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The Future of Wireless Telegraphy

By Dr. J. A. FLEMING, F.R.S.

WHEN a young man of good position comes of age and reaches the legal responsibilities of 21 years his friends not only celebrate the occasion but they also look forward into the future and endeavour to obtain some conceptions of his probable development and career. We are now reminded that it is just 21 years, this month, since Senatore Marconi applied for his first British patent for wireless telegraphy, viz., the epoch-making No. 12,039, of June 2nd, 1896, and hence that this date is the coming of age of wireless telegraphy. There had been attempts before that date to accomplish wireless telegraphy by methods based on electromagnetic induction and conduction through earth and soil, but beyond a few experimental installations nothing had been accomplished which gave promise of real utility. The ingenious inventor of the microphone, Professor D. E. Hughes, had indeed discovered as far back as 1879, the power of an electric spark to affect a metallic filings microphone at a distance, and Prof. E. Branly and Sir Oliver Lodge had provided a sensitive electric wave-detecting instrument in the coherer. Sir William Crookes had even made a remarkable literary forecast as to the possibilities of a telegraphy based on the use of Hertzian waves. But something was yet wanting to convert these experiments and speculations into a practical telegraphy. Marconi supplied that missing element by his suggestive and important invention of the aerial wire at the sending and receiving stations, and also by the earth connection at the same places. The novel and fruitful character of this invention is proved by the fact

Photo] [*Walery, Paris.*

PROFESSOR E. BRANLY, INVENTOR OF THE FILINGS COHERER.

that it opened the floodgates of invention in an astounding manner, and this British Patent, No. 12,039 of 1896, proved to be the progenitor of an ever-increasing volume of patent specifications in all the countries of the world. The clue to success once given, it is astonishing to note how soon electric wave telegraphy, in the true sense of the words, made for itself a position and a name. In the hands of Senatore Marconi and his assistants and coadjutors it went forward from triumph to triumph, and, by the interests excited, it converged upon it the attention of the most capable scientific minds in the world.

For a long time, in fact, practical invention and achievement outran scientific theory, and we were able to accomplish feats the true reasons for which were still obscure. Nevertheless, highly important investigations were being pushed forward. If Prussian militarism with all its immoral ambitions had not deluged Europe in blood and tears and required the whole civilised world to forsake the peaceful arts and pursuit of knowledge in order to crush them, we might by now have been far more forward in our knowledge of the scientific phenomena connected with long-distance electric wave telegraphy round the world.

We may perhaps utilise the enforced pause in our wireless work to examine the possible best directions for future research. It has become abundantly clear that the space round the earth does not act as if occupied by ether alone, in the propagation of long electric waves, especially when an earth connection is employed.

In spite of the fact that some mathematicians consider that diffraction alone will account for long distance radiotelegraphy over 3,000 to 6,000 miles, it is pretty certain that three causes are combined in effecting it, viz., a surface electric wave propagation, a diffracted space wave, and refraction of the space wave by the upper levels of the terrestrial atmosphere. To disentangle these effects will need much large-scale experimenting on the lines of the excellent researches by Dr. Louis Austin and Mr. Hogan under the auspices of the United States Navy Department. A large experimental station for this purpose was being prepared in Belgium just before the war broke out, and the Germans should be forced to replace it when they are compelled to reinstate their destructions in that unhappy country.

Meanwhile, one thing that we require is a better means of measuring small receiving antenna currents which can be used on board

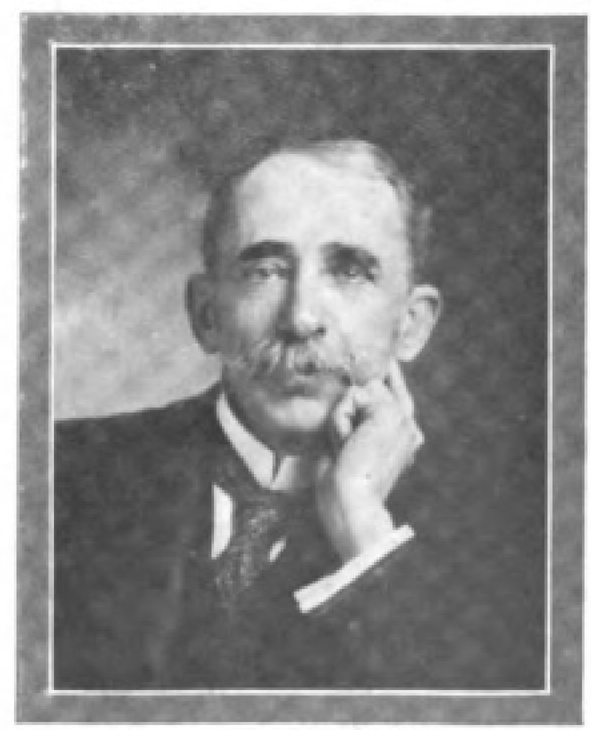
Photo] [*Whitlock.*

SIR OLIVER LODGE, WHO GAVE THE NAME "COHERER" TO BRANLY'S DEVICE.

Photo] [Whitlock.
SIR WM. CROOKES, WHO MADE A REMARKABLE FORECAST OF WIRELESS TELEGRAPHY.

ship. The shunted telephone method is not satisfactory, and methods employing the Einthoven galvanometer can only be used on land in a place free from vibration. A matter of especial importance is the invention of thoroughly valid methods of measuring the true space wave radiation from transmitting aerials. We want some instrument which shall do for long-wave radiation what the Féry radiation pyrometer does for radiant heat waves, and hence enable us to measure at once the true radiation resistance of an aerial wire. A further much-to-be-desired improvement is the advent of an extra high frequency alternator at a reasonable price. At present, judging by the quotations received by the writer, they are the luxuries of millionaires but not the attainable necessaries of Universities or Colleges crippled by the war. Short of this, we require better means for the production of undamped powerful electric oscillations. The three-electrode thermionic generator is probably capable yet of much improvement.

Turning then to the consideration of the development of practical wireless telegraphy we shall probably see in the near future progress made on lines analogous to the great improvements in telegraphy with wires connected with multiplex printing telegraphs. The Baudôt Multiplex System and its outcome, the Murray Multiplex and Western Union Multiplex, enable twelve or more messages to be sent simultaneously along a single wire, and the receivers print down the messages in Roman type on slip or page form. The transmitters are operated by keyboard typewriters, which prepare punched tape for automatic transmission. Some progress has been made towards such automatic transmission by the use of Creed transmitters, and Senatore Marconi's very practical method of duplex transmission in the case of long-distance stations opens the way to still further achievements in the establishment of quadruplex wireless telegraphy which might quite easily be established. Indeed, sixteen or seventeen years ago the writer witnessed *diplex* wireless telegraphy in Mr. Marconi's experimental station at the Haven Hotel, Poole, when two messages were received and sent simultaneously in the same direction.



Photo] [Elliott & Fry.
PROFESSOR J. A. FLEMING, INVENTOR OF THE FLEMING VALVE AND AUTHOR OF THIS ARTICLE.

As soon, therefore, as peace restores the possibility of fresh invention we may look forward to a great advance in automatic sending and printed-message receiving in connection with long-distance wireless stations. Such advances will bring up speeds and efficiency of service to the level of the best cable working. Up to the present wireless work has been conducted in International or American Morse Code; but as telegraphists well know, the five-unit Baudôt alphabet is the basis of all modern machine printing telegraphs. It is not impossible that future wireless work may be conducted with *five* antennæ at each station, each radiating or receiving one unit of a letter at a separate wave length. The whole letter being signalled and received simultaneously and recorded instantly as a printed letter on tape or page ready to be handed to the recipient.

In receiving devices the invention by the writer of this article of the thermionic detector opened a new chapter in this subject. In the United States more has been done than in England in developing this invention, but the British origination of it is generally deliberately ignored there, even in spite of Judge Mayer's able judgment last autumn, which did justice to the writer's claims and declared the Fleming Valve patent to be a master patent.

In wireless telephony we are still in the experimental stage, and await the invention of improved and more certain methods of generating undamped oscillations than those depending on the use of the electric arc. Some modification and simplification of the frequency-raising method employed in the Goldschmidt alternator would seem to be the best solution unless a conductor can be found other than the electric arc having a steep descending characteristic curve. These and other improvements will, however, only come as the result of persevering experiment, and are not to be looked for whilst the whole energies of inventive mankind have to be devoted to appliances for the destruction of human life rather than its benefit and elevation.

The Coming of Age of Wireless Telegraphy

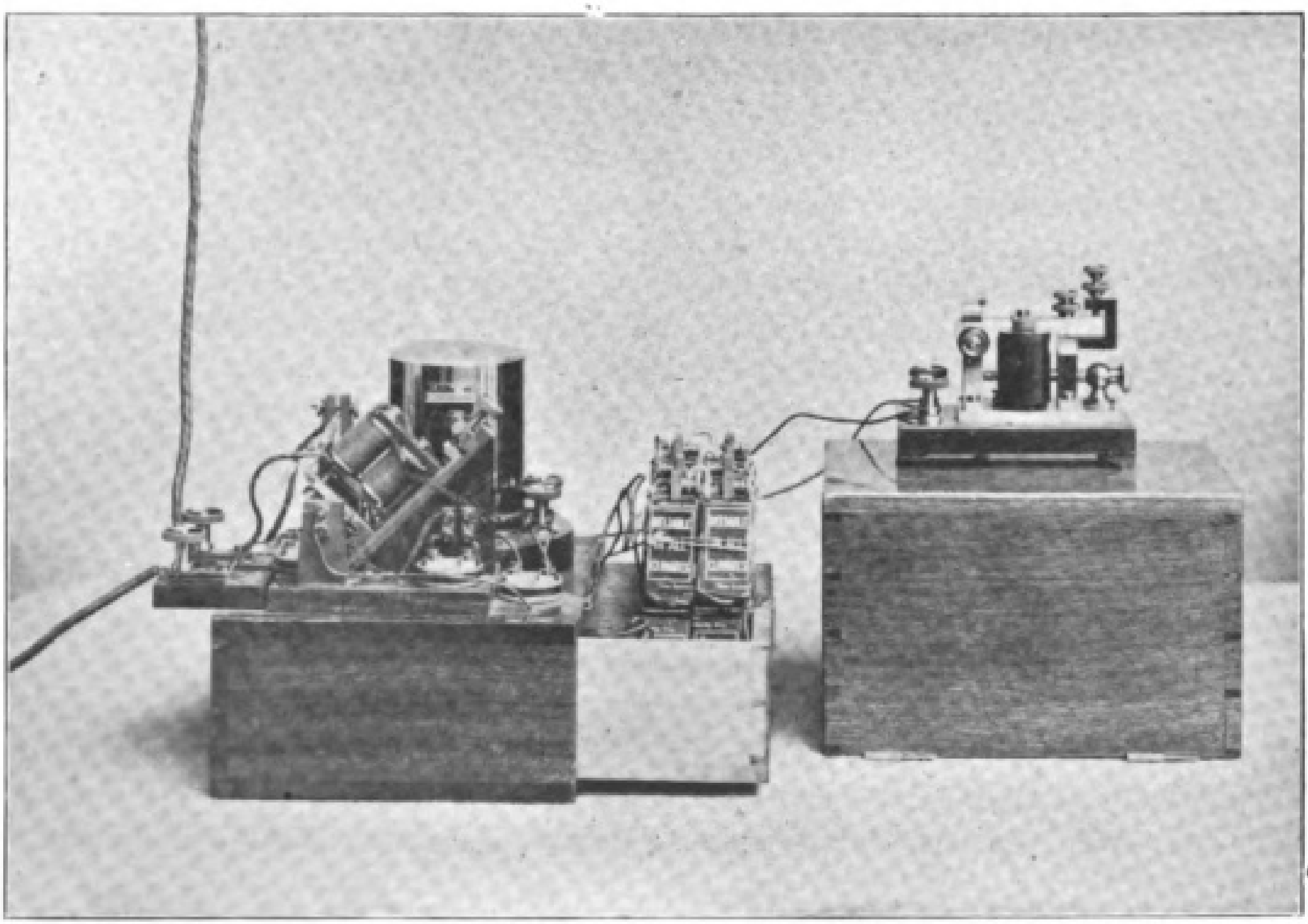
By E. W. MARCHANT. D.Sc.

THE coming of age of wireless telegraphy is a notable epoch in the history of applied science. It is difficult to give an exact date for the first conception of the possibility of sending messages by electro-magnetic waves. Scientifically, the discovery of Hertz in 1888 that it was possible to produce such waves in space and to detect their existence may be regarded as the starting point of aetheric telegraphy. One might go further back and say that the electro-magnetic theory of light due to Clerk Maxwell gave the first real idea on the subject. One must not omit, either, the classical work of Lodge in showing the existence of electric waves on wires, and of Branly in making the discovery of the coherer, and of many others. There is, however, a very long way to go between the discovery of a physical phenomenon and its application on an engineering scale, and I think everyone will agree that the practical application of electro-magnetic waves for sending signals across space owes an inestimable debt to Senatore Marconi. It is therefore fitting that the coming of age of wireless telegraphy should be celebrated 21 years after the taking out of the first Marconi patent. I well remember hearing the lecture given by Sir W. Preece at the Royal Institution in June, 1897, at which Marconi's experiments were described and signals were sent, I believe, from the library to the lecture table. I think it is no exaggeration to say that hardly anyone present at that lecture dreamt of the possibility of establishing within 21 years a world-wide service of radiotelegraphy which would encircle the globe. It is, I hope, no disparagement of the late Lord Kelvin to mention a remark that he made to me soon after Marconi's original experiments had been described. He was discussing the sending of messages by wireless telegraphy and said it was all very well, but that, for his part, he would rather trust "a boy and a pony." Lord Kelvin, of course, at that time was an old man, and although his mind was extraordinarily fresh and vigorous he was not, perhaps, quite so responsive to new ideas as he was in earlier days, but if a man of his eminence took that view it is not surprising that many who had very much less qualification to express an opinion were sceptical as to the possibility of sending signals on an "engineering" scale. It was not long before the naval authorities appreciated the importance of this method of signalling, and "wireless" has had a profound effect on the strategy of naval warfare. The service which wireless telegraphy has rendered to the Mercantile Marine is incalculable, and it would have earned the gratitude of the world if the only achievement it had placed to its credit was the saving of life on merchant ships suffering accident and disaster. To the scientific man the most remarkable experiment in wireless telegraphy was the transmission of signals from Poldhu to Newfoundland, first accomplished in 1901. Many of our scientists had doubted the possibility of sending signals over so great a distance because of the huge wall of water that lay between the sending and receiving stations. The success of the experiment, however, was beyond question, and the fact that signals were sent led to a great discussion as to how they travelled. It was shown by the comparative constancy of signal strength during the day time that there must be some medium affecting signal strength of a more or less stable character. Since that time signals have been sent round an arc extending over nearly a third of the globe, and the theory of the existence of an upper layer of the atmosphere which acts as a boundary wall or shield to prevent the waves travelling out into free space has been definitely established. Wireless telegraphy, therefore, has provided another method of increasing our knowledge of the upper atmosphere and may give us further material for the study of climatic and weather conditions. The design of a wireless station for transmitting signals from one place to another is no longer a haphazard affair, in which stations are built in the hope that they may achieve what is desired; it has become an exact science. As the result of an enormous amount of careful experimental work, formulæ are now available by which the average day strength of

Photo] [*Annan*.

LORD KELVIN, WHO SENT THE FIRST PAID WIRELESS MESSAGE.

current received from a distant point can be calculated with a fair degree of exactness, and nowadays the design of a wireless station for a particular service is almost as simple as the calculation of a transmission or telegraph line. When one looks back on the achievements of the past 21 years one is filled with wonder at the progress that has been made. The experiments of 1896 have been developed into the huge stations, controlling hundreds of horse-power, that are being erected on every side to-day. Every boat carrying passengers has a wireless installation; it is now regarded as an indispensable adjunct for securing the safety of a ship at sea, and it will not be long before every cargo boat will have to take the same precaution. It is difficult to speculate on the progress of a science which has already achieved so much in so short a time, but perhaps the most likely development of the near future will be the perfection of the wireless telephone. If a ship's master within a given radius were able to call up and speak to any other ship within range, or if a ship at sea could remain in telephonic communication with land, it would lead to an extension of our means of communication almost as great in labour and time saving as that which has been effected by the installation of the telephone exchange. Enough has been accomplished, however, in the last 21 years to raise the expectation of even greater things, and the day may not be far distant when it will be as easy for a merchant in Liverpool or London to ring up another at Paris or Petrograd as it is to-day to telephone from Liverpool to London. Wireless Telegraphy has already made its mark; before many years are over it seems likely to produce an even more far-reaching effect on the exercise of human activities.



AN EARLY TYPE OF RECEIVER. IN THIS APPARATUS A COHERER RELAY ACTUATES A POST OFFICE SOUNDER.

Notes of the Month

Senatore Marconi's Natal Day.

The forty-third birthday of Senatore Marconi, celebrated on April 25th last, was "noticed" with universal acclaim throughout the general Press. Many of our British contemporaries dwelt with well-founded pride upon the fact that, although an Italian by birth and a native of Bologna, this "Wizard of Wireless" (to quote from an eminent daily newspaper) "is Irish on his mother's side." It is strange indeed to recall the changes that have been brought about by the genius and initiative of this remarkable man, whose life-work only started a little over twenty years ago. It has already affected most departments of human activity, and seems likely, so rapid is its progress, in the near future to play a part in them all.

We note that the eminent Italian scientist is included amongst the members of the national mission of his country to the U.S.A., which is headed by the Prince of Udine, eldest son of the Duke of Genoa.

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Events Move Rapidly.

It is curious to observe how swiftly events are wont to march in times of war. It seems only the other day that Mr. John L. Hogan, jun., one of the most prominent radio research engineers in the United States, contributed to the *Electrical World* (of January 20th last) an important article dealing with the Electric Transmission of Intelligence in 1916–7. Mr. Hogan at that time protested emphatically against measures proposed by the Federal Government, "acting in the name of preparedness, and urging further and stricter laws to govern the commercial operation of radiotelegraphy." Our contemporary, in its editorial columns, endorsed that protest with even greater emphasis; adding the grave assertion that "The London International Radio Convention, having been subscribed to by the United States, has already hampered industrial radio development here."

The issue of the *Electrical World* dated April 7th (two days, therefore, posterior to America's formal declaration of "a State of War") refers with approval to the past reluctance of the U.S.A. Government to "interfere with legitimate private enterprise"; but continues, "the time has now come, however, to put the lid on tight, and to keep it on, until the national crisis has passed." "Every Wireless equipment, though dangerous if improperly used, can be of service to the Government when confined to legitimate or patriotic functions." The action on the part of the Federal Government followed immediately, and—as adumbrated in our last issue—American radio enthusiasts are acting with patriotic self-sacrifice and surrendering their apparatus in prodigious numbers. *What a testimonial to the progress and status of wireless telegraphy is implied in all these stringent measures!*

The Inventor of Wireless Telegraphy:

SENATORE MARCONI, G.C.V.O., LL.B., D.Sc.

Senatore Marconi

A Biographical Note

THIS month it is fitting that we should take as the subject of our biography Senatore Guglielmo Marconi, G.C.V.O., LL.B., D.Sc., the great inventor to whom all nations have paid their tribute. Although Italian by birth, Senatore Marconi has strong British interests, for his mother was Irish and he himself has married into a well-known Irish family. As a boy he had strong leanings towards scientific pursuits and his education at Leghorn and Bologna Universities only served to stimulate such propensities. The young Italian first had his thoughts directed towards the subject of ether waves by the lectures of Professor Righi, a scientist at Bologna University, who was following up the researches of Heinrich Hertz. Realising clearly in his own mind that it should be possible to turn ether waves to the practical use of telegraphy, Senatore Marconi at once commenced a long series of experiments which resulted in the creation of the first wireless telegraph transmitter and receiver, a crude device but nevertheless one destined to be the forerunner of the great network of wireless stations now covering the globe.

In 1896, twenty-one years ago, he came to England, bringing with him his new apparatus, and on being introduced to Sir W. H. Preece succeeded in convincing this eminent telegraph engineer that he had something really new and valuable. The story of how the experiments continued an ever-increasing success is told on another page, and it was not long before honours commenced to be showered upon the young Italian. Numerous seats of learning and many Governments have recognised his valuable work, and in 1909 he became the joint holder of the famous Nobel Prize for Physics. Senatore Marconi is an Honorary Doctor of many Universities, including Oxford, Glasgow, Aberdeen, Liverpool and Pennsylvania, besides having received the freedom of the principal Italian cities. The high honour of being elected Senator in the Italian Parliament was conferred upon him in 1914, and he would have been so honoured earlier in his career but for the fact that he had not until then reached the necessary age. In the same year in England he received from the King the Honorary Knighthood of the Grand Cross of the Victorian Order, and in the following year he was awarded the Albert Medal by the Royal Society of Arts. Space will not permit us to mention the other numerous distinctions and scientific awards which have been showered upon him by learned societies in various parts of the world.

On the outbreak of war Senatore Marconi placed his services at the disposal of King Victor of Italy, and he was immediately given the rank of Lieutenant in the Italian Army. After visiting England on a number of important military missions he was promoted in July, 1916, to the rank of Captain "for exceptional services." A few months later he was transferred from the Italian Engineers Service to be Temporary Captain in the Navy, a position which he still holds at the present time.

The Three-Electrode Valve

Its Working and Management

INTRODUCTION

THE following article forms the first of a series dealing with the three-electrode valve, a piece of apparatus which has now been perfected to such an extent that it may without any exaggeration be termed the wireless instrument of the future. Known by various titles, such as the Fleming valve, vacuum valve, three-electrode valve, thermionic valve, and audion valve, it is the result of experiments extending over a large number of years, and, like many other important devices, has not sprung fully developed from the brain of any one inventor.

Every three-electrode valve device now in use is a development and elaboration of the famous Fleming valve, invented by the well-known English scientist, Dr. John Ambrose Fleming, scientific adviser to the Marconi Company. On the Fleming valve coming into practical use, scientists and experimenters, both in Europe and America, set to work to develop and improve the valve for radiotelegraphic purposes, and a number of modifications were soon introduced. The recognition of the true function of the third-electrode marked a distinct step forward, for reasons which will be clear to the reader on perusal of the following article.

The reader will be helped towards a clearer understanding of the articles by the following introductory remarks, in which we shall try to give a short outline of the general principles underlying the subject.

Let us take the original Fleming valve with a battery, B, connected between the filament and plate as shown on Fig. 1, vary the voltage, v, and measure each time the corresponding current, i.

Next plot a curve showing the functional relation between v and i (see fig. 2).

The curve thus obtained will depend on the temperature of the filament, the degree of evacuation, and the construction of the valve (*i.e.*, the material of the electrodes, their relative position, etc.). Whatever the conditions, we shall always find that the curve may be roughly divided into three portions: The portion OA with $\frac{dv}{di}$ rather small; the portion AB which is comparatively steep $\left(\frac{dv}{di}\text{—large}\right)$; and the portion BC almost parallel to the V-axis $\left(\frac{dv}{di}\text{ almost}=O\right)$. The variation in $\frac{dv}{di}$ has a very important physical meaning.

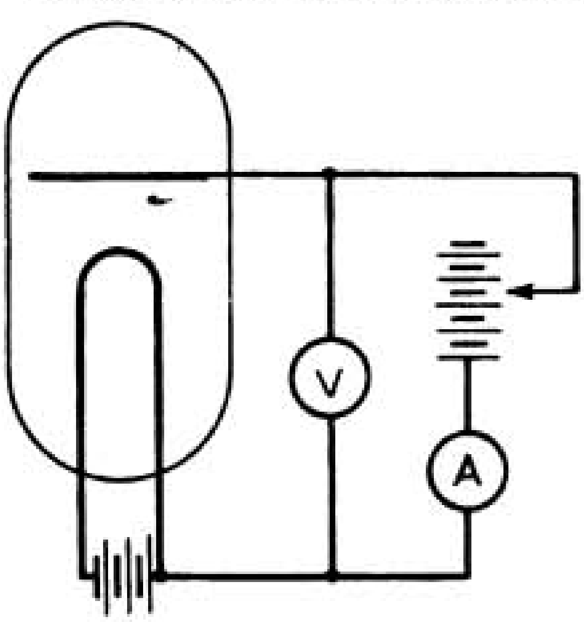

FIG. 1.

Let the valve be adjusted to the point A. If we increase the voltage by the amount V_0V_2 the increase in current will be given by $LV_2 - AV_0 = (\delta i)_1$. A decrease of the voltage by the same amount $V_0 V_1 = V_0 V_2$ will lead to a decrease in the current by $AV_0 - KV_1 = (\delta i)_2$. Now, obviously $(\delta i)_1 > (\delta i)_2$; therefore if a variable voltage is superimposed on the valve the net result will be an increase in the average value of the current from i to $i + (\delta i)_1 - (\delta i)_2$. The device is then a rectifier. In the same manner the valve adjusted to the point B will also rectify; only the average value of the current will be decreased instead of being increased as in the first case.

Let us now consider the case when the valve is adjusted to a point on the portion AB, say, to a point D.* Usually the portion AB is very nearly a straight line. Therefore if we apply a variable voltage the increase in current during one-half period will be compensated by the decrease during the second half-period. In other words: $(\delta i)_1 = (\delta i)_2$, the device does not rectify in this case, and the variable voltage produces an A.C. superimposed on the D.C. generated by the battery.

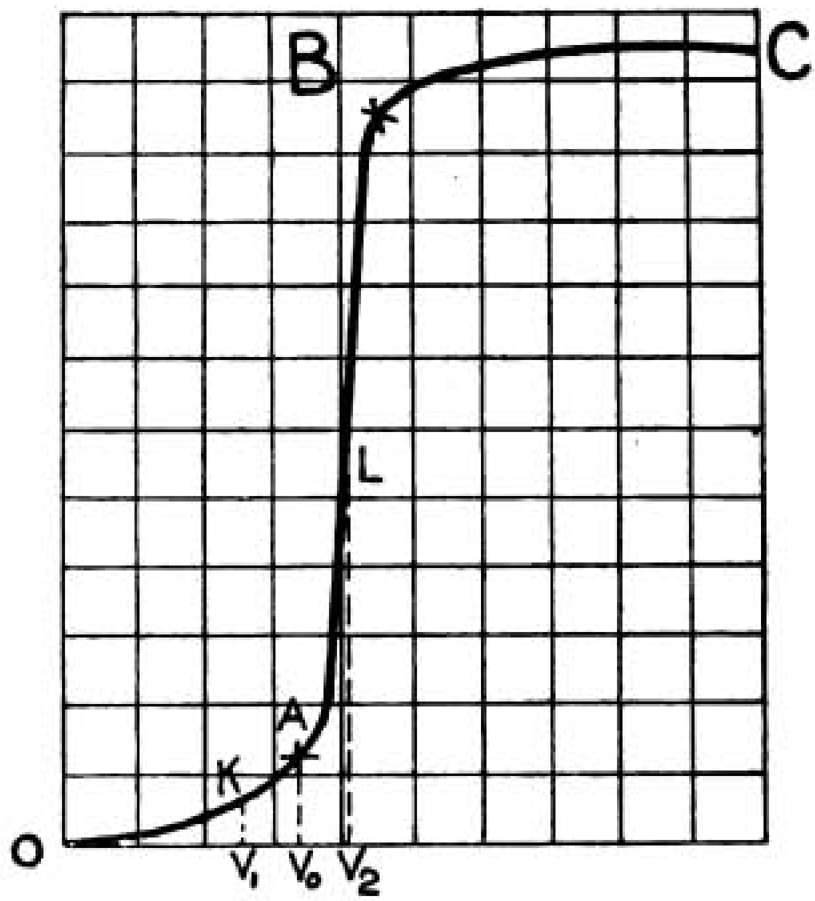

FIG. 2.

A question of the utmost importance is the value of the amplitude of the A.C. Obviously this value will vary with the slope of the portions in the neighbourhood of the chosen point D (the amplitude of the applied variable voltage is supposed not to exceed a certain value). The steeper the curve the larger will be the amplitude of the superimposed A.C. With the portion AB almost vertical, even a very small variation in the voltage will lead to a comparatively very large variation in the current. It is clear now that the presence of portion AB with a large value of $\frac{dv}{di}$ enables us to use the valve as a magnifier.

To get a large magnification it is necessary then to make the portion AB as steep as possible. It has been found that very steep characteristics can be got by providing the Fleming valve with a third electrode in the form of a grid, as explained in the article. The curve is essentially of the same shape as that shown on Fig. 2, and whether the device will work as a rectifier or as a magnifier will depend on the point to which it has been adjusted exactly in the same manner as in the case of a device with two electrodes.

In conclusion, we should like to draw the attention of the reader to the portion BC. Here the current is nearly independent of the voltage. When adjusted to a point of that portion the valve (whether with two or three electrodes) can be worked as a current-limiting device.

* The point D may be at L.

PART I.

THE use of three-electrode valves is rapidly becoming more and more general, even in comparatively small stations, and these notes are intended to assist those who have the care of such apparatus in keeping the gear in good adjustment and in discovering faults when signals are bad.

Valves are made in many different shapes and forms, and the electrodes may be disposed in various manners inside the exhausted chamber, but all work on the same principle. No attempt will therefore be made to describe the constructional details of any particular type of valve, and the remarks which follow may be taken to apply, in general, to valves all and sundry.

First of all, a brief explanation of what a three-electrode valve is, and the principle upon which it works. It consists of an evacuated vessel containing a filament, a mesh or grid and a plate. These three electrodes being so disposed that the grid either completely surrounds the filament or lies in between the filament and the plate. It is usual to use a small battery of accumulators (about four or six volts) to heat the filament to the required temperature. Now suppose that by means of a potentiometer we arrange that the grid shall be slightly positive with respect to the filament and we take a ten-volt battery and connect the positive pole to the plate of the valve and the negative pole to one leg of the filament ; a certain current will flow in the circuit comprising the battery, filament, space and plate. This current will have a certain definite value depending upon the E.M.F. of the battery, the nature and brilliancy of the filament, the construction of the valve and its degree of exhaustion. Now, leaving all these factors constant, it has been found that we can control the value of this current from plate to filament by varying the potential of the grid with reference to the filament. If the grid be made sufficiently negative with reference to the filament, then no current will flow from the plate to the filament even if the former is several hundreds of volts positive. Whereas, if the grid be a fraction of a volt less negative then a comparatively large current will flow in the plate circuit. In adapting this arrangement for use in wireless receiving circuits the incoming signal is applied in such a manner as to cause variations in the potential of the grid, and it is evident that if its steady potential is adjusted to the critical point before mentioned then when the alternating potential produced by the incoming signal is superposed upon this steady potential, firstly, when the grid is slightly more negative than the critical value no current will flow in the plate circuit ; and, secondly, when the grid is slightly more positive than the critical value a comparatively large current will flow in the plate circuit. Thus we have the valve giving the effect of a rectifier and magnifier. It should be noted that this relay effect occurs with great rapidity. Variations of the grid potential occurring at a frequency of even millions per second are faithfully reproduced as variations of the plate current. This enables the valve to be used as a relay for the actual oscillations in the circuits of a receiver, even when receiving on comparatively short wave-lengths. Now let us see how the valve is applied in receiving signals. In Fig. 3, *A* is the aerial, tuned to the desired wave-length by means of an inductance *L* and a condenser C_1. Coupled to this aerial circuit is a circuit composed of the inductance *I*, the coil *R* and the variable condenser C_2. This condenser C_2 being for the purpose of tuning the secondary circuit to the wave-length of the incoming signal. One side of the condenser C_2 is connected to the grid G of the valve, and the other side to the slider S of a potentiometer and battery P; the mid point of this battery going to one leg of the valve filament. B is a small battery of accumulators for supplying the current to heat the filament of the valve, this current being regulated by means of an adjustable resistance. This completes the first or grid circuit of the valve. The plate circuit is composed of the plate P_1 connected to one end of an inductance J, the other end of this inductance being joined up to the positive end of the high voltage battery H. The negative pole of H is connected to the filament. The inductance J is shunted by the condenser C_3; J and C_3 forming a closed oscillatory circuit which is also tuned to the wave-length of the signals to be received. The carborundum crystal D and its potentiometer Q are connected in series with the telephone T and the combination placed across the inductance J.

It will be seen that the full potential difference of the battery H is applied across the space between the filament and the plate of the valve. The value of the current which flows as a result of this E.M.F. will be, as already explained, dependent upon the potential of the grid with respect to the filament. Now suppose we slide the slider S of the potentiometer P slowly from one end to the other, in such a direction that the grid is first negative and ends up positive to the filament. It will be found that when the grid is sufficiently negative no current is flowing in the plate circuit, but as the grid becomes more positive we finally reach a point where a current commences to flow from the battery H through the inductance J to the plate P_1 and across the space in the valve to the filament. After this point a small increase in the potential of the grid will be found to make a big increase in this current. Let us adjust S so that this state of affairs exists, namely, so that we are producing a large change in the current through J by a small change in the potential of G. Now consider what will happen when an oscillatory current is produced in the aerial circuit by an incoming signal. The aerial circuit is coupled to the circuit C_2 I R by means of the coupling coil X.

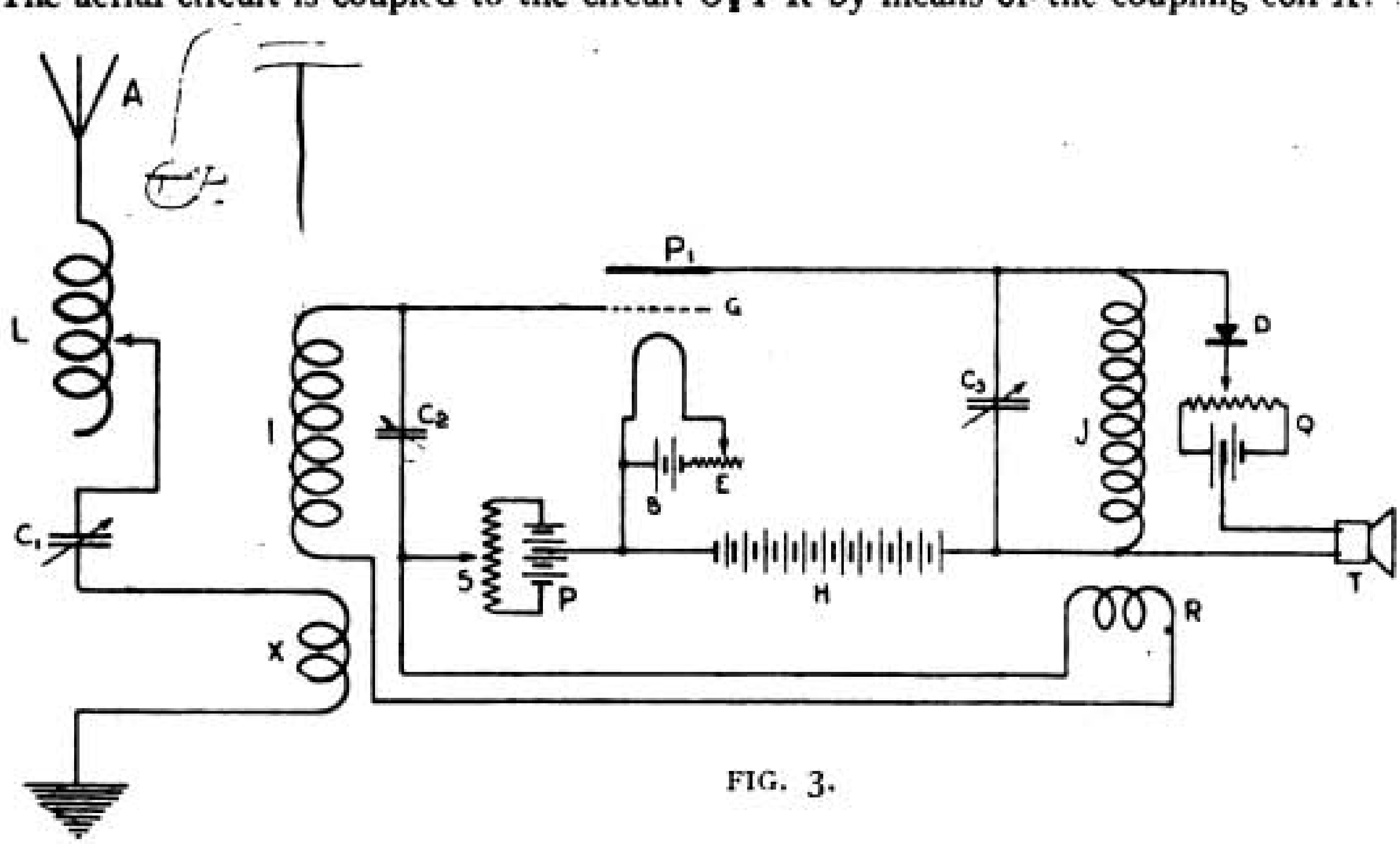

FIG. 3.

The current in the aerial will therefore induce an oscillatory current in this secondary circuit provided that they are both tuned to the same wave-length ; and the condenser C_2 will have an alternating *E.M.F.* produced across its terminals, which is of the same frequency as the received wave. One terminal of the condenser C_2 is connected directly to the filament of the valve (through the potentiometer *P*) and the other terminal to the grid *G*. The alternating *E.M.F.* will thus clearly vary the potential of the grid first to a potential a little more positive than the steady potential maintained by the potentiometer and then to a valve a little less positive than the steady one, these changes occurring with the frequency of the received signal. Now these small changes will in turn produce comparatively large changes in the current flowing from *H* through the inductance *J* to the plate P_1. This fluctuating current will excite oscillations in the circuit C_3 *J*, provided that this circuit is tuned tothe same frequency as the fluctuating current—*i.e.*, to the frequency to the signal. The oscillations in the circuit C_3 *J* are rectified in the usual manner by crystal *D* and the signal is heard in the telephone receiver *T*.

It will be seen from the foregoing that the function of the received signal is not to produce a current in the telephone as in an ordinary crystal receiver, but to open and close a circuit which is quite independent and which naturally can be made to supply more energy for making the sounds in the telephone than the signal itself can.

So far, no mention has been made of the coil *R*. The action of this coil is very important. It will be noticed that it is part of the oscillatory circuit across which the valve grid and filament are connected and that it is arranged so that it can be coupled with the circuit C_3 *J*. We have seen that the weak current in the circuit C_2 *I R* produces a much greater current in the circuit C_3 *J*—the coil *R* is to transfer a portion of the energy from C_3 *J* back to C_2 *I R* and so help in increasing the variations of potential across C_2 produced by the signal. The effect of this is further to reinforce the signal heard in the telephone *T*. There is a certain critical coupling of the coil *R* which is best—if it is too weak or reversed the signals will not be magnified as much as they might be—if it is too tight the circuits tend to maintain themselves in a state of continuous oscillation. When the latter state is reached it will be noticed, when using a plain carborundum crystal at *D*, that a howling noise is heard in the telephone. The character of this howl is a valuable indication of the adjustments of the receiver and will be referred to later.

It will be noticed that there are three tunings to be performed when picking up a station. (1) The aerial ; (2) the grid oscillatory circuit ; and (3) the plate oscillatory circuit. These can be reduced to two distinct tunings by the use of the circuit shown in Fig. 4. The only difference is that the grid and potentiometer slider are connected across the aerial tuning inductance instead of across the condenser of a closed oscillatory circuit. This second circuit has the advantage of being converted to a simple crystal receiver by merely switching off the valve filament battery. This fact will be evident by a study of the diagram. It will also be noticed that the valve potentiometer is not provided with a separate battery as in Fig. 3, but is connected across the filament heating battery. This connection is the usual one adopted in practice for the purpose of economising batteries.

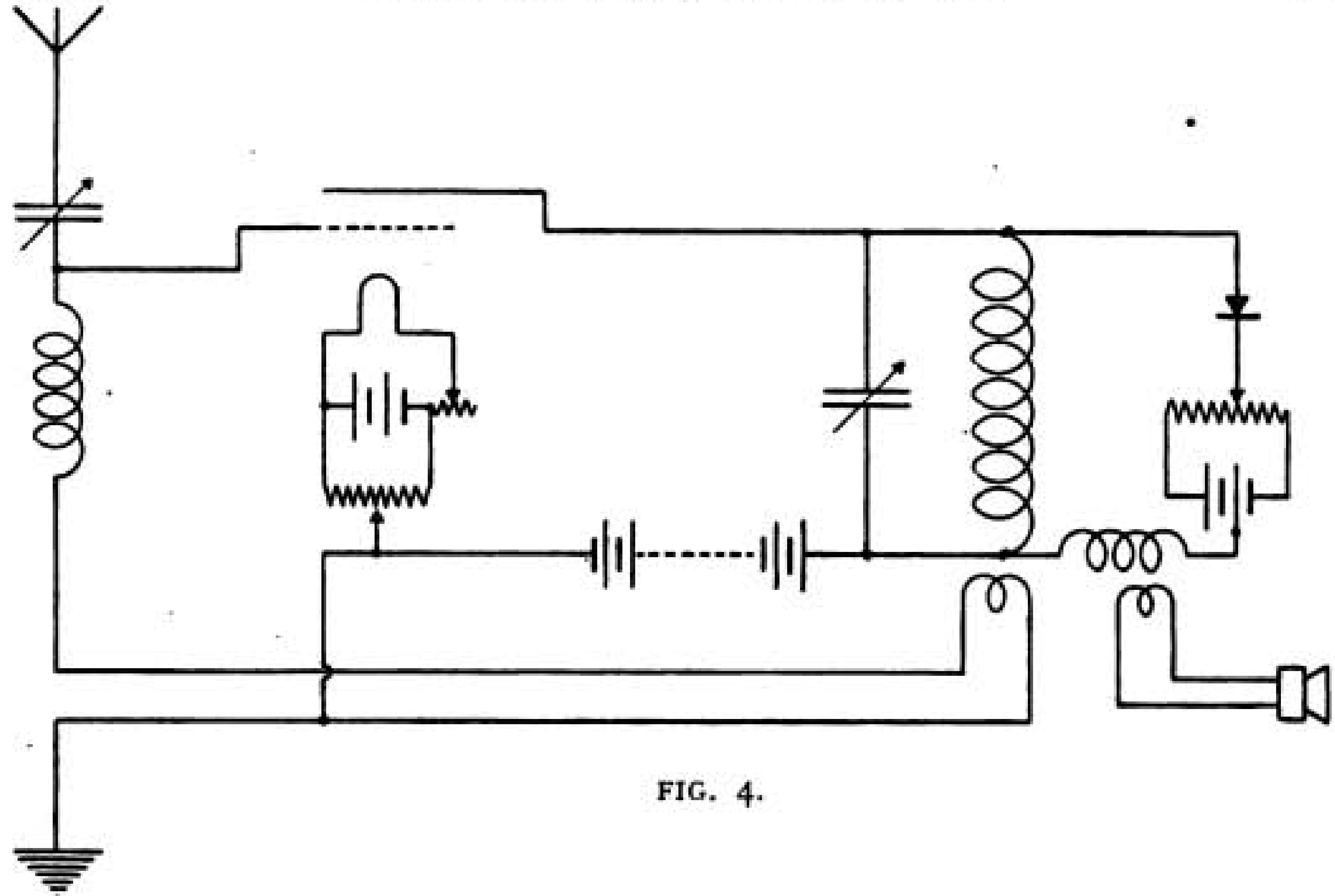

FIG. 4.

As already stated, the constructional details of different types of valves vary considerably. There are two kinds of filament in general use. (1) Platinum coated with calcium oxide (lime); (2) Tungsten. The lime-coated filament has the advantage of being much more active than the tungsten filament. It is particularly suited to the circuit shown in Fig. 4. The tungsten filament has the decided advantage of requiring less current to heat it to the requisite brilliancy, but is liable to become brittle after use. The degree of exhaustion of the valve is also important. Certain valves are specially designed to work with fairly low plate *E.M.F.s*, say 40–60 volts. These must have a certain amount of gas in them to operate well. Valves of this type are generally provided with some vacuum regulating arrangement. A common device consists of a small side tube, or " pip," sealed on to the glass bulb and containing a fragment of amalgam, or asbestos, which will evolve gas when heated, thereby lowering the vacuum.

Hints on the Adjustment of Valve Receivers.

The howl which is heard on bringing the reaction coil into action is one of the most valuable criterions of the adjustment of the apparatus in the absence of signals. If the howl is very high pitched the crystal potentiometer *E.M.F.* is not quite high enough and the slider should be moved in the correct direction to increase it (usually *away* from the centre of the resistance). If the howl is very low pitched, more like a succession of clicks, the crystal potentiometer should be moved in the reverse direction.

The valve potentiometer can also be well adjusted by listening to the howl. Place the slider in the position which is thought to be approximately correct and adjust the reaction coil so that the howl is just on the point of appearing. Now move the valve potentiometer to and fro and it will be found that there is a point where the howl is strongest—this is the correct working position for the valve potentiometer.

When putting a new valve into commission, the correct *H.T.* voltage to use can be approximately ascertained by sliding the valve potentiometer right to the end at which a blue glow usually appears in the valve and then increasing the *H.T.* voltage step by step until a faint glow can be seen. The correct position for the potentiometer can then be found by the howl as before mentioned. Any slight readjustments of the *H.T.* voltage may be made when listening to signals.

If the howl vanishes and signals are bad—

(1) Test the *H.T.* battery. Internal disconnection may have occurred.

(2) Examine crystal clip and crystal. If there is reason to think the crystal is a poor one, try a new one. Crystals possessing reverse conductivity do not give a good howl.

(3) If valve gives no faint blue glow even with full *H.T.* on, but hissing noises are heard at different points on valve potentiometer. Heat the pellet carefully with a match or spirit lamp, at the same time reducing the *H.T.* voltage. Care is necessary in carrying out this operation, as if the pellet is overheated the valve may be permanently spoiled.

(4) Examine the valve carefully to make sure that the fine platinum wires connecting the electrodes to the loops outside the bulb are intact. Breaks in these wires are sometimes difficult to see. A watchmaker's lens is useful for this purpose.

(5) Examine the filament. After a valve of the lime-coated filament type has had a long run the character of the coating changes. Instead of being a uniform white coating the lime can be seen to be adhering in hard crystalline patches; it may even be found that most of it has disappeared. These filament troubles are nearly always caused by the use of too much *H.T.* voltage.

(6) If high resistance telephones are in use it may be found that the windings have broken down. It is best to use low resistance 'phones with a transformer on valve receivers.

(7) Note the position of the valve series resistance when the valve is glowing normally. If the valve accumulators are well up and yet there is much more resistance cut out than usual, the valve has probably got air in it. Look carefully for small cracks, particularly round the base, the "pip" and the seals for the electrode connections.

(8) Sizzling noises in the telephones are often caused by standing the *H.T.* batteries and the accumulators on a wet floor near to each other. Keep all the various parts well insulated from each other and from earth.

Lastly, do *not* run the valves with the filament excessively bright and with too high a plate voltage. Use as small a magnification as is possible to get the required results. By keeping the filament dull and the *H.T.* volts down the life of the valve will be increased enormously and it will remain steady and reliable throughout its life.

NOTE.—The third portion of Mr. Coats' article on "Wireless with the Eskimos" will appear in our July issue.

Digest of Wireless Literature

IRON IN HIGH FREQUENCY MAGNETIC FIELDS.

MR. R. BOWN contributes to the *Journal* of the Franklin Institute a paper of considerable interest to wireless men. The author says that not many years ago it was quite generally believed that iron was unable to follow magnetic changes. Experiments which showed an apparent decrease in the permeability of the iron with an increase in the frequency of the magnetic cycle furnished a basis for a theory that iron was magnetically sluggish. Further and more accurate experiments proved, however, that the effects which had previously been ascribed to a peculiarity of the material were in reality caused by eddy currents in the sample. Theoretical calculations were made which demonstrated that eddy currents in an iron test piece increased as the square of the frequency and that for even the lower frequencies it was necessary to use quite thin laminations in magnetic circuits, in order to eliminate deleterious effects. Furthermore, it was found that owing to eddy currents and the magnetic properties of iron, the magnetisation in high frequency fields was confined to a thin surface layer of the piece. This " magnetic skin effect " reduced the cross section of the iron which was magnetically active even though the laminations were extremely thin. Careful experimental measurements compared with theoretical calculations proved that the real permeability of iron remained unchanged at frequencies up to about 10^6 and that previous results had been in serious error due to neglect of the factors mentioned. This fact having been established, efforts were made to see what practical use could be made of iron in high frequency work, and to that end some extensive experimental investigations of the saturation curves and core losses were made upon specimens laminated as thinly as was commercially practicable. The resulting data have furnished a basis for design.

It is a demonstrated fact that the permeability of all metals is unity for the magnetic cycles imposed upon them by heat and light waves. In the region between frequencies of about 10^6 where the true permeability of iron is practically the same as at zero frequency, and frequencies of about 10^{10} where the true permeability of iron approaches unity, the experimental values of μ decrease smoothly with the frequency. What happens to μ in the range of frequencies between the longest heat waves and the shortest Hertzian waves which have yet been made is a question which has many interesting features, but which has not yet yielded to the experimenter.

* * * * * *

A NEW QUENCHED GAP.

D. Biro and I. Bekepy describe, in the 1916 issue of the *Jahrbuch der Drahtlosen Telegrafie*, a form of quenched gap which consists of a hole bored in an incombustible and unmeltable substance, such as fired earthenware, the sparks from the electrodes being made to pass through the aperture. By the use of this gap it was found that for couplings of such value as would with an ordinary gap give the usual three-humped resonance curve only a single peak was obtained and much more energy was transferred. The wave length employed was 810 metres. The quenched effect is attributed to ionisation and the experiments show that for an un-ionised or ordinary gap the chief maximum was at 10 per cent. coupling, whilst that for the ionised gap was 15·5 per cent. Best impact excitation was secured at 34·1 per cent. coupling. The electrodes employed were all pointed copper wire of 1·5 mm. diameter placed 15·4 mm. apart. A similar gap without the pierced earthenware diaphragm gave the same spark potential at 9·3 mm. separation. The hole used was 3 mm. long and 1·8 mm. in diameter. Other metals such as zinc, aluminium and silver did not prove so suitable as electrodes. Since excessive heating destroys the effect, it is necessary to provide several earthenware plates in series if the energy employed is greater than a single diaphragm can deal with.—*Science Abstracts.*

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Signal Strengths of German Stations.

Professor L. W. Austin, in a paper delivered before the Franklin Institute, recently gave some valuable particulars of the strength of signals received at the United States Naval Radio Laboratory from the wireless station at Nauen and Eilvese. Reception was carried out on an aerial having an effective height of 30 metres, an oscillating valve circuit being used as a receiver. Both stations radiated continuous oscillations, and by suitable adjustment of the oscillating valve circuits a "beat" effect was produced, giving a musical note. Two curves accompany the paper giving results of observations at Nauen and Eilvese from January 1st to July 1st, 1916. The curves exhibit marked variability, the receive current ranging from 1×10^{-7} amperes to 80×10^{-7} amperes—that is, from about 25 audibility to more than 2,000 audibility. The cause of the variations is not clear. In some earlier experiments it was thought that probably the variations were to a considerable extent due to observational errors, but it now seems fairly certain that under normal conditions of atmospheric disturbance the limits of observational error are 20 to 30 per cent. It is now believed that variation in intensity is due for the most part to an irregular reflection or possibly reflection in the upper atmosphere, which brings to the receiving station energy in addition to that which travels along close to the relay. There is probably a certain amount of absorption due to the ionisation of the atmosphere.

The observations recorded in the curves were taken in June between the hours of 9 and 11 a.m., Washington time, and therefore represent the signals transmitted from Germany to America when daylight covers the whole path of transmission. Signals during April and May were stronger even than during the winter, and this period of strong signals is followed by a very decided drop in June.

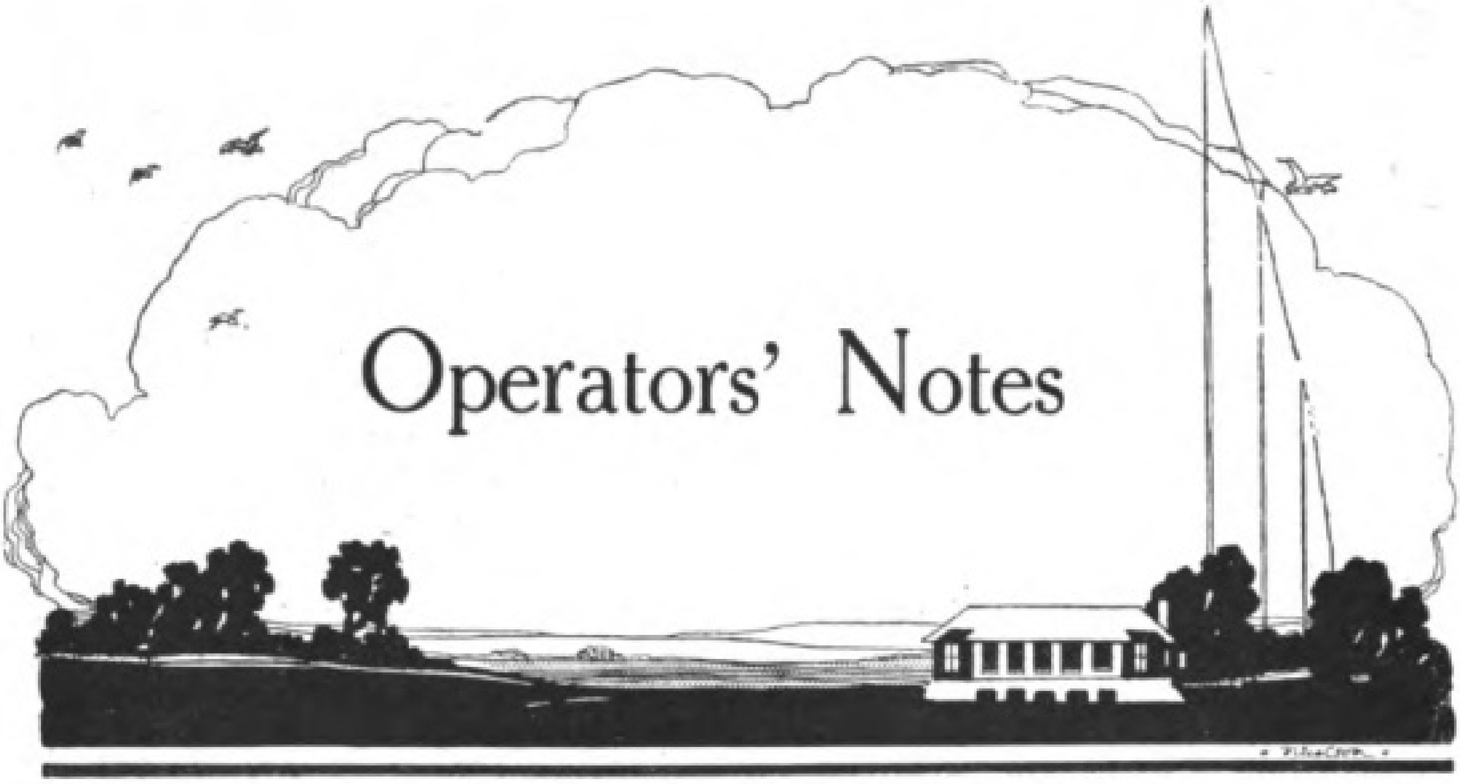
* * * * * *

Spark Transmitters in Radiotelephony.

Dr. Alfred N. Goldsmith, Director of the Radiotelegraphic and Telephonic Laboratory of the College of the City of New York, describes in the current number of the *Wireless Age* a number of radiotelephonic transmitters operating by the spark method. It has occurred to a number of investigators that practically sustained radiation could be secured in an antenna by using spark transmitters, but having these transmitters so arranged that the extremely high frequency of the sparks (above the limits of audibility) would render the usual "spark tone" inaudible. If, then, the antenna energy were modulated by a microphone or otherwise, radiotelephony would become possible. To specify in further detail, imagine a special form of spark gap and associated circuit so arranged that discharges occurred more or less regularly across the gap at an average frequency of, say, 50,000 sparks per second. If the circuit in which these sparks occurred were connected inductively to an antenna, there would be produced in the antenna practically sustained radiation, susceptible to suitable telephone modulation by a microphone transmitter or otherwise

A number of diagrams appear in the article, one of which shows an irregular radio-frequent spark excitation of an aerial. The diagram shows how highly damped oscillations, occurring rather irregularly in the primary circuit, start decadent wave trains, each of which still has a large current amplitude when the succeeding spark takes place, inasmuch as the sparks follow each other very frequently. Since the antenna circuit damping is low, the effect on the distant receiver would be appreciably that of sustained radiation at the transmitter, and particularly is this the case since the changes in antenna radiation occur above audio frequency. Most of the radio-frequent spark transmitters for radiotelephony operate in the fashion indicated. The Chaffee "arc" (which is really a spark phenomenon) is a special case which presents certain interesting features. To begin with, in this case the spark gap has such excessively high intrinsic damping that the spark discharges in the primary circuit tend to be aperiodic. The tendency to aperiodicity just mentioned is enhanced by Chaffee in that he couples the secondary circuit very closely to the primary, thereby obtaining a "quenched" action through the secondary reaction on the primary. In addition the direct current feed circuit of the arc and the coupling to the energy-absorbing secondary are arranged that the spark frequency is an integral fraction (*e.g.*, one-half, one-third, one-fourth, etc.) of the frequency of the oscillations in the secondary circuit. Thereby it occurs that the successive discharges come at just the right time to be in phase with the secondary (or antenna) oscillations and not at random (with possible interference) as in the case previously considered.

In general spark methods of radiotelephony are open to very serious objections. Unless the sparks not only follow with regularity but also have nearly equal current amplitudes (neither of which conditions are easily fulfilled, particularly in steady operation), there will be produced in the receivers of the distant station an annoying hissing sound which will interfere seriously with clear articulation in the speech. This accounts naturally for the frequently poor quality of spark radiotelephony transmitters.



Operators' Notes

Some Notes on the Balanced Crystal Receiver.

Of the many devices in use for the reduction of atmospherics the Marconi balanced crystal receiver is perhaps the most successful. As a number of receivers of this type are now being fitted to mercantile ships, a few notes regarding the principles of working will not be out of place.

Before considering the actual manipulation of the instrument, it is as well to explain clearly just what a balanced crystal receiver can do. This is necessary, as some operators who are not clear on the subject waste time in endeavouring to obtain impossible results.

A suitably adjusted balanced crystal receiver will very appreciably reduce the strength of all atmospherics which are louder than the signals it is desired to receive. Strong interfering signals will also be cut down. The advantage of the arrangement will be understood when we consider that atmospherics and signals very much louder than the signals it is desired to receive temporarily deafen the receiving operator and reduce the sensitiveness of his ear for weaker signals. The balanced crystal receiver, by keeping signals at a reasonable strength, enables the operator to receive in conditions which would otherwise make work impossible.

The principle of working is as follows : Instead of one crystal with its potentiometer and telephones being shunted across the " billi " condenser, two crystals with separate potentiometers are used. These are in parallel with one another but in series with the telephone receiver. The crystals are placed in their holders in such a way that they rectify in opposite directions, the rectifying power of one thus nullifying the power of the other. If the crystals are suitable and the two potentiometers are properly adjusted, no signals would be heard in the telephones, as the circuit ceases to be a periodic.

Every operator knows the principle upon which a crystal receiver works. If an increasing voltage be applied to the carborundum crystal, the current passing through the crystal will gradually increase up to a point where a very slight increase in voltage produces a considerably increased current. The object of the potentiometer is to supply just the right amount of electrical pressure to the crystal, in order that any slight increase of voltage due to the incoming signals may cause a comparatively strong current to pass through the telephones.

If now we slightly reduce the applied voltage on one of the crystals, a given increase of voltage due to incoming signals will cause a certain increase of current. This increase will not be so great as in the case of the other crystal adjusted to its most sensitive point. If both crystals are now switched in together and an attempt made to receive signals they will be heard in fair strength, as the rectifying power of one crystal will be superior to that of the other. In simple words the operator may be said to be working on the difference in rectification between the two crystals. But if signals of, say, six times the strength are now received, the sound in the telephones will not greatly increase, as the *difference* in rectification will not be six times as great, but perhaps only 1½ times as great, or even less than this. Signals weaker than those it is desired to receive will not be reduced to any great extent.

In practical working the following points should be attended to :—

(1) The two crystals used for balancing must be roughly of the same sensitiveness.

(2) They must be placed in opposite positions in the holders, so that when the potentiometers are adjusted the sensitive points are on opposite sides of zero.

(3) Each crystal circuit should be opened while the other is being adjusted.

(4) When the receiving circuits are all tuned up to some incoming wave it should be tested on one crystal and then on the other. If the crystals are good the strength should be roughly equal, and now, if both crystals are put on together, a rough zero of signals should be obtained, which can be made quite zero by moving one or other of the sliders a very slight amount.

(5) The practical working conditions for minimum atmospherics are now obtained by bringing one potentiometer towards zero potential until signals are roughly the same strength on the two crystals together as on the one with its potential not altered. It will then be found that signals stronger than those being worked with will be reduced.

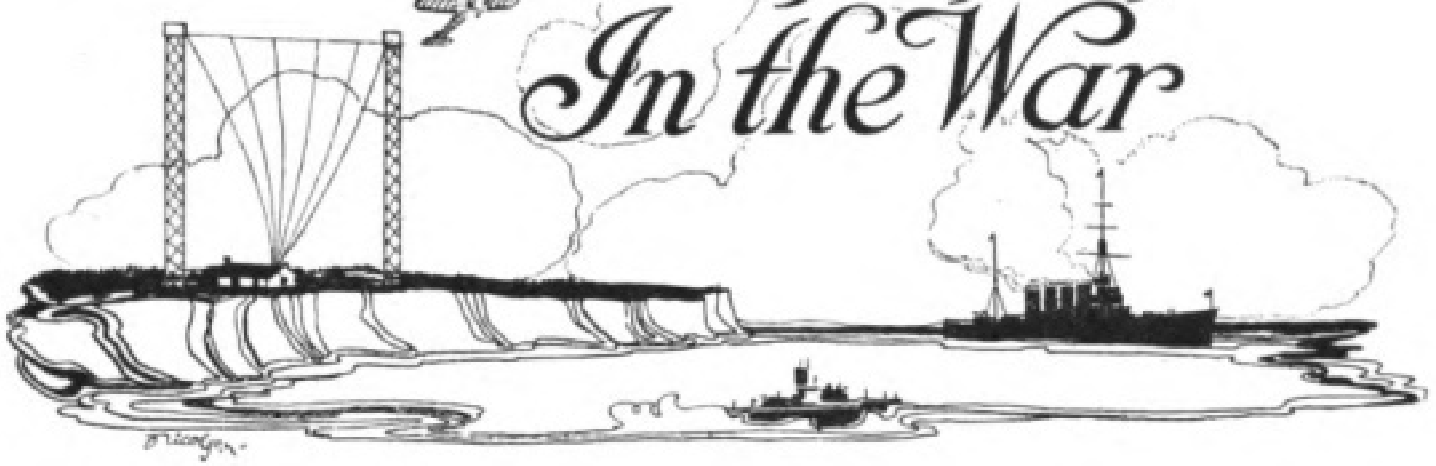
(6) It is necessary to readjust and rebalance for each different strength of signal it is required to receive, as strong signals will require more movement on the slider than those which are weak.

(7) If one of the crystals is slightly less sensitive than the other it is usually better to receive on the less sensitive one and balance with the more sensitive.

(8) Readjustment of the "billi" condenser will be necessary when the two crystals are used instead of one. This is due to the additional capacity of the second crystal.

Where there is no jamming and no atmospheric disturbance there is not the slightest advantage in using the balanced arrangement ; in fact, there is a slight disadvantage, as with the balance arrangement the strength of the signals received is slightly reduced. In such circumstances only one crystal—the more sensitive—should be used, the other being cut out of circuit.

Wireless Telegraphy In the War



"DOMINION"—IN VARIOUS MEDIA.

THE position of Great Britain has always, throughout her long history, rendered it necessary for her to be powerful at sea. Circumstances forced into her hands the sceptre of Dominion, and so arranged matters that, over a great length of time, the claim " Britannia rules the waves " has been justified in fact. This sea dominion was wormwood and gall to the would-be World-Dictator, Napoleon ; and his fustian Teutonic imitators have succeeded to his legacy in this respect. Nevertheless, the proverb still holds good—at all events as far as the surface is concerned—even more absolutely than ever before. The advent of wireless telegraphy enables the mighty fleets, both mercantile and naval, of Great Britain and her Allies, to be co-ordinated and worked as a complete whole in a way utterly undreamed of by the heroic founders of British sea power. When we come to add to the all-powerful navy of our own country those of France, Italy, Japan, Russia, and now America, we realise the absolute preponderance at sea of the Allied fleets as compared with those of Germany. Now, there are other media of a similar nature to water, and it may be worth while to consider whether they are not capable of being dominated by united effort to the same crushing degree.

The air is a medium bearing a marked resemblance to the sea in many respects, and we have witnessed a continual struggle all through this war for what some people are pleased to call the " mastery of the air." Great Britain was curiously behindhand in this matter at the start, and had a great deal of leeway to make up. Fortunately, as far as heavier-than-air machines are concerned, that object has been largely attained, although fresh efforts are constantly necessary in order to meet the ever-increasing counter-activities of the enemy. With regard to lighter-than-air machines, there seems little hope that we shall ever be able to challenge the enemy's supremacy in this respect in the course of the war at all events. We have ourselves on many previous occasions endeavoured to do justice to the inventive genius and organising power of the late Count Zeppelin and the valuable weapon which he placed at the disposal of his country. The Zeppelin airships, under his supervision, developed so as to be able to " keep the sea " in all states of weather, and the lifting power of the later types enables them to carry wireless apparatus of a sufficiently powerful nature to maintain communication over a radius of hundreds of miles, thus constituting them invaluable scouting auxiliaries in times of war and affording them immense possibilities for the further development of rapid communication in times of peace. One of the American newspaper correspondents who has been recalled to his own country in consequence of the rupture between the United States and Germany came back full of enthusiasm for the real merits of this form of aircraft and of its potentialities for conducting a long-distance service at unexampled rates of speed in peace time. He even went so far as to make the somewhat "tall" assertion that the failure of the Allies to break down the armed resistance of Turkey was due to the fact that Germany was able to supply Constantinople with some munitions of war, as well as men and machinery for manufacturing them, through the medium of Zeppelin airships, at a time when the Turkish supplies were at so low an ebb as to bring them to the verge of collapse. The Germans, after endeavouring to utilise those "rigid" aircraft for murder raids and ultimately failing in the attempt, have gone from one extreme to the other. Whereas in earlier days these products of Count Zeppelin's genius aroused their hysterical admiration, they have now fallen into undeserved disrepute.

The Wellman airship which, in 1910, endeavoured to cross the Atlantic and to initiate the forging of one more link between the New World and the Old, was but "an intelligent anticipation of events before they occur." There can be little doubt

THE 7TH DIVISION OF AUSTRALIAN WIRELESS MEN. [Photo: Meyers Bros.

[Photo: Meyers Bros.

THE 6TH DIVISION OF NEW ZEALAND WIRELESS MEN.

that the feat will be accomplished easily after peace once more settles down upon the world, and that we shall see possibilities offered to travellers of rapid transit such as has never before been known. Wireless telegraphy will play its part, and by maintaining connection between the travelling airships and their points of departure and arrival, double their utility and increase public confidence and safety to an immeasurable extent. We would remind our readers that in the case of the Wellman disaster radio communication was established between the unlucky pioneers and the Royal Mail liner *Trent*, which effected a sensational rescue of all on board. Unless, therefore, the Allies are prepared to continue to admit unchallenged the present enemy supremacy in lighter-than-air machines in peace as well as war, no time should be lost either by their inventors or by their industrial organisers.

There is a further field of dominion open to those who have energy and ingenuity enough to seize it ; we mean dominion in the ether. The thoughts of some readers will perhaps be directed by such a phrase towards what is generally known as " jamming " ; but, as a matter of fact, our own ideas do not run in that direction at all. All sorts of prophecies with regard to it were rife in pre-war days ; we ourselves, however, always taking the view that—just as it is acknowledged to be of more importance for a whist player to acquaint his partner with the state of his own hand than to endeavour to deceive his opponents—so would it turn out with regard to the use of radio-telegraphy in warfare. According to this view, the energies of wireless combatants would be more profitably directed towards establishing communication with their own people than in devoting their energies to endeavours to prevent such communication being utilised by the enemy. Although so much of the actual happenings of war must necessarily remain secret until the end of hostilities, such indications as we have been able to gather tend, on the whole, to confirm our first opinion. No! Dominion in the ether is to be looked for rather in the suppression of the enemy's means for maintaining stations and in the simultaneous addition to the number and power of our own. This course has been systematically followed right from the start of the struggle. The great stations situated within the confines of Germany's "places in the sun" have one by one succumbed to our persistent assaults. The huge enemy radio installation at Bagdad forms the latest case in point. With her cables severed, and her great long-distance wireless installations captured or destroyed, Germany was obliged to fall back on stations which stood in neutral territory and could not, therefore, be reached by force of arms. She abused her facilities in America to such an extent that—long before the outbreak of hostilities—President Wilson was obliged to take action to prevent her continuing thus to "violate neutrality." The entry of the United States into the arena of conflict has immensely aided the Allies in the establishment of that supremacy in the ether at which we have been steadily aiming for so long. As a matter of fact, that dominion, although even yet not absolute, is so far on its way towards becoming so that our enemies are confessedly suffering acutely from their wireless disabilities, and that to an extent which it is impossible for us, under present conditions, to fully realise.

A further factor in the establishment of ether dominion is referred to in the *Electrical World* of March 31st, and we cannot do better, with regard to this aspect, than quote the *ipsissima verba* of our eminent contemporary:

"It has, until recently, been generally accepted that any alliance of nations "which could maintain dominion on the seas would ultimately extend its dominion "over the lands. It now looks as though the dominion of the air would ultimately "transcend in importance the dominion of the sea. The dominion of the air is "obtained by flying machines and by radio-communication. Those nations which "collectively can maintain in alliance the greatest skill and ability in fleets of aero-"planes, and also the greatest skill and ability in radio-communication, may be "expected jointly to retain command of the seas, and in combination therewith to

2ND NEW ZEALAND WIRELESS CORPS. [*Photo: Meyers Bros.*

"maintain command of the land. This skill and ability is intellectual and moral. "It calls for a high degree of inventiveness, engineering, discipline, hardihood, "courage, and initiative. No single country can expect to maintain such an "hegemony, but a strong federation of progressive countries may hope to keep the "peace of the world through the joint dominion of the air."

GENERAL SMUTS' VIEW.

It is interesting to note, in view of the foregoing remarks, the observations made by Lieutenant-General Smuts on the recent occasion when the London Chamber of Commerce made a presentation to the South African Government of the Air-Fleet aeroplane "South Africa." He spoke of the "air supremacy" which the Germans appear at first to have temporarily obtained in South Africa. "Against this," said the Africander General, "our gallant lads made a most magnificent fight, very "often with inferior machines; with the result that the German machines did not "dare to come over our lines." He proceeded to say that our supremacy had been maintained, and that he considered it likely to become more absolute as time went on. General Smuts, after touching on the special difficulties presented by the *terrain* of South Africa, paid a warm tribute to radiotelegraphy, emphasising the fact that it had "played a most important part in the war in Africa, where the telegraph "and telephone would have been practically useless."

Our visitor from overseas did more than review the past; he looked into the future, and prophesied that after the war the aeroplane would prove one of the most potent instruments of peace, maintaining that the conquest of the air would open up new vistas of progress for the human race. After the war was over "the aeroplane "and wireless telegraphy would be of the utmost use in our commercial life." He is glad to know that the present Government has appointed a committee to consider how the enormous amount of aircraft in our hands can best be turned to commercial uses. Space and time are the great enemies of a close union between the scattered units of the British Empire, and it seems likely that these will soon be overcome.

This able exposition of the present situation and the promise of the future came from the lips of a victorious General who has been operating in that far-distant quarter of the globe wherein our enemy's miscalculations have proved most glaring. In days of yore, had such a military leader, with his laurels fresh upon him, returned to Ancient Rome, he would have been accorded by the Senate and the People the honour of a ceremonial "Triumph." The Victor from a Roman colony overseas would have proceeded in solemn procession between lines of acclaiming citizens up the Sacred Way to the *Capitol*, there to be presented by the Conscript Fathers with the Solemn Ovation of Victory. In his train would have marched the captives he had won, followed by a chosen band of his war-worn soldiery, the "spoils of war" being borne along in triumphal march to the accompaniment of choral bands and martial trumpets, whilst—all the way along—lines of acclaiming citizens strewed flowers and palms. The phlegmatic temperament of the Anglo-Saxon and the prosaic times in which we live forbid such ceremonies here; but we can, at all events, accord the tribute of a close attention to his well-reasoned pronouncement. In our opinion, *the* man, above all others, who has the right to guide us by speech is the man who has already led the way in successful action.

A Pioneer Voyage

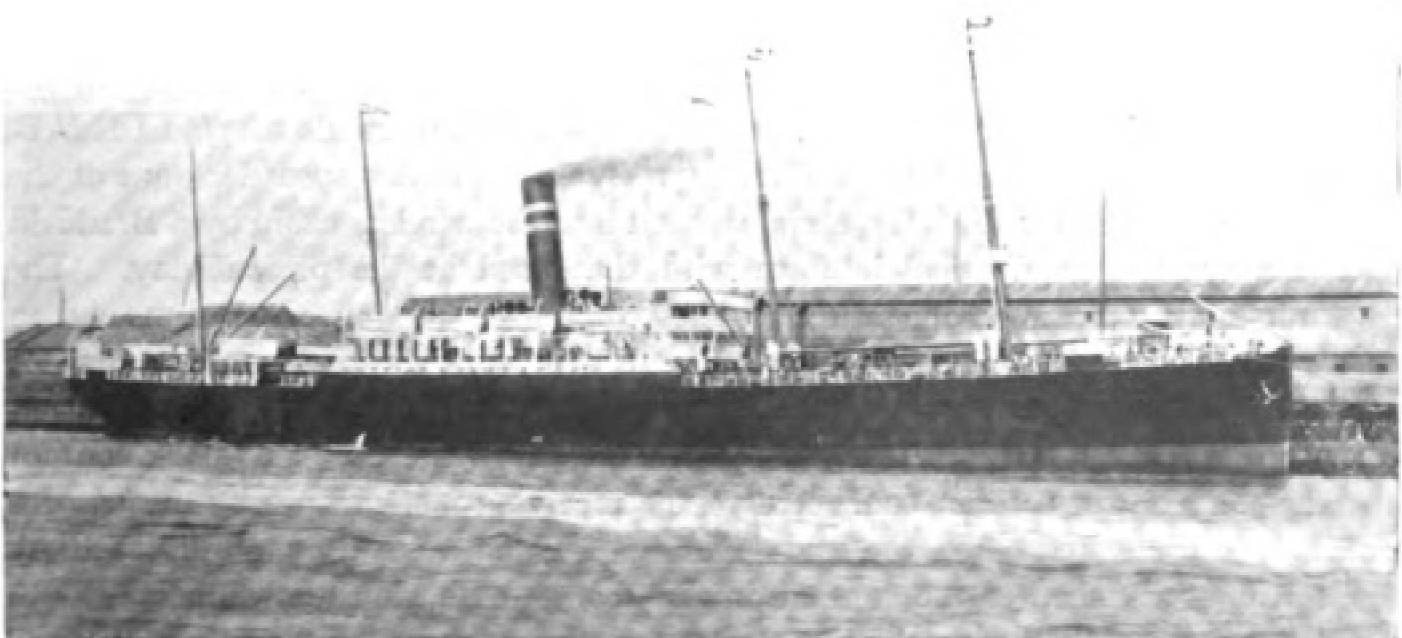
Recollections of the First British Operator to make a Transatlantic Crossing

By F. S. STACEY

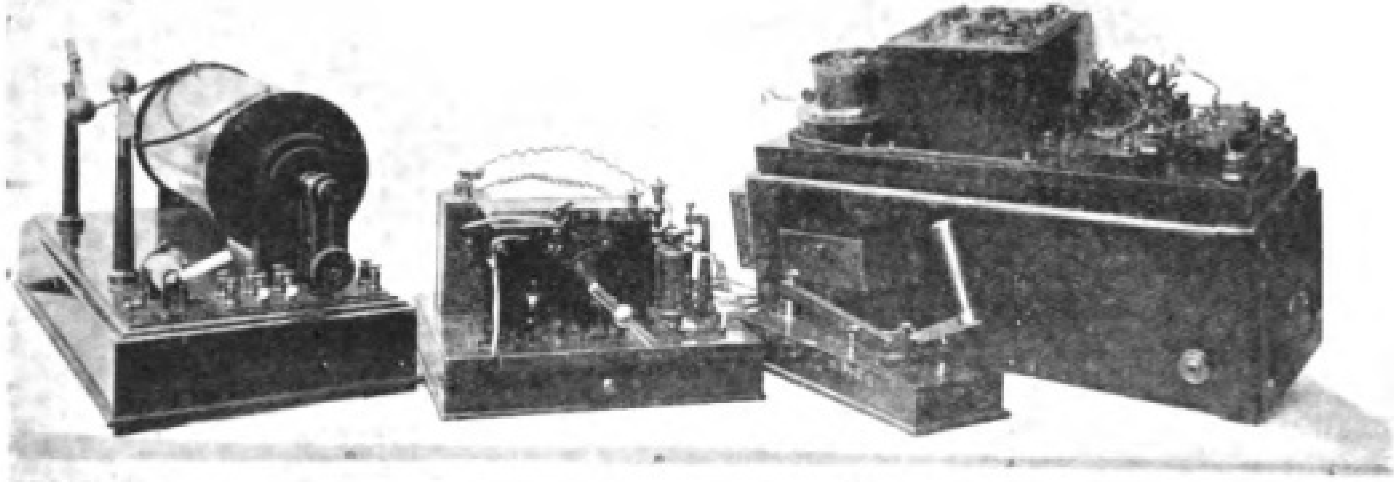
In responding to the invitation of the Editor to place on record a few notes regarding my pioneer voyage on the s.s. *Lake Champlain*, I am faced with the fact that no less than sixteen years have elapsed since this interesting event occurred. My memory, however, is still fresh upon many points which may be of interest to those operators who are now sailing the seas with apparatus of modern type. It will be seen later on that the conditions under which we had to work at that time were very different from those prevailing to-day.

It was in the year 1899 that I joined the Marconi Company, and after having made myself familiar with the apparatus, which was of a comparatively simple nature, at the office of the Company, then at 28, Mark Lane, and later on at Chelmsford, under Dr. Murray, I was able to act as technical assistant at several important demonstrations. When the Belgian mail packet *Princess Clementine* was fitted with wireless telegraphy I served aboard as operator.

The *Princess Clementine* having proved successfully that wireless telegraphy was a reliable form of communication, Captain C. V. Daly, who had then recently joined the Marconi Company as Marine Superintendent, arranged with the Beaver Line to instal a set of apparatus on board the s.s. *Lake Champlain*. The arrangements were



THE S.S. "LAKE CHAMPLAIN."



TRANSMITTING AND RECEIVING APPARATUS AS USED ON THE "LAKE CHAMPLAIN."

made with a Mr. Jones, later known as Sir Alfred Jones, and one of the directors of Messrs. Elder, Dempster and Company. Considerable importance was attached to the venture, particularly as the *Lake Champlain* was one of the Beaver Line's new vessels. As soon as negotiations were concluded I was instructed to get together the necessary apparatus and proceed to Liverpool to join the vessel, which was lying in the Alexandra Dock. The work of installation was carried out under the supervision of the late Mr. Bullock, afterwards appointed Traffic Manager to the Marconi International Marine Communication Company, Limited.

The transmitting apparatus consisted of a ten-inch induction coil working off current supplied by two six-volt accumulators. Four six-volt accumulators were supplied, two being worked whilst the other two were on charge. At that time there was no switchboard for charging, and the mains were connected to the accumulators through a bank of six carbon filament lamps which provided the necessary resistance. There were no tuning circuits, transmitting jiggers or aërial tuning inductances, the aerial being simply connected to one side of the spark gap and the "earth" to the other. A three-centimetre spark was used between balls of 1½ centimetres diameter. The receiving apparatus consisted of two coherer receivers with a Morse inker, the signals being received on tape. The aerial consisted of two wires supported about one hundred feet above the waterline by means of a sprit, hoisted to the top of the mast and about twelve feet long. These wires, which were made of 7/20 I.R.V.B. electric lighting cable, were kept six feet apart by means of two spreaders, one at the top and one at the bottom. The aerial was led into the wireless cabin by a Bradfield insulator practically identical in form with that used at the present day. The transmitting key consisted of a switch and key combined. The lever had at one end an ebonite handle and a platinum contact, and this worked upon another contact beneath. At the opposite end of the lever was attached a length of ebonite fitted with another contact and a terminal. When the key was "up" this back contact rested upon a lower contact connected to the receiving instruments by means of a length of lead-covered cable, the lead covering of which was very carefully earthed. The terminal attached to the contact on the ebonite extension was connected with the aerial lead, so that when the key was at rest the receiver was directly connected with the aerial. Thus, when receiving, electrical oscillations collected by the aerial wire passed to the terminal on the top of the ebonite rod extension on the key, from there to the contact and thence by the lead-covered cable to the receiver. On depressing the key for signalling the contacts at the end of the ebonite rod were broken and the receiver cut out.

As there was no available accommodation on the boat for the wireless apparatus, a special cabin had to be built, and it is interesting to compare this with the specially designed and equipped cabins used at the present day. It consisted of little more than a cupboard 4 ft. 6 in. in length and 3 ft. 6 in. in width, one side being formed by the iron bulkhead. It was made of matchboarding, without any windows, and when natural light was required the door had to be opened. The total cost of this palatial structure was £5!

The apparatus itself was mounted on a table covered with green baize, the accumulators being placed on the floor and the lamp resistance for charging the cells screwed on to the wall. Two induction coils were supplied, one being used and the other being kept as a spare. The two coil boxes one on top of the other served as a seat, the empty coil boxes providing a convenient cupboard for spares and sundries. The stationery supply was of the simplest description, and consisted of P.V. forms, Post Office telegraph forms, and some Marconi's wireless telegraph forms printed in red. Traffic abstracts and the many other papers now in use had then not come into being.

The s.s. *Lake Champlain* sailed on the 21st of May, 1901, with about 1,200 people on board. Soon after we cleared the land we established communication with the station at Holyhead (long since dismantled), and soon after losing touch with this we picked up Rosslare. Numerous messages were sent and received to and from the owners; messages were also sent by members of the crew. Our busy time soon ceased, however, for there were no other stations to communicate with in Great Britain and none had been erected on the American side.

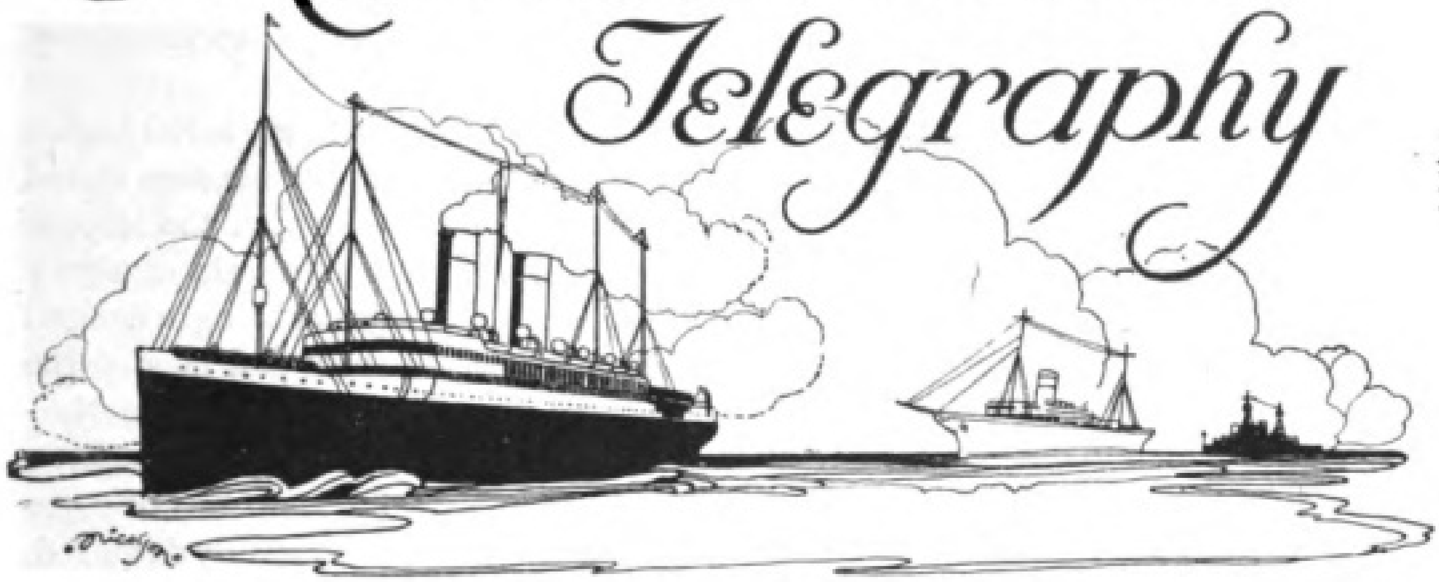
THE CUNARD S.S. "LUCANIA."

The new wireless installation naturally aroused tremendous curiosity and interest among the passengers and crew, who crowded in and out our tiny cabin from morn till eve. It is safe to say that it was much harder work explaining the apparatus and satisfying the visitors than actually manipulating it when occasion required. When the ship arrived at Halifax it was invaded by an army of newspaper reporters, who were quick to realise the possibilities of the new method of communicating, and Captain Stewart, Chief Engineer Samson and the writer were busy giving interviews and explaining the apparatus. Special articles appeared in the newspapers and were cabled to America and England. On arrival at Montreal further interviews were given and much interest aroused. Representatives from several of the scientific societies and technical colleges visited the ship, and Mr. Keeley, at that time Government Inspector of Telegraphs, journeyed from Ottawa with the express purpose of examining the apparatus. As a result of his visit the Canadian Government cabled to England and ordered two sets of apparatus for communication across the Straits of Belleisle, a distance of twenty-two miles, where considerable difficulty had been experienced in maintaining cable communication owing to the cable being continually felled by icebergs.

The return voyage was without event until on calling Crookhaven, which had not been erected at the time of our outward journey, but which was now working, we were considerably surprised to receive a call from the Cunarder s.s. *Lucania*, which was outward bound on her first trip with wireless. I exchanged several messages with the operator (Mr. J. St. Vincent Pletts), and as soon as communication was finished I picked up Crookhaven. Telegrams were sent to the owners and to Queenstown, and received some hours before they would have been if the old methods of signalling by means of flags had been used. After leaving Queenstown we communicated with Rosslare and Holyhead, and in due course arrived at Liverpool.

THE ORIGINAL MARCONI SCHOOL AT WATERLOO, LIVERPOOL.

Maritime Wireless Telegraphy



"SOS" Calls.

The successful torpedoing of one hospital ship after another by the German submarines creates a situation almost unexampled since the early dawn of modern civilisation. About a year ago an unsuccessful attempt was made against the hospital ship *Asturias*, and the German Government *then*, at all events, paid the hypocrite's tribute to virtue of "explaining" that this vessel, despite her conspicuous and distinctive marking, was "mistaken for an ordinary transport" in full daylight. Now, however, the mask of hypocrisy has been deliberately cast away. The *Britannic*, the *Braemar Castle*, the *Gloucester Castle*, the *Asturias*, the *Donegal*, the *Lanfranc*, and the *Salta*, all hospital ships, and some with a full complement of wounded on board, have been successfully torpedoed. The SOS calls for help radiated from their aerials have enabled the toll paid by the unhappy and helpless victims of "man's inhumanity to man" to be immensely less than it would otherwise have proved. But there is another and a further SOS call to be considered. Our ordinary ether-wave summons demands *as a right* assistance from every vessel which receives it, and the SOS call to humanity at large makes assuredly no less sacred an appeal.

On Sunday, April 22nd, the International Red Cross Committee (with its headquarters at Geneva) answered that appeal, and addressed a note to the German Government, pointing out that "in torpedoing hospital ships it is not attacking " combatants but defenceless beings, wounded or mutilated in war, and women who " are devoting themselves to the work of relief and charity." Such action on the part of the International Convention is, we believe, without precedent. The Red Cross Society has received the most solemn recognition of neutrality and vows of loyal allegiance from every civilised nation. It is truly "international" in the strictest sense of the term. The German Government treated their protest with contempt. It has thereby once again proved itself a traitor to its pledged vows, and formally placed its country "outside the pale" of civilisation. The call of the SOS radiated from the international aërials of the Geneva Convention has, therefore, failed as far as organised Governments are concerned. But it goes on vibrating just the same and makes its insistent note heard by every heart that is "listening in" for appeals from suffering and helplessness.

Beside such organised infamy, individual acts of treachery, however despicable and however general, seem dwarfed by comparison. Nevertheless, such cases as the following are well worth recording:

A Breton skipper received an SOS wireless call from the *Bergen*, a Norwegian three-masted sailing vessel. The signal was repeated and a further message stated the vessel to be sinking. In fulfilment of his international obligation the skipper made for the spot with all speed, and in an hour and a half came in sight of a grey three-masted vessel which (he was surprised to find) showed no signs of being in danger. She was flying the Norwegian colours, but suddenly lowered them and hoisted the German naval standard. The Breton skipper tried to escape, but the sham Norwegian barque opened fire, whilst German officers on board, roaring with laughter, shouted "*Vive la France.*" The bogus barque *Bergen* is really a steamer of 2,500 tons, cleverly disguised, and carrying several guns. She is commanded by Corvette Captain Graf von Ukner.

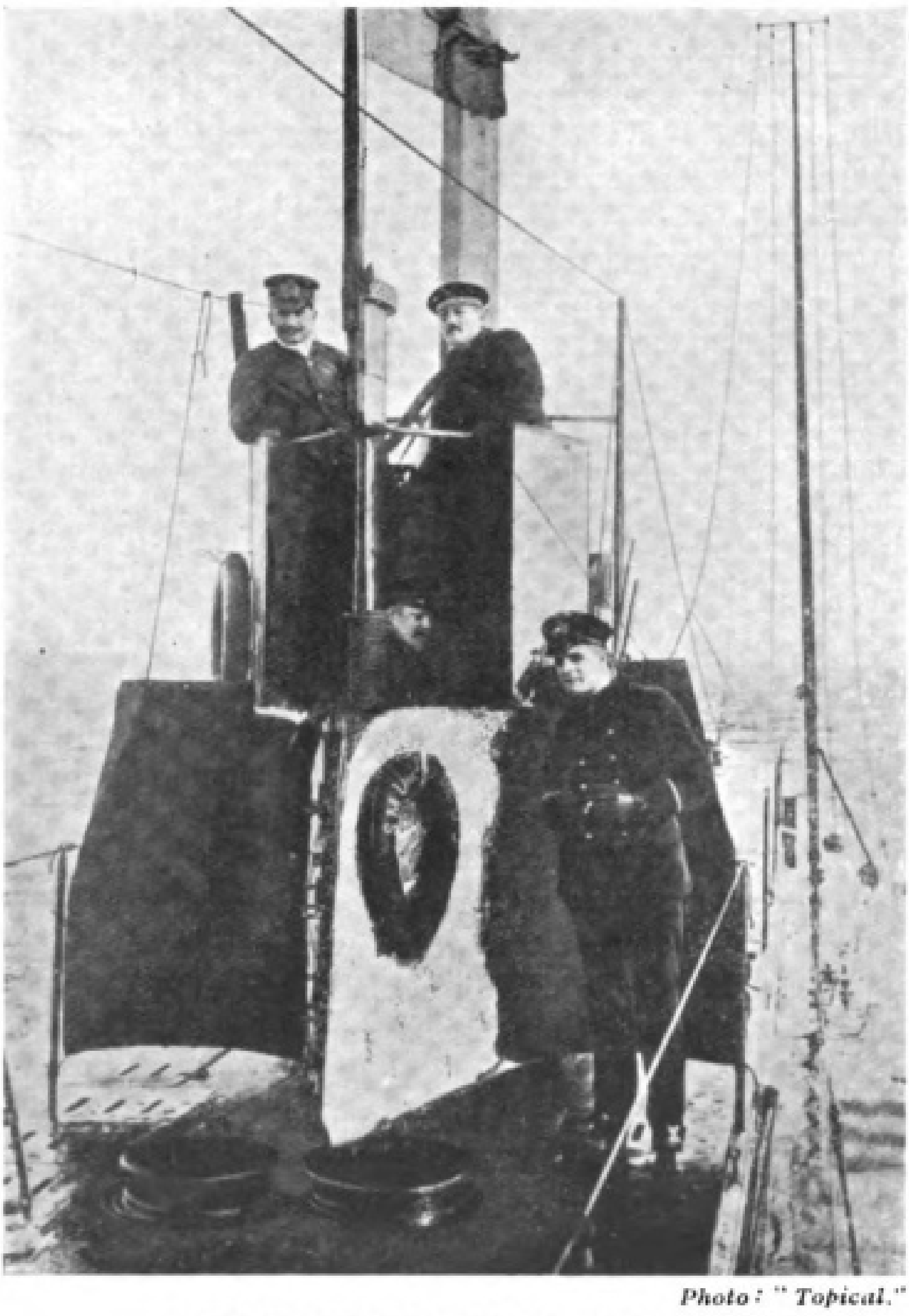


Photo: "Topical."

WIRELESS ON A GERMAN SUBMARINE.

* * *

NO WIRELESS WARNING RECEIVED.

A BOARD of Trade Enquiry was held at Belfast at the end of March and the beginning of April last on the collision between the London and North Western Railway Co.'s s.s. *Connemara* and the Newry steamer *Retriever*. It will be remembered that these two vessels collided in Carlingford Lough on November 3rd, 1916, with a resultant loss of 94 lives. Mr. E. A. Swayne, outlining the case for the Board of Trade, described the circumstances of the collision. The *Connemara* was outward bound from Greenore for Holyhead. She carried 51 passengers, three cattlemen, a railway guard, and a crew of 31. The usual complement of the *Retriever* was ten, but only nine were carried on that voyage. Of all the men involved only one (a member of the *Retriever's* crew) was left to tell the tale. Both vessels were amply equipped with life-saving apparatus, and the *Connemara* possessed a wireless installation. Nevertheless, no radio station under Government control received any distress signals whatsoever. This is the record of a terrible catastrophe of which, in all human probability, it will be impossible for us ever to reach the correct solution. It forms one of those rare occasions when the equipment of a vessel with wireless does not appear to have succeeded in saving some, at least, of the victims of a disaster at sea. The only comment that can be made is the sad admission that—let human forethought and prevision do all they may—there must be occasions when every precaution proves in vain.

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NEW GOVERNMENT REGULATIONS AFFECTING THE SAFETY OF BRITISH SHIPS.

The *Board of Trade Journal*, dated April 29th last, contains (on page 109) the following additional regulation affecting the safety of British ships:

After Regulation 37B the following Regulation shall be inserted:

"37C.—The Admiralty or the Shipping Controller may, with the concurrence "of the Board of Trade, give directions that any British ship shall forthwith be and "shall continue to be equipped with such apparatus as may be specified in the direc- "tions for securing the safety of the ship, and that the crew of the ship shall be "properly instructed in the use of such apparatus.

"If any ship with respect to which any such directions have been given puts to "sea from any port in the United Kingdom without complying with the directions, "the owner or master of the ship shall be guilty of a summary offence against these "regulations, and if the ship is at any time subsequently found at any port of, or "in the territorial waters adjacent to the United Kingdom, the ship may be seized "and detained."

WIRELESS WORLD readers will remember that, in order to give effect to the International Convention of London in 1912, the British Government amended the laws relating to merchant shipping by the "Merchant Shipping (Convention) Act, 1914," of which Part III. refers to wireless telegraphy. The text is given *in extenso* in the 1917 "Year Book." This Act came into force on July 1st, 1915, but has not yet been put into operation. However, new measures for securing safety at sea for British ships during war time are being regulated by Orders in Council issued under the Defence of the Realm Act. Regulation No. 37 under that Act, together with those numbered 37A, 37B and 37C, all refer to these various new measures. Of these, 37B, which was printed in THE WIRELESS WORLD of July, 1916 (page 460), and in the "Year Book" (page 242), refers specifically to radiotelegraphy, and makes it obligatory for wireless to be installed on all British ships of 3,000 gross tons and upwards. The above-quoted Order in Council would appear to be couched in general terms, so as to include the whole series of regulations.

Twenty-one Years of Progress

An Historical Résumé

THE earliest wireless electric telegraph was invented in 1842 by Samuel Morse, the creator of the code bearing his name. It was, however, little else than an interesting scientific experiment, for it was incapable of operating over anything but the shortest distance. Nowadays we should term it telegraphy by means of an earth leakage current. Two or three years later a similar method was used in Scotland by James Bowman Lindsay, and other inventors, following the same line, endeavoured to perfect the method, but with little success.

In 1892 a much more perfect form was invented by the well-known scientist, Sir William H. Preece. His method differed from those of his predecessors, in utilising what is known as electromagnetic induction between two parallel wires, a phenomenon which creates the difficulty in telephony known as "cross talk." Where two telephone wires run parallel for any distance there is a liability of speech conveyed in one wire being overheard by subscribers using the other, and special means have to be adopted to overcome this difficulty in practice. Sir William Preece utilised this effect, and coupled it with the method discovered by Morse to transmit signals over a distance of two or three miles. Two parallel telegraph wires each of a length practically equal to the distance separating them were erected, and very satisfactory results were obtained in several places, but the method could not be used for long distance communication, owing to the great length of wire necessary—lengths, it will be noted, more than sufficient to connect up the two places.

Thus it will be seen that, although Senatore Marconi did not invent "wireless telegraphy" in the broadest sense of the word, yet before the advent of his invention a form of wireless telegraphy which would communicate with ships at sea or over any considerable distance without the use of enormous lengths of wire was totally unknown. Marconi's method was entirely new, and it was long ago established beyond all possibility of doubt that he was the first to produce a wireless telegraph operating by means of waves of free electricity in space. In the mists of doubt which obscured the early days of the ether wave wireless telegraph attempts were made to deprive the young Italian inventor of the credit for his wonderful invention, by pointing out that many years before Sir William Preece and others had telegraphed without wires. Those who endeavoured to belittle Senatore Marconi's genius certainly did not realise that he was working on entirely new lines.

Just as the invention of the fountain pen consisted in combining two already well-known objects—the pen and the inkpot—so the creation of the ether wave wireless telegraph by Marconi consisted in combining a number of already known instruments to form a working telegraph. Professor Heinrich Hertz some years before had discovered that waves of free electricity could be propagated and detected in space; Morse in America had found out the way of transmitting intelligence by means of dots and dashes; Branly, in France, had made a sensitive detector of electric waves known as the coherer, and various workers in the telegraph field had produced instruments such as relays, Morse inkers, and the like. Marconi took all these things, improving and adapting them to his own purpose, and in the year 1896 came to England with a few boxes containing the whole apparatus necessary to communicate intelligence for a distance by means of Hertzian waves.

The early years of the Marconi telegraph were times of immense interest and immense endeavour. Only those who were actually concerned with the first experiments can realise the enormous difficulties which had to be overcome. The efficiency and reliability of the wireless telegraph of to-day is the result of twenty-one years of constant painstaking endeavour, of numerous and costly experiments, and of the unremitting labour of many great minds. Unlike many inventors who have produced some great invention, the young Italian scientist was never contented with what he had done, and since producing his first telegraph he had never ceased to labour for its constant improvement. All wireless men of to-day realise the stupendous technical difficulties which were faced by the pioneers, but not all understand the apathy, and, indeed, the actual opposition, which was at first offered by the scientific world. Even Sir William Preece, to whom Senatore Marconi was introduced on his arrival in England, and who placed at the disposal of the young inventor the facilities of the Post Office, had no great faith in the future of wireless telegraphy. In the year 1900, when interviewed by the representative of a well-known magazine, Sir William Preece remarked that wireless telegraphy had gone as far as it ever would, and Lord Kelvin is recorded to have said that he would rather trust a message to a boy on a pony. Many other scientists, whom we will mercifully leave unnamed, practically accused the enthusiastic young Italian of being a charlatan. And yet in spite of the discouragement and difficulty the inventor pressed on with his

PALAZZO MARESCALCHI, BOLOGNA, THE BIRTHPLACE OF SENATORE MARCONI.

SIR WILLIAM H. PREECE.

life work with an enthusiasm which he was fortunate in being able to communicate to his assistants.

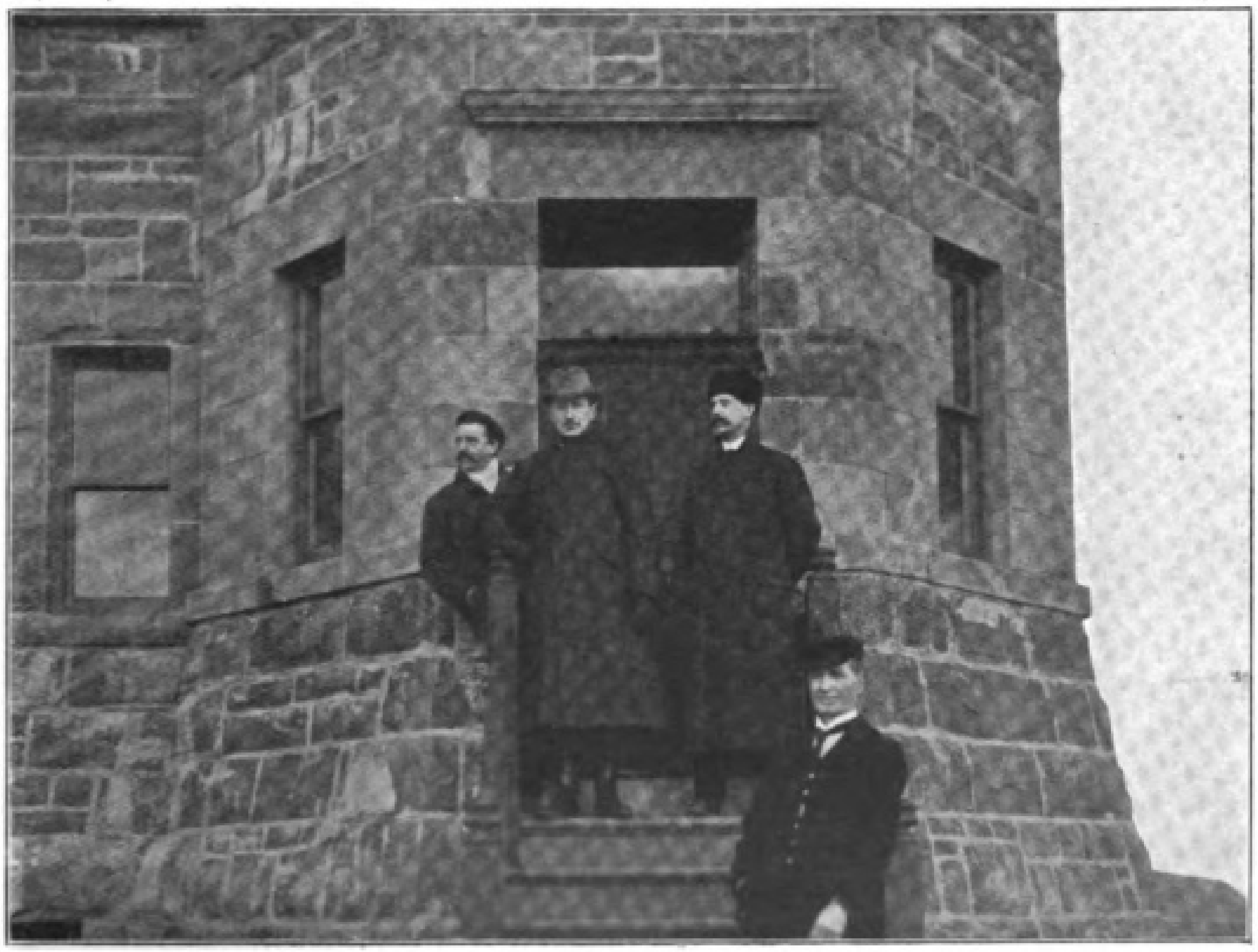
In March, 1897, Marconi succeeded in communicating over a distance of four miles before representatives of Government departments, and two months later the distance was increased to eight miles, the latter tests being performed in the presence of Professor Slaby, whom the German Government had sent as a scientific "spy." How Slaby went back to Germany, reported to his Government, and was instructed to produce a German wireless system on the same lines is well known to all who are acquainted with the early history of the subject. It is from this time that the Telefunken system dates—a system which, although it may differ nowadays in a number of respects from the British Marconi system, was, nevertheless, at first practically a complete copy of that invented by Senatore Marconi.

At the close of the year the first land station was erected at the Needles, Isle of Wight, and in December signals from the Needles Station were read on a temporary installation fitted to a steamer eighteen miles away.

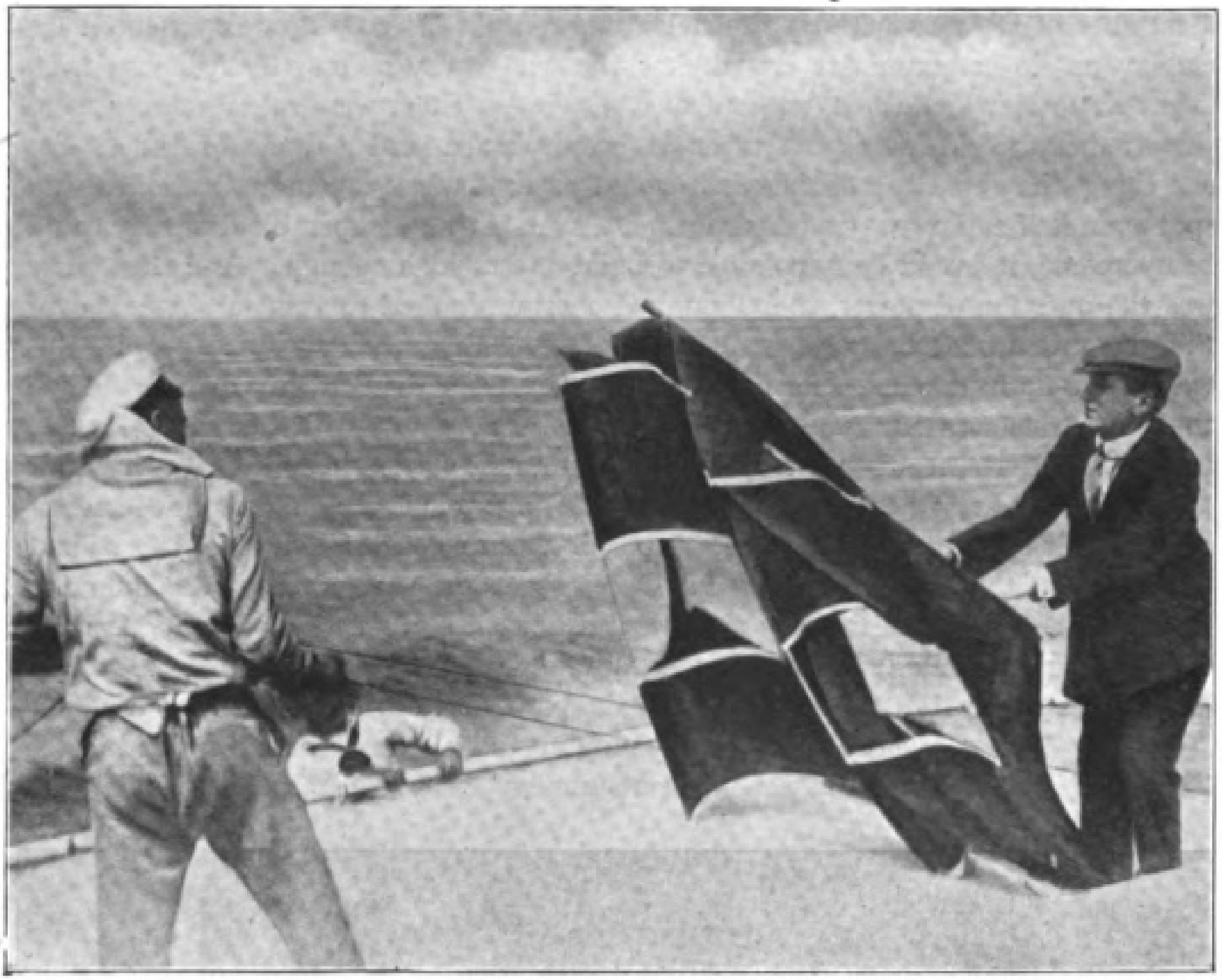
The first paid wireless message was sent by Lord Kelvin from the Needles Station to another installation at Bournemouth, and readers who are interested will find in our December, 1915, issue a photograph of the identical message scribbled in pencil on a half sheet of notepaper. Royal patronage was given to the invention two months later when wireless telegraph communication was established between the royal yacht *Osborne* and Ladywood Cottage, Osborne, in order that Queen Victoria could be kept in touch with the then Prince of Wales. By this time the Trinity House authorities had realised the value of the new telegraph in keeping lightships in touch with the mainland, and a number of vessels were fitted soon afterwards. The wisdom of this step was admirably demonstrated in January, 1899, when the East Goodwin lightship was damaged in a gale, and the mishap reported to Trinity House by wireless telegraphy.

In view of the enormous importance of radiotelegraphy in naval warfare it is interesting to note that the first British warships were equipped with Marconi apparatus in July, 1899, messages being accurately transmitted and received up to a distance of seventy-four nautical miles. The same year saw the first wireless sets purchased by the War Office, who despatched them for use in the South African war. They proved of considerable service and were later transferred to ships of the Navy. This fact will be of interest to those who supposed that the present great conflict is the first in which wireless telegraphy has been utilised.

By the year 1900 considerable technical as well as commercial progress had been made. The invention of "tuning" by Senatore Marconi enabled a high degree of selectivity to be obtained, and made possible the simultaneous working of a number of stations without mutual interference. Marconi now commenced his endeavours to communicate by wireless the whole way across the Atlantic, from Cornwall to Newfoundland, without any relaying. There were many reasons, said the scientific world, why such attempts were absurd and a waste of time. For one thing, the curvature of the earth would prevent wireless communication with a spot even half as far away as America, and, even if that insuperable difficulty could be overcome, it would be impossible to build masts high enough. And then there was the question of power, the amount of energy required to transmit signals over this distance would be quite unobtainable. Probably, thought some people, this was a hare-brained scheme for extracting money from the British public. And yet the impossible was achieved! The enthusiastic inventor, with his little band of faithful assistants, heard the first faint signals from the station in Cornwall, a rhythmic series of dots forming the letter S. When the first public announcement of success was made it is safe to say that nine responsible people out of ten refused to believe it. Thus, in the *Daily Telegraph* for December 18th, 1901, we find the following statement :—" Notwithstanding the detailed, signed statement by Signor Marconi, " appearing in the *Daily Telegraph* yesterday, there was an indisposition . . . to " accept as conclusive his evidence that the problem of wireless telegraphy across " the Atlantic had been solved by the young inventor. Scepticism prevailed in the " City. 'One swallow does not make a summer', said one, 'and a series of " S "



SENATORE MARCONI AND ASSISTANTS DURING THEIR STAY IN NEWFOUNDLAND FOR THE FIRST TRANSATLANTIC EXPERIMENTS.



SENATORE MARCONI RELEASING A KITE BY WHICH THE AERIAL WIRES WERE SUPPORTED IN EARLY LONG DISTANCE EXPERIMENTS.

"signals do not make the Morse Code.' The view generally held was that electric "strays and not electric rays were responsible for actuating the delicate instrument "recording the 'Ss' supposed to have been transmitted from near the Lizard to "Newfoundland on Thursday or Friday. Some attributed these wandering "currents to the old trouble—earth currents, others to the presence of a Cunarder "fitted with the Marconi apparatus, which was, or should have been, within 200 "miles of the receiving station at St. John's on the day of the experiment."

In the same article Sir William Preece is reported as having said that "We "shall want more information than we have at present . . . because the letters "S and R are just the letters most frequently signalled as the result of disturbances "in the earth or atmosphere."

Some people even went out of their way to write books proving that Marconi Wireless Telegraphy was largely a fraud, and we have before us as we write a little volume of a quasi-technical nature, in which a large portion has been given up to an attempt to prove that ether wave wireless telegraphy cannot possibly be tuned. The author says, after reproducing some diagrams of Marconi apparatus, "I challenge "any living individual using apparatus of this description, not only to tune the "currents successfully, but to tune it at all."

Even after it had been proved beyond question that wireless communication was taking place between Great Britain and Newfoundland the impression was deliberately created by interested parties that signals were only transmitted by means of the relaying of ships, that is to say, the impulses were transmitted from Cornwall to a ship a few hundred miles off the coast, from that ship to another a similar distance away, and so on, through many vessels until the opposite coast was reached. Although direct wireless communication between England and America was achieved by Marconi in 1901, and has been developed to such an extent that to-day we have a regular day and night commercial service between Ireland and Nova Scotia, it is a strange fact that there are still people who believe that this relaying method is the only means by which signals can be transmitted across the Atlantic.

In the May previous to the first transatlantic transmission the first British ship, the s.s. *Lake Champlain*, was equipped with wireless telegraph apparatus, and about the same date coast stations were erected in England and Ireland: at Holyhead, Caister, near Yarmouth, North Foreland, Crookhaven, Co. Cork, and Rosslare, Co. Wexford. The Committee of Lloyds also arranged for a number of their signal stations to be similarly equipped. The story of the first trip with wireless on the s.s. *Lake Champlain* is told on another page and operators of to-day will find it very interesting reading. Thenceforth progress in the fitting of ship installations was rapid, and before long a special school had been opened at Waterloo, near Liverpool, for the training of wireless operators. A photograph of the school—which, by the way, was in the same building as the wireless station used for communicating with ships—will be found on page 178. In February, 1902, Senatore Marconi made his famous transatlantic crossing on the s.s. *Philadelphia*, during which he discovered the difference between day and night ranges of a wireless installation. By 1903 the use of wireless had become so extensive tha the Great Powers held the first International Conference on Wireless Telegraphy in

LIGHTSHIPS WERE VERY EARLY FITTED WITH WIRELESS TELEGRAPH. THIS PHOTOGRAPH SHOWS THE INSTALLATION ON BOARD THE TONGUE LIGHTSHIP IN 1900.

Berlin. After considerable discussion, rules for international working were formulated and were the basis of the elaborate regulations which are now in force. As time went on the use of radiotelegraphy in calling for help in marine disasters became more and more apparent. Public interest in wireless as a life-saving invention was not, however, aroused until 1909, when in highly dramatic circumstances the wireless operator of the White Star liner *Republic*, which was sinking as the result of a collision, succeeded in bringing aid to the distressed vessel. The whole of the passengers and crew were saved before the vessel sank, and for the first time the general public realised the immense benefit which the Italian had conferred upon mankind. The distress signal, "CQD" (now supplanted by the well-known "SOS"), became indelibly impressed upon the public mind and journalists with more imagination than accuracy informed the public that the letters meant "Come quick danger." As a matter of fact it meant nothing of the kind, being simply a combination of the well-known telegraphic signal, "CQ," meaning "all stations," with "D" for danger.

Space will not permit us more than to glance at the subsequent history of radiotelegraphy and the extraordinary progress which it has made. Ships of all nations were soon fitted and coast stations erected in every part of the world, so that now we find between 800 and 900 installations on land and something between 5,000 and 6,000 sets of apparatus on board ship, quite apart from the enormous number of portable sets being used on the fighting fronts and by aeroplanes and airships. Numerous high power and transocean stations are in everyday use, and direct wireless communication can now be easily effected over immense distances. As an example of the enormous range of the modern high power stations we would mention that signals from the Marconi station in Hawaiian Islands are easily readable by the big wireless stations in Europe, and in favourable conditions it should be possible to send a message right round the world with only two relays. As a proof of the possibility of this it should be mentioned that the San Francisco Marconi Station is easily readable at Clifden, Co. Galway, the station at Nauen, near Berlin, has been heard by the Japanese Station at Funabashi, and Funabashi carries out a day and night service with San Francisco, our starting-point. This fact alone will serve to make the reader realise the enormous progress made in the twenty-one years of Marconi's wireless telegraph.

The "Marconi Tradition"

THE French Government official organ, *Gazette Officielle de la République Française*, corresponding to our *London Gazette*, announced in the course of April that: "Corothie (Ernest Alexander), an English wireless telegraphist (born on "the 23rd February, 1895, at Brecken in Scotland), was serving on board the s.s. "*Ohio* at the time when the personnel of the vessel was quitting her, in great haste, "after she had been struck, without warning, by a torpedo. The ship sank four "minutes after the explosion, but the young man remained at his post engaged in "radiating signals of distress and went down with the vessel."

The Reconnaissance

A War Story

THE twilight is deepening and the evening sky is a study in orange and grey, with the poplars and buildings cut out in sepia against its background. The infantry rest-huts by the Calvary at the end of the village are the scene of quiet activity. Men are filing from them and hurriedly assembling on the little parade-ground in marching order, shrapnel helmeted. They are "going in" to-night. Vague rumours have been flitting from unit to unit throughout the day. Something about the enemy retiring and other vague, wonderful camp rumours. Nobody exactly knows, everybody's heard from somebody else, and all the rumours and whispered scraps are official—authentic—absolutely.

True, the guns made the windows of the village and the old church belfry tremble the previous night, and caused the bats and pigeons to flutter sleepily from the beams, but to-day there hasn't been a sound—not a gun heard.

Suddenly you hear, "Everybody present, sergeant-major?" and a minute later the men are marching on the cobbles towards the line. They pass the field artillery lines—the R.E. dump, the transport and bridging tram lines, and then they are joined by four men helmeted like themselves and carrying small cases and boxes slung round their shoulders. The four fall in behind the rear platoon and drop into stride with the others.

The twilight is fastly deepening; occasionally an owl floats quietly across the roadway and the rooks in the clumps of trees have ceased to caw.

At length the cross roads where the communication trench begins is reached. The companies quietly drop into single file, and their helmets are soon bobbing up the trench-way like some long line of fisherman's floats on a grey evening tide. Still not a sound, not a very light even. It seems uncanny—eerie.

The leading file at length reaches the roadway just behind the supports. Here the road has not been dug, and the men quickly jump from the one trench, double hastily across the open roadway from force of habit and drop swiftly into the other trench, which leads to the supports and front line.

At length the fire trench is reached and the men file silently in. The companies which they are to relieve are not going back to billets; they are to man the supports and wait.

After a few minutes "Relief complete" is signalled, and everybody settles down for a brief rest, save the sentries and the party which has gone out manning the fire steps to cut the wire. In a few minutes they will be passing through the channels which are now being cut and cleared in it.

Everything is still—no rifle fire—not even a sound from right or left. The men converse in whispers—a curious hush has fallen over everything. The rattling of a rifle bolt far down the trench seems almost like a machine gun firing—so loud does it seem.

Suddenly the wire-cutting party crawl into the trench and signal all ready.

A stir passes down the line as the men get ready and give their equipment its final adjustments.

Suddenly the word comes down the line—" Over ! " The men scramble swiftly over the parapet and thread their way through the wire, clear it, and soon are walking slowly across No Man's Land, picking their way cautiously over the rank ground. In places the grass is knee deep. Tree stumps and twisted bushes abound, and there are, in places, little rows of stakes with fragments of rust-encrusted wire on them—dating, perhaps, to the early days of the war when one or other of the sides held the part of ground which now is No Man's Land.

The moon has come up and the night is fairly clear. At length the leading detachment reach the German wire and soon are busy with their wirecutters. The first man through leaps into the trench. Soon the trench is swarming with vague helmeted figures. There is no trace of the enemy—everything is deserted. A platoon commander, with his service revolver in his hand, shouts an inquiry in German down the inky shaftway of a dugout. There is no reply, and a couple of Mills's grenades go rattling down the earthen stairway. Five seconds later they explode with startlingly loud detonations. A wisp of smoke steals up the shaftway and drifts off on the night air. Again all is still. Other dugouts are searched and are found to be empty of occupants. Their floors are littered with paper, broken crockery and odds and ends of clothing and discarded equipment ; beds and tables and forms have all been carefully rendered useless.

The old German front line is soon left behind, and the waves cross the second, third and reserve lines quickly and silently. Still not a soul has been encountered. Two hours later the leading patrols emerge into fresh open fields and leave the elaborate system of trenchways and burrows behind. A halt is called, and everybody falls flat. A small patrol is detailed, and two of the men, with their small covered cases, join the group of men who are about to steal forward on their reconnaissance—the wireless men. A few whispered orders and the group leaves the main body. There is a small farmhouse almost half a kilometre ahead, showing ghostily grey in the moonlight. Perhaps the place is bristling with machine guns. It may still be occupied by part of the enemy rearguard. Exactly what its nature is the patrol are about to determine, or at least attempt to.

The men steal stealthily forward over the fields. Hedges they negotiate cautiously, but still there is no sign of anything human. Rats there are in plenty, which cause the men to pause, listen, again resume their cautious progress towards the quiet little dwelling ahead.

At length the building is reached, and the first two men wriggle swiftly forward with arms ready. One man raises himself and, bent almost double, glides along the gable. He pauses, and his comrades, kneeling in the little hacked and broken orchard on the west side of the building, take a tighter grip on their rifles. The silence is intense—oppressive. Then, with startling suddenness, there comes from the building peal on peal of awful laughter ; then there is a pattering of feet in the courtyard ; a thud, and again silence. The men rise and rush forward and swarm into the farm. In the barn they find a pair of machine guns, their muzzles trained through narrow slots cut in the brickwork. In the beam of the patrol commander's torch they descry a grey uniformed figure huddled over his gun, his features horribly mutilated. In the yard they find his fellow gunner, sobbing and muttering—mad! The two have evidently been detailed for the purpose of covering the retirement, and the strain has been too great for the pitiful figure in shabby grey huddled on the cobbles of the yard.

The patrol commander gives an order, and next second the two telegraphists are slinging their aerial from the gable of the house. A few minutes later the little transmitter is spitting and spluttering—then falls quiet.

Suddenly the fields to the west of the farm are dotted with hurrying figures, coming onward—the main companies. They at length come up, and a fresh patrol, including the two wireless men who had been with the main body, again steal out to the east of the building. The main body settle themselves in and around the building and in the hedgeways to right and left. The wireless men with their instruments are lying on the floor of the barn listening intently. In perhaps fifteen minutes the advanced station will signal them.

In the meantime the advanced patrol is making slow and methodical progress towards its objective—a sunken road almost a kilometre beyond the farm. To their right runs a row of poplars. Suddenly, with a loud rending crack, one of them falls. The patrol " freeze " like wild animals. Two of the men bear dimly off to the right to investigate, and find the trees on the verge of falling. Great yawning notches gape in their trunks.

The patrol passes on. Two hundred yards from the sunken road they again halt. Everything is deadly still—the moon sails from behind a cloud and shows the hedgeway bordering the road. Then with awful and dramatic suddenness there is a loud splutter as if some gigantic catherine wheel had been suddenly lit—an enemy machine gun. In an instant the men have dashed forward. A stream of sparks fly from a steel helmet as a round strikes it and ricochets. Some of the men fall, but in a second the machine gun emplacement is surrounded and the gunners overpowered.

A few minutes later the little transmitter is again spitting out its signal, and fifteen minutes afterwards the sunken road is manned and being consolidated by our men.

Again a patrol leaves the main body and through the night the stepping up goes on

Dawn comes and finds our positions advanced almost seven miles from the old line with artillery and reserves behind, and the prospect of another day of successes ahead, and thus the methodical advance continues.

PERIKON.

Graphical Symbols for Wireless Telegraphy

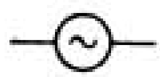
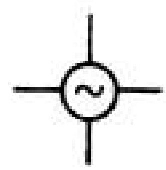
SOME READERS' VIEWS.

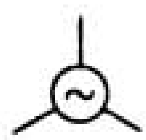
As a result of the article which we published in our April issue on "Graphical Symbols for Wireless Telegraphy," we have received the following two interesting communications. In view of the importance of the proposals now being considered by the Engineering Standards Committee we repeat our invitation to correspondents to furnish us with their view.

The Editor, WIRELESS WORLD.

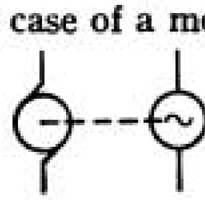
SIR,—With reference to the list of graphical symbols published in the current issue of THE WIRELESS WORLD as tentatively suggested by the Engineering Standards Committee for use in diagrams of wireless circuits, may I be permitted to offer the following comments?

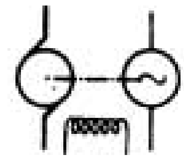
The symbol has already been very extensively used to designate an alternator, and should be retained without modification if possible. It is suggested that the connections should be drawn as above—viz., at opposite ends of a diameter—instead of close together as in the proposed symbol, both in order to keep the symbol in uniformity with other similar ones (such as used for measuring instruments, etc.), and also to avoid any confusion that might otherwise arise in case two-phase or three-phase alternators should be required to be indicated. The following symbols might therefore be standardised for this purpose:

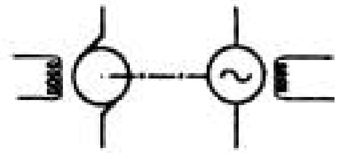
Alternator, single-phase  Alternator, two-phase 

Alternator, three-phase 

In some classes of diagrams, such, for example, as those dealing with certain forms of frequency raising and similar apparatus, some such means as the above for distinguishing between single and polyphase machines may be very desirable.

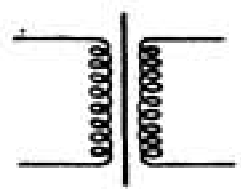
In this connection the proposed symbol 187 for a motor-generator seems, at least to me, to be scarcely adequate. When everything is considered, the object of a circuit diagram should be to clarify an explanation given in the text, and for this purpose all the symbols used ought to be as suggestive as possible and also consistent with one another. The latter condition in the case of a motor-generator would seem to be better met by some such symbol as , since each of the component parts are already in use to represent a direct-current motor (or dynamo) and an alternator respectively. In certain circumstances it may prove desirable to distinguish in some manner between a simple rotary converter and a motor-converter consisting of two coupled machines. For lack of a better method this might, perhaps, be effected as follows :

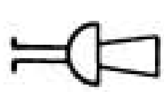
Rotary converter 

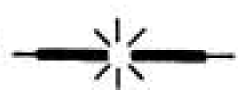
Motor converter (two machines) 

Composite symbols on the lines here suggested would have the additional advantage of enabling a distinction to be made between single or polyphase machines on the A.C. side of the converter in the manner already indicated for the simple alternator.

The above plea for clarity of the symbol may call for some modification in No. 192 proposed for a static frequency transformer. Would not this piece of apparatus be better represented (with not greatly increased difficulty of drawing) by a more explanatory symbol on the lines of an ordinary closed core transformer, especially as there are several different types of such apparatus in use. The addition of leads to indicate direct-current polarisation, for instance, such as is employed in some of these types would not appear to be able to be very clearly indicated if a symbol on the proposed lines is adopted.

In connection with ordinary static transformers no distinction appears to have been provided for between a low frequency iron-cored transformer and a high frequency air-core jigger. Is there any objection to the retention of the symbol in place of No. 193 to indicate an iron-cored transformer, while the two coupled coils without the central line is employed for the air-core jigger, as in No. 202 ? 

With reference to No. 195 proposed for a telephone transmitter, a slight simplification could be secured by using straight lines to indicate the mouthpiece instead of curves. The curved mouthpiece, although more true to the usual construction, is apt to look rather clumsy in a diagram if the centres for the arcs of the circles are not well chosen. 

As the symbol for an arc, something on the lines of  appears to me to be preferable to the simple cross in the connecting lines as in No. 178, since the latter symbol has been frequently adopted to designate disconnecting switches. Incidentally, some standard provision for such switches and also for fuses might well be included in the wireless list.

The remainder of the proposed symbols do not call for any special comment, as they are already in extensive use for the purposes indicated, but at the same time it is to be hoped that as many views as possible may be obtained on the proposed list, and also any modifications or additions thereto, before definite recommendations are drafted as to their general use.

In the majority of circuit diagrams, when accompanied by explanatory text, it is customary to employ reference letters to indicate the various parts. May it not be possible for the committee to issue certain recommendations as to these at the same time as for the symbols themselves, as conducive to greater uniformity in radio-diagrams. Merely to indicate the direction of this, I would put forward the following list, in the hope that it may bring forth suggestions of a like nature:

Alternator, $\sim$; antenna, A; ammeters, A_1, A_2, etc.; arc lamp, Ar; earth, E; inductance, L_1, L_2, etc.; key, K; telephone receivers, T; resistance, R; transformer, F or Tr; jigger, J; battery, B; buzzer, Z; audio-frequency condenser, K; radio-frequency condenser, C; decremeter, δ; wavemeter, λ; voltmeters, V_1, V_2, etc.; coherer, H; crystal detector, D; magnetic detector, M-D; telephone transmitter, M; vacuum detectors, V; spark gap, S; quenched gap, Q; rotary gap, Y; leakance resistance, S; generator or dynamo, G. Appropriate suffixes can be appended to these letters when required, and efforts should be made to maintain these as consistent with one another as possible. For example, the suffix 0 may be retained for parts of apparatus in the supply circuit; 1 for the primary or first oscillatory circuit; 2 for the secondary circuits, and so on.

It is hoped that the above suggestions may possibly be of some use in helping to arrive at a representative collection of graphical symbols. The work of the committee in compiling such a list will doubtless be welcomed by all workers in the radio-field. PHILIP R. COURSEY, B.Sc.(Eng.) Associate, I.R.E.

SIR,—I have received my April copy of THE WIRELESS WORLD and am very interested in the article on Symbols on page 42, and in response to your invitation for your readers' views I should like to make a few remarks.

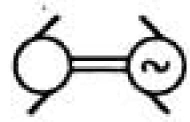
I heartily agree that all wireless engineers should adopt a standard symbol to represent any one piece of apparatus. In choosing such a symbol it is essential that it should be of simple construction, clearly showing what it is intended to represent, so that it may be fairly well recognised at sight, thus obviating the necessity of studying it like a Greek alphabet.

I also think that when showing the same apparatus as used by other electrical engineers, it should be represented by the same symbol as used by them.

We must remember that what standards wireless engineers of the present day accept will become the studies of our students in the future. The more obscure and numerous we make them, the more time and energy will be used in "incidental" education with its disadvantage of wearing out the student.

With reference to the list shown on pages 42 and 43, perhaps I may venture to make the following suggestions:

Fig. 176.—This shows an alternator. I feel that this is somewhat of a departure from the usual practice. Power and other electrical engineers invariably show a generator.  The periodicity sign could be inserted to distinguish between a D.C. and an A.C. machine. Phase distinction is, I hardly think, necessary for wireless work.

Fig. 187.—This shows a motor-generator. Such a symbol when connected up would look like this  . I think that uncertainty is liable to exist as to which are the D.C. and which are the A.C. leads. Of course, they may soon be found by tracing the circuit, but that takes up time, and I think it would be much clearer and surer to show a motor and a generator coupled together. 

The periodicity sign could be inserted in the alternator to prevent possible error. The sign shown, whilst quite suitable for a draughtsman or printer, is unsatisfactory for the rough hand-drawn diagrams so often used by engineers.

Figs. 185 *and* 186.—This shows two kinds of keys. No. 186 is the Standard Single-current Morse Key as used on line telegraphy, and No. 185 is the same key without the back contact. It does not seem necessary to have two separate symbols. In wireless, where only the lever and front contact are used, we need only show two wires, and can easily insert a back contact if required. The same symbol would then represent any key.

Fig. 193.—This shows a transformer. Is this to be interpreted as an ordinary voltage or " pressure " transformer ? If so, I think the favourite method of showing it is  , the primary and secondary winding being distinguished by a few thick and many thin lines respectively. As their natural inductance is not used in the sense of tuning, I think straight lines would be preferable to curves, thus differing from an oscillation transformer. As matters stand at present, No. 193 and No. 202 are absolutely identical ; also they do not show any difference between the primary and secondary windings. Nos. 194 and 203 are also identical.

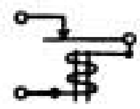
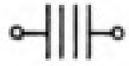
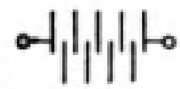
Fig. 197.—This shows a buzzer. In any diagram of importance I think it would be very unsatisfactory. This figure is very similar to the " Hedghog " transformer used by telephone engineers, the only difference being in the number of terminals. The construction of a sketch like this  is little, if any, more complicated, and shows at a glance what it is without liability of confusion. In any case, the balanced-crystal circuit is about the only one where a buzzer is shown, except where buzzer excitation of the aerial is used. In such a case a detailed drawing is made, in order that the aerials and earth connection may be shown. Therefore, why have a symbol for it other than that suggested above ? Testing buzzers are only shown in detailed drawings of receiving sets.

Fig. 204.—This shows a direct coupling. I think it is usual and best to show any variable point with an arrow head.  Where line meets line it is usually assumed to be a solid joint. The arrow head shows it can be conveniently adjusted.

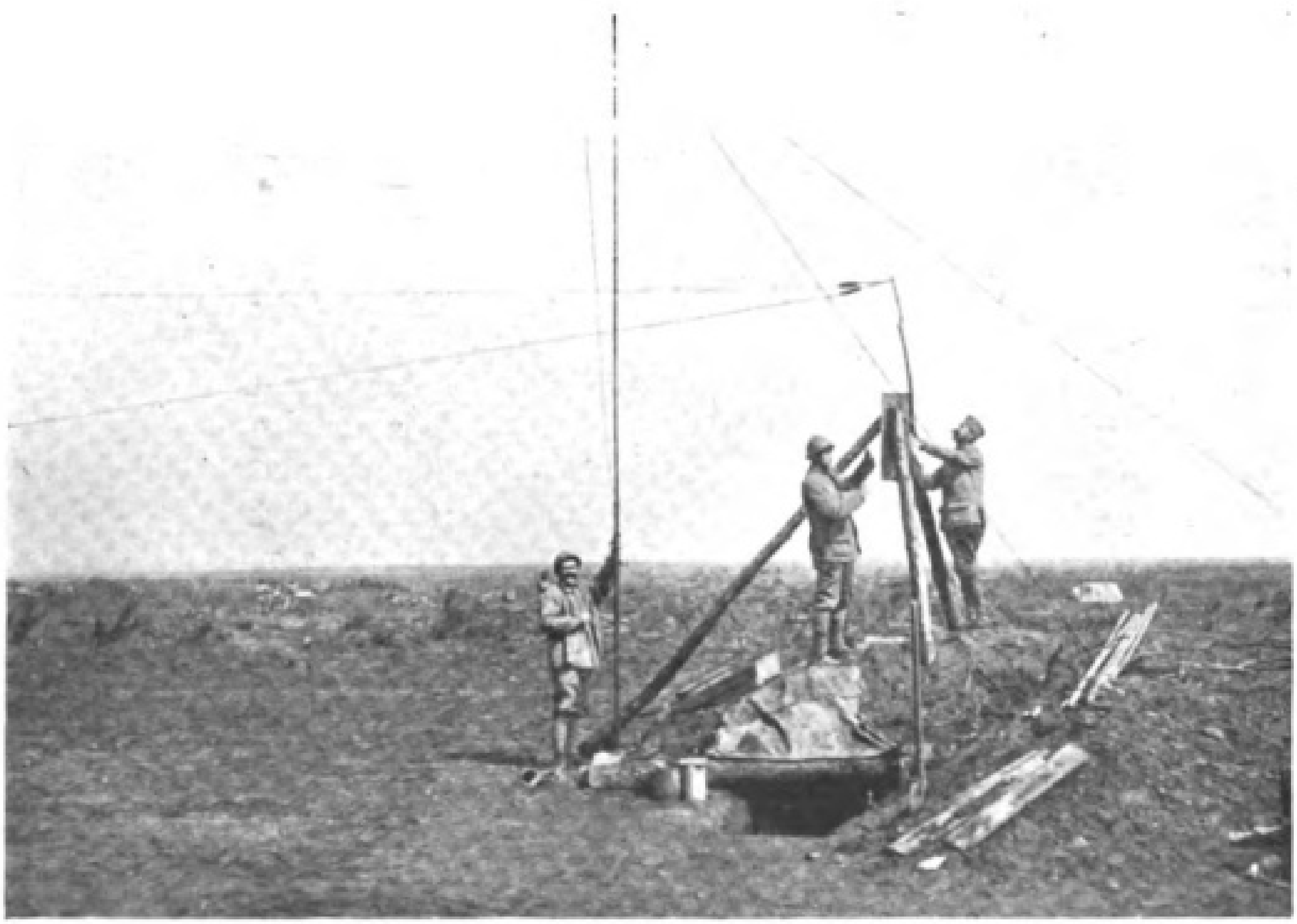
Once more may I venture criticism?

Fig. 212.—This shows a quenched gap. Personally, I cannot see any resemblance to a quenched gap in it. Such gaps are constructed by a number of flat plates connected in series,  or as in the F. J. Chambers Gap  where the electrodes revolve. I think the former sign is most suitable and less liable to misrepresentation than that shown in Fig. 212.

I hope my remarks will not be regarded in the light of adverse criticism, but rather as a straightforward discussion such as our institutions and societies have for their object.

I would very much like to hear what views some of your other readers have on the subject.

W. GORDON-CAMPBELL, R.E. Stud. I.E.E.



[*French Official Photograph.*

ARRANGING THE "LEAD-IN" OF A WIRELESS AERIAL ON THE FRENCH FRONT.

[*Photo: Record Press.*

A RUSSIAN MILITARY WIRELESS STATION IN THE FIELD.

Steam and Diesel Ships

The following note, of some interest to wireless operators, is extracted from our contemporary "Syren and Shipping":—

"WE are asked to state 'as briefly as possible' what the advantages of the "Diesel ship are as compared with the steamship. The superintending engineer of "a well-known British shipping company once gave them in a way which cannot, "we think, be improved upon. His owners have two vessels of exactly the same "dimensions—a coal-burning steamer with quadruple expansion steam engines "and a motor-ship with four-cycle Diesel engines. The power is about the same "in each case. On a New York voyage the Diesel ship carries, roughly, 600 tons "more cargo than the steamship. The weight capacity of each of the vessels is "about 6,500 tons leaving New York. The differences between the weights in "favour of the Diesel ship are: weight saved in hull and machinery, 70 tons; "weight saved in fuel, 470 tons; weight saved in fresh water, less stores, 60 tons; "total, 600 tons. For measurement cargoes the Diesel ship has an advantage "of 32,400 cub. ft. Other advantages are: (1) There is no loss of heat, such as "there is while raising steam or under-banked fires at anchorage, as when power is "not wanted there is no fuel being consumed; (2) fewer men are required; (3) "the speed of the vessel is maintained because it does not depend on firemen who "are affected by hot weather, and there are no fires to clean; (4) there is a saving "of fuel in port, as in the case of a steamship with winches there is a big loss of heat "by radiation and condensation; (5) the cost of keeping the ship clean is less."

Among the Operators

ANOTHER HOSPITAL SHIP.

OPERATOR F. AMOTT.

Of all the outrages perpetrated by the Huns during the present conflict the torpedoing of hospital ships is perhaps the worst. The story of the torpedoing of the *Lanfranc* has already been told in the columns of the daily Press. The *Lanfranc* carried two operators, Messrs. F. Amott and W. G. C. Marsh.

Mr. Frederick Amott, the senior, is 25 years of age, and was born in the south of London. After leaving school he entered a business house and later decided to take up the career of a wireless operator. He received his preliminary training at the British School of Telegraphy, Clapham Road, and joined the Marconi Company in 1912. His first trip was on the s.s. *Ivernia*, from which he transferred to the s.s. *Saldanha* and later to the s.s. *Maryland*, where he served for several trips. Prior to taking duty on the s.s. *Lanfranc* he had served on the s.s. *Carisbrook Castle*. We are glad to say that Mr. Amott escaped from the wreck without injury.

The junior operator, Mr. Walter George Marsh, was born at Barbadoes in the West Indies. After leaving school he took up an appointment in the Post Office and later held a commercial position in the City. Mr. Marsh had been connected with the clerical staff at Marconi House for some time prior to his transfer to the Marine Operating Department, and his many friends will be glad to hear that he was safely rescued from the wreck.

* * * * *

S.S. *Ballarat*.

The loss of the transport *Ballarat* was marked by scenes of the greatest bravery, and the accounts which have already appeared in the Press indicate that the story of the disaster will be remembered for many years as an example of the heroism of British troops in times of emergency. The two wireless operators were Messrs. Richard Jones and Thomas Francis O'Shea, both of whom were fortunately rescued.

OPERATOR W. G. C. MARSH.

Mr. Richard Jones, the senior operator, is 26 years old and hails from North Wales, his home being at Port Dinorwic, Bangor. After leaving school he joined the staff of the Post Office and later, at the suggestion of Sir William Preece, applied for and obtained an appointment in the Marconi Company's school. Joining the Liverpool school in March, 1910, he completed a course of training, and in January of the following year was appointed to the s.s. *Corinthian*. From this ship he transferred to the s.s. *Saturnia* and thence to the s.s. *Columbia*, on which he made a number of voyages. He afterwards served on a number of other vessels, one of which was torpedoed and sunk in 1915. The *Ballarat* is thus the second vessel on which Mr. Jones has met with misfortune, and we congratulate him on once again escaping uninjured.

OPERATOR R. JONES.

The junior operator, Mr. Thomas Francis O'Shea, is a native of County Cork, and is 18 years of age. On leaving school he took a course of wireless telegraphy at the Atlantic Wireless and Cable College, Cahirciveen, and in September, 1916, joined the Marconi House School. The *Ballarat* was his first ship, and we are glad to say that he escaped uninjured.

* * * * * *

S.S. *Arcadian*.

The steamship *Arcadian*, well known before the war as a palatial cruising yacht, was one of the recent victims of the German torpedo. The two operators were Messrs. Harold Arthur Bowman and Alfred Barrett Harwood. We regret to state that Mr. Harwood lost his life in the disaster, although fortunately Mr. Bowman was saved.

Mr. Harold Arthur Bowman, the senior, whose home is at Wrexham, is 23 years of age. On leaving school he took an interest in wireless telegraphy and studied at the Liverpool and Manchester Wireless Training Colleges, where he obtained his Postmaster-General's first-class certificate. Joining the Marconi House School in April, 1913, he was soon appointed to the staff, his first trip being on the s.s. *Campania*. He later served on a number of other vessels and was appointed to the *Arcadian* in August of last year.

OPERATOR T. F. O'SHEA.

The junior operator, Mr. Alfred Barrett Harwood, who, we deeply regret to say, is reported missing and presumed drowned, was born at Hebden Bridge, Yorkshire. After receiving his education

OPERATOR H. A. BOWMAN.

in his native town he held two business appointments in that place, and attained considerable proficiency in bookkeeping and accountancy. On taking up wireless telegraphy he studied at the Manchester Wireless Training College and applied himself so well that he obtained the Postmaster-General's First-Class Certificate in a very short time. In June, 1916, he was appointed to the staff of the Marconi Company and at once proceeded to sea on the s.s. *Asian*. After two months' service on this vessel he transferred to the *Arcadian*. Deep sympathy is felt with the parents of this young man in the terrible loss which they have sustained. The knowledge that he lost his life in the service of his country will perhaps be of some slight consolation to them in their time of trial.

THE LATE OPERATOR A. B. HARWOOD.

Wireless in the Courts

In the early days of the war when wireless enthusiasts were new to the working of regulations concerning apparatus established under the Defence of the Realm Act, a certain number of police court cases occurred, of which typical examples will be found in past issues of THE WIRELESS WORLD. Such cases have for a long time practically ceased to exist, but on May 7th last an electrical apprentice named Reginald George Harrison Cole, employed in Portsmouth Dockyard, was charged at Portsmouth Police Court, under the Defence of the Realm Act, with being in possession of a wireless telegraphic apparatus, without the permission of the Postmaster-General. A detective who visited the prisoner's residence at Southsea is stated to have found, attached to a 15-foot clothes pole, three fine wires similar to those used as aerials in wireless telegraphy, whilst in Cole's bedroom it is alleged that he discovered a table on which was a machine attached to aerials, and in working order. The account which has reached us states that the accused maintained he could only receive messages, and was remanded for further inquiry. The young man has since been committed for trial.

The Wireless Transmission of Photographs

Article II.

By MARCUS J. MARTIN

EDITORIAL NOTE: *The previous article of this series appeared in our issue for September last.*

BEFORE leaving the subject of films which was discussed in the last article it has been thought advisable to include the following notes relating to the question of speed.

Besides the Hurter and Driffield method of obtaining the speed numbers of plates and films adopted by a large number of makers in this country, there are also two standard English systems known as the W.P. No. (Watkin's power number) and Wynne F. No., both of which are used to a fair extent.

The "Actinograph" number or speed number of a plate in the H. & D. system is found by dividing 34 by a number known as the Inertia, the Inertia, which is a measure of the insensitiveness of the plate, being determined according to the directions laid down by Hurter and Driffield—that is, by using pyro-soda developer and the straight portion only of the density curve. If, for instance, the Inertia was found to be one-fifth, then the speed number would be $\frac{34}{\frac{1}{5}}=170$, and the plate is H. & D. 170. The W.P. No. is found by dividing 50 by the Inertia. Thus $\frac{50}{\frac{1}{5}}=250$ and the plate is W.P. 250, but for all practical purposes the W.P. No. can be taken as one and a half times H. & D. The Wynne F. numbers may be found by multiplying the square root of the Watkins number by 6·4. Thus

$$\sqrt{250}=15{\cdot}81 \text{ and } 15{\cdot}81\times 6{\cdot}4=\text{W.F. } 101.$$

For those photographers who are in the habit of using an actinometer giving the plate speeds in H. & D. numbers the following table, taken from the *Photographers' Daily Companion*, is given, which shows at a glance the relative speed numbers of plates for the various systems. The Watkins and Wynne numbers only hold good, however, when the Inertia has been found by the H. & D. method.

TABLE OF COMPARATIVE PLATE SPEED NUMBERS.

H. & D.	W.P. No.	W.F. No.	H. & D.	W.P. No.	W.F. No.
10	15	24	220	323	114
20	30	28	240	352	120
40	60	49	260	382	124
80	120	69	280	412	129
100	147	77	300	441	134
120	176	84	320	470	138
140	206	91	340	500	142
160	235	103	380	558	150
200	294	109	400	588	154

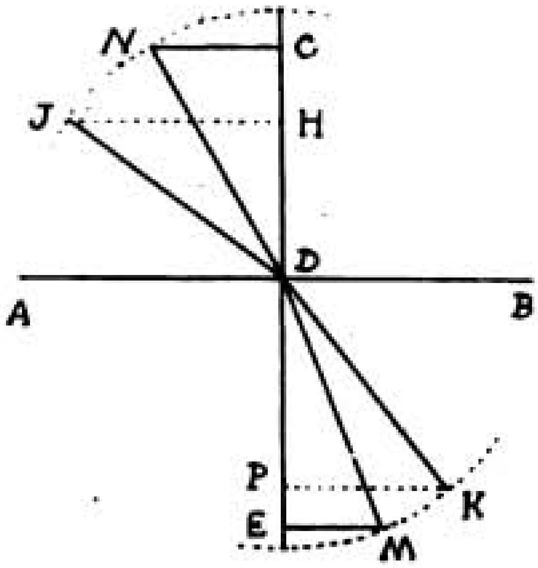


FIG. 1.

As already stated, the best film to use for purposes of photo-telegraphy is one having a fairly slow speed in which the range of exposure required comes well within the limits of the film. There is no advantage in using a film having a speed of, say, H. & D. 300 if good results can be obtained from one with a speed of H. & D. 200, as the use of the higher speed increases the risk of over-exposure. With the high-speeded films the difficulties of development are also greatly increased, there being more latitude in both exposure and development with the slower speeds and consequently a better chance of obtaining a good negative.

In these articles it is not desirable, neither is it intended, to give an exhaustive treatment on the subject of lenses and their action, but as optics plays an important part in the transmission of photographs, both by wireless and over ordinary conductors, the following notes relating to a few necessary principles have been included as likely to prove of interest.

Light always travels in straight lines when in a medium of uniform density, such as water, air, glass, etc., but on passing from one medium to another, such as from air to water, or air to glass, the direction of the light rays is changed, or, to use the correct term, *refracted*. This refraction of the rays of light only takes place when the incident rays are passed obliquely; if the incident rays are perpendicular to the surface separating the two media they are not refracted, but continue their course in a straight line.

All liquid and solid bodies that are sufficiently transparent to allow light rays to pass through them possess the power of bending or refracting the rays, the degree of refraction, as already explained, depending upon the nature of the body

The law relating to refraction will perhaps be better understood by means of the following diagram. In Fig. 1 let the line AB represent the surface of a vessel of water. The line CD, which is perpendicular to the surface of the water, is termed the *normal*, and a ray of light passed in this direction will continue in a straight line to the point E. If, however, the ray is passed in an oblique diiection, such as ND, it will be seen that the ray is bent or refracted in the direction DM. The angle NCD is called the *angle of incidence* and DEM the *angle of refraction*. If we measure accurately the line NC, which is the *sine of the angle of incidence*, and the line EM, which is the *sine of the angle of refraction*, it will be found that the line NC is $1\frac{1}{3}$, or, to be correct, 1·336, times the length of the line EM. If the ray of light is passed in a still greater oblique direction, such as JD, it will be found that the sines of the two angles JHD and DPK will also bear the same proportion to each other as 1·336 to 1. This proportion of the sines is maintained whatever angle the incident ray makes with the surface of the water, and the number 1·336 is termed the *index*, or *co-efficient*, or the *refractive power* of water.

The refractive power varies, however, with other fluids and solids, and a complete table is given in several works on optics.

Glass is the substance most commonly used for refracting the rays of light in optical work, the glass being worked up into different forms according to the purpose for which it is intended. Solids formed in this way are termed *lenses*. A lens can be defined as a transparent medium which, owing to the curvature of its surfaces,

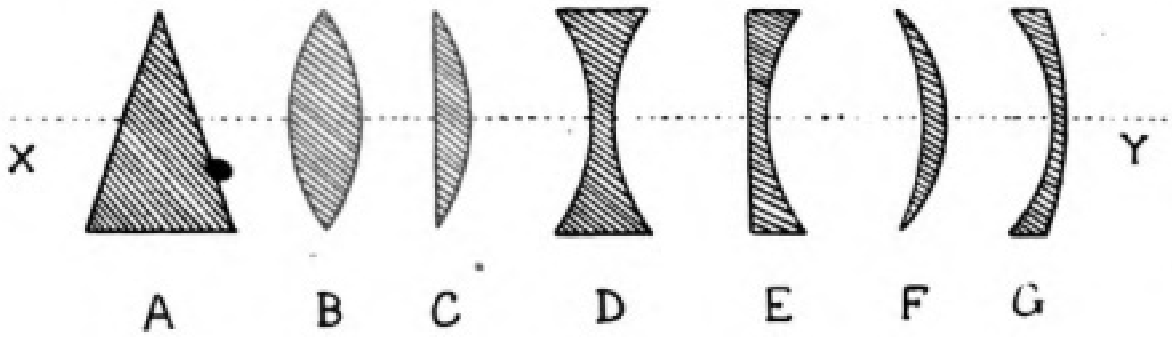


FIG. 2.

is capable of converging or diverging the rays of light passed through it. According to its curvature it is either spherical, cylindrical, elliptical, or parabolic. The lenses used in optics are always exclusively spherical, the glass used in their construction being either crown glass, which is free from lead, or flint glass, which contains lead and is more refractive than crown glass. The refractive power of crown glass is from 1·534 to 1·525, and of flint glass from 1·625 to 1·590. Spherical surfaces in combination with each other or with plane surfaces give rise to six different forms of lenses, sections of which are given in Fig. 2.

All lenses can be divided into two classes, convex or converging and concave or diverging. In the figure B, C, D are converging lenses, being thicker at the middle than at the borders, and E, F, G, which are thinner at the middle, being diverging lenses. The lenses D and G are also termed meniscus lenses. The line XY is the axis or *normal* of these lenses, to which their plane surfaces are perpendicular.

Let us first of all notice the action of a ray of light when passed through a prism. The prism, Fig. 3, is represented by the triangle BBB, and the incident ray by the line TA. Where it enters the prism at A its direction is changed and it is bent or refracted towards the base of the prism, or towards the normal, this being always the case when light passes from a rare medium to a dense one, and where the light leaves the opposite face of the prism at D it is again refracted, but away from the normal in an opposite direction to the incident ray, since it is passing from a dense to a rare medium. The line DP is called the *emergent* or refracted ray. If the eye is placed at T, and a bright object at P, the object is seen not at P, but at the point H, since the eye cannot follow the course taken by the refracted rays. In other words, objects viewed through a prism always appear deflected towards its summit.

In considering the action of a lens we can regard any lens as being built up of a number of prisms with curved faces in contact. Such a lens is shown in

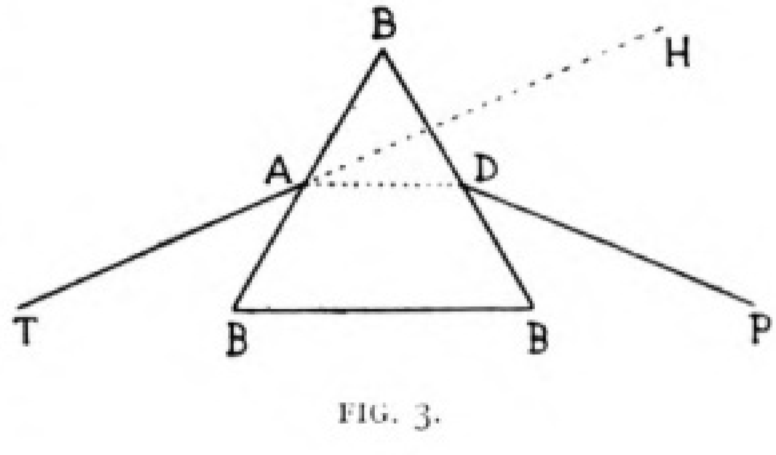


FIG. 3.

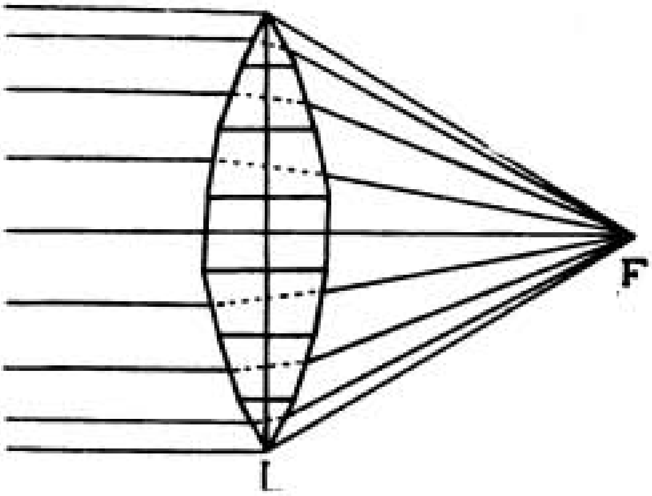


FIG. 4.

Fig. 4, the light rays being refracted towards the base of the prisms or towards the normal, as already explained; while the top half of the lens will refract all the light downwards, the bottom half will act as a series of inverted prisms and refract all the light upwards.

If a beam of parallel light—such as light from the sun—be passed through a double convex lens L, Fig. 5, we shall find that the rays have been refracted from their parallel course and brought together at a point F. This point F is termed the principal focus of the lens, and its distance from the lens is known as the focal length of that lens. In a double and equally convex lens of glass the focal length is equal to the radius of the spherical surfaces of the lens. If the lens is a plane-convex the focal length is twice the radius of its spherical surfaces. If the lens is unequally convex the focal length is found by the following rule: multiply the two radii of its surfaces and divide twice that product by the sum of the two radii, and the quotient will be the focal length required.

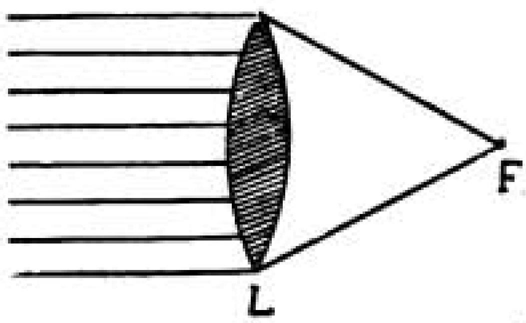


FIG. 5

Conversely, by placing a source of light at the point F the rays will not be refracted, but will be projected in a parallel beam the same diameter as the lens. If, however, instead of being parallel, the rays proceed from a point farther from the lens than the principal focus, as at A, Fig. 6, they are termed divergent rays, but they also will be brought to a focus on the other side of the lens at the point *a*. If the source of light A is moved nearer to the principal focus of the lens to a point A^1

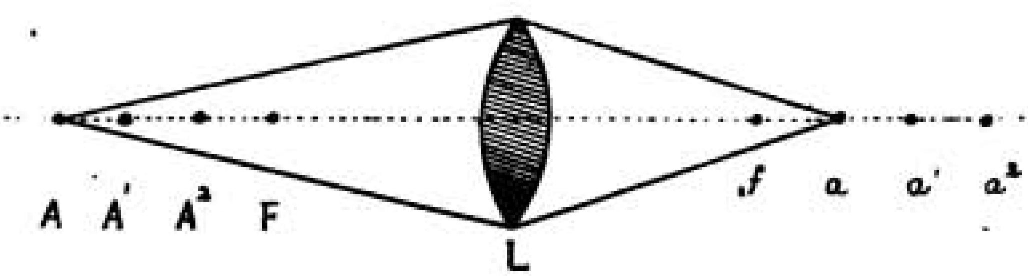


FIG. 6.

the rays will come to a focus at the point a^1, and similarly when the light is at A^2 the rays will come to a focus at a^2. It can be found by direct experiment that the distance *fa* increases in the same proportion as AF diminishes and diminishes in the same proportion as AF increases. The relationship which exists between pairs of points in this manner is termed the *conjugate foci* of a lens, and though every lens has only one principal focus, yet its conjugate foci are innumerable.

An Outline of the Design of a Wireless Station

By BERTRAM HOYLE, M.Sc.Tech., A.M.I.E.E., Lieut. R.N.V.R., H.M.S. "Excellent," 1917.

(*Continued from page 120 of the May issue.*)

THIS adjustable inductance is mounted with an axial worm of pitch equal to that of the turns; and carries an internal radial brush contact which can be rotated and drawn along at the required rate, thereby putting more or less of the coil into circuit.

[NOTE.—The fixed value of L_2 was purposely chosen on the low side because of the inductance of the aerial lead in and earthing system, which is appreciable, and which will have the effect of raising both λ min. and λ max.]

19. *Conclusion of Design of Transmitting Portion of the Station.*—No consideration of the more mechanical engineering problems involved has been given, such as the design of the high-speed signalling key, the design and distribution of stresses in the high-speed disc discharger, and the aerial span stresses and necessary allowance to make for wind and snow, in the amount of the stringing up tensions.

Some interesting deductions can now be made from the figures obtained so far for the stations:

	R.M.S. Values.	*Maxima Values.*
Transmitting :	I_2=71·65 amperes.	I_2=571 amperes.
	V_2=22,730 volts.	V_2=185,500 volts.
	K.W.=50·6	K.W. over one spark train =108,000.
Receiving :	$I_2=45\times10^{-6}$ amperes.	$I_2=367\times10^{-6}$ amperes.
	V_2=0·0146 volts.	V_2=0·119 volts.
	Watts $=0{\cdot}0184\times10^{-6}$	Watts over one train $=39{\cdot}57\times10^{-6}$

Duration of one train 0·000465 seconds.

PART II

INTRODUCTION.

A protective inductive leak to earth and micrometer jump gap would be paralleled with the receiving apparatus—*i.e.*, straight from aerial lead in to earth. The inductive leak to earth carries away any steady accumulation of electricity on the aerial due to electrified air. The jump gap in parallel with this carries away any induced sudden rise of voltage such as is caused by distant thunder storms or the rapid discharge of an electrified cloud in the neighbourhood of the receiving aerial.

The protective inductance must have a magnitude considerably greater than that necessary to tune in the longest desired waves.

20. *Inductance of the Aerial.*—The natural wave-length of the aerial is $\lambda_a = 59{\cdot}6\sqrt{L_a.\ K_a}$. and can readily be found by sparking the aerial to earth and measuring the wave-length by means of a wave-meter. If now an inductance of known value L_1 be added in series with the aerial and earth, and the wave-length again measured, then

$$\lambda_1 = 59{\cdot}6\sqrt{(L_a + L_1)K_a}.$$

Dividing one by the other we get

$$\frac{\lambda_a}{\lambda_1} = \sqrt{\frac{L_a}{L_a + L_1}}.$$

$$\frac{\lambda_a^2}{\lambda_1^2} = \frac{L_a}{L_a + L_1} = 1 + \frac{L_a}{L_1}$$

Whence $$L_a = L_1\left(\frac{\lambda_a^2}{\lambda_1^2} - 1\right) \text{ cms.}$$

In an actual case this would have to be measured and allowed for in the subsequent work; but as it can only be found accurately by direct measurement on the aerial in question, it is omitted in the following.

21. *Aerial Tuning Inductance.*—A.T.I. Firstly, the total aerial to earth circuit inductance must be determined. For this it is necessary to choose the maximum wave-length it is desired to be able to receive on the instruments.

Let $\lambda_{max.}$ be 10,000 metres, and to allow for a margin for tuning, take 11,000 metres. Then

$$L_{max.}\ \text{A.T.I.} = \frac{(11{,}000)^2}{(59{\cdot}6)^2\ 0{\cdot}0049} = 6{\cdot}95 \times 10^6 \text{ cms.}$$

This amount will be subdivided into two parts; one, either infinitely variable or in numerous steps, and the other a fixed amount for coupling purposes, forming the primary of a coupled receiver set. For good coupling leave about 150,000 cms. out, making $6{\cdot}80 \times 10^6$ cms. for the infinitely variable A.T.I.

(i.) Coupler-Coil Dimensions:

Using Lorenz's inductance formula again, and the tables of the Q, A, and B functions given in the December, 1916, issue:

Take $n = 54$ turns.
$a = 3{\cdot}5$ cms., coil radius.
$b = 60$ cms. coil axial length.

Winding with wire at nine turns per centimetre:

$\frac{d}{D} = 0{\cdot}90$. Whence $A = 0{\cdot}4515$

and for $n = 54$ the $B = 0{\cdot}3198$.

$\frac{2a}{b} = \frac{7}{6}$. Whence $Q = 15{\cdot}04$.

$$L_s = an^2 Q$$
$$= 3{\cdot}5 \times (54)^2 \times 15{\cdot}04 = 153{,}200 \text{ cms.}$$
$$\Delta L = 4\pi an(A + B)$$
$$= 4\pi\ 3{\cdot}5 \times 54 \times 0{\cdot}771 = 1{,}830 \text{ cms.}$$

True $L = L_s - \Delta L = 151{,}370$ cms.

(ii.) Aerial Tuning Inductance, A.T.I.:

Take $n = 330$ turns.

$a = 10$ cms. $b = 55$ cms.

$\frac{d}{D}$ for the wire as before 0·90.

$A = 0{\cdot}4515.$

$B = 0{\cdot}3345$ for $n = 330.$

$A + B = 0{\cdot}7860.$

$\frac{2a}{b} = 0{\cdot}3638.$ Whence $Q = 6{\cdot}183$

$$L_s = an^2 Q.$$

$$= 10 \times (330)^2 \times 6{\cdot}183 = 6{\cdot}743 \times 10^6 \text{ cms.}$$

$$\Delta L = 4\pi an(A + B)$$

$$= 4\pi \times 10 \times 330 \times 0{\cdot}786 = {\cdot}033 \times 10^6 \text{ cms.}$$

$$\text{True } L = L_s - \Delta L = 6{\cdot}71 \times 10^6 \text{ cms.}$$

which is sufficiently large because the amount aimed at was on the high side.

In most large stations the aerial tuning inductance is split up into numerous steps.

Owing to the flatness of tuning always obtained in the aerial to earth circuit, due to its large damping, the limits of wave-length that can be received on any one step can easily be made to overlap the wave-lengths obtainable on the adjacent steps.

The complete calculation of thirty or forty steps is somewhat long and is omitted here. The principle involved is simply that of trial and error and the method is clearly brought out in the following calculations for four steps of the receiver secondary inductance.

If it is desired to be able to receive small wave-lengths, below the natural wave-length of the aerial, then a variable capacity must be arranged so as to be connected in series with the aerial to earth circuit when required.

The usual laws of series condensers enable us to determine what value this series condenser must have for any given minimum wave-length.

Let K_1 be the effective capacity required for a given small wave-length λ.

$$\lambda_a = 59{\cdot}6\sqrt{L_a K_a}\ .$$

$$\lambda = 59{\cdot}6\sqrt{L_a K^1}\ .$$

where $\lambda < \lambda_a.$

whence $$K^1 = \frac{\lambda^2}{(59{\cdot}6)^2 L_a}\ .$$

Now let K^{11} be the additional series capacity, such that

$$\frac{1}{K^1} = \frac{1}{K_a} + \frac{1}{K^{11}}\ .$$

$$\therefore K^{11} = \frac{K^1 \cdot K_a}{K_a - K^1}\ .$$

This series capacity K^{11} will reduce the wave-length from λ_a, the natural wave-length of the aerial, to λ the desired small wave-length.

(To be continued.)

Instructional Article

NEW SERIES (No. 3).

EDITORIAL NOTE.—In the opening number of the new volume we commenced a new series of valuable instructional articles dealing with Alternating Current Working. These articles, of which the present is the third, are being specially prepared by a wireless expert for wireless students, and will be found to be of great value to all who are interested in wireless telegraphy, either from the theoretical or practical point of view. They will also show the practical application of the instruction in mathematics given in the previous volume.

INDUCTANCE.

12. Self-Inductance.—When a steady electromotive-force is applied to a conducting circuit it is found that the resulting current does not instantaneously assume its full magnitude.

This is because the circuit possesses a property known as **Self-Induction,** or, as it is termed for shortness, "**Inductance.**"

Inductance in a continuous current circuit is only effective at the starting and stopping of the current, but in an alternating current circuit it is effective for the whole time the current is flowing.

The effect of Inductance in a circuit can best be illustrated by considering first of all a mechanical analogy.

When a railway train is started from rest a certain force is required to act on the wheels for a certain definite time in order that the train may obtain a given speed. After this has been acquired the force necessary to keep the train moving at that speed is only necessary to overcome friction, which is much less. Now, if this last force is removed the train will not come to a sudden standstill, but will come to rest gradually, and will only come to rest more quickly if the brakes are applied or an obstacle is placed in the way.

It is seen, therefore, that the train resisted the force required to move it and likewise resisted the force exerted to bring it to rest. This resistance of a body to a change of motion is known as **mechanical inertia.**

13. Electromotive Force of Self-Induction.—If a length of wire is coiled round in the form of a spiral (Fig. 12) we have a coil possessing a large self-induction and hence termed an **inductance coil.**

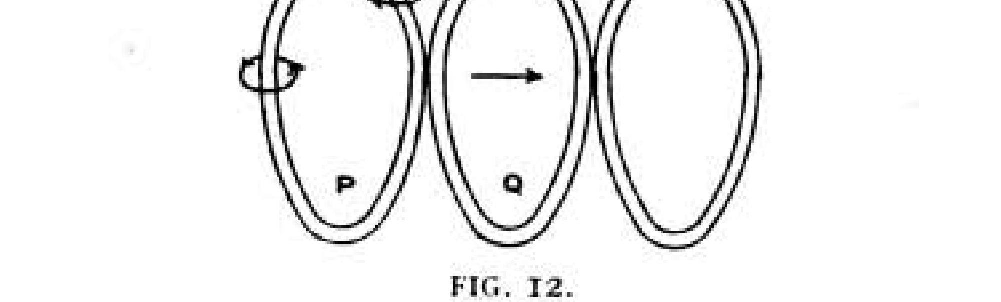


FIG. 12.

Apply to this coil an electromotive force. When the current is switched on it will traverse each coil of wire. Consider first the coil *P*.

The current flowing round coil, *P*, will create a magnetic field in the direction of the arrowed rings. This magnetic field will cut coil *Q*.

Since the current commences from zero and rises to its maximum value the magnetic field also changes in magnitude with it.

The magnetic field threads coil *Q* and the changing in magnitude is exactly equivalent to coil *Q* moving through a stationary constant magnetic field.

Now on page 62, it is shown that the latter will give rise to an induced electromotive force in coil *Q*.

This induced E.M.F. is known as the **E.M.F. of self-induction** or the **back E.M.F.**

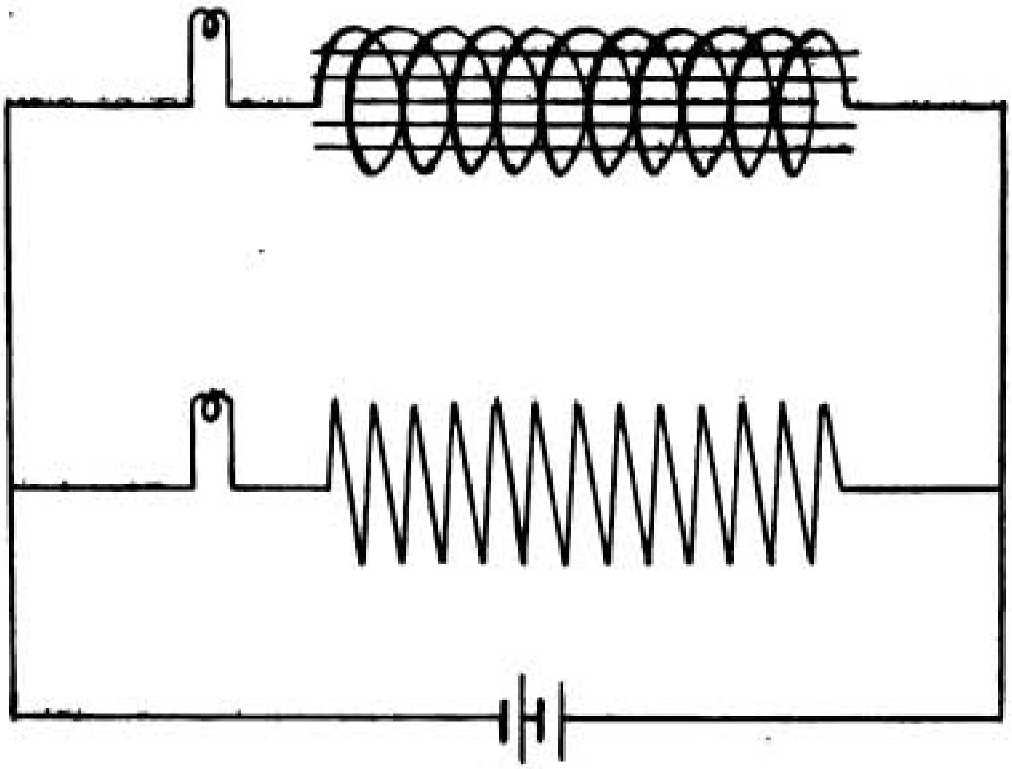


FIG. 13.

14. Growth of Current.—The E.M.F. induced in coil *Q* is in such a direction that the current flowing in *Q* will be in an opposite direction to that in coil *P*. This current will therefore tend to neutralize the current flowing in coil *P*, and consequently the current in the remaining coils will only gradually attain their maximum value. This is equivalent to the train attaining its maximum speed in our mechanical analogy.

This growth of a current in a coil of wire, or **Solenoid** as it is sometimes called, can easily be shown by connecting an electromagnet, that is a solenoid, with an iron core, to a coil wound in such a way that it has a very small inductance, two lamps and a continuous E.M.F., as in Fig. 13. The inductive coil must have the same resistance as the second coil, and the lamps must be the same size.

Then, when the current is switched on, the lamp in series with the inductive coil will gradually attain its maximum brilliancy, while the other lamp attains its maximum brilliancy at once, thus showing that the current in the inductive circuit gradually attains its maximum value.

Now if the inductance coil is connected to an alternating E.M.F. the current will vary in strength and direction. For the first quarter of a period the current is increasing in one direction. Therefore, as already seen, an induced E.M.F. is set up in coil *Q* in such a direction as to oppose the current in coil *P*.

15. Lenz's Law.—This law states that **any induced E.M.F.** tends to **oppose** the motion which produced them.

This is shown to be the case with the E.M.F. in coil *Q*. Now as the current is falling in the second quarter period, the strength of the magnetic field is decreasing, causing the coil *Q* to be cut in the opposite direction. Thus, again, the induced E.M.F. will **oppose** the current which produced it. The analogy of the train coming to rest applies to the decrease of the current. As the current completes the second half of the cycle in the opposite direction to the first half, the increase and decrease of the current and the E.M.F. of self-induction will be in the opposite direction to those during the first half cycle.

16. Coefficient of Self-Induction.—It has been shown that the E.M.F. of Self-Induction depends on the increase and decrease of the current strength. It is measured by the rate of change of the magnetic flux in the circuit, and the coefficient of self-induction or more shortly the inductance of the circuit is the ratio of the total number of magnetic lines of force in the circuit to the current producing them. This value is usually represented by the letter "**L.**" The **unit** of **self-inductance** is the "**Henry**" and the inductance of a circuit is **1 Henry,** when a back E.M.F. of **1-volt** is induced by a current changing at the rate of **1 ampere** in **1 second.**

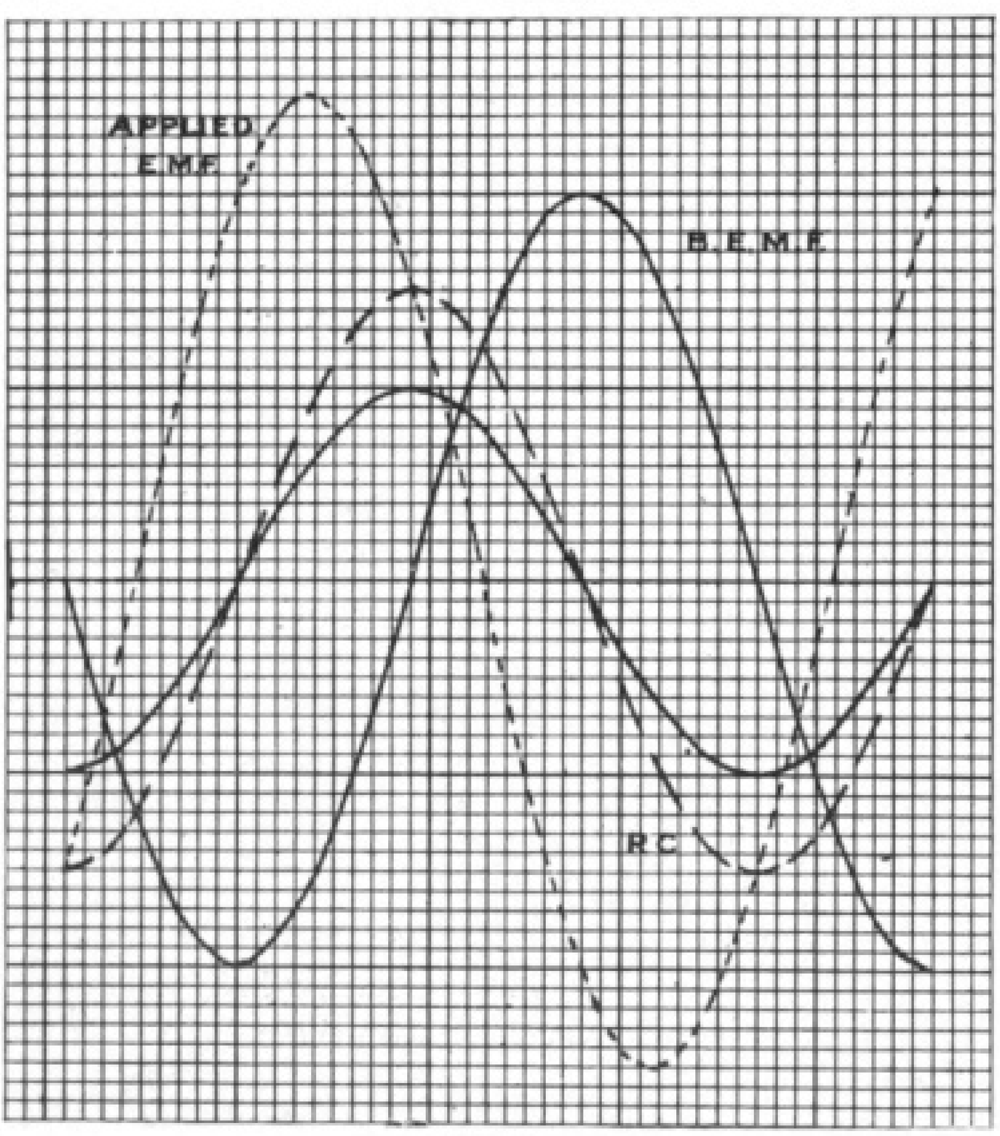


FIG. 14.

17. Angle of Lag.—The E.M.F. necessary to send a current through an inductance must be sufficient to overcome—

(1) The ohmic resistance of the circuit.

(2) The E.M.F. of self-induction.

In Fig. 14, let the current in an inductance be represented by the sine curve *C*. If the resistance of the coil is *R* ohms, then the curve *RC* represents the E.M.F. required to overcome the resistance of the coil, and is in phase with the current.

When the rate of change of the **current** is **greatest**, that is at zero, the rate of change of the strength of the **magnetic field** is **greatest.** The value of the **induced E.M.F.** is therefore a **maximum.** Let curve $E_{s.i.}$ represent the back E.M.F.

In order to obtain the value of the applied E.M.F. it is merely necessary to add the ordinates of RC and an amount equal and opposite to $E_{s.i.}$ If this be done over the complete cycle the curve E is obtained. This curve represents, therefore, the **E.M.F.** necessary to overcome the **resistance** and **inductance** of the coil.

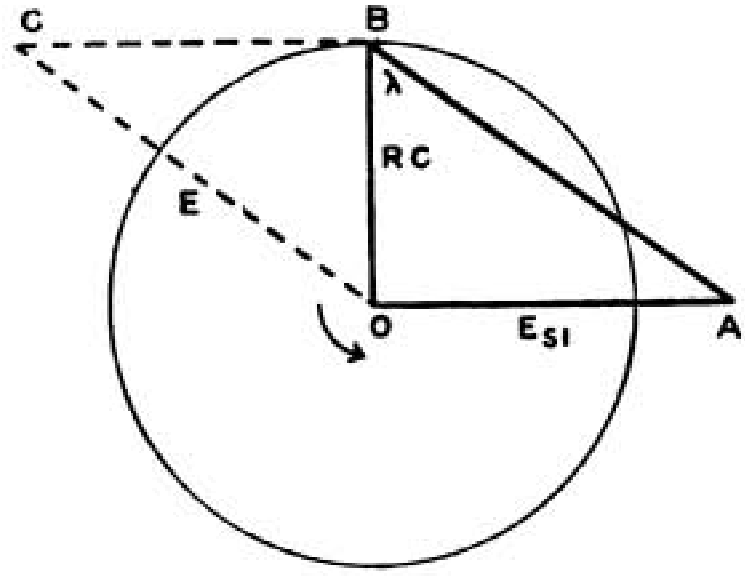


FIG. 15.

Now it will be seen that the current curve **lags behind** the applied E.M.F. curve, and the amount of this lag, measured in degrees, is known as the **angle of lag** (*see* Article 2, section 7).

We thus see that when an inductance is introduced into a circuit the current **lags behind** the applied E.M.F. and the angle of lag will depend on the relative values of $E_{s.i.}$ and RC, and it will easily be seen that if $E_{s.i.}$ is 0, $E=RC$ and the circuit is non-inductive. If $E_{s.i.}$ is large compared with RC then E becomes more nearly equal and opposite to $E_{s.i.}$ with the result that the angle of lag becomes nearly 90°.

The angle of lag can also be calculated by constructing a vector diagram of the three electromotive forces—*i.e.*—

E the applied E.M.F., RC the effective E M.F., and $E_{s.i.}$ the back E.M.F.

In Fig. 15, let BO represent the maximum value of the effective E.M.F., $RC=15$. Then as the vector rotates in an anti-clockwise direction the E.M.F. of self-induction $E_{s.i.}=20$ (AO) will be drawn 90° behind AO. Join AB.

Then complete the parallelogram O, A, B, C. Then the vector OC will represent the applied E.M.F. the value of which is equal to 25. It will be seen that the applied E.M.F. is in advance of the current by 53°, the angle of lag.

From the vector diagram it is obvious that :—

$$E=\sqrt{(RC^2+E^2_{s.i.})}$$

$$\text{Tan. } \lambda=\frac{E_{s.i.}}{RC}=\frac{\text{B.E.M.F.}}{\text{Effective E.M.F.}}$$

$$\text{and Cos. } \lambda=\frac{RC}{\sqrt{(RC^2+E^2_{s.i.})}}=\frac{Ee}{E}$$

18. Impedance. Ohm's Law.—From the formula $C_v=C_{max.}\sin\theta$ and knowing that the inductance of a circuit is a function of the rate of change of the current it can be shown that, if $\omega=2\pi n$,

$$\begin{aligned} E_{max.} &= \omega LC_{max.}\cos\theta \\ &= \omega LC_{max.}\sin(\theta-90^\circ) \\ &= -\omega LC_{max.} \quad 90^\circ \text{ out of phase with } C. \end{aligned}$$

In the vector diagram, Fig. 16, let AC represent the applied E.M.F., AB the effective E.M.F., RC lagging behind E by angle λ and BC equal to the B.E.M.F. $= -\omega LC$, 90° out of phase with RC, then :—

$$E = \sqrt{\{(-\omega LC)^2 + RC^2\}}$$
$$= C\sqrt{\{(-\omega LC)^2 + R^2\}}$$
$$= C\sqrt{\{R^2 + (\omega L)^2\}}$$

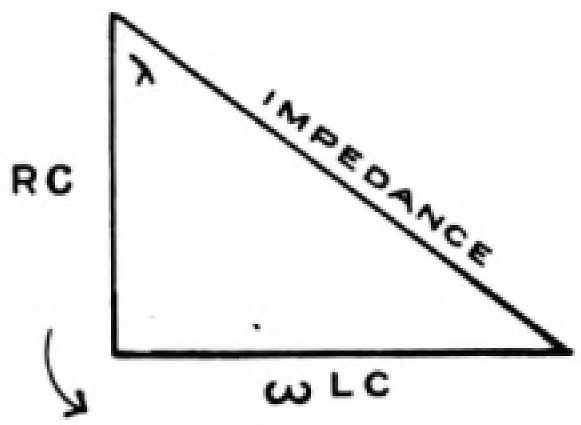
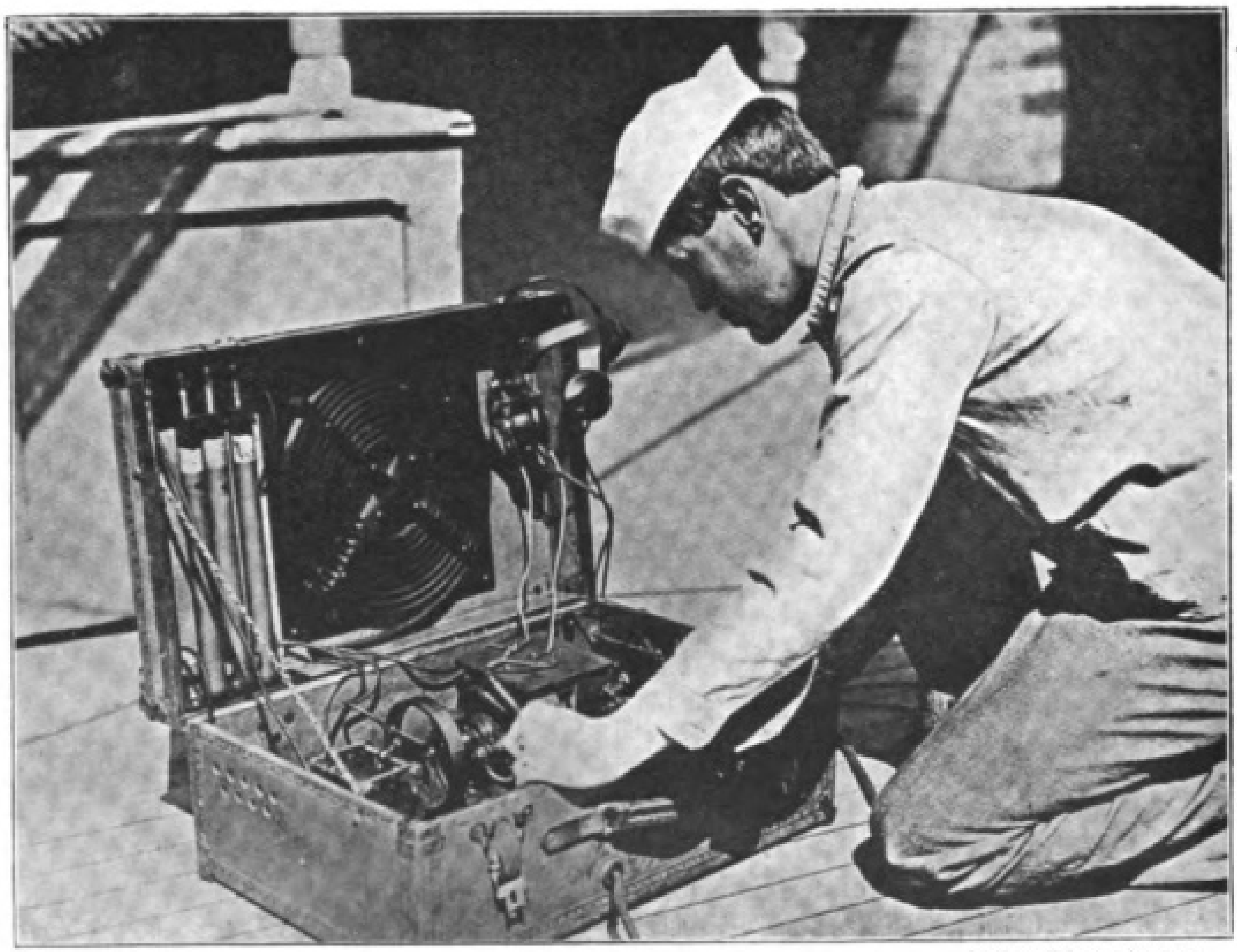


FIG. 16.

$$\text{or } C = \frac{E}{\sqrt{\{R^2 + (\omega L^2)\}}}$$

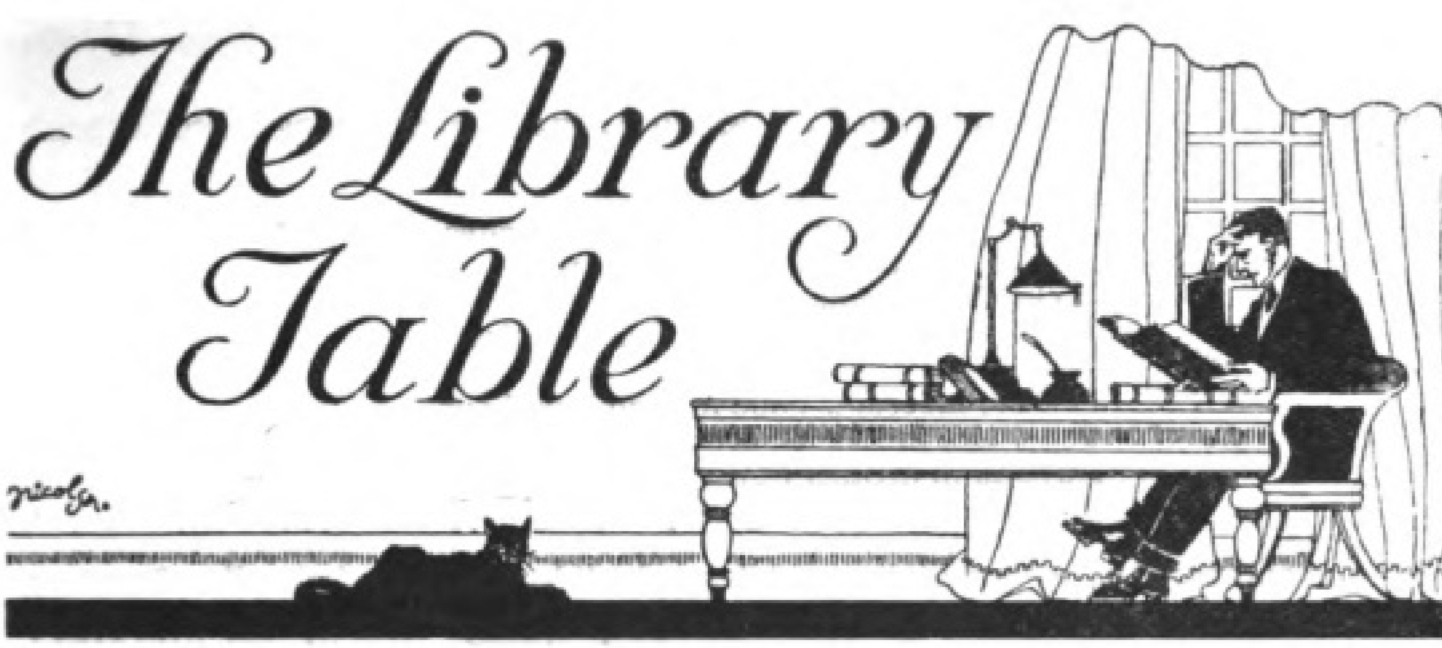
The term $(\omega L)^2$ is known as the **reactance** of the circuit and the whole term $\sqrt{\{(R^2 + (\omega L^2)\}}$ as the **impedance.**

Thus it is seen that the effect of self-inductance in a circuit is to cut down the maximum value or amplitude of the current, to cause it to lag behind the applied voltage and to set up a back E.M.F. in the circuit.



[*Giles' Photo Agency.*

BLUEJACKET ON BOARD A U.S. BATTLESHIP MANIPULATING A PORTABLE WIRELESS APPARATUS.



"*REMEMBRANCE, and Other Verses.*" *By Bernard Charles de B. White. Edited, with a Memoir, by de V. Payen-Payne. Selwyn & Blount, 27, Chancery Lane. 3s. 6d. net.*

THE "WIRELESS WORLD" in pre-war days owed much to the facile pen of Bernard Charles de Boismaison White, who acted over a considerable period as assistant editor. After the outbreak of war, fired by the call of his country, he joined the Officers' Training Corps of the University of London, and in February, 1915, was gazetted to the Eleventh Battalion of the York and Lancaster Regiment. He served through the remainder of 1915, and played a hero's part in the advance on the Somme of 1916, until on the 1st July of that year he was struck down whilst leading his men and bombing a German trench.

Mr. de V. Payen-Payne has, at the request of many friends, put together a little volume which we earnestly commend to the attention of our readers. They will find in its pages a true "Human Document," the record of a noble and upright life, together with a number of charming little poems, embodying the thoughts and aspirations of one who not only "loved his fellow men" but who delighted in every phase of existence. The glow of the sunset sky, the colour and perfume of flowers, the lovely curves traced in the forms of shells, struck responsive chords in the many-stringed lute of his affections and stirred within his emotional nature exquisite vibrations of delight. What he hated was the ugliness of vice and the ignominy of strife. Yet he showed himself to be the possessor of rare military mettle, and fell on the field of battle. It was the triumph of spirit over matter, his idealism carried him through. That unquenchable spirit of his is well expressed in his own lines :

> Out of the darkness it crieth,
> Into the darkness it dieth,
> This exquisite music of pain !
> Fears are the fruit of its measure,
> Yet in my bosom I treasure
> The song that is vain—that is vain.

Every now and again he varied the prose writing on matters wireless, which constituted his everyday occupation, for excursions into verse, and many established readers and old friends of the WIRELESS WORLD will recollect his "Rubáiyát of a Wireless Operator," which was published in this magazine and now reappears in his book. In the poem, after describing the Radio-telegraphist as having toiled through the small hours of the night, he says :—

Now, the new day reviving sleep's desires,
A weary * "Sparks" to solitude retires,
Kicks off his boots; takes to his bunk, and soon
In Morpheus' arms his gentle soul suspires.

. . . .

Poldhu, indeed, is gone for one brief hour,
Gone, too, the signals from the Eiffel Tower,
But still in dreams I hear confusèd sounds,
And still Marconi wave-lengths hold their power.

He addressed two sonnets on radio-telegraphy "by kind permission" to Senatore Marconi, in the latter of which he burst into the prophecy "Man speaks with Man: soon *World* shall speak with *World*!" As a general rule, Mr. Bernard White, although full of fun, considered that poetry was too sacred a medium to be used for an expression of the comic sense, and readers of this volume will understand the correctness of this attitude—from the point of view of Mr. White's own poetic inspiration. We cannot do better than give, as an example of the elevation of his style and feeling, the final verse of his appeal "Pro Patria" to wireless operators all over the world:

Ye in our camps, our ships, the stations that gird our seas
Holding in trust the key and power of the sacred flame
For England's greater honour, let not your service cease
Till ye confirm your loyal right to the scroll of Fame,
Till on the key
Of Victory
For the troubled ears o' the world ye tap out the signal
—PEACE.

An interesting biography conceived in the truly sympathetic spirit preludes the verse, and the volume contains two portraits of the poet. The frontispiece shows him in his lieutenant's uniform, a soldierly figure, and a fine specimen of the manhood of which England has every reason to be proud. The second portrait, however, depicts him in civilian garb, wearing those open collars, soft-fronted shirts and flowing ties which he affected in peace-time; seated upon the edge of a table, that attitude so familiar to those of us who had the privilege of knowing and working with him; whilst in his hand he holds "the eternal cigarette," which in waking hours he was seldom without. Mr. White was of Huguenot descent, and doubtless owed some of his individuality to the French strain in his blood.

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DICTIONARY OF SEA TERMS. By A. Ansted. James Brown & Sons, Glasgow, 1917. 5s. net.

Wireless operators making their first voyage to sea; ocean travellers who take more than a superficial interest in the boat on which they are sailing, and, in fact, all who are interested in the industry of shipping will welcome this little explanatory volume. Essentially popular in character the book does not profess to take the place of the various nautical dictionaries which admirably serve the purpose for which they

* The slang term for a wireless telegraphist.

are intended. It is particularly the beginner that the author is anxious to serve, and a very brief perusal is sufficient to indicate how well the task has been fulfilled. The explanations in all cases are sufficiently full to make the meaning quite clear, and, where necessary, small illustrations inset in the text remove any doubts which may still exist in the reader's mind. Altogether this is an excellent book and should prove very popular.

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PRACTICAL DYNAMO AND MOTOR MANAGEMENT. S. Rental & Co., Ltd., London. 6d. net.

This inexpensive little booklet is designed to supply the machine attendant with a guide to the chief faults which may occur in the dynamos and motors of commerce. There is no redundant matter, and all the hints and explanations are thoroughly practical and to the point. Starting with a description of the troubles which may occur with direct current motors, the author analyses the cause of sparking at the commutator and describes the best remedies. The setting of brush-holders, the removal of projecting mica, insulation testing, faults in field coils, and other similar matters are then treated, after which we proceed to a consideration of running troubles with alternating current machines. Excellent photographic illustrations are interspersed throughout the text, and at the end of the book we find a number of diagrams of connections.

From an Early Operator

THE following interesting letter has been received from one of our readers on a seaplane " Mother Ship " :—

" I have just had great pleasure in reading the article headed ' Wireless in the " Early Days,' by a Senior Operator. It takes me right back to February, 1908, " when I first joined The Marconi International Marine Communication Company, " Ltd., and I can well appreciate the description of New York jamming. Since " leaving the Company in 1911, I have taken in the WIRELESS WORLD regularly, " and find plenty of interesting matter especially in the great strides wireless has " made.

" This month's magazine has only just reached me, as you see I am away on one " of the seaplane ' Mother Ships.' I have come back to my old occupation of " wireless. . . . I find it all very interesting again, and I may be tempted to keep " to wireless in the future."

It is a peculiar coincidence that, although the writer of this letter and the author of the article have never met, they both had charge of the wireless on a well-known transatlantic liner, the latter taking over the post within two or three hours of the time the former left; the liner in question is now at the bottom of the sea.

Personal Notes

Congratulations to Mrs. F. R. Wilson on her recent marriage. Mrs. Wilson (*née* Miss Kitty Curran), who has been connected with the Marconi Company for a number of years, was the recipient of a valuable present from her many friends on the staff, who wish her all success. Mr. and Mrs. Wilson spent their honeymoon at Brighton.

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The following notice recently appeared in the *Commonwealth Gazette*:

Appointments to the permanent naval forces of the Commonwealth (Royal Australian Naval Radio Service) as from July 1st, 1916:

	At	Seniority
Radio-Commander—		
F. G. Cresswell		July 1st, 1916
Radio Lieutenant—		
A. F. Newman		July 1st, 1916
G. J. Weston		July 1st, 1916
Commissioned Warrant Officers—	At	
W. T. S. Crawford	Melbourne	July 1st, 1912
W. M. Sweeney	Perth	July 1st, 1912
G. A. Scott	Brisbane	July 1st, 1914
J. M. Martin	Darwin	July 1st, 1914
C. E. Tapp	Melbourne	July 1st, 1914
J. Leslie	Broome	July 1st, 1914
G. F. Chilton	Port Moresby	July 1st, 1914
F. J. Burgoyne	Adelaide	July 1st, 1914
Warrant Officers—		
J. J. W. Lamb	Sydney	July 1st, 1916
H. F. Coffey	Mount Gambier	July 1st, 1916
S. Trim	Wyndham	July 1st, 1916
M. G. Pope	Hobart	July 1st, 1916
W. Hollaway	Flinders Island	July 1st, 1916
D. H. Reader	Thursday Island	July 1st, 1916
W. G. Chapman	Brisbane	July 1st, 1916
V. Hodson	Esperance	July 1st, 1916
N. H. Mayger	Thursday Island	July 1st, 1916
C. G. B. Meredith	Geraldton	July 1st, 1916
F. J. C. Bridges	Roebourne	July 1st, 1916
G. W. Walters	Cooktown	July 1st, 1916
F. J. Henderson	Melbourne	July 1st, 1916

Continuous duty stations have Officer-in-Charge with rank of Commissioned Warrant Officer and one Warrant Officer. Other ratings are classed as Chief Petty Officers.

Non-continuous duty stations one Warrant Officer. All other ratings are Chief Petty Officers.

The above ranks are shore-station appointments.

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The directors and officers of the Amalgamated Wireless (Australasia), Ltd., recently entertained Lieutenant W. H. Payne, traffic superintendent, at a luncheon prior to his leaving for the Front.

Mr. H. R. Denison, chairman of directors, presided. Messrs. E. T. Fisk and J. H. Forrest, two other directors, and the following officers of the company were also present: Messrs. L. L. Meredith, J. F. Wilson, S. Stacey, G. Apperley, F. W. Larkins, V. Gardiner, D. Campbell, S. Whatson, A. W. Peek, P. M. Parmer, and W. H. C. Phillips.

After the toast of the King had been honoured, the chairman, in feeling terms, proposed "The Guest," to whom he referred in a patriotic manner and applauded Lieutenant Payne on his decision in going with the fighting forces to assist in his special wireless knowledge to contribute to the downfall of Prussianism.

Lieutenant Payne replied briefly, and assured those present that he would do all in his power to hold up the standard of the Anzacs abroad.

Later on, at Wireless House, Lieutenant Payne was presented with a luminous gold wristlet watch by the whole of the staff of the company.

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Mr. John Monro, of Kirkcaldy, has been officially notified that his son John Monro, aged 19, wireless operator and mechanic in the R.N.A.S., was lost with the airship which was brought down in the English Channel on April 21st. The deceased was a distinguished student at Kirkcaldy High School, and before enlisting was associated with his father in business.

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We regret to announce the death of Wireless Telegraphist Ernest Henry Glover, late of the H.M.S. *Peel Castle*. Mr. Glover, who was thirty-four years of age, volunteered for the Navy at the outbreak of war, and being an expert wireless telegraphist was posted to the *Peel Castle*, a patrol vessel. In January, 1916, the ship caught fire and was reduced to a mere shell. All the crew, however, with the exception of one who lost his life in the flames, were rescued by tug-boats, but they suffered terribly from the cold and exposure, and Operator Glover fell a victim to laryngitis. He was removed to his home as soon as conditions would permit, but pulmonary phthisis developed, with fatal results.

On leaving King Edward's Grammar School, Camp Hill, Birmingham, the late Mr. Glover entered the Birmingham G.P.O. Telegraph Department, and later took up a post as telegraphist in South Africa. He later returned to England, and entered the services of the Marconi Company, visiting many parts of the world in the course of his duties. Deep sympathy is felt with his parents in their terrible bereavement.

At the Angel Hotel, Liverpool, a farewell concert was recently given in honour of Mr. J. Furze, retiring from the position of Liverpool superintendent of the Commercial Cable Co. An excellent programme was rendered, in the course of which presentations were made by Mr. W. Steventon on behalf of the Commercial Cable Co., and Mr. F. Leighton on behalf of the Western Union Friends. Numerous messages of goodwill were received from prominent officials in the cable and telegraph world, including one from the traffic manager of Marconi's Wireless Telegraph Co., Ltd.

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A GOOD many wireless men in all parts of the world will be interested to learn of the marriage, on April 9th, of Mr. G. E. Turnbull with Miss M. C. Ditchfield. Mr. Turnbull began his wireless career early in 1902 as junior engineer on the staff of Marconi's Wireless Telegraph Co., Ltd., and was transferred to the Brussels office in 1904. In 1912 he returned to London, to take up the position he now holds of Assistant Manager of the Marconi "Wireless" and "International" Companies. His marriage, therefore, will be a matter of congratulation, not only from a number of friends in this country, but also abroad. Some of us have moreover the pleasure of knowing Mrs. Turnbull, and we take this opportunity of offering all felicitations and best wishes for their future happiness. The Directors and Staffs of the Marconi Companies seized the opportunity afforded by the happy occasion for presenting them with a handsome wedding gift as a token of their high esteem.

Share Market Report

LONDON, *May 9th*, 1917.

BUSINESS has been very quiet in the share market during the past month and there is little change to report. The closing prices as we go to press are: Marconi Ordinary, £2 16s. 3d.; Marconi Preference, £2 6s. 3d.; Marconi International Marine, £1 16s. 3d.; American Marconi, 15s.; Canadian Marconi, 8s. 6d.; Spanish General Wireless Trust, 9s.

Henley's Birmingham Branch

Notice of Removal

ON May 21st Messrs. W. T. Henley's Telegraph Works Co., Ltd., removed their Birmingham branch offices and stock rooms to Broad Street Chambers. The new premises afford facilities for carrying much larger stocks of electric wires and cables, flexible cords, jointing materials, boxes, tapes, &c., to meet war demands for urgent delivery. The new telephone number is Midland 790. The telegraphic address remains the same: "Henletel," Birmingham.

Questions & 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 telegraphy. There are no coupons to fill in and no fees of any kind. At the same time readers would greatly facilitate the work of our experts if they would 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) Replies should not be expected in the issue immediately following the receipt of queries, as in the present times of difficulty magazines have to go to press much earlier than formerly. (3) Queries should be as clear and concise as possible. (4) Before sending in their questions readers are advised to search recent numbers to see whether the same queries have not been dealt with before. This will save us needless duplication of answers. (5) The Editor cannot undertake to reply to queries by post, even when these are accompanied by a stamped addressed envelope.*

CTE DE LA B. (Paris).—It is difficult to compare the advantages and disadvantages of the "hard" and "soft" valves, as everything depends upon the particular use to which the valves are to be put. Further, the terms "hard" and "soft" are merely relative. The "soft" valve will require a lower voltage battery in the plate circuit than with a "hard" valve, and, in fact, the harder the valve the higher voltage battery will be required. Some very "hard" valves are at present being successfully used in which a high voltage direct current dynamo is used in the plate circuit. During the war no such catalogues as you mention are being issued, neither are the instruments supplied to the general public. We regret that we cannot answer questions 1, 2, 3, and 4, as they concern practical details of commercial and patented apparatus. The coupling between coils *R* and *S* is made variable and has to be adjusted for best results. We cannot give the minimum voltage of *B*, for the value of this battery depends upon the particular valve in use and may consist of only a few cells, or on the other hand may be composed of a very large number. The value of the resistance of the telephones is not very important, provided it is sufficiently high. In most cases low resistance phones are used with the telephone transformer. We see no reason why galena should not be employed. The reason for the almost exclusive use of carborundum in English commercial wireless apparatus is that this crystal is thoroughly reliable, constant and robust. It is far less easily deranged by strong signals and atmospherics than galena, silicon and many other crystals. All of the batteries save that used to provide current for heating the filament can be composed of dry cells, as the current required is very small. A new series of articles on ionic valves commences in this issue, and we would also refer you to an excellent article in the 1917 *Year Book of Wireless Telegraphy and Telephony*, by Professor W. H. Eccles, dealing with the same subject.

W. K. (Dudley).—There is no "standard size" for wireless operators in the employment of the Marconi Company. They are simply required to be medically fit and generally suitable for the work.

"MESSENGERS" (Northampton).—We should advise you to apply immediately to the Traffic Manager, the Marconi International Marine Communication Company, Limited, Marconi House, Strand, London, W.C. 2, who will forward you on request their scheme of free training.

"FLEUR-DE-LYS" (Waterford).—(1) In practice, with the set in question, an increase of spark frequency makes very little difference to the radiated power. (2) No. (3) Certainly it is correct to say that coupling has an effect on tuning. A loosely coupled transmitter, by giving something approaching a single radiated wave, will enable much sharper tuning to take place at the receiving station. On the other hand, a tightly coupled transmitter radiating a "double-humped" wave will make sharp tuning at the receiving station impossible and the signals will be received over a wider range of adjustment on the tuner. (4) If you intend to enter the engineering profession you should waste no time in entering an engineering college.

H. F. (Tranent).—As you do not say how old you are we cannot give a satisfactory answer to your question. If you desire to enter the Navy, we would suggest that you apply to the nearest Recruiting Officer, if the wireless service of the Mercantile Marine to the Traffic Manager, the Marconi International Marine Communication Company, Limited, Marconi House, Strand, London, W.C. 2, giving full particulars of yourself.

C. C. (Queen's Park, West Australia).—A number of different automatic starters are used on wireless installations, and as we do not know the particular one to which you refer we cannot give you the wiring diagram. However, they are all of them fairly simple to understand, Some work by means of a solenoid which pulls over the starter handle. The movement of the handle is slowed down by means of some braking device, such as a plunger working in oil, so that the resistance in circuit with the machine is cut out gradually. The solenoid is usually put in circuit by means of a small switch on the operating table. Others are motor driven by means of a worm gear to give the slow motion. (2) We are not acquainted with any one book which deals sufficiently fully with both continuous current and alternating current work. An excellent book on continuous current work is *Continuous Current Electrical Engineering*, by W. T. Maccall. It is published by the University Tutorial Press, Limited, and can be obtained through our publishers, price 11s., post free. For alternating current work we would recommend *Alternating Current Work*, by Perren Maycock, also obtainable from our publishers, price 6s. 6d., post free. They are both thoroughly practical books and cover all the points mentioned in your letter, including the Megger. Many thanks for your kind appreciation of our Magazine.

J. C. (Southampton).—As you do not supply your full name and address we cannot answer your questions.

F. W. (Amsterdam).—We are shortly publishing an article on a new wireless slide rule which will perhaps give you the information you require.

L. S. L. (Newport, Mon.).—The article which you will find under the heading of "Operators' Notes" in this number gives some valuable information of direct use in connection with type 31, crystal receiver. We may possibly publish an article dealing with this instrument in an early number. In reply to your second question, we are afraid we cannot publish a description of the system you mention at the present time, but if you will refer to *Wireless Telegraphy and Telephony*, by W. H. Eccles, you will find some details of the apparatus. The inductance with an adjustable iron core is *not* traversed by high frequency oscillations. These pass through a condenser which is in parallel with the inductance. Thank you for your kind remarks.

J. R. E. (Western Australia).—We cannot pass an opinion on the correspondence course you mention, as we are not acquainted with its details. We can, however, recommend the correspondence course conducted by the Amalgamated Wireless (Australasia), Limited, Wireless House, Sydney. If you will write to them mentioning THE WIRELESS WORLD they will be only too pleased to forward you particulars and explain any points of difficulty which may arise in your mind regarding future appointments.

A. H. M. (Portsmouth).—It is impossible to say what the needs of the Marconi Company will be on the cessation of hostilities. Everything will depend upon the conditions prevailing at that time.

T. J. (Liverpool).—It is evident from your letter that you are not acquainted with the *Elementary Theory of Electricity and Magnetism*, or you would not make the statement "magnetism of course means attraction." Any good manual of electricity and magnetism will give you the explanations you require.

T. L. G. K. (s.s. ——).—The time spent as a wireless operator would not count as sea experience when obtaining a second mate's certificate.

P. G. (C.E.F.).—We regret we cannot give you particulars of a constructional nature whilst the present restrictions are in force.

With reference to our answer to H. H. (Nelson), in our March issue, a correspondent kindly furnished us with particulars of the case in which a Warrant Telegraphist in the R.N.V.R. has been promoted to the rank of sub-lieutenant. The man in question has had considerable practical experience in the erection of wireless stations.

B. C. (Manchester.)—(1) and (2) The name of the Company is the Russian Company of Wireless Telegraphs and Telephones, 14 Lopuchinskaia, Petrograd, Russia. (3) Yes, but we cannot give you any details. (4) You do not give sufficient particulars of yourself for us to be able to advise you of what course to take.

ING. E. C. (Spezia).—Many thanks for your postcard and the correction contained thereon.

THIS MAGAZINE CAN BE SENT FREE TO OUR TROOPS ABROAD BY LEAVING IT AT A POST OFFICE.