauses of the conditions. The question is, what prospect is there of relaxation now? As a possible argument in favour of relaxation, I may remind you that history shows that many an invention comes in a general way, not in connection with scientific research, though, of course, we all want to see scientific research given a greater opportunity than it had before the war. If I am correct in telling you that history shows that many an invention arises from purely practical work surely that is an argument in favour of some relaxation. Another point is, as to whether the Defence of the Realm Act can be now relaxed in the matter of demanding a permit to purchase and sell wireless instruments. Then, again, as to whether the existing limitations as to receiving apparatus cannot be extended or altogether removed. I think I have given you a rough idea of our scope, and I will now ask Mr. E. Blake, the delegate for the Three Towns Wireless Club, to favour us with his views on any of the subjects here set forth.

Mr. E. Blake, A.M.I.E.E. (Editor of the *Wireless World* and Vice-President of the Three Towns Wireless Club): Sir Charles Bright and gentlemen, the Three Towns Wireless Club unfortunately are unable to send a delegate and they have asked me, as one of their Vice-Presidents, to represent them. All I need say on their behalf is that they are a very active and enthusiastic body, and are quite prepared to shoulder whatever proportion of responsibility may fall to their lot as participants in this affiliation. I may say that in this affiliation and this first Conference I see the realisation of one of my minor ambitions; but although I say it is a minor ambition, it is by no means unimportant. First of all, with regard to the question of what we may do and what we may not do, I should have preferred to hear first what Commander Loring has to say on the matter, as I understand he is to speak along those lines; but

there can be no two opinions amongst amateurs as to what we *want*. There is great divergence of opinion as to what *can* be permitted and what *should* be permitted. Personally, I should be inclined to suggest that the size of an aerial for a reception might be considerably enlarged, especially in cases where a man only intends to use a crystal. I cannot see any objection to an aerial ten miles long in such a case. Unfortunately we who are not in Government Departments are not in possession of all the considerations that must be taken into account. Therefore, I really hesitate to make any further suggestions. There are a number of schemes, no doubt, that the Government have in mind, of which I myself and many others here are quite ignorant. Therefore, I do not venture to suggest anything further than an alteration in the size of the aerial allowed for reception. With regard to the holding of an Annual Conference, I am fully in favour, of course, and I should like, if I may say so, to see a little stress laid on research. Research is very often considered to be a thing demanding a trained scientist, but, as a result of our recent competition in the *Wireless World*, I have found that men who have been trained in the elements of wireless telegraphy are quite able to make accurate observations of great value to the more highly-trained men who can fit the facts into their places. When I think of some of the gentlemen who are members of Amateur Clubs—many of them are eminent engineers and scientists—I feel that the general trend of the affiliation's work might perhaps be along the lines of definite research. I sincerely hope that these Conferences will be annual events, and that we shall have the pleasure of hearing papers read and of having a Conference upon, not only business, but perhaps scientific subjects. One suggestion that has come into my mind is more of a business nature. It is that possibly it would be as well if we could establish a central fund, which should be the property of the affiliation as distinct from the individual clubs, to provide against expenses incurred on account of Conferences. As I am here in a dual capacity, you will permit me to add a few words as Editor of the official organ of the Wireless Society. I want to say that I hope the Secretaries of all the clubs will take the fullest advantage they can of the facilities now open to them as members of the affiliation. These are exactly the same facilities as are enjoyed by the Wireless Society of London, but are available in a lesser degree, for obvious reasons. There are so many of us. Perhaps at some future happy period, when the affiliation is a great and important body—and I see no reason why it should not be—we shall have a Journal of our collective proceedings, which I hope will be greatly sought after by the scientific institutions of the world. (Applause.)

Sir Charles Bright: Before calling upon the next delegate, I want to say that it seems to me it will be best if, to begin with, we confine ourselves to the first subject—that is, the question of affiliation—which was, as you will remember, first proposed in a letter by our President, Mr. Campbell Swinton, early in December which was sent to all the Wireless Societies and Clubs. I think, on the whole, that

will be the best plan. I will refrain from calling on Commander Loring to begin with, because I think it would be very much better for him to have before him all the ideas of the various delegates. Then, perhaps, he would tell us anything he can to meet any of the remarks that are made. Before calling upon Mr. Yerbury I would remind you that we are due at Marconi House to see some work they will be good enough to show us in about one-and-a-half hours' time, and when we have finished this more or less formal discussion we are going to talk over the teacups in an adjoining room or this room, and I hope, as a result, we shall all get to know each other a little better; so I think we shall have to confine ourselves now as closely as possible to the main points under discussion.

Mr. H. E. Yerbury, M.I.C.E., M.I.E.E., M.I.M.E. (President, Sheffield and District Wireless Society): Sir Charles and gentlemen, at the outset, as representing the Sheffield and District Wireless Society, I desire to express our thanks for the invitation you have kindly given us to attend the Conference this afternoon. There are a few points I want to bring forward regarding our views on the matter of affiliation and working of wireless societies. The first I think is the importance of obtaining transmitting licences. No licence has yet been granted to any member of our Society or the Society itself in Sheffield. We desire to uphold any proper regulations which are imposed on us, and we think it is far better the thing should be done in a proper and regular way. I am afraid some members will have to admit that we have done those things we ought not to have done, but there is still health in us; so what we desire is, that restrictions should be waived, if possible, early. I trust that by concerted action our claims will be brought forward and certain working conditions amended by the Government Department. We think a reasonable wavelength and sufficient power should be granted to enable members of different societies, or at least the societies themselves, to communicate with each other. We think permission should be granted to use C.W. as well as spark transmission. Another point that we should like to bring forward is a proposal for inter-club visits. We think there might be arranged occasionally outings to inspect some of the large wireless installations in this country. Another matter that we think worthy of discussion is whether an invitation should not be extended to the authors of some of the London papers to come to the Provinces, give us the benefit of their paper and have a discussion. We think that would be conducive to increased membership. We also suggest that representations should be made to the Government on the subject of the release of Army wireless gear. We think there must be a large quantity in the country, and many wireless societies and amateurs, I feel sure, would like to purchase some of the apparatus. Perhaps in the near future one may hope that the work of your Society will be of such magnitude and importance that a seat might be offered on your Council or Committee to a representative of a local or provincial society. I may say that we have every hope and confidence

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that affiliation between your Society and the Provinces will be an advantage to every member engaged in this fascinating subject. (Applause.)

Sir Charles Bright: We have had two very interesting and instructive speeches, and, as these have both covered the whole ground, perhaps we had better, after all, continue in the same way that we have begun—that is, by every delegate saying all that he has to say on any of the points, and then, of course, unless any special question arises, we shall consider that everybody, having once spoken, has finished speaking.

Mr. A. L. Megson (Manchester Radio Scientific Society): Sir Charles Bright and gentlemen, I have not very much to say about our Society. It closed during the war, is just resuscitated, and it is like forming a new Society again. We have a few of the old members, but a great many were lost in the war. We were formed in 1913, and I think we look upon this affiliation as giving the necessary backing, not exactly to fight, but it will give the whole thing weight, as it were. The one point I should like to bring forward is with regard to transmitting. It is this. Does the affiliation give us the same advantages as the members of the London Society? In applying for a transmitting licence we understand that the Post Office require a Certificate of Proficiency from the London Society. I am not clear on it, but one of our members has written to your Society, and the reply is that it is outside your province to recommend members outside your Society. Does that mean that we cannot get transmitting licences unless we become members of the London Society? That is the point I wish to raise and upon which we are not quite clear.

Mr. Knight (Wireless and Experimental Association of Peckham): Mr. Chairman and gentlemen, unfortunately the Secretary of our Association, who I hoped would have attended with me to-day, is unable to attend, so that the particulars under discussion at the last Committee meeting I have not before me. But there are one or two small points upon which I might touch. There is the question of affiliation. I am greatly in favour of it, and I think that as the London Society started in 1913, and are making fair progress now, we shall find it a great advantage in all ways. The second item is the Annual Conference, which I think will be a splendid thing generally for provincial societies as well. I might make a suggestion on that. It was queried whether the Conference should be held in London in future. Our friends who come from the north have their expenses in London, and, of course, they have to pay their fares, and I would suggest that if this Conference is made an annual affair, we should hold it alternately in the Midlands and in London. As to transmitting licences, there is no member of our Association in possession of one. I believe about half a dozen of them applied, but without results. The instructions from the General Post Office are that unless they can produce evidence that the station in question will be of scientific value, or public utility, the licence will not be granted. But the Chairman

said that many small discoveries are found out by accident—I will put it in that way. Personally, I have had very similar cases, and several members of our Association have brought things before me, quite of an elementary nature; but I think if they were granted transmitting licences they might produce something of public utility at a later date. The question was also raised, I believe, by Mr. Yerbury, that some of the members might wish to purchase some of the ex-Army material. That, I think, would be very useful. The American, British and French apparatus, and some of the material that is knocking about, would, I think, if it were put on the market, be very useful, and enjoyed by all members. Those are the only things I have to say at the moment. (Applause.)

Sir Charles Bright then called upon Lieutenant E. R. W. Field, the delegate of the Southport Wireless Society, but that gentleman was not present.

Mr. W. P. Rogers (Hon. Secretary, Brighton Radio Club): Sir Charles Bright and gentlemen, I have really too much to say to tell it all to you, so as we are short of time I will say what I have to say very briefly. The question of affiliation has been definitely settled by our Society, and we heartily agree that it is a very fine proposition, and one to be readily accepted. The advantages are, I am told, and so I believe, very great. I might mention that I have a licence to receive, and I could, I think, with the amount of knowledge that I already possess, have obtained a transmitting licence had I pressed for it. I had one in Canada during the war. Before coming to England, in 1914, I was Secretary of the Calgary (Ontario) Radio Society. That was before the war; but when I went back to Canada as an inmate of a sanatorium I applied to the Government of Canada for permission to install a receiving and transmitting experimental station, and I received the licence within four days. We also have two hundred metres of aerial allowed, and you have less. I will just leave this to the consideration of Commander Loring, who perhaps knows better about it than I. I might mention that the difficulty that lies in the way of the amateur with regard to the length of an aerial is one that lies in my way at the present moment. I have a position at the back of a yard, where there is a factory with a very high chimney, and if I were allowed to extend my aerial a few more feet it would save me the cost of a thirty or forty feet pole, at two shillings a foot. Because I cannot extend my aerial a few more yards I must lay out this extra expense. Now, we have inside aeriels, but I am talking about the amateur who likes to have an aerial up, not possessing the more advanced instruments which will receive on an inside aerial. At present our members are very junior members, but we are forming a senior section. I find that the enthusiasm in Brighton is really unbounded. We want to get on the right footing, so as to get other gentlemen of Brighton who are members of the Wireless Society of London, and of much more ability than the members of my Society or myself, to give us a helping hand, and with the affiliation of this

Society I think everything is in favour of a very successful future. (Applause.)

Mr. A. G. Arthur (North Middlesex Wireless Club): Sir Charles and gentlemen, I came here this afternoon more with the idea of listening than of speaking: but, as delegate of the North Middlesex Wireless Club, I have a duty to perform to my Club, and in doing so I will take a leaf out of the Postmaster-General's book when dealing with our aeri-als, and cut my remarks as short as possible. I should say, before I go on to my own remarks, that my Committee have asked me to place on record their very great appreciation of the warm welcome extended to the members of the North Middlesex Wireless Club by the Wireless Society of London at their meetings. They have also charged me to say that they are unanimous in the feeling that the affiliating of all the principal Wireless Clubs in the United Kingdom is a step in the right direction, and that it will have a very far-reaching effect, inasmuch as the various members of these different clubs will come into contact, and there will be an interchange of thought which no doubt will make for an advancement of that science in which we are all so very interested. In concluding my very brief remarks, I should like to extend to all clubs, or members of all clubs, on behalf of the North Middlesex Wireless Club, a very hearty welcome to any, or all of our meetings.

Mr. J. M. Ellam (Hon. Secretary, Woolwich Radio Society): Mr. Chairman and gentlemen, like our friend who has just spoken, I was not prepared to speak, but I should like to wish the meeting every success possible. There is a question probably of interest to all of us. Some of us have had our licences for receiving stations less valves. May I ask whether it would be possible for members of Societies to use valves, apart from the aeri-als, to carry out any experiments they may have in mind, rather than wait for the General Post Office to let us have the licences. It might save a little time with regard to any incidental inventions such as have been mentioned. The representative of Sheffield made a very good suggestion with regard to inviting other Societies to lectures. I should very much like to confirm this. I had the idea some time ago of writing to the various Societies offering help from ourselves to them, and asking it for ourselves. We have a very good lecturer in Mr. James, an expert in directional wireless, who will, I have no doubt, be pleased to visit other Societies, and we shall be pleased to see anyone from other Societies with us. I think it would add a great deal of strength if we communicated with each other personally as well as by wireless. (Applause.)

Mr. W. R. Wade (Bristol Wireless Association): Mr. Chairman and gentlemen, I am afraid I am a very poor representative of Bristol. My co-delegate should be here, but I am afraid he is not, and I have had a letter since I left Bristol, ten days ago, asking me to represent him. I know very little about the Bristol Club. I have only been out of the Flying Corps ten days, and have had very little chance of doing anything there.

The Bristol Club have sent a letter to say they heartily agree with the affiliation of all the principal Clubs with London. What it would be quite impossible for them to get by their own efforts they will get through the London Society, who, I think, know a great deal more than the members of our other Clubs, many of whom are mere boys, or quite young men, at any rate. One thing that has been mentioned before is the question of permits for the purchase of material. I know one case where one of the members had to wait for three months to obtain half an ounce of crystals. I quite understand the reasons for delay: I have not been in a Government Department for four and a half years without knowing that one gets piled up with thousands of papers, but I would like to suggest that some arrangement should be made whereby a member of an affiliated Society should be granted a card allowing him to purchase various wireless things from a firm licensed under the Post Office to sell such things. It might save months, and allow us to go on with work we cannot do at the present time. I cannot say much about the Club in Bristol; I make Bristol my home, but previously I was a member of the Derby Society (as I am now), and am a member of the Manchester Radio Scientific Society.

Major B. Binyon (Vice-Chairman, Wireless Society of London): Mr. Chairman and gentlemen, it has been very pleasing indeed to see so many of our affiliated Societies represented here to-day, and I should like to add what the Chairman has already emphasised, our welcome to you on behalf of the Wireless Society of London. I must say that I attach very great importance indeed to the amateurs' work. I happen to be one who started about 1902 as an amateur, and became a professional, and still regard myself as combining amateur and professional. It has come to me very forcibly that during the war, where I happened to be in charge of experimental work for the Air Force, that the amateur turned out to be of very great value. I know a great many men who started as amateurs, and who, with the knowledge they gained in working on wireless throughout the war, have turned out to be some who rank among the first-class wireless engineers to-day, and if it had not been for the fact that they had taken, prior to the war, an interest in the wireless matters probably they would not have felt inclined, or might not have had the opportunity, of being roped into the many useful branches of wireless work which were carried on throughout the war. Therefore, I cannot help feeling that it is a very important matter for all amateurs that they should have facilities for carrying out experimental work. Commander Loring knows that I happened to sit on a Committee with him while I was still in the Service, that was discussing this very question. It is not for me to say anything about that, but I should like to bear out the fact that the amateur position was considered very thoroughly from every aspect, and, of course, it was a very difficult question indeed, but I hope that none of you here will feel that the Post Office has not given very deep, and I might say earnest, consideration to this question. If some of you

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feel that things have not moved so fast as they ought to have done I do not believe that the Post Office is in any way at fault. It is a very difficult problem and interlinked with many others which have to be considered at the present time, and which it is hard for us all to realise. There is one question I should like to ask Commander Loring; that is, regarding the use of a non-radiating, or artificial aerial. Those of us who are amateurs may not welcome the idea of using artificial aeri-als. It is, as it were, working without the cream and pleasure of establishing communication. Yet, on the other hand, it must be an admitted fact that a good deal of very useful work and scientific investigation can be done on an artificial aerial. I do not quite know exactly how we stand in that respect, regarding the obtaining of licences. I presume, of course, we have to have a transmitting licence to use an artificial aerial, but I should like to have Commander Loring's views as to whether he thinks that might possibly be one of the intermediate steps towards gaining the licence for radiating aeri-als. Questions have been raised about the sale of Army material. That, of course, is a difficult matter, about which I cannot speak. I believe one of the difficulties in the way has been the patent situation as regards such sales. Throughout the war thousands of people, we might say, have been taking out patents covering all kinds of things, and this has made the position very complicated. In conclusion I just wish to emphasise again how very glad we are to see all the delegates here, and I should like also to express the hope that this Conference will become an annual one. (Applause.)

Sir Charles Bright: Those of us who know what fine work Major Binyon has done will, I am sure, feel as I do that his remarks form a very happy conclusion to the debate. At the same time, before calling upon Commander Loring to tell us anything he can, I should like to ask if there is any gentleman present who has not so far addressed the meeting, and who wishes to do so.

There was no response to this appeal, and the Chairman continued: Receiving no response, I hope now that Commander Loring will tell us what he can. Before sitting down I will make one little plea. I do not know that it has been mentioned yet, but I believe I am correct in saying that on the whole the amateur wireless telegraphist has behaved fairly well during the war. No doubt small sins have been committed, but I rather hope that on the whole Commander Loring will be able to give the amateur wireless telegraphist a good character.

Commander F. G. Loring, R.N., M.I.E.E.: Sir Charles Bright and gentlemen, I should like before I start my statement to say that I am very much obliged to Major Binyon for his remarks, because he has made a splendid opening for me by pointing out several of the difficulties that we have to deal with. I have been asked to say a few words regarding Post Office policy in the matter of issuing experimental licences for Wireless Telegraphy, and more particularly licences for the transmission of signals. In the first place I may say that there is no intention of imposing any

unnecessary restrictions on experimenters. Rather it is desired to encourage them, since it is fully recognised that experiment is necessary in the interests of science. At the same time the Post Office is the custodian of Naval, Military, Air Force and Civil interests in this connection. These services make constantly increasing demands on a method of communication which suffers from many limitations. It is true these limitations are being daily reduced by the advance of science, but it is also true that advantage cannot be taken of this advance without the general adoption of a higher standard of apparatus and personnel. Compared with other scientific pursuits, Wireless Telegraphy suffers from one outstanding and peculiar disadvantage, namely, that all users have, so to speak, to work in the same laboratory. The chemist for instance, in the seclusion of his own particular den, can do as he likes without causing inconvenience to persons unconnected with him. But the Wireless experimenter employing transmitting apparatus may make himself a source of grave interference to others over a wide area. Not only therefore must the wireless experimenter be personally qualified to work in the general laboratory, but he must also provide himself with apparatus which is at least up to the standard of efficiency obtained in general practice. Thus it becomes necessary in the public interest, not only to restrict the operations of the wireless experimenter in certain directions, but to insist that he should show himself possessed of qualifications and apparatus which render him fit to be trusted to use a medium of communication which is common to all other users. I feel sure that everyone who gives serious thought to the matter will agree that it is not possible to issue experimental transmitting licences with the same freedom that was accorded in pre-war days. Even receiving licences which make use of valves for heterodyne reception and some forms of amplification must be restricted in the vicinity of certain important public stations. The supersensitive receivers employed at such stations have their disadvantages as well as their advantages. The policy of the Post Office in regard to the issue of licences is by no means stereotyped as yet. Experience of the effect of experimental licences on the general position is wanted, and the Department may perhaps be forgiven if, in the public interest it seems to move somewhat slowly towards a relaxation of the restrictions which were imposed under D.O.R.A. I will now indicate the general lines on which applicants may expect to receive consideration of their requests. It is proposed:—

(1) To issue receiving licences freely to all approved persons, with exceptions as regards the use of valves in certain limited areas.

(2) To issue 10 Watt licences wherever this can be done without interference with Government installations to approved applicants who can satisfy the Post Office that their qualifications, apparatus, knowledge of the subject and objects are sufficiently good to justify the grant. Licences will not be granted for mere intercommunication purposes.

(3) To issue licences for the use of power

exceeding 10 Watts only in special cases. The requirements of paragraph 4 of the conditions of issue must be fully complied with, i.e., that the applicant has in view some definite object of scientific research or of general public utility. The issue of such licences does not rest entirely with the Post Office, but is subject to the scrutiny of the other Departments interested in wireless telegraphy.

(4) To issue licences for the use of an artificial aerial when desired.

(5) To issue special permits for specific tests of apparatus on any power and wavelength over and above the conditions of the licence. Application for such a permit will have to be made in writing at least a week before the test, and it is obvious, I think, that such permits will only be issued to persons who can satisfy the Post Office that they have occasion to try out in practice an arrangement which has been thoroughly prepared in the laboratory.

(6) It is probable that all transmitting licences will be restricted as regards both waves and hours of working. Those over 10 watts, at any rate, are almost certain to be so restricted.

I would add in conclusion that it gives me great pleasure to have an opportunity of meeting so many representatives of the Amateur Wireless movement. As a member of the London Wireless Society and also of the Post Office I am strongly in favour of the affiliation of all provincial clubs with the London body. I think the effect will be beneficial from either point of view. A powerful Society which can place upon its Advisory Committee three such well-known names as Mr. Campbell Swinton, Dr. Eccles, and Prof. Howe, commands attention, and on the other hand the Government must feel that any recommendation made by such a Society is only advanced after full consideration, and is put forward not only in the interests of the Society, but of the country at large.

Admiral Sir Henry B. Jackson, G.C.B., K.C.V.O., F.L.S. : I think, although it is against the rules, I should like to propose a vote of thanks to our Chairman to-day for presiding over this meeting, and I should also like to thank Commander Loring for his very well-considered statement as to the Post Office policy, for it marks a distinct advance over what has been in the past. I think we must now be satisfied for some time. Those special permits for special inventions will be a great boon to many people. I think the proposal to use artificial aerials will have to be adopted by people who want to use transmitters. I happen to have joined the original Research Committee, the Wireless Committee, and I should like to say that I personally, or the Committee of the Board, will be very glad to receive any proposals on research work in wireless; but I must point out that we have a very long list before us. We have gone through it, and classified it, and I think it contains nearly all the troubles wireless is subject to at present, so it will have to be something new before it is worth sending. We have a list of fifty or sixty

things, and we think it contains all the troubles that we know to exist in wireless. Radiation is a very important study, and will take some time; we are not a closed book on that, working for Government Departments. We shall be very glad to receive suggestions, and later on I hope we shall be able to issue our results, as there is no intention of keeping things secret. I would like to add a word about not being able to purchase things. I went into a shop to buy some crystals. I did not want them for wireless work, but for something else; yet the man refused to sell them to me because I had not a licence from the Post Office. (Laughter.) Gentlemen, I move a vote of thanks to our Chairman for presiding this afternoon. (Applause.)

The vote of thanks was unanimously accorded.

Sir Charles Bright : Gentlemen, before once more calling upon Commander Loring I should like to say that, of course, I feel very guilty in not having made any allusion to his previous remarks—except what I did with my hands—but at the same time what was said came very much better from Admiral Sir Henry Jackson than anything I could say.

Commander F. G. Loring : There will be a report of this meeting, no doubt, in which case the points which have been raised will come under the notice of the Post Office. There are, however, one or two questions which I can answer at once. As regards the limitation of the size of receiving aerials, I do not think this restriction, even if rigidly enforced, would necessarily limit the field of the experimenter. As regards the position of the London Wireless Society, it was asked if its members would have any advantage over others in the matter of obtaining licences. They would not; all applications are treated alike. Another gentleman said that he would be able to get a licence in Canada, or America, without difficulty and without delay, and asked why it should be difficult in the United Kingdom. Assuming that he is correctly informed, the answer is, he should look at the map. The United Kingdom is probably the most congested wireless area in the world, and corresponding precautions are necessary to preserve the satisfactory communication of the essential services. Someone asked if I could give the amateur experimenter a good character in the past. I am glad to say that I can do so. With one or two exceptions, we had very few cases of complaint indeed. I am not including in the category of *bona fide* amateurs the several hundred persons who, on the outbreak of the war, were discovered to have erected stations without any licence at all. In conclusion I hope no one will think that applications for licences are either unnecessarily delayed, or will be at any time turned down without the most careful consideration. Some delay there must often be, owing to the important interests connected with the use of Wireless Telegraphy, but as we settle down after the war and get into routine I hope that delay will be minimised.

Sir Charles Bright : With Captain Loring's assurance I think we can very well close our meeting.

Wireless Telephony and Railway Strikes

An account of a Wireless Telephony System of Communication between the Great Railway Centres which was established during the Railway Strike of 1919.

OWING to the Railway Strike of September and October, 1919, there was a grave danger that the whole industry of this country would be paralysed, and it was speedily realised that an effective means to that end lay in the hands of the strikers, for by cutting the lines of communication on the railway they would quickly stop what little traffic was running.

It was then that the Government, with a view to linking up all the railway centres by wireless telephony, approached the Marconi Company, so that if the railway telephones were tampered with it would still be possible to ensure a rail service for the movement of foodstuffs and other essentials.

The Marconi Company at once agreed to supply both stations and personnel. It was decided that the $\frac{1}{2}$ K.W. Portable Set, Type YC 1, should be used, as this set is entirely self-supporting as regards electric supply.

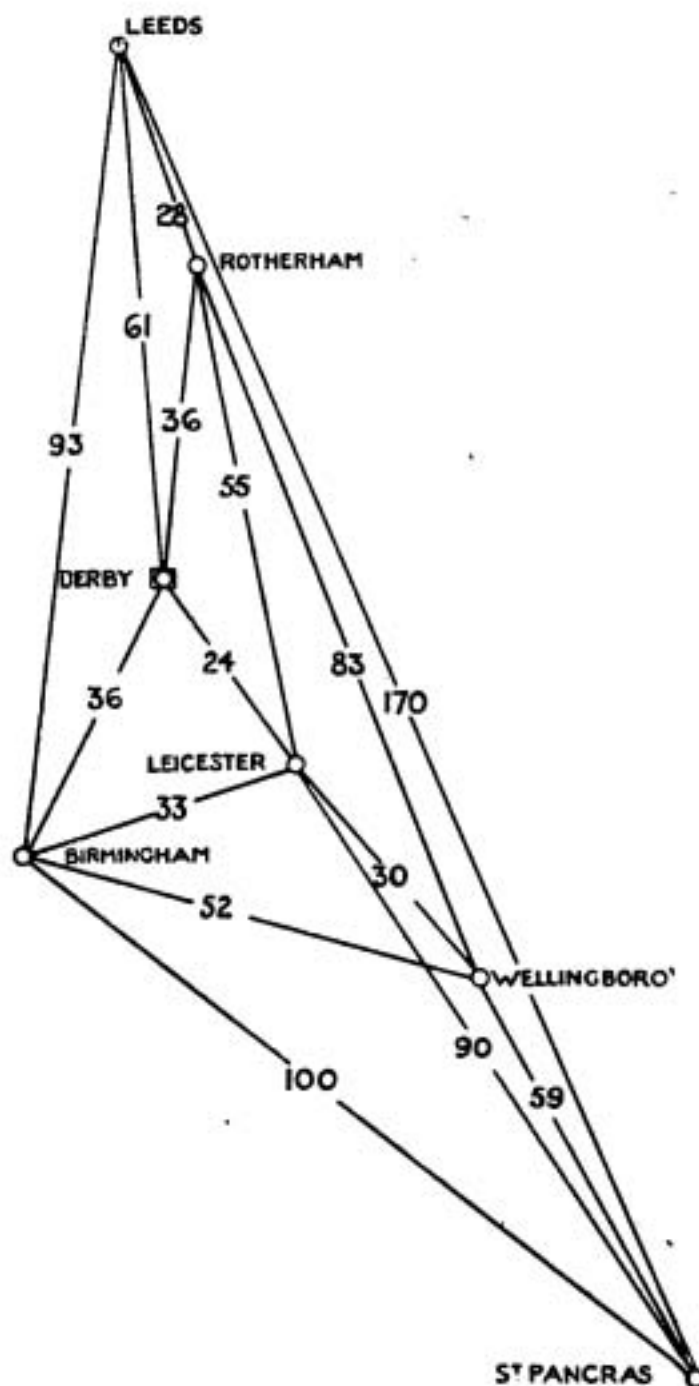
After consultation with the Railway Managers on Thursday, the 3rd October, it was decided to commence operations by linking up the main goods centres on the Midland Railway, to be followed by a similar service on the Great Western, North Western, and Great Eastern Railways respectively.

The Midland Railway centres selected were as follows: St. Pancras, Wellingboro, Leicester, Birmingham, Derby, Rotherham, and Leeds, and seven stations were allotted for this railway, together with a staff of four men per station. This number was required as the stations would be running both night and day.

By Monday afternoon all stations had been erected and were in touch with each other, speech being reported good and clear in all cases, with the exception of Leeds, where great difficulty was experienced in obtaining a suitable site at short notice.

Two outstanding features of the scheme are

worthy of notice. Firstly, the mobility and adaptability of this type of station, and secondly, the certainty with which communication can be maintained between important centres by wireless telephony, when other means have been put out of action.



The figure shows the position and distances in miles between the stations.

WIRELESS CLUB REPORTS

We shall be pleased to insert in our columns, free of charge, Notices and Reports of Meetings and other activities of Amateur Wireless Clubs. Such Reports, etc., should be forwarded as soon as possible after the event, to ensure early publication.

The Wireless Society of London.

On February 27th, in the Lecture Hall of the Royal Society of Arts, Mr. Alan A. Campbell Swinton delivered his presidential address, entitled, "Some Wireless Wonders." As usual, he attracted a crowded and appreciative audience. A full report of the address, with illustrations, will appear in our next issue.

Intending members of the Society should apply to the Hon. Secretary, Mr. H. L. McMichael, 32, Quex Road, West Hampstead, N.W.

Plymouth Wireless Society.

(Affiliated with the Wireless Society of London.)

A Wireless Society has been formed in connection with Plymouth and Devonport Technical Schools, with an initial membership of eighty, which promises well for the future. The following officers have been elected:—*President*, W. S. Templeton, M.A., B.Sc., A.M.I.E.E.; *Vice-President*, J. K. A. Nicholson, A.M.I.E.E.; *Chairman*, R. C. Laws; *Treasurer*, T. C. Andrewartha; *Hon. Secretary*, W. G. Terry; *Librarian*, T. H. Harwood; *Committee*, Messrs. S. E. Smith, W. Southard, W. J. Roper, E. Oldridge, W. Sampson and S. P. Branton.

At the opening meeting of the Society in February the subjects for study and discussion were taken by two of the members. Mr. R. C. Laws delivered an interesting and thoughtful paper on "The Advantages of Wireless Telegraphy as an Efficient Commercial Link in Telegraphic Communication." In the discussion which followed the lines upon which Wireless is likely to develop as a commercial asset were considered. Mr. B. Hoskings gave an able and lucid paper on "Safety Devices used on the 1.5 Kilowatt Marconi Standard Installation." Appropriate demonstrations were given on the Wireless Installation, illustrating the subject of the paper.

The Society gives promise of a useful and helpful future, and is open to all students, past and present, of the Plymouth and Devonport Technical Schools.

Particulars can be obtained from the Hon. Secretary, Plymouth Technical School, Tavistock Road, Plymouth.

February 13th.—Mr. S. V. Branton in the chair; and, with a full meeting, Mr. A. R. Winter gave a paper on the "Progress of Wireless Telegraphy"—a short sketch of the history of development of Wireless Telegraphy, with references to the work of the scientific men who have assisted to bring it to its present state of efficiency. A paper on "Spark Dischargers," by Mr. H. W. Harwood, was also read, in which the advantages and disadvantages of the quenched spark system were considered.

February 20th.—Mr. R. C. Laws in the chair, supported by the Committee. Mr. H. D. Pearce lectured on "Trench Wireless on the Western Front, 1915-18"—an interesting paper, detailing experiences and describing various trench wireless sets used by the Infantry and Artillery in offensive

warfare on the Western Front. This was followed by a lecture on "Valves," by Mr. E. J. B. Travers, who commenced with the historical development of the valve and then led up to the difference between "hard" and "soft" valves and their action. The lecture was clearly illustrated by practical experiments with a valve.

February 27th.—Mr. R. C. Laws in the chair. The following two papers were given by special request of the members: "Formation of X-rays," by Mr. D. J. Trotman, and "Incidents in a Voyage to the East," by Mr. H. J. French.

The Altrincham and District Wireless and Scientific Society.

(Affiliated with the Wireless Society of London.)

This Society is quite distinct from the two Manchester clubs.

The following officers have been elected:—*President*, Major Hamilton, M.P.; *Vice-President*, Mr. F. O. Read; *Hon. Secretary*, Mr. W. N. Lambert, Breeze Crest, Plane Tree Road, Hale, Cheshire. The Hon. Maurice Egerton has been elected an hon. member.

The wireless telephone experimental programme of Chelmsford has been picked up here on a single valve set, the circuit of which was devised by our Vice-President, Mr. Read. In view of the fact that we are 200 miles away, this is not a bad performance.

The Society possesses three complete sets of receiving apparatus, a good deal of which has been made by the members.

Intending members should communicate with the Hon. Secretary at the address given.

Manchester Wireless Club.

(Affiliated with the Wireless Society of London.)

The Club is making excellent progress, and a substantial increase in the number of members was recorded last month.

The Committee arranged a discussion, which commenced on February 25th and will spread over three meetings. The subject is "Wireless Detectors, Past and Present." Mr. J. Evans (late R.N.) opened the discussion, in which members freely joined; several gave interesting individual experiences with their various forms of early detectors. The success of the evening was mainly due to the able way in which Mr. Evans led the discussion.

The special interrupter buzzer circuit is working splendidly, and the "jamming" circuit appeals greatly to the members.

The Committee is still open to receive applications for membership, and full particulars can be obtained from the Hon. Secretary, Mr. J. C. A. Reid, 16, Hawthorne Avenue, Monton, Eccles, Lancs.

The Bristol and District Wireless Association.*(Affiliated with the Wireless Society of London.)*

A meeting of this Association was held at 11, Leigh Road, on February 28th, at 8 p.m. The business included election of new members, several being elected.

Mr. W. R. Wade, who represented the Association at the Conference of the Amateur Wireless Societies, gave a summary of the proceedings, which was listened to with much interest.

A letter, received from the Marconi Company at Chelmsford, thanking the Association for notifying them that their telephone message had been picked up clearly on crystal reception by many members, and wishing the Association luck for the future, was read. Meetings will be held in future on Friday evenings unless otherwise arranged.

The Association is now in full working order, and it is hoped that anyone in Bristol and District who is interested in W/T will communicate with the Hon. Secretary, Mr. Alan W. Fawcett, 11, Leigh Road, Clifton. Subscription is at present 5s.

North Middlesex Wireless Club.*(Affiliated with the Wireless Society of London.)*

A meeting of this Club was held at Shaftesbury Hall on February 25th, Mr. A. G. Arthur being in the chair.

Mr. Gartland, who is in charge of the Committee for installing the Club's receiving station, reported that the aerial was now fixed and that signals were being received successfully. Several members had brought various pieces of apparatus, many of which showed a high degree of skill in design and care in workmanship. The library continues to be well patronised, and altogether the Club is in a healthy condition.

In order to meet the increased costs of rent, stationery, etc., and to enable the Club to be run on attractive lines, the Committee has decided to raise the subscription to 10s. 6d. per annum for full members and 5s. per annum for corresponding members.

Those interested can obtain full particulars from the Hon. Secretary, E. H. Savage, "Nithsdale," Eversley Park Road, Winchmore Hill, N.

The Woolwich Radio Society.*(Affiliated with the Wireless Society of London.)*

A meeting of the above Society was held on January 30th, when a general discussion on wireless telegraphy took place.

At the meeting which was held on February 6th a lecture was delivered by Mr. James, who dealt with various types of aerials for direction-finding, after which he was kept quite busy answering questions of interest thereon.

At the meeting on February 13th a paper was read by Mr. J. M. Ellam, in which he explained the principle of the valve, leading up from the two-electrode to the three-electrode valve, with diagrams. The paper was much appreciated by the members.

On February 27th Mr. W. McPherson read a paper on "Continuous Wave and Allied Transmission Systems." He opened by enumerating the advantages of C.W. systems as compared

with spark. He then briefly described the old quenched spark methods of generating C.W., and also referred to the "timed spark" system as developed by the Marconi Company. The work of Alexanderson, in America, was touched upon, and various valve circuits dealt with. The lecturer also dwelt on the arc system, and concluded with a reference to the general features of C.W. reception.

Burton-on-Trent Wireless Club.*(Affiliated with the Wireless Society of London.)*

At the fortnightly meeting of this Club, held on Wednesday evening, March 3rd, at the offices of the "Burton Daily Mail," the members present divided into three parties and adjourned to different stations in the town in order to hear the Marconi Company's representative speaking from Chelmsford. These Wireless Telephony tests have been heard quite distinctly in Burton on every occasion since February 23rd. The message from Eiffel Tower to the Wireless Society of London on February 27th was also received clearly.

The Oxford Amateur Wireless Society.

An Amateur Wireless Club for Juniors has been formed in Oxford under the title of the Oxford Amateur Wireless Society. The maximum age for membership is eighteen years. Full particulars can be obtained on application to the Hon. Secretary, Mr. F. Pickett, 29, Bartlemas Road, Oxford.

New Club at Exeter.

An Amateur Wireless Club is being formed in Exeter. The organiser is Mr. H. E. Allcock, Prospect Villas, Heavitree, Exeter, with whom all interested should communicate. In the near future a demonstration will be given, particulars of which will be notified in due course.

Mr. Allcock would be glad if secretaries of existing wireless clubs would advise him the lines on which their clubs are run.

Wanted.

To form Wireless Clubs at Chelmsford, Croydon, Birmingham, Halifax, Spalding, Doncaster, Gloucester, Bradford, Mountain Ash (South Wales) and Grimsby. Those interested should communicate with Mr. C. E. Jackson, 3, Seymour Street, Chelmsford; Mr. A. F. Lake, 318, Brighton Road, South Croydon; Mr. A. H. Staples, Y.M.C.A., Dale End, Birmingham; Mr. J. R. Clay, "Woodview," Sowerby Bridge, Yorkshire (for Club in Halifax); Mr. W. G. A. Daniels, Pinchbeck Road, G.N.R. Crossing, Spalding; Mr. A. H. Wasley, Glenholme, Ravensworth Road, Doncaster; Mr. J. Mayall, Burfield Lodge, St. Paul's Road, Gloucester; Mr. J. Bever, 85, Emm Lane, Bradford; Mr. A. E. Hay, 6, Oxford Street, Mountain Ash, South Wales; Mr. C. Hewins, 42, St. Augustine Avenue, Grimsby.

In the March issue of the "Wireless World" under "The Amateur in Belgium," p. 726, the name of M. Pierre Tollenaere was given in error as the Secretary of Le Cercle Belge d'Etudes Radiotélégraphiques. This gentleman is the Assistant Secretary, the Secretary being M. G. de Brandner, 76, Rue du Lai, Brussels.

(We regret we are obliged to hold over several reports.)

PAGES FOR BEGINNERS

Under this heading we publish COMPLETE instructional articles, forming a series specially designed and written for beginners in wireless work. Hardly any mathematics will be introduced, and we hope to present the fundamental facts of wireless in such a manner as will prove attractive to a much wider range of students than that for which this series is primarily intended.

WIRELESS WAVES AND WAVE MOTION.

IT is assumed, in writing these articles, that the reader has an elementary knowledge of electricity and magnetism. Such terms as "inductance" and "capacity" and their relation to wireless telegraphy will be explained in due course; but too much space would be occupied here in dealing with first principles.

The word wave instantly suggests the ripples or waves which are caused by disturbing the surface of a pond. These surface waves have many things in common with wireless waves; but there is another kind of wave motion of which it would be as well to speak, namely, the waves of pressure, or "compression and rarefaction."

If we take a block of rubber and compress it, it will return to its original length when the pressure is removed. This is due to its *elasticity* or that property which enables it to recover its shape after being distorted. Another property which all matter possesses is that known as *inertia*. Inertia is that property of matter which tends to prevent any change of motion, *i.e.*, if a mass is at rest, inertia tends to prevent its being moved; if the mass is moving, inertia tends to prevent its stopping.

If we take a long block of metal and strike one end a blow with a hammer, the effect of the blow will not be transmitted instantaneously throughout the metal owing to this property, inertia. Instead, a wave of compression will travel through the metal, taking some little time before it emerges at the other end. The time taken by the wave to travel through the medium depends on the elasticity of the medium. The greater the

elasticity the greater the velocity of the wave.

These waves of compression can be easily demonstrated by the following experiment:—

A number of small balls are placed in a row, a slight distance apart, and the end ball is struck a light blow. The effect will be transmitted throughout their length by a wave of compression, as shown in Fig. 1.



Fig. 1.

Sounds are transmitted through the air by means of these waves of compression.

An important point in connection with these waves, which will be emphasised later on, is that the medium itself does not move bodily. In the case of the balls, after the impulse has been transmitted through the line, they will be found in approximately the same position. We can imagine that, if sounds were transmitted by the movement of the air itself, a powerful note, such as that given by a large organ pipe, would produce the effect of a strong wind!

Let us return to the original idea of the wave motion caused by a disturbance on the surface of a pond. If a stone is dropped in, it will cause a series of ripples to extend outwards in all directions from the centre, which would appear, if observed on a level

with the surface, as in Fig. 2. When the stone strikes the surface of the water, the whole level is not immediately displaced owing to the *inertia* of the water. The water

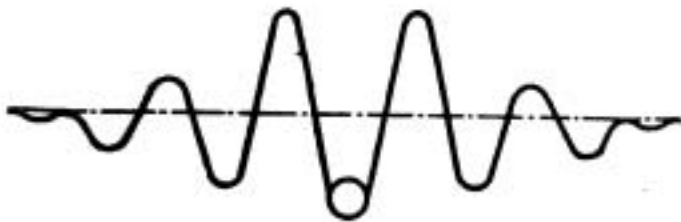


Fig. 2.

immediately under the stone is displaced and forms a heap round it, the height of the heap depending on the force with which the stone strikes the surface. This heap of water tends, as soon as it is formed, to return to the surface level; but, owing to its inertia, it does not immediately come to rest, but falls below the level and moves up and down two or three times before finally coming to rest.

Here, again, it would be as well to point out that the water does not travel outwards, but simply oscillates with an up-and-down motion. This can easily be proved by floating a number of small corks on the surface. As the ripples travel outwards the corks will bob up and down, but when the surface is calm again they will not have moved from their original position.

Before proceeding further it is desirable to define some of the terms used in speaking of waves.

The *amplitude* of a wave is the height of the highest point above the normal level. In Fig. 3 this is denoted by *h*. We see that in wave motion a particle passes through a complete cycle of changes—from the position of rest to a position of maximum displacement, and then returning through the normal level to a maximum position below the level, finally rising to the level again.

The point is said to have passed through a complete cycle or *period*. The *frequency* of a wave, therefore, is the number of complete cycles which occur in a definite interval of time, usually one second.

The *length* of the wave is the distance from one maximum or crest to the next, or from the commencement to the finish of the wave. In wireless this is usually denoted by the Greek letter λ (lambda).

Also, the *velocity* of the wave is the distance it will move in a certain time. Thus, if a wave travels 10 feet in 5 seconds it is said to have a velocity of 2 feet per second.

These "properties" of waves can be expressed in terms of one another, thus:—

$$\text{Frequency} = \frac{\text{Velocity}}{\text{Wavelength}}$$

or, re-writing—

$$\text{Wavelength} = \frac{\text{Velocity}}{\text{Frequency}}$$

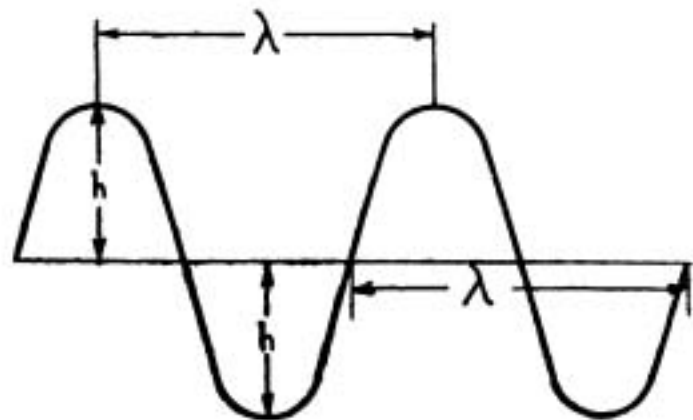


Fig. 3.

Referring to Fig. 3 it will be seen that one cycle corresponds to one wavelength. Hence, if a wave 1 foot long is transmitted at a frequency of 50 cycles per second it is equivalent to saying that it is transmitted at the rate of "50 wavelengths per second," or in other words, 50 complete waves will pass a given point in one second.

Obviously the velocity of the wave in question is 50 feet per second, because the first wave will have travelled 50 wavelengths, *i.e.*, 50 feet, before the last wave has passed the given point.

If the frequency were doubled, and the wavelength remained the same, the velocity would be twice as great, while if the wave-

length were doubled and the frequency kept constant, the velocity would be halved, because half as many waves would pass the given point in the same time. The velocity of wireless waves in space is however, a constant, namely, 186,000 miles per second, or 300,000,000 metres per second.

Scientists have assumed that there is a substance, or medium, which pervades everything, which is the medium through which light, wireless waves, etc., are transmitted. This substance is called the *Ether*. What this "ether" is, and what are its exact properties are still matters for some speculation. We know, however, this, that it resembles a very elastic solid, but yet it offers no appreciable resistance to the passage of any body through it. The ether surrounds the earth; in fact it occupies all space, and yet offers no resistance to the passage of the planets through it. Sir Oliver Lodge proved that the ether was not disturbed by the action of rapidly moving bodies. And yet the ether has inertia, or it would not convey wave motion from point to point.

It is a difficult matter to reconcile these facts, but there is no other manner in which we can explain the phenomena of wave motion in space. The subject of the ether will be discussed at length in a later article.

Let us collect the data which the foregoing examples have afforded us, and apply them to the study of wireless waves.

First, wave motion is produced by a definite cycle of changes recurring at regular intervals.

Waves have the property of radiating from the starting-point in all directions, and travel at a velocity proportional to the elasticity of the medium through which they travel.

The length of the wave remains constant and independent of the height of the wave. Lastly, the most important thing is that the *medium* through which the waves are transmitted *does not travel*.

A very natural question which would be asked here is: "What is it that travels?" In order to answer this we shall have to

consider the various effects produced by an electric current flowing along a wire.

We know that when a wire is carrying a current, lines of electric force radiate from it in all directions, like the spokes of a wheel. Also, lines of magnetic force are created, which take the form of concentric circles with their centre lying on the axis of the wire. The direction of this magnetic force is at right angles to the lines of electric force and to the direction of the current.

Imagine a copper rod standing upright on the surface of the paper, with the current flowing from the paper towards the reader, *i.e.*, upwards. The lines of force would appear as in Fig. 4, and the lines of magnetic force would appear as circles.

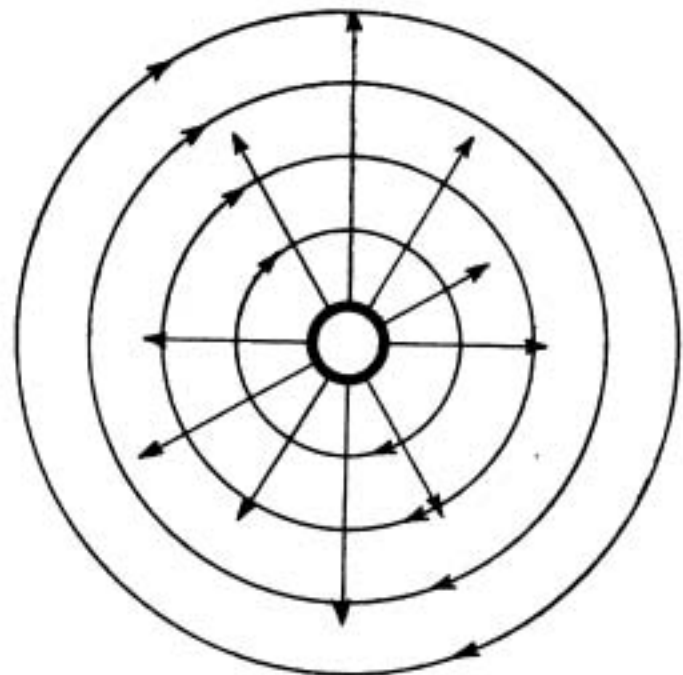


Fig. 4.

Poynting's theorem tells us that whenever lines of electric and magnetic force occur at right angles to one another energy is transferred from that point, into space, in a direction at right angles to the forces. So we have this state of affairs: while the current is flowing, lines of electric force are extending into space in all directions; circles of magnetic force are also spreading outwards from the conductor in ever widening circles, and energy is being transferred into space.

What happens when the current is suddenly switched off? Imagine a reel of twine being paid out quickly to a person a long distance away. This represents a line of electric force. Now, a sudden stoppage of the current is equivalent to suddenly stopping the drawing out of the twine—there is a violent jerk given to the line.

In the case of lines of force, this sudden jerk causes a "kink" in the line which will move outwards away from the conductor. See Fig. 5. Now, each of these "kinks" produces a corresponding magnetic force at right angles, so the stoppage of the current is accompanied by a radiation of energy which expands in all directions round the conductor. If the current were rapidly

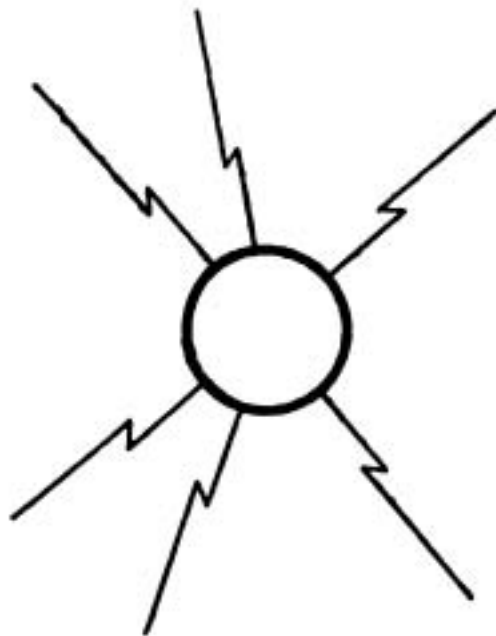


Fig. 5.

switched on and off, we can see that a continuous emission of energy would take place, as each "kink" in the lines of force would be rapidly succeeded by another "kink."

In the case of an alternating current, the

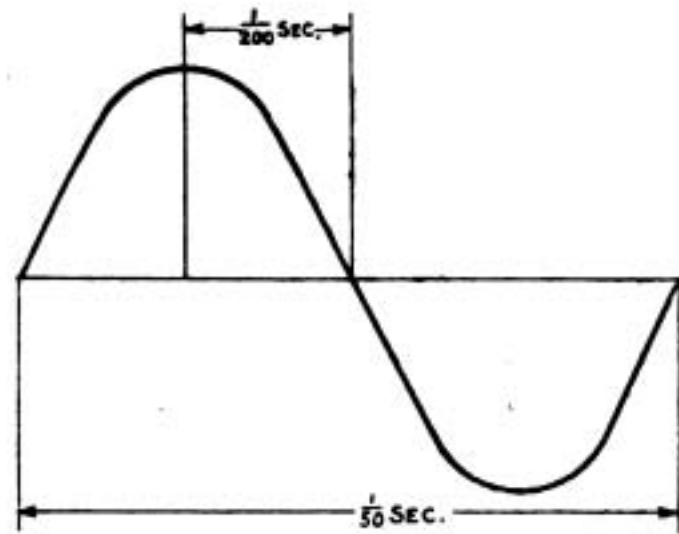


Fig. 6.

lines of force are continually changing, as the current rises to maximum, dies away and attains a maximum again in the reverse direction. The question now arises: "Why does not an ordinary alternating current transmit wireless energy?" Take the case of an ordinary alternating current, such as is used for lighting, having a frequency of 50 cycles per second. Each complete cycle occupies $1/50$ th of a second (Fig. 6), so that the current takes about $1/200$ th of a second to die away from its maximum value to zero. The time taken in stopping the lines of force is, therefore, $1/200$ th of a second. Now, in the case of an alternating current of "wireless" frequency, say 10,000 cycles per second, The current will only occupy $1/40,000$ th of a second in dying away, so we can see that a far stronger jerk will be administered to lines of force than in the previous case. The energy produced in the first case will not radiate far into space, but the more sudden the stoppage of the lines of force, the more powerful will be the energy radiated.

WHAT IS ENERGY?

In our next article for beginners we shall endeavour to present our readers with a scientific conception of the most important physical quantity with which the wireless man is concerned.

ALTERNATING CURRENT WORK WITH REFERENCE TO THE THREE - ELECTRODE VALVE*

By R. C. CLINKER.

IN alternating current work, and especially in radio-telegraphy, where high frequencies are employed, combinations of inductances, capacities and resistances in various relations are frequently met with. It is the aim of the present article to deal in an elementary manner with a common combination of these quantities, viz., the simple parallel circuit. A clear grasp of the properties of this circuit is absolutely necessary to the student who would understand the workings of wireless circuits in general, and "triode" circuits in particular.

In the following treatment, it is assumed that in all the cases considered, the resistance of the inductance or condenser (measured at the working frequency) is small compared to its reactance.

The reactance of an inductance coil is equal to $2\pi nL$, or ωL ohms,

where n = frequency, in cycles per second,

and L = inductance in henries.

The reactance of a condenser is equal to

$$\frac{10^6}{2\pi nC} \text{ or } \frac{10^6}{\omega C} \text{ ohms.}$$

where C = capacity in microfarads

We assume, then, that $\frac{\omega L}{R_L}$ and $\frac{10^6}{\omega C R_C}$

(where R_L and R_C are effective resistances of

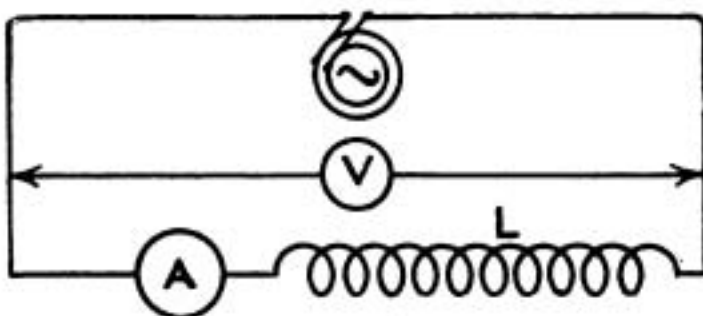


Fig. 1.

coil and condenser respectively), are large ratios.

Now take the simple case shown in Fig. 1. An alternator, giving constant voltage V , is connected to an inductance L . The current

shown by A is equal to $\frac{V}{\omega L}$ amperes, and

has the phase relation to the voltage V shown in Fig. 2

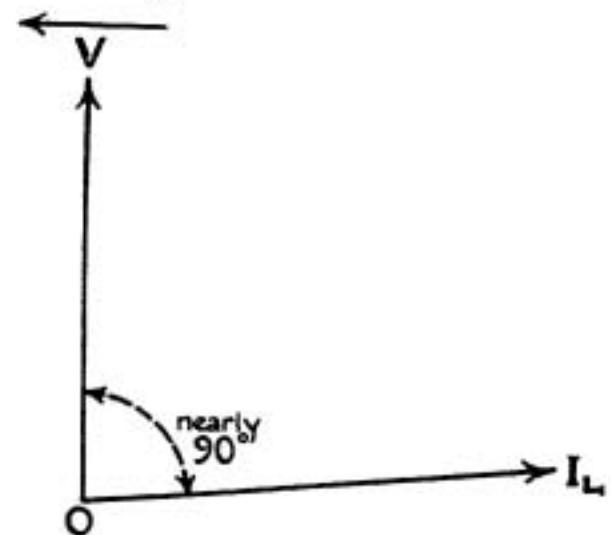


Fig. 2.

OV is the voltage vector rotating anti-clockwise. The current vector OI_L lags behind OV by nearly 90° because the resistance is very small.

Now let us place a variable condenser C across the coil, as in Fig. 3, and, beginning with a very small value of capacity, gradually increase it. We will also add two ammeters to indicate the separate currents.

Fig. 4 shows the conditions for a certain condenser setting. OI_C is the condenser current leading OV by nearly 90° . It is clear that, as the condenser current is almost opposite in phase to the coil current OI_L , the sum of the two shown by ammeter A

* Paper received Nov. 3rd, 1919.

ALTERNATING CURRENT WORK

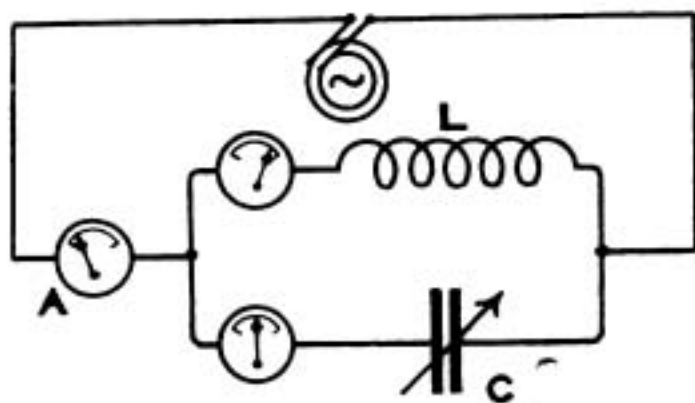


Fig. 3.

must be less than before, and is, in fact, equal to Oi in Fig. 4, *i.e.*, the resultant of OI_L and OI_C . Now let us increase the value of C still further until OI_C is equal to OI_L (Fig. 5). We have now a most interesting condition. The current shown by ammeter A has now decreased to a small value, Oi , while OI_C has increased until it is equal to OI_L .

This is sometimes called the condition of *current resonance*, and should be carefully examined by the student

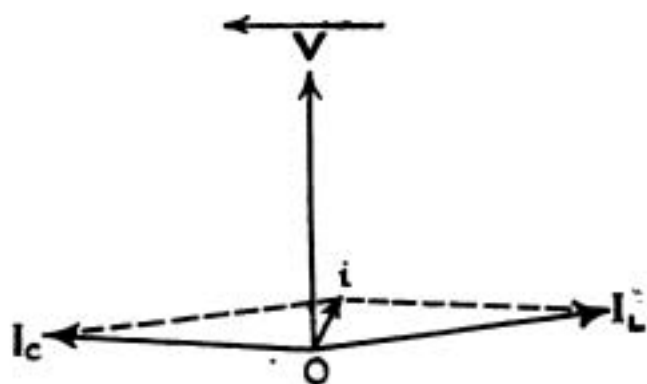


Fig. 4.

Note, firstly, that as the condenser and coil currents are equal and the resistances are small, the coil reactance, ωL ohms, must be closely equal to the condenser reactance $\frac{10^6}{\omega C}$ ohms. So we have $\omega L \approx \frac{10^6}{\omega C}$

Remembering that $\omega = 2\pi n$, we find that $4\pi^2 n^2 = \frac{10^6}{LC}$, or $n = \frac{10^3}{2\pi \sqrt{LC}}$.

But this is the well-known expression for the natural frequency of oscillation of a circuit of inductance L henries and C microfarads. We have produced resonance by making the natural frequency of the circuit equal to the applied frequency.

Note, secondly, that the effect of making $\frac{10^6}{\omega C}$ equal to ωL has been to reduce the resultant current taken from the source to a very small value. In other words, the

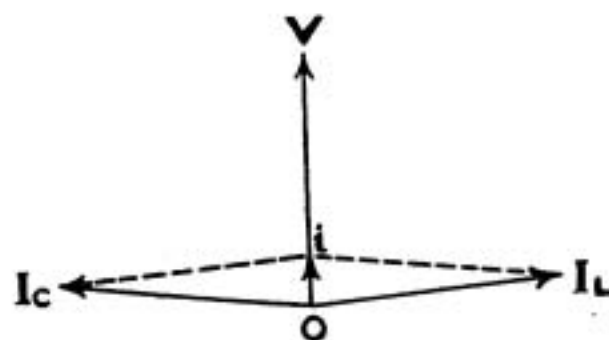


Fig. 5.

impedance of the circuit has greatly increased

It is important to see what this increased value of impedance is. Suppose, for a moment, that the circuit resistance is *absolutely* zero. Then, we have the two equal currents, OI_L and OI_C , exactly 180° apart, and Oi is zero. The condition may be looked upon as shown in Fig. 6. A current I (equal to the original I_L), circulates in the closed circuit formed by coil L and condenser C . As the resistance is zero there are no losses, so no current flows in through A . The impedance of the circuit under these conditions is, therefore, infinite. This case is not a practical

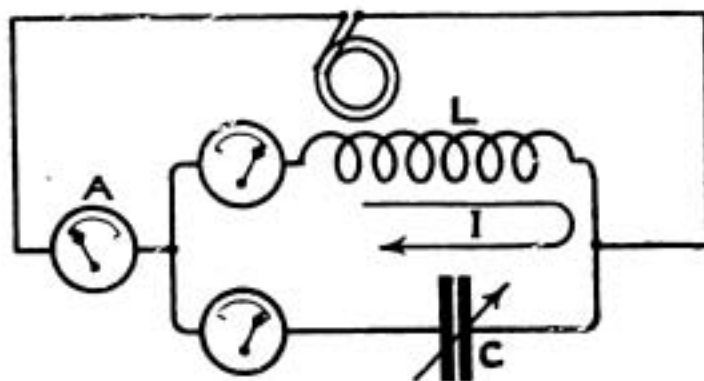


Fig. 6.

one, however, and is only mentioned to show that though the actual resistance in the loop circuit is small, yet its effective value in the alternator circuit is exceedingly large. It would seem, therefore, that, at the resonant condition, the higher the actual loop resistance, the lower is its effective value referred to the alternator circuit. This is true within limits, *i.e.*, so long as the actual resistances are small

compared to the reactances ωL and $\frac{10^8}{\omega C}$,

which we have already assumed to be the case.

Note, thirdly, that the external current Oi (Fig. 5) is exactly in phase with the voltage OV . In other words, the resonant circuit behaves exactly as a *non-inductive resistance* placed in the circuit of the alternator. Let us find the value of this resistance. Let R be now the total actual resistance, I the "internal" or loop current, and i the "external" or alternator current. We

require to know the value of $\frac{V}{i}$, which we

will call r . Now, as the circuit behaves like a non-inductive resistance, the power in watts supplied to it by the alternator is

$\frac{V^2}{r}$. This is equal to I^2R , which is the power

in watts dissipated in the circuit.

Hence $\frac{V^2}{r} = I^2R$. But, as $I = \frac{V}{\omega L}$ very

closely, we have by substitution, $\frac{V^2}{r} = \frac{V^2R}{\omega^2 L^2}$,

or $r = \frac{\omega^2 L^2}{R}$ ohms.

Putting the above result in words, we see that it is "the square of the reactance divided by the resistance," and that it must therefore be a large quantity. We may write

this in another form by putting $\omega^2 = \frac{1}{LC}$,

from which we find that

$$r = \frac{L}{RC} \text{ ohms.}$$

(NOTE.—If C is in microfarads, and L in microhenries, r will be in ohms.)

One other relation it is useful to know, *viz.*, the ratio of the "internal" to the "external" current. By similar reasoning to the above we find that this ratio—

$$\frac{I}{i} = \frac{\omega L}{R} \text{ or } \frac{1}{R} \sqrt{\frac{L}{C}}$$

i.e., is equal to the ratio of reactance to resistance.

(To be continued.)

DO THESE SUBJECTS INTEREST YOU?

Here are a few titles of articles which will appear in future issues of this magazine :—

Selenium and some of its uses (By Philip R. Coursey, B.Sc.).

Research for the Wireless Amateur (by W. T. Ditcham).

The Size and Shape of the Electron.

BOOK REVIEWS

SELECTED STUDIES IN ELEMENTARY PHYSICS.

By E. BLAKE, A.M.I.E.E.

London : The Wireless Press, Ltd., pp. 176,
5s. net.

THE author of "Selected Studies in Elementary Physics" is to be congratulated on having produced a most useful elementary text book written in such a clear and direct style that it cannot fail to be of the greatest assistance to all included in the author's group of "radiotelegraphists and others who may not have the time, the opportunity or the inclination to undertake the systematic study of physics."

This book can be recommended particularly to anyone wishing to amplify very elementary knowledge previously obtained, but it will be found of equal value to the beginner as only the most elementary knowledge of mathematics is demanded on the part of the reader, and the clearness of description throughout the book could hardly be improved.

The book is divided into two parts ; in the first part, "Ether and Space," "Matter, Force and Motion," "Work and Energy," etc., are dealt with amongst other things, and a short section is given to "Ether and the Electromagnetic Theory of Light." The second part commences with a section on "Atoms and Molecules," and goes on to consider "Chemical Action" and "Thermochemistry," and touches on, in a concise manner, heat and temperature. The only general objection I can raise is that the book is too small—a few more pages, say, a dozen, and simple treatments of, say specific heat (imperatively demanded by par. 216), specific resistance, the electron, etc., could have been included, and optics could have been touched upon.

To criticise a very few minor details, it

might be pointed out that the introduction of graphs (par. 44) is rather abrupt for a beginner, who will presumably be weak in mathematics also. He may be troubled by the sudden introduction of the dimensions of an acceleration (par. 31). The remarkable massless wheel of the example in par. 53 and the author's genealogical trees will present their difficulties, and he may find the examples of the indestructibility of matter a little indecisive.

The very minor points above are, however, the only faults I have to find in this very useful work, and, as stated, they obviously affect only the very beginner, and even he can hardly find ground for stumbling in any other part.

E.H.T.

THE HANDMAIDEN OF THE NAVY.

By G. S. DOORLY.

London : Williams and Norgate, pp. 144,
2s. 6d. net.

It is a trite saying that through the Great War the Merchant Service came into its own, but the stories which are gathered together under the above title show the how and why of the matter. There are nine of them, each a half-hour of solid enjoyment, especially to the reader who has personal experience of the sea, ships and shipmen. To those of our readers who as wireless operators "did their bit" on trooper or tramp in convoy during the past five years, when the seas were dotted with mines—or what looked like mines—and enemy periscopes—or what were mistaken for them—we recommend this book most heartily. The author evidently knows of what he writes. He does not annoy his seafaring readers by writing of "knots per hour" or his "wireless" readers by referring to extraordinary wireless instruments quite unknown to the profession. He has "been to see."

QUESTIONS AND ANSWERS

NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non-technical sides of wireless work. Readers should comply with the following rules.—(1) Questions should be numbered and written on one side of the paper only, and should not exceed four in number. (2) Queries should be clear and concise. (3) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. (4) The Editor cannot undertake to reply to queries by post. (5) All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume." (6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.

R.H.N. (Malvern).—(1) Very probably, if you apply to The Traffic Manager, The Marconi International Marine Communication Co., Marconi House, Strand, W.C. (2) In the Navy you would probably not be able to pick the type of vessel you think would suit you—unless you volunteer for submarine service. (3) We are not sure, and advise you to obtain full details of pay and conditions from the nearest recruiting office.

J.E.F. (Co. Donegal).—It all depends upon what formulæ you have in mind. Very little mathematical knowledge is required to grasp the formula for Ohm's Law, but the law connecting Resistance, Current, and Voltage in A.C. work is somewhat more difficult—and so on, until you reach formulæ involving a knowledge of Calculus and other mathematical methods.

R.A.W. (Garstang).—You will have to attend a School of Wireless Telegraphy. The qualifications for a position as a wireless operator vary according to what employment (civil, military, naval, etc.) you desire to enter. We can help you more when you have decided this point.

F.L. (Mapperley).—(1) We know of no wireless club in your county, although there is one at Derby. Why not start one yourself? We shall be pleased to help you if you will write us.

HOROLOGIST (Leicester).—(1) Try YN (Lyons) at 8:59 a.m., or Annapolis (N.S.) on 17,000 metres (C.W.) from 4:55 p.m. to 5:00 p.m. (2) Arlington should be readable by amateurs in this country, using suitable apparatus. Two valves should be sufficient.

N.P.N-M (Barnet).—Apply to Marconi's Wireless Telegraph Co., Ltd., Strand, W.C.

SPARKS (H.M.S. Orion).—(1) If you have not already received it, you would require training in the Marconi system, and in the handling of commercial traffic. (2) Apply to Traffic Manager, The Marconi International Marine Communication Co., Ltd., Marconi House, Strand, W.C.

SCOTTIE (Kirriemuir).—In future there will be a written as well as an oral examination.

R.K.W. (Kilburn).—Weak eyesight is not necessarily a bar, but the matter must be settled by the official medical examination.

W.J.T. (Co. Armagh).—(1) No further information on the subject of amateur transmission, other than that already published, is yet available. (2) We know of no amateur clubs in Ireland, and are informed that the whole question of amateur wireless in that country is still under consideration. (3) We believe the P.M.G. requires to be satisfied that the applicant for permission

to use a thermionic valve knows enough about the subject to be free from the possibility of his jamming other stations by allowing it to transmit strong oscillations. The P.M.G. will certainly require to see a sketch of the circuit which you propose to use.

G.W. (Watford).—We regret we know of no such book. It is a subject which hardly calls for a book. Here and there one occasionally sees isolated articles about it. You might find "Radiodynamics: the Wireless Control of Torpedoes and other Mechanism" of use. Author: B. F. Miessner. Publishers: Crosby Lockwood & Son, 7, Stationers' Hall Court, E.C.

J.C.H. (Godalming).—(1) V24 valves can be obtained from Marconi's Wireless Telegraph Co., Ltd., Marconi House, Strand, W.C., who will give you details of price, etc. (2) The P.M.G.'s Handbook for Wireless Operators. H.M. Stationery Office, Imperial House, Kingsway, supply this, 3½d., post free.

J.S.S. (Glasgow) has a receiver which works well on 600 metres, but gives no results on higher wavelengths. He asks for advice.

The circuit shown is quite a good one, but your secondary inductance works out at about 2,000 mhs., which will give you a maximum wavelength of about 1,850 ms. Your aerial inductance should be enough. Increase secondary inductance to about 350 turns. With a small aerial like yours you will need to be quite in tune to get MPD. You should have less difficulty with FL.

C.G. (London) asks (1) If a watch receiver wound with No. 44 to 2,000 ohms will be suitable for use with crystals. (2) Wavelength of a set from data supplied. (3) If phones as in (1) will be suitable.

(1) Yes, if well done. The more wire you can get on the better, even if more than 2,000 ohms.

(2) You give a lot of information, such as size of crystal batteries, which has no effect on wavelength, but do not describe your aerial very exactly. Wavelength might reach up to about 1,500 ms., but the set will not be very efficient.

(3) Phones will be suitable. Your blocking condenser should have considerably more capacity than you show.

B.S. (Helston) asks, re receiving circuit, page 483, "Wireless World," November, 1919 (1) What is the capacity of the condenser across the H.T. battery. (2) Whether a condenser across the reaction coil R would not be an advantage. (3) What valve is suitable for this set.

(1) The actual value of this condenser is not

important. Some sets will work without one at all. Try about .001 mfd.

(2) A condenser could be used, but you can get quite enough reaction without, and the introduction of another condenser means extra expense and trouble in tuning, and the results arrived at are not likely to be very different.

(3) Many valves are possible. The V24, with 6 volts (and a small series resistance) for the filament, and about 24 volts on the plate, is quite satisfactory.

CARBORUNDUM (Chapel-en-le-Frith) (1) *Submits a receiver diagram (Fig. 1) for criticism,* (2) *Submits suggestion for a telephone transformer,* (3) *Asks for approximate ranges for his set.*

(1) Your diagram, which is admirably clear, is quite correct. You might find it better to put a few tapings on the secondary coil for use with short waves. If possible, cut out completely the turns not in use. Primary coil might be 4" long, of No. 22, on a former 3" in diameter—say, 1,000 mhy. Secondary might be on a former 9" long by 4 1/2" diameter, wound with No. 28—say, about 20,000 mhy. This should give you 5,000 m. easily.

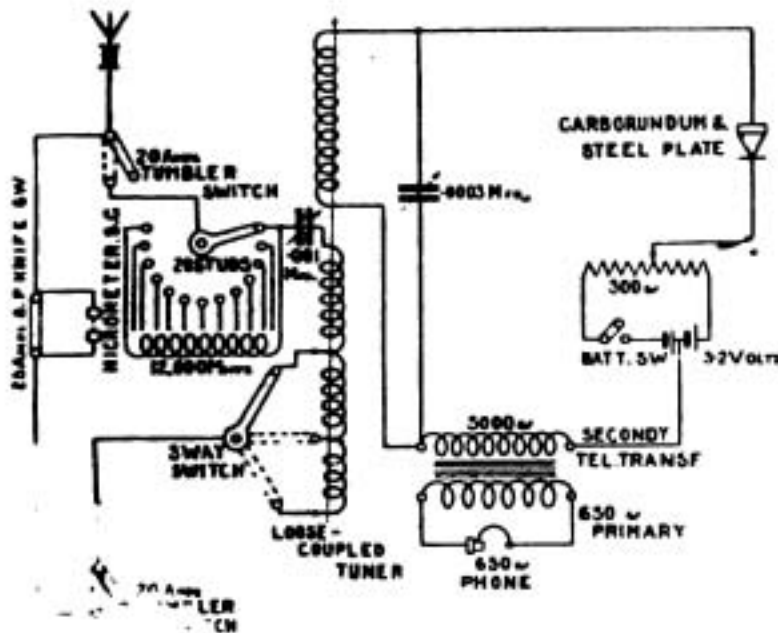


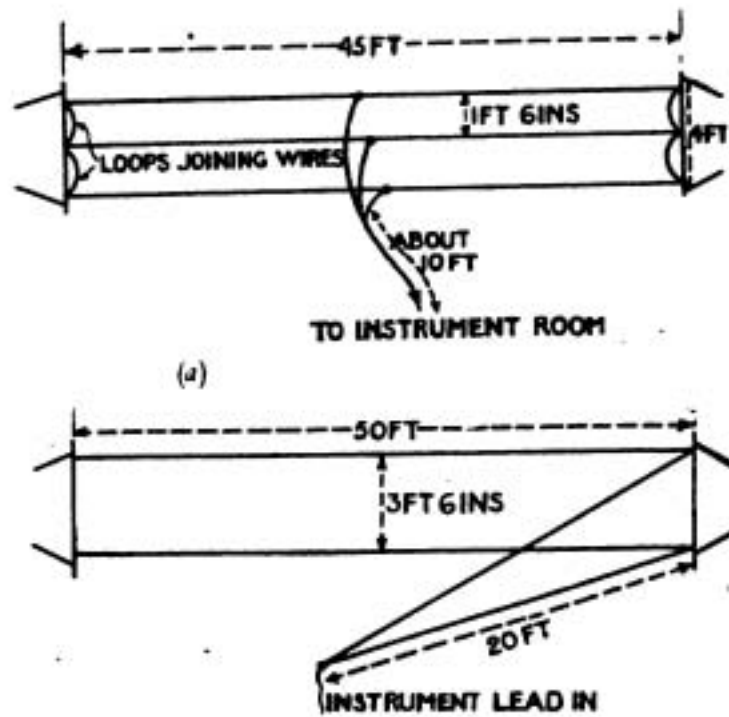
Fig. 1.

(2) The suggested scheme should be quite all right.

(3) It is difficult to give a range for any set, so much depending on workmanship and local conditions. You should get FL and MPD easily. On lower waves you should get ships, probably not very strongly.

F.H.K. (London) asks (1) *For advice with regard to two aeriels, sketched (see Fig. 2);* (2) *For further information re diagram on page 583 in January number.*

(1) Aerial in sketch (a) is not very good. The middle wire is so close to the side wires that it is practically useless. The wires should not be joined at ends, as you show. Proposed aerial (b) should



(b)

Fig. 2.

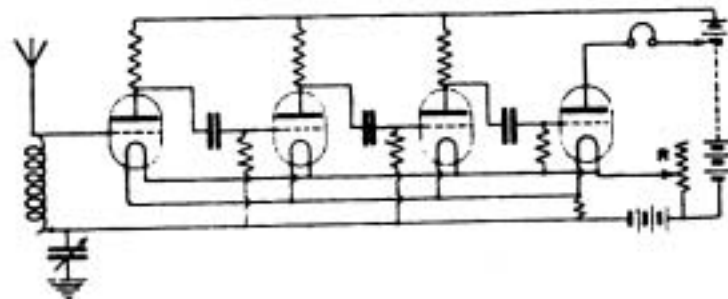
give you better results. (2) We are not very impressed with this device. A safety gap in parallel with the switch (2) will give you quite sufficient protection from lightning. The arrangements shown will not do any harm, of course, provided that you put a gap in, as suggested. If you do not, a lightning discharge would burn out either the chokes or the switch. Fibre formers would do. Bare wire would do if tuners do not touch. Use a few turns of fairly thick wire.

H.G.W. (Sutton) asks (1) *The gauge of a sample of wire.* (2) *The resistance per ounce of No. 50 copper wire.* (3) *The inductance of a coil of 400 turns on a 3" former.* (4) *Whether the distance between consecutive turns affects the inductance.*

(1) No. 44. (2) About 200,000 ohms. (3) It depends on the gauge. If the gauge is No. 22, the inductance is about 3,000 mhy. (4) Yes, the relationship is not easily worked out. (See Nottage's "Capacity and Inductance," page 19.)

ERRATA.

March issue, p. 702, col. 1, line 15 from bottom, read 0-0005 x 80,000. Also p. 704, col. 1, line 7 from top, read "longer than 600 metres." The plate circuit coils of Fig. 17 should be shown as impedances with iron cores, and Fig. 16 should be as here shown:—



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THE WIRELESS WORLD

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VOL. VIII. No. 2.

APRIL 17TH, 1920

FORTNIGHTLY

AETHER

THE SUBSTRATUM OF THE UNIVERSE.

By PHILIP R. COURSEY, B.Sc., A.M.I.E.E.

WHAT is the Aether—using the word not in its chemical sense of ether the anæsthetic, but with the meaning commonly assigned to it by the physicist? Much has been written about this universal medium (for such we may call it for want of more exact knowledge of its ultimate nature) and many are the theories that have been built up around the hypothesis of its existence. The term aether is generally used to designate this omnipresent universal medium which fills all space and is in, between, and around, all bodies and substances.

Some three centuries ago, at a time when the foundations of modern astronomy were being more surely laid upon the subsoil of fact and accurate observation, the first inkling became evident of the need for some medium in space to act as a connecting link for the transmission of light between the Stars, the Planets, the Earth, and the other bodies of the cosmos. The earliest ideas of the nature of light seem very crude when examined from the view point of modern knowledge. Descartes, for instance, about 1640, in his theories of the universe, proposed the idea that light was simply a statical pressure transmitted through some medium (which he regarded as a form of matter) between say the Sun and the Earth. He assumed that force cannot be transmitted from one point to another except

by actual pressure or impact, and thus was led to the enunciation of the principle that interplanetary space must be occupied by "matter" imperceptible to the touch but capable of serving as the vehicle of force and light. His basis of all things was a primitive, elementary, unique type of matter, boundless in extent and infinitely divisible. According to his theory the sun is the centre of a huge vortex so that the parts of the medium surrounding it and forming the vortex are straining away from the centre around which they turn. There is thus established an outward pressure in all directions, which was assumed to constitute the light which was evidently radiated from the sun in all directions in space.

Needless to say such postulates are not accepted at the present day, as it is generally recognised that light is really a form of wave motion. It is interesting, however, to recall these old ideas of light being a force, in conjunction with the more modern observations on the *pressure* of light.

An idea of light more in accordance with modern views, was set out by R. Hook in his *Micrographia* published in 1667. He recognised the fact that the parts of all luminous bodies are in rapid motion, and hence inferred that it was much more reasonable to suppose light also to be a vibratory motion rather than a statical pressure or force. To quote from

his work he says, speaking of the medium for transmitting this motion, that it will be easily granted :—

“ First, that it must be a body susceptible . . . of the motion ; and next, that the parts of such a body must be *homogeneous*, or of the same kind.

“ Thirdly, that the constitution and motion of the parts must be such that the appulse of the luminous body may be communicated or propagated through it to the greatest imaginable distance in the least imaginable time, though I see no reason to affirm that it must be in an instant.

“ Fourthly, that the motion is propagated every way through an homogeneous medium by *direct* or *straight lines* extended every way like rays from the centre of a sphere.

“ Fifthly, in an homogeneous medium this motion is propagated every way with equal velocity”

light rays—the aether must evidently be a medium that is capable of transmitting such waves, a medium whose nature and physical properties fit in with the conditions necessary for such propagation.

Visible light then is a transverse vibration of the aether of frequency ranging between 770 billion and 375 billion oscillations per second ; but the actual so-called “ light ” spectrum extends much further than this in both directions. The appearance of the spectrum obtained when sunlight is refracted through a prism is well known. The mean wavelength of the blue rays at one end is 0.41 micron, and that of the red rays at the



The Solar Spectrum showing the Fraunhofer lines.

In the above extract we see also the important conceptions of a *finite* and a *constant* velocity of light propagation—facts subsequently verified with great accuracy. Other portions of his work also convey a logical explanation of the phenomena of refraction, an explanation that accords remarkably closely with more modern views. His idea as to the causes of different colours in light, however, seem very hazy, and it was left to the systematic reasoning of Isaac Newton to give us a truer explanation, in terms of the wavelength (or “ bigness ” as he then termed it) of the aether vibrations. Some difficulties however arose with these early wave theories of light about this time, due mainly to the assumption, then made, that the direction of the vibrations was in the line of propagation (longitudinal waves) whereas it is now known that the waves are transverse, *i.e.*, that the direction of the wave motion or vibration is at right angles to the direction of propagation of the wave.

Taking these known facts relative to the nature of light waves—facts supported by amongst others the classical experiments of Fresnel and Young on the interference of

other is 0.65 micron, where the micron, which is a unit frequently employed in the measurement of such minute quantities, is the ten-thousandth part of a centimetre (approximately one twenty-five-thousandth of an inch). Every known element when under a suitable stimulus emits light of definite wavelengths, and thus gives rise to a spectrum characteristic of the particular element. In this manner the so-called Fraunhofer lines are formed in the solar spectrum by the absorption of these characteristic wavelengths from the normal continuous spectrum, and their presence is taken to indicate the existence in the solar atmosphere of the elements with which they are usually associated.

It may perhaps be of interest to construct an artificial “ spectrum ” covering the complete range of aether waves known to us. Owing to the enormous range of frequencies involved such a spectrum may most conveniently be set out on a logarithmic scale, as indicated in Fig. 1. This scale is extended down towards zero frequency to include the range of ordinary acoustic frequencies, merely for comparison purposes, although it should be

AETHER: THE SUBSTRATUM OF THE UNIVERSE

borne in mind that the ordinary sounds are waves in *air*, not in aether. There is no theoretical reason why such waves should not also exist in the aether, but in ordinary electrical apparatus they are not met with.

It is particularly interesting to note that there are only two gaps in the whole scale of frequencies from zero to a hundred-million-billion per second (10^{20})—viz., a gap covering the frequency range of 1.5×10^{11} to 5.7×10^{13} between the shortest waves produced by physical apparatus in the laboratory using solely electrical means, and the longest heat rays that have been detected in the solar spectrum. Even here, however, there are a few isolated values of frequency corresponding to very long heat rays produced by special apparatus that partly bridge over the vacant

space. Secondly, there is the gap between 3×10^{15} which is the highest known frequency of the rays in the extreme ultra-violet, known as the Schumann rays, and 2.5×10^{17} which corresponds to the longest known X-rays produced by the lightest elements. The upper frequency limit of the X-rays produced by the heaviest elements is 10^{19} , while the most penetrating radiations from radium are estimated to have a frequency of somewhat over 6×10^{19} per second, and these constitute the limit of our knowledge in this direction—the wavelength of these rays being less than 0.000 000 000 5 of a centimetre, *i.e.*, less than one five-thousand-millionth of an inch.

All these waves are propagated through the aether with a uniform velocity of 3×10^{10} cms per second—or roughly, one-hundred-and-

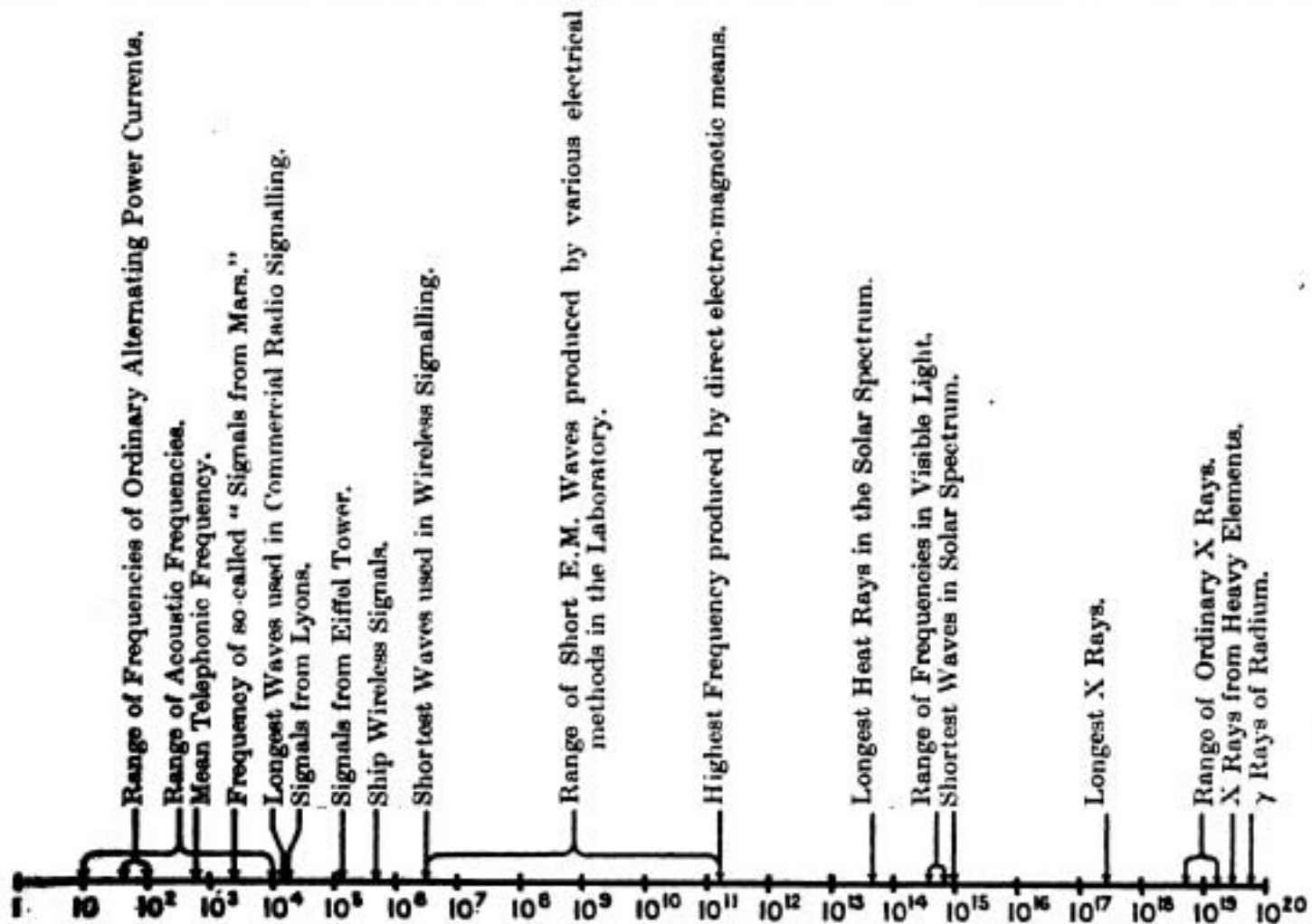


Fig. 1.

The Aether Spectrum.

The frequencies given in this diagram are calculated from the recorded wavelengths of the various waves and pulses, taking the velocity of light as 3×10^{10} cms. per second.

eighty-six-thousand two-hundred miles per second—travelling a distance equal to nearly eight times round the earth in a second!

Every form of wave motion requires the possession by the medium in which it is propagated, of the properties of both density and elasticity, the connecting relation being that the velocity of transmission is proportional to the square root of the elasticity divided by the density. Since we know the velocity exactly, it follows that the elasticity of the aether must be nine-hundred-million-billion times its density $[(3 \times 10^{10})^2 = 9 \times 10^{20}]$. Hence in the lack of other information we may either assume that the elasticity is similar in value to that of ordinary matter, and the density very small; or that the density is more like that of common objects, and the elasticity enormous. We have, however, the further consideration that for the mere *formation* of such enormous frequencies as we have seen to exist in X-rays we should expect the density to be very large, since the denser a material, in general, the more rapidly can it vibrate. We have, however, the further consideration that the known particles of ordinary matter are very small and far apart so that their individual density must be much greater than that of the complete aggregation, just as when we measure the density of a powder we obtain a value much less than that of the material particles of which it is composed.

We can get some insight into the possible density of the aether from the known physical properties of the electron. Taking its measured mass and diameter, Sir Oliver Lodge has estimated that its mean density is of the order of one billion C.G.S. units (grams per cubic centimetre)! The density of the aether must be at least as great as this and would be equal to it if we assume, as in one theory, that the electron is merely an aether vortex, and that the aether is incompressible. Granting this figure for the density, the elasticity of the aether must be 10^{33} (one-thousand-million-billion-billion units), a value inconceivably greater than that of any known material substance,

and one that must be attributed to electromagnetic rather than to material properties.

When summing up his recent course of lectures on "Positive Rays," at the Royal Institution, Sir J. J. Thompson put forward some rather novel views as to the constitution of matter and its connection with the aether. He suggested the idea that the ultimate structure of matter may involve the existence of mass particles very much more minute even than the electron. The true mass of the electron, which as mentioned above may be synonymous with the mass of the aether, is customarily regarded as being contained within a radius of 1.87×10^{-13} centimetre, but although for most practical purposes the major portion of its mass is inside this radius, yet a small proportion of it extends outside, much as the atmosphere surrounds the earth, and gradually fades off into space as the distance from the centre of the mass is increased. Sir J. J. Thompson stated that a consistent view of the relations between matter and the aether could be obtained by assuming that these minute mass particles are rotating round the lines of electrostatic strain in the aether with the velocity of light. When a closed loop of electrostatic strain travels off in space these revolving mass particles travel with it, and convey the energy of the radiation. On this view—which was put forward more with the idea of forming a consistent visual conception of the universe, than as a serious theory—the radiation might be said to carry its own aether with it, supposing that this mass stuff may be identified with the aether, and perhaps some of the apparent difficulties of the Relativity Theory may be overcome by this hypothesis. Be this as it may, we have yet no definite evidence for or against the suggestion, and nothing further as yet to warrant the throwing over of the idea of the universal nature and presence of the aether, which must still be regarded as being in a totally different category to ordinary matter, and can only interact with it through the medium of electrical forces.

THE PROPOSED IMPERIAL WIRELESS SYSTEM

THE French have already planned out a scheme of wireless communication to link up all their colonial possessions with the mother country. The equivalent Spanish scheme has been for some time an accomplished fact. The stations which will connect Holland with the Dutch East Indies are already being built and the United States possesses numerous stations of sufficient power to communicate over a radius of 3,000 miles. Twenty-five years have elapsed since Senatore Marconi brought his invention to this country, and yet we have not even begun to use wireless imperially, nor do we boast a single English station which transmits time or "scientific" signals.

Under these circumstances particular interest attaches to the proposal for an Imperial Wireless System put forward by Marconi's Wireless Telegraph Co., Ltd., the details of which were made public last month. This scheme would appear to be the most ambitious and striking conception of an ideal *réseau* yet propounded in any country, and the terms upon which the Company's offer is made are no less noteworthy, inasmuch as the construction, maintenance and operation of the stations will cost the country nothing, whilst the stations can be acquired by the Government at the end of thirty years, free of charge.

The desiderata which have been kept in mind in framing this proposal for an Empire-wide network are:—

(1) That such trunk routes and branch routes be provided, as will enable England to obtain wireless communication with any part of the Empire.

(2) That any part of the Empire be capable of communicating with any ship suitably equipped with modern wireless receivers, in whatever sea she be: roughly speaking, between latitude 60 N. and 50 S.

(3) That no submarine cable be relied upon to form part of this network of communications.

(4) That the use of land telegraph lines be, as far as possible, avoided: and that these lines be restricted to the passage of messages between the public and the nearest wireless station.

(5) That, where alternative routes are available, such as between England and South Africa via the East Coast or West Coast, both routes be provided.

(6) That, on the trunk routes, automatic transmission and reception at a speed of not less than one hundred words per minute be provided; and that separate transmitting and receiving stations be erected, in order that the service may be duplexed.

(7) That as much foreign traffic as possible be attracted to the network, in order that the system be at least self-supporting as a commercial enterprise: it being understood that preferential treatment could be accorded to British traffic.

Fig. 1 is a diagrammatic representation of the English stations proposed, although the communications shown are not necessarily those to be adopted. Fig. 2 shows the proposed Main Trunk Wireless Routes, the numbers representing Great Circle distances in nautical miles.

Proposed Routes and Branches.

- Route 1.* England to India, and thence to Singapore, Australia and New Zealand, with a branch from Singapore to Hong Kong.
- Route 2.* England to Egypt, and thence to East Africa, and South Africa.
- Route 2A.* England to Egypt, and thence to India, Singapore, etc.
- Route 3.* England to West Africa, and thence to South Africa; with a branch from West Africa to South America.
- Route 4.* England to West Indies.
- Route 5.* England to Montreal, and thence to Vancouver.
- Route 6.* Australia to Vancouver (only night service to begin with).

A number of Main Feeder stations would be required in each country, linked with Local Feeder stations, as illustrated in Fig. 1.

With regard to the proposed design of the stations, it is interesting to note that the Marconi Company recommends the use of C.W. transmission. It is stated that such rapid strides have been made in the development of transmitting valves, that apparatus is already being assembled capable of dealing

efficiently with an output of 100 kilowatts. The corresponding aerial power is confidently expected to be 75 kilowatts, and the design of the set is such that it can readily be adapted to three or four times this power. Recent research leads to the expectation of an aerial current of upwards of 300 amperes.

The proposed aerial system for reception is that of Franklin, which is a development of the Marconi-Bellini-Tosi Direction Finder. With this system any number of receiving stations may be located on one site and no balancing aeriels are required. An important characteristic of Franklin's system is the absence of long horizontal aerial wires, which enables the various receiving systems to cross one another. So great is the importance of the Franklin aerial that the scheme of wireless communications outlined in this proposal depends fundamentally upon its adoption.

Such, in brief, are for the general reader the most interesting features of the scheme, but the terms upon which the proposal is

submitted to the Government also command attention, and are as follows :—

(1) The Company offers entirely at its own cost to construct, maintain, and operate a complete and efficient network of Imperial wireless communications, in accordance with the proposal outlined above.

(2) The Company will pay yearly into the Treasury of each Government, in whose territory one or more stations may be situated, a sum equal to 25 per cent. of the net profits earned by the said station or stations.

(3) On the expiration of a period of thirty years dating from the inauguration of any wireless service comprised in the network, the stations conducting such service will become, if so desired, the property of the Government or Governments concerned, free of any payment.

(4) The Company guarantees to complete the Trunk Stations within a period of three years from the date on which permission to commence work is given.

(5) The Government or Governments concerned will have the right to take over the stations at any time by paying for them the value at which they stand in the Company's books, plus any sum which may have been expended on the creation of the services, and by paying to the Company 10 per cent. of the gross receipts for the remainder of a period of thirty years dating from the inauguration of the services.

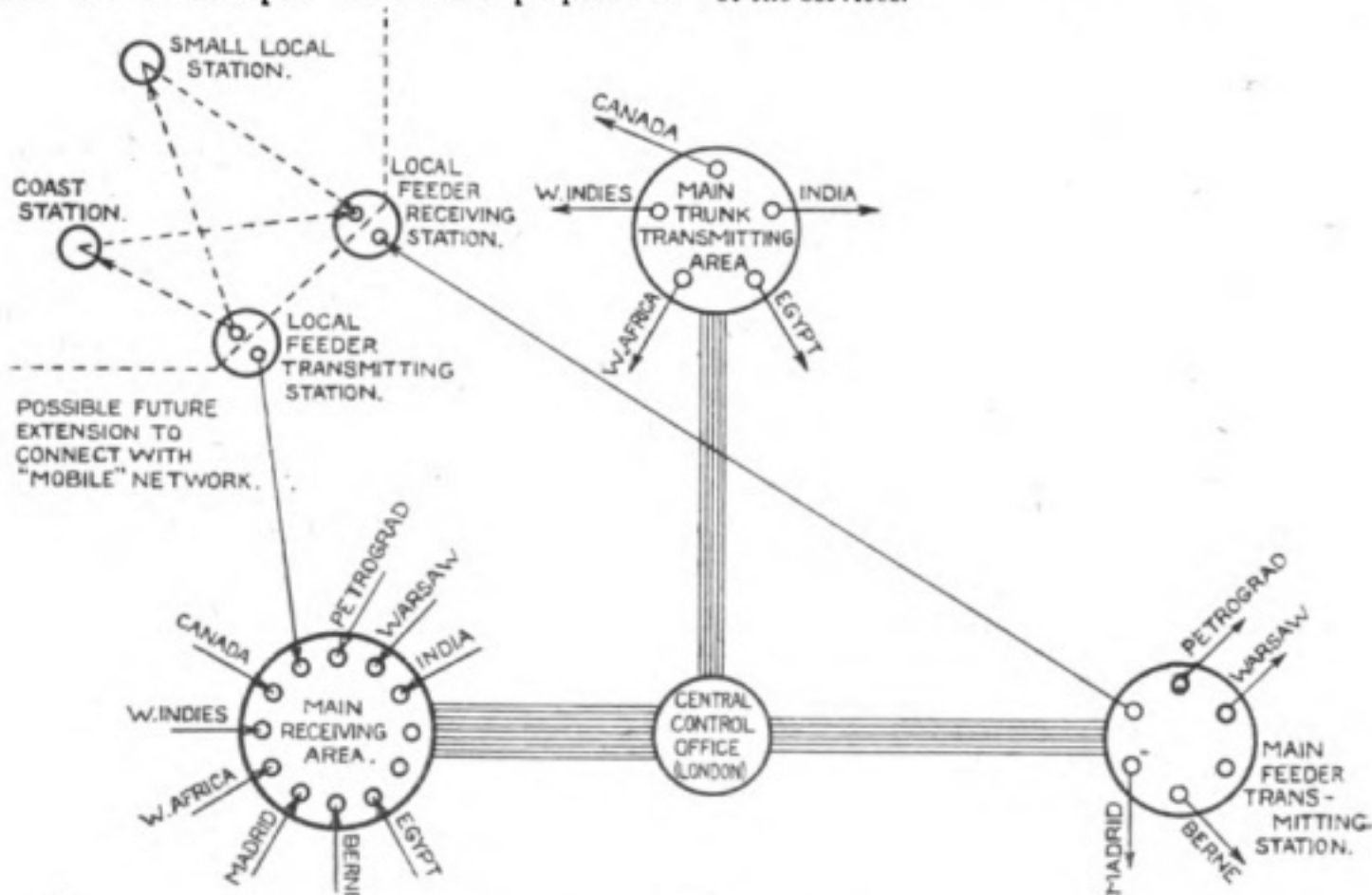


Fig. 1. Diagrammatic representation of proposed English Stations.

THE PROPOSED IMPERIAL WIRELESS SYSTEM

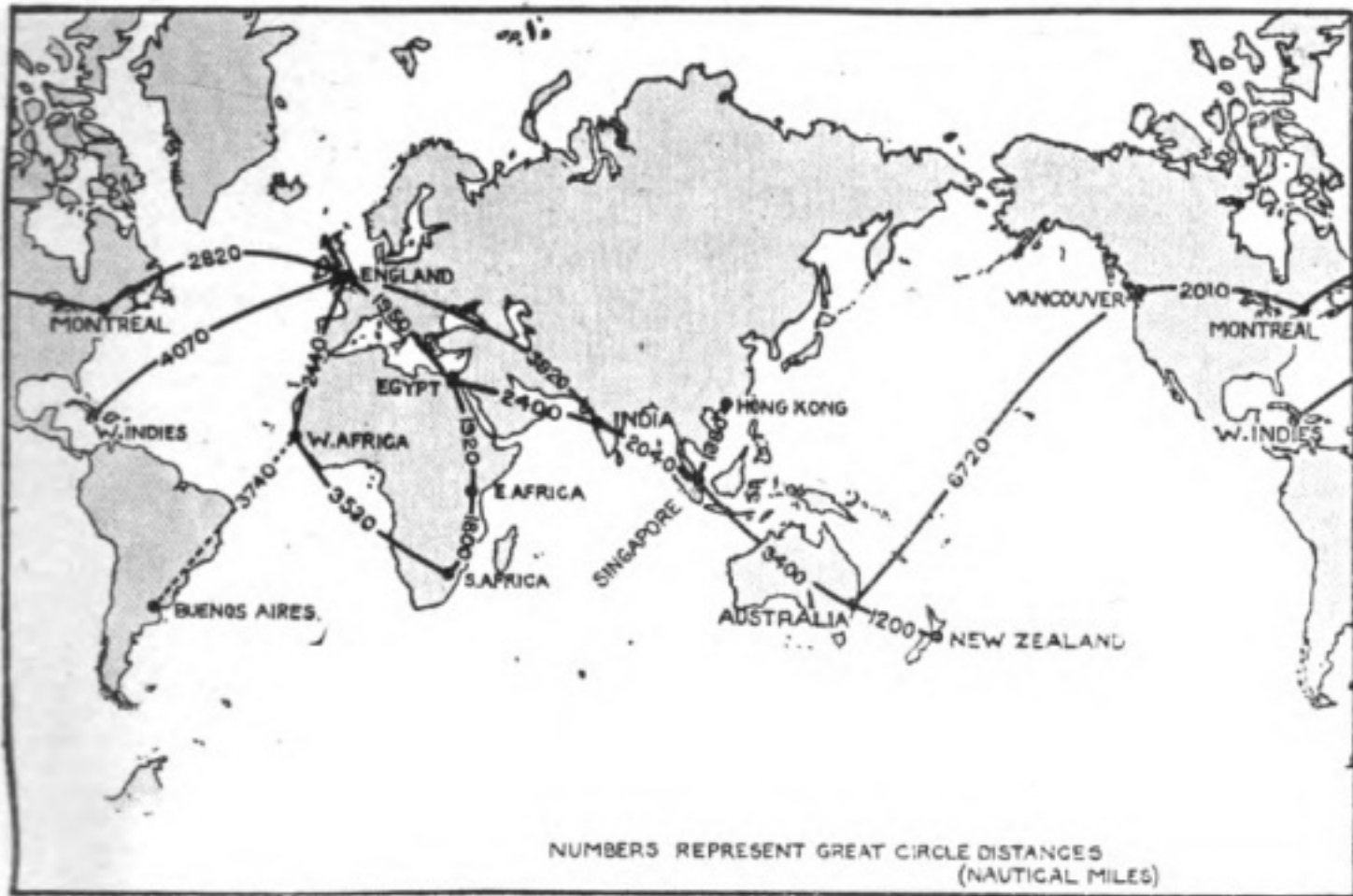


Fig. 2.

The proposed Main Trunk Routes.

(6) The Government will have the right to take over the control of the stations during any period of war or national emergency, all arrangements for such control being settled between the fighting services and the Company, and to be subject to periodical revision.

(7) This offer is subject to the following conditions:—

- (a) That the Government or Governments concerned shall issue all requisite licenses for a period of thirty years, shall grant every facility for the acquisition of sites (by compulsory purchase, if necessary), and shall carry out, as a repayment service, the work of building, laying and maintaining all the underground and overhead telegraph and telephone lines required. Where such work is not the monopoly of the Government concerned, the Government shall grant all reasonable facilities for carrying out the work.
- (b) That the stations, when erected, shall not be diverted from the duties for which they were constructed, except in the event of national emergency.
- (c) That the Company shall reserve the right to extend the system to foreign countries to any extent and on any terms that may be commercially advantageous, provided that Imperial traffic shall invariably have preference over foreign traffic.

(d) That the Government or Governments concerned shall secure the allocation of suitable international wavelengths to the stations comprised in the network, and shall see that stations belonging to other companies shall not be allowed to use unscientific apparatus or granted wavelengths which would interfere with the working of the Imperial network; and that, except in the event of national emergency, the stations comprised in the network shall not be compelled to communicate with other stations which would interfere with the Imperial services. The Company asks for no monopoly: it is prepared to stand on its own merits. The offer is, however, conditional upon adequate protection on these lines being given to the service.

(8) The Company is also prepared to undertake the work of establishing local networks in any country, or district, whether they are required to link up with the Imperial network or not.

(9) Where the Government or Governments so desire, the Company is also willing to undertake the construction and maintenance, under similar conditions, of stations for communication with ships at sea and aircraft in flight, and to link up such a system of stations with the main Imperial network should it be practicable to do so.

NOTES AND NEWS

The Steady March of Wireless will soon be a misnomer, because its speed is rapidly increasing. The Handley Page Company have brought into use on their London-Paris Air Service the Marconi wireless telephone. The first use made of this apparatus in this service was on the passenger aeroplane which flew from London to Paris on the 4th March with six passengers, a crew of three and a load of freight.

From Germany comes the news that tests in wireless telephony between Berlin and Karlsborg (Sweden), distance 440 miles, and between Berlin and Moscow, distance 1,060 miles, have been carried out, and that complete success has attended these tests.

The results of the Wireless Telephonic Experimental Programme of Chelmsford are very encouraging. From all quarters come news of the clear reception of the signals; in one case a ship over 1,000 miles away heard the programme on the ordinary ship set.

The German Ministry of Posts and Telegraphs has erected a wireless station at Dortmund. It is proposed to utilise wireless for the transmission of important communications of the express service of the Foreign Trade Office.

A new wireless station for the use of the Japanese Navy has been erected near Tainan, Formosa. Another station will shortly be erected near Lin-shu-tun, Manchuria.

The Danish Parliament has appointed a commission of experts to proceed to New York to study the different Wireless Systems, and make the necessary arrangements in America in connection with the proposed direct Wireless Service between Denmark and America, for which purpose a big station will be built at Copenhagen.

It seems certain that within a few years all the main European countries will have a direct wireless service with America.

The Otter Cliff U.S. Wireless Station has succeeded in establishing direct communication with the Stavanger Station, Norway.

A new high-power wireless station is in course of erection at Tokio, Japan, which, when completed, will be in direct communication with a station on the Pacific Coast of the United States.

The German Government has in hand a scheme to utilise wireless as an adjunct to the existing inland telegraph system. The proposal is to instal stations in all the large German towns controlled from a central station, and thus there will be throughout the country a wireless link which will be of extreme usefulness for, amongst other things, the press services.

A New Wireless Company was constituted on the 3rd January, 1920, at Warsaw, under the title of the Société Radio-technique en Pologne ("Radiopol"), with the object of undertaking the manufacture, installation and maintenance, in Poland, of every system of telegraphy, including wireless. The capital of the new Company is 6,000,000 marks, and its founders include Marconi's Wireless Telegraph Company, Limited, Société

Française Radio-Electrique, Compagnie Générale de Télégraphie sans Fil, Compagnie Générale de Radio-Télégraphie, Société Polonaise de Construction et d'Exploitation des Procédés Radio-techniques and the Banque du Commerce et de l'Industrie of Warsaw.

The office of the Company is situated at 22, Rue Wilcza, Warsaw.

The Nederlandsche Seintoestellen Fabriek was incorporated on 27th February, 1918, with a capital of 1,000,000 florins in shares of Fls.1,000 each. The head office and works are at Groest 104-106, Hilversum, Holland. The Company has acquired from Marconi's Wireless Telegraph Company, Limited, the right to manufacture and sell, in Holland and the Dutch Colonies, wireless material according to their patents, drawings and designs.

A successful demonstration of long distance wireless telephony was carried out recently between London and Rome. Signor A. Cassuto, London Editor of the *Messaggero* of Rome, speaking by Wireless Telephony from Chelmsford was heard distinctly by the receiving station in Rome and long messages from him were recorded in shorthand. The apparatus at Rome was not sufficiently powerful to enable a reply to be sent by wireless telephony, but immediately Signor Cassuto had finished speaking a wireless telegraph message was received from Rome announcing the success of the experiment. The result of this demonstration opens out fresh vistas of international communication especially from the point of view of press services.

The Admiralty wireless direction-finding stations in the United Kingdom (of which there are nine) have been opened for some little time to the use of the Mercantile Marine. No charge has been made hitherto, but it is proposed as from the 1st of April to make a nominal charge of 5s. for each bearing requested and given.

Naval wireless operators will be glad to learn that the Admiralty, with a view to assisting Naval ratings in the wireless telegraph branch who, on discharge, may wish to enter the civilian wireless service, has made arrangements for the Postmaster-General's certificate of proficiency to be issued to telegraphist ratings.

The Amateur in France. *L'Electricien* in its issue of the 15th March last, gives details of the French Ministerial decree dated 27th February, 1920, embodying the rules and regulations under which small private wireless installations, for the reception of time signals and meteorological telegrams only, are permitted in France. The regulations are stringent and the facilities for amateur wireless work very restricted. Transmission will not be allowed.

Wireless telephony and direction-finding in conjunction with aircraft were demonstrated to the press on March 25th by Marconi's Wireless

NOTES AND NEWS.

Telegraph Company, Limited. The members of the ground party occupied a station at Writtle, near Chelmsford, and conversed freely by wireless with other pressmen in a Handley-Page aeroplane which started from Cricklewood. Messages to various London dailies were sent by wireless telephone from the machine. The speech obtained was excellent and thus notably superior to what the Post Office sells us nowadays.

The U.S. Naval Communication Service. In an article by Captain S. W. Bryant, U.S.N., in the *Journal of the Franklin Institute*, describing the development and organisation of the United States Naval Communication Service, the author mentions that on the technical side, efficiency in high power transmission was increased during the war from 30 per cent. to 90 per cent., and the speed of transmission from 30 to 100 words per minute. The U.S. Service increased the life of their valves from an average of 5 to over 5,000 hours. Directive receiving was increased in efficiency by 75 per cent. Captain Bryant states that the old type of overhead aerial is being rapidly replaced by balanced loops and underground wires, and radio phase changers, etc. Another important development was that of the radio compass, which is now an important aid to navigation. The author is also of opinion that a strict central control of radio communication is necessary to prevent private interference with public service.

Obituary.—We regret to have to announce the death of M. Lucien Poincaré, Vice-Rector of the Academy of Paris, and brother of the French ex-President. M. Poincaré held an honoured position in electrical circles.

Mr. E. V. Appleton, M.A., B.Sc., of St. John's College, Cambridge, who in the past was a frequent contributor to our columns, has been appointed an Assistant Demonstrator in experimental physics.

We have received a copy of the Advance Edition of Prospectus No. 8 of the University Engineering College, Regent's Park, London. This College undertakes professional training and preparation for technical examinations (including wireless subjects) by correspondence.

The Postmaster-General's Handbook for Wireless Operators can be obtained at H.M. Stationery Office, Imperial House, Kingsway, W.C.2, or from any bookseller, price 3d., postage paid.

The Radio Engineering Co., Ltd., particulars of which we give below, has recently been formed.

Private company. Registered February 23rd, 1920. Capital, £5,000 in 5s. shares. To carry on the business of mechanical and electrical engineers, instrument makers, etc. The subscribers (each with one share) are: H. E. Straker, 47, Nelgarde Road, Catford, S.E.6., secretary to a limited company; F. H. B. Frere, 21, Wakefield Road, South Tottenham, N.15, gentleman. The first

directors are not named. Solicitors: J. Hoare, 3, Crooked Lane, E.C.

Compagnie Générale de Télégraphes sans Fil.—This Company, which has close connection with the Compagnie des Cables Télégraphiques, the Société Française Radio-Électrique and the Compagnie Générale de Télégraphie et de Téléphonie, has just published the results of its first activities. Although this Company has only been in existence ten months it has been able to remunerate its shareholders and distribute a dividend. According to its first balance sheet, dated December 31st, 1918, the Company possessed the station of Tuckerton, in America, was the title holder of new patents and held further property estimated at nearly 5,000,000 francs. Since the closure of the 1918 practice the Company has increased its capital from 12.5 to 25 millions, this augmentation being necessary owing to the rapid development of social affairs.—*Revue Générale de l'Électricité*, January 24th, 1920.

Mrs. Bertha Ayrton, the widow of the late Professor W. E. Ayrton, of University College, is the only lady member of the Institute of Electrical Engineers. In 1906 she was awarded by the Royal Society the Hughes Medal for her investigations on the electric arc and phenomena of sand ripples.

Commander J. R. Schofield, Principal of the Swansea Wireless Training College, has been presented by the ex-Service Students of the College with a barometer.

Mr. G. Valdemar Goulding, European Manager of the Western Union Telegraph Company, retired on the 1st of March last. Mr. Goulding has been with the Western Union Company for some fifteen years.

To Honour Mr. Marconi.—Various organisations in America are working actively to make the Marconi Fund for War Relief in Italy a big success. The services rendered to mankind by Mr. Marconi are too well known to be commented upon, and the present is believed a propitious moment to honour such services and at the same time by so doing contribute towards the relief of War distress in Italy.

Wireless is among the powers to be reserved to the Imperial Parliament under the conditions of the new Home Rule Bill which has been placed before the House of Commons.

The question of Wireless and Cable Communications in the West Indies is to be considered and reported upon by a Sub-Committee appointed by the Imperial Communications Committee, which will consist of representatives of the Colonial Office, Admiralty and Post Office. Captain L. Burgis, 2, Whitehall Gardens, London, is the Secretary to the Committee. A correspondent to the *Times* says that the high cost and inefficiency of the cable service have been for many years a standing grievance in the Western Tropics.

DIGEST OF RADIO LITERATURE

REPORT OF THE GENERAL SIGNAL OFFICER, U.S., TO THE SECRETARY OF WAR, U.S. (*Annual Report of the U.S. War Department for Fiscal Year ended June 30th, 1919, issued by the Washington Government Printing Office.*)

This is a voluminous report, superbly illustrated throughout. It contains a chapter on the "Radio Service, American Expeditionary Forces," which recounts the activities of the Wireless Branch of the various American Expeditionary Forces, commencing with information as to the formation of that Branch of the Service in 1917.

EFFICIENCY OF THE THERMIONIC DETECTOR. H. J. van der Bijl, M.A., Ph.D. (*Proceedings of the Institute of Radio Engineers; December 1919; 33 pp., 15 figs.*)

A paper dealing with the means of determining the detecting efficiency of valves. The author gives details of the theory of a method which has been devised in this connection, and which it is claimed would overcome many of the difficulties hitherto experienced in determining the detecting efficiency. Particulars are also given of the various tests carried out on the strength of the theory, together with experimental data and method of comparing the detecting efficiencies of a standard valve with that of the valve used in the tests.

STATIC ELIMINATION BY DIRECTIONAL RECEPTION. Greenleaf W. Pickard. (*Radio Amateur News, New York; January 1920; pp. 337-341; continued on pp. 372, 374, 376, 377, 378, 379, 380.*)

The problem of eliminating the disturbances known under the various names of "atmospherics," "X's," "strays," etc., has always been a pressing one to wireless men. All amateurs will know the trouble sometimes experienced in reception through such disturbances. This article, which runs into many pages and is copiously illustrated with

diagrams and photographs, commences with a discussion of the source of atmospherics, etc., and the different varieties. A theory of static is then outlined, on which solutions of the problem of the elimination of static are based. The author states that, in a broad sense, there are two solutions for the problem, one involving a separation of signal and static based upon their difference in wave form, and the other a separation based simply on sharply directional reception. Amongst other things dealt with is the shielding of the aerial wires by loops, etc. Much has been written from time to time on "cage" aerials and many tests carried out with them. In dealing with the problem of statics the question of the type of aerial employed necessarily plays a large part and in this article the question is considered at length. At the end of the article is given a bibliography of the papers, journals, etc., referred to in the article.

NEW DETECTOR AND AMPLIFIER UNITS. (*Everyday Engineering Magazine, New York; January, 1920; p. 235.*)

A short article, with illustrations, dealing with detector and amplifying units of a receiver. The writer impresses upon amateurs the tendency towards simplification of design and the advantage of using as few parts and instruments as possible.

THE VACUUM TUBE: AN ELECTRICAL ACROBAT. Pierre H. Boucheron. (*The Scientific American; January 17th, 1920; pp. 64-65, continued on p. 78.*)

This article deals with the valve from a general standpoint. The author commences with a history of the vacuum tube, and proceeds to discuss, to use his own words, "What it is: What it does: Who uses it, and How: What it may do in the future." Illustrations of various types of valves are given, together with diagrams of the various uses to which it is put.

THE PROCEEDINGS OF THE WIRELESS SOCIETY OF LONDON

PRESIDENTIAL ADDRESS :

“SOME WIRELESS WONDERS”

A MEETING of the Wireless Society of London was held on Friday, February 27th, 1920, in the Lecture Hall of the Royal Society of Arts, John Street, Adelphi, London, W.C., the President Mr. A. A. Campbell Swinton, F.R.S., occupying the Chair. The minutes of the previous meeting were taken as read, and it was announced that the ballot for new members would be taken at the next meeting. The President then delivered his address.

Ladies and Gentlemen,—No less than six years have elapsed since I gave, in January, 1914, my first Address to this Society upon *Wireless Telegraphy*. The Society was then in its early youth, having been founded in July, 1913, but even then, to judge by the rapid growth of its membership and the interest taken in its proceedings, its prospects appeared to be promising. Indeed, perhaps it is worthy of note that our meeting on January 21st, 1914, was, as I understand, the most numerously attended meeting of any kind ever held in the large Lecture Hall of the Institution of Electrical Engineers; a larger meeting, indeed, than any held up to that time at all events, even by the Institution itself.

During the war our Society had perforce to suspend its operations; but that it is now once more in very active work cannot, I think, be better demonstrated than by reading to you the following message which is to-night being sent out by wireless telephone from the Marconi Company's Chelmsford Station, so that all who have the necessary receiving apparatus will be able to hear it:—

“The first annual conference of the Provincial and Suburban Wireless Clubs which have become affiliated to the Wire-

less Society of London, was held this afternoon at the Royal Society of Arts, at 3 p.m. Sir Charles Bright presided, and was supported by Admiral of the Fleet, Sir Henry B. Jackson, Capt. F. G. Loring, R.N., representing His Majesty's Postmaster General, and other Vice-Presidents and Officers of the Wireless Society of London, including Mr. Frank Hope-Jones, Chairman, Major Basil Binyon, O.B.E., Vice-Chairman, and Mr. Leslie McMichael, Honorary Secretary. A proposal for the affiliation of all Wireless Societies in the British Isles was made by letter from the President of the Wireless Society of London, Mr. A. A. Campbell Swinton, at the beginning of this year. Practically, without exception, the Wireless Clubs and Societies of this country accepted the proposal and have become affiliated, the conference held this afternoon being the outcome of this sustained effort of the Wireless Society of London to bring about a fusion of all those interested in wireless experimental work for their mutual good. Clubs and Wireless Societies from the following towns and districts were represented at the conference:—

“Manchester, Altrincham, Woolwich, Southport, Bristol, Glasgow, Plymouth, Sheffield, Burton-on-Trent, and Derby; also two London suburban wireless clubs from North Middlesex and South-East London.

“We congratulate the Wireless Society of London on the initial success of their scheme.”

I am sure that we much appreciate this expression of the Marconi Company's goodwill.

Since the date of our meeting in 1914, many and great events have taken place, some of which could not well have been foreseen, but in this connection I may perhaps remind you that on the last occasion in 1914, when the Admiralty, despite a promise to keep off, broke in upon and partially jammed the wireless message that we were in the act of receiving from Paris, I pointed out to you that evidently some grave event must have been the cause; either, I said, Mr Winston Churchill, then First Lord of the Admiralty, had resigned, or war had broken out. Words spoken in jest sometimes turn out to contain more truth than was at the moment intended.

Well, we ourselves as well as our Society and wireless telegraphy also, are all older now, but if, as we must hope, we have each increased in wisdom and understanding, no advance that any individual of us has made can, I fancy, compare with the progress that has taken place in the science of wireless itself. It has been a momentous time, but in all this strenuous period of blood and tears no science has made greater advances than that to the furtherance of which this Society is dedicated. And here I am brought face to face with the difficulty of my position, which is that I am addressing an audience many of whom have an understanding and an experience of the subject vastly transcending my own. It was well enough in 1914, when we were nearly all amateurs, much upon the same level as regards knowledge, or rather want of knowledge, struggling with the intricacies of what was then a comparatively new and largely unexplored technique. Now the case is quite different, as during the war numbers of our members, having devoted their energies to the subject, have become experts and have some of them played their part in bringing about these great improvements and developments of which I have just spoken.

I must ask these gentlemen to bear with me if, to them, the remarks that I make and the experiments that I show, appear wanting in novelty or interest, remembering that all

of us are not as well-informed as they are, while to-night we have present a number of visitors to whom much of the subject is still of the nature of a sealed book. And this brings me to the matter of the objects of a Society like our own, which does not set up any high standard of qualification, but is intended to embrace all those, who, whether as a pastime or with more serious purpose, are interested in the particular application of science with which we deal. Not so many years ago the ignorance of the average individual in this country in regard to all mechanical matters was perfectly abysmal, the fault being chiefly, I fancy, with our antiquated system of education. Then came the bicycle, the sewing machine, the typewriter and various other mechanical appliances of wide-spread utility which taught something of mechanics to both sexes. At a later stage education in this direction was vastly extended by the advent of the motor cycle and the motor car, while on parallel lines photography has done much to give a general acquaintance with chemistry and optics. Wireless telegraphy, as a hobby, is a step in the same direction, and tackles many of the laws of electricity in some of their more recondite aspects. All general scientific education of this character cannot, I think, but be something to the good, and may even in time react on the woeful ignorance of all scientific matters generally displayed by our politicians and public men, and especially by the editors of some of our daily papers.

A fair example of the absurdities of newspaper science has recently been manifested in what has appeared in the daily press in connection with so-called signals from the unknown. Founded originally upon some remarks let fall by Senator Marconi and continued for some time after that eminent gentleman had specifically disclaimed in the scientific press the interpretation put upon them, the suggestion was made that mysterious dots and dashes received on wireless apparatus indicated that signals were being sent to the earth from some other world. Now whether

THE WIRELESS SOCIETY OF LONDON



General View of Apparatus used by Mr. Campbell Swinton.

a wireless signal is to be regarded as a dot or as a dash is entirely, to use a very popular phrase at the present time, a question of relativity, and given that disturbances occur, there is nothing surprising in that in some instances they take a shape that will fit into certain letters of the Morse alphabet.

Perhaps it might with advantage be pointed out that the intensity of received wireless signals varies inversely more or less as the square of the distance between the source and the point of reception; so if we suppose the mysterious signals in question originate on the planet Mars, the power of the sending apparatus must be of prodigious dimensions. For instance, if the signals in question are received in London as loudly as those from

Paris, the power employed in Mars must be greater than what is used in Paris in the proportion of the square of 200—the rough distance in miles from Paris—to the square of 49,000,000, the distance in miles from Mars.

The power employed in Paris is about 200 HP; so that unless the inhabitants of Mars have improved methods of directional sending greatly surpassing our own, the power used on Mars to give equal effects in London must be about 60,000,000,000 times as great as in Paris or say, 12,000,000,000,000 HP.

This certainly seems a fairly large amount for even Martians to employ for purely signalling purposes and would entail the use of a Morse key of ample dimensions.

Surely a much more reasonable supposition

is that the so-called signals originate in the sun where natural outbursts of electromagnetic activity exceeding in amount even this stupendous horse-power are, it is known, of not infrequent occurrence. Indeed, our great luminary is continually radiating into space some ten thousand horse-power per square foot of its surface, and as its diameter is 865,000 miles there are a great many square feet, and the total horse-power it radiates *in toto* is something altogether enormous. It is thus evident that even comparatively small ebullitions on the sun's surface may well cause disturbances on the earth amply sufficient to account for the so-called signals.

But, unfortunately, this rational way of looking at the matter does not appear to satisfy those journalists who seem to be in search not of truth but of sensation, and whose chief desire would appear to be to gratify a jaded and degraded appetite for the sensational which they themselves have greatly assisted to bring about.

The aim of the Press, as it seems to me, should be to educate the world in regard to scientific facts and principles, and surely the true fairy tales of modern science are interesting enough, if only properly told. I hope that those members of the Press who are present will bear with me. These comments are made in a friendly

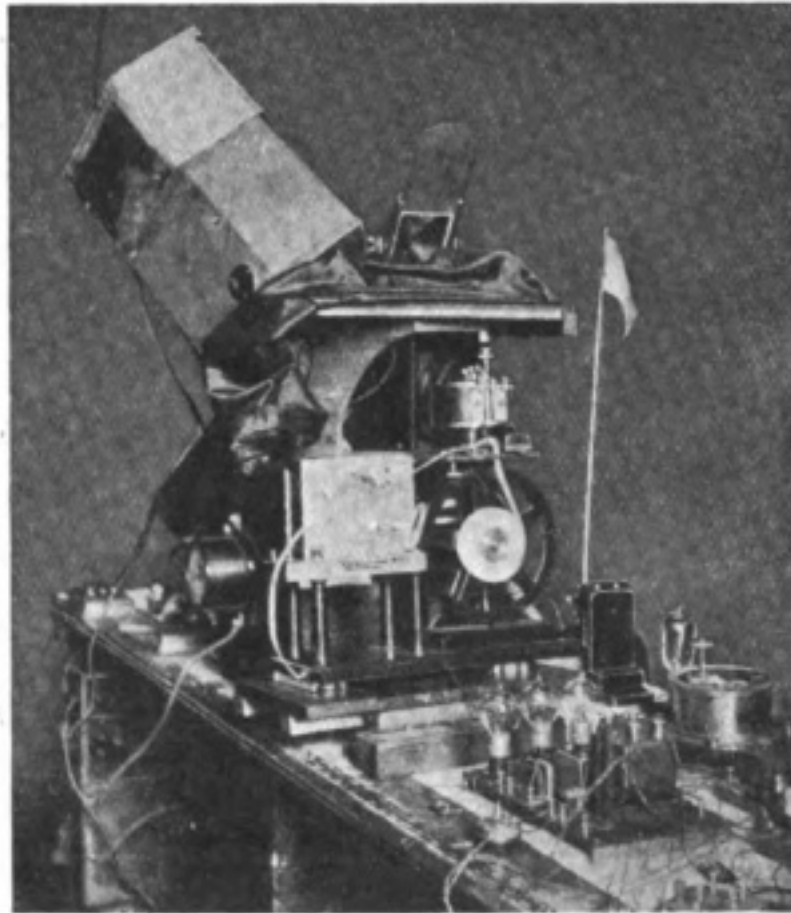
spirit and I hope that they will be received in good part.

How all the methods of applying the forces of Nature to the needs of mankind—methods which form the basis of our civilisation—depend upon research and discovery in the domain of pure science, is exemplified nowhere better than in the history of wireless telegraphy. From the original enunciation of the undulatory theory of light about the year 1807 by Thomas Young to Clerk Maxwell's electromagnetic theory of 1870, and its

experimental proof by Hertz some twenty years later, including also all Oliver Lodge's early work, up to his memorable demonstrations at the Royal Institution and at Oxford in 1894, the whole of the investigations that paved the way for practical wireless were carried out by physicists who had as their aim the advancement of knowledge pure and simple without even the slightest notion of any useful application. Yet had it not been for the labours of

these pioneers wireless telegraphy could never have eventuated.

Similarly, it is entirely to investigations in pure science and, moreover, investigations of the most recondite description, that we owe by far the greatest advance that has been effected since the date of my previous address. The thermionic valve or tube has completely



Siphon recorder and low frequency amplifier as used by Mr. Campbell Swinton.

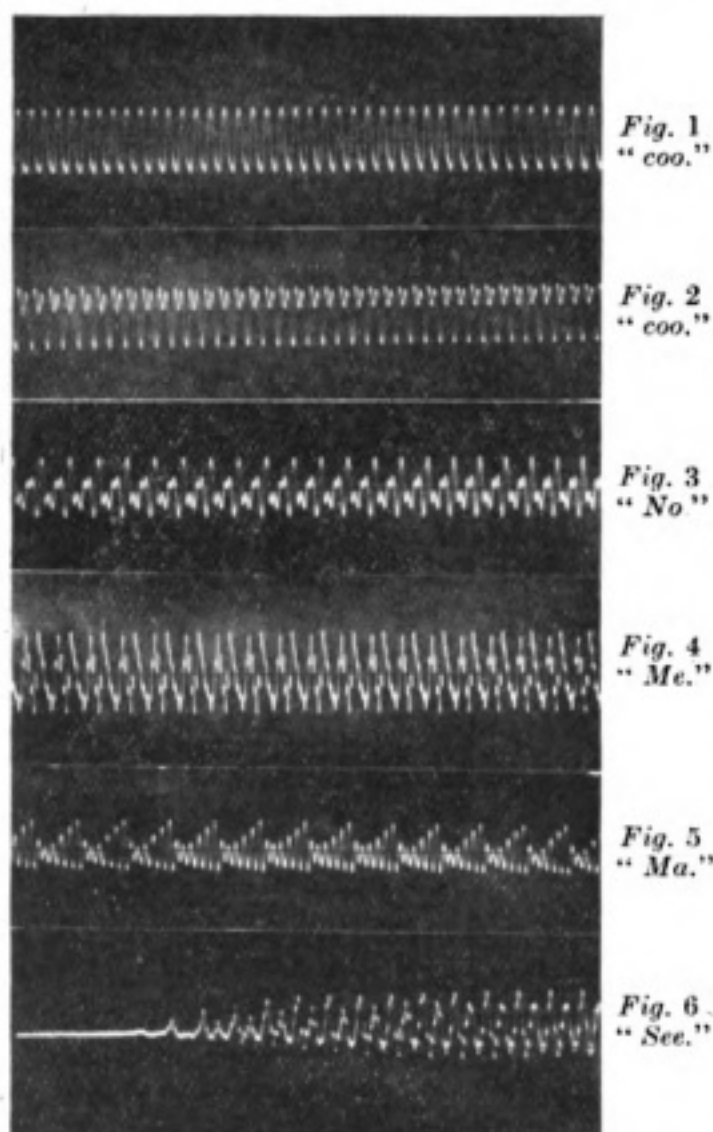
THE WIRELESS SOCIETY OF LONDON

revolutionised the whole science of wireless although as yet we are only on the threshold of its possibilities.

I have here a bulb from which the air has been removed by means of a vacuum pump until only about one-millionth remains of its original contents. Some of you may perhaps think that with 999,999ths of the air removed there cannot be much left, but as a matter of fact in a bulb of these dimensions the number of molecules of air contained in the residuum is a matter of billions. Within the bulb is mounted a small strip of platinum which I can heat red hot by means of an electric current from a 2-volt battery connected by terminals sealed into the glass. Sealed into the glass is also a third electrode and between this and the platinum strip I can connect another battery, in this case giving 100 volts. On connecting the 2-volt battery as you see, the platinum strip begins to glow. If I connect the 100-volt battery between the glowing platinum and the third electrode, you will observe that what occurs all depends upon the way in which I make the connection. If I connect the battery so as to make the glowing platinum positive and the third electrode negative, nothing happens; but if I reverse the connections and make the hot platinum negative, a soft bluish effluvium is immediately seen to dart out from the platinum and especially from a small portion of it that has been coated with lime. This continues just so long as the platinum remains heated and the 100-volt battery is connected, but disappears the moment either is discontinued. Furthermore, in the bulb there is also a flat metal plate, also connected to a terminal sealed through the glass. Under normal circumstances, the blue effluvium, which emanates from the negatively electrified hot platinum, which effluvium is known as cathode rays, falls on the plate, and this continues when the plate is positively electrified by being connected to the positive pole of the 100-volt battery. If, however, the plate is connected to the negative pole of the battery and thus charged negatively, as will be seen, the cathode

rays are repelled from the plate and cease to come up in contact with the latter. It is upon phenomena such as I have just shown you that the working of the thermionic valve is based. By means of this and other not very dissimilar experiments, it has been proved that the cathode rays consist of exceedingly small negatively electrified particles now commonly called electrons. As you know, all matter, whether solid, liquid or gaseous, is made up of atoms. These atoms are so very small that they are quite invisible in even the most powerful microscope. Indeed, it would take at least three million atoms, perhaps ten or twenty times as many set close together in a straight line, to cover a single inch. Now, small as are the atoms, the negative electrons which appear really to consist of little bits of disembodied negative electricity, are much smaller still. Indeed, as one physicist has put it, a negative electron inside an atom may be compared to a bumble bee inside St Paul's Cathedral; or to put it in another way, an atom may be compared with the solar system, when the constituent electrons within a single atom are as distant from one another relatively to their size, certainly as are the earth and the moon, and possibly as are the planets. Furthermore, these negative electrons attain in an electric field incredible velocities up to something like 50,000 miles per second, and as they are carriers of negative electricity they form an electric current and can be put to many purposes. For instance, under suitable conditions, when caused to bombard a piece of metal inside a Crooke's vacuum tube, they create the Röntgen Rays in much the same way as the bullets from machine guns may create sound by rattling on a target.

These negative electrons, in spite of the enormous velocities at which they travel have but little inertia, and therein lies their great advantage for wireless purposes. Their motions are readily controlled by comparatively small electric forces, and so by their means electric current can be modulated not only to give the usual Morse signals, but also to follow correctly and without distortion the



Wave forms of speech sounds.

highly complicated wave forms that constitute musical sounds, and human speech. Some idea of the intricate nature of speech vibrations may be gained from the following figures which are photographs taken by the late Mr. William Duddell with his oscillograph. Fig. 1 shows one of the simplest forms of sound wave, namely, that produced by saying the word "coo." No. 2 is also the sound "coo" with a slight overtone. No. 3 is "No"—as you will observe, a much more complex sound. No. 4 is the sound "Me." No. 5 "Ma" and No. 6 "See." The Telephone diaphragm that repeats sounds such as these, has to follow all these complicated vibrations correctly, and in order to get it to do so, the actuating electric current has to be correspondingly modulated. This the thermionic tube, with

its practically inertia-less electrons, enables us to accomplish.

Our esteemed Vice-President, Prof. J. A. Fleming, who I regret to say has been recently seriously ill, but who is now recovering, was the first to make use of cathode rays for wireless telegraphy. This he did in his well-known detector tube in which the unidirectional rectifying properties of a hot filament in proximity to a cold plate in a vacuum were utilised to replace the electrolytic or crystal detector. He is the father of the thermionic valve, but important improvements have been made by others, notably by de Forest, and by Lieben and Reisz, who independently introduced a third grid electrode between the hot filament and the cold plate and thus converted the apparatus into a relay or magnifier, and by others who modified the form of the tube and schemed out the various methods by which a number of tubes can be connected in cascade. Much of this work was done during the war by a brilliant band of French physicists, under the lead of our friend and Vice-President, General Ferrié; but important work was also done by Round of the Marconi Company, by Langmuir and others. It is impossible here to do justice to the claims of the many concerned while the pioneer and essential investigations on the whole subject of electrons and their emission by hot bodies by Crookes, J. J. Thomson, Rutherford, Richardson and many others should not be overlooked.

We are trying this evening to show you experiments in wireless telegraphy received without the use of any external aerial. As you know, until recently, for the purpose of receiving, as it is still for the purpose of transmitting, it was necessary to employ an aerial of considerable dimensions high up in the air, and, if in a town, generally above the roofs of the houses. To-night, however, we are going to show you receiving without any aerial of this description, the waves being received inside the room by means of a flat coil, or loop as it is usually called, only about a yard in diameter. This, indeed, is the

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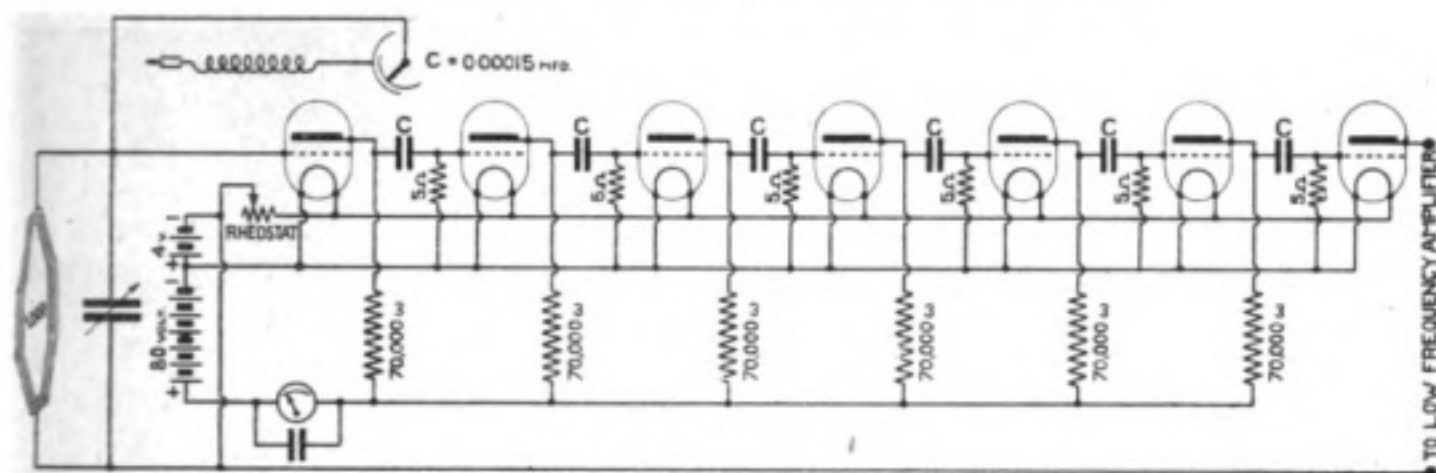


Fig. 7.

reason for this meeting being held in this ancient lecture hall belonging to the Royal Society of Arts. Apparently, the architects and builders who designed places of this description in the middle of the eighteenth century knew that a hundred and fifty years later we should require a hall like this, built entirely of brick-work and timber, wherein to receive wireless signals, whereas a hall such as that of the Institution of Civil Engineers, where we usually meet, and which was completed only just before the war, is so framed in with iron girders that the wireless waves are unable readily to enter, so that with an internal aerial signals cannot satisfactorily be received there.

As you see, the loop that we are going to use consists merely of a wooden frame on which are wound a number of turns of wire in a flat coil about a yard in diameter.* There are, in all, a hundred turns, but by means of plug connections the number of turns in use can be varied. For most purposes about thirty-five to fifty turns give the best results,

tuning to suit the wavelength being accomplished by means of an adjustable condenser connected across the terminals of the loop. These terminals are also connected to the 7-valve amplifier shown in Fig. 7. This is a high frequency resistance amplifier of ordinary description such as has been frequently described. Its connections and electrical dimensions are shown in the figure, and when suitably adjusted it is self-heterodyning for continuous wave reception. If desired, however, electrostatic reaction between the plate circuits of any one of the valves and the grid of the first valve can be established by means of a small adjustable condenser, one plate of which is connected by means of a flexible cord to a plug which can be joined to any one of the plate terminals. As a general rule, however, this additional reaction arrangement is not required.

The "out" terminals of this 7-valve high frequency resistance amplifier are connected to a 3-valve transformer low frequency amplifier, as shown in Fig. 8, to the "out" terminals of which the receiving telephones are connected through a telephone transformer. Connected also to the "out" terminals of the 3-valve amplifier is another special very low frequency amplifier, Fig. 9, which directly operates the movable coil of a siphon recorder without the employment of any mechanical relay such as is otherwise required. This special very low frequency amplifier, which is connected to the 3-valve amplifier through a step-up transformer, is also a resistance amplifier like

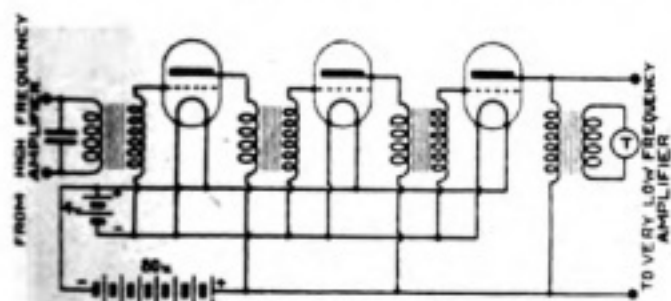


Fig. 8.

* See photograph on page 49.

the 7-valve amplifier, only instead of its being constructed to respond to radio frequencies or to audible telephone frequencies, it is fitted with condensers of comparatively large capacity, with the result that it responds to the signal frequency, that is to say, to the frequency of the beat of the Morse key at the transmitting end. In addition, at the "out"

place from which the signals originate, and that if the loop is turned round so that its plane is at right-angles to this direction, the signals are not received; indeed, by this simple means it is possible to tell, within a few degrees, the direction of the sending station, even though that station may be hundreds of miles away.

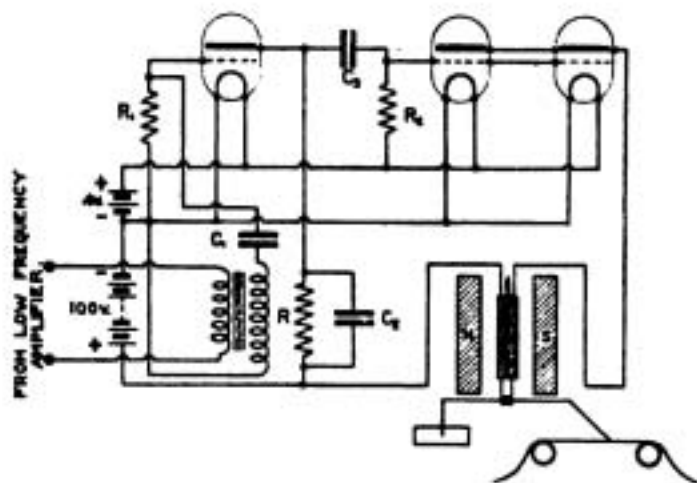


Fig. 9.

This amplifier is seen on the lower right-hand side of photograph on page 50.

end, two valve tubes are connected in parallel so as to give a larger current to operate the siphon recorder. This arrangement, which is similar to that described by Messieurs Abraham and Bloch, of the University of Paris, is advantageous in doing away altogether with the necessity of any mechanical relay.

For the purpose of demonstration, and in order to let you see how the apparatus works before we commence to receive real wireless signals from a distance, we have fitted up another loop, with about thirty turns of wire upon it, in the far corner of the hall. This loop is connected with a buzzer and a Morse key, and, as you will observe, when Morse signals are transmitted by this arrangement, they are received on our receiving loop, amplified, and made audible to you all in the telephones, operating also the siphon recorder. What I particularly wish to make clear to you, however, is that in order to receive wireless signals with the maximum effect, the plane of the receiving loop has to point at the

It is really very wonderful that, with an apparatus like this, and using no extensive outside aerial but merely this little loop, that we are able actually to record on the siphon recorder signals coming from very great distances. For instance, if you take the case of Paris where about 200 kilowatts is employed to send out the messages from the Eiffel Tower, even if we assume that the whole of this 200 kilowatts or the greater portion of it is radiated into space in the form of wireless waves, we have to remember that these waves are sent out in all directions, so that by the time they reach London, which is about 200 miles distant from Paris, they have become very attenuated. Indeed, the amount of energy received in London on the square yard or so presented by a loop of these dimensions, is this 200 kilowatts divided by the number of superficial square yards there are on the surface of a sphere of 200 miles radius. This works out at only .012 of a microwatt, or say one eighty-millionth of a watt, or one sixty-thousand-millionth of a horse power. These are very small amounts of energy, and it says a great deal for the magnifying power of the modern amplifier that, with only such minute quantities to deal with, signals loud enough to be heard all over a hall like this, or strong enough to be recorded on a siphon recorder, can be obtained.

Moreover, when once we can get signals strong enough to work relays, there is practically nothing that we cannot do with them. In place of the siphon recorder we can, of course, use an ordinary Morse printer, and we have arrangements here whereby the signals can be made to turn on and off an electric lamp, so as to convert the usual sound signals into flash-light signals, or, again, we

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can cause the signals to wave this tricolor flag, appropriate to signals from Paris.

We are now going to receive a message from the Eiffel Tower, Paris, from our good friend and Vice-President, General Ferrié. As you observe, it is now audible to you all and is being recorded by the siphon recorder. The message reads as follows:—

“General Ferrié and his assistants are sending to President Campbell Swinton and to the Members of the Wireless Society of London hearty salutations, with expression of their certitude that French and British union will continue to give splendid results everywhere, and particularly for Wireless Telegraphy.”

of wireless telephony which, thanks to the aid of the valve, has now become a matter of everyday practice, particularly in connection with flying craft between which and the earth verbal communication can now readily be maintained over distances as great as 100 miles. Moreover, transatlantic telephony, which I suggested in my address of 1914, would, if it ever took place, be by wireless, has actually, as I anticipated, been accomplished between the United States and Paris as long ago as 1915. That it is not yet in daily practical operation for Mr. Wilson to use at the present juncture is a matter for which politicians on this side may perhaps be not entirely unthankful.



Fig. 10.

“FRENCH AND BRITISH”

Reproduction of portion of message received from General Ferrié on Siphon recorder.

Fig. 10 gives a portion of this message as taken down by the siphon recorder.

Here we have now a message from Slough, sent by Mr. Basil Binyon from the Radio Communication Company's station. The Eiffel Tower transmission that we received was a spark transmission, but this one from Slough is by continuous waves produced by a Poulsen arc. As you see, the note varies with the position of the adjustable condenser, this being reception by musical beats, or heterodyne.

Then, finally, we now have a wireless communication, also on the continuous wave system, sent by the kindness of Major Hamilton from the Air Ministry. As you observe, the siphon recorder, actuated through the very low frequency amplifier, responds to these continuous wave stations equally as well as to the spark stations.

I ought to mention that I am indebted to Mr. Horace Beck, of the well-known optical firm of that name, for the loan of the apparatus whereby the writing of the siphon recorder is projected on to the screen.

No section of wireless is more indebted to the thermionic tube, both for receiving and also in connection with transmitting, than that

Indeed, so common is now wireless telephony that listening to the wirelessly spoken word has added a new joy to the amateur's receiving station, as one never knows what next one may hear. To give a few instances only, a few months ago there was a Colonel who recited reams of poetry from Kenley, near Croydon. I do not know whether it was his own composition, but from his evident gusto I rather fancy so. Then, later on, one heard Mr. Godfrey Isaacs conversing with Sir Joseph Ward and the other Colonial Premiers.

Then again, quite recently, we had Chelmsford—or was it Marconi House—talking in a truly terrible mixture of Spanish and Esperanto to Madrid, as I understand, directly to King Alfonso of Spain, himself, who, however, unfortunately does not appear to have been furnished with the necessary apparatus to enable him to reply. Furthermore, orchestral and operatic music from Rome has recently been heard by wireless in London, while the dulcet strains of the gramophone are not uncommon. Clearly we are only at the beginning of these disembodied sounds, this *vox et præterea nihil*; these voices conjured out of space.

Then again, the general news to be picked up by wireless is now vastly more extensive than it was in pre-war times. Our own country, though it gives Greenwich time to all Europe, still sends out no time signals, but of these signals there are what appears to be quite an unnecessary number which are regularly received here several times every day from Paris, Nauen, and Lyons in Europe, and from Annapolis and Panama in America. In addition, there are numerous others emanating from every corner of the earth. Next, there are the weather reports which tell us with exceeding exactness the temperature of the air and the state of the sea, the direction and velocity of the wind, the visibility through the atmosphere, the position of the clouds and the behaviour of the barometer and other interesting details of the conditions obtaining in numerous places of which we have never heard and which we shall never see.

We also get general news on politics and on current events all over Europe, if not as voluminous as appears in the daily papers, at any rate as complete as what is received on the club telegraph printing machines. Such news, moreover, is not only in languages such as our own but in French, German, Italian, Spanish, and Dutch, which some of us perhaps can hope to understand, but we also have messages, where from I am not very sure, in what I am assured are Polish, Roumanian, and Czecho-Slovak. Again, we get communications from Moscow and St. Petersburg, I presume from the Bolsheviks. These are either in German or in Russian modified to suit the limitations of the Morse alphabet which has, I believe, fewer characters than the true Russian language. Indeed, as a school of languages neither Pelman nor the Berlitz correspondence institution is in it with the modern wireless receiver.

Then in addition to all this, there are numerous private messages both between ships in the channel and the various ports, and though it may not sound very exciting to hear that a vessel entering Antwerp has on board a cargo of bananas which it wishes to tranship

to London, and that the packing must be done with special care as the consumers of bananas in London are extra particular, still for a time the novelty and variety of even messages like these when intercepted from the ether, have a certain degree of attraction. More interesting, however, are some of the private messages, particularly those that are despatched from Germany, for though in the terms of our Post Office licence we may not divulge the import of their contents, it is, I must confess, gratifying to one's own personal curiosity to read the communications that are passing between those who largely control the world's *hautes finances*, as for instance a message that I recently recorded that was sent out from Nauen and signed by the Deutsche Bank, being addressed to "Spy, New York," which is the registered telegraphic address of Messrs. Speyer Bros., the well-known international financiers.

To listen on a modern wireless apparatus is, in fact, to any thinking person, not far short of a revelation, and this too without any particular reference to the language or the meaning of what is said, for under these conditions one realises to some small extent the otherwise unknown but ceaseless activities that surround us. Everywhere, at all times, in this very room, at this present moment, all space is now permeated by wireless waves actuated by human intelligence and conveying human thought. Some strong in amplitude come from our own and other European countries. Others, weakened by expansion over long distances, reach us from America, Africa, Asia, and even from Australia. In greater or lesser degrees of attenuation, probably all of them reach us, though it is only the stronger ones that at present can be made to register their existence with sufficient exactness to deliver the messages that are the reason for their despatch. Without the necessary apparatus—delicate and wonderful apparatus such as I have brought to your notice this evening—we should know nothing of these waves. We should be entirely unconscious of their existence, for directly even

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the strongest of them have not the slightest effect upon any one of the five senses which are the sole avenues whereby we appreciate anything that is external to ourselves.

Only a very few years ago the means either for creating or for detecting these waves did not exist, and one cannot but wonder how many other physical activities there are going on around us concerning the existence of which we have not at present even a suspicion.

But lest I be misunderstood in this, let me impress upon you the desirability of keeping to effects of this kind which have a physical basis and can be put to physical experimental tests, for if extended to psychological phenomena, I fear that that way madness lies. However this may be, truly we live in a wonderful world, and not the least amongst its wonders is modern wireless telegraphy.

Admiral of the Fleet SIR HENRY B. JACKSON, G.C.B., K.C.V.O., F.R.S.—I have been asked to propose, and I have very great pleasure in asking you to join with me in giving a hearty vote of thanks to the President for his very interesting and elucidating exposition of wireless telegraphy this evening. We all sympathise with him that his first experiment did not come off, but he has made up for that in the later experiments. He has shown us what a wonderful thing wireless telegraphy is, and as he has put it, the wonders are not yet at an end. I think we are only in the first stage of them, and I dare say a generation or two hence these things will be thought nothing of, as the wonders will be increased to such an extent. However, I will not keep you, but ask you to join with me in giving the President a hearty vote of thanks.

The vote of thanks was carried with acclamation and the meeting closed.



*A neat American Amateur Station.
Owned by Mr. Raymond L. White, of Ennis, Texas, U.S.A., who is seen in the photograph.*

WIRELESS CLUB REPORTS

The Wireless Society of London.

An Ordinary General Meeting was held on March 26th in the Lecture Hall of the Institution of Civil Engineers, Mr. A. A. Campbell Swinton occupying the chair. Mr. L. A. T. Broadwood, A.M.I.E.E., read a paper entitled "Harmonics in C.W. Transmission," which was followed by a discussion. A full report of the proceedings will appear in future issues.

The Three Towns Wireless Club.

(Affiliated with the Wireless Society of London.)

February 11th.—A short description of the various forms of inductances most commonly found in wireless instruments was given by Mr. Voss; he also mentioned the best proportions of length, diameter, etc., to get the greatest amount of inductance for a minimum length of wire, thus securing the least possible damping. Mr. Rose added a description of the recently-introduced honeycomb types of coils, which show a great advance on previous methods of winding a large inductance in a small space. After the discussion which followed it was decided to seek affiliation with the Wireless Society of London, the Chairman (Mr. J. Jerritt) pointing out some of the reasons rendering this course highly desirable. Mr. Rose gave notice of his intended resignation from the position of Hon. Secretary, owing to business matters claiming a larger portion of his time than hitherto, and making it difficult for him to give his attention to club matters.

February 18th.—Mr. J. Jerritt, in the chair, paid a tribute to the work of the retiring Hon. Secretary, Mr. W. Rose, who was also thanked by the members for his services, with a note of regret that he could not continue in office. Mr. L. J. Voss was elected to the Hon. Secretaryship, and it was also decided to appoint a Treasurer. This position fell to Mr. A. J. Canniford. The final settlement regarding affiliation was made, and this matter has since been completed. The strain on the Club finances caused by the weekly rental of the room was noted, and a decision was made to have as large a proportion as possible of outings during the coming session. Mr. Jerritt supplemented this with the offer of a room free of charge when necessary, for which he received the meeting's thanks. He then gave a demonstration with some Geissler tubes, and concluded with an X-ray experiment. Some beautiful effects were produced with the former, and several members took advantage of the latter to examine their hands, purses, etc., in a "new light."

February 25th.—One of the members broached the subject of "Spiritualism," and an informal discussion on the possible relation of certain well-known phenomena to wireless took place. No definite relation could be shown, but the discussion brought to light many items of interest to the "radio-bitten."

March 3rd.—The meeting was held at Mr. Jerritt's house. The P.M.G.'s permission having been received during the week, an aerial was erected, somewhat hastily, and sundry coils, condensers, crystals, etc., joined at the lead-in. Not a breath

resulted, however, in spite of several members patiently "connecting up" in most of the possible (and some impossible!) ways. (However, with the natural cussedness of things, signals came roaring in the next day—when only two or three were present.) We had hoped to receive Chelmsford, but did not, so must wish for better luck in future.

March 10th.—Better results were forthcoming at the next weekly meeting. There was, however, a counter-attraction, in the shape of a "wireless" chair, which bumped the floor in answer to various questions put by the member who originally introduced the "Spiritualism and Wireless" question. There was no apparent physical effort on the part of the questioner or his confederate, and the strength of signals was not affected by turning the gas (light) up or down. In this, of course, it differs from pure radio; but how else, and to what extent? However, levity aside, there appears to be some connection, and we look for further advances.

All communications in future to the Hon. Secretary, Mr. L. J. Voss, at 16, Bedford Park, Plymouth.

Sheffield and District Wireless Society.

(Affiliated with the Wireless Society of London.)

Definite proposals for affiliation with the Wireless Society of London having been put forward, it was decided at the meeting on February 6th to take the necessary steps, and arrangements were afterwards made for the President, one of the Active Vice-Presidents, the Hon. Treasurer and one member of the Executive Committee to attend the Conference in London as representatives from this Society.

Many of the members have now equipped their stations for reception, and keen competition is being shown in the design of efficient apparatus.

The following fortnightly papers were read by members:—

Continuous Wave Transmission, by Mr. H. Lloyd.—The author dealt with the various systems from the "Singing Arc" of the late Professor Duddell, to the more modern Poulsen Arc and H.F. Generators of Alexanderson and Goldsmith. The application of the Thermionic Valve was then described, and its valuable service during the war emphasised. The reading of the paper was followed by an animated discussion.

Continuous Wave Reception was the subject of a most interesting lecture given by Messrs. L. Johnson and W. A. Ward. Various methods for detecting continuous or undamped waves were briefly outlined, the descriptions being illustrated by a splendid set of lantern slides specially prepared for the purpose. The lecture concluded with a practical demonstration of C.W. reception by means of a very efficient three-valve amplifier designed and built by the authors, the audience being enabled to hear several of the large Continental wireless stations at work.

Wireless Telephony was dealt with by Mr. Forbes Boyd, on February 20th, the lecturer confining his remarks to the use of valves for transmission as practised largely in the Army during the war.

WIRELESS CLUB REPORTS

The subject proved a most fascinating one and was illustrated by numerous diagrams. The interesting discussion which followed showed the evident desire of the members for further information to enable them to carry out experimental work in this direction. Several members reported having heard wireless speech at their receiving stations.

The Society has a membership to date of ninety.

Brighton Radio Society.

(Affiliated with the Wireless Society of London.)

The usual weekly meeting of the Brighton Radio Society was held on Friday, March 12th, at 7.30 p.m., at the temporary headquarters, Y.M.C.A. (Basement), Old Steine, and was well attended.

The Secretary gave an account of his visit to the Convention of the Wireless Society of London, and expressed his appreciation of the cordial reception accorded him, and he was able to assure the members of the Brighton Radio Society that the advantages they would enjoy, now that the Society has become affiliated, were many. Mr. G. Gooderick, who also attended the Convention, endorsed the Secretary's remarks, and stated that he had thoroughly enjoyed the time spent with the Wireless Society of London.

It was reported that the recently-projected workshop was fast becoming a realization and that many members were working hard to bring this about. It is hoped that more suitable premises for the Society will be acquired shortly. Several new members were introduced during the evening, and buzzer practice was also carried on.

Full particulars can be obtained upon application to the founder and Secretary, Mr. W. P. Rogers, "Grasmere," Dyke Road Drive, Brighton.

Bristol and District Wireless Association.

(Affiliated with the Wireless Society of London.)

A meeting of the above Association was held in the Physics Lecture Theatre, University of Bristol, on Friday, March 19th, at 8 p.m. The Chairman was the Rev. W. P. Rigby, who voiced his pleasure at seeing at the meeting some of the members of the old Association.

Mr. L. S. Palmer, B.Sc., delivered an interesting lecture on "Thermionic Valves," in which he gave a short account of the forerunner of the three-electrode valve, namely, the two-electrode valve of Fleming. Passing on to the three-electrode valve, he showed by means of lantern slides and apparatus various uses to which it could be put. He also explained the reception of continuous waves by the "beat" method. Unfortunately, owing to certain dates clashing, the lecturer was unable to exhibit all the apparatus he had intended.

Following the lecture a good number of questions were asked.

A vote of thanks was accorded Mr. Palmer, who, it is hoped, will be able to give another lecture to the Association at a not very distant date. In proposing the vote, the Chairman stated that he had come to the meeting knowing very little about valves, but that he would go away feeling he knew quite a good deal.

The Hon. Secretary is Mr. A. W. Fawcett. Subscriptions should be sent to the Hon. Treasurer, Mr. J. Carpenter, 35, Sunnyside Road, Weston-super-Mare.

Burton-on-Trent Wireless Club.

(Affiliated with the Wireless Society of London.)

A meeting of the above Club was held at the *Burton Daily Mail* Offices on March 17th, Mr. A. Chapman presiding.

An interesting lecture was given by Mr. Selby, with a demonstration of wireless sets. In the course of his lecture he dealt specially with telephone receivers (incidentally warning the members not to buy cheap 'phones) and valve amplifiers.

Mr. Smith suggested that all members who were making amateur sets should bring their apparatus to the club meetings for examination by and for the interest of the other members. The Chairman expressed the hope that lectures by experts on wireless telephony might be arranged later, and Mr. Selby suggested that during the summer experiments with kite aeriels and other simple appliances might be made.

Plymouth Wireless Society.

(Affiliated with the Wireless Society of London.)

March 5th.—Mr. S. V. Branton in the chair, supported by the Committee. Mr. R. C. Laws read a paper on "Land Line Telegraphy," giving a short outline of the working of the Single Current Simplex and Double Current Working, and the enormous progress of the Post Office Telegraphy since being taken over by the Government. Mr. R. Holwill also read a paper on "Communications in Mesopotamia"—a brief outline, giving insight into communications and their gradual establishment. A description of the principal towns on the lines of communication proved of great interest.

March 12th.—Mr. R. C. Laws in the chair, with a full meeting. It was proposed, seconded, and carried by the meeting that Mr. S. G. Monk, B.Sc., A.M.I.E.E., be elected Vice-President. Mr. S. Bond, in a short paper on "The Operator at Sea," gave useful information on the general bearing, requirements, uniform and maintenance of uniform. Also an interesting paper was read by Mr. L. Norman on "The Personal Experience of a Pilot in the R.A.F.," dealing with his life in England and France. Points of special interest were: types of aircraft, the simplicity of wireless (from his point of view) on an aeroplane, and thrilling encounters during bombing expeditions and patrols.

Birmingham Wireless Association.

A meeting of the above Association was held, on March 10th, at 7.30 p.m., at the Birmingham and Midland Institute. There was an attendance of sixty-eight, and forty-two names were given in as prospective members. The President (Mr. E. W. Dobbs), opened the meeting by stating briefly the objects of the Association, and suggesting conditions of membership.

A discussion followed, in which Dr. Ratcliffe, Messrs. Shaw, Upton, Whitfield and others took part. The only difficulty seemed to be concerning the title of the Association. At present it is a section of the Scientific Society, and, if possible, it is hoped to revert to the old title. The annual subscription is 10s. 6d. for external members, and 5s. for members of the Institute.

Mr. Briggs, of the Birmingham School of Wireless Telegraphy, made a very kind offer to allow members to see the apparatus any time during school hours, and he stated he would also be pleased to arrange other times when the apparatus could be demonstrated and used. The school, of course, will have all the latest instruments, and the opportunity of seeing and using them should prove a very valuable help to many members.

The date of the next meeting will be sent to all who left their names at the last meeting, and if there are any prospective members who were not present on March 10th, or who failed to leave their names and addresses, they should notify the Hon. Secretary, Mr. J. C. Watkins, 215, Alexander Road, Acocks Green, Birmingham.

The Edinburgh Wireless Club.

The first meeting of the above Club was held on February 29th in the rooms which have been taken provisionally in the "Outlook Tower."

Intending members present examined the situation and its possibilities as regards the installation of a receiving station, with favourable results.

Two members present offered their apparatus, which is still, however, in the care of the Post Office, for club use.

The following resolutions were passed:—(1) That a permit to erect and use a receiving station employing valve amplifiers be applied for. (2) That buzzer classes be instituted as early as possible. (3) That the Club be advertised more widely. (4) That negotiations for affiliation with the Wireless Society of London be made. (5) That the subscription be fixed *pro tem.* at 5s. entrance fee and 10s. annually. Pending further developments the meeting was closed.

Owing to the difficulties which appear from all corners I expect that it will be some time before we "get going" properly, although great keenness was shown by everyone.

During the course of the meeting Mr. W. Winkler was appointed Hon. Secretary.

If intending members will apply to that gentleman, address 9, Ettrick Road, Edinburgh, he will be pleased to give them all necessary information.

Halifax Wireless Club.

Under the above title a new amateur wireless club has been formed, with headquarters at the Y.M.C.A., Clare Hall, Halifax. The Hon. Secretary is Mr. L. Pemberton.

The committee has decided to affiliate the club with the Wireless Society of London.

The Postmaster-General's licence for a receiving set has already been obtained, and an aerial erected. One of the members has kindly loaned to the club a single-valve set, with which excellent results have been obtained.

At present the membership of the club is about twenty. New members will be welcomed, and all

interested should communicate with the Hon. Secretary, at the Y.M.C.A.

Liverpool Wireless Association.

The re-opening meeting of the above Association was held at McGhie's Café, 56, Whitechapel, Liverpool, on March 17th, when plans were arranged for future activities. It was recognised that it was more than ever important that wireless experimenters should band together for mutual help and protection.

The subscription was arranged at 5s. per annum, meetings to be held the second and fourth Wednesdays in the month. It is intended to apply for affiliation with the Wireless Society of London.

Mr. S. Frith, 6, Cambridge Road, Crosby, is Hon. Secretary and Treasurer *pro tem.*

A cordial invitation is extended to all persons interested in wireless telegraphy to attend the meetings, and to join the Association, which was one of the first in the United Kingdom.

The Glamorganshire Scientific Wireless Research Society.

Under the above title, and with a nucleus of sixteen members, a new amateur wireless club has been floated in Mountain Ash, Glamorganshire. The Hon. Secretary is Mr. A. E. Hay, 6, Oxford Street, Mountain Ash, and Mr. W. A. Andrews (late Captain, R.F.C.), head of the Wireless Department at the Technical College, Cardiff, has promised his support, and has kindly placed the Wireless Department of the College at the disposal of the Club for meetings, etc.

The Technical College, Cardiff, is making application for a wireless transmitting licence (for research purposes).

Will all interested please communicate with the Hon. Secretary, Mr. A. E. Hay. New members will be cordially welcomed.

Wireless Club for Surrey.

Mr. William Le Queux, the famous novelist, is organising an Amateur Wireless Club for Surrey. Intending members should communicate with Mr. Le Queux at Lavender Cottage, Guildford.

Wanted.

To form Wireless Clubs at Chelmsford, Croydon, Birmingham, Halifax, Spalding, Doncaster, Exeter, Grimsby, Gloucester, Bradford and Preston. Those interested should communicate with Mr. C. E. Jackson, 3, Seymour Street, Chelmsford; Mr. A. F. Lake, 318, Brighton Road, South Croydon; Mr. A. H. Staples, Y.M.C.A., Dale End, Birmingham; Mr. W. G. A. Daniels, Pinchbeck Road, G.N.R. Crossing, Spalding; Mr. A. H. Wasley, Glenholme, Ravensworth Road, Doncaster; Mr. H. E. Allcock, 1, Prospect Villas, Heavitree, Exeter; Mr. C. Hewins, 42, St. Augustine Avenue, Grimsby; Mr. J. Mayall, Burfield Lodge, St. Paul's Road, Gloucester; Mr. J. Bever, 85, Emm Lane, Bradford, and Mr. A. Wilkinson, 176, Tulketh Brow, Ashton, Preston.

PAGES FOR BEGINNERS

Under this heading we publish COMPLETE instructional articles, forming a series specially designed and written for beginners in wireless work. Hardly any mathematics will be introduced, and we hope to present the fundamental facts of wireless in such a manner as will prove attractive to a much wider range of students than that for which this series is primarily intended.

ENERGY AND POTENTIAL.

IN most textbooks electricity is defined as a form of energy, recognised by the effects it produces. Like most abstract quantities energy is practically impossible to define. We are only told how to recognise it when we meet it in various forms; and if we look up the definition of energy, we find some such statement as: "Energy is that which is capable of doing work," which again only enables us to recognise energy in one form or another. If we see a spring driving a train of clock-wheels, we know there is energy in the spring, because it is performing work. And if the spring is coiled up and at rest, there is still energy in it, because if allowed to uncoil it would set a mechanism in motion.

A law, known as the Law of Conservation of Energy, states that "Energy can neither be created nor destroyed." Viewed from this standpoint, we see that the term "generator of electricity" is, strictly speaking, wrong. A dynamo merely *converts* the mechanical energy supplied to it, into electrical energy.

This electrical energy can be utilised in various ways. It may be converted back into

mechanical energy, such as when a motor is used to drive machinery, or it may be converted into heat and light by means of lamps.

Working back, we see that energy is supplied to the dynamo from, let us say, a steam engine. This steam engine derives its energy from the coal in the furnace. The coal originally derived its energy from the sun, the source of most of the energy supplied to the world. Fig. 1 gives some idea of the various forms in which energy appears before it comes to us as electricity.

This brings us to the forms in which energy can exist. When we come to compare the energy stored in coal with the energy of a fly-wheel rotating on its shaft, we see that it can obviously take two forms—energy at rest, and energy in motion. The former is spoken of as *potential energy*, and the latter as *kinetic energy*.

Consider a weight on the surface of the earth. If we lift that weight one foot above the level of the earth we expend a certain amount of energy. The weight is now possessed of energy due to its position above

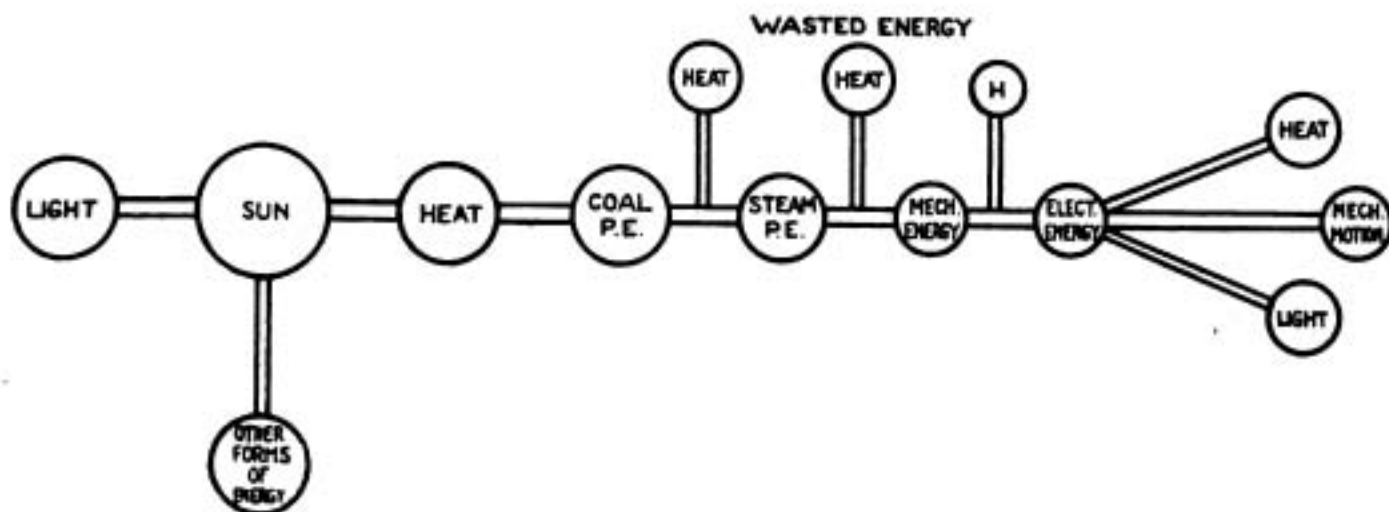


Fig. 1.
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the ground level. If it were allowed to fall it would perform work. As long as the weight is fixed at a certain height, it possesses potential energy due to its position. Now, if we attach a cord to the weight and connect it to a train of wheels, the potential energy will be transformed into kinetic energy, and the wheels will revolve.

It must be noted that whatever amount of energy we put into a system we can never obtain exactly the same amount in the form in which it is desired. A certain amount, however small, is always converted into heat, and is dissipated in the surrounding atmosphere. In the case referred to above, a certain amount of energy is expended in heat due to the friction of the air and the friction of the various supports and bearings of the train of wheels.

The less energy that is lost in this manner the more *efficient* is the apparatus said to be.

All physical quantities such as work, velocity, electrical power, etc., are expressed in terms of fundamental units of length, mass, and time.

The unit of length is taken as the *centimetre*; that of mass is the *gramme*, and unit time is considered as one *second*. This centimetre-gramme-second (or C.G.S.) system forms the basis of the everyday units of power and electricity.

We know that we cannot do work without overcoming a force. If we wish to lift a weight from the floor we are acting against the force of gravity, which must be overcome before the weight can be lifted. If we lifted the weight twice as high as at first we should perform twice as much work. Work can therefore be said to be proportional to force, and to the distance moved.

The unit employed in speaking of work is known as the *erg*. One erg of work is that amount of work done in pushing a mass of one gramme for a distance of one centimetre against unit force.

The unit of energy is the same as the unit of work. The reason for this is seen from the definition above. If a body possesses ten

units of energy it is obviously capable of performing ten units of work; or, speaking generally, unit energy is the capacity for doing unit work.

It is obvious, on consideration, that the question of time must play a part in the work done. We may lift a pound weight one foot high in a second, or we may take an hour to do it. There must therefore be some quantity which will express the *rate* at which work is done.

The unit quantity is known as the *watt*, which is equivalent to ten million ergs of work per second.

The common unit of power is the *horse-power*.

This was originally based on the actual amount of power exerted by the horse in unit time, but it is easily seen that such measurements are liable to error. However, the unit "horse-power" is still accepted for everyday use. The relation between the units is as follows:—

One horse-power is equivalent to 550 pounds raised one foot high in one second.

As one foot-lb. equals 1.356×10^7 ergs, one horse-power is equal to

$$\begin{aligned} &550 \times 1.356 \times 10^7 \text{ ergs.} \\ &= 746 \times 10^7 \text{ ergs or } 746 \text{ watts.} \end{aligned}$$

The question of the units of work will arise again when we consider the actual measurements of electric potential.

POTENTIAL.

The early experiments on electricity were confined almost exclusively to that which we now call "static" electricity. "Dynamic electricity," or electricity in motion, was not considered until the researches of Volta, and, later, those of Faraday.

In the early stages of electrical experiments several theories were advanced to account for the peculiar effects observed when glass, resin, etc., were rubbed by dry cloths.

It appears that the terms "positive" and "negative" as applied to electricity were first formulated by Franklin, who propounded the following theory:—

PAGES FOR BEGINNERS

All bodies contain an electric "fluid" uniformly distributed throughout them until it is disturbed by friction or other means. Thus, when a rod is rubbed, the "fluid" is distributed unequally between the two bodies, one being said to have more, the other less, than the average. Franklin termed the body possessing more electricity *positive*, while the other was termed *negative*.

Of course, in view of present-day knowledge, the term "fluid" as applied to electricity is quite erroneous. Electricity is not a fluid, however much it resembles one in its properties. Nevertheless, for practical purposes the idea that electricity can *flow* along a conductor is useful, provided we take care not to confuse assumption or analogy with facts.

It was found, in dealing with the attraction and repulsion of electrified bodies, that some sort of unit was essential by which the intensity of various charges of electricity could be compared. The electrostatic unit of electricity was therefore defined as that quantity of electricity which, when placed at a distance of 1 centimetre from a similar and equal quantity, repelled it with unit force.

Imagine, now, a small positively-charged ball, standing by itself on a table. If we bring a similarly charged ball near it, the first one would tend to repel it. The repulsion would depend on two things (1) the amount of charge on the second ball, (2) the distance at which it is placed. As the two balls are brought nearer and nearer to each other the repelling force will grow greater and greater, and we shall have to exert more and more force to bring the two balls together. (Fig. 2).

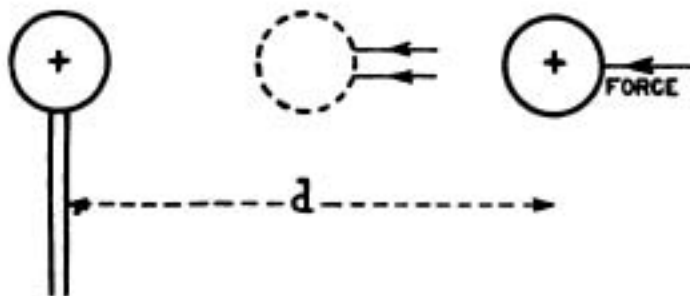


Fig. 2.

As we move the balls nearer and nearer we perform a certain amount of work against the force exerted by the first sphere. If we released the pressure the two spheres would fly apart. Obviously, then, both spheres *possess the capacity for doing work*. This capacity for doing work, possessed by either sphere, is said to be its *potential*.

Returning for a moment to our previous definitions of work, it will be seen that if we lift a pound weight 4 feet we expend 4 foot-lbs. of work, and if we allow the weight to fall, it will expend 4 foot-lbs. of work in falling back again.

The *potential* at any point, therefore, is the amount of work that must be performed on a unit of electricity in order to bring it up to that point from an infinite distance. It follows, therefore, that at a point infinitely distant from any electrified body, there would be no forces exerted, and the potential, therefore, would be zero.

From the foregoing it is but a step to proceed to define *difference of potential*. The difference of potential between two points is the amount of work done in carrying a unit of electricity from one point to the other.

Therefore, unit difference of potential exists between two points when we have to expend one *erg* of work in transferring one unit of electricity from one point to the other.

In dealing with electro-magnetism or electrodynamics (as opposed to electrostatics) these definitions still hold true; but we shall have to adopt a unit of convenient dimensions as a standard. It has probably been noticed that the C.G.S., or absolute units, are somewhat inconvenient for everyday measurement. The work we do is not measured in ergs, but in horse-power, or foot-lbs. Similarly the unit of potential is taken as the *volt* (after Volta, the Italian physicist), which is equivalent to 100,000,000 or (10^8) absolute units. If two wires having a difference of potential of 1 volt are joined, and unit quantity of electricity passes in unit time (1 second) the wire is said to carry a current of 1 ampere.

A summary of the practical units is given below :—

Unit Potential exists between two points when it requires one erg of work to convey a unit charge of electricity from one point to the other. The practical unit of potential is the Volt, which is equal to 10^8 absolute units

Unit Current of electricity is that current which conveys unit charge of electricity past a given point in 1 second. The practical unit is the Ampere. If unit current passes in a wire having a difference of potential of 1 volt between its extremities, the wire is said to have a *resistance* of 1 ohm. (Fig. 3).

One watt, therefore, is equivalent to the product of 1 volt and 1 ampere.

A convenient multiple of this, in dealing with large amounts of power, is the *Kilowatt*, which equals 1,000 watts.

NOTE.—In Fig. 4, page 28, the direction of the arrow heads on the lines of magnetic flux should be reversed.

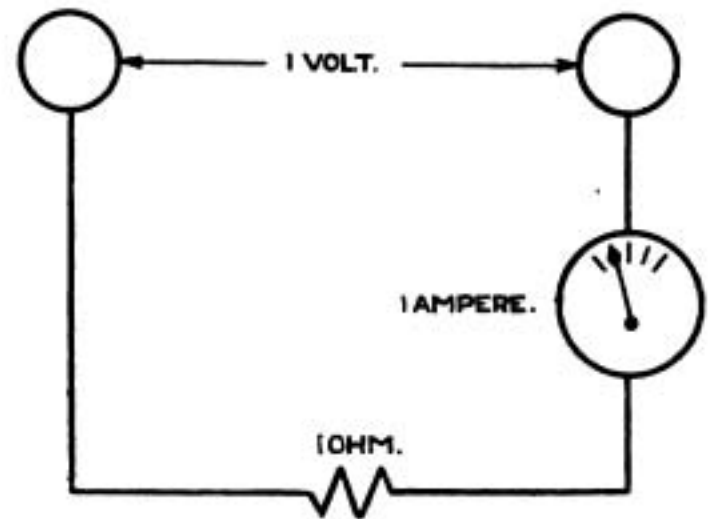


Fig. 3.

Lastly, if 1 ampere is flowing under a pressure of 1 volt, unit power is produced.

Unit power, it will be remembered, is "rate of working," and in practical units is the *watt* (10^7 ergs per second).

The CONSTRUCTION of AMATEUR WIRELESS APPARATUS

A Crystal Receiver with Valve Magnifier (Part I).

THE present series of articles is intended to provide the amateur with sufficient information to enable him to make up most of his own apparatus. Many, of course, may wish to avail themselves of the services of manufacturers advertising in the *WIRELESS WORLD*, and purchase the component parts of a set ; but others, whose means are more limited, will be glad of some practical information and advice so that they may become manufacturers for themselves.

When constructing apparatus the amateur should always endeavour to make each part a well-finished yet not too elaborate article, bearing in mind that as he improves his knowledge he will wish to use his parts for more useful and sensitive apparatus

It is intended to outline in this article the design and construction of a Valve Receiver giving "reaction" magnification over a wavelength range of 300 metres to 3,000 metres. We shall use what is known as the "French" valve, which has a spiral grid and cylindrical anode mounted in a spherical shaped glass bulb.

The circuit we shall use is as shown in Fig. 1.

Stated briefly the operation of the circuit is as follows :—The high-frequency oscillations in the aerial circuit will give high-frequency voltage changes across the aerial inductance, and as the grid is connected to the top of the inductance these voltage changes will vary the normal potential of the grid. If the normal grid potential is adjusted to the right

THE CONSTRUCTION OF AMATEUR WIRELESS APPARATUS

point on the characteristic curve these H.F. variations will be repeated in the plate circuit, and if the secondary circuit is in tune with the

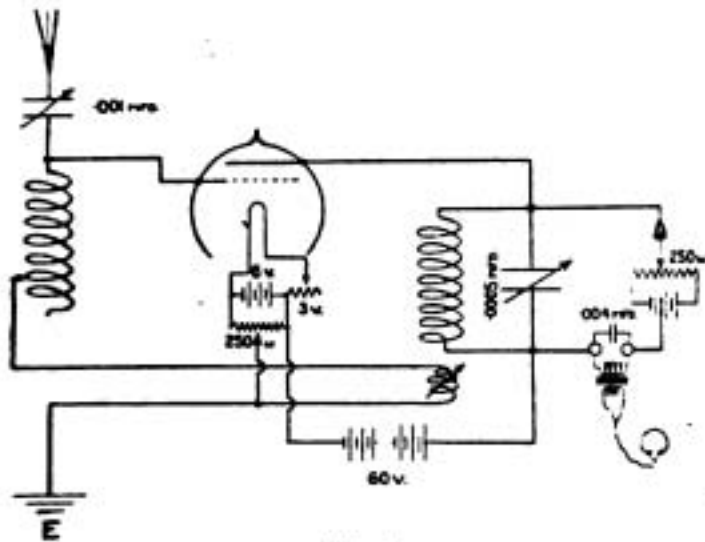


Fig. 1.

aerial circuit the variations in the plate current will build up the amplitude of the oscillations in the secondary circuit. Then if the reaction or coupling coil is properly adjusted, part of the oscillating energy in the secondary circuit may be coupled back into the aerial circuit to build up the voltage changes on the grid and give bigger changes still in the plate current, increasing still more the amplitude of the oscillations in the secondary circuit. This process is repeated and maximum signal strength obtained by carefully adjusting and readjusting the variable units of the set. The valve, being adjusted for the most efficient H.F. magnification, will not be an efficient rectifier, hence a crystal and potentiometer are used in conjunction with a telephone transformer and low resistance telephones.

The complete outfit will consist of:—

1. The Aerial.
2. The Aerial Inductance and Condenser.
3. Unit comprising Coupling Coil and Jigger Secondary with Jigger Switch complete.
4. Secondary Condenser.
5. Valve Holder, Filament Resistance, and Grid Potentiometer.
6. High Tension Battery.
7. Telephones and Telephone Transformer.

8. Crystal Holder and Potentiometer.
9. Telephone Condenser.
10. 6-Volt Accumulator of 20 or 40 ampere hours' capacity.

Item 1.—The Aerial. A full description was given in *WIRELESS WORLD*, December, 1919. "An Amateur Receiving Set." Maximum length allowed by Post Office is 100 feet of single wire or 70 feet of twin wire.

Item 2.—The Aerial Inductance was also fully described in the above-mentioned article.

The Aerial Condenser of 0.001 mfd. should be purchased. If preferred a Variometer may be incorporated in the Aerial Inductance unit. A description of a variometer was given in the "Amateur Wavemeter" article, *WIRELESS WORLD*, April 3rd, 1920.

Item 3.—Coupling Coil and Secondary Unit may be made up together with a small switch.

Item 4.—Secondary Condenser of 0.0005 mfd. It will be better to purchase this.

Item 5.—Valve Holder for French type valve may be constructed as shown by Mr. E. W. Kitchen, *WIRELESS WORLD*, February, 1920.

The filament resistance of 3 ohms and grid potentiometer of 200 to 300 ohms may be made up.

Item 6.—H.T. Battery can be made up of fifteen 4-volt pocket-lamp batteries—"Ever Ready" type. This should not be made up until last, so that the cells may be in good condition when the set is ready for use.

Item 7.—Telephones should be purchased and a Telephone Transformer made up as described by Mr. A. D. Kent, *WIRELESS WORLD*, March, 1920.

Item 8.—Crystal Holder. Described in *WIRELESS WORLD*, December, 1919.

Item 9.—Telephone Condenser of 0.003 to 0.004 mfd. may be made up.

Item 10.—Six-Volt Accumulator must be purchased. The larger the capacity in ampere hour rating the better.

CONSTRUCTIONAL DETAILS.

Taking the items of apparatus in the foregoing order, items 1 and 2 need not be discussed here. The 3rd item, a coupling

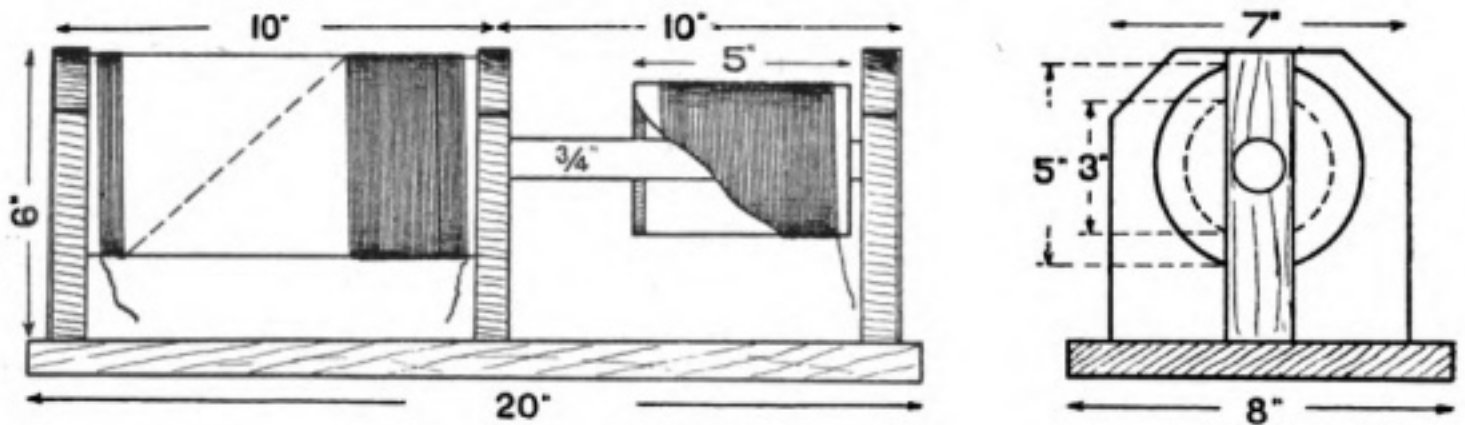


Fig. 2.

coil and secondary unit we must make up ourselves. Fig. 2 gives a general idea of what is required with approximate dimensions.

The base can be made of wood about 20" by 8" and $\frac{1}{2}$ " thick. Three wooden supports will be required, two of them to hold the large former and the third to be used to form a support for the brass tube along which the small former is permitted to slide.

General dimensions are given in the sketch. This shows the large former to be 5" in diameter; it will therefore be necessary to make a hole 5" in diameter in the wood supports for this former. If possible ebonite or fibre should be used for both formers, or a very good substitute can be made with thin Bristol board rolled round, several thicknesses, in the form of a tube of the required diameter. In order to make this tube of good insulation the Bristol board must be varnished with thin shellac varnish whilst rolling, and finally baked in a warm oven to dry and harden off. When taken out of the oven it should be left to cool and then carefully fitted into the wooden supports. For convenience of winding the final mounting into the base should be left until the last operation.

To make the smaller or coupling coil, two wooden discs are required, 3" in diameter, and $\frac{3}{8}$ " thick, having a $\frac{3}{4}$ " diameter hole in the centre to allow the brass tube to fit in "friction tight."

These two wooden discs will form the two end supports for the former. A Bristol board tube must be made 5" long and 3" diameter.

This tube can be built up on the wooden discs, the cardboard being neatly pinned on to the discs.

The formers are now ready for winding; should the surface of the former be uneven it is a good plan to wrap round it one or two layers of varnished or waxed paper, to give an even surface to wind upon.

A $\frac{3}{4}$ " hole must be drilled in the first and third wooden supports to allow the brass tube to rest in and finally a thin piece of wood may be screwed on to the supports to prevent the tube shifting when the position of the coupling coil is varied.

If desired, a terminal board can be made up with four terminals upon it, to which to bring the leads of the two coils. The base of this must be made of ebonite or fibre, because sufficient insulation will not be obtained by merely screwing the terminals direct into the base of the stand. This terminal board is quite optional.

In order to tune the large former to any wavelength from 300 to 3,000 metres with the condenser having a capacity of 0.0005 mfd., it will be necessary to make tappings on the winding, the leads from which must be connected to a switch in order to reduce the value of the inductance to be within range of the desired wavelength to be received, in conjunction with the variable condenser.

Particulars of winding and values for the same will be given in the next issue, when we shall give further particulars of the other parts of the receiver.

ALTERNATING CURRENT WORK WITH REFERENCE TO THE THREE - ELECTRODE VALVE

By R. C. CLINKER.

Continued from page 32.

A SIMPLE form of triode connection for the generation of oscillations, is shown in Fig. 7. L and C form the main oscillating circuit, and with resistance R may be regarded as a "dummy" aerial.

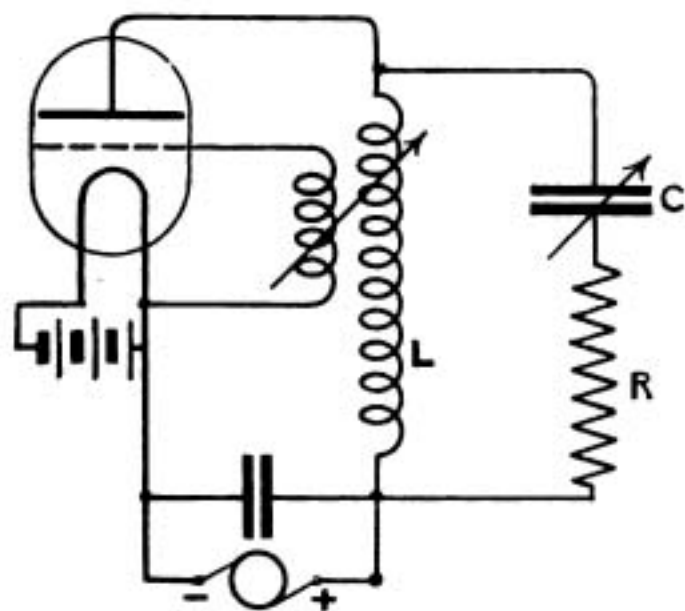


Fig. 7.

For the present purpose we may assume, which is very nearly true, that the frequency of oscillation is the natural frequency of circuit LCR. We may take the following figures :—

$$\lambda = 2000 \text{ metres } (n = 150,000),$$

$$R = 30 \text{ ohms.}$$

For a frequency of 150,000 the product LC must be closely 1000, where L is in millihenries, and C in cm. We can, therefore, vary the ratio of L to C without affecting the wavelength ; but this variation

will affect the quantity $\frac{L}{CR}$, which is the effective resistance of the oscillating circuit in

the plate circuit of the valve. A tabulation will make this clear :—

LC	L (milli- hen.)	C (cm.)	R	$\frac{L}{CR}$ (ohms.)
1,000	0.5	2,000	30	7,500
1,000	1.0	1,000	30	30,000
1,000	2.0	500	30	120,000
1,000	3.0	333	30	270,000

The question now arises as to what value of

$\frac{L}{CR}$ is the best to use with a given triode if

it is desired to obtain the maximum alternating current output, *i.e.* the maximum value of I^2R . To decide this, we must consider the characteristics of the triode itself. Fig. 8 shows a group of curves for a certain triode, each curve showing the relation between grid voltage and plate current for a fixed plate voltage.

Confining attention to the straight portions of the graphs, we note that (1) their slopes are all practically the same, *i.e.*, the change of plate current per grid volt is constant, and (2) the effect of changing the plate voltage is to shift the curve horizontally by an amount (measured in grid volts) proportional to the change in plate voltage. Taking the values shown in Fig. 8, the plate current changes by 0.5 milliamps per grid volt, while the "shift" is 10 anode volts per grid volt, or a voltage ratio of 10 to 1.

If, now, we apply to the grid circuit an alternating E.M.F. of 10 volts maximum value, we can regard the plate circuit as experiencing an alternating E.M.F. of 100

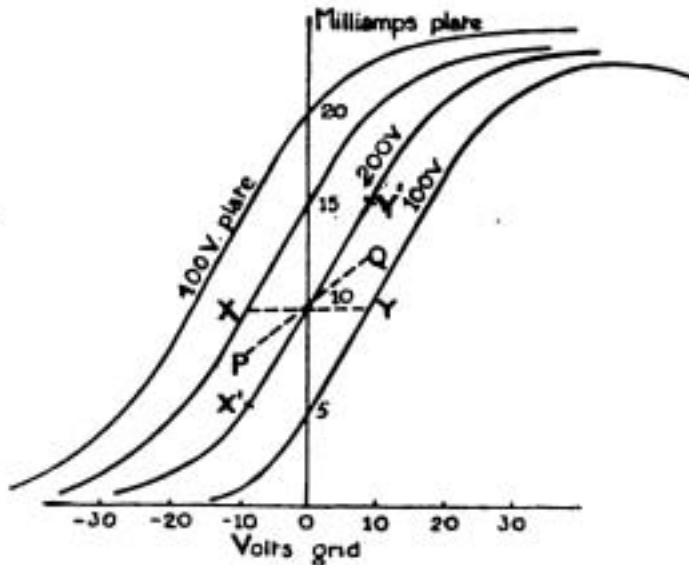


Fig. 8.

volts maximum value. In other words, the plate circuit behaves as if it contained an A.C. generator giving 100 volts maximum on "open circuit," *i.e.*, when no variation of plate current is allowed. This condition can be realised by including in the plate circuit a very high reactance of low resistance which will practically prevent any A.C. component, while allowing the D.C. component to flow freely. The line XY in Fig. 8 then represents the variation of grid and plate voltages for a D.C. plate voltage of 200. The A.C. plate current is practically zero, but an A.C. voltage component of 100 maximum is "generated" in the plate circuit.

Now, if we cut out the reactance, this A.C. plate voltage will disappear and give place to a plate current having an A.C. component of 5 milliamps maximum, corresponding to

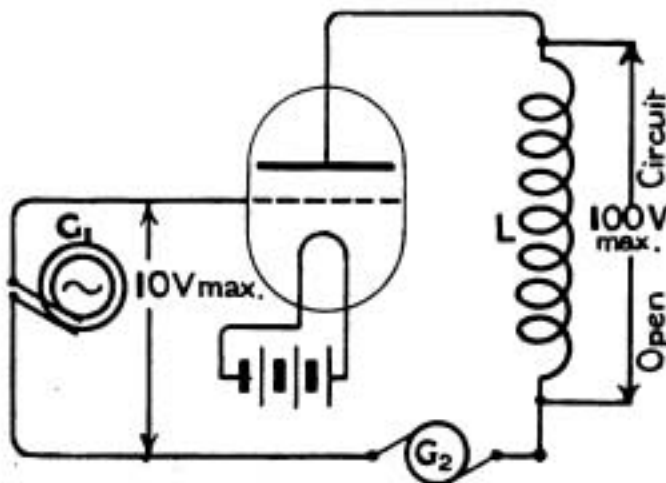


Fig. 9.

the applied grid voltage of 10. The line X'Y' now represents the oscillation, and is obviously part of the 200-volt curve.

Figs. 9 and 10 show the two conditions described. The plate circuit is supplied from D.C. source G₂, whilst the grid circuit is supplied from A.C. source G₁ at 10 volts (maximum). In Fig. 9 a very high reactance L is placed in the plate circuit. This substantially prevents any A.C. current from flowing, but allows the D.C. to pass. Looking at the plate circuit as an A.C. generator, this may be regarded as the "open circuit" or "no load" condition, the full generated voltage of 100 appearing across the reactance L. In Fig. 10 the reactance is removed.

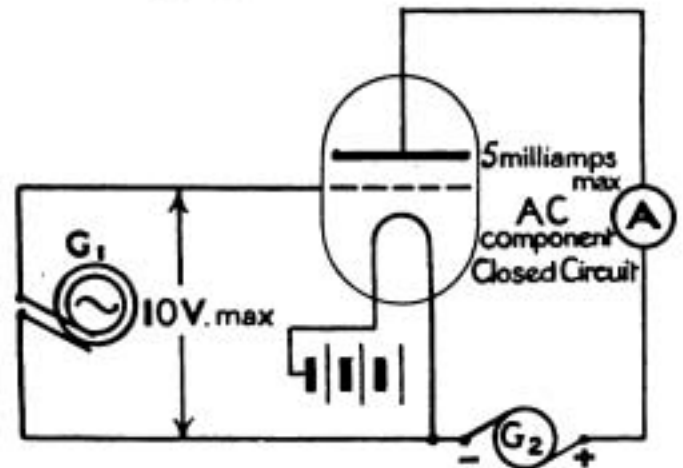


Fig. 10.

This may be regarded as the "short circuit" condition of the generator, where the voltage of 100 is all absorbed in driving the A.C. current of 5 milliamps through the triode. The effective resistance is therefore—

$$\frac{100}{0.005} = 20,000 \text{ ohms.}$$

and this we will call the "triode resistance." If, now, we add external resistance, keeping the D.C. plate voltage constant, we can calculate the A.C. current by adding the external resistance to the triode resistance. For example, a resistance of 20,000 ohms placed in the plate circuit will reduce the A.C. current, in the foregoing case, to one-half, or 2.5 milliamp. The line of oscillation will then be along PQ in Fig. 8, and have a slope midway between XY and X'Y'.

BOOK REVIEWS

WIRELESS TELEGRAPHY AND TELEPHONY: FIRST PRINCIPLES, PRESENT PRACTICE AND TESTING
By H. M. DOWSETT, M.I.E.E., F.P.S.L.,
M.Inst.R.E.

London: The Wireless Press, Ltd., pp. 331
+ xxxi 9s. net.

ACCORDING to the author this book has been designed to act as a connecting link between the elementary textbook and the advanced treatise, and, in particular, to meet the demand for a book of instruction which can be used in sequence to the *Handbook of Technical Instruction for Wireless Telegraphists* by J. C. Hawkhead and the author himself. We are of opinion that both of these purposes are admirably served by the volume under review and, further, that the book has a much wider significance than is indicated in Mr. Dowsett's modest claims.

Chapter 1, which is entitled "The Nature of Electricity and the Atom," is notable in that it contains a striking conception of the atom as an electron vortex. In the model atom described, a core of "positive electricity" has no place, and this, we believe, marks a distinct advance in the evolution of electronic theories of the atom. Limitations of space prohibit a discussion of this theory, which we should like to see expounded more fully elsewhere, when perhaps Mr. Dowsett will divulge his method of calculating the approximate sizes of atoms.

Chapter 2 is a discussion of phase displacement effects in elementary circuits and includes a useful section devoted to vector diagrams. Chapter 3 is a detailed treatment of the spark discharge, which should be of enormous interest, especially to ship-station operators.

Chapter 4 deals with C.W. transmitters and includes, of course, descriptions of the Duddell 2,000-cycle alternator, the Alex-

anderson machine, the H.F. alternator of the Société Française Radio-Électrique, the Goldschmidt alternator, the Marconi "Timed Spark" method, the Duddell arc, the Poulsen arc, the Marconi-Poulsen arc and the valve oscillator.

Chapter 5 is headed "Thermo-ionic Effects and Oscillation Valve Phenomena," and appears to be fairly up-to-date, even with regard to wireless telephony. Those who know the rapidity with which this branch of radio work has developed will realize that we have not in the preceding sentence attempted to "damn with faint praise" this section of the book. Writing on the subject of wireless telephony for a book to be published months afterwards, must be somewhat analogous to climbing the greasy pole—a continuous energy output and a constantly lengthening pole.

Chapter 6 is unique. It is a description of the special apparatus used for high-speed transmission and reception, a subject we have never seen treated so fully before in one publication, and one which will probably acquire greater general interest upon the establishment of an Imperial Wireless System.

It is to Chapters 7 to 14 we particularly direct the attention of our readers. These chapters occupy half the volume and cover the measurement of Current, E.M.F., Resistance, Capacity, Inductance, Frequency, Dielectric Strength, Decrement, Direction and Distance of Transmitting Stations, and of the Intensity of Received Signals. Here the author is on his own special ground, and as Chief of the Testing Department at the Marconi Works his knowledge of present-day electrical testing and measurement is intimate, comprehensive and practical. This portion of the book is indispensable to the student of electrical engineering, and many a full-blown wireless engineer will be glad to have it.

The illustrations, 305 in number (with a special index), are excellent, many of them being quite away from the beaten track.

QUESTIONS AND ANSWERS

NOTE.—This section of the magazine is placed at the disposal of all readers who wish to receive advice and information on matters pertaining to both the technical and non technical sides of wireless work. Readers should comply with the following rules.—(1) Questions should be numbered and written on one side of the paper only, and should not exceed four in number. (2) Queries should be clear and concise. (3) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. (4) The Editor cannot undertake to reply to queries by post. (5) All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom de plume." (6) Readers desirous of knowing the conditions of service, etc., for wireless operators will save time by writing direct to the various firms employing operators.

J.M.J. (Amersham) wishes to make a loose coupler for a range of 300–4,000 m., and asks (1) Whether formers of sizes as follows are suitable—primary, 8" long, 5" diameter; secondary, 8" long, 4½" diameter. (2) What, and how much, wire to use.

You omit to give particulars of aerial or secondary condenser, so reply can only be approximate. (1) The formers will be all right, but do not couple them too tightly. (2) For primary, fill up former with No. 22 or No. 24, i.e., with about 420 feet of 22 or 500 feet of 24. For secondary, if condenser has capacity of about 0.0005 mfd., fill up with No. 26 or No. 28, i.e., about 500 feet of 26 or 600 feet of 28.

J.M. (Nottingham) asks (1) What are the capacity and inductance of a 4-wire horizontal aerial of given height and length. (2) Whether a frame aerial can be used with crystal rectifiers. (3) Whether sheet iron can be used for the plates of a condenser.

(1) The values will depend on the size of the wire, and the distance between the wires, which you do not give.

(2) A frame aerial, unless of very large size, would not pick up enough energy for use with crystal detectors.

(3) Iron plates could be used, but would not be very efficient; firstly, because iron has rather a high resistance; and, secondly, because the "skin effect," which makes the high-frequency resistance greater than the D.C. resistance, is very much more marked in iron than in other metals.

G.H.L. (Devonport) sends a diagram of a valve receiver for comment, and asks for information on certain points.

The receiver, with closed oscillating circuit in the grid circuit, auto-coupled to the aerial, and with a reaction coil in the plate circuit, is quite a good one. The capacity of the condenser across the H.T. battery is not important, provided it is not too small. It merely forms a path for H.F. currents round the resistance of the battery.

A spherical former would be better than a tubular one for a reaction coil, if you intend to rotate it; a tubular one would waste space. The best winding for the reaction coil will have to be found by trial, as it will depend on your wavelength, etc. If you use a spherical, try winding it nearly full in one layer with about No. 26.

E.W. (Maldstone) is in trouble with a receiver which will not give signals, and asks for advice.

If you will let us have a better sketch we shall be glad to help you. There is nothing in your remarks to indicate the cause of trouble, and we cannot get any idea of what your circuits are from your sketch. Sketches, to be of any use, must be diagrammatic, and must show clearly the exact electrical relationship between all the parts of the circuit. The only test you are likely to be able to make with the aerial is a continuity test, with a galvanometer. (See also reply to **SILENT AERIAL**.)

THERMIONITE (Knowle) asks (1) For a sketch showing how to use valves instead of a crystal in a receiver, of which he sends a diagram (Fig. 1). (2) What instruments he will require for transmitting 20 miles, and what current in watts he will require.

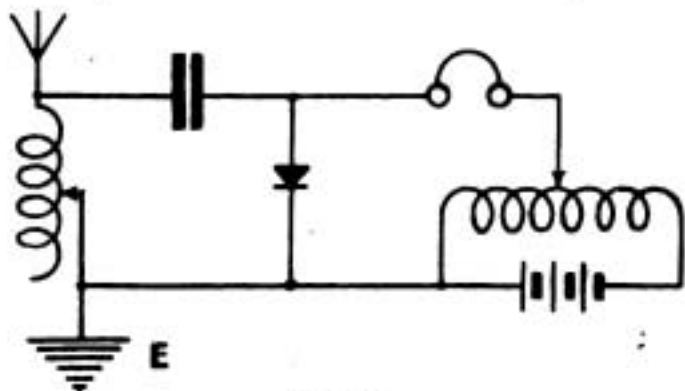


Fig. 1.

(1) The circuit shown is a bad one, the diagram showing that the writer has not properly mastered the principles of crystal reception yet. Among other things, the crystal is shown in series with the secondary condenser, instead of in shunt across it. He is strongly advised to arrange a good crystal circuit, and get experience with this before trying valves. When he is ready for a valve circuit he will find many suitable ones in Bangay's "Oscillation Valve."

(2) At the time of writing, transmitting regulations are hazy, so we cannot advise. Current is not measured in watts, as a rule!

A.H. (Margate) enquires (1) What prospect there is of developing a relay with a microphonic type of contact to increase sensitiveness of reception. (2) What risk there is of damaging high resistance phones by strong signals from a neighbouring station. (3) If it is normal for him to lose weak stations when coupling loose enough to get rid of GNF distant only a few miles. (4) If he should be able to tune out FL entirely in receiving MPD.

QUESTIONS AND ANSWERS

(1) The prospect is not good. Telephone relays of the type can be made (cf Brown's), but, while they give good amplification with fairly strong signals, they are not sensitive enough to work with really weak signals. (2) With a crystal detector, very little. (3) This result is quite to be expected. (4) Probably not, unless the receiver is particularly selective.

J.A.G. (London) calculates the capacity of a multiple plate condenser of given dimensions, and asks if the result will be fairly accurate in view of the fact that the fixed and moving plates are of different materials and thicknesses.

We make the capacity rather higher than your value, viz., 0.0075 mfd. The result should be fairly accurate. The nature of the material of the plates does not affect the result. The thickness might slightly affect the end corrections, but these are generally small enough to be ignored.

A.R. (Brighton) submits two sketches of receiving circuits, as shown in Fig. 2, giving dimensions of parts, and enquires which will be the more satisfactory.

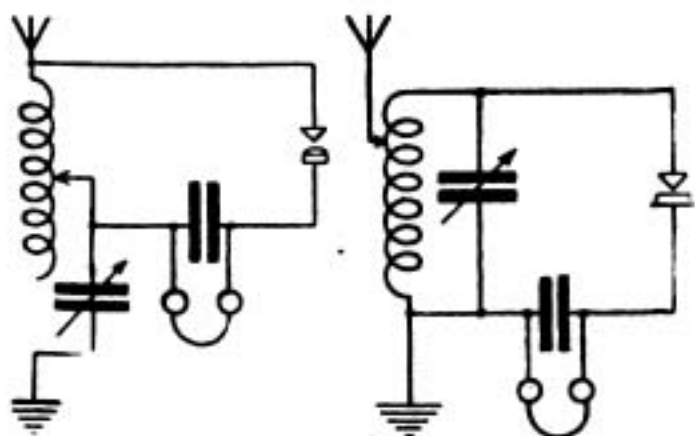
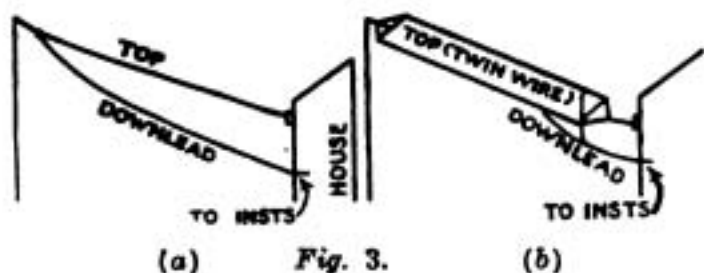


Fig. 2.

We prefer the second, particularly for use with a short aerial.

DAMPED (Southampton) asks for advice with regard to his aerial, which appears to be very inefficient.

From the sketch submitted we are not surprised that the aerial is inefficient. We reproduce it roughly here as it illustrates a fundamentally bad type of aerial. (Fig. 3a).



(a) Fig. 3. (b)

It will be seen that the down lead makes a sharp acute angle with the top wire. This should always be avoided. Seeing that DAMPED says that it is not possible to increase the span or raise the poles, we advise him to use a twin aerial connected

as in Fig. 3b, making up the length with cord if the allotted 70 feet do not reach as far as his mast.

SILENT AERIAL (Cardiff) has a one-circuit receiver, with the crystal tapped across the A.T.I. The receiver appears O.K., but does not give signals. He asks for advice, and criticism of this type of receiver.

The general design appears satisfactory. We do not like an earth clipped to a water pipe: the resistance at the contact will be too high. Is your earth lead too long, i.e., more than 15 feet, say? Your aerial is low, and probably badly screened. (See also reply to DAMPED.) Have you tried reversing the potentiometer battery?

This type of receiver is fairly efficient if you are working on such a wavelength that you need a good deal of A.T.I. for tuning, since the P.D. applied to the crystal depends on the P.D. across the A.T.I., which, in turn, depends on the number of turns in circuit. If you are only using a few turns of A.T.I., the receiver is insensitive. You can improve it by a double slider coil, as shown in Fig. 4.

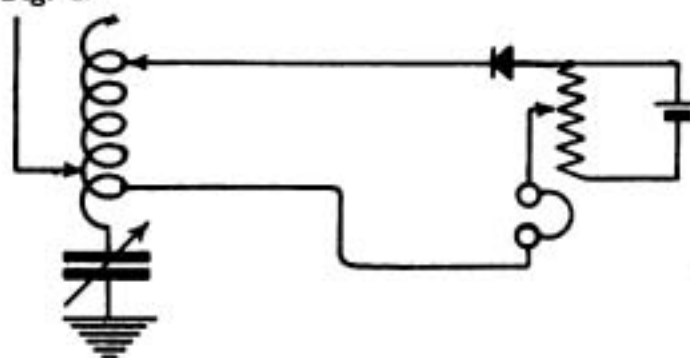


Fig. 4.

A two-circuit receiver, as you suggest, will give still better results.

TYRO (Wellington) asks for the best proportions between height and length for the maximum two-wire aerial allowed by the P.M.G.

A very good type, convenient for erection, is shown in the answer to DAMPED. This does away with the necessity for erecting two masts. The exact angle at the stay is not important. Get the top end as high as convenient, but do not bring the aerial quite into the vertical if so doing will bring the lower part very close to screening masses. The aerial can be quite straight without appreciable loss of efficiency if you prefer it.

F.G. (London).—Consult Bangay's "Elementary Principles," part 2, paragraph 1139, et seq.

"R.E. W/T" (Carlignose) sends a somewhat lengthy theory of the Poulsen arc, and enquires if his ideas are fairly correct.

The theory given is interesting, but rather highly speculative. The explanation of the oscillating action seems needlessly involved; we prefer the simpler treatment given, for example, in Rupert Stanley's book. The treatment of the action of the magnetic field is novel and probably correct. The whole theory is fairly correct, but we should hardly care to assent to some of the statements on points of detail.

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