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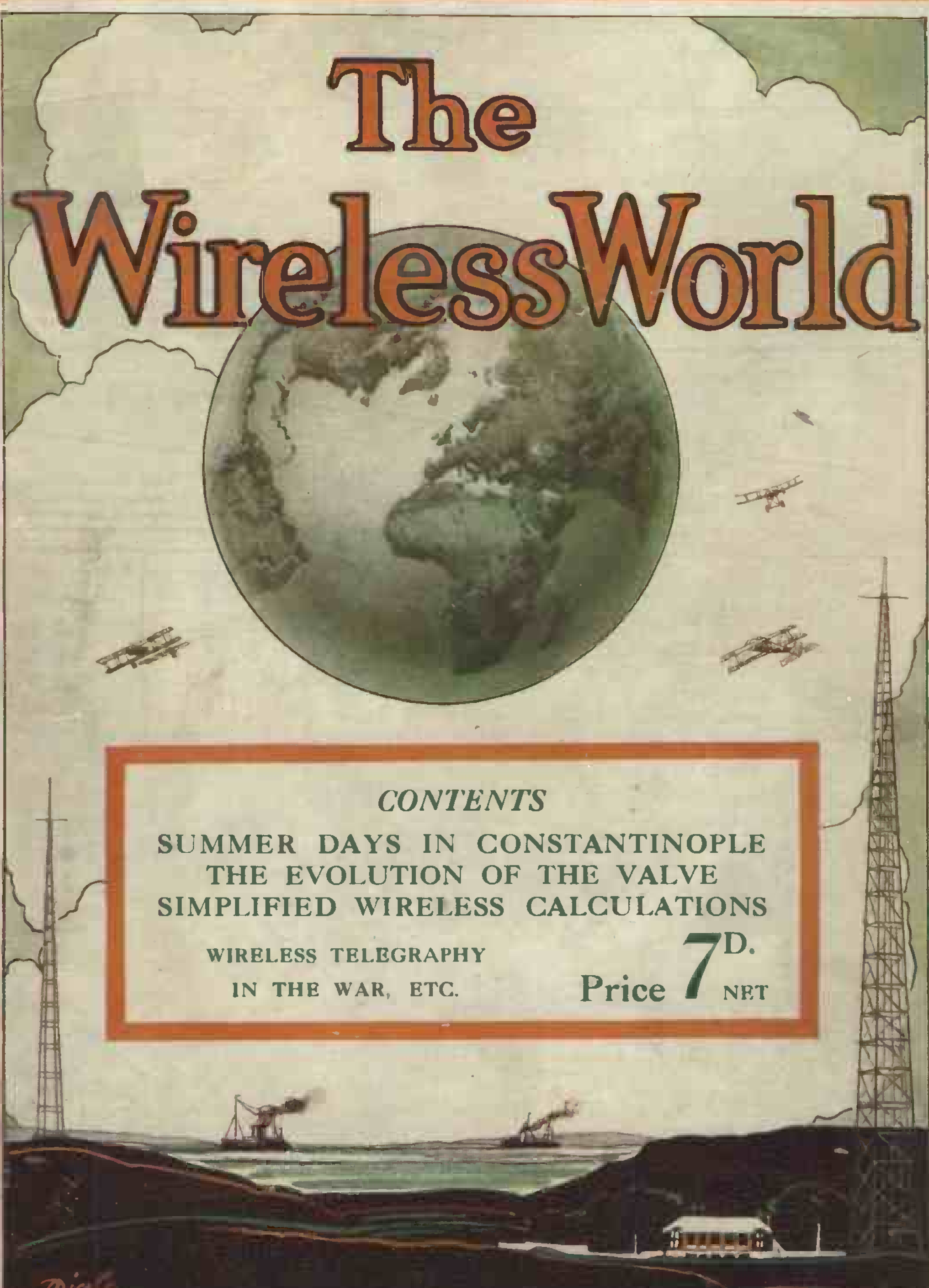
The Wireless World



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THE WIRELESS WORLD

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GENERAL.

The WIRELESS · WORLD ·

Volume VI. No. 61. APRIL, 1918.

Summer Days in Constantinople

By P. W. HARRIS

WE had come down to Constantinople on one of the numerous ferry steamers which play the part of a tram service and unite the suburban villages which nestle on the banks of the Bosphorus. With a jolt and a creak the little craft, which seemed strangely reminiscent of a Thames steamboat, drew up against one of the landing stages by the Galata Bridge, and in the twinkling of an eye the packed decks were clear of their human freight. Here, in the Golden Horn, which quivered and glittered in the burning sunlight of a summer day, were crowded craft of every imaginable description—lumbering barges which a few hours before had laboriously toiled their way across the Sea of Marmora, bringing melons and other fruit to the Constantinople markets; slender caiques darting here and there under the skilful handling of Turkish boatmen, every bit as adept as the famous Venetian watermen; laden Greek merchantmen ready to sail for Mediterranean ports; British tramp steamers calling at Constantinople on their way from the Black Sea, and a dozen or more ferry steamers whistling and snorting in their endeavours to find a vacant landing place at one of the many quays. Unaccustomed as we were to the scuffle and crowding of this busy city, it was some time before we

A TYPICAL STREET SCENE IN CONSTANTINOPLE.

emerged from the crowd and reached the bridge by way of a creaking staircase. Once on the bridge, however, we felt more free, and were able to look around.

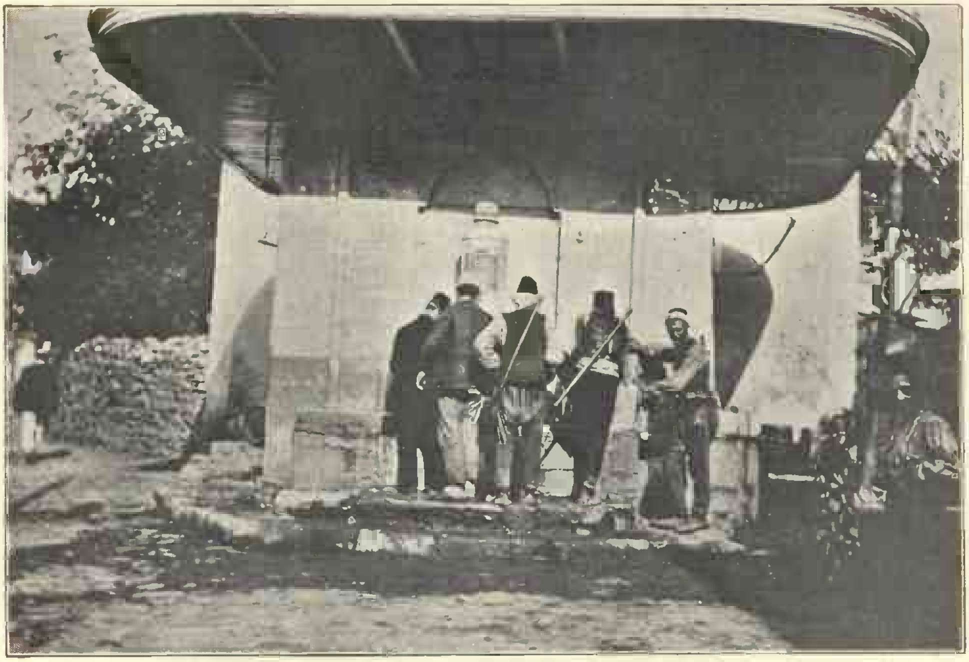
The three of us from the yacht on which I was serving as telegraphist had come on this, the first of a series of visits, to see the sights of the native quarter, and pay a call at the world-famed mosque, Saint Sophia. There is perhaps no place in the world which offers more interest to the visitor, or where life is more kaleidoscopic and varied. Crossing from the centre of the Galata Bridge, which spans the Golden Horn joining Galata and Pera (the European quarters), and Stamboul, which may be termed Constantinople proper, we found ourselves mingling with the stream of foot passengers seemingly of every race and class. Every two yards whining beggars crouched against the ironwork of the bridge thrusting out their filthy palms, or, worse still, exhibiting their maimed and contorted limbs in the everlasting appeal for alms. Porters, known locally as "Hamals," stoically carried loads, the like of which none of us had ever previously seen carried on a human back. We had not gone many yards before we passed one staggering hamal bearing on his back a moderate-sized piano!

Greeks with European headgear, Turks and Armenians with the well-known red fez, swarthy Persians wearing headdresses of astrachan, elderly sheiks with large turbans wound round their fez, passed to and fro incessantly. Women, some heavily veiled with the famous yashmak, and others, more modern perhaps and less fettered by tradition, with the thinnest of veiling through which their faces could be plainly seen, were conspicuous in the crowd, and wandered singly or in groups chattering in high-pitched voices. They could recognise their friends, it seemed, through their veiling, although to us they appeared all alike.

Drainage systems are unknown in this part of the world, and only a few years ago the city was overrun with pariah dogs, which acted as four-footed scavengers. Some little while before our visit these dogs had become such a nuisance, and had grown so fierce from years of toleration, that it was decided to remove them. The obvious thing to do was to destroy these beasts by one of the many methods available, such as by poisoning or lethal chambers. But methods such as these offended against the Mohammedan religion, for, according to the rules, it was wrong to kill them. "Where there is a will there is a way," however, and it was decided by the ruling officials that the dogs should be collected and placed upon one of the islands in the sea of Marmora. With a great deal of trouble, and much biting, this plan was carried out—thousands upon thousands of wretched, half-starved dogs being cast, without a scrap of food or water, upon an uninhabited island a few miles away. There they went mad, one by one, attacked each other, and died in the greatest misery.

Returning to the object of our visit, in due course we came to the entrance of the famous mosque, which is not difficult to find, as, owing to its position, it stands out as a landmark. After a short conference we decided to engage a guide, and

BEIKOS: A VILLAGE ON THE UPPER REACHES OF THE BOSPHORUS.



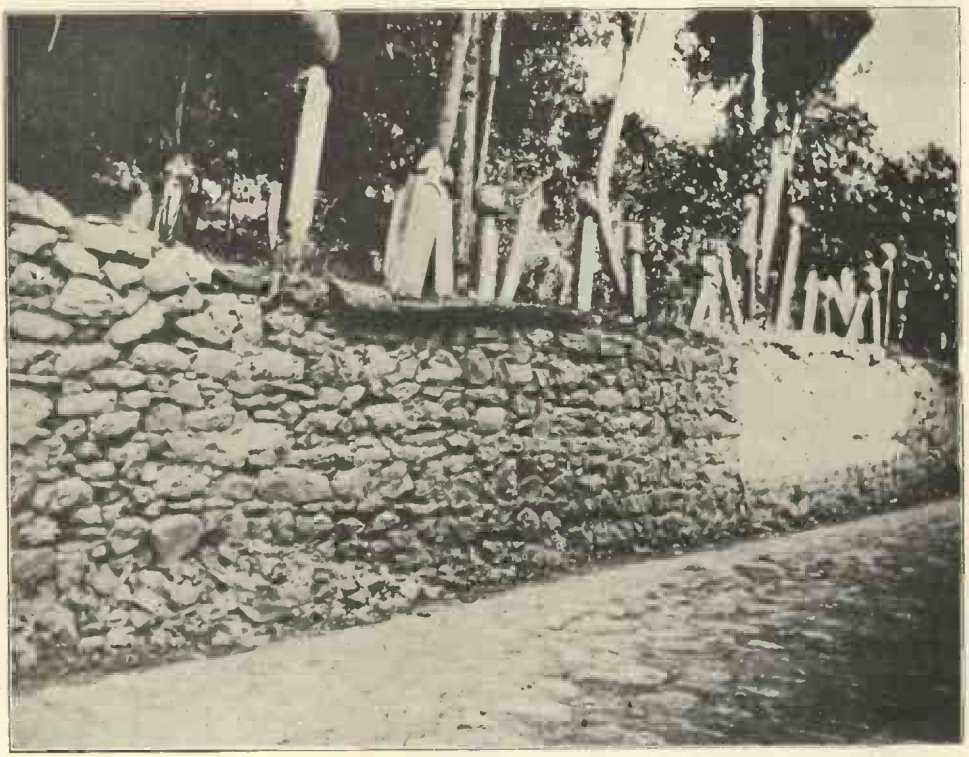
PUBLIC FOUNTAINS ARE NUMEROUS AND FREQUENTLY ORNAMENTED WITH CARVED AND GILT LETTERING.

soon we were fortunate enough in coming across a professional dragoman, by all appearances a Turk of Turks, and dressed accordingly. Later events showed that our choice was a wise and fortunate one. It so happened that for months afterwards this guide was referred to among the ship's company as "Marconi's Special "Friend," for on hearing that I came from London he confided to me that he was really an Italian, and at one time made a great deal of money in hawking carpets at Finsbury Park!

Adequately to describe the beauties of Saint Sophia in a large volume would be an impossibility. To give any indication of the interest of this great edifice in a short article can scarcely be attempted. It should be noted, however, that although used as a mosque for the last 500 years it was originally built as a Christian church by the Emperor Justinian. Prior to the building of the present structure, the Christian Church had existed on the spot from the year 326 A.D., but the original church was burnt to the ground, as was also the second erected on its site, and it was not until 532 A.D. that the present pretentious building was started. The Emperor Justinian decided that Saint Sophia should be the finest and most gorgeous structure in Christendom, and to this end engaged the best talent available at the time. Originally gold, silver and jewels were lavishly used to adorn the church, and the interior was largely covered with gorgeous mosaics. Many of these latter remain on view to the present day, although the greater portion have been destroyed by the numerous earthquakes which have devastated the region. Even now, and in spite of the fact that much of the beautiful decoration has been whitewashed over by the Turks in converting the church into a Mohammedan mosque, much of the gorgeous effect endures, and of the 107 columns scarcely two are made of the same kind of marble. It is said that, Justinian, on driving to the church for the opening ceremonies, raised his hands to heaven and cried, "Blessed be God Who "has chosen me to execute such a masterpiece. I have surpassed thee, oh "Solomon!"

Standing in the nave and looking around it seems incredible that this great Byzantine church was built in five years, but such in truth is the case. Had a longer period been given to the building it would probably have been much stronger, and one of the results of the "rush" was that, twenty years after the opening, a slight earthquake destroyed a part of the dome, the altar, and many of the most precious objects. There is a Mohammedan legend that this earthquake coincided with the birth of the Prophet.

There are many details in Saint Sophia which are likely to be missed by the visitor unless he is under conduct of a guide. Among these should be mentioned the imprint of a bloodstained hand, high on one of the walls, and said to be the mark of Muhammed the Second, the Turkish invader who captured Constantinople, drove out the Christians, and converted the Christian church into a mosque. Then,



A TURKISH CEMETERY. THE SIZE OF THE TURBAN INDICATES THE SOCIAL RANK OF THE DECEASED. THE SECOND STONE FROM THE LEFT MARKS THE GRAVE OF A WOMAN.

TURKISH RESIDENCES ON THE ASIATIC SHORE OF THE BOSPHORUS. THEY ARE MOSTLY BUILT OF WOOD.

again, there is the famous "cold window" on the western side, through which, day and night, summer and winter, there blows a cold wind irrespective of the temperature outside. We had good proof of this, for when we went to inspect the window the draught was almost icy, although outside we knew it to be a burning hot day. Another interesting object is known as the "weeping pillar"—this pillar contains a hole in which the finger can be inserted, and which is always dripping with water. Superstitious people ascribe to this many curious properties. We were not told why this moisture is always present, but it is probable that the base of the column rests upon ground near a spring.

Suspended from the roof are thousands of lamps, consisting of nothing more than small glass bowls which can be filled with oil and a simple floating wick. These lamps are lighted but once a year, on the feast of the Ramazan. On this night Saint Sophia is packed with the faithful, and there are frequently wild scenes of fanaticism should any number of foreigners be in the locality. Ramazan does not always occur at the same time of the year, as the Mohammedan differs in length from the Christian year. It so happened that at the time of my visit Ramazan fell in the hottest part of the year, not long after we arrived. The religious rites on this great feast-night were a sight to be viewed, if possible, so a party of English residents and visitors, including ourselves, had arranged to witness the ceremony from one of the galleries. At the last moment, however, and much to our disappointment, word came from the Embassy that it would be inadvisable for us to go.

By the time we returned up the Bosphorus to our anchorage at Beikos evening was falling. I know of no more beautiful spot in the whole of Europe than this waterway connecting the Black Sea and the Marmora. On both sides hills rise up from the water's edge, and here and there are small villages, with numerous cafés where the Turks idle away their time. Palaces, large and small, and in various states of repair, line the Bosphorus on both sides, many of them, if not the majority, being of wood, but others of plaster, brick, stone, and even marble.

A few miles up the Bosphorus, and nearer to the Black Sea, are situated the summer residences of the various embassies. In this district I remarked quite early in our visit a palatial building, bigger than any of the others, and surrounded by a high wall, quite obviously kept in perfect repair, and as clean and fresh as a new pin. It was situated not far from the German Embassy. I went to some pains to discover who was the proud possessor, learning, after a little trouble, that it belonged to Krupp's agent.

TYPICAL HOUSES OF THE POOREST QUARTER.

Whilst my summer days were spent either in Stamboul and the European parts of Constantinople, or in the numerous picturesque villages in the vicinity, my evenings and sometimes whole nights were spent "listening in" and experimenting with the wireless apparatus. The general conditions for wireless experimentation were as near ideal as it is possible to imagine, for "freak" nights were in the minority, and there was practically no interruption from nearby stations.

Every night after sundown I could rely on hearing loud signals from Pola, at the head of the Adriatic, Sebenico, Port Said (some 650 miles to the south), Fort de l'Eau, and frequently Saintes Maries de la Mer (Marseilles). On long wavelengths the near-by station at Constantinople could be heard working frequently to Adrianople—it was at the time of the siege of the latter city—but generally "pumping out" messages by the hour with 3 kilowatts to the Turkish "Fleet" lying practically in sight. On one or two rare occasions, after setting the receivers to the maximum sensitiveness, I succeeded in hearing signals from Eiffel Tower, but they faded away after a few minutes and were not heard again.

PERSONALITIES IN THE WIRELESS WORLD

MR. J. ORCHISTON, M.I.E.E.

THE wire telegraph service in New Zealand is justly a source of pride to the inhabitants of that distant and progressive Dominion, and from articles which have appeared in this magazine our readers will know that the radiotelegraphic service is equally well managed.

The subject of our biography this month, Mr. J. Orchiston, M.I.E.E., is the Chief Telegraph Engineer of the General Post Office at Wellington, New Zealand, all radiotelegraphic matters in that country being handled by his department.

Mr. Orchiston, who was born in Aberdeen, Scotland, in the year 1857, left the "Old Country" with his parents at the early age of five. When seventeen years old he joined the telegraph department as a cadet, and shortly afterwards was placed in charge of the Hawera Office. After performing the duties pertaining to officer-in-charge and postmaster for three and a half years, he was transferred to the technical branch of the service. At the age of twenty-one he was Acting Sub-Inspector in charge of all construction work in the Wellington District, and two years later was promoted to the rank of Sub-Inspector and placed in charge of the Auckland Telegraph District. In 1894 his designation was altered to that of Inspector, and he was transferred to the Otago District, and finally promoted to the position of Chief Engineer, at Wellington, in January, 1911.

In view of the exceptionally favourable atmospheric conditions which exist in that quarter of the globe, we may expect many interesting post-war developments under such able leadership. Who knows but what direct communication with the Motherland may be established before many years have passed?

10

The Evolution of the Thermionic Valve

By R. L. SMITH-ROSE, B.Sc., A.R.C.S., D.I.C., Student, I.E.E.

Read before the Students' Section of the Institution of Electrical Engineers on January 22nd, 1918.

Elementary Thermionics.

I.

The term "Thermionic" currents was first applied by Professor O. W. Richardson, in 1902, to the currents obtained by the emission of electricity from solid bodies raised to a temperature of incandescence. Since then the term has come into very general use in dealing with this subject, and the valves used for radio-telegraphy and other purposes, which depend upon this phenomenon for their action, are most suitably designated by the title "Thermionic," or, more briefly, "Ionic Valves."

Although it is nearly two hundred years since it was first observed that the air in the neighbourhood of red-hot metals is a conductor of electricity, the chief advance in our knowledge of this phenomenon has taken place during the last twenty or thirty years. Among the earlier investigators, Guthrie, in 1873, was the first to call attention to the distinction between positive and negative electrification.* He showed that a red-hot iron ball in air could retain a charge of negative but not of positive electricity, whereas when the ball was raised to a white heat it could not retain either a positive or negative charge.

The first systematic investigations were carried out by Elster and Geitel† during the years 1882–9. They studied in great detail the charge acquired by an insulated metal plate mounted close to a metallic filament within a glass bulb, under different conditions of filament temperature and gas pressure.

When the gas is air or oxygen at atmospheric pressure, the metal plate receives a positive charge which increases as the temperature of the filament is increased, until this is at a yellow heat. As the temperature is raised above this point the charge diminishes until, with the filament at a bright white heat, the charge received by the plate is very small. When the pressure of the gas inside the vessel is reduced, the charge received by the plate diminishes, and as the exhaustion proceeds a point is reached at which the charge changes sign, and for high filament temperatures and low gas pressures the charge on the plate reaches a large negative value. Both the sign and magnitude of the electrification are influenced by the nature of the substance comprising the filament and also by the nature of the gas ; for example, Elster and

* *Phil. Mag.* iv. 46, p. 257 (1873). † *Wied. Ann.* 1882–1889.

Geitel showed that in hydrogen the plate acquired a negative charge, even at atmospheric pressure.

At the Philadelphia Exhibition in 1884 Edison exhibited a discovery made by him during his investigations upon incandescent electric lamps.* The phenomenon, which has since become generally known as the "Edison effect," is briefly as follows :

A small insulated metal plate is sealed into an incandescent lamp, between the legs of the horse-shoe-shaped filament. When the filament is made incandescent by direct current, and a galvanometer is connected between the insulated plate and the negative end of the filament, practically no current will be observed flowing through the galvanometer ; whereas if the galvanometer is connected between the plate and the positive end of the filament a current will be observed flowing through the galvanometer, in direction from the filament to the plate, the current amounting to two or three milli-ampères, under suitable conditions. Neither Edison nor Sir William Preece, who subsequently carried out some experiments on this effect, gave any explanation of the phenomenon, nor was any practical application made of it.

Professor J. A. Fleming,† in 1890, showed that when the negative leg of the carbon loop was surrounded by a cylinder of either a metal or an insulating substance, the Edison effect almost entirely disappeared, and other experiments of a similar nature showed that the effect was due to passage of negative electricity from the incandescent filament to the cold electrode, an occurrence which Elster and Geitel, by a somewhat different method, had previously demonstrated in very high vacua.

Fleming also showed that the Edison effect is obtained, although to a very much smaller degree, when using platinum, instead of carbon, for the incandescent filament.

At this time the existence of electrons was unknown, and the flow of current between the incandescent filament and the metal plate was attributed to the passage of negatively charged carbon atoms. This view was also apparently supported by the fact that both carbon and platinum give off very fine dust, if they do not actually volatilise at high temperatures, as shown by the familiar deposit of carbon or metal on the glass walls of an evacuated vessel in which a filament has been glowing for a long period.

In 1899, however, Sir J. J. Thomson announced his epoch-making discoveries concerning masses much smaller than atoms, carrying a charge of negative electricity, which were first called "corpuscles," but which are now generally known as "electrons," and are still regarded as the ultimate units or elements of negative electricity. These electrons were shown to be the carriers of the negative electricity in the cathode rays present in the high tension discharge through a vacuum tube, and from measurements made in Sir J. J. Thomson's classical experiments it was shown that, while each electron carried the same charge as that carried by a hydrogen atom, its mass is equal to approximately only $\frac{1}{1800}$ of the mass of a hydrogen atom.‡

Similar measurements showed that in the case of a carbon filament glowing in

* Dyer and Martin, *Edison, His Life and Inventions*, Vol. II. † *Proc. Royal Institution*, 1890.
‡ J. J. Thomson *Conduction of Electricity through Gases*, Chapters V. and VI.

hydrogen at a very low pressure the negative electricity is given off by the filament in the form of free electrons.*

It was subsequently proved by Wehnelt that the electric current emanating from a lime-covered platinum cathode (the well-known Wehnelt cathode) is carried in the same manner by these negatively-charged corpuscles,† and that the current from such a cathode is much greater than that obtained from the platinum alone.

Hence it may be said that when a metal or carbon filament is rendered incandescent in a highly-exhausted vessel there is a continual evaporation or emanation of negative electricity from it in the form of electrons, the rate of such emanation being dependent, in the first place, on the nature and temperature of the glowing filament and on the nature and pressure of the surrounding gas.

This emission of electrons is readily explained by the electron theory which assumes that these negatively-charged corpuscles are disseminated through metals and carbon at all temperatures; they are in constant vibratory motion similar to that of the molecules of a gas, and are free to move in any direction under the influence of an electric force. These free electrons are normally retained within the metal by the electric force at the surface, which acts in a similar manner to the force at the surface of a liquid tending to prevent the molecules of the liquid escaping into the region above it. If the velocity of any electron is sufficiently high its kinetic energy may be great enough to carry it through the surface layer, and so enable it to escape from the metal into the surrounding space. Since the average velocity of the vibratory motion increases rapidly with the temperature, then, as the temperature increases, more and more of the electrons will be able to get through the surface layer and escape from the metal, the whole process being exactly analogous to the evaporation of a liquid with increasing temperature.

Applying the electron theory in this manner, Professor O. W. Richardson found that the rate of emission of electricity from incandescent bodies could be expressed by an equation of the form :—

$$N=a\sqrt{T}\,e^{\frac{-b}{T}}$$

where N is the number of electrons emitted per square centimetre of the hot body per second. T is the absolute temperature of the body, and a and b are constants. Richardson's measurements of the current obtained from a hot wire at different temperatures agree well with a formula of this form, and from his observations on different substances he gives the following values for the constants a and b ‡ :—

For carbon : $a=10^{34}$, $b=9{\cdot}8\times10^{4}$
,, platinum : $a=7{\cdot}5\times10^{25}$, $b=4{\cdot}93\times10^{4}$

These figures show that the emission from carbon is much greater than that from platinum. The rate of emission from tungsten at different temperatures, as calculated from an equation of the above form by Dr. Irving Langmuir, is shown by the curve in Fig. 1.

* J. J. Thomson, *Phil. Mag.* xlviii., p. 547 (1899). † Wehnelt, *Phil. Mag.* x., p. 80 (1905).
‡ J. J. Thomson, *Conduction of Electricity through Gases*, 2nd Edition, p. 201.

According to Richardson's theory an incandescent metal at any temperature emits electrons at a definite rate, which is independent of the electric field surrounding the hot body. If there is no electric field in the space surrounding the incandescent body, the electrons emitted return to the body and are reabsorbed. If, however, a positively charged body is brought near the heated solid, the electrons emitted will be drawn towards and absorbed by this body, their passage across the intervening space constituting an electric current flowing from the hot filament as cathode to the positively charged body as anode. The currents obtained in this manner were termed by Richardson "Thermionic Currents," a term which has since come into very general use.

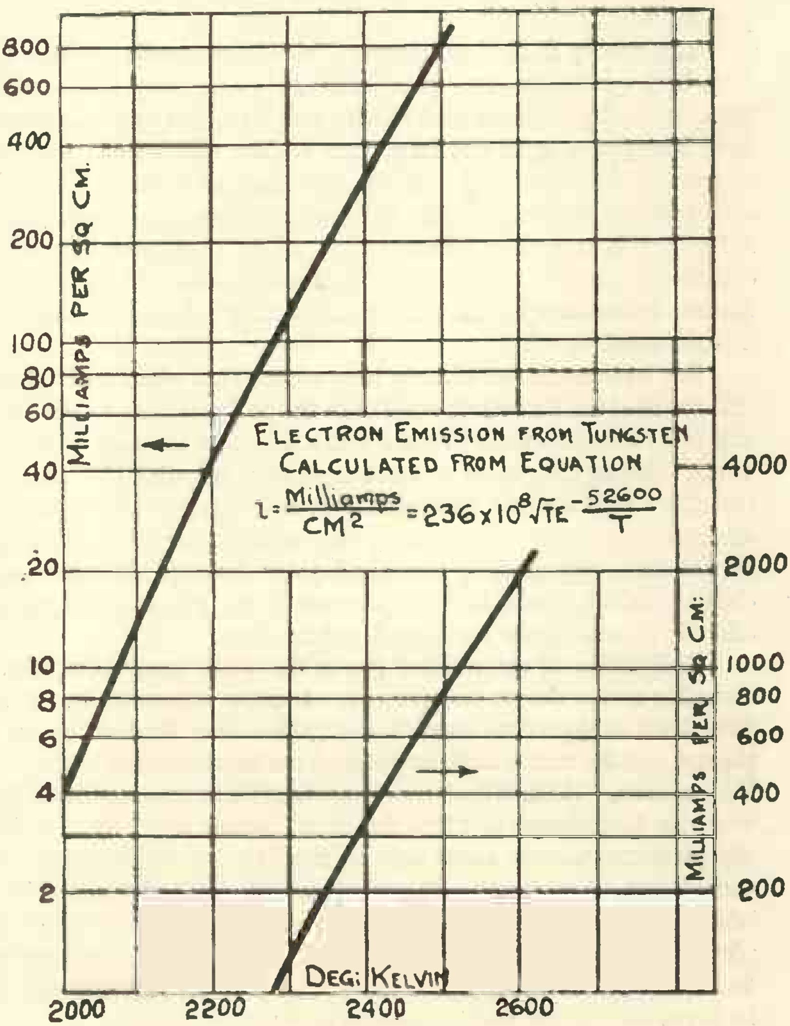


FIG. I.

If a negatively-charged body is brought near the hot filament, the electrons will be repelled from it and will ultimately return to the filament in a similar manner to the case in which there is no field external to the filament.

Viewed in this manner, the electron emission is independent of the flow of a thermionic current, the latter only taking place when a positively-charged electrode is brought near the glowing filament. As the potential of this electrode is increased, an increasing proportion of the electrons will be attracted towards and absorbed by it until finally a point is reached at which all the electrons emitted by the hot cathode are absorbed by the cold anode, and any further increase in potential of the latter will produce no increase in the current flowing to it. At this stage the thermionic current is said to be "saturated," and the magnitude of this current will be equal to the total charge carried by all the electrons emitted by the hot cathode per second.

The theory as thus put forward would apparently give a satisfactory explanation, both qualitative and quantitative, of elementary thermionic phenomena ; but there are many experimental results which are not so readily explained and which have brought to light one important feature which must be borne in mind when comparing the theoretical with the experimental results. The above theory takes no account of the action of the gaseous atmosphere surrounding the hot cathode, and it has now been well established that, unless very special precautions are taken to exclude it, the residual gas present in our so-called "high vacua" exerts a very marked influence upon the thermionic emission from any heated body enclosed in an exhausted vessel.

For instance, it has already been stated that when a metal wire is heated to a dull red heat the first effect consists in the production of positive ions round the wire, which increase in number as the temperature of the wire is raised, up to a certain value. Above this value of the temperature negative ions make their appearance, and these increase at a greater rate than the positive ions, until finally the sign of the resultant charge given off by the metal is negative. The presence of oxygen at pressures approaching one atmosphere favours the emission of the positive charge, while a diminished gas pressure or the presence of hydrogen has a marked effect in increasing the number of negative ions.

This action of the residual gas in the space surrounding the heated body and a similar action due to the presence of slight impurities in the heated body itself have been subjected to much investigation since Richardson first put forward his theory, and the results have emphasised the importance of taking these considerations into account. H. A. Wilson has shown that the electron emission from a hot platinum wire can be reduced to 1/250,000 of its former value by a preliminary boiling of the platinum wire in nitric acid to free it from the hydrogen which it so readily occludes on its surface.* The admission of a little hydrogen brought the current back to its former value. On one occasion during these experiments when a little phosphorus accidentally got on the wire the emission was enormously increased. In all cases, however, he found the variation of the emission with temperature could be expressed by the relation given above.

Some experiments carried out by Pring & Parker in 1912 showed also that the thermionic currents obtained from incandescent carbon in a vacuum decreased to extremely small values as the carbon is very carefully purified and the vacuum improved.†

Richardson also has shown that the positive emission from a heated wire is of a transitory nature. If the metal is heated at a constant temperature, the emission

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* H. A. Wilson, *Phil. Trans.* 202, p. 243 (1903). † Pring & Parker, *Phil. Mag.* xxiii., p. 192 (1912).

of positive ions falls off rapidly with time, the rate of decay increasing rapidly as the temperature is increased.

The results obtained by these and other investigators led to considerable doubt being thrown on Richardson's theory, and it was suggested the thermionic currents obtained in the majority of, if not in all, cases were due to chemical action arising from the impurities in the heated wire or the gas surrounding it, and that if a perfectly pure metal were heated in a perfect vacuum there would be no electron emission from it.

A very common example illustrating how small is the electron emission from an incandescent metal in a high vacuum is afforded in the ordinary tungsten filament incandescent lamp. The vacuum inside a tungsten lamp is very high, probably of the order of one-millionth of a millimetre of mercury after the lamp has been burning for some time, while the high efficiency of the lamp is due to the refractory nature of the metal, tungsten, enabling it to be run at such a high temperature without fear of its melting. It is evident that in the ordinary lamp the current flowing from one part of the filament to the other must be very small, whereas, according to Richardson's equation and experimental results, the thermionic emission from tungsten at temperatures near its melting point might amount to several ampères per square centimetre of its surface.

Dr. Irving Langmuir, however, has recently studied in great detail the thermionic currents from tungsten filaments in extremely high vacua, the pressures used being of the order of one-millionth of a millimetre of mercury or less ; and he has shown that the smallness of the currents previously obtained was not due to the failure of the filament to emit electrons, but due to the potentials applied to the anode being insufficient to enable the space surrounding the filament to carry the currents which could otherwise be obtained.* As a direct result of his investigations he concludes "that the electron emission from heated metals is a true property of the metals themselves, and is not, as has so often been thought, a secondary effect, due to the presence of gas."

In a typical experiment of Dr. Langmuir's two single-loop tungsten filaments were mounted in a bulb, which was then exhausted to the highest possible degree, utilising special methods of exhaust and special methods of treating the electrodes to free them from all occluded gas. One of the filaments was heated by an electric current and was used as the cathode, while the other filament served as the anode. A constant positive potential was applied to the anode in series with a galvanometer, and by varying the cathode heating current the relation between the thermionic current measured by the galvanometer and the temperature of the cathode was obtained and plotted in the form of a curve.

This curve representing the thermionic current as a function of the temperature consisted essentially of two parts ; during the first part the current increased according to Richardson's equation, and was independent of the voltage and the shape and size of the anode, whilst during the second part of the curve the current was influenced by both of these factors. If the dimensions of the anode and its potential

* I. Langmuir, *Proc. Inst. Radio Engineers*, April, 1915 ; *General Electric Review*, May, 1915 ; *Electrician*, lxxv., 240 (1915).

are maintained constant the current finally reaches a saturation value, and any further increase in temperature of the cathode produces practically no increase in the thermionic current. The greater the potential at which the anode is maintained, the greater will be the value of the saturation current and the higher will be the temperature to which the cathode must be raised before this saturation value is reached.

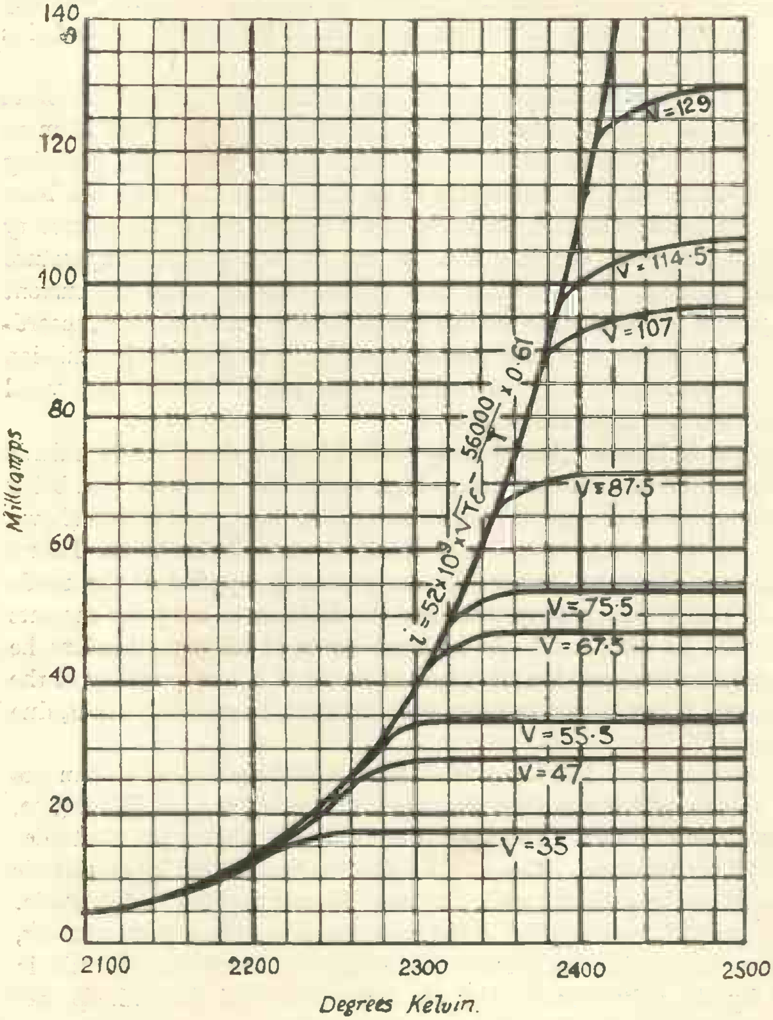

FIG. 2.

Fig. 2 shows a typical set of "current-temperature" curves obtained in the manner described above for different voltages applied to the anode. It will be observed that the early parts of all the curves coincide with the curve plotted from Richardson's equation.

This limitation of the thermionic current by the potential applied to the anode was found to be due to the electrons carrying the current constituting an electric "space charge" between the electrodes, which repelled the electrons escaping from the hot filament causing them to return to it. Langmuir has calculated the effect of this space charge, and finds that, in any bulb, the maximum thermionic current that can be carried by the space between cathode and anode is proportional to the potential difference between the electrodes raised to the power 3/2; and his experimental results are in complete accordance with this law, in the cases where the vacuum is so high that there is no appreciable positive ionisation within the bulb.*

The presence of a very minute trace of gas within the bulb, however, may lead to the formation of positive ions, sufficient to neutralise to a large extent the electronic space charge, and so greatly increase the current carrying capacity of the space. For instance, the presence of mercury vapour at a pressure of 10^{-5} mm. has been found, under suitable conditions, to completely neutralise the effect of the space charge, so that a current of 0·1 ampère was obtained with 25 volts on the anode, whereas without the mercury vapour over 200 volts were necessary to draw this current through the space.

Apart from this enormous effect on the current-carrying capacity of the space, the presence of a gas or vapour within the bulb exerts a considerable influence upon the thermionic emission from the cathode. But Langmuir found, contrary to the previously generally accepted opinion, that when the cathode is of pure tungsten the effect of any gas present is to decrease rather than increase the electronic emission. For example, it is found that the presence of oxygen or a gas containing oxygen, such as water vapour, at a pressure of 10^{-6} mm. will cut down the electronic emission to a small fraction of the value obtained in high vacuum.

This reduction of the emission by the presence of a gas is probably due to some chemical action, for it has been found that the inert gases of the argon group produce no such effect, and this fact has been employed in one type of rectifying valve, to obtain neutralisation of the space charge effect, without reducing the electron emission from the tungsten cathode.†

Having thus briefly reviewed the progress of our knowledge of the subject of thermionics, we will now proceed to consider the application of this knowledge in the various types of thermionic valves, used for the rectification, amplification and generation of alternating currents.

(*To be continued.*)

Share Market Report

LONDON, *March 12th*, 1918.

BUSINESS has been fairly active during the past month in the shares of the Marconi Group. The shares of the American Company are receiving marked support in view of the imminence of the publication of the figures. All other classes of shares have been well supported and show a marked upward tendency as we go to press. Marconi Ordinary, £3 3s. 9d.; Marconi Preference, £2 13s. 9d.; Marconi International Marine, £2 11s. 3d.; Canadian Marconi, 10s. 9d.; American Marconi, £1 5s.; Spanish and General, 9s.

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* I. Langmuir, *Physical Review*, ii., p. 450 (1913).

† G. S. Meikle, *Gas-Filled Rectifier, General Electric Review*, April, 1916; *Electrical Review*, lxxviii., p. 472 (1916).

Digest of Wireless Literature

Wireless Equipment on Submarines.

In a recent issue of the *New York Times*, an article was printed giving many particulars of the wireless equipment on German submarines. To receive or transmit wireless messages, says the writer, part of the apparatus must be raised above the earth or the water's surface. Much of the time the U-boat is below the water, and even when afloat, her masts rise but a few feet. Space, too, is so limited that it is difficult to find room for the rather bulky apparatus, and the extreme violence of the boat's movements in even a moderate sea adds greatly to the troubles of the wireless man.

The submarine wireless is so vital to these boats, that the problem has been attacked with unusual energy. Improvement in wireless equipment and methods has been amazing. Even at the beginning of the war the methods were comparatively crude. The most remarkable advance has come only within the past few months.

It is difficult to guard wireless secrets successfully against big fleets of warships and patrol boats in the waters infested with U-boats. German submarines, with their wireless equipment intact, are captured from time to time, thus enabling wireless experts to discover their newest secrets.

The great problem in fitting a submarine with wireless is to raise the antennæ as high as possible. At first special masts were built, which were set up amidships when the U-boat came to the surface, and the aerials were strung from the top of it to the furthermost ends of the deck. The sending radius was naturally limited. At the commencement of hostilities this was the only practicable method. The next step was to raise two masts, one at either end of the boat, and sling the aerials between them.

Telescopic masts then appeared, so that when the submarine came to the surface these masts were quickly pulled out to their extreme length, and set in place. The range both for sending and receiving messages was thus much increased. One of the great advantages of the telescopic device was the speed with which it could be adjusted. When the U-boat could show itself for only a few minutes, it was possible to put the wireless apparatus in place in a short time. At the signal to take down the wireless, preparatory to submerging, the masts could be taken down and folded up in a few seconds. Should a submarine go under with its wireless masts still in position, it ran the risk of having them carried away and lost.

Several German boats, says the article, have been captured carrying an ingenious device for winding up the aerial automatically, in order to save a few priceless seconds. The wire was coiled up instantly by the mere touching of a spring. Such apparatus, or adaptations of it, are still in use on some of the German submarines.

According to the article, for the accuracy of which of course we cannot vouch, the newest German device for extending the range of wireless signalling is a highly ingenious use of balloons. The success of the U-boats is believed to be largely due to this. Antennæ are raised to a height of at least 2,000 feet above the sea by means of the balloons, two of which are used connected by a stiff rod. When an enemy is sighted they are pulled down quickly by means of a windlass operated by electricity. The balloons are painted partly white and partly blue, so that they are scarcely distinguishable from the sky.

It is practically impossible, therefore, to bring them down with anti-aircraft guns. With the antennæ raised to the height of half a mile, it is possible to receive wireless communications from almost any part of the world.

ELECTRICAL CONDUCTION IN METAL AT LOW TEMPERATURE.

The experiments of H. K. Onnes, on the resistivity of metals and liquid helium temperatures, have shown that certain metals possess an increased conductivity when the temperature, current density, and magnetic field are less than certain critical values. It is pointed out by F. B. Silsbee, in a recent publication of the Bureau of Standards, that a definite relationship is to be expected between the values of critical current and critical field, and that this relation is in agreement with the experimental data available.

The present state of our experimental knowledge of this subject is somewhat as follows: Certain metals—mercury, tin and lead—at the very low temperatures obtainable in a bath of liquid helium, show a very greatly increased electrical conductivity to which Onnes has given the name "superconductivity." The actual resistivity of the metal in this state is too small to measure, but has been shown to be less than 2.10–11 times the resistivity at 0° C. As the temperature of any of these metals is lowered from room temperature the resistance decreases uniformly with the normal co-efficient of about 0.4 per cent. per degree, until the temperature is very low, when the rate of decrease becomes for a time less rapid. At a certain critical temperature, however (4° 2 K for mercury, 3° 8 K for tin, and 6° K for lead), there is a sudden break in the curve connecting resistance and temperature, and within a temperature range of a few hundredths of a degree the resistance drops from about 10–8 times its value at 0° C. to less than 10–10 times the same value. Other metals, such as gold, silver, platinum, iron, etc., do not show this phenomenon, and their resistivity tends to approach a constant value as the temperature is lowered to the lowest value (1° 6 K), at which such measurements have been made.

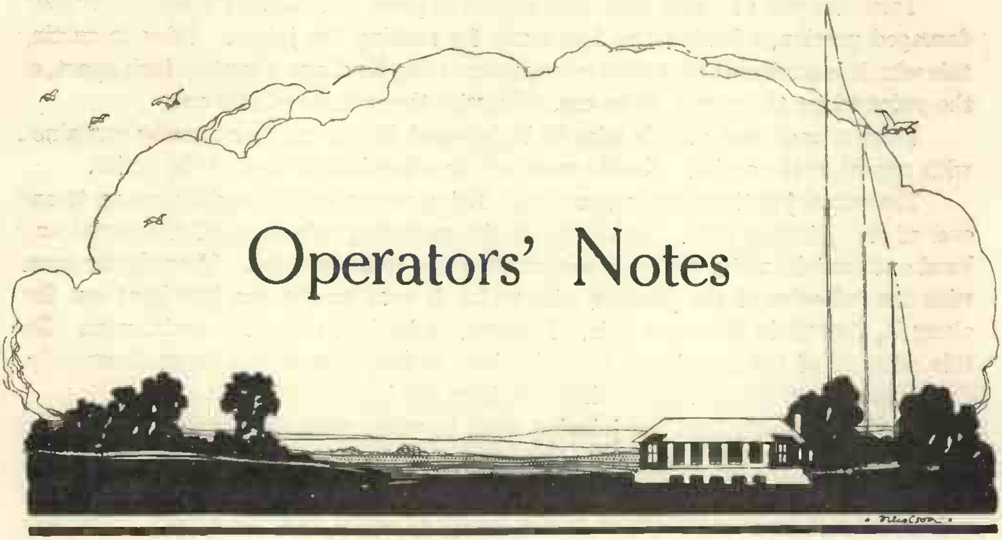
It is further found that when a superconductor is placed in a weak magnetic field it remains superconducting, but that, as the field is increased, the normal resistance appears suddenly at a certain critical value of the magnetic field, and, for still higher values of field, increases slowly with the field.

The Detection of Undamped Oscillations.

It is a well-known fact that undamped oscillations cannot be detected by the ordinary radio-frequency rectifier, because of the fact of the advancing wave train. Hence some means must be provided at the receiving apparatus whereby the incoming signals can be converted into an audio-frequency current suitable for operation at the head telephones. A recent United States patent, granted to Elmer E. Bucher, shows a novel method for converting radio-frequency currents into currents of audio-frequency. The mechanical receivers heretofore adopted for such a detection have been either the tikker or the slipping contact detector, both of which possess the disadvantage that they were somewhat troublesome in adjustment, and would give an impure or imperfect note in the head telephones. Besides these methods there are, of course, those utilising the vacuum valve already explained in the pages of this magazine. The novelty of the system disclosed by the inventor lies in the use of a rotating condenser of variable capacity, which is placed in various positions in the receiving circuit to vary the amplitude of the incoming oscillations. The rotating condenser resembles in construction the ordinary air condenser composed of two sets of plates interleaved with one another. In the case of this invention, the moveable plates are attached to the shaft of an electric motor. One method of connecting the rotating condenser to the receiving circuit consists in substituting it for the usual variable condenser shunted across the secondary inductance. Across this the crystal detector and telephones, together with a small condenser, are shunted in the usual fashion. If the value of the secondary inductance is properly adjusted, so that at a certain position of the revolving condenser the circuit is in resonance with the incoming oscillations, current will flow periodically through the crystal rectifier, charging the condenser across the telephones, this condenser discharging through the telephones in the usual fashion. If the rotating condenser is of such construction, or revolves at such speed that the secondary circuit is thrown into resonance with the aerial circuit, say 500 to 750 times per second, a very clear tone will be obtained in the telephones. If the condenser is stopped at the required value of capacity the circuit will respond equally well to damped waves. Other arrangements place the rotating condenser directly in series with the aerial, and in a separate circuit coupled to the aerial.

The Arlington Wireless Station.

A recent issue of the *Electrical Experimenter* gives an article from the pen of a wireless amateur who had an opportunity, not long ago, of visiting this powerful station. Speaking of the lattice towers, which are well known to our readers from the photographs which have appeared from time to time, the writer says that illustrations cannot possibly give an idea of the immense size of these structures. The receiving room he describes as built like an ice box, with walls 2 feet thick. Inside the room not the slightest sound is heard from the adjacent transmitting plant. Two men are always on duty, one in the transmitting room, and one in the receiving room. On the receiving operator hearing a call, he signals to the transmitting room to start up the set, he himself transmitting by means of a relay key.



Repairing an Aerial

By HAROLD WARD

I WONDER how many operators splice their own aerials when necessity arises? Very few, if any. The very word "splice" seems to raise up a terrifying picture of ropes and spikes in a seemingly hopeless tangle, with dozens of seemingly useless ends. The usual procedure is to go to the bo'sun, who tells off an A.B. to do it for you. On some boats it would be considered *infra dig.*, I know, for anyone in a double-breasted brass-buttoned coat to do such work, but at the same time much more satisfaction is derived from a job done personally.

Now although to splice correctly a seven-strand wire requires considerable experience, a very satisfactory substitute joint—this is the age of substitutes—can be readily made. The method employed is simplicity itself, although the explanation is necessarily somewhat involved, and after a little practice an operator should be able to turn out a firm joint in fifteen minutes or less.

Proceed, then, as follows. Lay the broken aerial along the deck, with ends touching, and measure the length of rotten or damaged wire which it is advisable to remove. If the break has occurred above the funnel this will be about twenty or thirty feet. Cut out the damaged wire with pliers, and about nine or ten inches higher up bind tightly with string. This is to prevent the ends from flying out.

Untwist the seven component wires and splay them out, wide apart. Should each component wire be of seven smaller strands, these ends should be temporarily bound with string. An ordinary seven-strand wire is usually formed of six strands wound round a central one known as the "core." This core should be cut off at the point where the other component strands were first bound together, which will leave a main wire with six sub-wires radiating from it like the ribs of an umbrella.

Take the coil of spare wire and cut off a piece of sufficient length to replace damaged portion, allowing two feet extra for making the joints. Prior to cutting this wire it is advisable to make two separate string bindings, about an inch apart, at the point where the wire is to be cut, otherwise the strands will fly out.

Prepare each end of this wire to be inserted in the manner already explained with regard to the aerial. Do the same at the other broken end of the aerial.

The actual jointing now commences. Bring one end of the aerial close up to one end of the jointing wire. Take one of the radiating sub-wires of the aerial and bend out straight along the main wire of the piece to be inserted. Then do the same with the sub-wire of the jointing wire which is next to the one just bent out flat along it, though in this case it is, of course, to be laid along the aerial wire. Do this with all of the remaining ten sub-wires, taking care to use them alternately, that is, one from the aerial and then one from the jointing wire.

Having done so, hold the jointing wire, together with the six sub-wires of the aerial, firmly in the left hand, and give any one of the wires belonging to the jointer a complete twist round the main aerial wire, making it as tight as possible. This twist must not be at right angles to the length of aerial, but nearer 45°. The best angle can only be found by experience. Now follow suit with the other five wires, utilising them in their proper order and taking care that they lie close to each other. This will give six sub-wires spirally twisted round the main aerial wire. Make as many twists as is necessary to use up the whole length of all the sub-wires. Bind the end of these twists firmly and neatly with copper binding wire, having made them as tight as possible with the aid of pliers.

The next step is to change hands and, holding the aerial in the left hand, proceed to twist the six sub-wires forming it firmly round the jointing wire in the same manner as just described, not forgetting to bind their ends well. This completes one joint.

All that remains is to go through the whole process again with the remaining two ends, which will, if carefully done, give a neat and strong joint. The greater the pull on the aerial the tighter will the joint become and therefore the better contact will be made.

The above is known as the "star joint" and is much used for lighting and power wires.

It is a good plan to practise with odd lengths of ordinary 7/18 soft copper cable before trying aerial wire, as the springiness of phosphor bronze is rather discouraging until the knack is acquired.

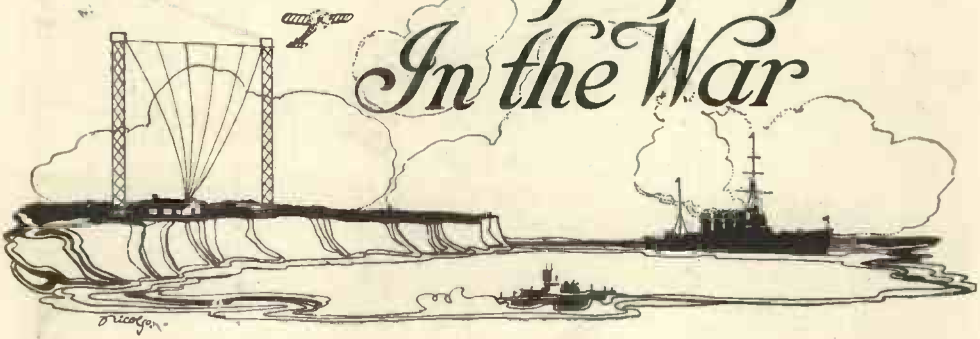
In case there is no time to make a star joint in the aerial, a good temporary one may be made as follows :

Cut out the damaged wire and bind up the ends of the aerial. Measure, and cut off, the jointing piece. Bring the two ends together and lay them alongside each other for about a foot. Now bind them tightly together with binding wire. A little solder will ensure a good connection and give a fairly secure joint.

Whenever soldering aerial wire always use the soldering iron in preference to the lamp, as thus only the minimum amount of heat required is used.

Avoid soldering an aerial whenever possible, as it makes the wire brittle.

Wireless Telegraphy In the War



WIRELESS ABUSE—A TWO-EDGED WEAPON.

WHEN the Bolsheviks in December last announced their intention of immediately erecting a chain of wireless stations for the greater enlightenment of the Russian peoples and the peaceful development of the several nationalities which they hoped would become loyal components of the Russian Republic, it appeared as though these extremists had grasped one of the great possibilities of radio-telegraphy and had evolved a practical constructive programme. The news at the time of writing suggests that the Bolsheviks, in their use of wireless to date, have been playing with an edged tool, and have succeeded thereby not only in crippling themselves but in inflicting grave, if not mortal, injury upon the national life of millions whom they audaciously claimed to represent.

One of the earliest Bolshevik battle-cries was in effect a condemnation of secret diplomacy. It was cleverly timed, and following closely upon the "Willy-Nicky" and other revelations of international intrigue, gained the moral support of many whose sympathies are naturally against underground methods. The delusion, however, that the Russian Revolutionaries were about to open up a straight and wide road to common brotherhood was short-lived, for it immediately became apparent that the Bolshevik idea of "open diplomacy" embraced, amongst other things, the public abusing of those with whom diplomatic relations were intended.

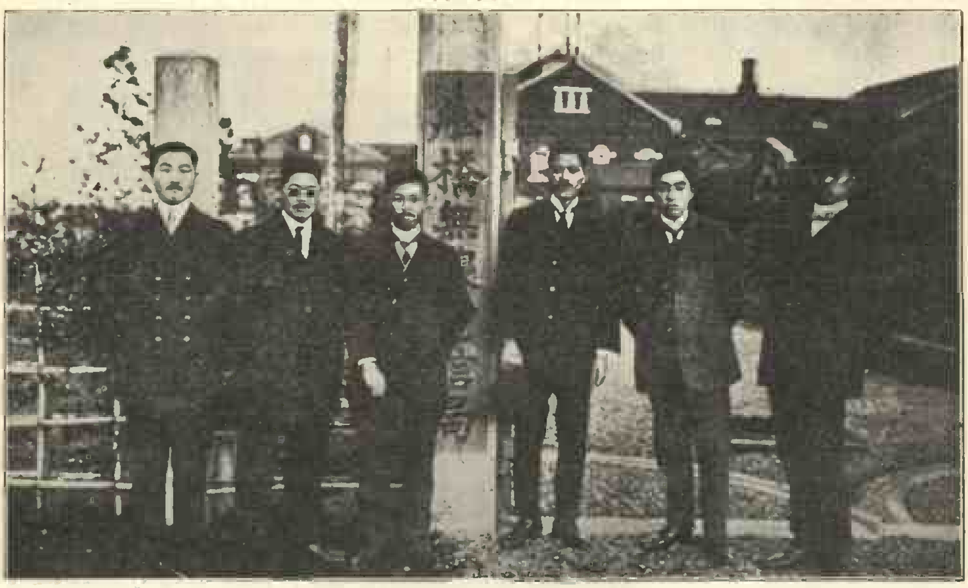
The history of the war is hardly likely to contain more astonishing documentary material than the peculiarly undiplomatic addresses and Proclamations radiated by wireless from Russian Government stations during January and February of this year. Whatever the Bolsheviks had in mind when they circulated such fanatical outpourings it is difficult to imagine, but, in common parlance, they were simply asking for trouble, for, being unable like the Germans to support their insolence with force of arms, they placed themselves somewhat in the position of a schoolboy making long noses before the magisterial birch. That punishment was premeditated by the Germans was obvious, but it is unlikely that the blow was softened by the "wireless" indiscretions.

OFFICERS AND MEN AT AN IMPORTANT WIRELESS STATION "SOMEWHERE IN ENGLAND."

Why Lenin and Trotzky should have stimulated the predatory activities of the German militarists by hurling wireless abuse at the power behind the German military machine is but one of the baffling features of the Bolshevik policy. Their "wireless" appeal on February 17th for an immediate "wireless" explanation of the German "provocative telegram" of the previous day announcing a renewal of hostilities would suggest either that these men were ignorant of German psychology or that they were German agents acting a double part. Their apparent childlike belief that a "wireless" message, tantamount to the command "Halt!" would reduce the advancing German hordes to marking time is equally astounding, and the one lesson which they must have learned is, that whereas wireless can provide a means of instant communication even between belligerent nations, radiotelegraphy cannot of its own power effect an instant and accommodating reply. On the other hand, these wireless demands undoubtedly embarrassed the Germans, who, taxed to find a means of delaying their replies whilst their troops "made good" on enemy soil, had to resort, first of all, to the excuse that a wireless message could not be regarded as an official document, and later, when the signatures arrived by special messenger, to the explanation that the deliberations upon the Note of reply would necessarily occupy a few days. What happened during the few days is now well known. The moral of the episode is that for the satisfactory development of the great and valuable medium for international intercourse which wireless affords, a special training of the imaginative faculties is required. The Bolshevik imaginings were concentrated upon the exotic clothing of their abuse.

"ARMED" WITH WIRELESS: A TYPICAL ADVENTURE.

Amongst the several excellent stories of British pluck *versus* German U-boat piracy which the Admiralty have wisely considered worthy of publicity was one told recently in the *Yorkshire Observer* by a well-informed writer hiding his identity beneath the pen-name "Ajax." Relating the adventures of two steamers, one of which was armed and detailed to protect her "sister," he tells how the armed ship—armed with a gun that is—ran into the danger zone of a submarine and received a hit from a torpedo. The crew, with the exception of the master and his two gunners, drew away, under instructions, in the ship's boat. The unarmed vessel, meanwhile manœuvring for safety, made off according to previous arrangement. The fight between the three men on the sinking vessel and the submarine proved an unequal one, for the submarine with its greater mobility was able at the end of half an hour's duelling to get home a second torpedo, leaving the plucky master and his gunners no alternative but to take to the emergency boat and await help. This happily was ultimately forthcoming, for the sister ship happened also to be armed—not with guns, but that very useful weapon, "wireless," and when the first torpedo found its billet the Marconi man also went into action with the regulation appeals for assistance. These were picked up by an American destroyer, which, with an alertness characteristic of the naval service of our cousins, steamed at full speed to the spot. The U-boat and its victim were gone, but the gallant seamen were rescued. The unarmed vessel reached its destination without further incident. No better illustration has been furnished of effective co-operation between two boats unequally protected against the hidden foe. We can thoroughly understand that



THE OPERATING STAFF AT FUNABASHI WIRELESS STATION, JAPAN, NOW ENGAGED ON IMPORTANT WAR WORK.

additional sense of security which all feel who go to sea in these days with a Marconi man and his mysterious "box of tricks."

Wireless Clue to "Lusitania" Crime.

Students of criminology tell us that experience reveals a surprising inability on the part of the habitual evil-doer to completely cover up his tracks, so that in such instances where crimes remain unsolved the fault lies rather in the lack of ingenuity or persistence on the part of the investigators. The criminal history of the German nation appears closely to follow that of individuals in this characteristic weakness, for day by day facts are being laid bare before the whole world which certainly were not "intended for publication" by their fiendish authors. It will be remembered that when the *Lusitania* was sent to the bottom with its numerous innocent souls the German Government whilst permitting "irresponsible folk" to celebrate the massacre by the striking of a medal, took care officially to suggest that if the loss were due to submarine activity, the U-boat commander responsible for the deed had acted off his own bat and not under instructions from the Wilhelmstrasse.

Whilst few persons have had any doubt as to the real authors of this unspeakable outrage upon humanity it has taken nearly three years to give to history undisputed evidence of the German Government's direct guilt, and this, if the whole story has been told, has only been possible through systematic investigations of wireless enthusiasts attached to the staff of the *Providence Journal* working under the direction of the editor, Mr. John R. Rathom.

On the morning of April 29th, 1915, Mr. Rathom's assistants, who were listening to a Nauen programme, intercepted the following:

"From Berlin Foreign Office.

"To Botschaft, Washington.

"669 (44-W) Welt nineteen-fifteen warne 175 29 1 stop 175 1 2 stop durch 622 2 4 stop 19 7 18 stop LIX 11 3 4 5 6." Now this obvious code bore no resemblance to the "Father dead" or other types of secret messages which had so often been flashed abroad from Nauen, and for a while the self-appointed detectives were puzzled. Later on, however, when the disaster to the *Lusitania* became known and American interest in all things German became intensified, the *Providence Journal* investigators learned that Prince Hatzfeldt, of the German Embassy staff, spent part of the morning of April 29th, 1915, hunting for a copy of the *New York World* Almanac for 1915. This fact provided the much sought-for key, for the pages, lines and words of the "Welt" Almanac indicated by the figures given above, provided the following transcription:

"Warn *Lusitania* passenger(s) through Press not voyage across the Atlantic."

The German Ambassador, it will be remembered, admitted the publication of an advertisement in the New York papers but denied that it had any particular reference to the *Lusitania*. How much truth can be attached to that statement is revealed, firstly, through the present exposure of the coded message from Nauen.

and secondly, from his action in giving a dinner in New York to celebrate the crime on the very evening when he declared to the American Press that he was overwhelmed with grief at the great Cunarder's fate. Is there still in the whole world any honest man who is prepared to defend the arch-rogues of Central Europe ?

Wireless Warfare in Oxford Street.

If the coded wireless message of that April morning in 1915 condemns for all time the exalted murderers of the Berlin Court, another much more recent and more easily understood communication through the same channel has indicated a continued intent to deceive. In the second week of February England was made to rock with laughter by a German wireless story for neutral consumption of an alleged riot in Oxford Street, London. The wily director of Hun propaganda, with the double purpose of impressing the world with the authenticity of the story and of providing a loophole should he be caught out in his facts, credited the details to his Amsterdam correspondent. For the benefit of our readers who, being at sea or otherwise engaged, did not read the message when published in the newspapers, we reproduce it here in its entirety.

" During the whole of January the strikes in England have led to numerous " riots and scenes in the streets. Hardly a day passed during the month without " the crowd coming into conflict with the police in English towns. Concerning one of " these riots which took place in London on January 17th and which is typical of " the state of affairs in England, our Amsterdam correspondent gives the following " details :

" On January 17th at 3 p.m. there was a conflict between the police and the " crowd, in which the police had the worst of it and were put to flight. Then a " detachment of Scotch recruits who were in barracks at Sheper Bush (Shepherd's " Bush ?) were summoned to their assistance. When they reached Oxford Street, " where the principal fighting between the crowd and the police took place, and " the soldiers were ordered to fire, the majority of them refused, and about 80 men " were arrested and taken to the prison of Old Bailey. At Selfridge's great shop " in Oxford Street all the windows were broken in the riot. In the evening there " were other tumults near Threadneedle Street."

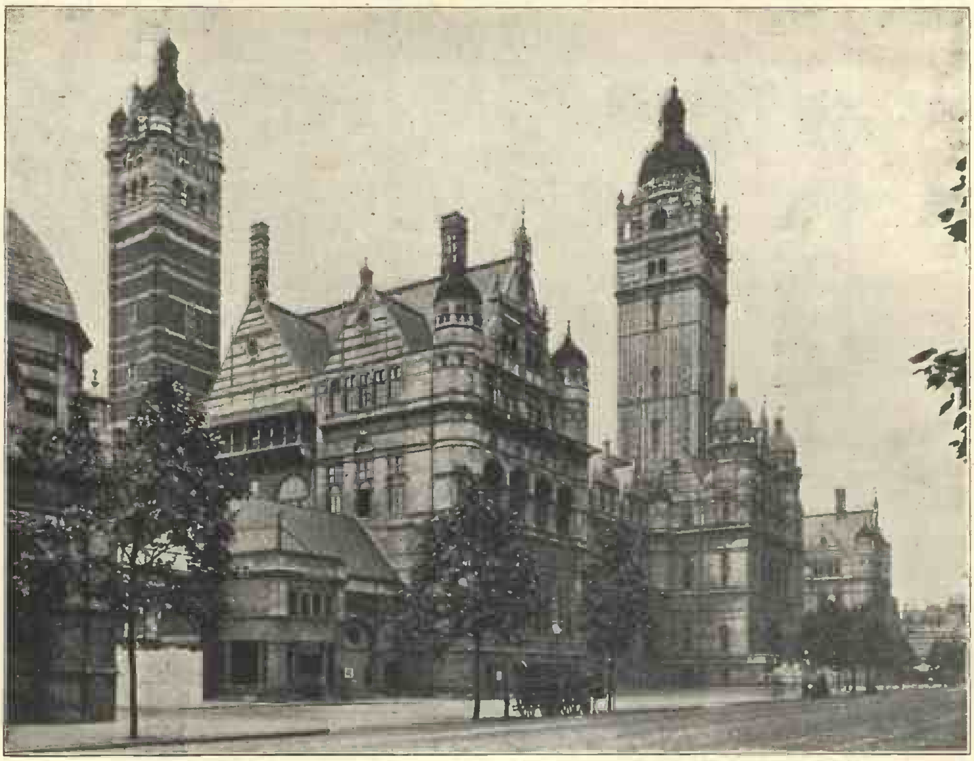
Now the Amsterdam correspondent of the Berlin Department of Information, so " thoroughly informed " regarding time and place of this highly entertaining episode, omitted one or two details which might perhaps have carried conviction for those who, not knowing London, are " given to thought," even when dealing with Berlin wireless. Seeing that the police had been put to flight there is no clue as to the forces employed for the arrest and incarceration of the " Jocks " from " Sheper Bush " in a jail which ceased to exist long before the war, neither have we information on that point of legitimate curiosity, namely, the number of casualties caused by that minority of kilted " rookies " who did not refuse to fire. Somehow the laugh which echoed throughout the country when the story was told over here has aroused suspicion in the German provinces, for certain German journals have been at pains to explain that this pretty little legend was not radiated by wireless at all, but was concocted here, presumably as a spare-time effort, by British spies.

The Science Museum at South Kensington

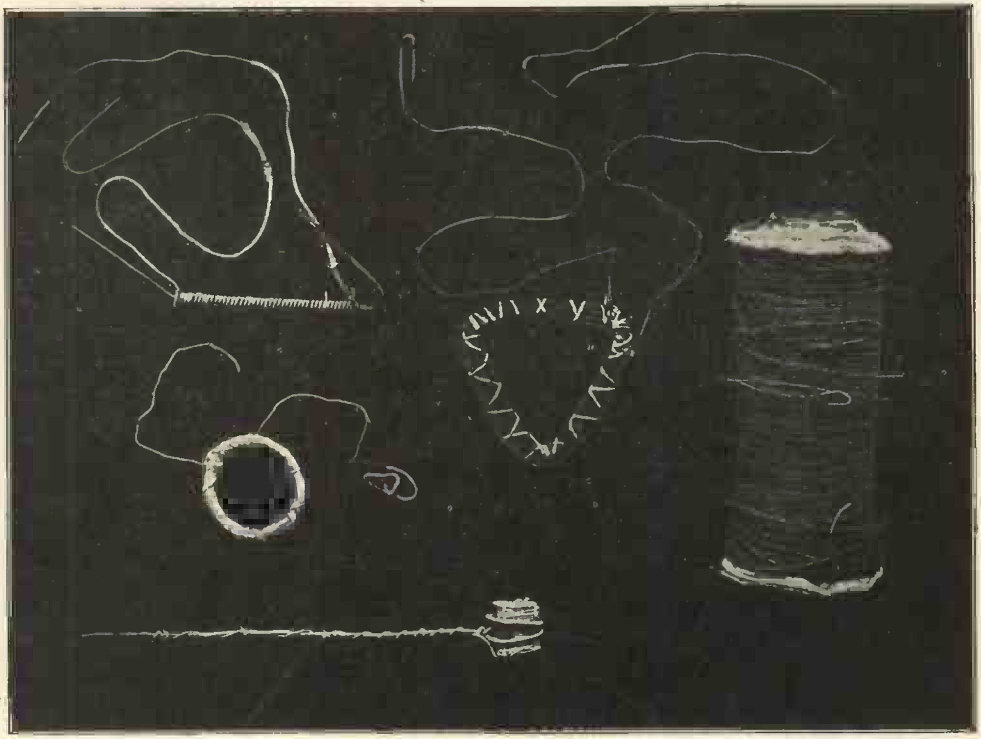
Exhibits of Interest to the Wireless Student

FEW students of wireless telegraphy now resident in London are aware that there exists in the Science Division of the Victoria and Albert Museum at South Kensington a collection of electrical apparatus, the examination of which would prove of the greatest value to them in their studies. In normal times these galleries are open every weekday, but at present the electrical section—the part of particular interest to our readers—is open only on Thursday and Friday between the hours of 2 p.m. and 4.45 p.m. Needless to say admission is free and the exhibits are so well desciibed and labelled that there is no need to purchase a catalogue.

The visitor to the Science Museum should make his way first to the South Kensington " Underground " Station (Distiict Railway or Piccadilly and Brompton Tube), and thence walk up Exhibition Road to Imperial Institute Road, a turning



IMPERIAL INSTITUTE, SOUTH KENSINGTON.



COILS USED BY FARADAY.

to the left, some five minutes' walk along the former thoroughfare. The Imperial Institute, a photograph of which is reproduced in this article, is easily found, the central tower being a landmark of South Kensington. The Science Museum occupies galleries on both sides of Imperial Institute Road, the entrance to the Western Galleries being to the extreme left of the photograph, the word " Division " in the illustration being a part of the " Science Division." Just opposite this entrance are the Southern Galleries, for which the student should aim. The Electrical Room is at the top of the staircase immediately facing the visitor on his entry.

There are few exhibits of actual wireless apparatus in this room, but many which can be profitably studied by the student endeavouring to obtain a good groundwork of electricity and magnetism. Students of high tension electricity will be interested in the splendid exhibit of Frictional and Wimshurst machines, a giant example of the latter being one of the first objects seen. This machine, which has two huge glass plates each 7 feet in diameter, will generate a 14-inch spark and was constructed by Wimshurst himself. In a near-by case a much more compact, although equally powerful, instrument consists of twelve plates, 2 feet 6 inches in diameter. The Wimshurst machine is an instrument of which the construction can be understood far more easily by examination than by any number of diagrams, and five minutes spent before this case will probably serve to clear up a host of difficulties. To those who wish to understand the construction of various forms of measuring instruments such as ammeters, voltmeters and the like, there is a splendidly arranged collection of instruments, many of them in pieces or in sections. In particular we would mention a series of hot wire ammeters. Accumulators, too, are clearly explained, and wall cases show the various parts of chloride and other cells in process of manufacture. There is no better method of explaining the construction of an accumulator than to show the student the various parts in process of manufacture, and, seeing that the chloride cell is largely used in wireless work, this exhibit should be carefully studied.

In the section devoted to induction coils and transformers will be found a representative section of various forms of interrupter, including the vibrating, mercury jet, and electrolytic types. It may be mentioned that there are at least three forms of Wehnelt Brake at present on view.

Not the least interesting of the exhibits is a full-sized model of a table used by the famous French electrician Ampère for research and lecture work, and near by will be found a collection of some of the original coils used by Faraday. If they serve no other purpose these exhibits will show the student that the best work of some of the greatest scientists has been done with the crudest and simplest apparatus, and that it is not necessary to be equipped with elaborate apparatus to make important discoveries. The actual apparatus used by many other famous men is also on view and the wireless student should particularly note the first shunted field dynamo made by Wheatstone and the first series wound machine made by Siemens. Particular interest also attaches to the first alternator made by Ferranti, to be found not many yards away.

Visitors who wish to trace the history of the wire telegraph will find an unrivalled collection of original apparatus dating right back from the time of Morse and Lindsay. Our remark above concerning the simplicity of the apparatus

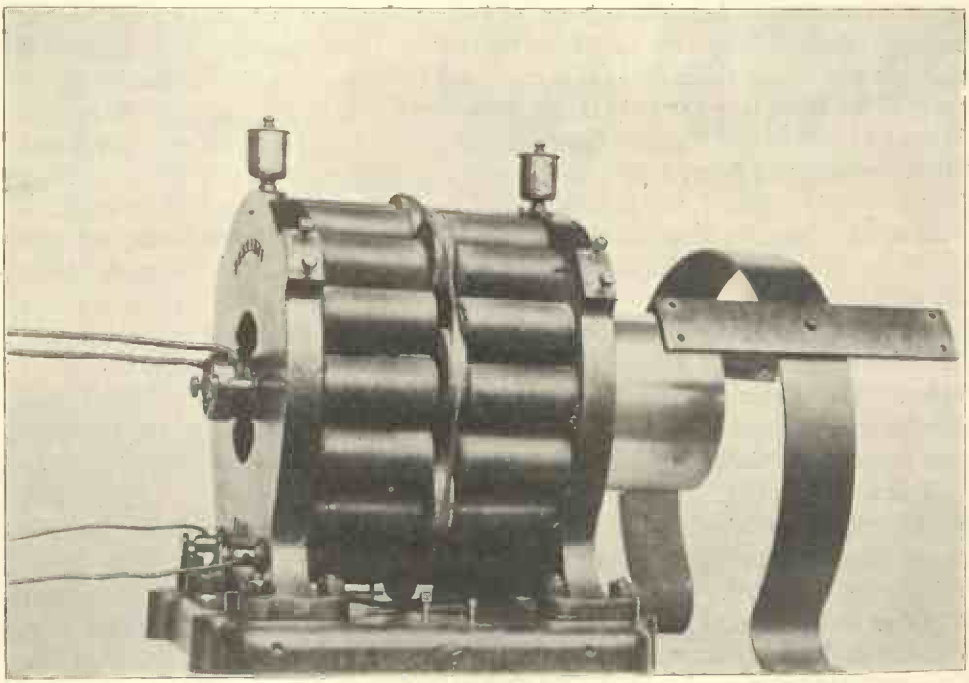
EARLY INDUCTION COIL.

used by great inventors will be found to apply equally to that of Morse and the workers who followed him in his researches.

The telegraph apparatus illustrated on pages 830 and 831 of our March issue can be examined in the original and the gradual improvement through succeeding years traced progressively, and a recent addition to the collection is the apparatus constructed by Mr. Duddell and illustrated in our January issue, pages 673 and 676.

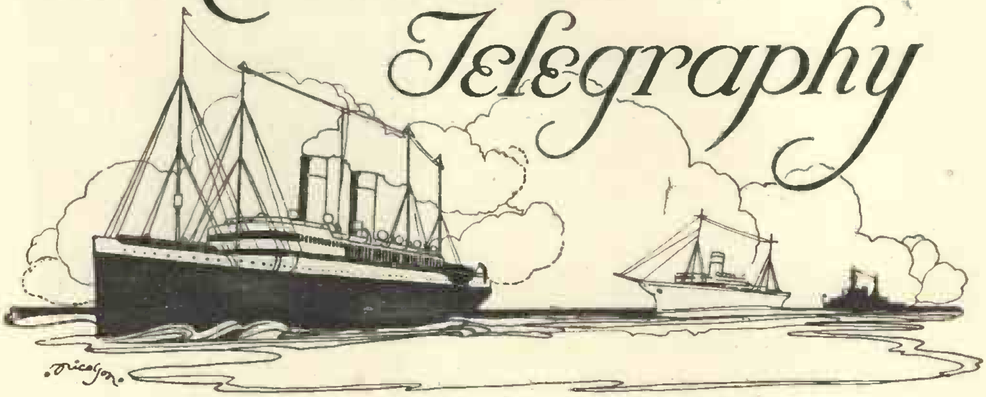
ROTOR WINDING OF THE FIRST ALTERNATOR.

In view of the completeness of the wire telegraph and telephone sections of the exhibits, it is somewhat surprising to find that radiotelegraphy is given but one small case. Here we find a Fleming Cymometer, an early Marconi Coherer Set, a small Demonstration Transmitter and Receiver and a model of the Magnetic Detector. In order to make the collection representative, many more wireless exhibits should obviously be added, and we trust that as soon as conditions permit this question will be looked into by the Museum authorities.



THE FIRST ALTERNATOR.

Maritime Wireless Telegraphy



The Seventh Hospital Ship.

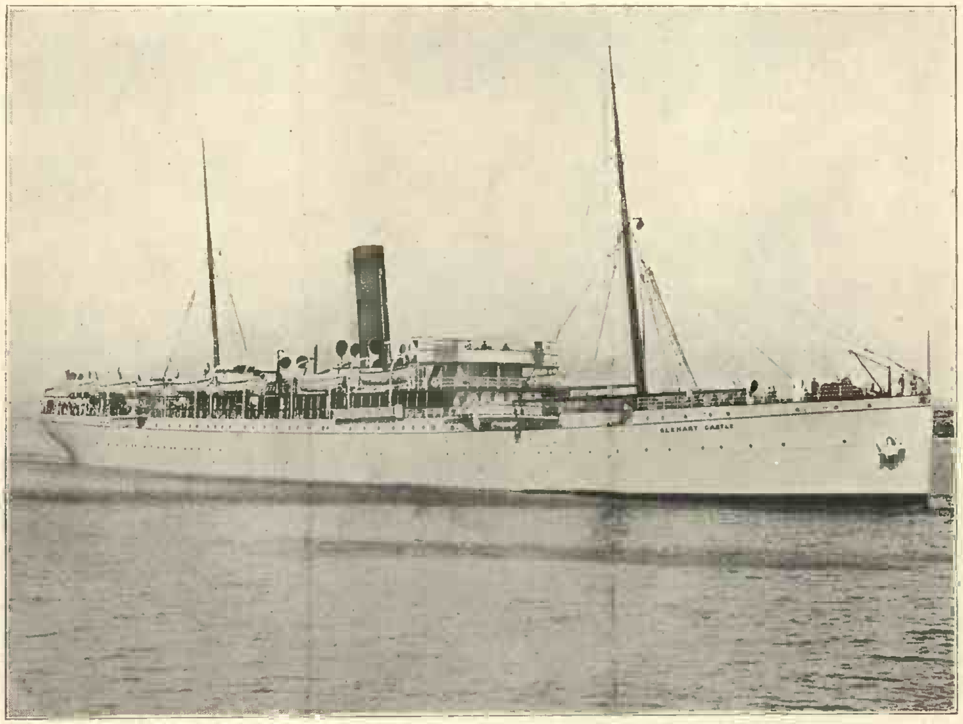
If there is any special significance to be attached to the number "7" the German Admiralty should be experiencing an innate uneasiness, for they have now definitely registered on their infamous records the sinking of seven British hospital ships. As by a desperate decision to sink at sight any vessel suspected of carrying munitions of war the German Government merely succeeded in bringing into conflict against them a most formidable group of foes, so, by these ghoulish attacks on the sacred symbols of humanity they have created for themselves a lasting shame. If when the war is over Germans of high and lowly birth find themselves shunned as the lepers of the East, they can only thank those who for slight material gain abandoned all sense of honour and common decency. We have oft repeated the conviction that British seamen will never forget, and if retribution is not immediately forthcoming through other agencies it will ultimately be found in the ostracism of every wretched German who dares to show himself upon the high seas. The *Glenart Castle*, although unable to utilise her wireless when she succumbed to this foul and inhuman attack, did on at least one occasion make a material contribution to the triumphs of radiotelegraphy. Early in the war, when known as the *Galician*, she was stopped off the Canaries by the *Kaiser Wilhelm der Grosse*, then engaged as a commerce raider. The *Galician's* wireless operator sent the usual "SOS," but was threatened with immediate sinking if he tapped out another signal. The Germans then boarded the *Galician*, destroyed the wireless apparatus and ordered the ship to follow the raider. The broken message, however, had taken effect. Two British cruisers hastened to the rescue and the *Kaiser Wilhelm der Grosse*, hearing an exchange of messages between these warships, made off with all the speed which she possessed. Shortly afterwards she encountered the light cruiser *Highflyer* and was sent to the bottom. The *Highflyer* received "wireless congratulations" on her prowess. Happily we are able to record the safety of the *Glenart Castle's* operator.

A FINE SAVE: THE TUSCANIA'S "SOS."

It is gratifying that "wireless" played so effective a part in saving the great majority of the American troops which were aboard the Allan liner *Tuscania* when she was torpedoed off the coast of Ireland early in February. This fine boat, the first, and let us hope the last, American transport to be torpedoed, was completed on the Clyde early in the war. She was fitted with every modern appliance securing comfort and relative safety. Thanks to the wireless signals sent out by the emergency apparatus, British escorts and patrol vessels were able to save 2,187 out of the 2,397 souls aboard. The attack on this ship took place under the cover of darkness, when presumably the Germans expected a maximum of confusion; but all reports show that despite the fact that many of the troops aboard had not seen the sea until they left the American port they behaved with traditional courage and stoicism, lining up on board, and singing their national airs whilst standing as on parade. Such lives as were lost, apart from the direct effects of the explosion, were caused by a natural anxiety on the part of a few to get clear when the ship took an ugly list. Even this effort by the Germans will not be without its reflex action, for some two thousand officers and men have gone to France with personal accounts to settle against the Huns. To use an American's own words, "Our hearts are steeled."

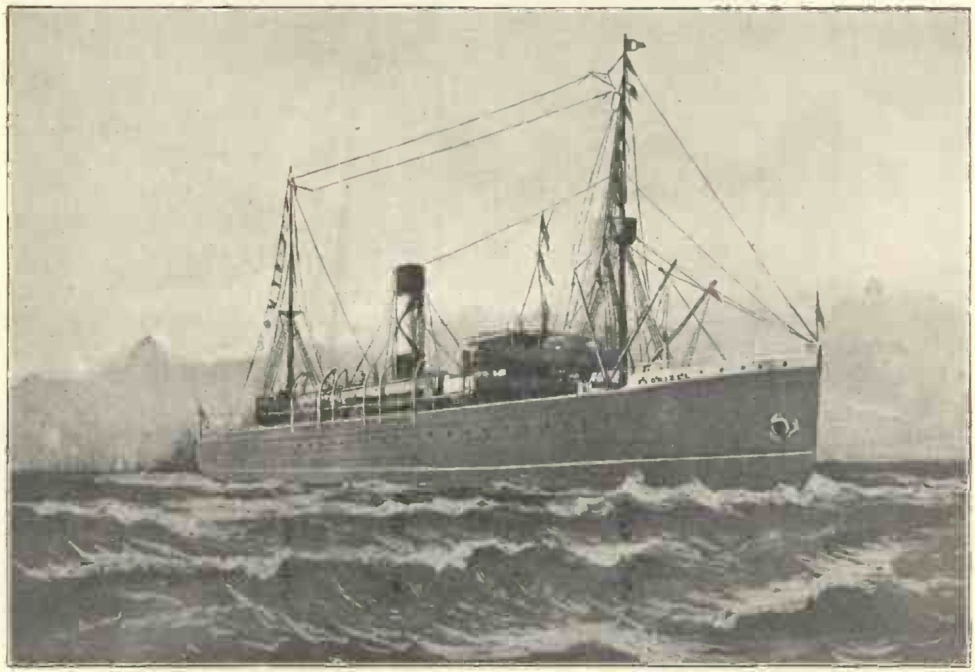
WRECKED OFF CAPE RACE.

The loss of the Red Cross Line steamship *Florizel*, off the rugged coast of New-



THE TORPEDOED HOSPITAL SHIP "GLENART CASTLE" IN PRE-WAR DAYS.

foundland, during a gale, towards the end of February, is a disaster which, quite apart from the heavy list of casualties, will have been noted with particular regret by Marconi men. No ship was more at home in Newfoundland waters, for, although at the time of the catastrophe she was carrying passengers from St. Johns to New York, she had contributed materially to the prosperity of the Island Colony by a singularly successful career as a sealing vessel. The *Florizel* was one of four steel ships built in 1909 for the Newfoundland seal fisheries. She was the largest of the four, and her owners, Messrs. Bowring Brothers, with commendable foresight, decided to equip her with wireless. As the pioneer boat in this direction she proved so useful that in the following year other ships engaged in this particular industry were similarly fitted. Some data regarding the vessel appeared in the very first number of the *Marconigraph*, the wireless monthly from which THE WIRELESS WORLD was evolved, and an account of a sealing voyage made by the then Marconi officer, Mr. Ernest T. Fisk (now managing director of the Amalgamated Wireless (Australasia), Ltd.), in 1910, appeared in the second issue, of May, 1911. On that voyage 30,488 seals were captured, and the success was notified to the owners through the Marconi station at Cape Race. The same wireless equipment did good service to the last, for the fact that the ship had gone ashore was announced by a single wireless meassge. Happily the Marconi operator, Mr. Cecil S. Carter, was rescued, so that we hope, in due course, to be able to give to our readers some details of the catastrophe, which came as a heavy blow to the people of St. Johns.



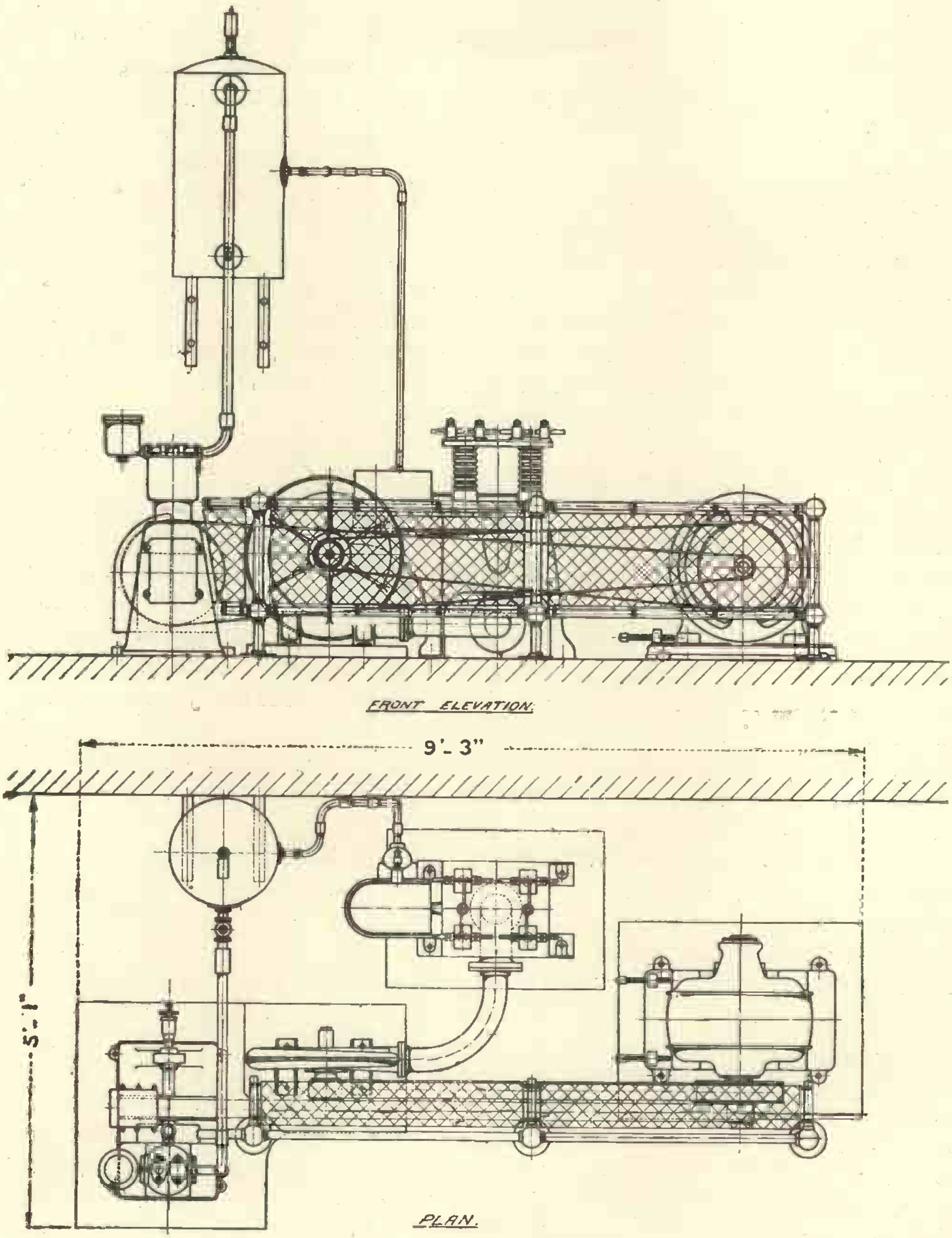
S.S. "FLORIZEL" LEAVING ST. JOHNS, NEWFOUNDLAND.

THE RETURN OF THE "WOLF": VICTIMS LACKING WIRELESS.

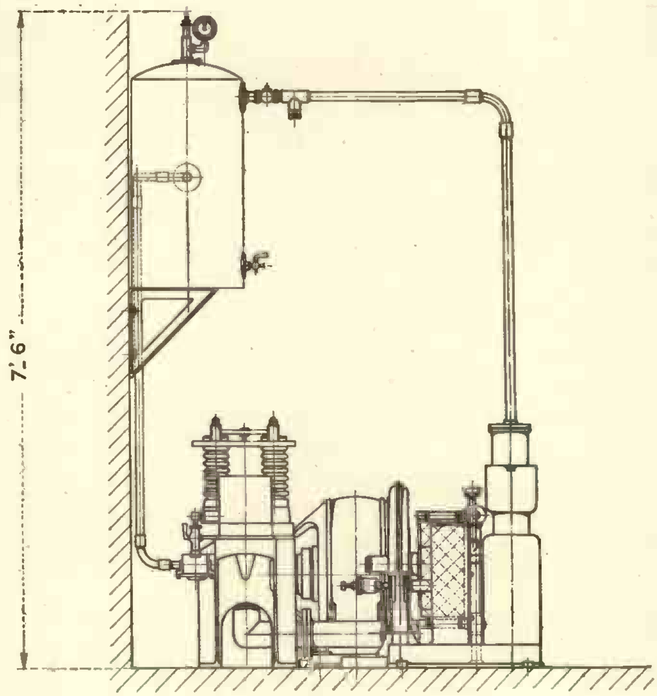
Towards the end of February; when the German Government was assembling the machinery for a new war loan campaign, there was flashed abroad one morning by wireless, and the usual channels in Copenhagen, Amsterdam and Zurich, news of the return of a buccaneering auxiliary cruiser, the *Wolf*, which according to the official report had been careering about the Indian, Pacific and Atlantic Oceans for a period of fifteen months, sinking merchantmen, seizing stores and making prisoners. To assist her in her risky business the *Wolf* fitted out one or more of her captures for special purposes such as mine laying or decoy work, but so far as has yet been made known all her auxiliaries came to grief. The *Turritella* was sunk by her own crew on encountering a British warship, and the *Igotz Mendi*, a Spanish vessel, captured and detailed to return to Germany with prisoners and stores, ran ashore off Jutland when within a day's steaming of Kiel. The German Government, of course, quite unable to allow a straightforward record of daring seamanship to stand on its own merits, preferred to spoil the whole affair by circulating deliberate falsehoods. Not satisfied with a claim to have destroyed 35 enemy vessels with an aggregate tonnage of at least 210,000, they added to this modest total the Japanese super-dreadnought *Haruna* of 28,000 tons and the suggestion that a British or Japanese cruiser had also been badly damaged. The story was duly radiated by "wireless" with the hope that an impression might be created amongst all the belligerent countries. But once again the lying character of the German propaganda reacted upon its authors, for on the receipt of the German claims in London, the British Admiralty and the Japanese Naval Attaché were able to show that no British nor Japanese cruiser was in any way damaged during the cruises of this boat.

It may therefore be safely assumed that the total tonnage claimed by the German Admiralty is equally fictitious and the greater part of the story open to suspicion.

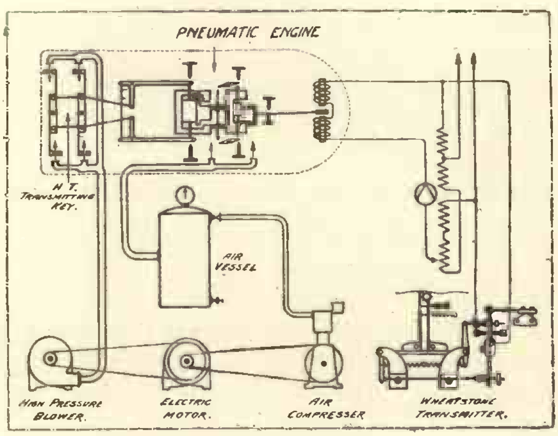
The fact remains that the *Wolf*, by fair means or foul, successfully evaded our cordon of outposts, and, during the course of several months accounted for at least eleven boats, three of which were American sailing vessels and one an English sailing vessel. It is interesting to note that of the eleven "possibles" published by the Admiralty the majority, so far as we have been able to ascertain, were not fitted with wireless. Had they been so fitted, even making allowance for the cunning of the German commander, it is extremely unlikely that they would all have been captured. On the other hand it is highly probable that the *Wolf* itself would have been cornered. When one realises the superhuman task which has been set the British Navy in keeping the seas free from such adventurous craft it is wonderful testimony to British thoroughness that during the three and a half years of war only three or four ships of this character have been able to leave harbour and return. It is not the policy of the British Admiralty to proclaim all its deeds on the housetops. Perhaps when the war is over the Germans may learn something of the fate of other ships which have ventured abroad on similar errands.



Apparatus for High-Speed



END ELEVATION.



EXPLANATORY DIAGRAM.

Wireless Transmission (see page 51).

Notes of the Month

NEW MASTER OF TRINITY: A SCORE FOR SCIENCE.

THE appointment of Sir Joseph Thomson to the important post of Master of Trinity, Cambridge, is a matter of great interest to the world of wireless and is directly, we should imagine, the outcome of the lessons of the war. The famous Cavendish Professor of Physics, a worthy successor to the Chair once so ably filled by Clerk Maxwell, to whom radiotelegraphy is indebted for much of its basic theory, has himself contributed materially to the newer theories associated with certain electrical phenomena; in fact, before his award of the Nobel Prize for Physics in 1906 he had published volumes on "The Elements of Mathematical Theory of Electricity and Magnetism" and "The Discharge of Electricity through Gases." Cambridge has long taken a lead amongst the ancient universities in matters scientific, and it would appear that the national necessity for a much wider recognition of science by these important institutions, and the awakening of Oxford to studies of this character, has aroused amongst the learned professors on the Cam a determination to make even greater departures on the modern side of academic study. We trust that the new Master of the great Tudor Foundation, which proudly includes amongst its *alumni* Newton and other distinguished philosophers, will give such a place to the study of wireless as will assist in maintaining for this country a pre-eminence in its practical development.

MARCONI FREE TRAINING: SOME MISAPPREHENSIONS.

We should like to take this opportunity of correcting a false impression which has spread abroad, apparently as the result of the great success of the recent call for wireless operators. In order to meet the urgent national need for wireless men in the mercantile and allied services the Marconi Company at considerable expense to itself instituted a system of free training, with guaranteed appointments to men who had attained proficiency. The result of this daring experiment has been eminently successful not only in securing large numbers of candidates but in opening the service to many keen and intelligent young fellows who, residing many miles distant from a training centre, would have been prevented from entering upon a wireless career. The exceptional needs of the moment had to be met by exceptional methods, but because the Marconi Company is still offering "free training" it does not necessarily follow that this offer will remain open indefinitely, and such intending operators as think that "any time will do," provided they are on the right side of eighteen, will be well advised not to build hopes on a continuance of the facilities now afforded. On the other hand, if there are any hanging back under the impression that "free training" means an inferior training we hope that the following arguments, which should be obvious to all, will at once dispel this idea. Firstly, at a time like this, when every fit man that can possibly be spared is required in the fighting line, the authorities are not going to release anyone from military service who is not proven to be expert in his profession, so that the standard of proficiency, and consequently the thoroughness of the training curriculum, is in all cases maintained at least to the peace-time standard. Also the needs of the moment are such that men passed into the service must be proficient beyond dispute and certain of maintaining the high tradition of the Marconi Company and doing justice to that Company's apparatus.

"HIDDEN SCIENCE" IN SOUTH KENSINGTON.

There are not a few amongst the scientifically inclined of London's millions who will have welcomed the reopening of the Science Museum at South Kensington. We are totally at a loss to understand why the Government ever arrived at the decision that it was in the national interest, particularly at a time like the present, when the study of applied science has received such impetus, to veil from public view our classic milestones on the path of invention and discovery. Fortunately someone has been found who in these topsy-turvy times can think the right way up and has not to stand on his head to carry out the mental processes. We would suggest, however, to this unknown benefactor that there is room for further improvement in the changes recently effected and that the Electrical Department of the Science Department at Kensington should be open on Saturdays as well as Thursdays and Fridays as at present arranged. Speaking for wireless men to whom all branches of electrical science provide a very keen interest we know that there are very few, particularly amongst the students, who can get as far as South Kensington on any day but Saturday and then only in the afternoons.

"IN THE AIR"—A GERMAN ELECTRICAL BARRICADE.

During a lull in the bombing attacks on London towards the end of 1917 many fantastic stories spread amongst the ignorant as to precautions alleged to have been taken by those responsible for the aerial defence of the metropolis against enemy raiders. Although we have hitherto sought in vain for a sense of humour amongst our Teuton enemies it would appear that they, having learned something of the credulity of the masses respecting anything outside the limits of direct observation, had determined to follow up the London rumours with a few of their own. Anyhow, some of the most responsible English dailies despite an obvious shortage of space for serious news, found room during the first week in March for an Amsterdam report on new Hun methods for catching such of our airmen as dare to give practical demonstrations over German cities of the type of aerial warfare which the German public has hitherto professed to appreciate. We are told that towards evening the Germans send up twenty captive balloons and attached to these are electrified steel cables. "The electric barrier thus created is claimed to constitute a danger to all airmen coming in contact with it." . . . (Interval for refreshments.) . . . Perhaps some night one of our aviators, in his dreams, will take a Lewis gun and bring down those twenty balloons with their network of electrical impedimenta and quietly electrocute the Germans sleeping so composedly beneath their novel barricade. Then, of course, someone, the aviator or the inventor of the fantasy, will wake up. The legend, which, of course, would be valueless without some reference to "electricity," recalls the story, told—dare we say it—against a British Government Department which, before the war, agreed to certain trials on the East Coast of an invention wherein "wireless" waves were to be utilised to magnetise the pistons of aero engines, cause them to "seize" and bring the helpless aviator to earth. The "inventor," if we remember rightly, used the occasion as an opportunity for making off with certain Government property, and to this day the trials, like the German electrical barricade, are still "in the air."

ENCOURAGEMENT OF INVENTORS.

The Marconi Company has recently formulated an excellent scheme for the encouragement of embryo inventors on its staffs. According to the new arrangement, every invention submitted by a member of the staff and adopted by the Company will be paid for in cash; a minimum sum of £10 to be paid on the Company taking out a provisional patent, and a further sum to be paid if the Company proceeds with the patent and considers the invention of value. This second sum will, of course, be dependent entirely upon the adjudged value of the invention.

On the subject of inventions, we notice that some valuable remarks were recently made by Captain W. S. Smith, of the United States Navy, in a lecture to the Engineers' Club of Philadelphia. His subject was inventions relative to war material, and he successfully disposed of the idea that the war will be won by any *one* great new invention. He wisely pointed out that all profitable invention is no more than prudent development of what has preceded it, and told his audience that the usual method is to divide an invention into ten parts. The inventor comes with one, and if he cannot harmonise with the other nine, his invention is not worth it. Captain Smith gives the example of a man who brought forward a new device for guiding torpedoes. It had to be pointed out to him that the design of all existing torpedoes would have to be changed to meet the requirements of his invention. A torpedo is the development of years of study, and just in order to put a little thing on the torpedo it would have been necessary to start from where they had begun and build the torpedo up to the inventor's ideas.

Wireless inventors would do well to consider their inventions from this point of view, for it is obvious that no commercial company can "scrap" thousands of pounds' worth of apparatus for the purpose of introducing a very minor improvement.

Some Curves and Nomograms for Wireless Calculations

By P. BAILLIE, L.Sc.

IT is the purpose of the present paper to give several examples of graphical calculations. Similar examples have already been published in these columns. Several new nomograms will be given hereafter, in view of their application to radio stations design. Though the matter of design has already been competently dealt with by Lieut. Bertram Hoyle, M.Sc.,* certain formulæ will be quoted again for the sake of completeness. A number of curves will be given which it is hoped will shorten and facilitate numerical calculations.

First of all, a value I_R of the mean current in receiving antenna must be assumed, to obtain fair signals.

According to Professor Fleming,† this value may be estimated as 40 micro-amperes. Captain Chenevix Trench, discussing Dr. Austin's tests, admits a smaller value.‡ Of course, figures much below should be adopted when using amplifiers. A value has also to be assumed for the wave-length; the best wave-length to be used is given by §

$$\lambda \text{ (metres)} = 250 \cdot a^2 \cdot d^2 \text{ (kilometres)} \quad . \quad . \quad . \quad (1)$$

where a is the absorption coefficient $= 0{,}0015$.

Curve Fig. 1 gives the best value of the wave-length in terms of distance d.

It is obvious that the use of the best wave-length is not always practicable.

The mean current I_S in sending antenna is obtained from Dr. Austin's formula:

$$\frac{I_R}{I_S} = 4{,}251 \cdot \frac{h_R\, h_S}{\lambda\, d} \cdot e^{-\frac{0.0015 \cdot d}{\sqrt{\lambda}}}$$

All the lengths are in kilometres.

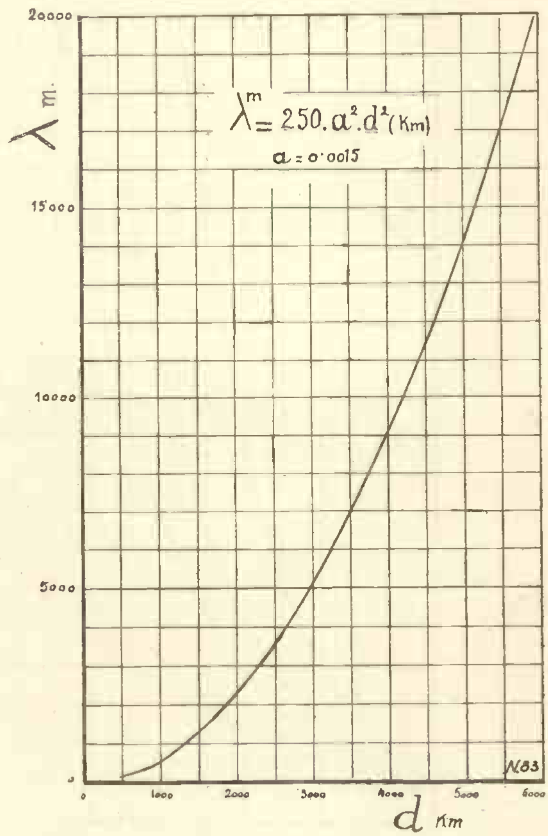
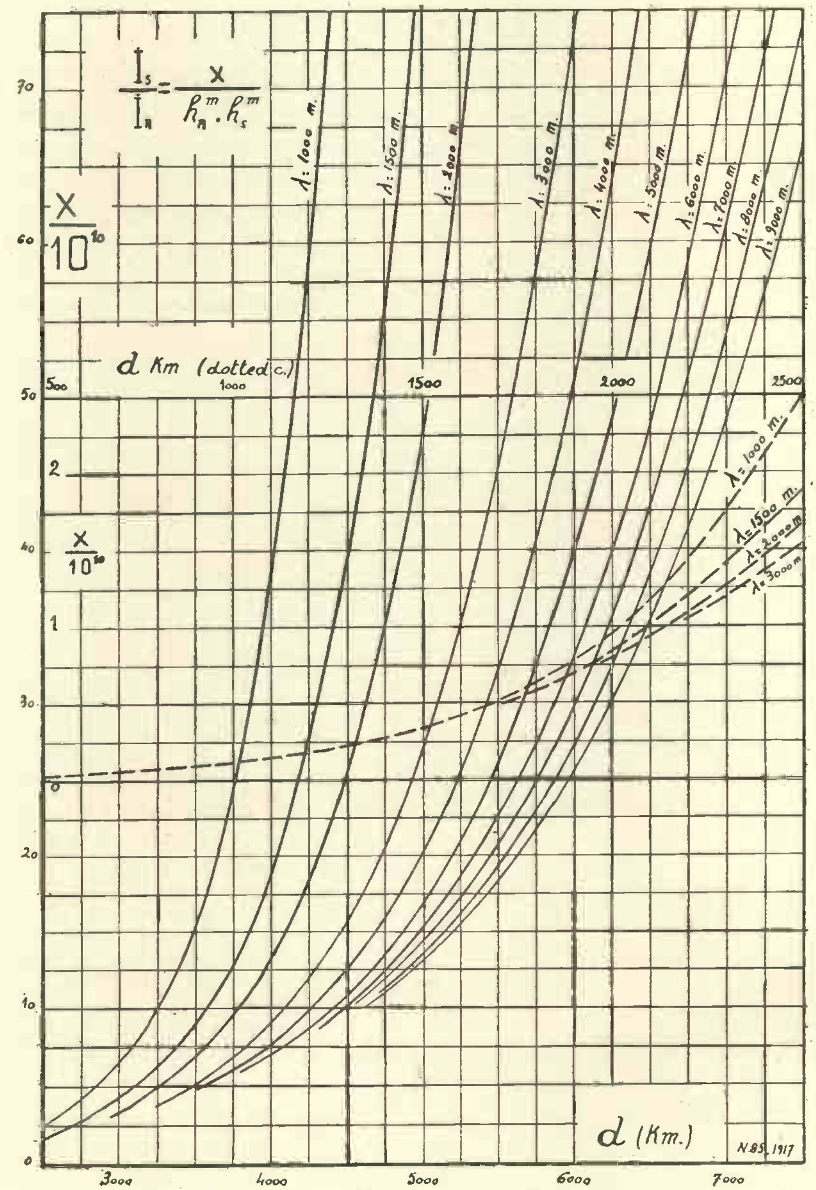


FIG. 1.

* See THE WIRELESS WORLD, March to July, 1917.
† *Wireless Telegraphist's Pocket Book*, page 233.
‡ *The Electrician*, Vol. LXXIX., April 20th to May 4th, 1917.
§ See THE WIRELESS WORLD, Vol. II., page 552.



$\frac{I_s}{I_n} = \frac{X}{h_n^m \cdot h_s^m}$
$\frac{X}{10^{10}}$
d Km (dotted c.)
d (Km.)
λ: 1000 m.
λ: 1500 m.
λ: 2000 m.
λ: 3000 m.
λ: 4000 m.
λ: 5000 m.
λ: 6000 m.
λ: 7000 m.
λ: 8000 m.
λ: 9000 m.
λ= 1000 m.
λ= 1500 m.
λ= 2000 m.
λ= 3000 m.
N.B.S. 1917

FIG. 2.

Curves Fig. 2 give values of factor $X=\frac{10^6}{4{,}251}\cdot\lambda\cdot d\cdot e^{\frac{0{,}0015\,.\,d}{\sqrt{\lambda}}}$ in terms of d (kilometres) and λ (metres):

Thus $$\frac{I_S}{I_R}=\frac{X}{h_R\,h_S}\quad h_R \text{ and } h_S \text{ in metres} \qquad (2)$$

Maximum potential V_{max}, and number of sparks per second N being chosen, the former according to insulating conditions, and a value being assumed for the decrement per semi-period, the antenna capacity is:

$$C\ (\text{mfds.})=\frac{I_S\ (\text{amp.})\cdot 10^6}{V_{R.M.S.}\ (\text{volts})\cdot\omega}=\frac{I_S\ (\text{amp.})\cdot\lambda\ (\text{metres})}{600\cdot\pi\cdot V_{max}\ (\text{volts})}\cdot\sqrt{\frac{24\cdot 10^8\cdot\delta}{N\,e^{\delta}\,\lambda\ (\text{metres})}} \qquad (3)$$

Nomogram Fig. 4 gives factor $\sqrt{\frac{N\,e^{\delta}\,\lambda\ (\text{metres})}{24\cdot 10^8\cdot\delta}}$.

Mean potential $V_{R.M.S.}$ and maximum sending current can be calculated by aid of the same nomogram. Its use is as follows:

Join by a straight line (Fig. 3) value of λ (λ scale) to value of N (N scale). Draw a straight line from point where it meets D line to value of log-decrement δ per semi-period (δ scale).

Read at junction with the proper scale value of $\frac{I_{R.M.S.}}{I_{max}}$ or of $\frac{V_{R.M.S.}}{V_{max}}$

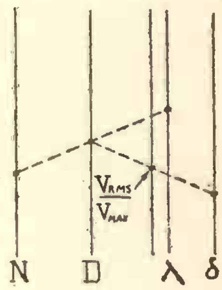


FIG. 3.

Power in sending antenna is:

$$P=\frac{N\cdot C\ (\text{mfds.})\cdot V^2_{R.M.S.}\ (\text{volts})}{2\cdot 10^9}\ \text{kilowatts} \qquad (4)$$

Dimensions of antennæ may be calculated by Professor Howe's method.* Nomogram (Fig. 6) will shorten such calculations, especially when interpolation is necessary, and for solving reciprocal problems. Since it is not quite so simple as the preceding one, its construction will be described.

Professor Howe's formula may be written

$$C\ (\text{mfds.})=\frac{1}{4{,}145\cdot 10^6}\cdot\frac{l}{\log_{10}\left[\frac{l}{1{,}362\cdot d}\cdot\sqrt[n]{\frac{d}{r}}\cdot e^{-\frac{B}{n}}\right]}.$$

Let OA and O′A′ (Fig. 5) be two parallel straight lines, and take $OM=\log\frac{d}{r}$.

Let P be the point of OO' such as $\frac{PO'}{PO}=\frac{a}{b}=\frac{1}{n}$.

Line MP meets $O'A'$ at M' and $\frac{O'M'}{OM}=\frac{a}{b}=\frac{1}{n}$.

Hence $$O'M'=\frac{1}{n}\log\frac{d}{r}=\log\sqrt[n]{\frac{d}{r}}.$$

* See THE WIRELESS WORLD, December 1914 and January 1915.

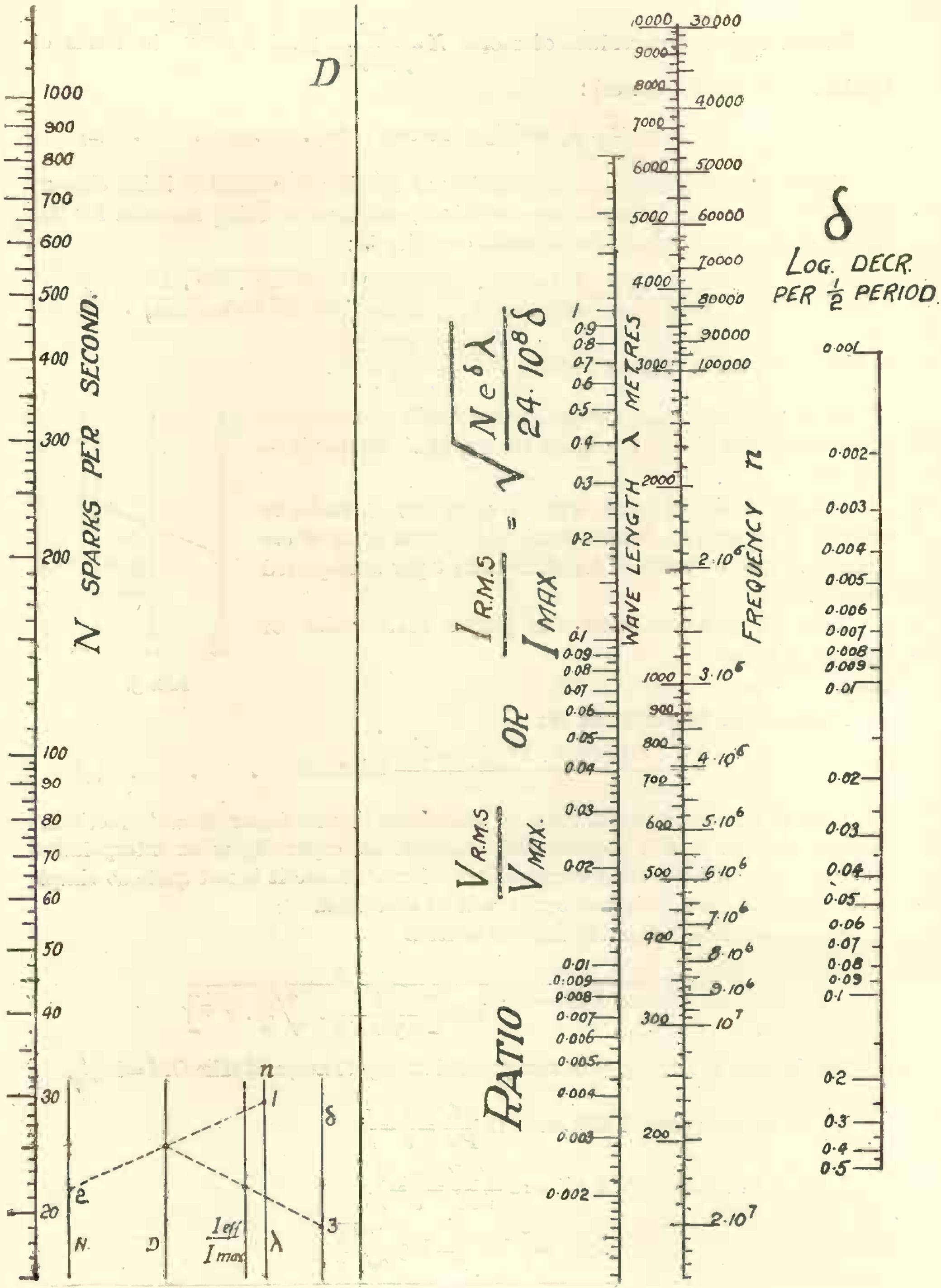

N SPARKS PER SECOND.
1000
900
800
700
600
500
400
300
200
100
90
80
70
60
50
40
30
20
D
RATIO $\frac{V_{R.M.S}}{V_{MAX.}}$ OR $\frac{I_{R.M.S}}{I_{MAX}} = \sqrt{\frac{N e^{\delta} \lambda}{24 \cdot 10^{8} \delta}}$
WAVE LENGTH λ METRES
FREQUENCY n
δ
LOG. DECR. PER ½ PERIOD.
N.
D
$\frac{I_{eff}}{I_{max}}$
λ
n
δ
1
2
3

FIG. 4.

Let PQ be parallel to OA, and take $PQ=\frac{b}{a+b} \cdot \log \frac{1}{1{,}362} \cdot e^{-\frac{B}{n}}$ and contrary to OM.

Lines OQ and MQ meet $O'A'$ at R and N respectively.

We have
$$\frac{RN}{OM}=\frac{a}{b}=\frac{1}{n};\ \frac{PQ}{O'R}=\frac{b}{a+b}$$

$$O'N=O'R+RN=\frac{a+b}{b} \cdot PQ+\frac{OM}{n}=\log\left(\frac{1}{1{,}362} \cdot e^{-\frac{B}{n}} \cdot \sqrt[n]{\frac{d}{r}}\right).$$

Each value of n has a point Q [such as lengths $O'N$ equal to log $\left(\frac{1}{1{,}362} \cdot e^{-\frac{B}{n}} \cdot \sqrt[n]{\frac{d}{r}}\right)$] and all having O' as origin.

Now let BC and DE be parallel to $O'A'$ and such as $BD=DO'$, and take $BS=\log \frac{l}{d}$. Line NS meets DE at T and $DT=\frac{1}{2}(O'N+BS)$

or
$$DT=\frac{1}{2} \log\left[\frac{l}{1{,}362 \cdot d} \cdot \sqrt[n]{\frac{d}{r}} \cdot e^{-\frac{B}{n}}\right]$$

and we shall have $C\text{ (mfds.)}=\frac{1}{8{,}289} \cdot \frac{l\text{ (metres)}}{DT}$.

Draw FG parallel to DE and take $FU=\frac{l\text{ (metres)}}{8{,}289}$.

Line TU meets DF at V and we have $\frac{VF}{VD}=\frac{FU}{DT}=C$ mfds.

The capacities scale will be DF, and graduations will be points dividing DF in the ratio 0,0001, 0,0002, etc. . . . Thus this nomogram is used by joining by a straight line value of $\frac{d}{r}$ to value of n, afterwards joining point where it meets A line (see small fig. on nomogram, Fig. 6) to value of $\frac{l}{d}$; and finally joining point where this line meets B line to value of l. The result is read at meeting with C scale.

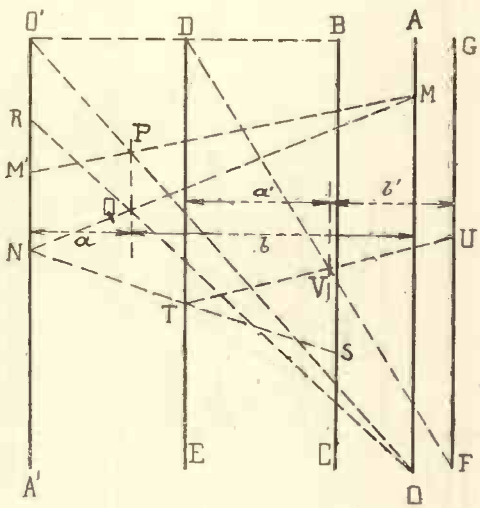


FIG. 5.

With regard to effect of earth, we have

$$\frac{1}{C'\text{ (mfds.)}}=\frac{1}{C\text{ (mfds.)}}-\frac{9{,}000 \cdot E}{l\text{ (metres)}} \quad (5)$$

C' = capacity when accounting for effect of earth.

C = capacity when neglecting effect of earth.

E is given by Professor Howe's curve (WIRELESS WORLD, Vol. II., page 617).

(To be continued.)

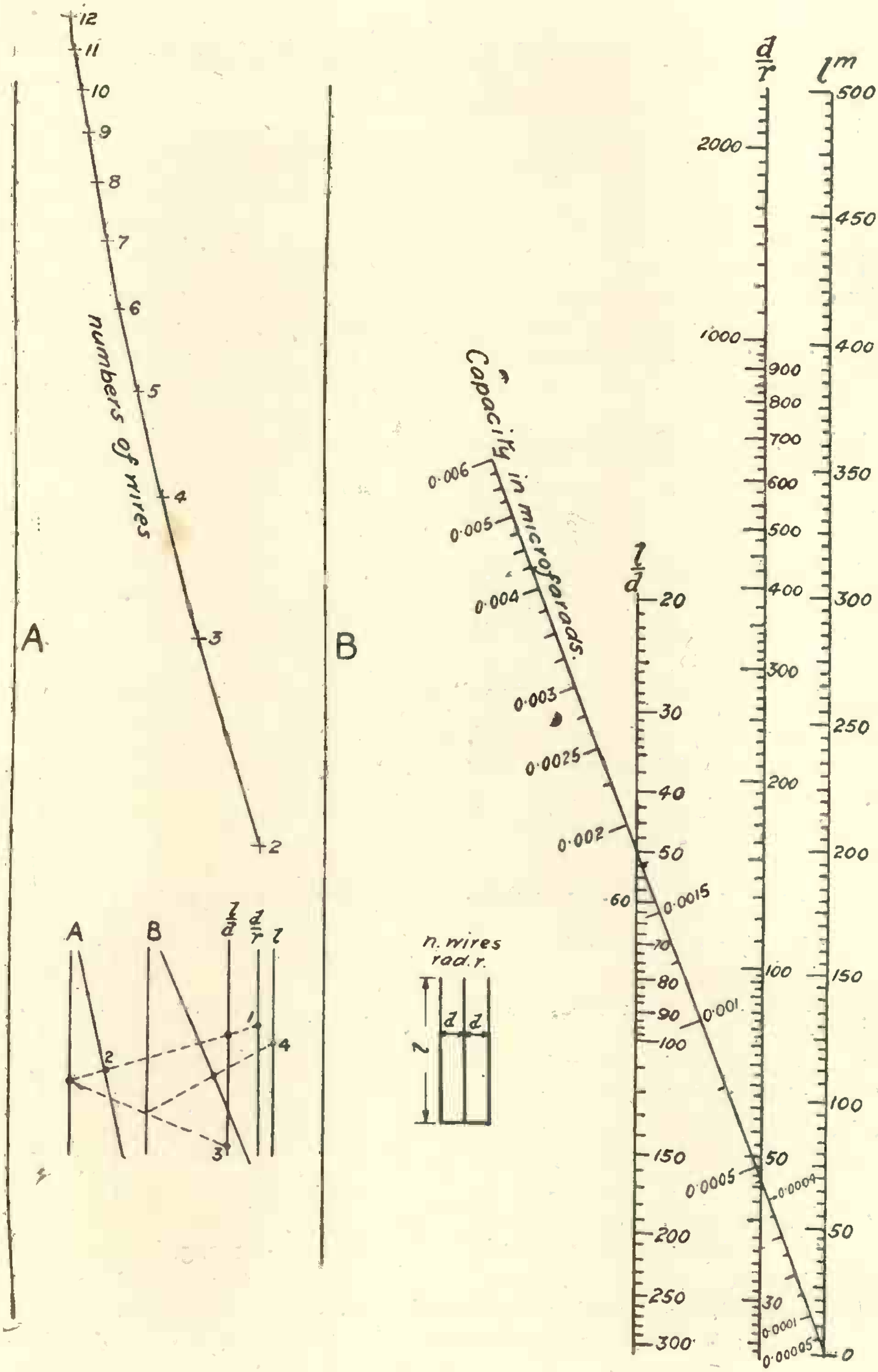

A
B
numbers of wires
Capacity in microfarads.
$\frac{l}{d}$
$\frac{d}{r}$
l^m
n. wires
rad. r.

FIG. 6.

Among the Operators

It is our sad duty, month by month, to record the deaths of the brave operators who have lost their lives at sea by enemy action and other causes in the wireless service of their country. Owing to the necessity of preventing information reaching the enemy, the names of ships and localities of action cannot be published, and in view of the fact that but few particulars are available of these actions full tribute cannot be paid to many gallant deeds. In one case this month, however, we are enabled to record a voluntary act of self-sacrifice and devotion to duty, which ranks with the highest it is possible to imagine.

Both for our own part, and on behalf of our numerous readers, we extend to the parents and relatives of these young men who so nobly uphold the "wireless tradition" the deepest sympathy in their bereavement.

* * * * * *

ROLL OF HONOUR.

The case referred to above is that of Mr. Eric William Gardiner, who was in his nineteenth year, and born at Edinburgh. Educated at the Royal High Street School, Edinburgh, and at Allan Glens College, Glasgow, he was, previous to his training at the North British Wireless Schools, Ltd., Edinburgh, employed as Customs clerk at Messrs. R. S. Waddell & Co., of Glasgow. After gaining his P.M.G. certificate Mr. Gardiner joined the Marconi Company in February of last year. Appended is the story of his heroism.

OPR. ERIC WILLIAM GARDINER.

On the night of November 7th, 1917, the s.s. —— sailed from Europe on her way to the United States. At 8.30 on the following morning, when about 140 miles off the coast, the ship was attacked by a submarine, which launched a torpedo at her. Fortunately the torpedo passed under the ship without doing any damage. At this particular time Mr. Gardiner was in the wireless cabin sending out the distress call. A short time later the submarine appeared on the surface at a distance of about four miles, and commenced shelling the ship.

This shelling continued for about one hour, during which time Mr. Gardiner had got in touch with a shore station, and had been promised immediate assistance from a British destroyer. During the whole of the first hour's shelling he sat in his cabin, at his instrument, keeping in touch in case of getting nearer assistance. About 9.30 a.m. the captain sent a message by the first mate to say that now he had got the offer of assistance he thought it advisable that Mr. Gardiner ought to leave the exposed position of the wireless cabin and take shelter.

Mr. Gardiner's reply to the first mate was that he had just got in touch with an American light cruiser, which he believed was nearer than the British destroyer, and likely to give earlier assistance. On these grounds he refused to leave the wireless cabin, saying that as soon as he got the full message through from the American cruiser he would take cover. The mate then left the cabin to report to the captain, and two minutes later the submarine, having abandoned solid shell for shrapnel, fired a shot which passed directly through the wireless cabin, decapitating Mr. Gardiner, and bursting on the roof of the engine room.

When the captain and officers went to the wireless room to see what had happened, they found his headless body still sitting in his chair, with the completed message of the American cruiser in front of him. (This actual message is still in the captain's possession.) As things turned out, the submarine continued to shell the ship with shrapnel, causing a great deal of damage, and although the gun crew on the ship put up a very brave fight, had it not been for the timely arrival of the American cruiser in all likelihood the ship would have been sunk.

The outstanding feature is the fact that, whereas Mr. Gardiner was offered release from his post, he refused because he thought he might get earlier assistance by remaining there. This proved to be the case, as the captain and officers state that although he had already been promised assistance it is quite possible that this assistance might not have come in time. To use the words of the captain and officers, "The plucky action of the wireless operator in sticking to his post was undoubtedly the means of saving the ship and the lives of the officers and crew, numbering forty-five."

* * * * * *

Mr. John Jenkins, who lost his life when his ship was torpedoed, was born in Edinburgh on October 17th, 1897, and educated at Renfrew, Airdrie, and Shotts. Trained at the North British Wireless Schools, Ltd., Glasgow, he qualified, and after receiving the P.M.G. certificate was appointed to the Marconi Company's staff in June, 1917.

OPR. J. JENKINS.

* * * * * *

OPR. R. Y. BURRY.

Born at Alyth, Perthshire, in August, 1900, Mr. Robert Young Burry was educated at Harris Academy, Dundee. After leaving school he took up farming, being employed at Auchterhouse, and at Ardgath Lundie, by Dundee. Desiring to embrace wireless as a profession he entered the North British Wireless Schools,

OPR. J. E. BRITTON.

Ltd., Dundee, where he gained the P.M.G. certificate, and received an appointment in the Marconi Company last July. The ship on which Mr. Burry was serving was sunk by torpedo, and he is amongst the missing.

* * * * * *

Mr. John Edwin Britton, another victim of the torpedo, was born at Walthamstow in 1895, and went to the Coopers' Company's school at Bow. Commencing his career with the Atlas Assurance Company, Cheapside, E.C., he subsequently attended the East London Wireless Telegraph College, and there gained the P.M.G. certificate. Mr. Britton's service with the Marconi Company dated from September 6th, 1914.

* * * * * *

OPR. T. E. WALMSLEY.

Of Lancashire birth, Mr. Tom Ernest Walmsley was 24¾ years old, and hailed from Blackburn. Receiving his education at the Highfield Council School, Darwen, and Darwen Technical School, he was first employed by Messrs. Farrer, Baynes, Taylor & Co., cotton weavers, of Darwen. Later, taking up wireless, his training was completed at the Manchester Wireless Telegraph Training College, where he gained the P.M.G. certificate. He was appointed to the Marconi Company's staff on October 10th, 1915. The ship to which Mr. Walmsley was attached was sunk by torpedo.

* * * * * *

OPR. L. A. CATTLEY.

Mr. Louis Allen Cattley, formerly a clerk in the Railway Audit Office, Londonderry, was born in that city on June 18th, 1899. He was educated at the First Derry National School and the Evening Technical College there. Entering Marconi House School for training in wireless telegraphy, he gained the P.M.G. certificate, and was placed on the staff on December 17th, 1916. Mr. Cattley went down with his ship when she was torpedoed.

* * * * * *

OPR. J. PICKERING.

"Missing" is written against the ship on which Mr. John Pickering sailed. Harwood, Lancashire, was his birthplace, and he was 20¼ years of age. Receiving his education at the Accrington Secondary Day School, Mr. Pickering was first employed by the Premier Mills Company, Ltd., Great Harwood, in a clerical capacity, but being anxious to serve as a wireless operator he went to the City School of Wireless Telegraphy, Manchester, for training. When in possession of the

P.M.G. certificate he was accepted by the Marconi Company and joined the operating staff on June 12th, 1917.

* * * * * *

OPR. A. C. S. PEGGS.

Mr. Arthur Clifford Sydney Peggs, born at Little Ilford on June 28th, 1899, was drowned when his ship was sunk by torpedo. His education, begun at the Ursuline Convent School, Ilford Branch, was completed at Leigh Hall College, Leigh-on-Sea, after which he entered the service of Messrs. Furness, Withy & Co., Ltd., as a clerk. Like many others, the "wireless call" appealed to him, and he commenced training at the British School of Telegraphy, London. The P.M.G. certificate was earned, and on its bestowal he proceeded to sea in the service of the Marconi Company.

* * * * * *

OPR. R. BAGGE.

Drowned when his ship was torpedoed, Mr. Richard Bagge was born on October 18th, 1899, at Kinsale, and received his education at Macroom. Being greatly interested in wireless telegraphy he underwent training at the Irish School of Telegraphy, Cork, and there qualified for the P.M.G. certificate. Mr. Bagge received his appointment in the Marconi Company's service on February 6th, 1916.

* * * * * *

OPR. J. McKEAN.

Mr. James McKean, missing after the torpedoing of his ship, was born at Bonhill, Dumbarton, on June 5th, 1900, and educated at the Academy, Vale of Leven, Scotland. For some time after leaving school he was engaged on clerical work for the Dalmonach Printing Works, Alexandria, Scotland, leaving that situation to take up wireless. Trained at the North British Wireless Schools, Glasgow, Mr. McKean obtained his P.M.G. certificate, and was appointed to the Marconi Company's staff on September 11th last.

* * * * * *

OPR. H. WORFOLK.

Mr. Harold Worfolk, also missing after his ship was sunk by enemy action, was nearly nineteen, and born at York, where he received his education at the Priory Higher Grade School. After being employed for a time by Messrs. Leak & Thorp, Ltd., drapers, York, on leaving school; he decided to adopt wireless as his profession, and was trained at the North-Eastern School of Wireless, Leeds. After receiving his P.M.G. certificate he was given an appointment by the Marconi Company at the end of November, 1917.

* * * * * *

OPR. A. WILLIAMS.

At his father's house, Merlin Lodge, Carmarthen, the death occurred on February 12th, after a short illness, of Mr. Aled Williams, who was stricken with consumption.

Mr. Williams was born at Gaiman, Argentine Republic, on February 28th, 1897, where his parents at that time owned a farm. Coming to Wales with his family in 1912, he attended Merthyr Secondary School, and Old College School, Carmarthen. His wireless tuition was received at the South Wales Wireless Training College, Ltd., Cardiff, where he gained the P.M.G. certificate, entering the service of the Marconi Company on August 29th, 1915. Mr. Williams was beloved by all who knew him, and his intense desire was to recover good health so as to be able to return to duty and, if need be, lay down his life in its execution.

High-speed Wireless Transmission

A Few Notes regarding our Double-page Illustration

ON pages 36–7 we publish the first of a series of large drawings illustrative of interesting wireless apparatus. The illustration of the Marconi apparatus for high-speed transmission largely explains itself, but the following notes will perhaps help to elucidate one or two points of difficulty.

First of all it should be realised that the problems connected with high-power apparatus such as that shown are quite different from those of smaller power plant. In a high-power station the signalling key has to break extremely heavy currents, and elaborate precautions have to be taken to prevent wastage of power in arcing, and to enable clear-cut signals to be made. The opening and closing of high-power circuits at the ordinary speeds of hand-sending is difficult enough, but when signalling has to be effected at a speed of 100 words or more per minute the difficulties are multiplied a hundredfold. The apparatus in our illustration works as follows:

Firstly, signals are punched in an ordinary Wheatstone tape, such as is used for Post Office working, the tape then being passed through a Wheatstone transmitter at the requisite speed, long and short signals being sent "to line." These long and short electric currents actuate a specially designed pneumatic engine, opening and closing air valves and releasing air under pressure provided by the air pump shown. Tubes from the pneumatic engine are led to the signalling keys which, as in the case of all other high-power Marconi apparatus, are placed in the high-tension circuit to avoid dangerous surges.

In a forthcoming issue we hope to publish a large drawing of one of these high-tension signalling keys.

52

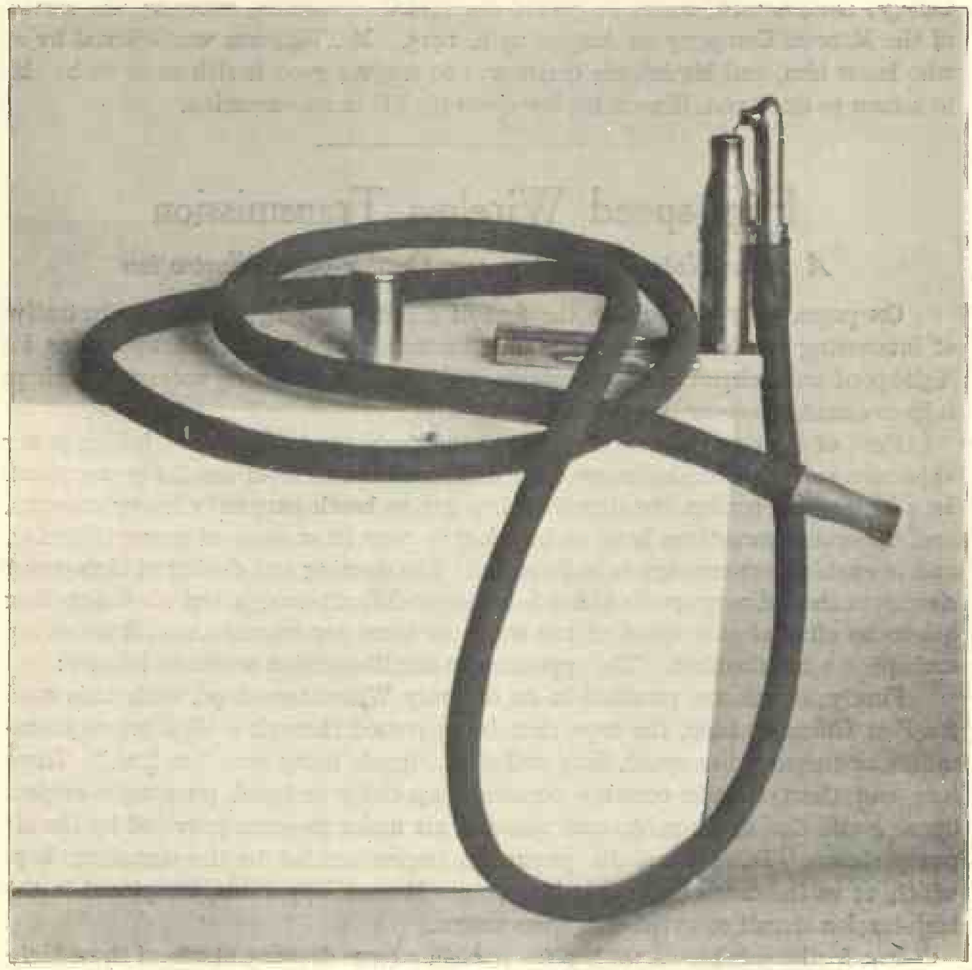
Improvised Tools

By W. E. SNOW

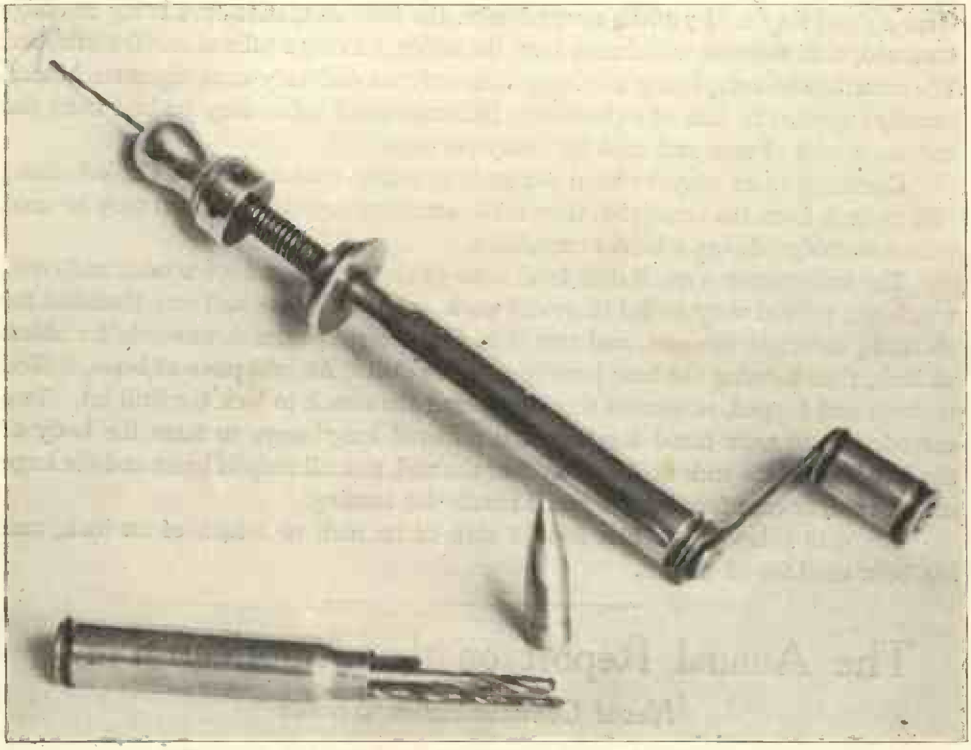
Most operators, at some time or other, experience small breakdowns, when, perhaps owing to lack of tools, they have to improvise something to repair the fault.

Usually it is a case of soldering, and where no blow-lamp is available, a lamp, giving a flame hot enough for most work, can easily be made from material at hand, thus saving what may be a serious delay.

All that is required is an ordinary ink bottle, with a small length of brass tube, or piece of tin rolled into the shape of a tube, inserted through the cork. The



BLOW LAMP MADE FROM CARTRIDGE CLIP AND CASE, ETC., AS DESCRIBED.



SMALL DRILL MADE FROM ODDS AND ENDS.

bottle is then filled with methylated spirits, the cork replaced, and cotton or substitute used as a wick.

Simpler still is the metal case containing the spare bradawl blades, just filled loosely with cotton waste soaked with spirits, which will hold enough to burn with a big flame for at least ten minutes.

A little thought will easily suggest other things which can be used for the same purpose.

The writer once used an empty cartridge case for a quick repair, and later, improving the idea, now possesses a novel little blow-lamp which has been used for sweating-on large size thimbles, as well as for the smallest work, giving an intense flame which will even *braze* small parts.

The following is a short description of how it was made.

A cartridge clip formed the stand or base, enabling the lamp to slide along in any position desired. The cap, or cover, was constructed from the large end of another case, cut off, and smoothed down to fit over the shoulder of the case forming the lamp.

The blowpipe itself was made from a bullet, the lead first being melted out, leaving the nickel shell, and an ordinary nipple fitted in the top, and silver soldered in.

A small brass spring clip holds the pipe to the lamp case, allowing it to slide up or down for adjustment. A rubber tube was next required, and this was obtained from a short length of 7-16ths covered wire, the fibre insulation first being carefully removed, then the wire withdrawn from the inside, leaving a tube of excellent rubber. The mouthpiece completing the lamp is merely an ordinary cane cigarette holder, usually supplied in tins of cigarettes. Different sized tubes may be had from the various grades of wire and used for many purposes.

Cartridge cases may be used for making many useful things. Cut off about half an inch from the large end, they make excellent crystal cups, and may be used with a cartridge clip as a holder and slider.

The writer made a small drill from some of these cases and a few odds and ends, which has proved very useful in model work. A 6-inch wire nail was threaded for about 2½ inches at one end, and two slots cut at right angles downwards for about an inch, thus forming the four jaws to grip the drill. An odd piece of brass, drilled through and tapped, screws on this, and forms the chuck to lock the drill bit. Two cartridge cases were fitted together and soldered lengthways to form the body of the drill handle, the ends drilled to fit over the nail, a small strip of brass and the large end of another case forming the small handle for turning.

The drill takes morse bits from 1-16th of an inch to 1-64th of an inch, and has been used for all metals.

The Annual Report on the American Navy

Naval Communication Service

A RECENTLY published Annual Report on the American Navy makes interesting reading. Reference is made under the heading of "Naval Communication Service" to radio-telegraphy, and it is mentioned that an executive Order issued by the President on April 6th, 1917, directed the establishment to take over such radio stations within the jurisdiction of the United States as may be required for naval communication.

It is also directed that all radio stations not necessary to the Government of the United States for naval communications be closed. In the enforcement of this Order 53 commercial radio stations were taken into the naval communication service for naval purposes. A larger proportion of the stations taken over were formerly operated by the Marconi Wireless Telegraph Company of America, in connection with their ship and shore service for the Mercantile Marine, and also for service between fixed points, such as that between Japan and the territory of Hawaii, and the United States. It was found that a number of the stations operated by the commercial companies could not be made available for naval uses, on account of duplication of the work, and accordingly 28 commercial radio stations were closed. In addition to this number, thousands of small amateur radio stations were closed, as well as several stations for service between fixed points, for which landlines were available and suitable. At the present time no radio communication is permitted on United States territory—not including Alaska—except through stations operated by the Naval Department or by the War Department.

Instructional Article

NEW SERIES (No. 1).

EDITORIAL NOTE.—Below we give the first of a new series of twelve Instructional Articles devoted to PHYSICS FOR WIRELESS STUDENTS. *Although at first sight the subject of physics would not seem to have a very intimate connection with wireless telegraphy, yet a sound knowledge of this subject will be found of the greatest use in understanding many of the phenomena met with in everyday radiotelegraphy. As in previous series, the articles are being prepared by a wireless man for wireless men, and will therefore be found of the greatest practical value.*

PHYSICS is that branch of science which is concerned with the study of inanimate matter, its physical properties, the energy associated with it, the physical changes it undergoes and the laws regulating those changes. This interpretation excludes Biology, which is the science of matter and energy under the influence of life, and Chemistry, which deals with the changes of matter in respect to its essential nature and properties. As, however, chemical changes are always accompanied by physical changes, physics and chemistry are so intricately connected that it is difficult to distinguish between them. Accepting as a rough distinction the definition given above, physics is sub-divided into sound, light, heat, magnetism and electricity. The following articles will deal with those parts of the subject which are considered to be of special utility and interest to the student of wireless telegraphy. Electricity and magnetism have received special attention in former articles.

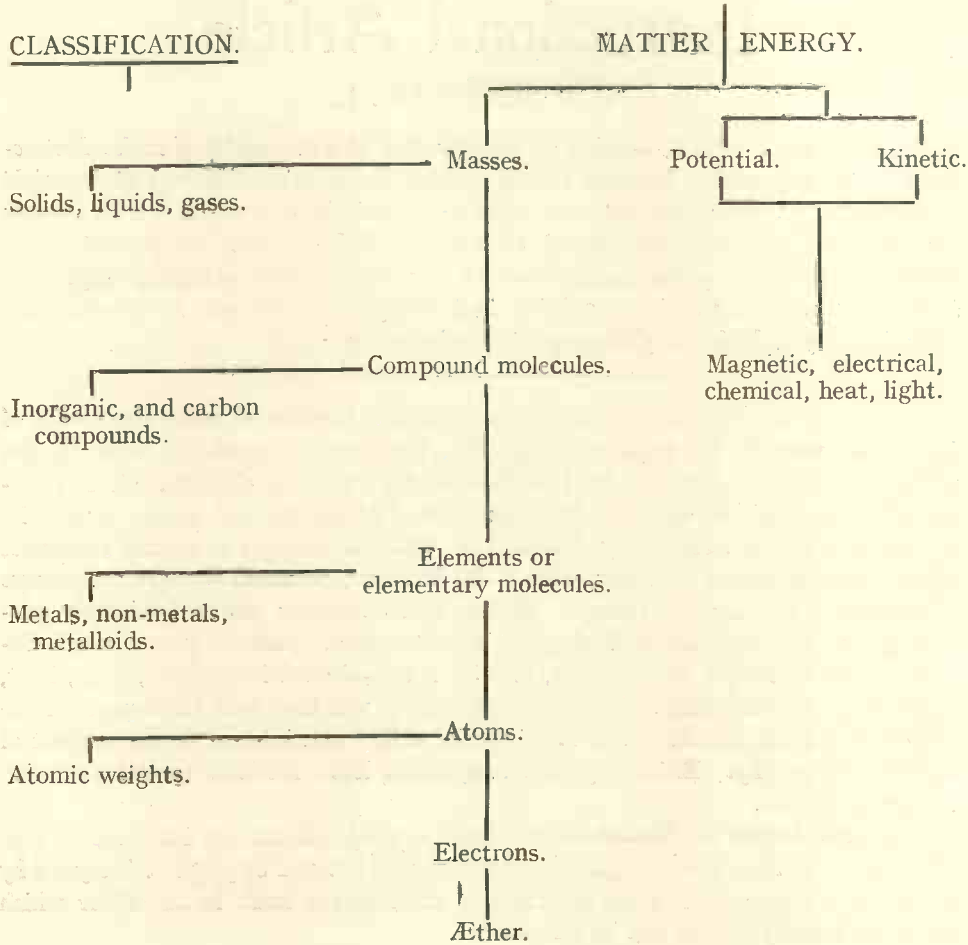
General Survey of Physics.—The accompanying schemes are intended to give the student a comprehensive glimpse of the ground covered by physics. They are by no means exhaustive, but are sufficient to indicate the main heads under which scientists classify matter and its phenomena.

First of all there is the grand generalisation that in the universe there are for the physicist only two **real things,** matter and energy; when we come to discuss them it will be shown why the number is limited to two. Under the general heading of matter there appear its various sub-divisions.

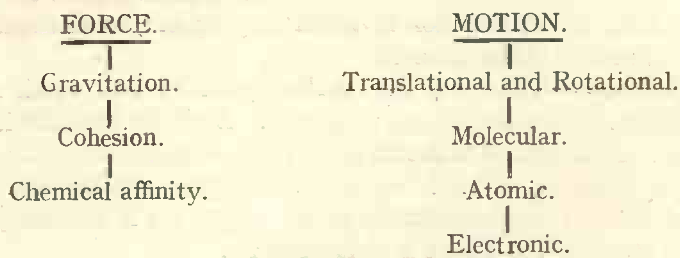
(1) **Masses.**—This refers to material bodies, including gases and liquids, in the particular form and distribution in which they appear, as distinguished from the sum total of matter in the universe.

(2) **Molecules.**—These are the smallest particles into which matter can be divided without losing its original properties. A **simple molecule** is a molecule of an element. A **compound molecule** is one which contains more than one element—*e.g.*, copper sulphate, which is composed of copper, sulphur and oxygen. The number of kinds of simple molecules known at present is between 70 and 80; the number of compound molecules is almost infinite.

(3) **Elements.**—This refers to matter in which the molecules are all of the same kind. The elements are divided into **metals, non-metals** and a third class



SCHEME 1.



SCHEME 2.

containing those elements which in certain respects resemble metals and in others are akin to non-metals.

(4) **Atoms.**—These are the particles of matter of which molecules are built. They are defined as the smallest particles of matter which can take part in a chemical change and are conveniently classified by means of their weights as compared with that of the oxygen atom which is taken as 16.*

(5) Finally, atoms have been shown to be associated with smaller particles called **electrons.**

Under the heading of energy come its two main forms, **Kinetic Energy,** or the energy of motion, and **Potential Energy,** or the energy due to position ; energy of whatever kind can be classed under one or the other of these.

In the small scheme are roughly classified forces and the forms of motion. It may be noted here that **Gravitation** can be considered as attraction between masses, **Cohesion** as attraction between molecules, and **Chemical Affinity** as attraction between atoms.

These schemes are to be regarded merely as a synopsis, but should assist the student to sort out his ideas of the contents of the universe.

SPACE AND ÆTHER.

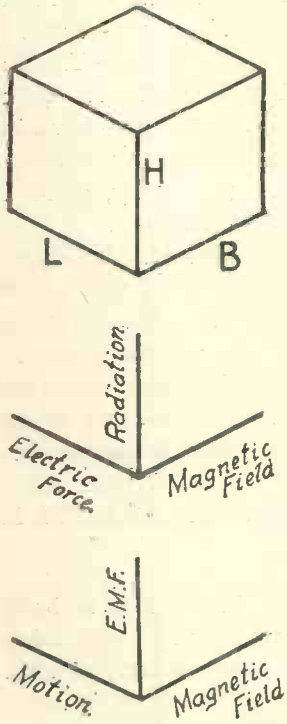
Matter may be broadly defined as that which occupies space, or which, to use everyday language, takes up room. Nothing else which is perceived by our senses can be similarly defined. Matter does not occupy the whole of space, which is conceived to be infinite, nor can any mass of matter occupy, at any given time, space occupied by any other mass. Those two statements hold good for our present purpose, although conclusions drawn from recent researches seem to contradict them.

There is, however, something which *does* occupy the whole of space, and which *does* occupy space filled by ordinary matter. This is the æther, which students of radiotelegraphy will recognise as being the medium in which electro-magnetic waves are propagated. **The conception of æther as a space-filling, elastic, imponderable medium possessing inertia is a highly essential part of the mental equipment of the student of Physics.** At present we need to fix our attention only upon the idea that it fills all space and that it therefore permeates all matter to such a degree that it may be conceived as filling up the spaces between the smallest known particles. As a net is moved through the sea in any direction and yet has its meshes filled with water all the time, so the densest material bodies can move in the universal ocean of æther without disturbing its uniform distribution in any way whatever. Ordinary matter cannot *grip* æther. The student may ask, " Yes, but what about the individual movements of the very smallest particles of matter ? Do these disturb the æther ? " The reply is that they do, but as this brings us abruptly to considerations in advance of our present subject we will leave the matter, having grasped the idea of the permeation by æther of all bodies, and turn to another very important conception.

The Three Dimensions.—There are three fundamental dimensions by means of which we can make measurements relative to space. In the case of a cube it is

* Formerly, their weights were compared with the weight of the hydrogen atom, which was taken as 1.

easily seen that all its measurements, apart from its length, breadth and height, are but functions of these. For instance, its volume is a function of S—that is, the length of a side, and is given by the equation $V=S^3$. Similarly its surface area is given by $A=6S^2$. Again, in the case of a rectangular prism the surface area is $2(LB+LH+BH)$, and its volume is $L\times B\times H$, where in each case L, B and H are respectively length, breadth and height. In all these examples our measurements are based on the three fundamental dimensions and for all similar operations we are necessarily so limited, for a fourth dimension is outside our experience.



FIGS. 1, 2 AND 3.

Fig. 1.—The lines L, B and H denote the length, breadth and height. Note that **they are at right angles to each other.***

Fig. 2.—The same three lines represent the directions of the electro-magnetic and the electro-static components of an æther wave and the direction of radiation. Note that **they are at right angles to each other.***

Fig. 3.—The same three lines represent the relative directions of a magnetic field, of the motion of a conductor cutting it at right angles, and of the resulting EMF in the conductor. **They are mutually at right angles.*** In this example the reader will recognise the principle of the dynamo.

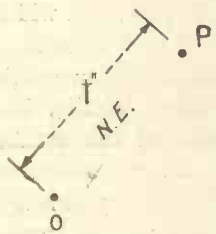


FIG. 4.

By this time it should be seen that the three dimensions of the æther and the distribution of electro-magnetic effects in them are matters of great importance to him who aspires to a true conception of the nature of æther-waves.

Position of a Point.—(1) *In a plane.*—The position of a point in one plane can be fixed by stating its distance and direction from some point of origin. Thus in Fig. 4 the point P is distant 1 inch from the point O, in a north-easterly direction. Its position can also be described by stating the length of a line joining O and P and the angle which OP makes with some other line, usually a horizontal line through O, the angle being measured in a positive (*i.e.*, counter-clockwise) direction.

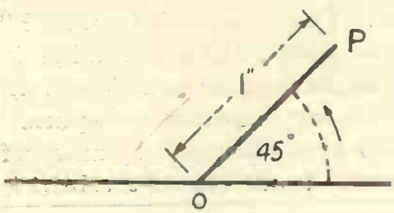


FIG. 5.

In Fig. 5 the position of P is $1_{45°}$, the unit of distance being the inch. If the unit chosen is $\frac{1}{8}$th of an inch the position of P is $8_{45°}$; if the unit be 1 foot we write $\frac{1}{12}{}_{45°}$.

* It is, of course, impossible to *draw* them at right angles to each other, but as they represent three converging edges of a cube, the reader will see that they *are actually* at right angles.

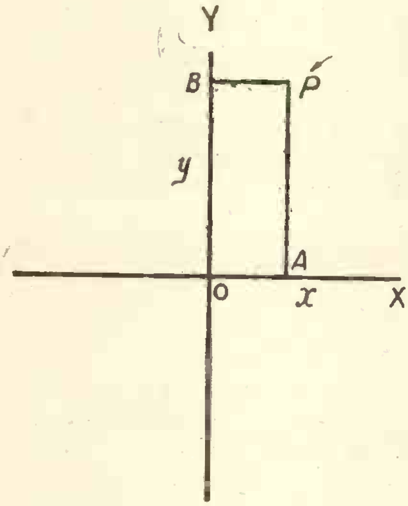


FIG. 6.

Another method of determining the position of a point in a plane is by finding its reference to its two **co-ordinates,** which are two lines at right angles to each other. In Fig. 6 the line *OX* is the **axis of x,** and *OY* the **axis of y.** A perpendicular is drawn from *P* to *OX* meeting *OX* at *A*, and another line perpendicular to *OY* is drawn from *P* to *OY*, meeting *OY* at *B*. *OB* is the **ordinate** of *P*, and *OA* its **abscissa.** Assuming the chosen unit of length to be $\frac{1}{10}$th of an inch, then *P* is "the point (4, 10)."

(2) *In space.* Space being three-dimensional the position of a point in it can be fixed by reference to three planes at right angles to each other. In Fig. 7 these planes are *A*, *B* and *C*. If the figure be supposed to represent a block fitted into the corner of a room it is easy to see that the two walls *A* and *B*, and the floor *C*, are three planes mutually at right angles. A corner of the block, the point *P*, is that the position of which is to be described.

PQ is the distance of the point *P* from the plane *B* (see fig.), *PK* its distance from the plane *C*, and *PS* its distance from the plane *A*. *PS* is called the **x co-ordinate** of *P* because it is parallel to the axis of *x* (*OX*), *PK* is the **z co-ordinate** and *PQ* the **y co-ordinate,** so that if the *x*, *y* and *z co-ordinates* of *P* are, say, 6, 4 and 3 respectively, measured each in the same units, the point *P* can be called "the point (6, 4, 3)."

Note that the point *O* lies in all three planes and that all its co-ordinates are zero.

Change in Position of a Point.—A change of position is called a **displacement,** to express which we must specify two things, its **magnitude** and **direction.** If a vessel starts from a buoy and travels in a straight line for 10 miles in a northerly direction the magnitude of the displacement is 10 (if expressed in miles), and the direction is *N*. A displacement is a **vector quantity** and can be represented by a straight line drawn to scale and in a certain direction. In the example just given we will take as our scale 10 miles to the inch. Fig. 8 then re-

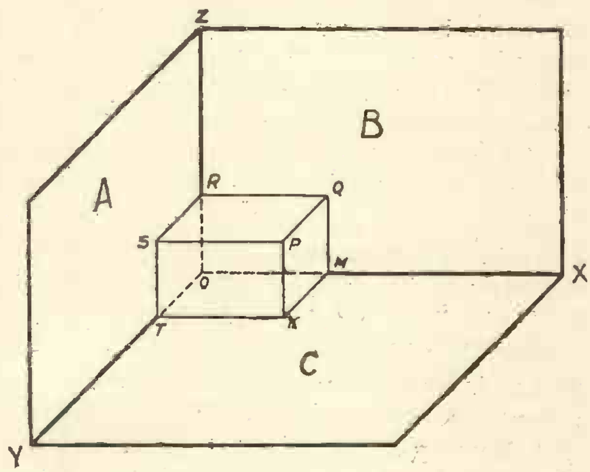


FIG. 7.

presents the displacement undergone by the ship. Suppose the ship changes its course after reaching *B* and travels ten miles to the east, thus arriving at *C* in Fig. 9. It is obvious that, so far as its final position is concerned, it might as well have travelled directly from *A* to *C*. Thus the vector *AC* represents the resultant of the two displacements, and is equal to about 14 miles in an north-easterly direction. The process of finding this resultant is known as the **Addition of Vectors**, a subject with which the reader will deal more fully in his mathematical studies.

FIG. 8.

TIME.

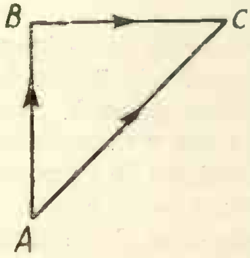


FIG. 9.

The time element is one of the most important factors in innumerable questions relating to physics. Without due consideration of **duration** we could not express quantities such as velocity, acceleration or power, and, in fact, the whole system of physical units would collapse. Time being conceived as infinite, we have to refer it to a working unit based on some observable phenomenon which occurs at regular intervals. The daily rotation of the earth is such a phenomenon and the $\frac{1}{86400}$th part of the mean solar day is the **mean solar second,** which is taken as the unit of time.

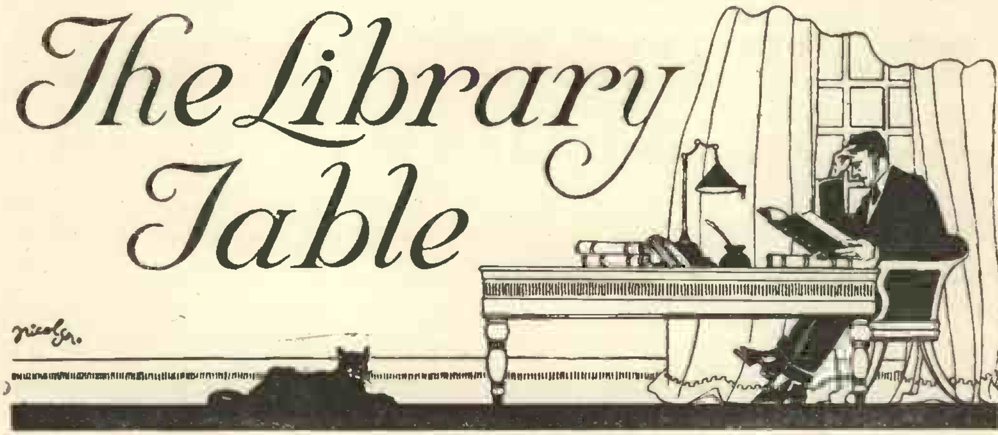
(*To be continued.*)

"Wireless World" and the Paper Shortage

A Serious Position

WITH the drastic curtailment of the imports of paper and raw materials and the rising cost of every item connected with the production of THE WIRELESS WORLD, we are compelled to raise the price of the magazine to 10d. per copy and the annual subscription rate to 12s. post free, commencing with the May issue. This price will, of course, be reduced immediately the present abnormal conditions cease, and meanwhile we trust that we shall continue to receive the wide support of which we are justly so proud. The present high standard of the magazine will be maintained, and all the regular features will appear as heretofore.

The position has also necessitated our revising the system which has been in force regarding the return by newsagents of unsold copies. Newsagents will be required to return to our publishers, not later than the 20th of the month of issue, all copies over-purchased commencing with this issue, and on their receipt credit will, of course, be given as usual. As our paper supply will be reduced, we shall have to "ration" the distribution of the magazine, and it is thus imperative that all readers who wish to receive the magazine regularly should place a standing order with their local newsagent, or send an annual subscription to this office. At the present time no magazine can afford to distribute large supplies on the off-chance that they may be sold to casual readers, and all who place a regular order will be playing their part in preventing waste during the present crisis.



THE THEORETICAL PRINCIPLES OF WIRELESS TELEGRAPHY, WITH SEVERAL NEW HYPOTHESES FOR R.E.'S. By an I.R. 1918. *Published by Gee & Co.* (*Publishers*), *Ltd.*, 34 *Moorgate Street, London, E.C.*2. *Price* 6*d.*

THERE have been very few examples of humorous books published on the subject of wireless telegraphy, although several books not intended to be funny have caused considerable amusement to experts. Of the consciously humorous variety, however, the example before us is by far the best we have seen.

On the first page of the book the author remarks that a preface seems to be necessary, if only to enable him to disclaim any responsibility for it. He felt the need of a book like this when he went through his course, as a kind of antidote, and determined that students should no longer suffer for lack of such a book.

Chapter I. deals in a light-hearted manner with the nature of electricity. Defining a conductor, the author says : " This is a substance through which electricity flows. If it does not flow through it, the conductor is an insulator, and must be treated accordingly." Not to be outdone by rival text-books, the writer adds to each chapter a series of questions to test the students' knowledge, such as (3) " Will a current flow uphill ? If not, why not ? Would it make any difference if there was a path up the hill ? "

Chapter II., dealing with the nature and properties of alternating current, a somewhat difficult subject, is particularly illuminating. We cannot refrain from quoting paragraph 1 on Alternating Currents : " Alternating currents flow in opposite directions, but so quickly that it is difficult to know just where they are going. They therefore appear to be stationary (not stationery—a different thing altogether). They must therefore be considered in that light. When currents are obtained in this condition they are the cause of all the wireless phenomena at present known to science. . . . Oscillatory currents are even worse. You *cannot* tell which way they are going. Even scientists and professors cannot, so do not try, and let us assume they are going one way or the other ; and this convenient hypothesis fully explains all the phenomena of ether waves with their static strain lines and magnetic fluxes. Magnetic flux . . . is of no use in soldering."

The author then pursues his light-hearted career through all the most difficult branches of the science, giving formulæ where necessary (and unnecessary), and illustrating some of his worse examples by diagrams. Tilting at those who are so fond of mechanical analogies, he produces the following gem, relative to the properties of inductance and capacity. "A good mechanical analogy will make quite clear to the embryo student these two important properties of a circuit. Imagine a large steam engine of the marine type. The *fly-wheel* (the big heavy wheel with spokes that revolves round and round) would represent the *inductance*. The *spring* would represent the *capacity*."

Originally this little book was produced for private circulation among the author's friends, but it has proved so successful that a limited number of copies are available for the general public, and may be obtained from our publishers, price 7d., post free.

A DICTIONARY OF AIRCRAFT. By W. E. Dommett. London: The Electrical Press, Limited. 2s. net.

This useful little book should prove of service to the large section of the general public interested in aviation. The scope of the dictionary has been arranged to include popular as well as scientific and technical terms, also symbols and abbreviations used in aeronautical periodicals and text-books. As a whole the terms are clearly explained, although in some cases improvements might be made. Thus "camber" is defined as "the convexity or rise of a curve of an aerofoil from its chord usually expressed as the ratio of the maximum departure of the curve from the chord as a fraction thereof." This is not very illuminating to the non-technical man, and in any case there should be cross references to "aerofoil" and "chord," both of which terms are explained in their proper place.

The definition of "airplane" too, is not very satisfactory. It is said to be the "Anglicised form of 'aeroplane,' a term used by the Admiralty and *Daily Mail*." The word is largely used in the United States, which fact should certainly not be ignored.

We notice certain omissions which might be rectified in subsequent editions. For instance, although the "L.V.G." and "Fokker" machines are explained, we cannot find any reference to the Gotha or Albatros types—quite an inexcusable omission, seeing that the book is dated December, 1917.

The Purchase of Books for Readers

THE Publishers of THE WIRELESS WORLD are pleased, at all times, to obtain for readers any of the publications reviewed in these columns, as well as books on all technical subjects. Orders should be accompanied by a remittance covering the full cost of the book and postage. Should the amount forwarded exceed that required, the balance will be returned to the sender.

Personal Notes

On February 11th last the Head Office Staff of the Associated Marconi Companies met together for the purpose of making a presentation to Mr. and Mrs. Godfrey Isaacs on the occasion of their silver wedding. The gift, which took the form of a handsome Georgian tea service in silver, was handed to Mr. Isaacs on behalf of the staff by Senatore G. Marconi, G.C.V.O., and Captain Sankey, R.E. In a short speech Captain Sankey said that the gift was a unanimous expression of the regard in which the staff held Mr. and Mrs. Isaacs, the former both as an employer and friend and the latter for her interest in the social activities and sports.

Senatore Marconi, who was not expected to be present, managed to find time among his multitudinous duties to attend the presentation, and in a moving speech

CAPTAIN SANKEY, F.E., HANDS THE GIFT TO MR. AND MRS. ISAACS.

MARCONI HOUSE STAFF AT THE PRESENTATION.

spoke of his own kindly regard for Mr. Isaacs and said how pleased he was to be associated with the staff in their tribute. Mr. Isaacs in reply said that he was at a loss how to express his emotions on receiving such a splendid gift from the staff. During the time he had been associated with the Marconi Company he had learnt to hold in high esteem those who were working with him, and he thanked them most sincerely for this gift. Mrs. Isaacs followed with a happy little speech, and on Captain Sankey calling for three cheers for Mr. and Mrs. Isaacs these were given with a heartiness which could not be mistaken. The staff, feeling that three cheers were scarcely enough to celebrate the occasion, followed with three more just as hearty and the little ceremony terminated.

DOVER PATROL LOSSES.

From Dover we learn with regret of the death of Warrant Telegraphist Francis Gordon Linwood, who was killed in action with enemy destroyers on February 15th. Aged 30 years, he received his wireless training at the British School of Telegraphy, Clapham Road, and joined the staff of the Société Anonyme Internationale Télégraphie Sans Fil in 1910, subsequently serving on German, Dutch and Spanish vessels, as well as at the Cadiz Station and in the Brussels Office. He had left the Marconi Service prior to the war, but, although far from strong, he volunteered for naval service in November, 1914, serving first on an Admiralty collier with the

WARRANT TELEGRAPHIST
F. G. LINWOOD, R.N.R.

Fleet during the Falklands Battle, afterwards on vessels of the Dover Patrol, where he had many times seen action with the enemy. He was buried at Teddington on February 22nd with full naval honours, a party of about 200 officers and men being in attendance. His loss is keenly felt by his fellow wireless officers of the Dover Patrol, with whom he was extremely popular.

Harold Fielding, a wireless operator on one of the mine-sweepers in the Dover Patrol, who was killed in action on February 15th, was the son of Mr. Ernest Fielding, of Hugh Oldham Drive, Lower Broughton, Manchester. In December, 1915, he enlisted in the R.N.V.R., and at the time of his death was in his 22nd year.

Wireless Operator Gilbert Lambert, R.N.V.R., formerly on the staff of the Folkestone Electricity Supply Co., Ltd., and Wireless Operator C. S. Harrison, a student at the Royal Technical Institute, Salford, were both killed in the enemy raid on the Dover Patrol of February 15th. All wireless men will join with us in expressing sympathy with the parents and relatives of these gallant young men.

Good Wishes.

Senior operators of the M.I.M.C. Co., Ltd., will be interested to read of the marriage of R. Jones, who was with the Company from 1910 until last summer, when he was transferred to the R.N.V.R.

The marriage took place in London early in February, the bride, formerly Miss Millicent Watson, of Brisbane, Queensland, returning with her husband to Scotland, Mr. Jones being stationed at one of the Admiralty stations there.

Killed in Action.

Members of the staff of Marconi's Wireless Telegraph Co., Ltd., will be sorry to hear of the death of Phillip Hugh Soorn, who was killed in action on February 2nd. Mr. Soorn, who prior to the war was engaged as a wireless operator at the Towyn wireless station, joined the forces on their mobilisation, rising to the position of staff sergeant. He was wounded during a bombing raid and never regained consciousness, passing away after a few hours. He was held in high esteem by all with whom he was associated, and we take this opportunity of expressing our sympathy with this gallant soldier's parents in their grief.

STAFF-SERGT. P. H. SOORN, R.E.

POSTHUMOUS AWARD.

Among the recipients of war honours at a distribution at Leeds recently was Mrs. Bradley, who received the D.S.M. awarded to her son, Walter Edwin Bradley, Chief Petty Officer (2nd grade), R.N.A.S., who was killed in a seaplane on December 10th, 1916. Mr. Bradley was engaged at the wireless station of Las Palmas from 1912 to 1914 and afterwards entered the R.N.A.S. in the wireless section. Mr. Bradley was very popular in the Marconi Service, and the senior men who will remember him in pre-war days will be proud of the recognition accorded to their colleague.

MILITARY APPOINTMENTS.

The following have been appointed Acting Captains in No. 3 Wireless Signal Squadron of the Indian Army :—Lieut. F. J. Foxlee (Indian Army Reserve of Officers), Lieut. B. M. Peek (Hampshire Regiment), Sec.-Lieut. R. A. E. Blake (Hampshire Regiment), Sec.-Lieut. B. Mead (Hampshire Regiment).

MISS F. K. WEST.

MISSING.

We learn from the *Bury Guardian* that Clarence Richardson, wireless operator, R.N.V.R., was on a boat sunk recently. He has since been missing, and in the circumstances it is feared that he has been drowned. Richardson, prior to joining the wireless service, was a railway goods clerk. He was 18, and was a patrol leader in the 14th Bury Troop of Boy Scouts. His father, Private William Richardson, was killed in September last.

WOMEN'S SERVICE.

The accompanying photograph shows Miss F. K. West, a recent recruit to the W.A.A.C. from the staff of Marconi's Wireless Telegraph Company, Limited. Miss West is the third of this Company's staff to join the forces.

A WELL EARNED AWARD.

We are glad to announce the award to Air Mechanic J. H. Holdershaw, R.F.C., of the Distinguished Conduct Medal. Holdershaw, who stuck to his wireless post in the face of violent attack, had his aerial blown to pieces nine times in one day.

MENTIONED IN DISPATCHES.

In the *London Gazette* for March 7th the following wireless men are mentioned in dispatches :—Second Lieutenant J. A. Cooper, Lance-Corporal A. C. Diver, Sergeant G. S. Little and Sergeant A. Porteous, all of the wireless section of the Royal Engineers attached to the East African Forces.

DEATH OF A WELL KNOWN OFFICIAL.

We regret to announce the death of Commander A. Houghton, R.N.R., President of the Mercantile Marine Service Association. Commander Houghton, who had been suffering from ill-health for some time, made his last appearance in public on November 20th, presiding over a meeting of the Council of the Association.

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.* (6) *All queries must be accompanied by the full name and address of the sender, which is for reference, not for publication. Queries will be answered under the initials and town of the correspondent, or, if so desired, under a "nom-de-plume."* (7) *During the present restrictions the Editor is unable to answer queries dealing with many constructional matters, and such subjects as call letters, names and positions of stations.*

C. C. G. (Musselburgh).—(1) Your first question is of a constructional nature and therefore cannot be answered during the war. (2) The effect you mention is one of many to be obtained with sensitive receivers. If you will carefully examine the chart of connections, you will see that there is a capacity path to earth through the crystal if connected in the way you mention. Signals so received are, of course, untuned.

AMPLIFIER (Newport Pagnell).—The address you ask for is Marconi's Wireless Telegraph Company of Canada, Ltd., Shaughnessy Building, 137, McGill Street, Montreal.

E. C. (Kingston-on-Thames).—In the event of an operator losing his effects at sea as the result of enemy action, compensation may be paid by the Board of Trade up to a maximum of £50. Application must be made to a Board of Trade Shipping Office for a claim form. This insurance costs the operator nothing.

H. W. L. (Rotherhithe).—(1) Each circuit of the receiver (and this includes the aerial) must be tuned to the particular wave-length it is desired to receive, unless the station from which signals are being received is fairly close, when with tight coupling oscillations may be forced upon the receiver irrespective of its tuning. (2) Inductance is in centimetres. (3) Whether an L or T aerial is erected on board ship depends usually upon the position of the cabin and the convenience of arrangements. For a given length of wire the L aerial has greater inductance as the inductances of the two arms of the T aerial are in parallel. An L aerial with a long top is directional both for transmitting and receiving, signals coming in strongest from the direction away from the free end. Unless, however, the top of the L aerial is long in relation to the down lead this effect is not very noticeable.

BOB (Stroud Green).—(1) At the present time there are no publications devoted entirely to Continuous Wave Telegraphy. The Wireless Press, Ltd., will shortly issue a volume devoted exclusively to the subject, and an announcement will appear in our pages in due course. (2) Normally the age limit of the Marconi Company is 25, but at the present time, owing to the requirements of the Military Service Act, men are not accepted above the age of 18 years unless, of course, they are ineligible for the Army. Such a man with the qualifications you mention would probably be accepted immediately by the Company, provided he passed the Company's doctor. His training would then be completed in the Marconi Company's own school. Application should be made to the Traffic Manager, The Marconi International Marine Communication Company, Limited, Marconi House, Strand, W.C.2.

G. T. S. (Hounslow).—(1) The doctor's fee for the medical examination of the Marconi Company's students is 10s. 6d. It is necessary that applicants should be tested by one of the Company's own doctors. (2) A mess suit is not essential to an operator's outfit. With regard to the second part of your question, we would refer you to the notes on this subject which appeared in March, and would suggest that you consult your local tailor.

W. D. (Beeston).—Both the purchase and possession of wireless apparatus are prohibited to amateurs at the present time, and therefore you would not be permitted to purchase the set to which you refer. We would advise you to spend your spare time in studying the theory of wireless telegraphy in preparation for the time when amateur experimentation is again permitted.

E. N. S. (Blackpool).—(1) The vacancies in the Marconi Company's service are for men to go to sea as wireless telegraphists. In practically all cases appointments to land stations are given after some years of service on board ship. (2) *The Elementary Principles of Wireless Telegraphy* is a more suitable book. Please see Rule 5 at the head of this section.

A. G. B. (s.s. ——).—(1) We have heard of several cases similar to that you describe, on ships wired on the two-wire system without an earth return, and the trouble is usually due to a leakage to earth from the dynamo. Sometimes, too, there is a leakage from one of the lampholders. From the fact that there is one noise per revolution of the dynamo we should think that there is a "flat" on the commutator, which gives a little sparking, although not sufficient to show on inspection. (2) We are always pleased to consider articles for publication to be paid for at our standard rates. Many thanks for the cutting attached to your letter, which is very interesting.

B. W. F. (Leeds) does not send his full name as stipulated in our rule No. 6. On the receipt of this we will give him the information he desires.

L. A. (Ipswich).—There are wireless sections connected with the Royal Flying Corps and the Royal Engineers, for both of which the men are trained by the Army authorities. You should apply to the local recruiting office for particulars of how to join these sections, and as you are not yet 18, it will, of course, be possible for you to volunteer for such work.

L. H. (Tod).—We would advise you not to attempt to construct the apparatus you mention, as it would be difficult to prove that it was not intended for wireless work.

"NAVIGATION" (London).—You do not say whether the appointment you desire is in the naval service or on the staff of a commercial company. Coast station appointments in the naval service are usually made from the ranks of experienced naval radiotelegraphists, and it is highly improbable that such appointments could be gained by a new recruit to the service. The Marconi Company's land stations in Great Britain are at present being used for Government work, and, in any case, positions in them are reserved for experienced men.

D. O. G. (Ashton-under-Lyne). — Coast station appointments, as mentioned above, are reserved for experienced men, and, in view of your age, we do not think that you would be able to qualify for an appointment as a wireless engineer.

A. B. (B.E.F.) sends no name on his query, and it therefore cannot be answered.

W/T (B.E.F.), who has practical experience with wireless apparatus with the Forces, wishes to know whether he can sit for the Postmaster-General's Examination by taking a correspondence course. *Answer:* A good correspondence course can teach our correspondent sufficient theory to pass the theoretical side of the examination, and if he can send and receive not less than twenty words a minute he should be able to pass the telegraphic side. The Postmaster-General's Certificate certifies that the operator "is able to adjust the apparatus ordinarily used in some well-known system of wireless telegraphy, so as to suit the varying conditions of working, without using excessive transmitting power, and has an efficient working knowledge of the regulations applicable to the exchange of radiotelegraphic traffic." From this our correspondent will be able to judge whether he has sufficient knowledge to pass the practical side. With regard to question 3 in our correspondent's letter, asking whether in the event of his obtaining a First-Class Postmaster-General's Certificate he would have a chance of success in the Marconi service, we can, of course, offer no opinion, as no one knows what the conditions will be on the termination of hostilities.

"A MECHANIC" (Edinburgh).—The fact that you do not possess the Postmaster-General's Certificate would prevent you obtaining employment as a seagoing wireless operator. Without any more particulars regarding your other qualifications we cannot pass any opinion upon your prospects of obtaining other wireless employment.

A. O. C. L. (Grantham).—You are quite correct in your statement, and we must thank you for bringing the error to our notice. It is strange that it has never been remarked before.

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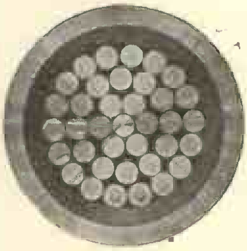

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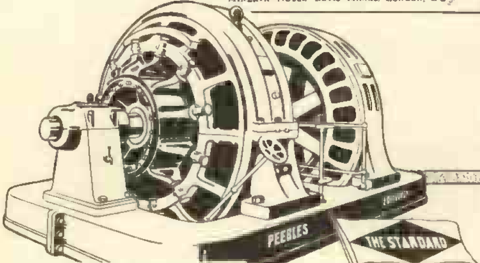

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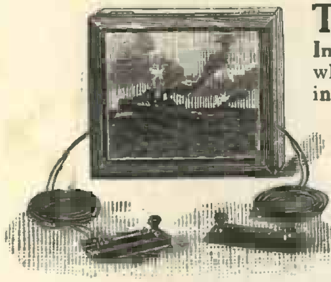

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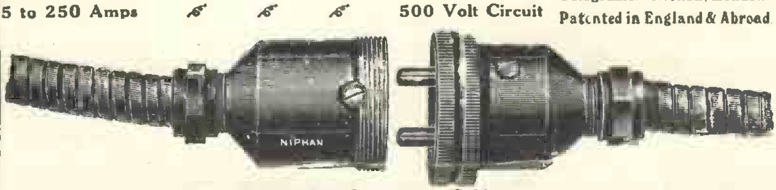

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