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THE WIRELESS WORLD

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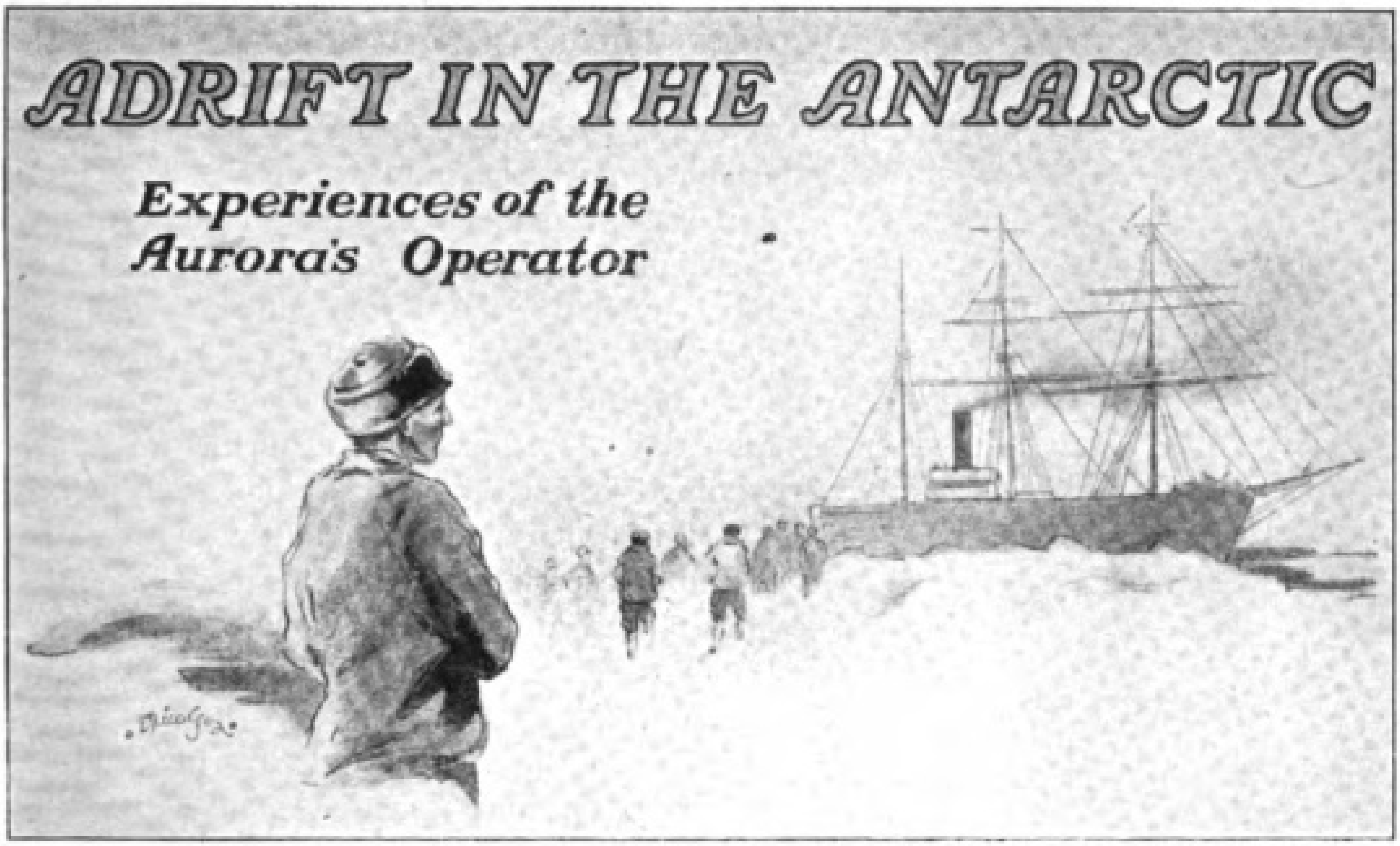
1916

"Aurora" Operator's Story

Captured German Wireless Sets

1916 Year Book of Wireless Telegraphy



An article transmitted from the Antipodes, and illustrated by J. W. Nicolson.

It is significant of the world-wide interest taken in Polar exploration that, in spite of the terrible and ever-present topic of the war, no small amount of space in the newspapers was recently devoted to the adventures of Sir Ernest Shackleton and the ss. *Aurora*, which was to have picked up the explorer and his comrades. It was the intention of Sir Ernest to traverse the Antarctic Continent from the shores of the Weddell Sea to the shores of the Ross Sea, passing by way of the South Pole. It was calculated that the total distance would be about 1,700 miles. The arrangement was that the intrepid explorer and his party should sail from Buenos Aires in the *Endurance* during the latter part of 1914, and that the *Aurora*, with a supporting party, should leave Australia to pick up the explorers at the Ross Sea. There was also assigned to this ship the duty of laying food depots towards the Pole for Shackleton's use. She was to remain there until March, 1916, and, had all arrangements worked satisfactorily, would have brought him off after his great journey. The first news of the catastrophe was received from the *Aurora* towards the end of March last. The gist of the telegram was to the effect that the *Aurora* had experienced a very rough time in the ice, and her hull had been severely strained. The enormous pressure of the ice also destroyed her rudder, and until a jury rudder could be fixed she was helpless. In addition she lost her anchors, and ran short of fuel. Unfortunately during a great blizzard the ship broke away from her moorings in the Ross Sea, leaving five or six men (who had gone ashore to establish food depots) stranded.

A few days after the receipt of the first telegram, a second wireless dispatch was sent from the *Aurora* as she was on her way from the Antarctic to New Zealand. This second telegram confirmed that there was a fair amount of stores available for the explorers marooned on the Ross Barrier.

"NIGHT AFTER NIGHT . . . IN HIS CABIN."

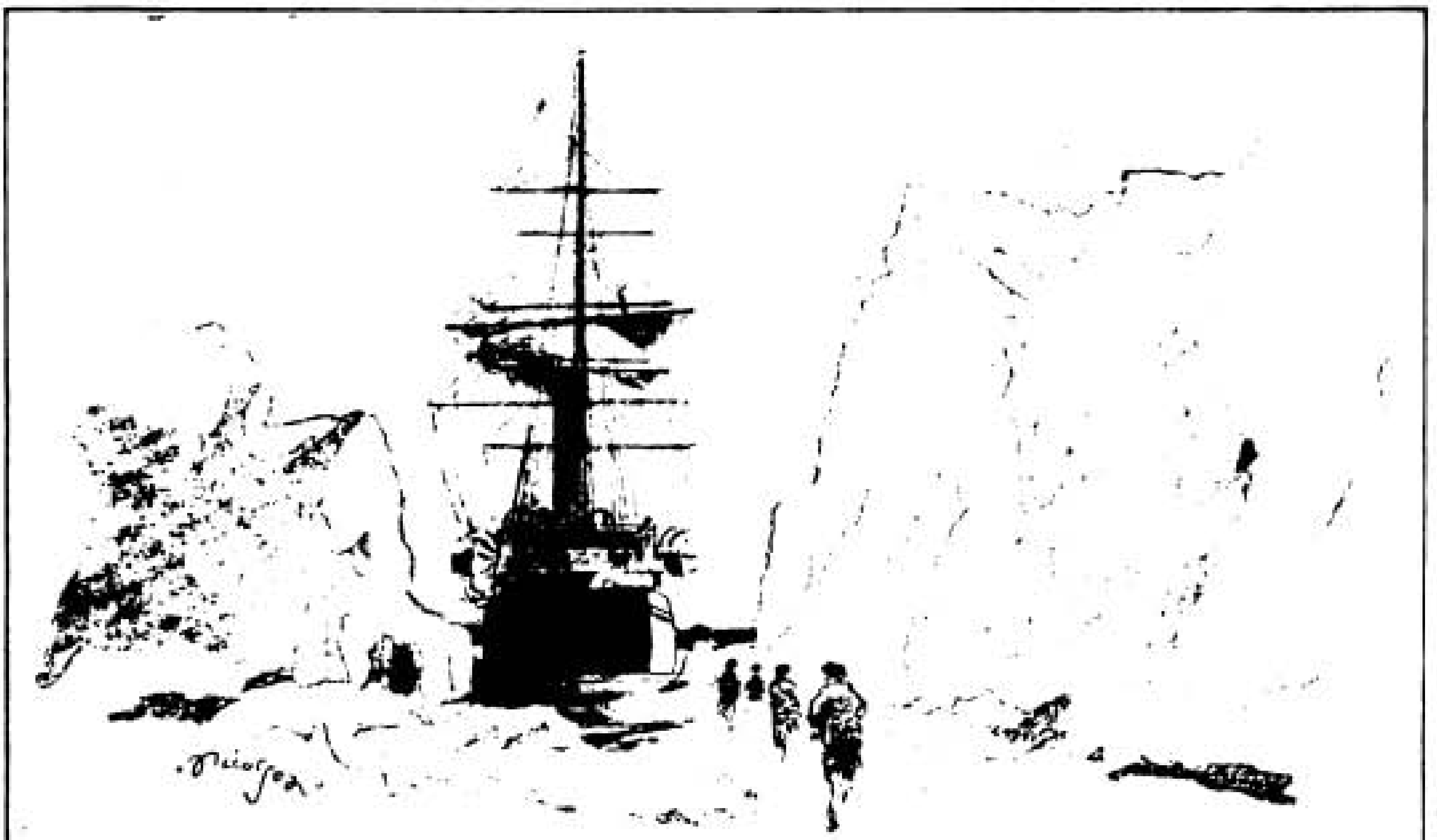
A third wireless message was subsequently received from the *Aurora* stating that she was 250 miles south-west of Port Chalmers, New Zealand, and was setting towards Snares Islands, under the influence of the elements, and was incapable of being manœuvred in the high sea owing to damage done to the jury rudder. The Prime Minister of New Zealand (Mr. Massey) immediately arranged for a tug to be sent. In the evening of the same day the *Aurora* sent a further message reading—"Now sailing three knots, all well." The tug, which was specially fitted with wireless apparatus for receiving messages, eventually picked up the distressed vessel, and brought her safely into harbour at New Zealand.

One of the greatest puzzles to wireless telegraphists and scientists alike is the peculiar power some radiotelegraph stations possess of occasionally transmitting messages over many times the distance for which they were originally intended to operate. We are fortunate at being able to include in this article a considerable amount of information received from Mr. Lionel Alfred Hooke, of the SS. *Aurora*, an operator chosen for this important position, not only for his skill in manipulating the apparatus, but also for his versatility and resourcefulness.

The *Aurora*, under Lieutenant Aeneas Mackintosh, R.N.R., was about to leave Sydney, in December, 1914, for her journey to the Great Ice Barrier, where she was to await the arrival of Sir Ernest Shackleton and his party after their journey across the vast Antarctic Continent, where it was suggested that the ship might be materially safeguarded in her perilous journey to and from the ice-fields if she carried a wireless equipment. No sooner was the suggestion made than the people of Sydney with their traditional public-spirited generosity subscribed for the necessary plant. The one purchased was that which proved so useful in the Mawson expedition of 1912–13. There was never any suggestion that this particular installation would be capable of keeping in constant communication with the world at large, but it was hoped, and reasonably so at the time, that with two or three wireless stations operating in the Southern Seas, and a constant stream of traffic between New Zealand and the Straits of Magellan, useful signals might be exchanged on occasions when help might be considered necessary. There was just the remote possibility also that, under "freak" conditions already alluded to, some message might get through to the wireless station established for scientific research in Macquarie Island, and another much more powerful station at Awarua in the south of New Zealand. To assist in this plan the "wireless" operators on ships in southern waters were ordered to keep a look-out for signals from the *Aurora*.

No ship could be less suited for a wireless installation with any pretence at long distance service than the *Aurora*. She is a small craft constructed of wood. Two of the essentials for effective radiation are lofty aerial and an effective means of getting the electric waves to "earth." The *Aurora's* mast being relatively short and her hull constructed of wood instead of metal, the odds were all against effective working, but by means of extensions to the masts proposed by the manager of the Wireless Company in Australia, and ingenious use of such metal parts as were to be found in contact with the sea water, the installation was given an effective transmitting radius of about 200 miles. The transmitter was of 2-kilowatts capacity, the alternator being driven through a belt from a 10-h.p. De Dion petrol engine. Exceptionally good distances were achieved with this apparatus, and Hooke reports that he was able to keep in constant communication with the station at Macquarie Island until the period of perpetual daylight arrived. As we have already mentioned, the *Aurora* was not the ideal type of ship to achieve best results with a wireless installation, the barquentine rigging proving a hindrance to the fitting of a good aerial. Further troubles were caused by the lowness of the aerial, the maximum height being but 78 feet.

It is well known to those familiar with the elements of wireless that in certain parts of the world and at certain times of the year messages can be transmitted two or three times the distance by night than is possible with the same plant in the daytime. Here, then, was another limiting factor, only to be found, of course, in Antarctic and Arctic regions. Hooke, realising that communication was impossible with the outer world during the summer months, joined the land parties which pushed south for the establishment of food depots for the trans-continental party. In April, 1915, when the summer duties at Cape Evans concluded, the wireless operator prepared to get in touch with the outside world. His experiences in the rigging, endeavouring to add twenty feet to the height of the masts during a blizzard, and with nearly 40 degrees of frost, are described as "terrible." The heightened aerial was completed on May 6th,



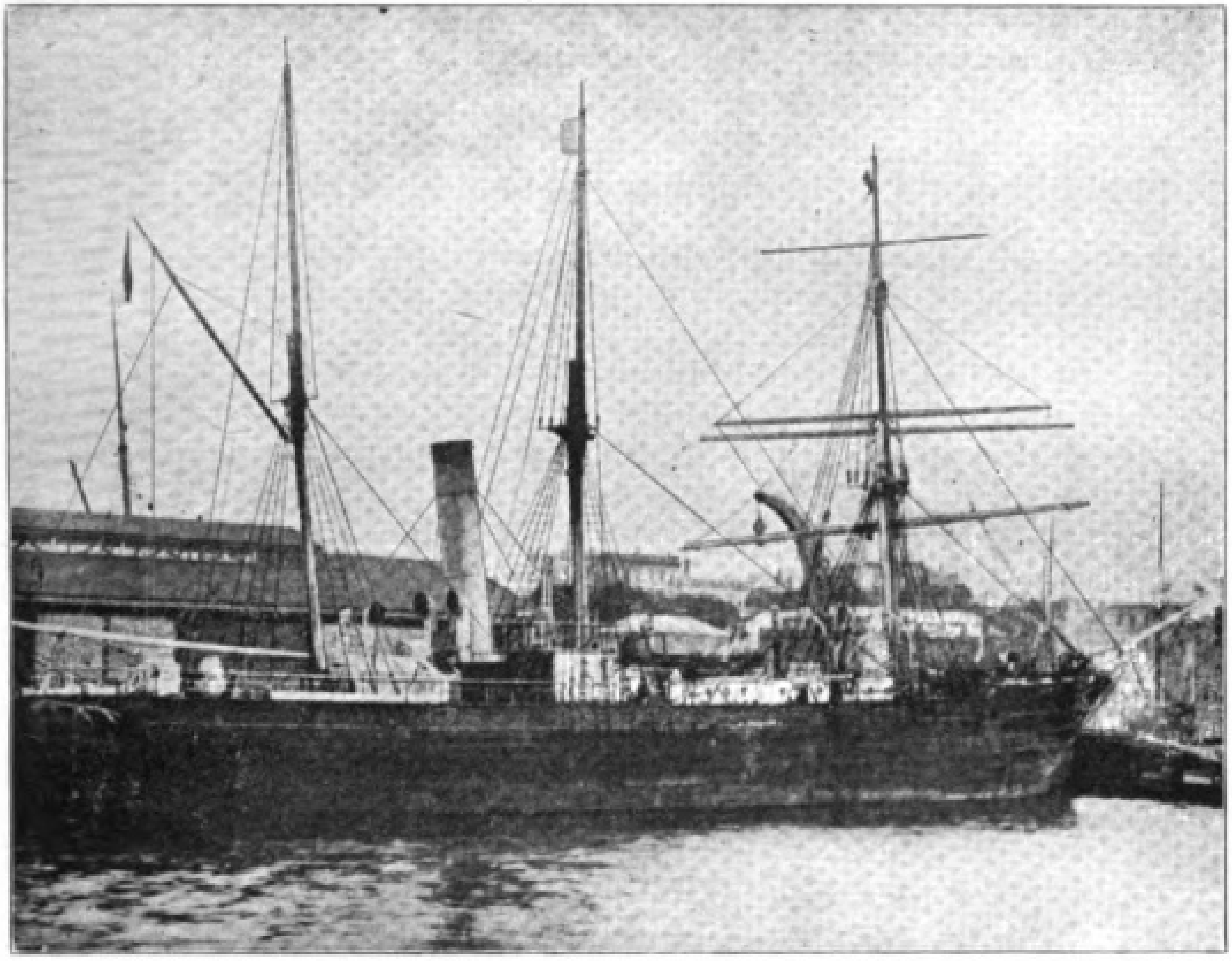
"THE 'AURORA' WAS CRUSHED IN THE ICE."

and then on May 19th the ship's moorings were carried away by irresistible ice floes. Hooke at once endeavoured to get in touch with the marooned party, hoping that they had been able to erect the receiving set landed previously, and it is just possible that the land party now isolated in the inhospitable wastes of perpetual snow learned by these signals of the *Aurora's* ill-fortune, and were able to make the earliest possible provision against an unexpected twelve months on land. At this point it tells us that considerable trouble arose from the insulators, which became conductive on account of ice. As we know that fresh-water ice is an excellent insulator, we can only presume that what it refers to must have been a layer of frozen salt water. Finding that his radiation was reduced to a minimum, Hooke tried smothering the insulators with vaseline, but this apparently made matters worse. He next tried a coating of bitumastic solution, which gave a slight improvement, and he records that Marconi Strain insulators work better minus their cones. Finally, Hooke adopted insulators of the porcelain egg type (see article on Porcelain Insulators in the September and November, 1915, issues) completely coated with a mixture composed of pitch and resin in equal proportions to a thickness of ½ inch; there were no Marconi Strop insulators aboard, the operator says, and he expresses regret on this point, as he believes that these would have been exactly what were required.

[*Photo Newspaper Illustrations.*

SIR ERNEST SHACKLETON, PHOTOGRAPHED A FEW DAYS BEFORE HE LEFT ENGLAND ON HIS PRESENT EXPEDITION

On June 1st Hooke, basing his hopes on the fleeting possibilities of abnormal wireless conditions, commenced to call Australia, but without success. He attributed his total failure to electrical phenomena peculiar to the polar regions, and he made exhaustive experiments with all sorts of makeshifts in the hope of getting definite results. It is well perhaps for Hooke and his fellow adventurers that they did not know the real reason for their non-success, as the hopes of relief which buoyed them until their return might have been shattered.



S.S. "AURORA," WHICH WAS TO HAVE PICKED UP SIR ERNEST SHACKLETON AND HIS COMPANIONS

Here the war was playing the devil's part. In the first place the Commonwealth, in the interests of economy, recalled the staff of the wireless station at Macquarie Island. This removed the first possibility of inter-communication with the little party drifting in the Antarctic ice. Secondly, owing to military reasons, the transmitting apparatus at Awarua was transported to a more distant place, so that had it been possible for the *Aurora*, by a combination of favourable circumstances, to send distress signals as far as New Zealand, she would not have received any reply. Thirdly, by the large reduction of the shipping on the Magellan Straits route all reasonable possibilities of the *Aurora* appealing for help were removed.

Hooke, however, stuck to his post. On July 22nd, 1915, the *Aurora* was terribly crushed in the ice; apparently hopelessly. The boat was then 100 miles from land and 500 from the nearest food depot. Hooke again overhauled his apparatus even to the extent of lowering and re-erecting his masts, in the hope that by so doing he might help those on shore, and his fellows on what appeared to be a doomed ship. Night after night, through long and weary hours, he sat in his cabin with the telephone receivers strapped around his head, straining to catch sounds which would tell of the world's knowledge of their fate and efforts at rescue. Twice he heard faint signals, on August 17th and August 26th, but they were unintelligible—ghostly murmurings of life from a world which might be seen no more.

Once again there came the blizzard. On September 5th, 1915, the *Aurora* was dismasted, the wireless aerial going with the *débris*. Twice were the triple 280-foot antennæ created by linking up the main mast with ice hammocks, but Macquarie Island remained silent—no one had been left to listen. At the end of February, with the ice breaking, the *Aurora* was freed to drift with her broken rudder.

But the wireless operator's story now changes from sadness to joy. On March 25th, with a quadruple aerial eighty feet above deck, he succeeded in obtaining definite signals from stations in Tasmania and New Zealand, 990 miles distant. Great difficulties were experienced in starting the engine owing, of course, to the cold; but after a glow-lamp had been used and hot water run into the jacket of the engine transmission was commenced, and then followed the message which startled the globe. This message was transmitted 900 miles with an apparatus normally suitable for about 200 miles radius, and eclipsed, for a day at least, the interest in the great world-war. Hooke admits that navigation was greatly assisted on the return journey by the time and other signals received by him from the New Zealand wireless stations.

There are some folk, notably amongst the complex British peoples, who rise to the height of their courage and resource when enveloped in peril and dogged by the factors of disaster. The modest operator on the *Aurora* briefly records that from three days before the *Aurora* broke adrift, whilst the mast extensions were being prepared, he fitted up a 330-foot aerial to one of the huts on Cape Evans with the idea of ascertaining whether the "Aurora Australis"—the "distant" cousin of the Aurora Borealis and one of the most beautiful of nature's pyrotechnics—had any effect on wireless signals. No effect whatever was found. How far these researches, continued throughout the winter, tally with those previously recorded, is a matter for meteorologists and others directly interested to decide. These notes serve, however, to show that even under the most adverse conditions which it is possible to imagine there is a place for wireless, even in Antarctic exploration.

Wireless Association in Holland

WIRELESS specialists, men of science, practical operators, and amateur enthusiasts in Holland have found it possible to co-operate, and have recently formed a wireless association—the "Nederlandsche Vereeniging voor Radio-Telegrafie," with headquarters at The Hague. It has already created for itself a wide field of action; scientific and military committees are being formed, as well as committees for training and examinations, for merchant-naval interests and traffic concerns. Meteorological and agricultural specialists have taken part in the initiation of this body. Owing to the liberality of its patrons, the association will be able to start at once with the establishment of a library and instrumental collection. A monthly publication will form part of the programme.

Among the members of the board of direction are Dr. Koomans, engineer of the telegraph staff, and Mr. L. A. Bakhuis, chief of the cabinet of the Minister of Colonies. The secretary is Mr. J. Corver, van Aerssenstraat 162, The Hague.

Germany's Early Wireless Stations

SIXTEEN years ago when Wireless Telegraphy was known to a limited public merely as a scientific curiosity, the Germans, with a foresight characteristic of that nation, arranged for the Marconi Company to erect two wireless installations near the mouth of the Elbe.

Although these stations were nominally erected for the Norddeutscher Lloyd Steamship Company, there is no doubt that the German Government were highly interested in what they could do, realising even then the strategic importance of such stations for communications with ships at sea.

BORKUM RIFF LIGHTSHIP.

BORKUM LIGHTHOUSE.

The two stations, one on the Borkum Riff Lightship and the other at Borkum Lighthouse, are illustrated on this page, and although the apparatus was of course crude, compared with that installed in modern stations, yet they worked excellently and served to handle many messages with the giant liner *Kaiser Wilhelm der Grosse*, which, curiously enough, was brought to book by Senatore Marconi's invention early in the War, after the famous vessel had become notorious as a pirate. It is interesting to note that both installations were put in place by Mr. W. W. Bradfield, whose biography and portrait appear in this issue.

The actual apparatus at these two stations has long since been dismantled, other installations taking their place, the station at Cuxhaven together with the well-known station at Norddeich serving to handle the commercial traffic in peace time.

In the piping times of peace the Borkum district is visited by a large number of German holiday-makers who benefit considerably from the fine air and North Sea breezes.

B

PERSONALITIES IN THE WIRELESS WORLD

MR. W. W. BRADFIELD, A.M.I.E.E.

PRACTICAL radio-telegraphy owes much to William Walter Bradfield, whose connection with the Marconi Company dates from September 3rd, 1897, when he entered what was then known as the Wireless Telegraph and Signal Company Limited.

As electrical assistant to Senatore Marconi, he took part in experimental work on Salisbury Plain, and assisted in the erection of the wireless station at the Needles, Isle of Wight.

In the year 1899 Mr. Bradfield installed the first wireless apparatus on British battleships, and a little later took charge of the demonstrations to the United States Government on board the U.S. Battleship *Massachusetts*.

In 1901 he undertook similar demonstrations before the French Government, when communication was established between the French Riviera and Corsica. In the same year he supervised the erection of the famous stations at Siasconset (Nantucket Island) and the Nantucket Lightship.

By 1902 Mr. Bradfield had been offered, and had accepted, the position of chief engineer to the Marconi Wireless Telegraph Company of America, and continued to hold this post until 1908, when he returned to England as deputy-manager of the parent Company and the Marconi International Marine Communication Co., Ltd. In 1910 he became manager of both concerns.

During his tenure of the post of chief engineer of the American Marconi Co. he journeyed to Europe to take part in the now historic first International Radio-Telegraphic Conference, which, it will be remembered, took place in Berlin in the year 1906.

An Associate Member of the Institute of Electrical Engineers, Fellow of the Institute of Radio Engineers (America), and an Associate of the American Institute of Electrical Engineers, Mr. Bradfield follows keenly the progress of every phase of the great science with which he has been so long connected.

The Special Problems of Aircraft Wireless—VI

By H. M. DOWSETT, M.I.E.E.

The Danger of Fire.

Owing to the use of an explosive gas as a lifting agent which leaks through the balloon envelope, and a liquid fuel from which there is always a certain amount of waste giving off an explosive vapour, all aircraft using either or both of these agents are subject to the risk of fire which must be met and countered by suitable precautions. The possible causes of fire may be grouped under two general heads :—

A. Structural Causes.

B. Physical Causes.

Thus, under A :—

1. Explosion of the gas envelope may occur due to failure of the relief valve apparatus, a very rare occurrence.

2. The explosion which destroyed the Zeppelin L2 at a height of 900 feet above the ground was supposed to be due to a leakage of hydrogen from the balloon into a covered way connecting the two gondolas, which prevented it dissipating into space, and along which it gradually found its way to the exhaust of one of the engines.

3. " Several military airships have been sent up on trial trips with open exhaust pipes instead of being fitted with silencers, or chambers in which any flames could be guarded."*

Under B :—

1. The sudden conflagration which destroyed the Zeppelin L4 on landing is supposed to have been due to a strong spark discharge from its metal frame to earth by way of some trees, which fired the balloon gas, the electric charge having been acquired from the atmosphere when the balloon was flying high.

2. Balloons are known to have been struck and destroyed by lightning.

3. Electric sparks at the wireless transmitting key, and the spark or arc at the H.F. primary circuit discharge.

4. High-tension brushing from the wireless transmitting aerial circuit.

5. Sparks and brushing induced by the wireless transmitting circuit in neighbouring metal work.

We are concerned with the causes mentioned in Group B, each one of which is a form of electric discharge in the atmosphere in the neighbourhood of an explosive gas.

Some knowledge, therefore, of the state of electrification of the atmosphere, of the nature of the electric discharge in gases, and of the conditions necessary to fire an

* Hearne, *Aerial Warfare*, 1909.

explosive gas electrically, is necessary, if satisfactory methods to combat the danger of fire are to be devised.

THE IONISED ATMOSPHERE.

The whole extent of the atmosphere in which aircraft manœuvre is electrified. In fair weather the vertical potential gradient near the earth averages 2½ volts positive per inch; so that, supposing this gradient to be maintained at high elevations, a metal-framed aircraft ascending, say, to 10,000 feet and acquiring the potential of the air at that elevation, namely, 300,000 volts would—on quickly descending without losing its charge—be capable of sparking to earth over a distance of *nearly 22 inches*.

Obviously measurements of potential at such an elevation are difficult to make and are subject to large errors. It is known, however, that the potential varies considerably from day to day, and at times it certainly reaches a much greater value than the figure given above.

But it takes time for an aircraft to assume the potential of its surrounding medium. An unelectrified metal body with no connection to earth can only be electrified slowly by the bombardment of the ionised gaseous particles nearest to it, which thus release the charge of opposite sign and leave it finally with a charge of the same sign as that of the surrounding medium.

The process of charging—and of discharging—is considerably hastened if the body can, as it were, shed its electrical skin into the medium. Such an action would take place were it to give off gas, the gas carrying the skin charge away with it, and such is the action of the waste gases, the products of combustion from the aircraft engine. The crew themselves, for a similar reason, assist this equalisation of charge.

The same agencies will assist leakage from the body of an opposite or excess charge to that of the surrounding medium, which it may have acquired.

The question of the time required for an unelectrified conducting body which is not connected to earth to arrive at the local potential of the atmosphere, and for the charge to leak back again into space, is one of importance. The generally accepted theory of the sudden destruction of the L4 on landing is, that it descended too rapidly to have given up all its charge, its potential on coming to earth being estimated at 100,000 volts. Even this potential could have been rendered harmless if a metal drag rope had been used to make contact between the earth and the metal frame before the latter itself reached the ground.

It is more safe for an aircraft to assume the potential of the surrounding medium than to remain unelectrified, as a difference of potential above a certain value will give rise to a brush discharge which, under certain conditions, would prove a source of danger. The engine exhaust gases, therefore, act as a form of aircraft electrical safety valve.

THE LIGHTNING DISCHARGE.

A thunder cloud is a fog of highly charged air, each gaseous ion of which has become a nucleus to a water drop. These drops are all separate and tend to remain apart—a jet of water when electrified breaks up into drops—and the insulation through the cloud, if nothing disturbs it, may be of a very high order. It is common knowledge, for instance, that a good porcelain insulator, 2 feet in length, or a 3 feet rubber aerial mast-head insulator, will stand up without difficulty to a pressure of 100,000 volts to earth in a rain shower, provided the surface remains in good condition and does not tend to break the drops and make them run together. This is the order of insulation which often obtains in a thunder cloud.

A thunderstorm involves local charges often of enormous magnitude, which result in flashes some of which have been estimated by competent observers to reach a length of as much as six miles. A lightning discharge may take place from a cloud to earth, or from one cloud to another, or between different parts of the same cloud. It may be started by the potential difference being increased above the critical value, or by the insulation resistance between the opposing charges being lowered due to ionisation, or by turbulence--the wind driving one charged cloud into or near the other.

The character of a lightning flash is less that of a sudden and complete breakdown of the air dielectric, than that of one or many small and incomplete breakdowns followed by the main flash which completes the breakdown. There is in fact a trigger action, similar to that well-known method for starting H.F. oscillations in which a small spark discharge ionises the gap and thus releases a much larger spark discharge. For this reason the length of the flash can seldom be used to estimate with any degree of certainty the actual potential involved.

When the relation of lightning to aircraft is considered, one is necessarily obliged to take into consideration the relation of aircraft to these three agencies—ionisation, turbulence, and the trigger discharge—which release lightning. Thus a difference of potential between the metal work of the machine and the surrounding air may lead to brushing on some prominent part, which in its turn may cause sufficient ionisation of the air locally to create a trigger discharge. Again, the turbulence created by the engines and propellers of a dirigible would tend to precipitate a lightning flash. On the other hand turbulence might lead to a silent discharge which would prevent a dangerous accumulation of potential electrical energy.

The Protection of Aircraft against Lightning.

If an aircraft were in the immediate path of the main lightning discharge one could not expect it to survive, but it is very unlikely to be in such a position, as, although thunder clouds gather quickly, they show obvious signs of their presence, and—with the exception of free balloons—aircraft have the power of avoiding their immediate locality.

The danger from lightning lies more in its tendency to create recoil discharges between capacity areas in the neighbouring space. The danger will be reduced, the more the capacity area is reduced, and the more the concentration of the electrostatic field at points, edges, and elongations of all kinds which encourage the brush discharge, is eliminated.

Then if an aircraft must remain aloft in thundery weather, as a measure of safety it should not attempt to use its wireless ; instead, the aerial should be wound in-board to reduce the total capacity or conducting extension in space.

It may be possible in certain special cases such as that of the free balloon fitted by Mosler,* or the dirigibles of the Lebaudy class,† to take in also the balancing capacity, but in general this is not possible. The balancing capacity more usually is part of the

* Wireless World, January, 1916, p. 650. † Wireless World, March, 1916, p. 770.

airship structure, and as such is fixed. All that can be done is to pay special attention to its design in the first instance, so as to avoid the concentration of charge on it at points and extensions.

THE "BRUSH" OR "SILENT DISCHARGE."

If we study the initial conditions of an electric discharge from metal conductors in air, as the potential increases—a subject which is closely related to the safe use of Wireless on Aircraft—we find that it takes one of three forms :—

1. A glow which develops into a brush and then into a spark ;
2. A brush, and then a spark, but no glow ;
3. A spark, without any preceding glow or brush.

The glow is characteristic of the first stage of breakdown of the air due to a positive charge, whereas a negative charge first shows itself in the form of luminous beads scattered at intervals along the conductor.

The glow and the beads both develop with increase of potential into the brush discharge.

These three phenomena, generally known as the "corona," are associated with gaps which on the average are more than ten times the radius of curvature of the discharge faces. If the ratio is less than this, the gap will break down by means of a spark only.

Thus a thin wire in space, such as an aircraft aerial, will glow and brush when it reaches a sufficiently high potential relative to its surroundings ; and the coppery glow of a thundercloud may be associated with a brush discharge from its constituent water globules ; but the frame of a Zeppelin, which has been strained by a voyage, when given a charge will have minute sparks passing across the rivet holes wherever the rivets are loose, and there will be no brush in the holes.

Whenever the silent discharge takes place energy is leaving the capacity circuit and is being consumed in the air, giving rise to effects of heat, light, chemical action and ionisation.

With thin wires this loss commences even below the potential at which the wire becomes luminous. As an instance of the amount of energy which can be absorbed in this way one may quote a test made by E. F. W. Alexanderson,* in which he used two wires 40 inches long, ·01 inch diameter, suspended free in air and 2 feet apart. The measureable corona loss first appeared when there was a difference of potential between the wires of 15,000 volts. At a P.D. of 27,000 volts, the loss had increased to 500 *watts*. This energy was not used up in the wires, for they remained quite cold, and it can be shown that they would have fused at less than this value.

The resistance of two such wires at 60° F. would be ·287 ohms. At 1980° F., at which copper melts, their resistance would be about 1·6 ohms. This gauge wire fuses at 16 ampères. Then the C^2R. value at the melting point would be about 410 watts —certainly not more. Thus there would be ample energy available to fire an explosive gas if the potential on conductors immersed in it were allowed to reach a value at which strong brushing took place.

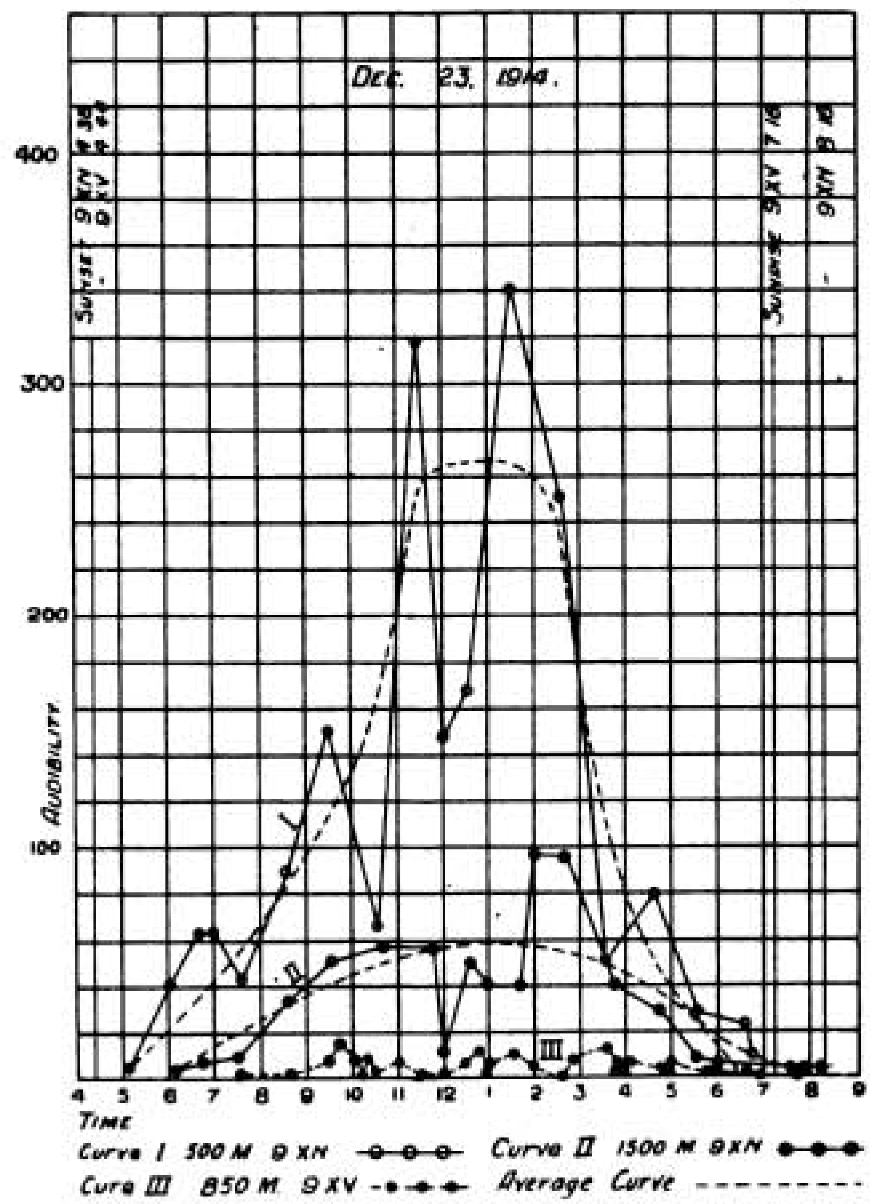
(To be continued.)

* "Dielectric Hysteresis at Radio Frequencies." Institute of Radio Engineers, November, 1913.

Digest of Wireless Literature

VARIATION IN WIRELESS SIGNALS.

In the current issue of the "Proceedings of the Institute of Radio Engineers," a highly interesting paper on "Variations in Nocturnal Transmission" is contributed by Messrs. A. Hoyt Taylor and Albert S. Blatterman. Space will not permit us to give full consideration to this important paper, and we therefore have to content ourselves with reproducing a few of the interesting features.



Messrs. Taylor and Blatterman deal with certain experiments in nocturnal transmission carried out by radio stations "9XN" (University of North Dakota, Grand Forks) and "9XV" (Washington University, St. Louis, Missouri), in an attempt to test the interference theory of "fading" and "swinging" effects, and to correlate, if possible, transcontinental weather conditions with radio transmission.

The radiation current at Grand Forks being limited to 13 aerial amperes and that at St. Louis to 7, the observations were necessarily restricted to the periods of twilight and total darkness, and since the distance between the stations is 1,250 kilometres (780 miles), no observations were possible during the mid-summer period of violent strays and bad transmission.

After considering critically the bibliography of wave absorption, the writers describe the apparatus used at the stations and the method of the tests. Observations on signal strength were taken hourly throughout the night with 15-minute periods near sunset and sunrise. Primarily two waves were used by Grand Forks, 1,500 metres and 500 metres with a 2-minute interval necessary to make the shift in aerials and in transmitter connections, as the transmitter is not located in the same room with the receiving and controlling apparatus. After a two-minute rest, the St. Louis wave was observed. The calls were of 3-minute duration. The wave lengths were chosen by both stations of such values as to create a minimum of interference with other stations.

During part of one test, a seconds ticker was used at Grand Forks for sending the signals, but irregular and rapid sending, usually with an automatic key, was found more satisfactory and less deceptive.

Observations on general transmission conditions from other stations were made from time to time during the night, and an attempt was made in all cases except one, subsequently mentioned, to have the sensibility of the receiver as nearly uniform as possible by checking the audion with a standard buzzer test, set for the desired wave-length, or with a perikon detector of very constant adjustment. It is a matter of regret that the conditions of constant sensibility were not fulfilled at Grand Forks as well as could be desired, inasmuch as two audion bulbs were burned out during the tests, making unavoidable some alterations in sensibility.

* * * * * *

RESULT OF THE TESTS.

The tests were run on the nights of December 23rd, 1914, January 7th, January 28th, March 6th, April 17th and June 10th, 1915. Besides these tests the two stations had a standing appointment for 9.30 and 10 p.m., Central time, on every Monday and Thursday evening until about May 1st, when the St. Louis signals were no longer audible at Grand Forks.

A number of curves are given accompanied by weather maps for the time of the tests. Of these we reproduce herewith Figure 1. Curves I, II, III of Figure 1 present the data of the first test, on December 23rd, 1914. The Grand Forks waves show the greatest regularity in this test, but pronounced fading effects were observed in the St. Louis wave, although it was audible from 7.45 p.m. to 7.40 a.m. Curve I shows the reception of the 500-metre wave, and Curve II the 1,500-metre wave at St. Louis. Curve III shows the reception of the 850-metre wave at Grand Forks.

The extraordinary regularity of the 1,500-metre wave during the first half of the night contrasts sharply with the fluctuations of the 500-metre wave. It is doubtful whether the fluctuations of the 850-metre wave are synchronous with those of the 500-metre wave. Experience has shown that fluctuations may occur so rapidly that tests for reciprocity of transmission must be made almost simultaneously to be of any great value. Further special tests are contemplated on this point.

The 1,500-metre wave shows wide variations between 11.45 and 3.40, which are almost exactly duplicated by the 500-metre wave. This was not due to maladjustment of the St. Louis receiver, as the operator reported that other stations to the south and east sending in this interval showed little change in intensity.

For neither wave do the curves seem to be symmetrical about the solar midnight. Grand Forks reported good transmission from the south and east and fair transmission from the west. St. Louis reported transmission in general not better than the average for mid-winter. Good transmission was reported from south and east.

Enormous variations in the signals of various amateurs in Michigan and Ohio on short waves were reported at Grand Forks and similar results at St. Louis.

The 1,500-metre wave persists well into daylight, being still received at 8.15 a.m. when discontinued. The St. Louis wave, of 850 metres, although varying widely at Grand Forks, was reported at Memphis as fairly steady. [Memphis is about

250 miles (400 km.) further from Grand Forks than St. Louis and on the same line approximately.]

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TWO KINDS OF FLUCTUATION.

Discussing the results obtained in the tests, the writers say that there seem to be two kinds of fluctuations in nocturnal overland transmission. The first is a rapid fading and the second is a slow swinging in signal strength. The first may be due to changes, in the nature of interference effects. These could be local at the sender or at the receiver, or they might be caused by rather sharp surfaces of discontinuity almost anywhere between the stations.

The second or slower effect may be due to refracting masses of moving ionized air in the path of transmission, producing at times a lens-like concentration and at other times a dispersive effect. It might be contended that all of the fluctuations can be accounted for on this basis.

The presence or absence of true interference effects has a most important bearing on the transmission theories outlined in the first part of this paper. Fortunately the tests seem to throw a little light upon this point.

The generally favourable effect of cloudy days on the following nocturnal transmission is confirmed, thus suggesting that sometimes the conditions causing fluctuations may be at low atmospheric levels.

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THE DISCUSSION.

Amongst those who joined in the discussion following the reading of the paper we find the names of Dr. J. Zenneck and Roy A. Weagant.

Dr. Zenneck said: "It is well known that the received current depends largely "on the decrement of the receiving antenna as well as on the decrement of the transmitting antenna. Both of these decrements are dependent on atmospheric conditions; wet weather, for instance, generally causes a very marked increase in the "decrement of the antenna. Therefore, measurements of the received current are "only comparable if it is sure that the decrements of transmitting and receiving "antennas have remained constant, or if both of these decrements have been measured "and their actual variations taken into account. It is not sufficient to keep "the current at the transmitting antenna constant. I should like to ask Professor "Taylor if he would kindly tell us whether he has taken into consideration the decrements of the transmitting and receiving antennas and their possible changes caused "by atmospheric conditions?"

Professor Taylor: "In reply to Professor Zenneck's suggestion that variation "in the decrement might account for the apparent variations in transmission, I would "like to point out that in wet weather, where one gets abnormally high decrements "and a lowering of energy radiated, we invariably get an improvement in the transmission. In other words, the change of decrement is in the wrong direction to "explain our results. Very large variations in decrement might be shown on an "amateur set with wooden insulators, but with a good sending and receiving set it

" would be entirely impossible to get decrement variations of a sufficient magnitude " to account for even a small percentage of the changes which we have observed."

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Variations in Detectors.

Mr. Roy A. Weagant in the course of his remarks said: " My own experience is " that variations due to variations of the apparatus alone are often thousands of times " greater than anything happening in the intervening medium. I do not know of any " commercial form of radio detector, of sufficient reliability, combined with sufficient " sensitiveness to make readings at all quantitative. The audion, with which we " are all familiar, generally changes its sensitiveness from the minute you close the " switch on it. It is not constant in any two consecutive instants, hardly, and not " at all over any considerable period of time. More or less similar remarks are true " of any form of detector in use."

This drew forth from Mr. A. S. Blatterman (one of the authors) the following: " I " must take exception to Mr. Weagant's remarks in which he would dismiss all idea " of swinging and fading in transmission and lay it to irregular detector action. We " are quite sure that our curves are not plots between detector sensibility and time. " Personally I have observed the fading effects for about seven years with a great " many different detectors, the electrolytic, the crystals and the audion, and if " intelligently handled and tested from time to time it is a practical certainty that " variations in sensibility are totally inadequate to obscure the changing conditions " between stations. Moreover, one frequently hears the signals from one station " getting stronger while those of another are fading out, which shows pretty positively " that the detector is not to blame. If Mr. Weagant really believes that irregular " detector sensibility overshadows the changing meteorological conditions between " stations, I can only say that he cannot have directed his attention to transmission " at night over land, especially on the shorter wave-lengths."

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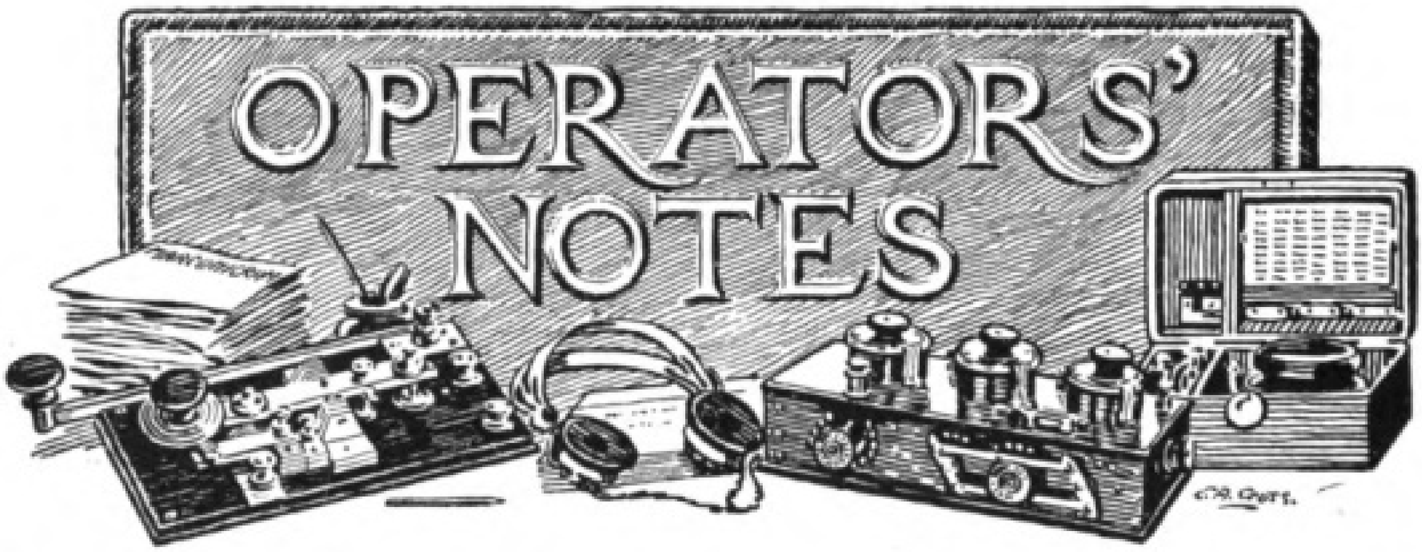
Engineering and Scientific Research.

In a valuable paper on the above subject presented to the Society of Engineers on May 1st, Dr. J. A. Fleming, M.A., pointed out that the great thing to guard against on the part of the student is premature specialisation. He should broaden as much as possible his knowledge of the principles of Chemistry, Mechanics, Physics, Mathematics, and Metallurgy, and he will then be able later on to build up on this foundation. Unless he does lay this foundation he will not be able to follow or assist in improvements. As an illustration of this we may take subjects such as telephony or wireless telegraphy. It is impossible now for anyone to make any really important addition to these subjects who has not a very competent knowledge of physics and some parts of mathematics. The easier problems are worked out and the design of telephonic systems or radiotelegraphic stations has become a matter in which advanced scientific knowledge is an important factor. Then, again, to make any advance in metallurgy requires a very intimate acquaintance with the chemistry of metals. A lucky accident might give a clue to an improvement, but an observer not sufficiently acquainted with modern chemical principles could not take advantage of it or follow it up.

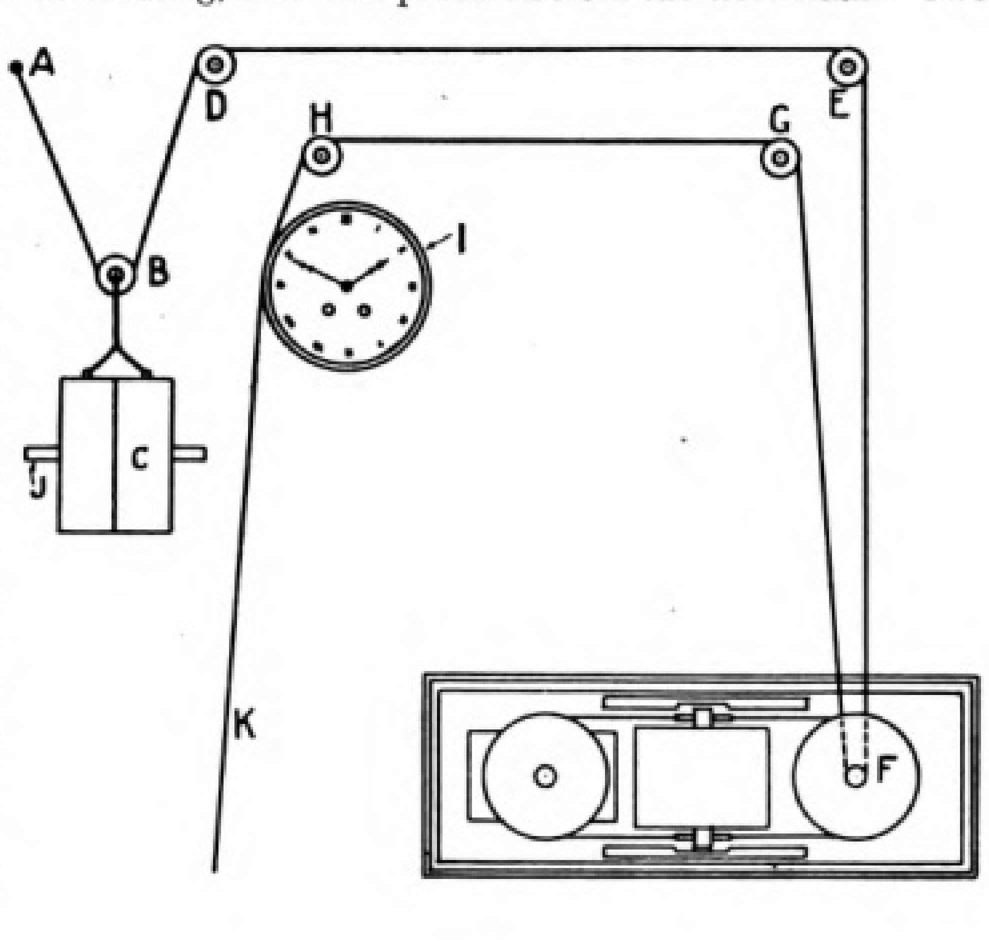


Running a Magnetic Detector Without Clockwork

By E. A. J. DAUBNEY

Editorial Note.—The following account of how a broken clockwork was dispensed with will, we are sure, interest many operators, and will also serve to demonstrate the ingenuity of the operating staff in times of emergency. The Editor invites similar articles from wireless operators explaining how they have overcome their practical difficulties. All such articles as are accepted will be paid for.

When the magnetic detector broke down I took out the entire spring and barrel. On the spindle just behind the driving pulley I fixed a piece of sand-paper, and then replaced the detector in position on the partition. Four pulleys were fixed in the ceiling, two immediately above the detector and two as near the adjoining bulkhead as possible. These pulleys were made from small insulators with staples bent to serve the purpose of spindles as well as fixing, and were procured from the electrician. Two old dry cells were then tied together for the weight (C) and a cotton reel (B) fixed to them by means of stout copper wire, upon which the reel could revolve freely. A piece of wood (J) was fixed to the cells, and this kept them steady against the bulkhead and prevented them from turning when the ship rolled. One end of a piece of cord was secured at A, the other being taken round the reel (B) over pulleys D and E, then round the spindle F, and



back over pulleys G and H; the loose end resting round the clock. The sand-paper on spindle prevented the cord from slipping and the weight exerted a gentle pull which caused the detector to revolve. I left the fan inside of detector, and this regulated the speed as it does with the spring. It took three-quarters of an hour for the weight to reach the floor of the cabin. All that was then needed was to lift weight in one hand, pull cord at K. This brought the weight again to the ceiling. We found that the slight resistance caused by the cord passing round the clock was quite sufficient to keep cord tight enough to prevent slipping at F. Although everything was done in a crude way, it worked beautifully, and we suffered but slight inconvenience.

Manchester School of Technology

WE have just received a copy of the Manchester Municipal School of Technology's prospectus for the Summer Evening Classes for 1916, and a very interesting prospectus it is. Mechanical and Electrical Engineering, as would be naturally expected from the fact that the classes are located in Manchester, occupy the predominant positions, although classes on municipal and sanitary engineering and architecture, besides chemistry and chemical technology, run them hard. In view of the conditions which are rightly to prevail after the close of the war, such opportunities for studying the theoretical side of practical industries like that of the textiles, of mining practical geology, and confectionery should be welcomed by those young Englishmen who are devoting their life's work to the practical branches of this subject. From the point of view of workshop and practice, the English have always more than held their own. But our German competitors have in the past obtained a distinct lead in the field of theoretical study, and this must not be the case in the future. The Municipality of Manchester sets an excellent example, and we should hope that it may prove true, in this instance at all events, that—as the old Midlands boast runs:—"What Manchester thinks to-day England thinks to-morrow."

Share Market Report

LONDON, *May 12th*, 1916.

THERE has been a steady demand for "Wireless" shares since our last report, and, with the exception of the American Company, there has been an appreciation in prices. Marconi Ordinary, £2 3s. 9d.; Marconi Preference, £1 18s. 9d.; American Marconi, 14s. 6d.; Canadian Marconi, 8s.; Marconi International Marine, £1 6s. 3d.; Spanish and General Wireless Trust, 6s.

"The Year Book of Wireless Telegraphy and Telephony, 1916"*

A VERY practical method of arriving at the various stages of progress made by any science is that of studying the evolution of its literature. A general sequence is almost invariably followed.

A Darwin, a Newton or a Faraday reads a paper before a learned society, or startles the scientific world by some epoch-making treatise. This exposition brings forth from other scientists revelations of their own research. They narrate the results they have obtained and the methods they have followed. These methods are co-ordinated with those of the great discoverer, and thus a new science is born.

The next step is probably marked by the appearance of scientific volumes, closely followed by reviews, articles, and correspondence in the learned journals and magazines. The final stage is not reached until some practical application of the new science arrests the attention of the general public. Then popular volumes follow in rapid succession. The regular periodicals devote increasing space to it, and finally an annual book of reference is brought out, collating and putting into readily accessible form the latest information with regard to every branch of the subject.

Some of these books of reference restrict themselves to mere cut-and dried lists of facts, tables, and formulæ, and restrict their sphere of usefulness accordingly. Others travel outside these boundaries, and include popular expositions of the latest phases of those branches which are attracting current attention. Such volumes base their right to public appreciation on a double foundation, and it is amongst this class that must be included the *Wireless Year Book* which has just been published.

It does not afford any proof of the firm establishing of wireless telegraphy. This practical science, though born but twenty years ago, has long outgrown that stage of development ; but the appearance of a fourth annual issue of so substantial a volume, in an edition of 10,000, *does* constitute a very clear indication of the world-wide interest taken in the subject.

In view of the volume's established popularity it would appear necessary to make some apology for referring in detail to some of the regular items, which have already proved their value. Later on reference will be made to the new sections ; but, for the moment, it will be best to deal with a rapid survey of those regular features which form the mainstay of the book.

In a brief foreword the editor justifiably refers to the pride felt by the publishers in bringing out such a volume at such a time. Only those intimately concerned with the compilation of reference books can appreciate the difficulties of editor and publishers alike, ranging from shortage of labour in the printing world and the ever-present paper trouble, to difficulties connected with the "Defence of the Realm Act."

It is a very happy idea to give as the frontispiece a portrait of Senatore Marconi in the uniform of a lieutenant in the Italian Army, and many thoughts are inspired by

* *The Year Book of Wireless Telegraphy and Telephony for 1916.* Published by the Wireless Press, Ltd. Price 3s. 6d., or post free 4s. inland and 5s. abroad.

this handsome picture of the gallant officer who has contributed so potent a weapon for the present fight for liberty.

From the perusal of a well-compiled calendar we turn to the standard feature :—" A Record of the Developments of Wireless Telegraphy," in which—under the various years—we find a *précis* of the events leading up to Senatore Marconi's discovery and an account of the leading points of interest in connection with it, chronologically treated. This section of the Year Book has proved so valuable, that one of the magazines in the Far East actually brought out a " Wireless Telegraphy " number, devoting more than half of the magazine to a reprint of this part of last year's issue. This year many additions and revisions have been made, and a glance over the pages devoted to 1914 and 1915 brings home vividly to the readers the gradual, though sure, collapse of Germany's world scheme of wireless communication.

The portion of the volume devoted to the laws and regulations of the various countries has received the addition this year of a valuable index, facilitating reference in a high degree. Thus, if we require to ascertain what are the responsibilities of shipowners with regard to Wireless Telegraphy on Danish vessels, or what restrictions are imposed in Trinidad, we have but to glance at the index to trace the required page in a moment. Needless to say, the laws and regulations themselves have been brought up to date, as far as present war conditions will allow, and this applies also to the list of wireless telegraph stations of the world which follows this section.

Thousands of copies of the year book are used in all parts of the world by people who need to turn up particulars of call letters, ship stations, shore stations, and rates, and we would remind new readers that the possession of a copy of the year book places in their hands a complete and up-to-date list of all the land and ship stations, with their rates, call letters, hours of service, range, wave-lengths, and other valuable particulars.

A welcome feature in each edition consists of a number of special articles contributed by well-known men, and dealing with various phases of wireless telegraphy and telephony. This year these articles alone are worth far more than the cost of the whole volume. For instance :—Mr. Archibald Hurd, the well-known naval writer, contributes a valuable article on *Intelligence in Naval Warfare*, a highly interesting history of the various means of signalling in the Navy. The difficulties of signalling before the days of wireless are vividly brought home to us, and when speaking on this point Mr. Hurd quotes from the life of Howe as follows :—" Now, my dear Kempy, " do, for God's sake do, my dear Kempy, oblige me by throwing your signals overboard, " and make that which we all understand, ' Bring the enemy to close action.' " Dr. J. A. Fleming, M.A., F.R.S., writing on *Photo Electric Phenomena*, a subject to which he has devoted considerable attention and research, reveals to the reader many vital and interesting facts concerning light, electricity, and the earth's atmosphere. He mentions in the course of his article that one cubic mile of sunlight near the sun's surface contains energy sufficient to throw twenty of H.M.S. *Elizabeth's* fifteen-inch shells over the top of Mont Blanc. Let us be thankful that the welcome rays of sunlight, which fall upon us here, have at least been tempered in their effect before reaching London ! Colonel F. N. Maude, C.B., contributes an article entitled *The Allies' Strategy in 1915* ; whilst the world-wide reputation of Dr. W. H. Eccles will secure many readers of his most valuable article on *Capacitance, Inductance, and Wave-length* *of Antennæ.* The diagrams (known as "abacs") which accompany his text enable various ratios to be read at a glance, whereas until recently these were only obtained by mathematical calculations, involving great care and considerable difficulty. To the general reader a contribution by Mr. H. J. B. Ward, B.A., on *Wireless Waves in the World's War* will be especially welcome, containing as it does a general survey of war happenings affecting radiotelegraphy. In writing on *The Problems of Interference* Mr. P. W. Harris points out the difficulties which confront the practical wireless man, and the reason why so many of the patents which endeavour to solve the difficulties of "jamming" are valueless.

A valuable article devoted exclusively to the *Progress of Radio Telephony in U.S.A.* serves to inform the reader of just what has been done in that country, and what may be expected in the future. With regard to research, the report of the Committee for Radiotelegraphic Investigations of the British Association will be welcomed by many experimenters, as well as the contribution under the title of *A Measurement of Signal Intensity,* by John L. Hogan, jun., the well-known American investigator.

Now that long-distance wireless services have been established in many parts of the world, we are glad to see in the Year Book a brief outline of radiotelegraphic progress in this direction, in which the significance of the much discussed Imperial scheme is touched upon. International time and weather signals, the Report of the Committee of Standardisation of the Institute of Radio Engineers, and a large section devoted to useful data merit a word of praise, whilst the section on useful formulæ and equations has been thoroughly revised and brought up to date by Dr. J. Erskine-Murray, the well-known radiotelegraphic investigator and lecturer.

A feature of great value appears as usual in "Wireless Telegraph Patents in 1915," and this is followed by particulars of leading companies engaged in the commercial development of wireless telegraphy. A word of commendation must also be given to the sections devoted to biographical notices and the literature of wireless telegraphy.

The map of the world, on which will be found the land stations referred to in the list of wireless stations already mentioned, has, like the other section, been brought up to date.

So far we have made no mention of the excellent illustrations on art paper which are interspersed throughout the text. Of these there are thirty, many being portraits of well-known men in the world of wireless, whilst others depict stations and apparatus. Special interest attaches to the plate facing page 624, which shows some of the brave wireless operators who have performed their duty in the face of great peril.

This edition of the year book shows a great improvement upon the last issue, excellent as this undoubtedly was. The printing and general production is all that could be desired, and is certainly far better than that of many of the other well-known annuals which come before us from time to time. It only remains for us to state, and we are sure that all those who have previously made acquaintance with the *Wireless Year Book* will bear us out, that this volume is indispensable to every man or woman whose interest in wireless telegraphy is anything more than superficial. In spite of the substantial increase in cost of production, the price remains at three shillings and sixpence.

Administrative Notes

Argentina.

According to the *Revista Telegraphica* of Buenos Aires there has recently been opened to public service a new radiotelegraph station at Rio Grande in Tierra del Fuego.

Australasia.

The following rates will be charged on messages :—

(*a*) From ship stations for delivery in the Commonwealth and relayed through the new stations in the Pacific Islands :

Via	Land Line Charge.	Radio Relay Charge.	Coast Station Charge.	Ship Station Charge.
Kawieng (New Ireland)	1d.	Plus 4d.	Plus 6d.	Plus 4d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.
Kieta (Bougainville)	1d.	Plus 3d.	Plus 6d.	Plus 4d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.
Madang (formerly Wilhelmshaven) ..	1d.	Plus 3d.	Plus 6d.	Plus 4d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.
Nauru	1d.	Plus 3d.	Plus 6d.	Plus 4d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.
Port Moresby, New Guinea	1d.	Plus 2d.	Plus 3d.	Plus 2d. for ships whose rate is 2d. per word.
Port Moresby, New Guinea	1d.	Plus 2d.	Plus 6d	Plus 4d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.
Rabaul (New Britain)	1d.	Plus 3d.	Plus 6d.	Plus 4d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.
Woodlark Island	1d.	Plus 2d.	Plus 3d.	Plus 2d. for ships whose rate is 2d per word.
Woodlark Island	1d.	Plus 2d.	Plus 6d.	Plus 4d. for ships fitted by Amalgamated Wireless (Australasia), Ltd., charging 4d. per word, and all other ships.

(*b*) For messages to and from ships at sea for delivery within the Islands, viz. :

	Coast Station Charge. per word	Ship Station Charge. per word	
For ships licensed in Australia and New Zealand	3d.	2d.	Plus delivery charges, if any, to be collected from addressee.
For other ships	6d.	4d.	

(*c*) The following is a list of approved rates for wireless messages between the Pacific Islands, viz. :

	Per word.
Nauru to Kieta *via* Woodlark Island	3d.
Port Moresby to Kieta *via* Woodlark Island	3d.
Port Moresby to Nauru *via* Woodlark Island	3d.
Port Moresby to Rabaul	2d.
Port Moresby to Wilhelmshaven	2d.
Rabaul to Nauru *via* Woodlark Island	3d.
Rabaul to Kieta	2d.
Rabaul to Wilhelmshaven	2d.
Wilhelmshaven to Kieta *via* Rabaul	3d.
Wilhelmshaven to Nauru *via* Woodlark Island and Rabaul	4d.
Woodlark Island to Kieta	2d.
Woodlark Island to Nauru	2d.
Woodlark Island to Port Moresby	2d.
Woodlark Island to Rabaul	2d.
Woodlark Island to Wilhelmshaven *via* Rabaul	3d.

Delivery charges (if any) to be collected from addressee.

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The Radio-Telegraph Service of the Australian Federation will in future be administered by the Department of the Navy, and this Department, therefore, begs that from now onwards all correspondence concerning this service shall be addressed to the " Naval Secretary, Department of the Navy, at Melbourne, Australia."

Chile

In view of the fact that various wireless stations have been established in this country, and that several are already connected to the State telegraph lines, the following decree has been issued by the Government authorising the use of the wireless stations for commercial purposes :—

1. The State Telegraph Office will have under its control the radio-telegraphic stations in as far as the public service, collection of tariffs, payments and relations with other countries are concerned. The naval authorities will continue having under their control everything relating to operators, apparatus and similar services.

2. The Wireless Offices will be given over to the public service as and when the State Telegraph Office shall decide, beginning with the stations already connected to the State telegraph lines, which are those situated at Valparaiso, Antofagasta and Punta Arenas. The others will be put into service as soon as the necessary connections are made with the telegraph lines.

3. In accordance with the International Convention the charges will be :—

(*a*) To the coast station, 60 centimes.

(*b*) To the ship station, 40 centimes.

(*c*) The charge for transmission over the lines of the telegraph system, 10 centimes.

(*d*) The transit charges of the intermediate coast or ship stations and charges appertaining to special services required by the sender.

4. The State Telegraph Office will fix the following tariff for messages :—

(*a*) Radio-telegrams sent to ships from coast stations, $5.50 gold of 18d. for the first ten words and $0.55 gold of 18d. for each additional word.

(*b*) For radio-telegrams sent between Chilian coast stations, $4 currency for the first 10 words and $0.40 currency for each additional word.

(*c*) For radio-telegrams transmitted to any State telegraph office from on board Chilian warships by the officers or crew, $2 currency for the first 10 words and $0.20 currency for each additional word.

(*d*) If, in order to reach their destinations, messages have to pass over the lines belonging to other companies or administrations, additional charges corresponding to said lines will be made.

(*e*) Press telegrams will be sent with a rebate of 50 per cent.

The only persons who may send messages gratis are the President of the Republic, the State Ministers when referring to Government matters, the heads of the Navy, commanders of warships, and the Director-General of Telegraphs.

The service will comply with the regulations of the London Radio-telegraphic Convention of July 5th, 1912.

Before this decree was issued permitting the commercial use of the wireless stations, all messages for Punta Arenas had to be sent across the Andes to Buenos Aires, and thence *via* the Argentine lines, which necessarily caused many delays. This is another case in which wireless has come to the aid of the business man by helping to bring the southern part of Chile into closer commercial relations with the important agricultural and industrial region of the central valley, in which Santiago, the capital of the Republic, is situated.

Pacific Islands.

King Island Radio Station was opened on February 14th at 9 a.m. for the transaction of public business. The station is not yet completed, but in order to provide radiotelegraphic means of communication between King Island and the mainland as early as possible, a portable wireless installation was forwarded, and has been installed pending the installation of the proper apparatus. Up to the present time King Island has been isolated, and has not been provided with any means of communication with the mainland. Particulars of rates, hours, etc., follow :

For ordinary telegrams, 1d. per word, with a minimum charge of 1s. per telegram, plus ordinary land line charges ; deferred cablegrams half the rate for ordinary telegrams. Week-end cablegrams, quarter the rate for ordinary telegrams. Press telegrams not exceeding 25 words, 1s. 3d. ; exceeding 25 words, but not exceeding 50 words, 2s. 6d. ; exceeding 50, but not exceeding 100 words, 5s. ; additional 50 words or portion of 50 words, 2s. 6d., plus Commonwealth land charges for press telegrams. Rates for ship traffic in accordance with wireless telegraph regulation No. 23 of Post and Telegraph Guide.

The hours of service are 9 a.m. to 6 p.m., Monday to Saturday, with no service on Sundays.

The rates for Flinders Island Radio have been altered to correspond with the rates for King Island, as set out above, as from February 14th.

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A powerful wireless station is being erected in the Solomon Islands. The work will probably be completed in three months. Delay has occurred owing to the scarcity of labour. The islanders have for some time past been relying on the steamer *Kulumbangra* for their urgent news, as this vessel has an up-to-date wireless installation on board. It was found useful to the authorities in the early stages of the war.

Spain.

The following is an extract from *Boletin Oficial del Cuerpo de Telegrafos*, Madrid, dated February 1st, 1916:

" From time to time the General Direction of Telegraphs in Spain has noticed " the extraordinary frequency with which claims arise regarding the non-delivery of " radio telegrams to addressees, and regarding delivery so very much delayed as to " render them useless; and, what is still more to be regretted, these troubles nearly " always have their origin on the land lines, in spite of what has been recommended " in circulars from time to time, and also by numerous communications sent by the " Department to the stations which handle this service, but especially the Cadiz, " Teneriffe and Vigo stations.

" In view of the disregard of what has been communicated, the General Direction " finds itself obliged to advise chiefs of sections and the staffs under them that it feels " disposed to apply Article 56 of the Regulations of the Telegraphic Service in all " its rigour so that the devolution of the amounts collected from the charges paid by " the senders of messages shall not be borne solely by the treasurer."

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According to the *Shipping Gazette* a new wireless telegraph station is in course of erection in the Naval yard at Ferrol.

United States.

The superintendent of the Naval Radio Service announces that, commencing from last March, a complete communication chart is issued to the public, gratis, upon request. This chart includes the various merchant vessels in the North and South American trade, the time and date they may be reached by wireless telegraphy, the coastal stations through which the traffic should be sent, and the rates for radio landline services.

It is notified that the wireless station at Key West, Florida, is open to commercial traffic, and handles ships' position reports, which are forwarded to the *New York Herald* not later than 8 p.m.

Impressionist Sketch of a British Admiral.

A series of articles which have appeared in the columns of the *Times*, from the pen of a writer who has been serving with the Grand Fleet, contains many delightful pictures of that side of Britain's war activities. A recent sketch of the duties which fall to the lot of a British admiral must enlist the sympathies of every Englishman, for all of our hearts are always ready to go out to those who have business in the great waters.

We read of the "stormy time" always in store for the admiral whenever he is in harbour. The wind and sea may be calm outside, but within the white enamelled walls of his state room, there rages a never-ceasing tempest of paper. Reports, despatches, memoranda of all descriptions blow in upon him in fitful gusts, and it is only during his twenty-four hours day at sea that he really feels himself free from stormy troubles. It is true that even then his Commander-in-Chief keeps in constant radio-telegraphic touch, whilst that "strange and inscrutable providence," the Admiralty, possessed of high-power wireless apparatus, directs all his doings, watching and listening to him night and day. But after he has exchanged his warm and luxurious sleeping cabin in the after quarters for his sea cabin, high up on the superstructure which clusters round the fore-mast; after his course and speed have been decided for the night, he is likely to be undisturbed by unnecessary communications. The flag lieutenant may occasionally pop his head in the door, and deliver various items of information; but nothing merely vexatious is likely to be received in the small hours, and the admiral may rest in peace.

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"Truth" stranger than Fiction.

Our distinguished contemporary in a recent number, after stating that the war had been in progress long enough for the Admiralty "to have digested the various "problems arising out of the use of wireless," proceeds to demonstrate that his own digestion is slightly dyspeptic! Some one appears to have been alarming the mirror-holding goddess with dreadful stories about enemy familiarity with British Naval Codes. She appears to view with misgiving the fact that the constant "touch" maintained between the British Admiralty and the Commander-in-Chief Afloat is kept up by wireless, a form of communication which employs "the universal aether." Our Divinity, therefore, with truly feminine illogicality, advocates the laying of "A

THE "MIRROR-HOLDING" GODDESS IS FRANTICALLY ALARMED!

"cable telephone, or "even a telegraph "wire"! and delivers a little homily on the absurdity of employing "a costly staff "whose sole business "it is to be continually "constructing new "codes, which are deciphered by the "enemy, and thereby "rendered useless and "dangerous, almost as "soon as they come "into operation."

We wonder what the Commander-in-Chief Afloat would say to the *Truth* proposal? Would he be expected to remain continually at anchor by the side of the terminal of the precious wire? or has some genius invented a flexible cable which can be dragged about by the flag-ship? Let us suppose for a moment that the problem has been settled upon one of these two alternatives: is the "costly staff" engaged on "continually constructing new codes," immediately dispensed with by this *Truth* expedient? Of course, it is very annoying that our enemy should be so ingenious as to readily decipher codes, but it seems a little hard on him to confine our high opinion of his ingenuity to this single qualification. Nothing is easier, as far as land telegraph lines are concerned, than the process known as "tapping," and is there any reason to doubt that enemy submarines would be able to extract from *Truth's* cable all the information it wanted, and then cut it? No! Our contemporary has in this instance not displayed the acumen which usually characterises him; he has credited the Germans with too little enterprise in the way of cable "tapping" and "cutting," whilst crediting them with too much in the way of code decipheration. We can assure him that British Admiralty codes are by no means the easily solved "jig-saw puzzles" which he imagines; we might enlarge on the subject, but—with the Whitehall censor before our eyes—think it well to refrain.

This question of secrecy is one which has, ever since the advent of wireless telegraphy, been constantly employed by the "vested interests" who hold the field with regard to overseas and trans-ocean cables. It is a bogey which, like the great sea serpent, continually crops up under various forms in the columns of the Press. Even if there were anything in it, any whist player of experience knows perfectly well that it is far more important that you should acquaint your partner with the state of your own hand rather than follow such rules of play as will mystify him as well as deceive your opponents.

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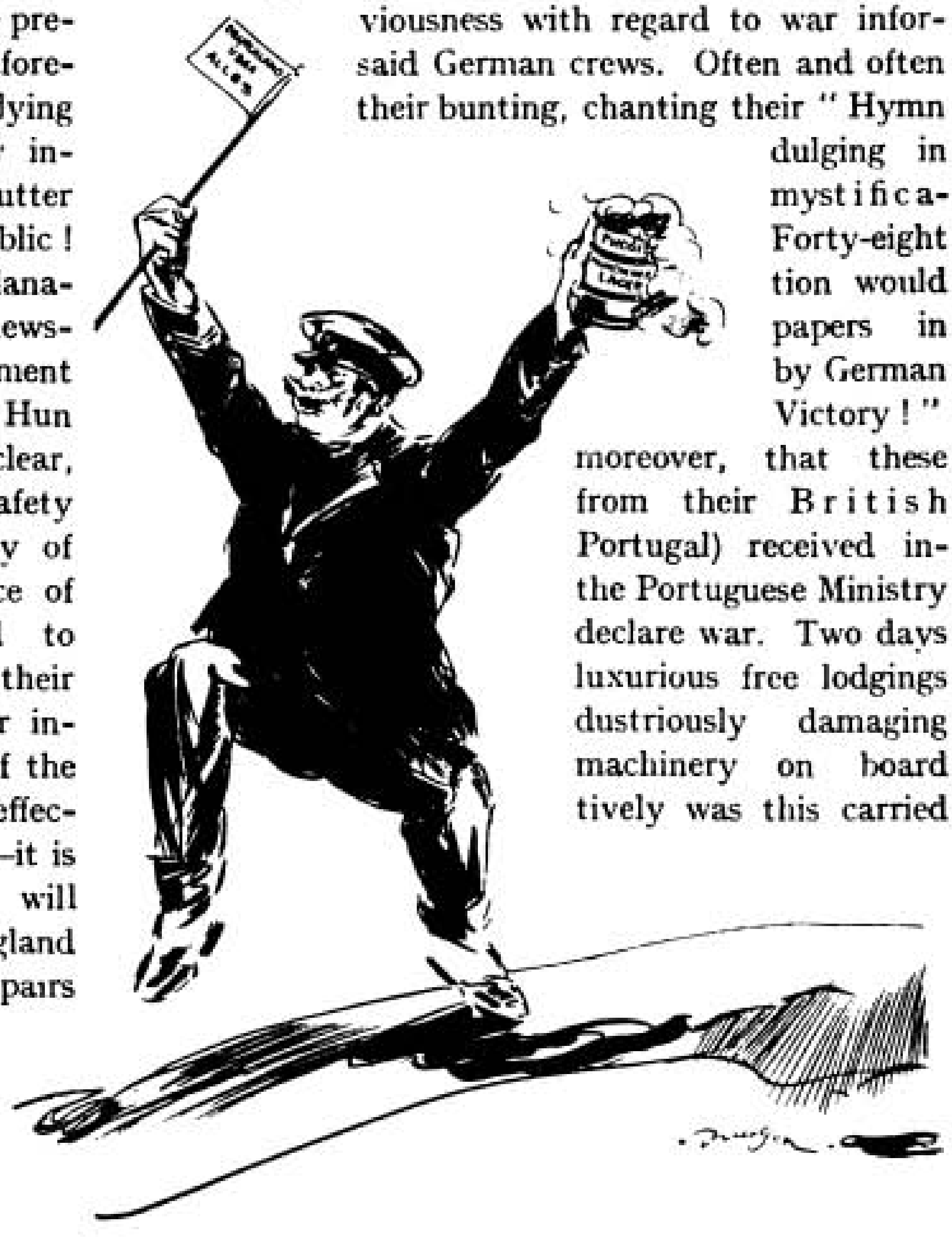
Perfidious and Unwelcome Guests.

The Iberian Peninsula has all through this war been swarming with German visitors. Very unpleasant and troublesome guests their Spanish and Portuguese hosts have found them! One of the effects of the declaration of war by Germany upon Portugal has been that the smaller country at all events has been able to free herself from the incubus. A correspondent, writing from Lisbon on the subject of the German crews of the interned vessels recently taken over by the Portuguese Government, comments upon the fact that German residents in Portugal have all through the war been, from time to time, caught using surreptitious wireless apparatus at night, and—when questioned about it—have made the almost invariable excuse, that it was merely a piece of toy apparatus. It is to such apparatus, however, that is most plausibly attributed the remarkable previousness with regard to war information possessed by the aforesaid German crews. Often and often they have been observed flying their bunting, chanting their "Hymn of Hate," and generally indulging in gala festivities, to the utter mystification of the Portuguese public! Forty-eight hours or so later the explanation would appear in the Lisbon newspapers in the shape of the announcement by German agencies of a great "Hun Victory!"



It is abundantly clear, moreover, that these guests (who owed their safety from their British enemies to the neutrality of Portugal) received information well in advance of the Portuguese Ministry that Germany intended to declare war. Two days before the event they left their luxurious free lodgings and fled to Madrid, after industriously damaging the most vital portions of the machinery on board their own vessels. So effectively was this carried out, that—in some cases—it is believed that the ships will have to be towed to England before the necessary repairs can be carried out.

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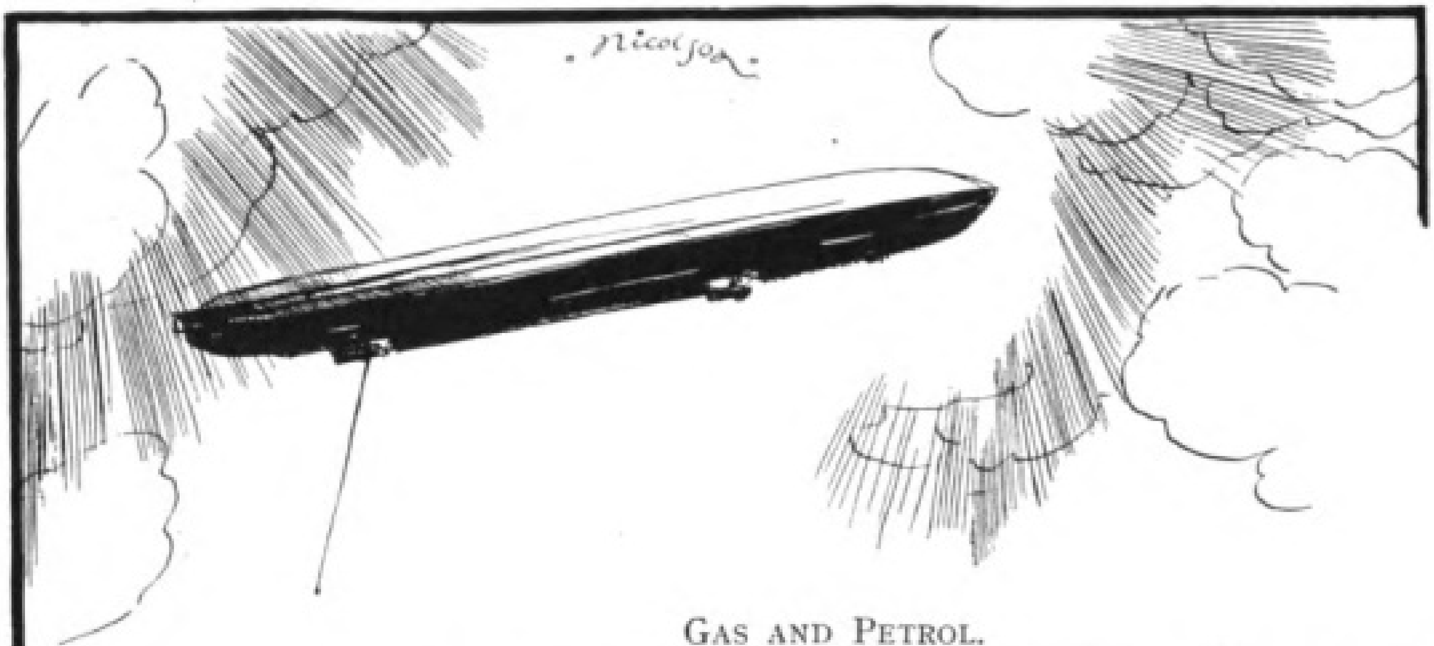
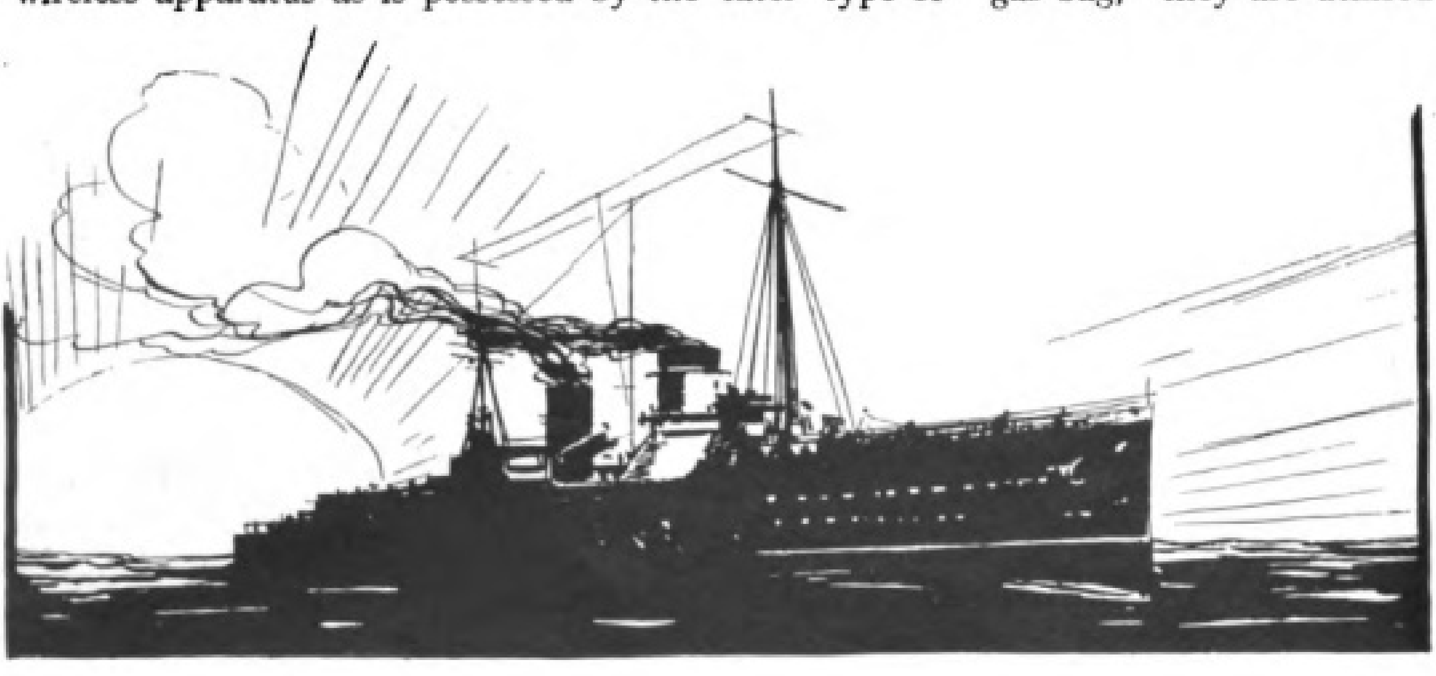


Gas and Petrol.

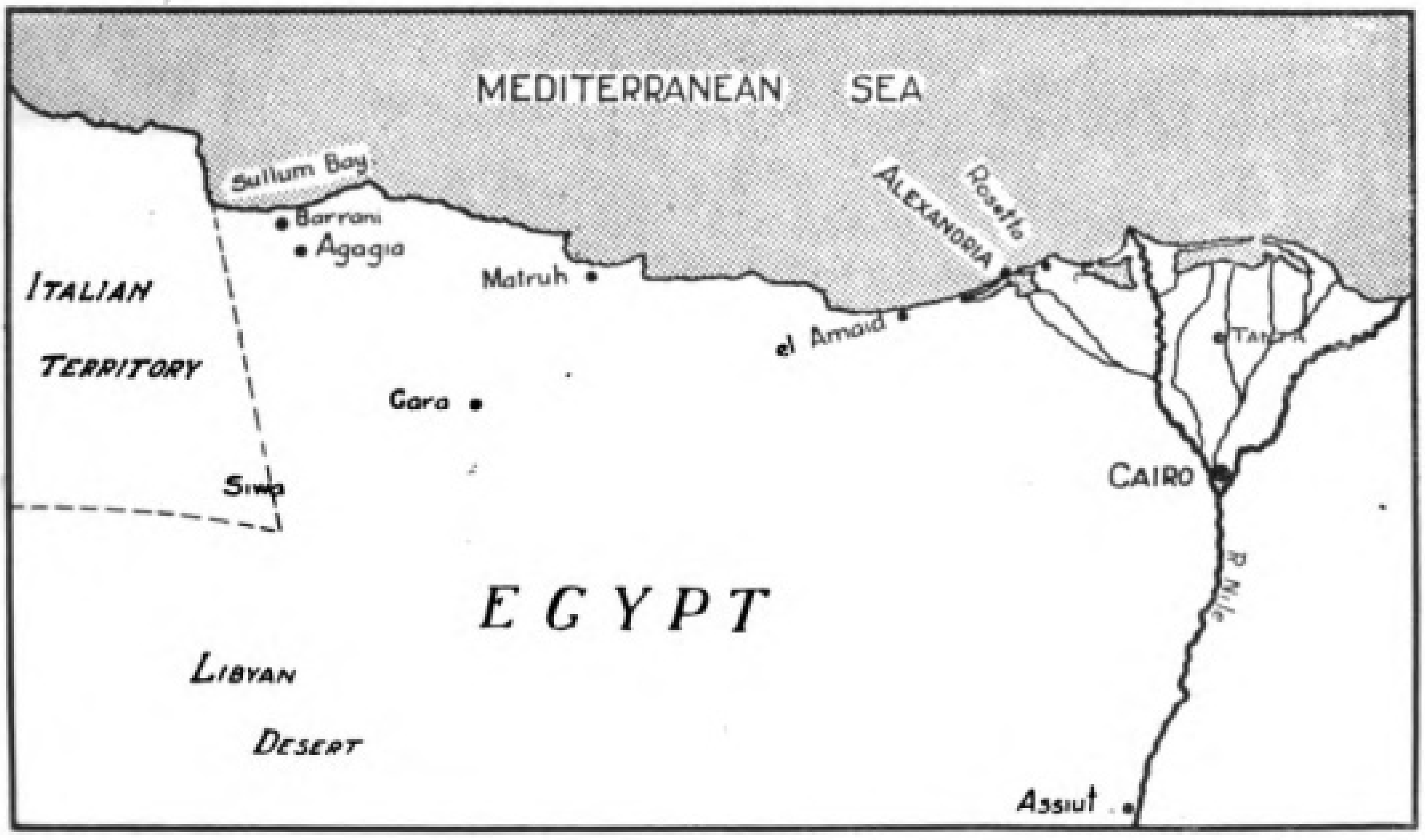
One of the most interesting writers on Naval Affairs is Mr. Archibald Hurd, whose contributions to the *Daily Telegraph* and to the *Wireless Year Book* are probably well known to our readers. In one of his recent articles he dwells upon the advantages bestowed upon our enemy by his possession of the highly developed "lighter than air machines," which we know as Zeppelins. Their proper and legitimate sphere of action is that of scouts, for which the wireless apparatus which the later machines are capable of carrying renders them specially efficient. From these aircraft, flying at a great height completely out of gun range, the North Sea can be viewed as though it were one vast panoramic theatre. They can scan all the more important operations, and by means of radio-telegraphy can report where British men-of-war are to be met with and where they are not. It must be remembered, too, that a Zeppelin can travel at about twice the speed of the fastest warship afloat. The British Fleet was unprovided with these rigid dirigibles at the commencement of the war and is handicapped to this extent.

On the other hand, of course, although the British do not possess Zeppelins, their seaplanes are both more efficient and numerous than any equivalent machines possessed by the enemy; and although, constructionally, they are not able to carry such powerful wireless apparatus as is possessed by the later type of "gas-bag," they are utilised



from floating bases, and, therefore, do not require to report direct for such long distances. The exploits of British seaplanes, like those of British submarines, have been far more numerous and important than the general public has been able to learn through the medium of the Press. It is only now and again that a glimpse at their activities is vouchsafed, a notable instance being the occasion when a combined naval and seaplane excursion delivered an attack upon the German airship sheds in Schleswig-Holstein at the end of March.

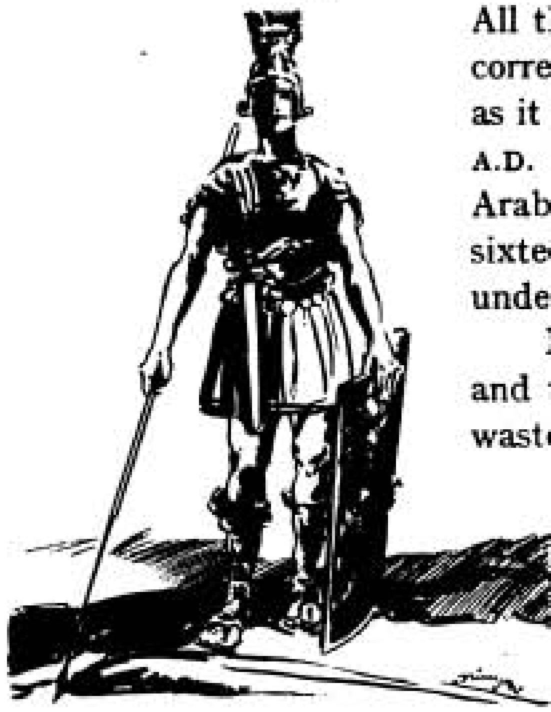
On the whole, the ceaseless vigilance, which wireless telegraphy enables the Fleet to maintain, gives these islands a defensive screen such as they have never possessed in past ages, and the rarity even of abortive attempts, like the recent bombardment of Lowestoft and Yarmouth, demonstrates that the enemy is fully aware of the extreme peril run by their raiding squadrons when they make such short and hasty excursions.



"Vox Clamantis in Deserto."

It is a curious thing that the "Desert," which in old times was associated with man and nature in its most primitive state, should nowadays bear such fruits of advanced civilisation as installations of wireless telegraphy. A recent report from the War Office dealing with the restoration of law and order in the northern area of the district west of Egypt includes the statement that two German wireless sets had been recently discovered hidden in the midst of a desert tract, south of Sollum, and had been brought in as booty by the British reconnoitring forces. The old proverb about *Vox clamantis in deserto* (the voice of one crying in the wilderness) would appear in this instance to have been amply justified.

Throughout the Italian campaign in Tripoli and, we may add, ever since, German strife-stirrers have been exceedingly busy in this region, but the fruits of their activities appear to have been little worth the careful and expensive culture lavished upon them.



THE ROMAN LEGIONARIES RULED LIBYA SUPERIOR.

All this district was at one time subject to Egypt, and corresponds to the ancient Cyrenaïca, or Libya Superior, as it was called by the Romans. In the seventh century A.D. it was wrenched from Latin domination by the Arabs; it passed into the hands of the Turks in the sixteenth century, and finally, together with Tripoli, fell under Italian rule in 1912.

None but small streams irrigate the countryside and the landscape presents the aspect of an extensive waste of naked rocks and loose sand, interspersed—to the extent of about one-fourth of its area—with wonderfully fertile patches, producing rice, dates, olives, etc., in great abundance. It was in this district that Nuri Bey, brother of Enver Pasha, had for a considerable time been occupying the attention of the British, and Sollum was the scene of the dashing armoured motor-car raid in which the Duke of Westminster so brilliantly distinguished himself on the fourteenth of March last. It will be remembered that on that occasion the whole of the enemy artillery was captured, together with 91 prisoners, crews of vessels shipwrecked on the Cyrenaica coast who had been seized by the Senussi.

These operations were rendered possible by reconnaissance through the means of aeroplanes reporting to General Peyton's force by wireless, and the supreme importance of radio-telegraphy to mobile forces and "flying columns" could hardly have been more graphically illustrated.

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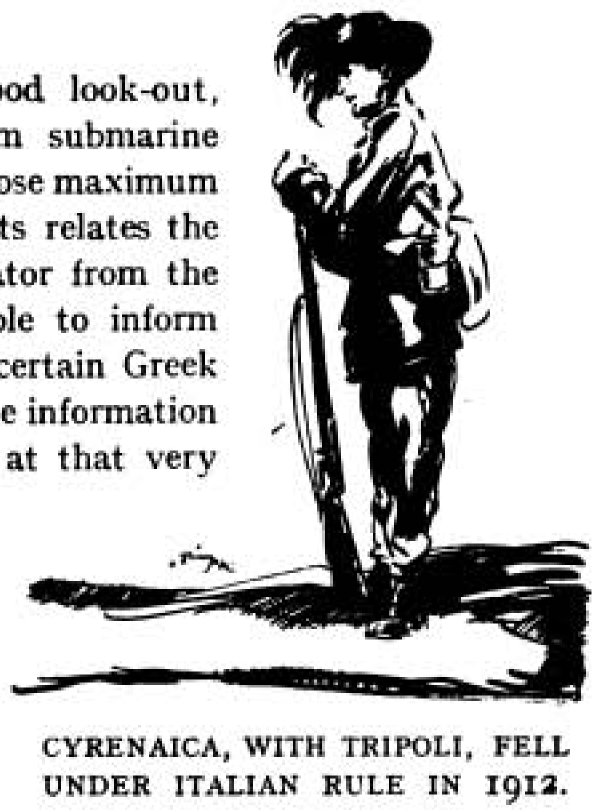
A NARROW ESCAPE.

As a rule, and providing they keep a good look-out, transports are usually comparatively safe from submarine attack, but a correspondent on board a vessel whose maximum speed, even at the best, rarely exceeded 10 knots relates the anxiety felt on board when their wireless operator from the message-waves picked up by his aerials was able to inform them that a submarine had been sighted off a certain Greek island. The perturbation was not lessened by the information given by the officer on watch that the vessel at that very moment was passing the island in question. Here was a case where "ignorance was bliss," for had the submarine sighted the transport nothing could have saved her.

The only resource was to go ahead and trust to luck. This the skipper did, and by good fortune they escaped.



CYRENAICA, WITH TRIPOLI, FELL UNDER ITALIAN RULE IN 1912.

War Notes

In war time as in peace time anecdotes of all kinds go the round, and it is often extremely difficult to know whether there be any foundation in fact for the original tale or not. As a rule it is safest to place the odds against accuracy as at least 5 to 1. One of our contemporaries, the *Illustrated Sporting and Dramatic News*, reproduced a wireless yarn with the statement that it happened at "Luderitz, and is not a war invention." The scene of action is laid in what was erst German South-West Africa. In the course of the campaign so admirably conducted by General Botha in that arid land the Imperial Light Horse, during a halt, marked out a "field" in the sand for a Rugby football match. Whilst the game was going on a German aeroplane flew over, and appears to have reported the passion for sport evinced by the Britisher to German Headquarters; because, soon after its disappearance, a wireless message came from the enemy jeering at the English for lingering behind to play football instead of coming out into the desert to fight. In the course of the same night, English and German patrols came into contact, and the latter were forced to retire with a loss of two killed and one wounded. The British wireless then replied to the enemy message, saying that they had played the game, and that its result had been "England two goals one try, Germany "nil." If the story isn't true, it ought to be.

Two Good Sporting "Stories."

Our second yarn deals with the great fight between the converted cruiser *Alcantara* and the German raider *Greif*, which figured in our columns last month. After the destruction of the Teuton's wireless and the release of the *Alcantara's* radio apparatus from jamming, other British cruisers quickly appeared upon the scene. One of them, as she arrived, fired a shot over the *Alcantara* which went home upon the already sinking German. On nearing the scene of action, this cruiser, realising that the business had already been done before her arrival, sent a wireless message to the *Alcantara*, which was read before the latter vessel had, in her turn, disappeared; the message ran:—"Sorry—your bird"!

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Rear Admiral Sir Dudley de Chair, who in March last relinquished his command of the 10th Cruiser Squadron to become the F.O. Adviser on enemy trade, recently gave an illuminating interview to the London Correspondent of the *Brooklyn Eagle*. The gallant Admiral paints a vivid picture of the procedure in the case of a typical blockading cruiser. "See her steaming "on her allotted tract of open sea, no lights allowed by night, seaplanes "hovering on the watch by day. At 11 p.m. daily, if our radio-tele-"graphist be not otherwise engaged, he picks up for us the day's war bulletins from "Poldhu, from the Eiffel Tower and from the German long-distance wireless station. "One day a blotch of smoke rises on the horizon: Now, as we are in close touch "wirelessly with our neighbouring units, we know that this can be none of them, "therefore it must be some outsider, perhaps attempting to elude the blockade. We "overhaul her and fire two blank cartridges. She heaves to, and often at sore peril "to life and limb we send an armed guard and boarding party on board."

Daily Routine of a Blockading Cruiser.

With the Russian Expeditionary Force.

We have so largely been used to connect wireless calls from ships at sea with signals of distress that perhaps some of us may not realise the fact that these calls are even more frequently used to signal escape from danger. Petty Officer J. J. Smith, a Birmingham man attached to the British party serving in Russia under Commander Locker-Lampson, describes in a letter to his wife how they encountered, on their way out such fearful weather that "it was a matter of touch and go whether the vessel would recover or not," and in the course of the night two of their life-boats were carried away by the heavy seas. However, the good ship managed to come safely through the storm, though sorely battered, and their wireless operator was able to radiate the welcome message that the vessel was "O.K."

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A Wireless Periodical at Sea.

A brother officer of Mr. J. J. Smith, serving with the same Russian Expedition, sent home some issues of the periodical published for the amusement and edification of the members of the force. The following extracts from *The Tireless Wireless* will give a very fair idea of the scope of the matter contained therein: "The electric light gave out in a certain part of the ship, and "some confusion ensued, until a cheerful voice floated across the "darkness, 'Never mind if our lights are off, we still have our "Lampson.'"

"We are all nearly up the pole."

"Vim and Vitality.—If you suffer from nerves, debility, or any trouble that makes "life a misery, don't hesitate—try our December sea trips—you won't know "yourself.—Apply *Tossem* S.S. Co."

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Wireless Precautions.

In consequence of our vital interests and nearness to the scene of action, the British public keenly realises the full iniquity of our enemy, and is sometimes unjustifiably impatient with our cousins across the water. They have their own difficulties, and contend with them in their own way, and it is fairest for us to "leave it at that." Signs have not been wanting recently that the American patience, which has been wonderfully long-suffering as far as Germany is concerned, is now wearing thin. It is a significant fact that on the date of the reopening of the improved submarine campaign, which is now in full operation, the United States decided to increase the strictness of their wireless regulations. Ever since the start of the war it was officially decreed by Washington that all belligerent ships entering New York Harbour should dismantle their radio-telegraphic installation, and that the latter should remain sealed so long as the vessels remained within territorial waters. These regulations were, in consequence of the fresh submarine campaign, considerably "tightened up," and notices served upon all incomers by a United States destroyer specially detached for the purpose. Moreover, following on the presentation of the latest Wilson "Note," special protection has been arranged for the Arlington, Sayville and other private and national wireless stations, whilst the State Guards at naval yards, munition stores, and other vital spots have been doubled.

From an Operator's Notebook

I. A Night in a Wireless Station

By DOUGLAS R. P. COATS

THE reader who knows Quebec, or has seen pictures of the city, must remember the Citadel, perched way up three hundred feet above the River St. Lawrence and overlooking the Chateau Frontenac. The wireless station is situated within the historic walls of the Citadel and nestles in the southern corner beside an obsolete twelve-ton muzzle-loader, dated 1892—a striking reminder of the rapid strides of modern invention.

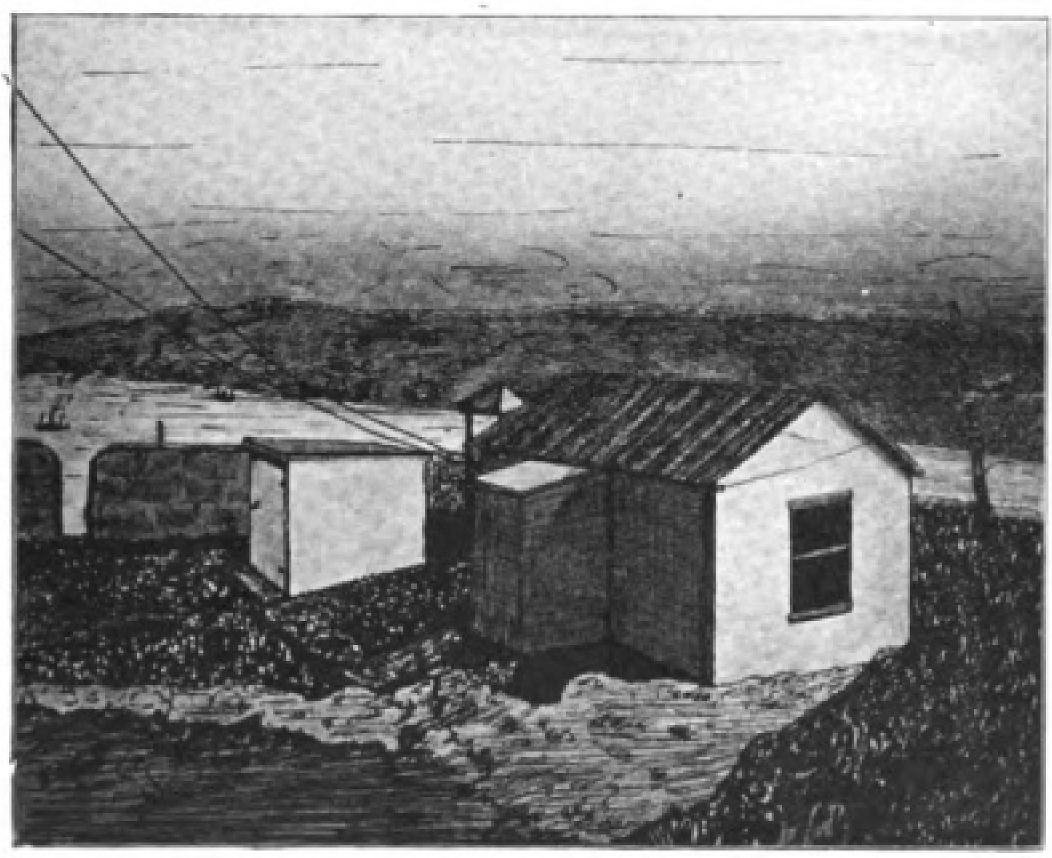
In mid-winter the climb up the northern slope to the fortress is tedious and often difficult, for the ground is frozen to a glassy hardness. On the cool September night of which I am writing, however, the tufted grass gave good foothold and, although a clock struck eleven before I reached the summit, the fresh Canadian air was invigorating and lent enjoyment to the task. Far below a brilliantly lighted steamer was dropping down the stream bound, perhaps, for England—luckymen aboard her—while a busy little launch puffed shorewards. The riding-lights of many craft dotted the water, blinking in the smoke from an east-bound collier whose throbbing screw told of an empty hold. A siren bellowed in the distance as I finished my climb and descended by some dilapidated steps to the moat.

Admittance to the Citadel was gained by means of a private key through a door

THE CHATEAU FRONTENAC AT QUEBEC. THIS IMPORTANT BUILDING IS SITUATED IMMEDIATELY BELOW THE CITADEL, WHICH LATTER IS OVER 300 FEET ABOVE THE ST. LAWRENCE.

opening on to the parade ground, for entrance by the main gate meant a longer walk, and the man whom I was relieving was no doubt sighing for his bed. Across the square, nearly breaking my shins on the trail of a field gun, and between the stores building and the old French magazine, I picked my way until I saw a light in a window and discerned the dim outline of the cabin.

My brother operator was visibly delighted at my arrival. "Static bad," he observed, "and several ships in the river. Good-night!"—and I found myself alone. The static *was* bad, as the 'phones soon assured me, and, mingling with the "X's", but readable enough, came into my ears the high-pitched note of an American station sending press. He had plenty to say. Over Turkey, Mexico, the suffragettes, and the rest of the world's troubles—insignificant enough as compared with present events!—he wept in long and short musical sobs. He told in tones of shrill satisfaction of the defeat of Vardon, the English golf champion, and became almost nasal—so I imagined—in his rendering of the latest baseball scores. The stock market—dry details concerning Pittsburg Steel and Amalgamated Copper; the New York weather report, and finally "Good-night," dropping down the scale to an almost inaudible "VE." His tale of woe and rejoicing was finished.



A PEN AND INK DRAWING OF THE MARCONI WIRELESS STATION AT QUEBEC.

A low-throated purr called "VCC," meaning Quebec, and informed me that the *Lake Manitoba* was forty miles east. A slight adjustment of the tuner awoke a bedlam of noises of varied pitch; a further adjustment, and one sound increased in volume at the expense of the others, which were lowered to a mere whisper like the shouting of a multitude a long way off. Midland, Ontario, was transmitting to a distant station on the Great Lakes. A variation in tuning brought in the *Lusitania* conversing with Siasconset, and then the *Imperator*, now so dumb, thanks to the British Navy!

Presently the *Teutonic* came into range with a batch of traffic for me, claiming my attention for a while. Then a freighter, happy in the pride of a wireless installation, chirped merrily and announced her position with ostentation and no uncertain spacing, as if to say—"I'm the steamer *So-and-so*, I am, decently owned and right up-to-date, and not one of Kipling's '*little* cargo-boats' either." The telephone rang, and for a few minutes I wrestled with someone whose English was but a shade superior to my French-

A CORNER OF THE ROOM IN THE QUEBEC WIRELESS STATION.

Canadian patois. I forget what he wanted —the wrong number, anyway, so he shut me off with apologies. A few messages straggled in for the *Teutonic* and one for the freighter, followed, by a lull during which I devoured a chapter of *Gotty and the Guv'nor*—that most delightful tale of a Southend fisherman. A vision of the lower Thames, Westcliff, and all the dear old haunts rose before me as I read, to be rudely shattered by a call from another incoming vessel and forgotten in the handling of "traffic."

A break came at last, however, and I was able to partake of another portion of *Gotty*. Soon the signals from far-distant stations grew weak, and presently most of them ceased altogether. The wireless receiver is most sensitive at night, and now the day was breaking. Through the windo over the operating table I saw the time-bal apparatus silhouetted against a blood-red sky, presenting a grim resemblance to a gibbet. It was impossible to resist the temptation to snatch a peep at the effect of that deep-red herald of sunrise upon the river and city, and I had no cause for regret, for the scene was one of exquisite beauty. The lights of Levis on the opposite shore were not yet extinguished, and shone like gems on a cushion of purple plush. To the south of them, and stretching far back as the eye could see, was an archipelago of hill-tops set in a sea of snow-white mist. Some stars were not yet dimmed : Orion continued his never-ending combat with Taurus the Bull, while I watched where

"The fiery Sirius alters hue,
And bickers into red and emerald."

In the southern heavens the gold of a gibbous moon was fast being transmuted to silver as the day climbed over the eastern hills. It seemed but a moment and the effect was lost, for soon the red sky changed to pink, and then to grey as a ray of yellow sunshine sought out and vanquished each star in turn.

Three Rivers spoiled my meditations, breaking, with all the harshness of a "fixed discharger," into the memory of something finer than all the lithographed Turners I have ever seen, with a well-intentioned "Good-morning!" By and by came the weather report from Montreal, and I knew my duty was drawing to a close. The réveillé sounded somewhere within the Citadel, followed by a footstep scrunching the gravel. The door opened ; my watch was ended and my "relief" had come.

TIME BALL POST, QUEBEC.

Notes of the Month

COMMENCING with its issue of October 1915, we have noticed with interest that the *Revista Maritima Brazileira*, which is published in Rio de Janeiro, has been printing an excellent article entitled " An Historical Resumé of Radio-Telegraphy." It appears to be a chronological survey of the invention right from the earliest times of wireless telegraphy down to the present day.

It is a very excellent plan to recapitulate the steps which have led up to the present day efficiency of the art, and we congratulate our contemporary for its initiative in dealing so thoroughly with a subject upon which the attention of the whole world is riveted.

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An inquest was recently held at Amlwch (Anglesey) Wireless Station concerning the death of John McGrath, retired naval man, who had been engaged as cook at the station. It appears that deceased and a friend were returning home from Amlwch. The night was dark, and the men missed a footpath along which they intended to walk, and fell down a rocky slope as there was no fence of any description. Assistance was procured by the man's comrade, and his lifeless body was removed to the wireless station. The jury returned a verdict of accidental death, and added a rider to the effect that the place should be properly fenced in as a number of people had tumbled down the ravine, which was very dangerous.

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Last month a special Court was held at the Courthouse, Valentia Island, for the purpose of investigating charges of larceny preferred against two persons for " unlawfully and feloniously stealing, taking and carrying away a quantity of lead," made up of four lead containers of a D.P. battery, the property of the Postmaster-General, London, and which was installed at Valentia wireless station. Evidence was brought forward which stated that constables had searched the houses of the culprits, where the stolen goods were discovered. In order to give time for further enquiries to be made the two accused were remanded for eight days.

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An interesting personal touch is recorded in connection with the sinking of H.M.S. *Russell*. Rear-Admiral Fremantle is known universally throughout the Navy as " my son Sydney," that being the way in which his father, Admiral Sir E. Fremantle, was accustomed to refer to him. Rear-Admiral Fremantle was, at the beginning of the war, Director of Signalling at the Admiralty, which included, of course, looking after wireless telegraphy. He served on the North Sea before going to the Mediterranean.

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The decision of the Editor of this Magazine to alter its style with the new volume has, we are pleased to say, been well timed. From the Public and Press alike, we have received words of commendation which are particularly gratifying, in view of the difficult circumstances under which the change was made. As an example, we would quote from the *Nautical Magazine* for May. It says: "The new volume of THE WIRELESS WORLD (April issue) has exceeded all our expectations."

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We were all pleased to learn of the rescue of the prisoners whom the Arabs captured on the North-West Egyptian Coast, after the stranding of the s.s. *Tara*. This was accomplished by the Duke of Westminster's armoured car fleet. Last month we published a photograph of these people, who looked none the worse for their experience with the fanatical Senussi.

The ship's officer and the Greek interpreter who were missing among the prisoners have been found and are safe. They went under escort to Tobruk for food, the guard telling the Italian authorities that the prisoners would pay. While food was being procured, the Italians received a wireless message to rescue the prisoners, and the two men were therefore immediately released.

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We have referred in our magazine to the loss of the steamship *Volturno* on October 9th, 1913, which was occasioned by fire in the North Atlantic Ocean. In connection with this disaster, we are pleased to record that the King conferred upon Seaman Samuel Gaskell, of the *Minneapolis*, the Board of Trade Silver Medal for gallantry in saving life at sea. Seaman Gaskell incurred very considerable risk in rendering the service on account of the strong gale and very heavy seas prevailing at the time.

Wireless "Pickles"

OUR contemporary the *Telegraph and Telephone Age* is evidently much perturbed by the appearance of so many youthful wireless experimenters. Under the heading "Knee-Pants Inventors," it writes as follows :—

"The wireless telegraph art has brought into being a new species of engineer (?) "of the 'knee-pants' variety. They might be classed as one of the '57,' but in "whatever category they are placed there is no doubt that many of them make "nuisances of themselves and cause a great deal of trouble and annoyance by their "unbridled enthusiasm and aggressiveness.

"Wireless telegraphy has an unaccountable fascination for the youthful mind, and "school boys, ranging from ten to fifteen years, are its victims. In many cases they are "sons of influential and wealthy parents, who, like most parents, believe their boys are "wonders. These boys get ideas from manufacturers' catalogues and immediately get "busy on something they know nothing about. After some dabbling and crude experi-"menting they hit upon something that is not in the catalogues, and they think they "have made a discovery. Their papas, not knowing any better, try to gain official "recognition of their sons' achievements, and the result is lengthy and time-consuming "correspondence before a quietus can be placed upon the exuberance of youthful spirits."

There is, of course, another side of the shield, and doubtless the writer of the paragraph was "one of the 57" himself when young!

To Our Readers

THE ancient Romans had a proverb which said, " You settle your "own problems as you go along" (*solvitur ambulando*), and this phrase expresses, in succinct form, that with regard to the question as to whether our readers have appreciated the many innovations in our new volume the best solution is afforded by the experience of our two last issues.

We have had the pleasure of receiving a number of letters and comments, almost all entirely favourable, from various subscribers. One of the most eminent scientists in the radio-telegraphic world summed up his opinion by the statement that our magazine appears to him " to hit a happy medium " between the severely technical review and the popular journal." This pronouncement went " right home," for the " middle course," although it is proverbially the " safest," is always the most difficult of execution. We have a large and highly diverse circle of friends to please, and amongst all the varying tastes and requirements it would be quite impossible for us to " hit the fancy " of each one upon every page.

When, in April, 1911, we first appeared before the reading public under our old title of " The Marconigraph," our issue consisted of 16 pages, and we believe that few of our most enthusiastic supporters ever anticipated that we should be able within five years to bring out an issue more than five times the size, and attaining so high a standard in matter and production. We are the prouder of this fact, in that our latest expansion has occurred at a time when so many of our contemporaries, a large number of whom possessed many excellent features, have been forced by the adverse circumstances brought about by the war to suspend, or disappear altogether.

To co-operation on the part of our readers our magazine owes a great deal of this success and appreciation. As I write, there lies before me upon the editorial table a letter from a correspondent, plainly not written for the purposes of flattery, because it deals with a specific matter which is likely to find attention in our technical pages. Incidentally, our correspondent makes use of the following sentence :

" I shall never have any doubts as to recommending it wherever I go, " and if by letter or article I can help in the least to maintain its high reputation, I shall have great pleasure in so doing."

These few lines seem to strike just the right note, and to afford a hint to many other friends. Here we have a reader who is desirous of helping us to maintain the high standard of interest which we have already reached by offering for our pages paragraphs or articles likely to appeal to other readers. If those of our friends who work or live in various more or less remote parts of the world were to give us the benefit of their experiences in the form of articles or paragraphs (especially if the text were accompanied by photographs or illustrations) they would be simultaneously showing their appreciation of our efforts, and placing in our hands materials for many more of those topographical articles which already find place in our pages, and which interest perhaps a larger proportion of our clientèle than any of the matter which we publish.

Our correspondent's eulogium, however, contains yet a further point. What he says, in effect, amounts to the statement that, having enjoyed THE WIRELESS WORLD for some years himself, he is desirous of extending that enjoyment to others. With this object, he is prepared to recommend it wherever he goes, and no magazine reader can better further the interests of his favourite journal than by consistent pursuance of such procedure. No editor can enjoy a more satisfactory form of encouragement than that of continually seeing his circulation undergoing a steady increase from month to month. We may now let our readers into a secret! All sorts of lugubrious prophecies were made at the time when, at the beginning of our new volume, we added substantially to our pages, with the result that we were obliged also to increase our price. These lugubrious prophecies have been falsified by the event. The whole of our April issue was sold out within three days. We printed a larger edition for our May issue, and that (increase included) has followed suit. But—see what the result of success is upon the editorial mind! Because we have already done so well, we are desirous of doing still better. We feel that we have many readers like the one whose letter we took as the "text" of our present remarks. If such readers would put down upon paper a list of friends whom they know to be interested in radio-telegraphy, and ask them, either verbally or by correspondence, whether they have seen some article, paragraph, or illustration in the latest issue of THE WIRELESS WORLD which has arrested their own attention, they will bring our magazine before the notice of a number of future readers. Please remember that the wider the circle by whom we are read, and the larger the number of copies we are justified in printing, the more we are in a position to add fresh features of interest to those we have already offered. In other words, "nothing succeeds like "success."

The Editor.

Mutiny on a Liner.

The severe penalty laid down as applicable to persons convicted of wilfully refusing to obey the orders of the captain on board ship fortunately makes mutinies very scarce happenings. A case has just been reported in which wireless telegraphy played a prominent part.

It transpires that a number of union seamen on board the steamer *Mongolia* mutinied when the vessel was off Gravesend Bay, owing to the presence of non-union men on board. Wireless calls for assistance were immediately sent out. These were answered by patrol boats, which, proceeding to the spot, took off 130 union seamen.

This vessel is probably the 13,639-ton liner of the Pacific Mail Steamship Company, New York.

* * * * * *

A Curious Incident.

According to the *Gazette de Hollande* the steamer *Soerakarta*, of 6,926 tons, belonging to the Rotterdam Lloyd Steamship Company and convoyed by the steamer *Kawi*, of 4,871 tons, left Falmouth recently on her homeward voyage to Holland, by way of the North of Scotland route. Two days later when the ships were between the Irish coast and the Shetland Islands, the wireless apparatus on the *Soerakarta*, which was in constant use between the two ships, suddenly stopped, after she had wirelessed that she had been summoned by a submarine to lower a boat and show her papers. The *Kawi* at once returned to the *Soerakarta* and saw at her port side a submarine, without any indication as to her nationality.

Suddenly a shot was fired, and the four people who had emerged from her disappeared in the water. A second shot finished the submarine. Both shots were fired by a British trawler which had appeared on the port side of the *Kawi*; the second shot hit the submarine amidships.

The whole affair took place within about ten minutes. The British vessel enquired whether any help was needed, and whether anyone was wounded in the Dutch boats, which had been very near the fire. The answer being in the negative, she disappeared after having stated that the submarine was German and of the latest type with a crew of sixty, and that the British had been lying in wait for her for four days.

* * * * * *

A NOTABLE BRITISH SAILER.

Our readers will no doubt be surprised to learn that the White Star Line's steamship *Mersey* has been sold to Norwegian owners and renamed *Transatlantic*. She will continue to act as a training ship, but will carry cargo. It will be remembered that the White Star Line fitted her with electric light throughout and equipped her with wireless preparatory to her employment as a training ship for cadets destined to hold positions in the White Star Company's fleet.

* * * * * *

FRENCH LINER ATTACKED.

The utility of wireless intercommunication between ships at sea has just been recently interestingly and happily exemplified in the case of a French liner, the *Colbert*, which was attacked and fired at without warning by an enemy submarine. She not only succeeded in herself escaping by putting on full steam, but the wireless warnings which she was able simultaneously to radiate from her aerials were picked up by another liner, which was running straight into the lion's mouth ! As a result the latter changed her course and succeeded in eluding the attention of the enemy.

* * * * * *

THE SINKING OF THE " PRINCIPE DE ASTURIAS."

The Argentine Press has published ample details of the horrible catastrophe which caused the loss of 100 lives of persons who were travelling on board the luxurious Transatlantic liner *Principe de Asturias*, which sank off the Brazilian coast.

From private information supplied by survivors themselves we may state that the radio-telegraphists who were on board did everything possible to work their wireless apparatus in order to call for help. They could only send two or three SOS signals without giving their position.

Moreover, this call, even if it had been complete, would have been almost useless, as the Santos and Rio de Janeiro stations only have limited hours of service and the Island of San Sebastian could not hear them as the wireless operator there had died on that day.

In our opinion, coastal stations, if they are to be effective, should have a continuous service in view of the fact that accidents happen at sea by night as well as by day.

* * * * * *

INDIAN LINER STRIKES A MINE.

On her last homeward voyage to Amsterdam, the Royal West Indian Mail Line steamer *Columbia* sent a wireless message that she was in a sinking condition off the New Galloper Lightship in the North Sea, and asked for help. Before arrangements had been completed for sending the assistance required, another wireless message was received announcing that aid was no longer wanted.

The vessel subsequently arrived under her own steam at Gravesend, where she was examined. From the damage revealed, it is believed that the vessel struck a mine.

The forecastle and forehold were full of water, but fortunately no casualties were reported.

The *Columbia* was on her way from Baltimore to Amsterdam with 4,300 tons of maize for the Dutch Government.

* * * * * *

MINE SWEEPERS SUMMONED BY WIRELESS.

While the Dutch steamer *Maashaven* was being towed by two tugs near the Galloper buoy the look-out saw the Dutch steamer *Dubhe* strike a mine. Curiously enough the tug which went to her assistance also struck a mine and sank in four minutes. Meanwhile the *Maashaven* herself ran on one of these engines of destruction, but fortunately kept afloat. A British trawler appeared and at once requisitioned aid by wireless from four British mine sweepers. These assisted the *Maashaven* and *Dubhe* to the British coast.

* * * * * *

EXCEPTIONAL WIRELESS DISTANCE.

The Oceanic Company's steamer *Sonoma*, which recently arrived at Sydney from San Francisco, was not out of touch with land from the time she cleared the Golden Gate until she entered Sydney Heads. All the time the vessel obtained news of the war and other important world events from the American side, no news being available from any of the stations in Australia or Fiji. At a distance of 4,700 miles she was kept informed, while the receipt of news at 2,300 miles was quite an ordinary performance. This is very creditable, as the distance between the two ports is about 7,000 miles.

* * * * * *

SS. "DUENDES" ATTACKED.

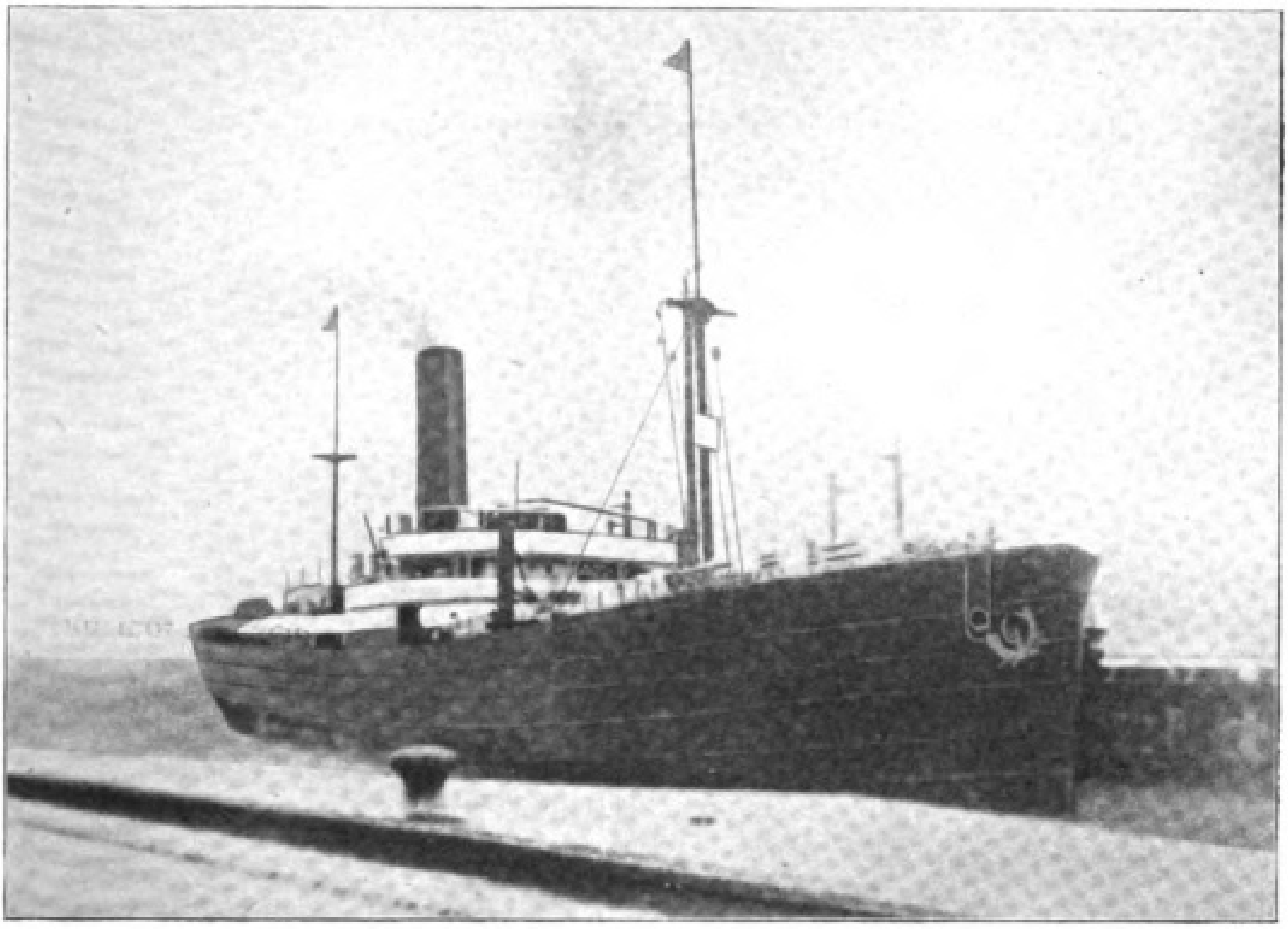
The following report has been made by the master of the ss. *Duendes*, which was attacked by gunfire without warning by a German submarine. The master of the vessel, Captain Alban Chittenden, by his judgment, pluck and skill, succeeded in saving the ship from destruction, although hit by shell nine times.

"On Saturday, March 25th, at 5 p.m., we observed a Scandinavian barque lying hove to, distant about five miles, under two lower topsails with the main topsail to the mast.

"In consultation with the chief officer, John Blacklock, we thought it very strange, and fearing that a submarine might be lying on the other side of her, we kept a good look out, keeping away two points from the barque. Our course was North 83 East true, speed 10.5 knots.

"At 5.40 p.m. we heard a shot, which dropped about four ship's lengths astern of us. We then sighted a submarine, which opened fire on the starboard quarter at a distance of about three miles. We immediately altered the helm so as to bring the submarine right aft, and sent to the engine-room to put all hands on to the fires and open the ship out to the utmost. At the same time I instructed the Marconi operator to send out the SOS. signal, giving the position of the ship, etc., which he did ; the same was immediately picked up by a shore station, after which the Marconi operator sent out all positions as the course of the ship was changed.

"The submarine continued firing from the port and starboard quarters until



SS. "DUENDES," OF WHOSE ESCAPE FROM A SUBMARINE A STORY IS TOLD IN THESE PAGES.

6.30 p.m., working us round to the north-east and north in order to keep us in the remaining light in the sky.

"As the firing in the stokehole became greater and the speed of the ship increased, flames came out of the funnel, which made a valuable target for the submarine, consequently we were forced to put the dampers on.

"The firing ceased from 6.30 to 6.45 p.m., when he commenced again, the shots falling ahead of the ship on both sides. He continued firing until 7.25 p.m., then ceased for ten minutes owing to the weather becoming squally. At 7.35 p.m., the squall clearing, he opened fire on us with shrapnel, working us right round as before to the remaining light in the sky. We kept altering the course to keep the ship out of the light and to bring the sea abeam, which made it very difficult for him to aim accurately.

"One of the shrapnel shells put the wireless apparatus out of order for a time, some of the shots entering the Marconi cabin and bridge deck house. The firing ceased at 8 p.m.

"The deck was strewn with shrapnel, and the ship has been hit in several places with small pieces, but as far as we are at present aware no serious damage has been done, with the exception that two of the plates on the starboard side have been knocked in rather badly with some of the first shots.

"The behaviour of all on board was admirable."

(The *Duendes* is a steel screw steamer of 4,602 gross and 2,948 net tons, built at Sunderland in 1906 by Sir James Laing & Sons, Ltd., and owned by the Pacific Steam

Navigation Company. Captain Alban Chittenden entered the service of the Pacific Steam Navigation Company in 1894, and was appointed to the command of the *Duendes* in 1912.)

* * * * * *

H.M.S. "RUSSELL" LOST AT THE END OF APRIL LAST.

At the end of April last the Admiralty announced that H.M.S. *Russell*, flying the flag of Rear-Admiral Fremantle, had struck a mine in the Mediterranean and sank. Unfortunately about 120 officers and men are missing. H.M.S. *Russell* was a battleship of the *Duncan* class, laid down in 1901 and completed in 1903. She possessed a displacement of 14,000 tons, and her prime cost was £1,037,995. Her main armament consisted of four 12-inch guns, twelve 6-inch guns, twelve 12-pounders and four torpedo tubes, together with the sister vessels of her class. She was fitted with wireless telegraphic apparatus. It is interesting to recall here that H.M.S. *Montague*, which was wrecked on Lundy Island in 1906, was a sister ship to H.M.S. *Russell*.

* * * * * *

JAPANESE STEAMER ON THE ROCKS.

According to a dispatch from Hong Kong, the captain of the Japanese steamer *Chiyo Marun* wirelessed that there was a heavy south-easterly sea, and his vessel was slipping on to the rocks. Subsequent news was received to the effect that she had been abandoned. Early next morning a British destroyer, which was standing by, sent a wireless telegram that the position of the ship had changed. She would not reply to the destroyer's messages, either by lamp or wireless. It was therefore presumed that the crew who had remained on the vessel had landed. A Japanese cruiser went to the assistance of the stranded vessel, and relieved the few members of the crew who still remained aboard.

* * * * * *

NORWEGIAN STEAMER WRECKED.

Whilst on a voyage in the South Atlantic the Spanish steamer *Leon XIII*. picked up a boatload of nine people, members of the crew of the Norwegian steamer *Marika*, which had been wrecked. The captain of the *Leon XIII*. immediately sent a wireless message to Monte Video reporting the incident. The Marika was on a voyage from Buenos Ayres to Copenhagen.

* * * * * *

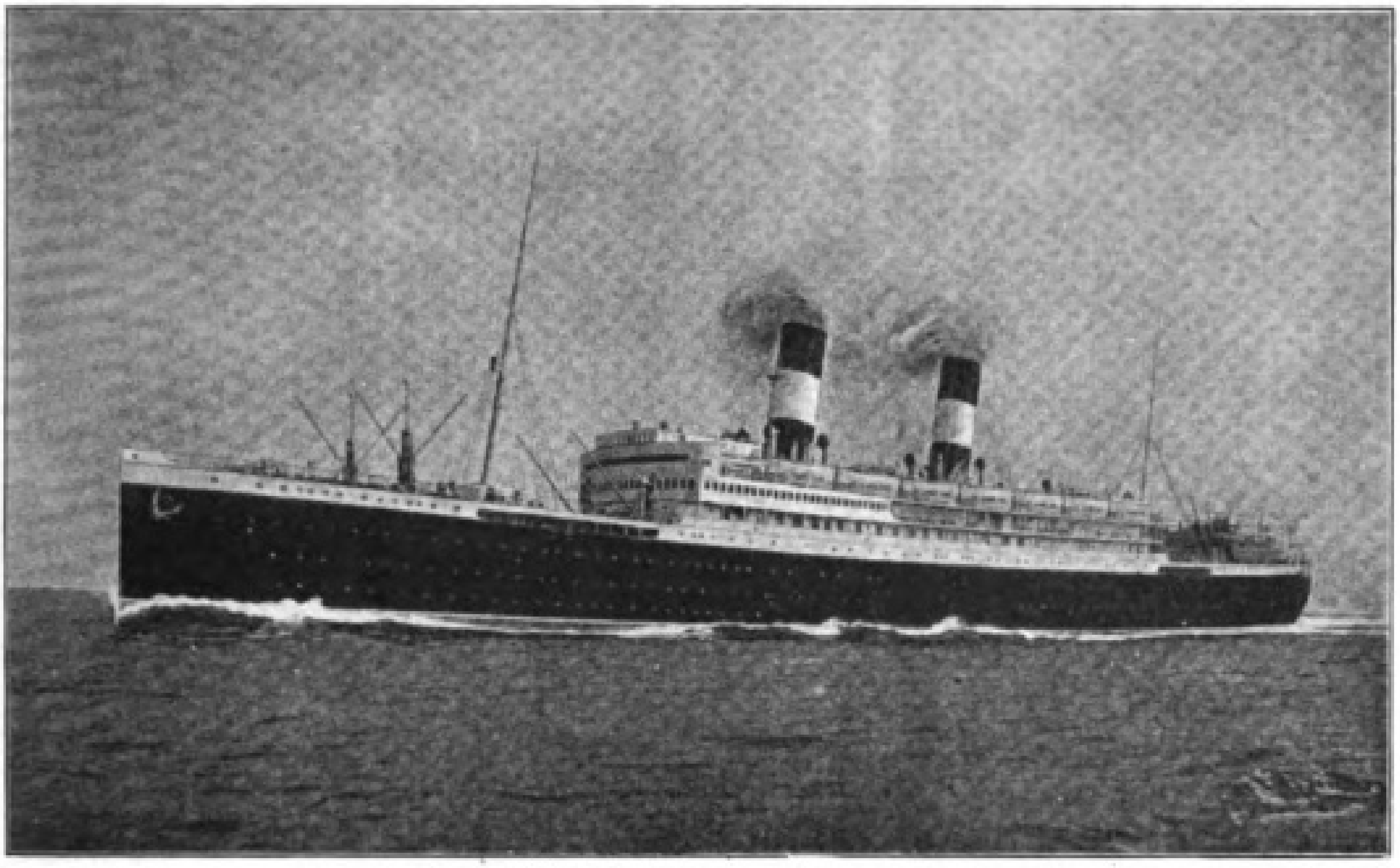
UNARMED SHIP SHELLED.

Referring to the attack made recently on the London steamer *Ashburton*, which was sunk by a German submarine, it transpires that she was unable to send a call for help owing to the fact that her wireless equipment was shot away. Unfortunately five of the crew were injured by shrapnel. The *Ashburton* was a vessel of 4,445 tons, and owned by the Australian Steamship Company.

* * * * * *

A NEW ITALIAN LINER.

We are able through the courtesy of the London Office of the Italian State Railways to publish a photograph of the new steamer *Duilio* belonging to the Navigazione Generale Italiana, which is to inaugurate the new quick service between Europe and South America.



SS. "DUILIO," THE NEW PASSENGER STEAMER OF THE NAVIGAZIONE GENERALE ITALIANA.

She is the largest and best appointed liner plying between Europe and South America. Her displacement is 27,000 tons, length 660 feet, breadth 78¾ feet, depth 124½ feet, and registered tonnage 22,000. She was built by Messrs. Ansaldo & Co., of Genoa, and has eight decks. The propelling machinery is on the quadruple turbine screw system, and her designed speed is 20 knots. The safety of passengers and crew has been amply provided for, the ship being partitioned into 17 watertight compartments. A double bottom runs the whole length of the vessel, and the lifeboats, including motor boats, will accommodate 3,000 persons. Special submarine apparatus has been fitted to give warning of the proximity of rocks, icebergs and other dangers, and a high-power wireless system is fitted. From the point of view of comfort, she will be one of the most luxurious steamers at present sailing the high seas.

* * * * * *

Relief Ship Beached.

According to a telegram from the North Foreland Wireless Station, the following wireless message was received from the Dutch steamer *Batavier IV.*: "Swedish steamer *Fridland*, Belgian relief vessel, sinking. Steamer *Rio Branco* has been sunk." Later the same evening another message was transmitted, reading: "We are near Longsand Lightship with the steamer *Fridland*; will bring her into Black Deep."

From Southend the next day came a telegram to the effect that the *Fridland* had been beached on the Blyth Sand at the mouth of the Thames.

The *Fridland* is a steamer of 4,960 tons, built in 1910, and registered at Gothenburg. In the early part of the war she was captured and taken to Kirkwall for examination. The *Rio Branco* referred to in the first message was a Brazilian steamer of 2,258 tons, registered at Rio Janeiro. It is surmised that both these vessels struck mines.

THE TRUE ORIGINATORS OF THE MORSE CODE.

Correspondence

To the Editor of THE WIRELESS WORLD.

SIR,—I read with interest your article in this month's issue of THE WIRELESS WORLD *re* gramophone records as a means of instruction for students in the Morse code, and I note you pay a glowing tribute to the numerous amateurs who have found the experience gained in the pursuit of their hobby useful to them in the service of their country. This, however, is quite contrary to my own experience. Prior to the war I was a keen amateur, and flatter myself that my station was well equipped and efficient, and every portion of the installation was made entirely by myself. I continued the study after my station was dismantled, and have since obtained the P.M.G. first-class certificate. I have also been studying the various systems employed, and have neglected no opportunity of adding to my knowledge of the subject. I naturally thought that my knowledge would be of some little use in some sphere or other at the present time, and made several enquiries, but only to receive the " cold shoulder " at every attempt.

The mercantile marine will not have me as I am of military age, and yet I am *too old* for the Navy. I have not tried the Army, as several of my fellow-students tell me that when they applied recently there were no vacancies. I am just turned thirty-three, and am married, and a partner in an old-established business, which it would be a considerable sacrifice to leave, even for the period of the war, so can anyone blame me if I object to joining the Army as an ordinary infantryman, and spending several months in a training camp learning to form fours, etc., when by several years of self-study and a considerable amount of expense I have qualified to fill a technical position, of which there *must* be some need. (Signed) G. R. LEWIS.

To the Editor of THE WIRELESS WORLD.

SIR,—With reference to the article on " The Action of Crystal Detectors," the author appears to have completely neglected the effects of a boosting voltage. This might cause some modification in his arguments, since in the case of a valve there is, in the majority of instances, a certain amount of steady current flowing through the telephone circuit (even in the entire absence of a " boosting battery " in the usual sense) due to the stream of electrons shot off from the hot filament. It would seem only fair in comparisons to specify the same conditions in both cases—say, for example, with boosting voltage to obtain the greatest sensitiveness in all cases.

If the author has not already seen it, may I be permitted to draw his attention to a paper by Mr. D. Owen, read before the Physical Society a few weeks ago, in which very good agreement is shown to be obtained between measured rectified current from a crystal contact, and that calculated on a simple themo-electric theory ?

His statement that " there are several detectors on the market which utilise much more of the wave than a valve can possibly do, and yet none of them is as sensitive " scarcely seems quite accurate when considering, say, the " audion " type of detector in which the oscillatory P.D. is applied to the " grid " electrode and the telephone circuit is connected from the plate to the filament ; as in this case, *both* positive and negative voltage loops may be effective in modifying the telephone current, so that " more of the ware " is utilised than in the case of a simple rectifier. Such detectors, as a rule, are more sensitive than the simple valves. (Signed) PHILIP R. COURSEY.

The Methods Employed for the Wireless Communication of Speech (iii)

By PHILIP R. COURSEY, B.Sc.

(Read before the Students' Section of the Institution of Electrical Engineers, on February 2nd, 1916.)

SHORT SPARK METHODS OF GENERATING OSCILLATIONS.

THE apparatus placed in this group is generally classed as producing trains of damped oscillations, which follow one another with great rapidity so that the group frequency is above the acoustic limit. This, as pointed out above, is not necessarily the case, and hence some writers often refer to them under the heading of "Arcs," so that it will be convenient to consider them here after having briefly reviewed the principal forms of arc generator. The question as to whether a given discharge is an arc or a spark is often rather a difficult one to decide, as the distinction between the two is not by any means a ways apparent to the eye even if the discharge is visible. The distinction between the two is more a matter of convention than of real difference in many cases, since one form of discharge readi y merges into the other with little apparent change in its characteristics.

In the ordinary meanings of the terms, a spark is a definite disruptive breakdown of the dielectric between the two terminals by reason of the electric stress applied to the medium being greater than the critical breakdown value. The current which passes across the dielectric under these conditions is only momentary, and is carried by a few ions which generally arise from the material of the dielectric. An arc, on the other hand, is a sustained discharge through the dielectric, which therefore requires the provision of a plentiful supply of ions to form carriers for the current. In the majority of cases these ions are produced from the material of the electrodes, and often arise through chemical dissociation by reason of the heat generated.

If an arc discharge goes out the source of ionisation ceases as soon as the electrodes cool down again, so that if the electrodes are fixed it is necessary that the dielectric should be punctured by a spark before an arc discharge can be restarted between them, unless some exterior source of ionisation is provided. Hence, it is evident that an arc discharge cannot be maintained if a sufficient supply of ions is not available. If the electrodes are kept cool, or made of a material which does not readily yield ions, it will be difficult to start or maintain an arc discharge between them, and hence if a discharge take place at all between such electrodes it will tend to remain in the spark form, so that once a discharge has passed it cannot continue more than a very short space of time on account of the lack of ions to form the conducting path. Therefore it follows that a discharge gap of this form will be of the "quenched" variety —meaning that the discharge is quenched or extinguished very rapidly. Further, if the discharge is quenched out very rapidly it follows that the gap should be ready for

Erratum.—On p. 95 of the May issue, *read* $n = \frac{1}{2\pi\sqrt{CL}}$ *instead of* $n = \frac{1}{2\pi}\sqrt{CL}$.

the passage of a fresh discharge a very short space of time after the first has passed, and hence this type of gap satisfies the requirements of being able to produce a series of discharges following one another very rapidly ; in other words, it should be suitable for the purposes of wireless telephony.

Spark-gaps of this kind form the basis of the Lepel, Telefunken, Peukert and other patents, and are based on the results of experiments of M. Wien on the quenching effect of short spark-gaps.

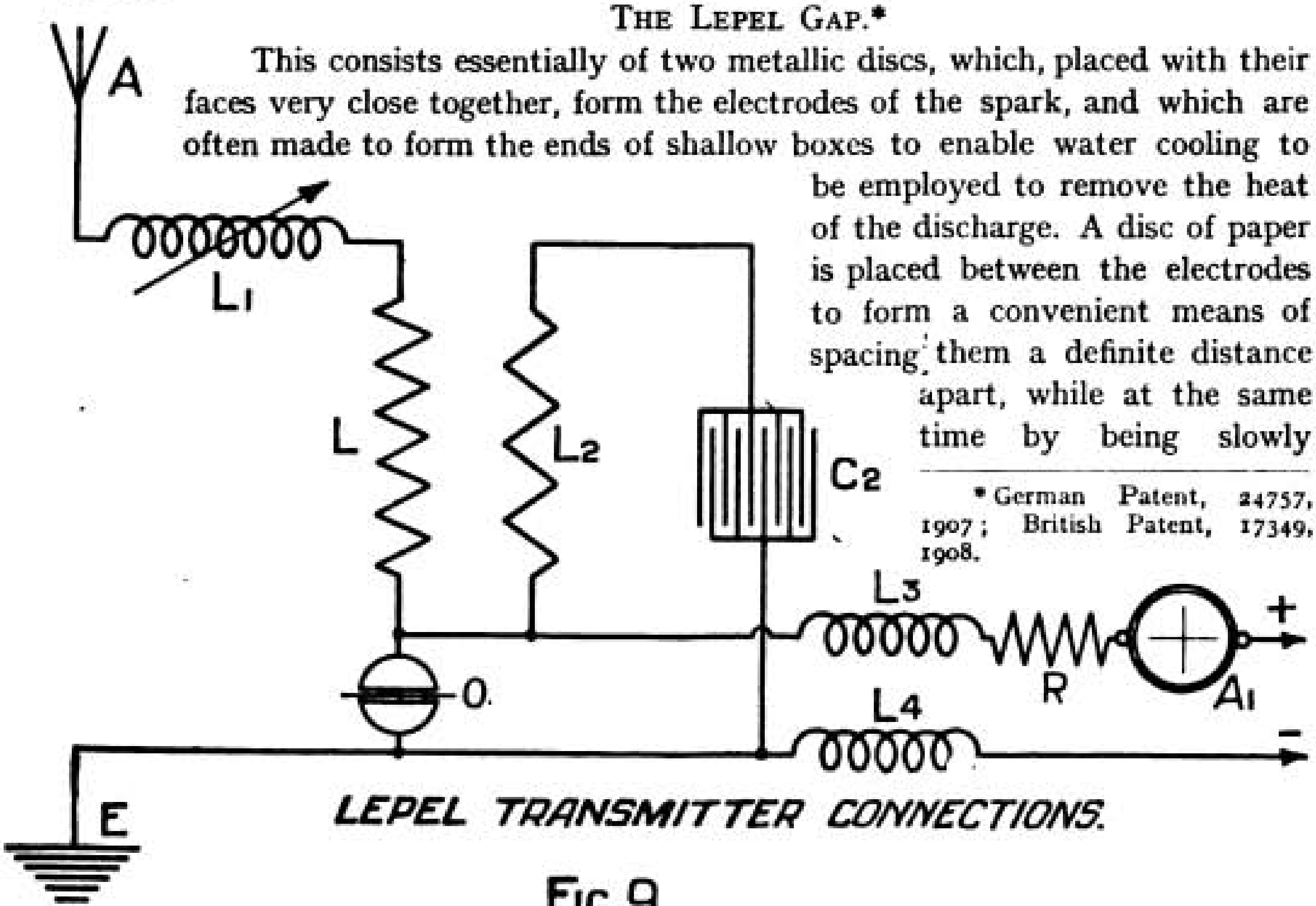
Of these gaps the Telefunken is most commonly used in practice with alternating current (of frequency about 500 per sec.) for the purposes of spark wireless telegraphy so as to obtain a good musical note. The Lepel gap is most commonly used on direct current, and under such conditions the spark frequency may be made very high, and is generally sufficiently so for use in wireless telephony.

Any of the forms of quenched gaps will yield a high spark frequency if connected to a suitable direct current source, and the electrical constants of the circuits are properly adjusted. The most important adjustments in this respect are those of the choking inductances in the main supply circuit, and also the value of the condenser in the oscillation circuit, since this capacity combined with the capacity between the plates of the oscillator itself, in conjunction with the choking inductance and series resistance, determines the "time-constant" of the charging circuit (charging the condenser between each spark), and hence also the spark frequency. That is to say, an increase in the choking inductance or in the series resistance will increase the charging time, and therefore lower the spark frequency, while a decrease in the capacity of the oscillation circuit condenser or of the capacity of the oscillator will raise the spark frequency.

THE LEPEL GAP.*

This consists essentially of two metallic discs, which, placed with their faces very close together, form the electrodes of the spark, and which are often made to form the ends of shallow boxes to enable water cooling to be employed to remove the heat of the discharge. A disc of paper is placed between the electrodes to form a convenient means of spacing them a definite distance apart, while at the same time by being slowly

* German Patent, 24757, 1907 ; British Patent, 17349, 1908.



LEPEL TRANSMITTER CONNECTIONS.

FIG. 9.

burnt away it furnishes a hydrocarbon atmosphere in the discharge gap, which improves its operation.

The thickness of paper most commonly employed is from 5 to 10 mils. (0·005 inch to 0·01 inch), but, of course, varies somewhat with the supply voltage. The latter is generally about 400 to 500 volts D.C.

When in operation the gap should be connected in series with suitable choking inductances and resistances to limit the flow of current from the supply mains, and also to determine and regulate the spark frequency. The oscillation circuit is connected in shunt across the gap in the usual manner. Usual diameter of discs = 3 inch to 5 inch.

A spark frequency of the order of 10,000 per sec. or more can usually be obtained.

The discharge that takes place in the gap is often described as an arc rather than as a spark, and the improvement that is stated to result from the hydrocarbon atmosphere, resulting from the decomposition of the paper ring separating the electrodes, perhaps lends support to this view. It is probable that the discharge really partakes of the nature of both the spark and the arc, and is intermediate between the two types.

THE TELEFUNKEN SPARK-GAP.*

This spark-gap is very similar to that of von Lepel, just described, and operates in the same manner. The chief points of difference in the most usual constructions are the use of mica ring separators between the copper disc electrodes instead of the paper employed in the Lepel gap; and the use of a number of gaps in series in place of the usual one, or at most two, in the Lepel arrangement. This means that higher voltages must be employed, with consequently a great power output. Air cooling of the discs is also generally resorted to instead of water cooling.

The Peukert Oscillation Generator is similar to either of the above with the exception that oil is employed as the dielectric, and it is kept in circulation by the rotation of one of the discs. This dispenses with water cooling.† The discs are usually spaced about 1/250 inch apart. Direct current at 500 to 600 volts is employed. The discs are silver-plated copper.

A somewhat similar arrangement to the Telefunken gap has been employed by Ditcham in some recent experiments. Successful telephonic communication has been carried on by their use for distances up to about 100 miles.

A number of spark-gaps are used in series on a supply voltage, direct current of from 1,000 to 2,000 volts. (See *The Electrician*, Vol. 72, p. 569.)

Recent experiments with oscillations produced in this manner by means of short-quenched spark oscillation generators have shown that they may probably prove to be of considerable value for the generation of oscillations suitable for the uses of wireless telephony.

By investigation of the oscillations produced by the spark-gap, by means of a Braun cathode ray tube, it has been shown that under certain conditions a short spark-gap between brass and aluminium or other metallic electrodes placed in an atmosphere of coal gas, and supplied with direct current at about 400 volts through suitable choking

* German Patents, 27164, 1908; 27483, 1908; 28198, 1908; also British Patent, 6424, 1909.

† See *The Electrician*, Vol. 64, p. 550, 1910; see also J. A. Fleming and G. B. Dyke, *Proc. Phys. Soc. Lond.*, 23, p. 117, for description of similar spark-gap.

inductances and resistances, is capable of yielding practically undamped oscillations; this means that the spark frequency must synchronise with the oscillation frequency, so that impulses are supplied to the oscillation circuit exactly in phase with the oscillations at periods which cannot be further apart than about two or four half-waves of the oscillation current, so that the amplitude of the oscillations is maintained practically constant. It may perhaps be emphasized in this connection the excellent manner in which the phenomena which takes place in such oscillation circuits may be shown up and studied by means of the Braun cathode ray tube, previously mentioned. The effect of varying the capacity in the circuits or the choking inductance, etc., may be investigated very easily, and the best effects obtained by proper adjustments. Some interesting experiments on this subject have recently been carried out by H. Yagi on the production of undamped oscillations from an aluminium-brass spark-gap.*

THE MARCONI DISC DISCHARGER FOR GENERATING UNDAMPED WAVES.

Another form of spark discharger by means of which it is possible to generate undamped waves is the Marconi multi-disc discharger.† The arrangement of apparatus is very much that of the usual Marconi studded disc discharger fed from direct current.

In this instance, however, the spark frequency is arranged to be much higher than the usual, and at the same time a number of such discs are arranged on the same shaft, with their studs or contacts so displaced relatively to one another that the sparks will occur on successive discs at regular intervals during the spaces on the first disc. Each disc is preferably arranged to discharge through its own condenser and oscillation circuit, independent of the others, the effects of them all being summed up in a secondary circuit connected to the aerial in the usual manner.

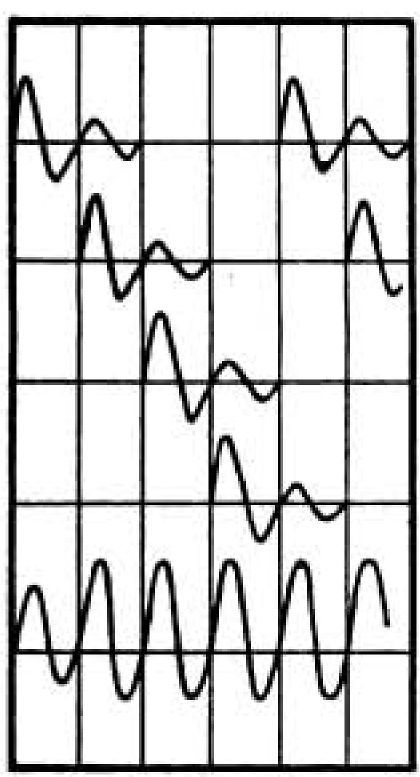


DIAGRAM OF MODE OF OPERATION OF MARCONI MULTI-DISC DISCHARGER.

FIG. 10.

If now we so arrange the oscillation frequency of each circuit that one complete wave (or at the most two) of current takes place in the interval between the spark on one disc and the next spark on the next disc, the effect of the second spark will reinforce that due to the first, and the oscillations will be maintained.

If the sparks take place every complete wave the oscillations will be to all intents and purposes undamped; but if every second wave, there will be a slight diminution of amplitude every alternate wave—much as may probably be the case

* H. Yagi, *The Electrician*, 76, p. 195, Nov., 1915.

† WIRELESS WORLD, 2, p. 75, 1914.

with some of the short spark dischargers, described above. Such an arrangement should be capable of dealing with considerable power if properly designed, while the oscillations produced would be eminently suited for wireless telephony. The system, in fact, amounts to an attempt to accomplish in a regular mechanical manner what happens in effect in some of the short quenched spark dischargers—*i.e.*, to ensure that each fresh impulse due to the passage of a spark shall exactly synchronise with the existing oscillations in the circuit. To a considerable extent this occurs automatically in the short spark methods by reasons of the reactions which take place between the currents in the various circuits; but, nevertheless, some irregularities will generally occur. The great objection to the mechanical method, apart from the difficulties of the high speeds required for the discs, is the difficulty of maintaining the discs running at a perfectly definite and constant speed. This is essential if the method is to work properly in order that the successive impulses shall synchronise properly with one another. It renders imperative some very sensitive form of speed governor that will maintain the discs running at a constant speed.

VACUUM OSCILLATION GENERATORS.

In 1884 Edison showed that an incandescent filament of carbon (such as a lamp filament) possesses the property of ionising the surrounding air, so that it becomes a unilateral conductor.*

This property has been turned to practical utility by Dr. Fleming and others, and forms the basis of the well-known Fleming oscillation valves which are now often used as wireless detectors. Some of these values have characteristics (*i.e.*, volt-ampere curves) which at some point are negative, like an arc characteristic, and hence it is possible to use such valves as generators of oscillations just as the arcs can be so used.

The use of a third, or "grid" electrode, as it is generally called, as in the de Forest "Audion" and others, leads to considerable advantage from the point of view of their operation as oscillation generators.

The mode of operation of this type of apparatus may be briefly summarised as follows: The hot filament has the property of emitting negative electrons, and hence the combination of hot filament and cold plate in an exhausted vessel forms an electrical conductor, which will allow current to flow in one direction only—that is to say, it is a unilateral conductor, and therefore will exert a rectifying action on an alternating P.D. applied to it. Since the current passing through this vacuous space is carried by a stream of moving electrons, and since an electron is merely a negative electric charge, it is evident that the motion of the electrons can be influenced either by an electro-static or by a magnetic field, and therefore the strength of the current flowing between the filament and the plate can be varied by subjecting the electron stream to electric or magnetic fields arranged so as to deflect the stream off, or partially off, the plate.

As shown in Appendix 2, for the conditions usually met with in oscillation valves the electric deflection will produce greater effects than the magnetic. Hence its use in practice for this purpose. If it is desired to influence the electron stream by an electric field, the point to which the deflecting potential is applied should obviously be placed as close to the electron stream as possible. Hence the "grid" electrode in the "audion" type valve is placed right in the path of the

* See J. A. Fleming, *Proc. Royal Institution*, 1890.

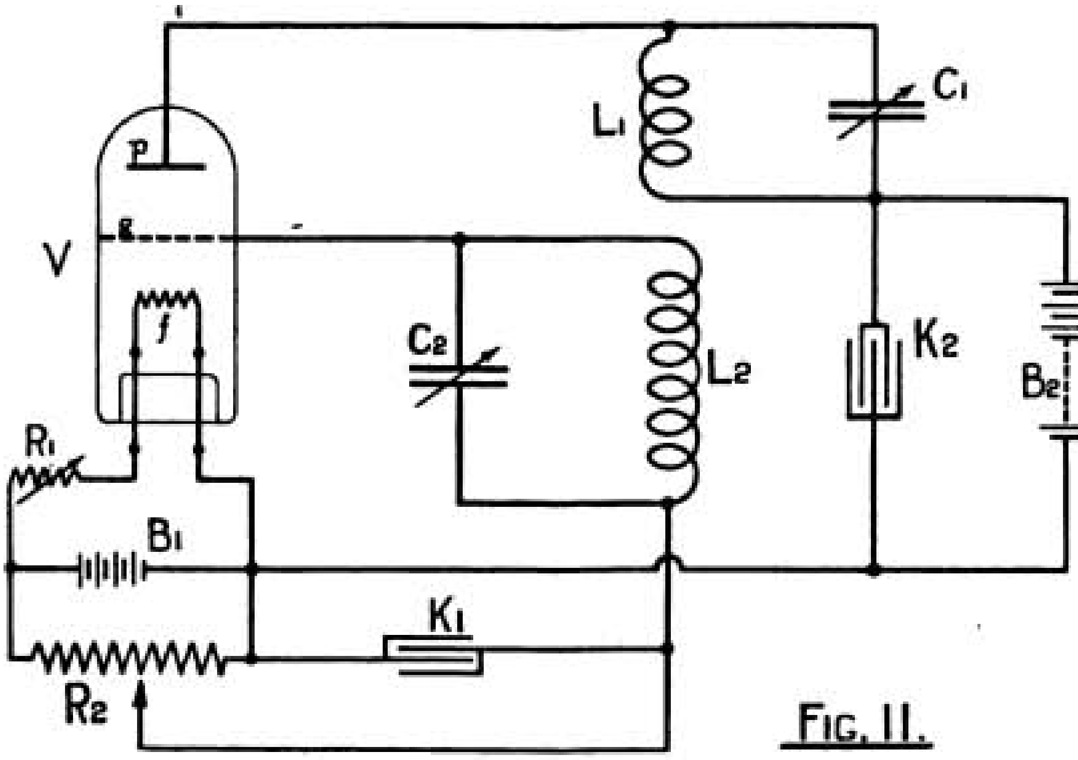


FIG. 11.

electrons between the filament and the plate, so that a small P.D. applied between this grid and the filament will cause large variations in the current flowing to the plate. The Marconi Co. have, however, shown* that it is possible to have the third electrode of the valve outside the glass bulb instead of inside, so that this should lead to a simplification of the construction. In general, however, this method of construction is not so effective as when the "grid" is placed inside the valve, and in the path of the electrons between the filament and the plate. This renders it possible to use this type of valve as an amplifier and consequently as an oscillation generator, for if we apply a small oscillatory P.D. to the grid circuit the above action of the valve as an amplifier will result in a magnified oscillation in the plate circuit. By arranging this magnified oscillation, to be further magnified by repeatedly passing through the amplifier, its amplitude will be continually increased until a steady state is reached. In this manner fairly powerful oscillations may be set up which may serve for use in wireless telephone transmission.

They possess the great advantages of simplicity and of reliability of operation; but since the forms at present constructed are only capable of handling relatively small powers, it is necessary to utilise a considerable number of them in parallel in order to obtain sufficient energy.

In fact, in the most recent long-distance tests with this method as many as from 300 to 500 of such oscillation valves, or "audions," were used in parallel. Successful speech was obtained across the Atlantic from Arlington, Va. (U.S.A.), to the Eiffel Tower, and also from Arlington to Honolulu, a distance of 5,000 miles.

A difficulty that arises when attempting to construct larger models of these valves to handle heavier oscillatory currents is the rapid disintegration of the hot filament by the ions, etc., shot off from it, and by the extra heating that is caused by the large oscillatory currents passing through it, and through the vacuous space. The electronic bombardment of the grid and plate may also give rise to considerable heating unless means are provided for keeping them cool.

The Marconi Co. claim in some recent patents† to have overcome this difficulty to a very great extent by the use of a platinum tube inside the valve, the tube being heated by internal carbon filaments, thus avoiding the sealing in of very large con-

* Marconi Co., British Patent, 13247, 1914.

† See, for example, British Patent, 6476, 1915.

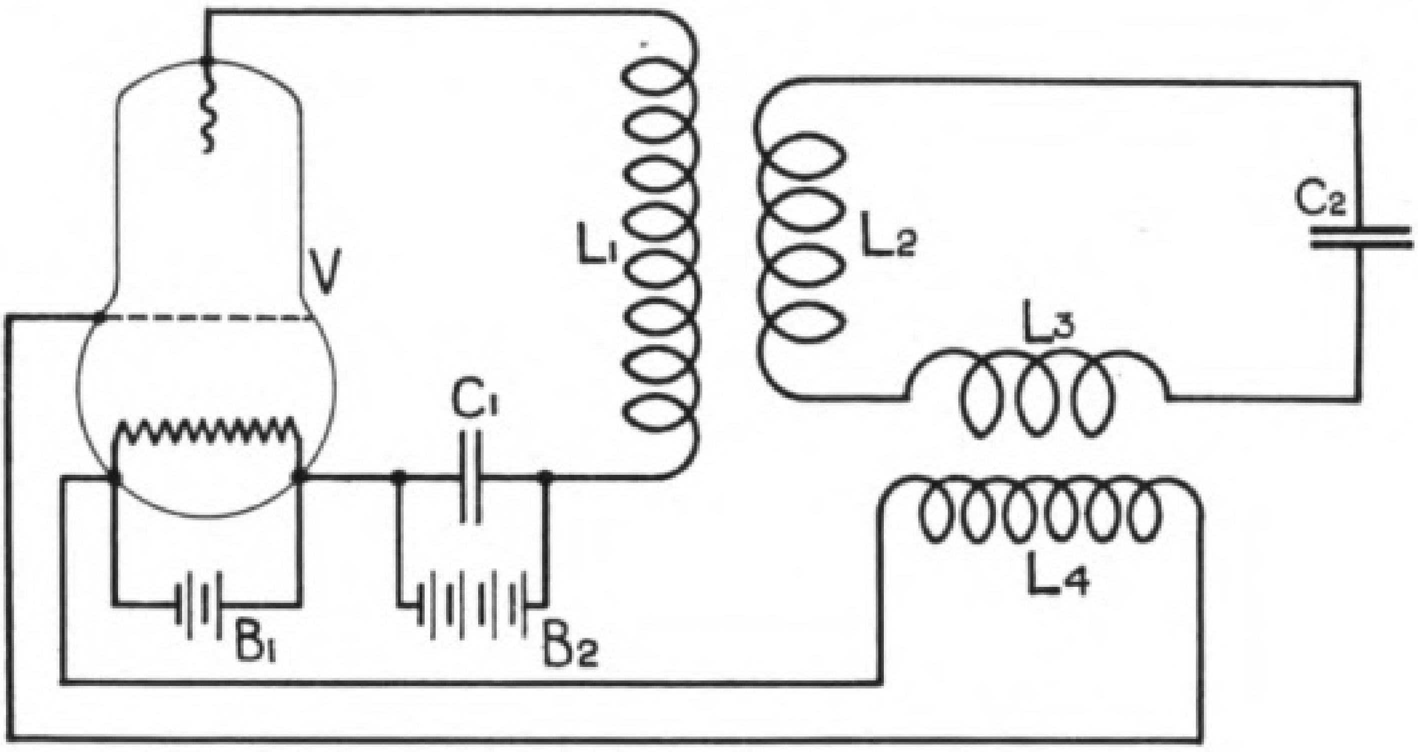


FIG. 12.

ductors to heat the large mass of platinum inside the valve, while at the same time the large surface of the platinum tube prevents its rapid disintegration.

The use of a coating of lime on the incandescent filament has been shown, by Wenelt* and others, to yield a much greater conductivity of the vacuous space ; that is, the heated lime promotes the emission of a copious supply of electrons from the cathode, or heated electrode. R. S. Willows† and others have described some interesting experiments which bring out the advantages to be obtained from its use, and also from the use of heated aluminium phosphate on the anode (which substance J. J. Thomson has shown emits positive ions when it is heated). It might, therefore, be expected that the use of these substances in the vacuum oscillation generators would lead to greatly improved operation of the same, but very little work seems to have been done in this direction. A serious disadvantage, however, appears to be loss of vacuum due to emission of gas.

O. Tugman‡ has investigated the effects of gas pressure and electrode spacing on the operation of these vacuum valves and has arrived at some valuable conclusions which should also be applicable to the cases we are considering, viz.—of oscillation generators.

Within the last year the results of a considerable amount of experimenting in this direction have been published in America by Langmuir§ and Dushman||, and it has been found that greatly improved results may be obtained by using very much higher vacua—so much so that the name of "kenotron" (from the Greek κενος, an empty space) has been given to the oscillation rectifiers that they have constructed. They have used the name "pliotron" (Greek πλειον "more") to designate the oscillation amplifiers having the third or "grid" electrode. These may also be used as oscillation generators. These generators are apparently capable of handling consider-

* *Annalen d. Physik*, 14, p. 425. † *The Electrician*, 68, p. 302. ‡ *Physical Review*, 29, p. 154.
§ I. Langmuir, *Proc. Inst. Radio Engineers*, April, 1915.
|| S. Dushman, *The General Electric Review*, May, 1915.

able powers owing to the fact that the high vacuum enables much higher voltages than the usual to be employed.

For this purpose they have suggested a combination of the two types of valves—viz., one a high voltage rectifier (kenotron), to rectify a high voltage A.C. supply which may then be used to supply a high voltage direct current to the pliotron oscillation generator. The initial high voltage is most easily obtained by this arrangement from a step-up transformer run off an ordinary A.C. supply circuit. This method apparently represents a considerable advance on previous apparatus of this kind.

As mentioned above, all apparatus of this class possesses great advantages over the arc and similar methods of oscillation generation, on account mainly of the relative simplicity of the apparatus and of the ease and reliability of its operation, coupled with the fact that practically no attention or adjustment is required beyond the initial switching on. The large range of frequencies obtainable from them and the ease of adjustment of the frequency also give them further advantages over the frequency raising apparatus, which we shall consider later, while, in addition, the oscillations obtained in this manner are much steadier and of more constant frequency than those from any existing form of arc generator. The fact that the same type of apparatus is available for both transmitting and receiving should also lead to a considerable simplification of the construction of the plant necessary at wireless telephone stations equipped on those lines, and corresponding economies in their operation and maintenance.

[*Photo: Frank C. Perkins.*

MR. THEODORE N. VAIL SPEAKING BY WIRELESS TELEPHONE FROM NEW YORK TO MARE ISLAND, CALIFORNIA, 2,500 MILES AWAY.

Among the Operators

S.S. *ACHILLES.*

OPERATOR G. J. NICHOLLS

Mr. George John Nicholls, operator of the above steamer, comes from Croydon, and is 22 years of age. He received his education at Penge, and afterwards underwent a course of training in wireless telegraphy at the British School of Telegraphy, Clapham Road. After completing his studies at Marconi House he received his first appointment—to the s.s. *Dominion* in June, 1913, afterwards serving for a considerable period upon the s.s. *Huntsman.* Prior to joining the s.s. *Achilles* he had sailed on the s.s. *Knight of the Thistle.*

We understand that Mr. Nicholls has sustained severe injury to his arm, probably from the explosion of a shell fired by the German submarine which sank the *Achilles.* We are sure all of our readers will join with us in wishing him a speedy recovery.

* * * * * *

S.S. *GOLDMOUTH.*

Another victim of German piracy is the s.s. *Goldmouth*, recently torpedoed by an enemy submarine. The operator of this vessel, Mr. R. C. Older, hails from Kingston-on-Thames, and is one of the younger members of the Marconi staff. Educated at St. Mary's College, Harlow, Essex, he decided to take up wireless telegraphy as a profession, and went through a course of training at the British School of Telegraphy, London. From this school he entered the Marconi Company's service in May, 1915, proceeding to sea upon the s.s. *Gaika*, from which he was transferred to the *Goldmouth* in July of that year. We are sorry to hear that Mr. Older received serious injury to his foot as a result of the explosion of a shrapnel shell near by, and at present he is receiving treatment in hospital. We trust that he will make a rapid recovery.

OPERATOR R. C. OLDER

* * * * * *

S.S. *DUENDES.*

Mr. Harry Kidston Sang, who recently went through such thrilling experiences on board the above steamer (see page 210), was born north of the Tweed at Row, in the county of Dumbarton. Although only 22 years old, Mr. Sang has already served three years as a wireless operator on the sea, having entered the London School of the Marconi Company in May, 1913. His first appointment was to the s.s. *Minnewaska,* whence he transferred to the *Sicilia,* and thence to the s.s. *Aaro, Athenia* (on which he made many voyages), the *Cameronia, Pretorian,* and in October, 1915, to the *Duendes.* Prior to joining the Marconi School Mr. Sang received a preliminary course of wireless training at the Glasgow Wireless School. We are glad to say that he escaped from the gunfire uninjured.

OPERATOR H. K. SANG

* * * * *

S.S. *PARISIANA.*

Mr. Samuel Deeming, of Tamworth, the operator of the above vessel, which was recently torpedoed by a German submarine, entered the wireless service in June, 1912, and after completing his training served for two years on the vessels of Messrs. Nicolas Mihanovitch, Ltd., trading on the South American coast. Upon returning to this country he took up an appointment on the s.s. *Glenroy,* a steamer which was wrecked off Singapore within a month of his joining. He then sailed upon the s.s. *Englishman, Anglo-California, Vandalia,* and was appointed to the s.s. *Parisiana* in April. He was, however, destined to be wrecked a second time, for on the fourth day of her voyage the vessel was torpedoed and sunk by the enemy. Mr. Deeming, who is 22 years old, fortunately escaped without injury.

OPERATOR S. DEEMING

* * * * *

S.S. *SHENANDOAH.*

Many of our readers will have seen in the daily Press a report of the sinking of the s.s. *Shenandoah,* which it will be remembered struck a mine and sank. Mr. Ernest Marshall, a native of Manchester, was in charge of the wireless, and we are sorry to say did not escape unscathed. At the time of writing we are not aware of the extent of Mr. Marshall's injuries, but we trust that he will make a rapid recovery. The *Shenandoah* was Mr. Marshall's third appointment, as he is a comparatively new member of the Marconi Company's operating staff. He is 25 years of age, and received his preliminary training at

OPERATOR E. MARSHALL

the Universal School of Telegraphy and the City School of Wireless, Manchester.

* * * * *

S.S. *SIMLA*.

The P. & O. Company have had the misfortune to lose several ships in the present war; the s.s. *Simla* being the most recent to go down. Two operators were carried: Messrs. Frederick Wm. Harvey and H. Varley. Mr. Harvey, the senior operator, is a Barnstaple man, and is 28 years of age. On joining the Marconi Company in July, 1912, he proceeded to South America and served for two years on steamers trading on that coast. On his return to England he was appointed to the s.s. *Mellore*, and transferred a few months later to the s.s. *Harmatris*. He was appointed to the *Simla* in July, 1915. Mr. Varley, the assistant operator, only recently joined the Marconi Company, the *Simla* being his first ship. Before taking to wireless he had some experience in the Post Office as a telegraphist, and this was, of course, of great use to him in studying for his new profession. Mr. Varley's home is in Leeds, and he is 20 years of age. Together with Mr. Harvey he fortunately escaped uninjured.

OPERATOR H. VARLEY

OPERATOR F. W. HARVEY

S.S. *YONNE*.

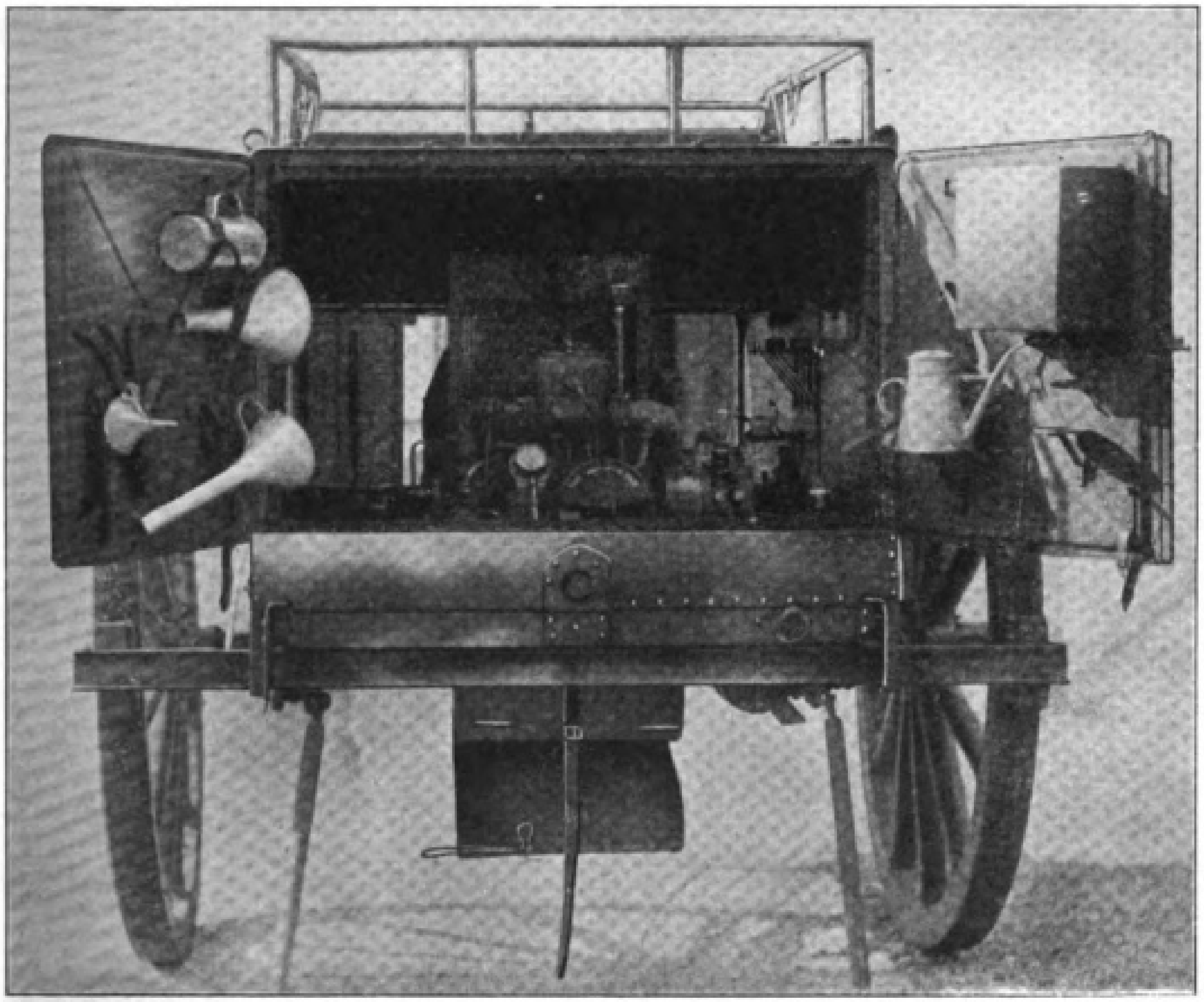
The s.s. *Yonne*, sunk by a German submarine, carried one operator, Mr. Martin Rohan, of Aughacasla, Co. Kerry. Mr. Rohan commenced his wireless studies at the Atlantic College of Wireless Telegraphy, Cahirciveen, and later came to London to join the Marconi School in the Strand, where he completed his studies. After sailing for one voyage as operator on the s.s. *Saturnia* he was transferred to the s.s. *Kastalia*, which was afterwards renamed the *Yonne*. Mr. Rohan is 23 years old, and is none the worse for his exciting adventure.

OPERATOR M. ROHAN

Some Spoils of War

German Portable Wireless Apparatus Captured by General Botha

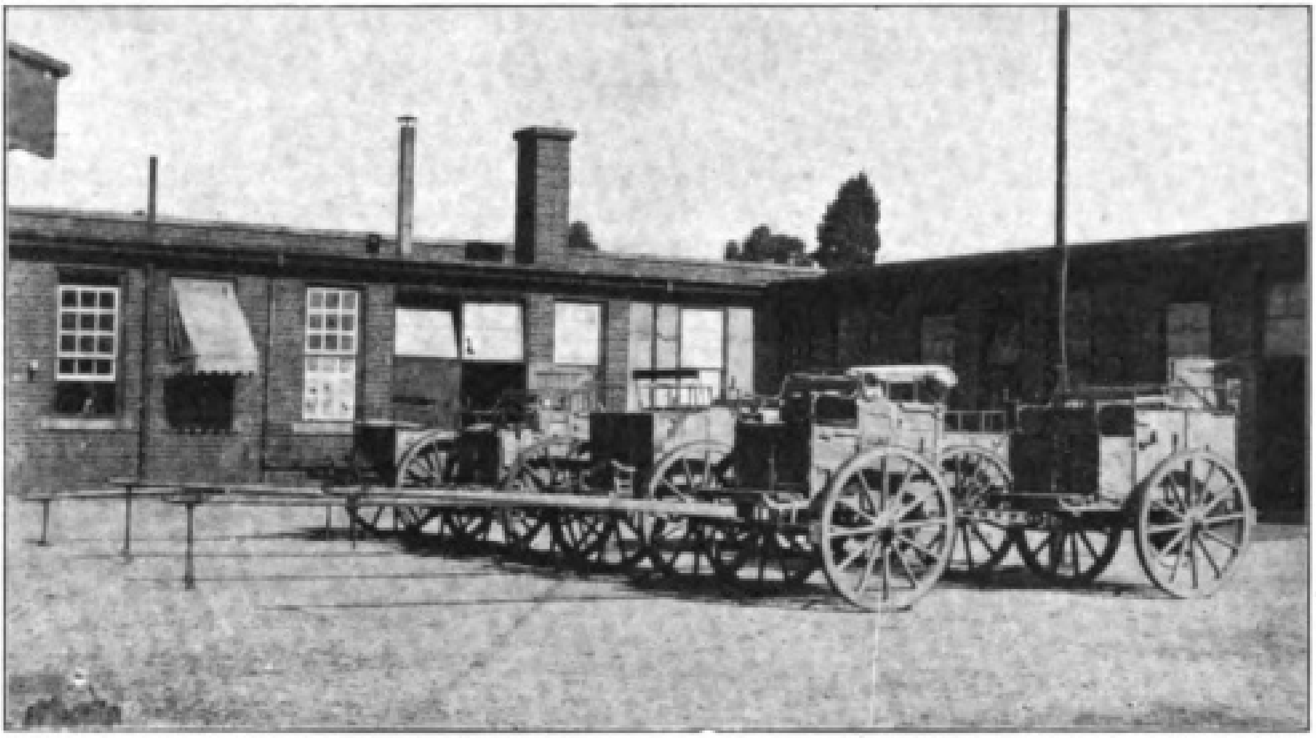
We are sure our readers will be interested to see the accompanying photographs of the Telefunken Portable Wireless Apparatus captured by General Botha from the German forces in the recent campaign. There is ample evidence to show that the enemy forces were well equipped with portable apparatus and made good use of it.



[*Photo: M. Edward, Johannesburg.*

FIG. I. THE PETROL ENGINE AND GENERATOR.

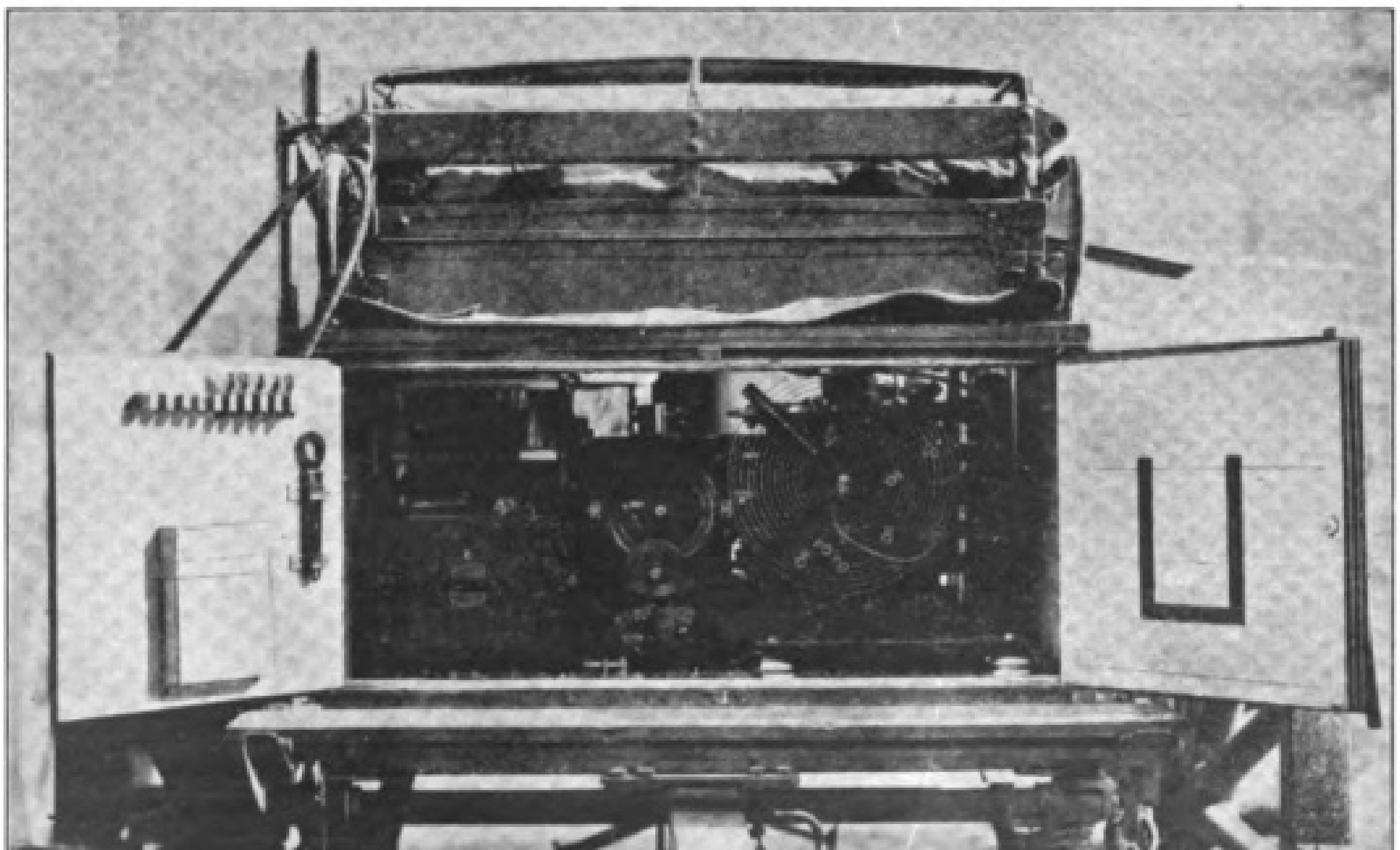
The photographs in this article are of two such stations, which at the time of the surrender were erected respectively at Karab and Zesfontein, a distance of 250 miles separating the two places. The apparatus for each set is carried on four carts, which couple together in pairs. Figure 1 shows the generating plant. The water-cooled petrol motor has a bore of 95 mm. with a stroke of 110 mm., and runs normally at a speed of 1,500 revolutions per minute. Coupled to the engine is a 500 frequency alternator giving 35 amps. at 85 volts, and a dynamo giving 8 amps. at 50 volts; this latter serves as the exciting dynamo for the alternator.



[Photo: M. Edward, Johannesburg.

FIG. 2. THE TWO PORTABLE SETS AT JOHANNESBURG.

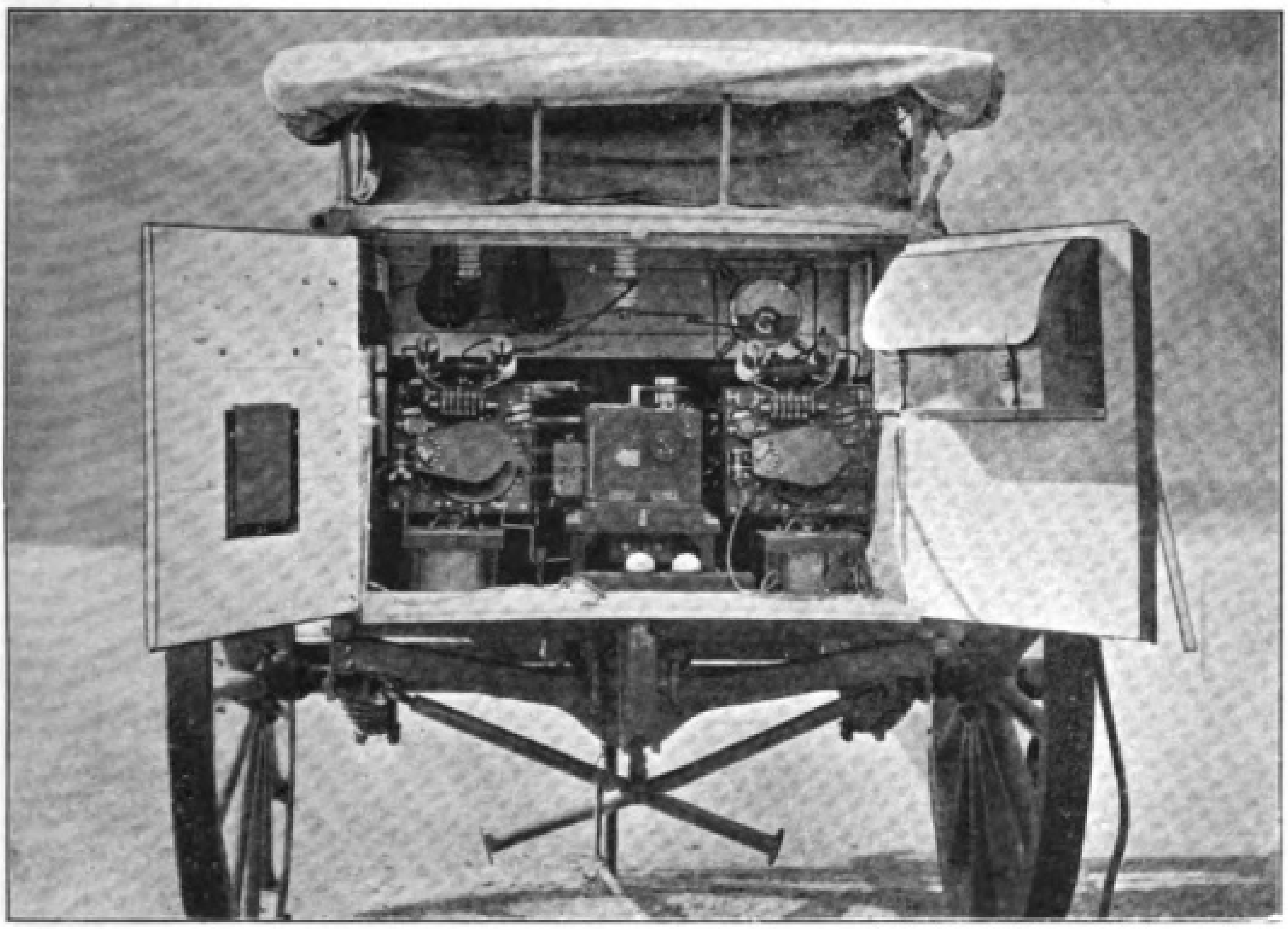
In figure 3 we see a transmitting apparatus. On the left is placed a transformer surmounted by a quenched spark gap, and on the right the flat spiral inductance of the auto-jigger. Plug clips have been attached to this spiral inductance in several places, to facilitate rapid changes in wave-lengths. The switch handle and studs to be seen



[Photo: M. Edward, Johannesburg.

FIG. 3. THE TRANSMITTING APPARATUS.

in the centre of the space control the low frequency inductance. The receiving apparatus, which is carried at the other end of the same vehicle as the transmitter, is clearly shown in Fig. 4. Two compete receivers, one on each side, are provided, the aerial lead-in being in the centre. The change from " send " to " receive " is effected by means of the switch visible at the top of each tuner. Coupling is varied by moving the primary closer to or further from the secondary, the latter being mounted on a hinged flat. With the assistance of the variable air condenser in the front of each tuner, wave-lengths from 100 to 3,000 metres can be tuned in, the small two-way switch



[Photo: M. Edward, Johannesburg.

FIG. 4. THE DUPLICATED RECEIVER.

visible on the top right-hand corner of each set being used to change from short to long wave-lengths and *vice versa*.

Two crystal detectors are provided for each set, these being mounted on the top left-hand corner of the base boards. Just behind the receiver on the left-hand side the handle of the sending key can be seen. The box between the two receiving sets contains the wavemeter, and above the right-hand tuner will be noticed the hot wire ammeter for measuring the current in the aerial. As already mentioned, the aerial lead-in is shown in the centre of the roof of the cart, the smaller insulated terminal to the left being connected to the earth or balancing capacity. The large leather bag hanging on the right-hand door carries the necessary stationery.

Instructional Article

NEW SERIES (No. 10).

The following series, of which the article below forms the tenth part, is designed to provide wireless telegraphists, amateurs, and technical students generally, with clear and precise instruction in technical mathematics, in order that they may be enabled to read and understand the more advanced technical articles which appear from time to time.

Graphical Solution of Equations.

72. In the previous article we dealt with the plotting of curves on squared paper, and we shall now proceed to consider the application of such curves to the solution of equations.

To start as usual with a very simple example, we will take the equation

$$17x-15=0.$$

In place of the o on the right-hand side of the equation put y, so that

$$17x-15=y.$$

The solution of the original equation is obviously obtained if we find the value of x for which $y=0$, as then we should have

$$17x-15=y=0, \text{ or } 17x-15=0.$$

Now tabulate pairs of values of x and y as follows :—

$x=4$	2	0	-2
$y=53$	19	-15	-49

Plotting these values we obtain a straight line, as shown in Fig. 52.

Now the only possible positions for the points $y=0$ lie along the horizontal axis through the origin, and one such point is P where the curve $17x-15=y$ crosses this axis. This point P thus satisfies the *two* equations $17x-15=y$ and $y=0$, and accordingly its x value is the solution of the equation $17x-15=0$.

It will be seen that the solution is approximately $x=0{\cdot}9$. Now if the result is required correct to a higher degree of accuracy we can obtain it by plotting to a larger scale a small portion of the curve on either side of the point P.

In order to do this we need to calculate two values of y (or more than two when the curve is not a straight line) for values of x just smaller and just greater than $0{\cdot}9$.

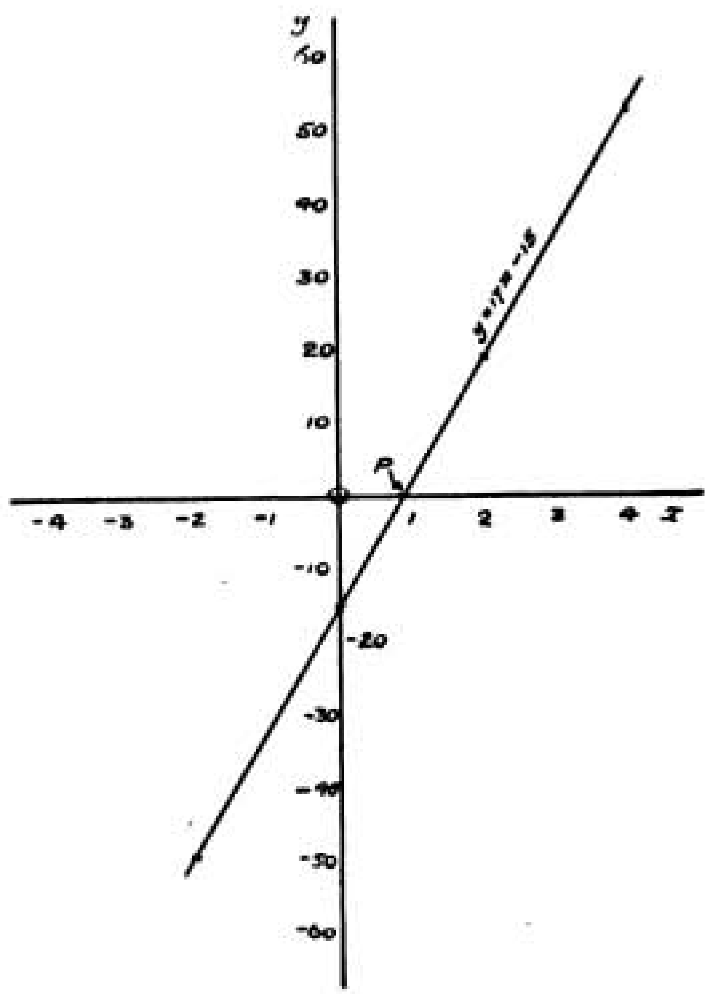


FIG. 52.

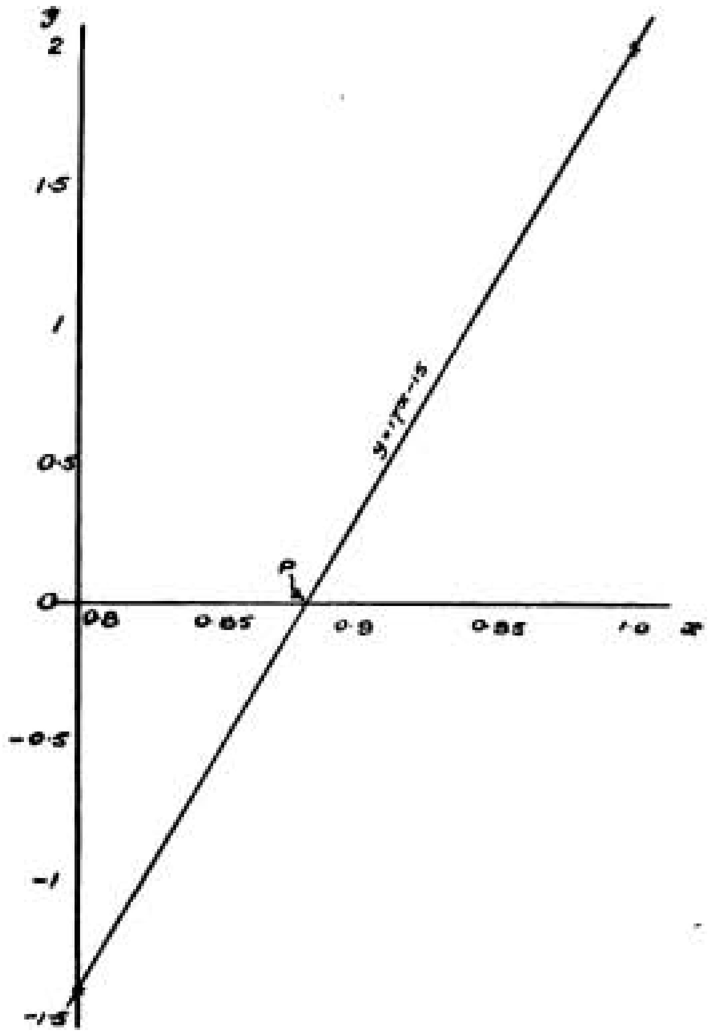


FIG. 53.

For example, if $x=0{\cdot}8$, then $y=-1{\cdot}4$
and if $x=1{\cdot}0$, then $y=+2$.

This portion of the curve is shown plotted in Fig. 53, and it will be easily seen that the accuracy with which we can read off the value of x at the point P is much greater than before. We can read off $x=0{\cdot}882$ (approx.), and if we cared to work out the values of y when $x=0{\cdot}881$ and $x=0{\cdot}883$ and plot them, we should obviously obtain a still more accurate result.

73. To take another case, let us solve the equation

$$5x^2-9x=7.$$

This equation being a quadratic, we shall expect to obtain *two* values of x as solutions.

We can either put $5x^2-9x=y$ and from the curve find the values of x for which $y=7$, or we can put $5x^2-9x-7=0$ $=y$ and find the value of x for which $y=0$.

The latter being the more usual method, we will use it in the present case.

Tabulating values—

$x=$	0	1	2	3	-1	$2\frac{1}{2}$	$-\frac{1}{2}$
$y=$	-7	-11	-5	$+11$	$+7$	$+1\frac{3}{4}$	$-1\frac{1}{4}$

It will be noticed that values of y have been worked out on either side of $x=0$, that is for positive and negative values of x; also that when it was evident that solutions would be obtained

(1) between $x=2$ and $x=3$

and (2) between $x=0$ and $x=-1$, the extra values of y for $x=2\frac{1}{2}$ and $x=-\frac{1}{2}$ were worked out. These two latter values will give us points on the curve close to the points we have to find.

On plotting the curve we obtain Fig. 54. In this case the curve is not a straight line on account of the equation being of the *second* degree; that is, con-

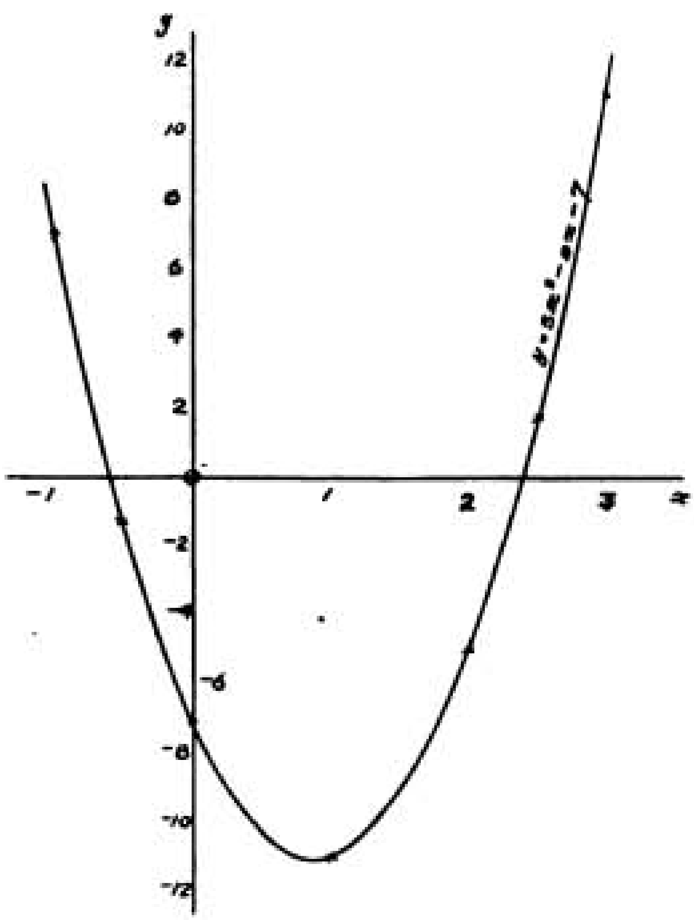


FIG. 54.

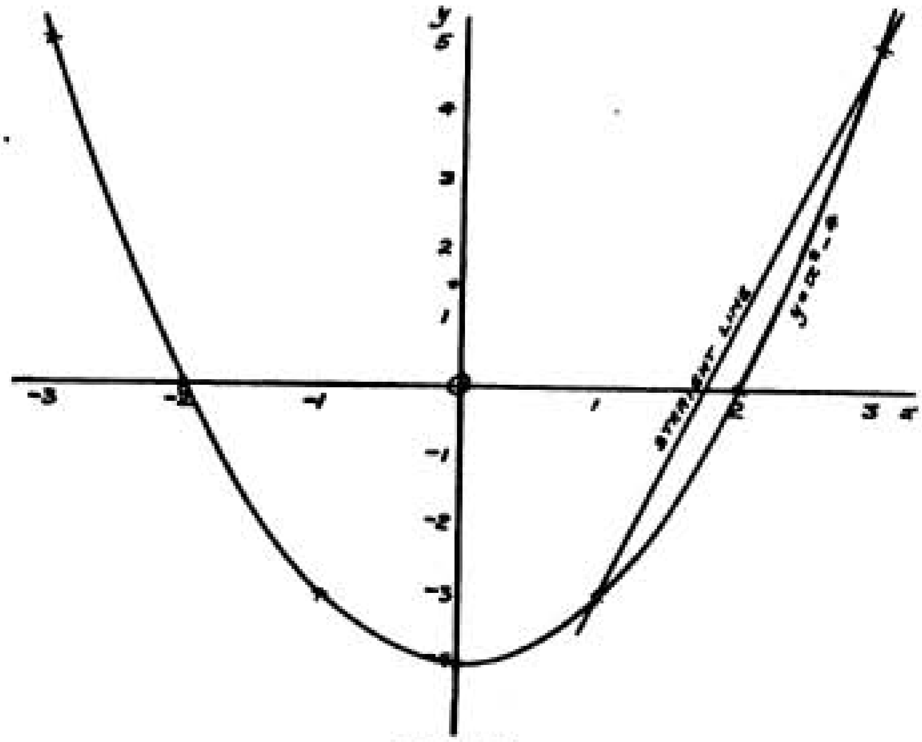


FIG. 55.

taining a term ($5x^2$) which involves the *second* power of x.

It will be seen from the curve that the two solutions of the quadratic are approximately

$x=2.4$ and $x=-0.6$.

We can, as before, plot the portions of the curve near these values to a larger scale if we wish to obtain more accurate results. It must be remembered, however, that as we are now dealing with a *curved* curve, more than two points must be plotted in each case, and a fair curve drawn through all these points. We might, for example, work out the values of y for $x=2.3$, 2.4 and 2.5 in order to obtain one of the values.

74. To make this last point somewhat clearer, let us consider the very simple quadratic

$$x^2-4=0,$$

the correct solution of which is obviously $x=\pm 2$.

Put $x^2-4=y$, and tabulate values—

$x=3$	1	0	-1	-3
$y=5$	-3	-4	-3	5

Plotting these values (Fig. 55) the curve, as we should expect, crosses the x-axis at $x=2$ and $x=-2$, that is, at (2, 0) and (-2, 0). If, however, we simply plot the two pairs of values

$$x=1, y=-3$$
$$\text{and } x=3, y=5$$

and join them with a straight line, we find that this line will cut the x-axis at the point $x=1\frac{3}{4}$ (approx.), thus introducing an error of $\frac{1}{4}$ or $12\frac{1}{2}$ per cent.

As against this, however, we should find that if we calculated y for $x=1{\cdot}99$, $x=2{\cdot}00$ and $x=2{\cdot}01$, values which are

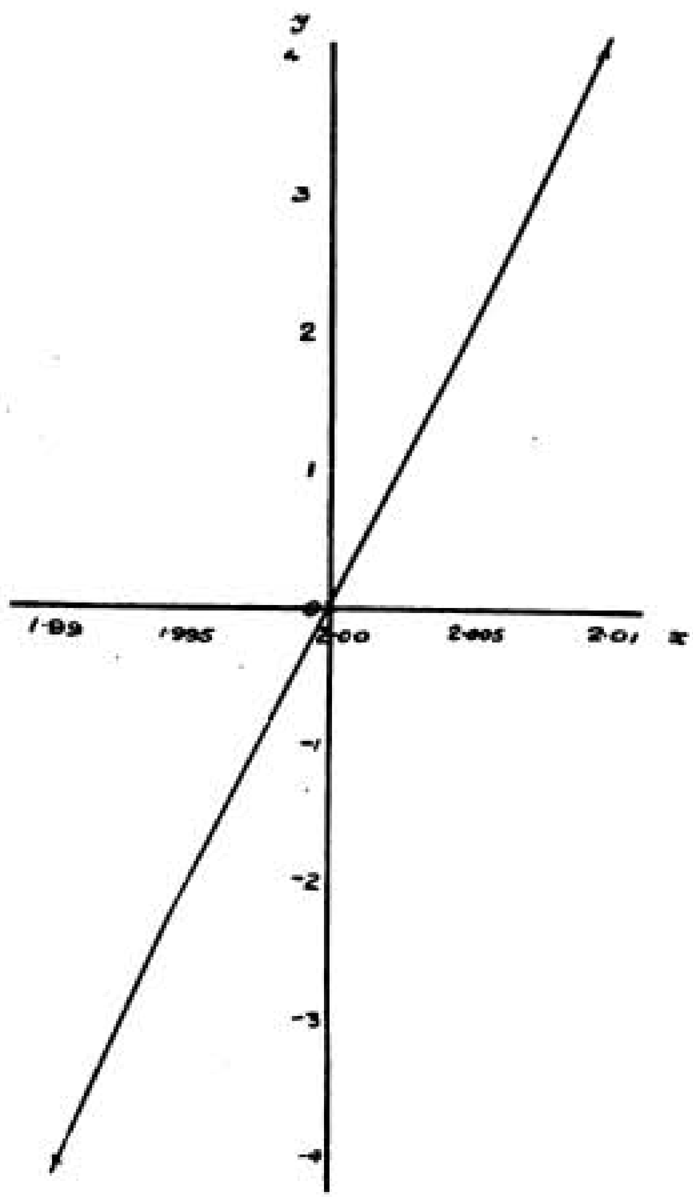


FIG. 56.

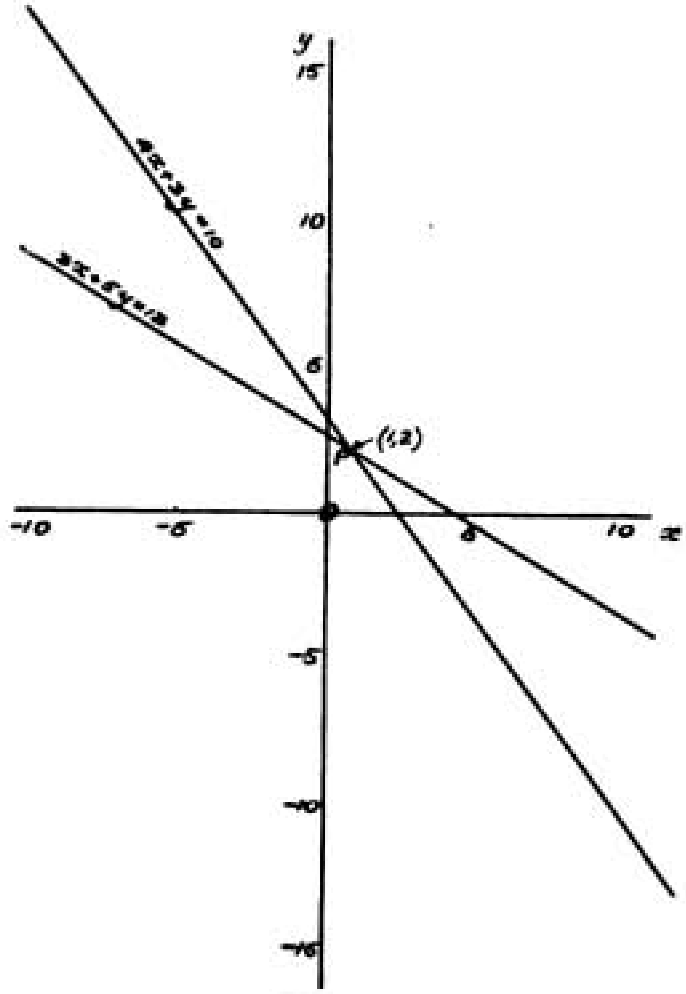


FIG. 57.

very near together, then these three values would lie so nearly on a straight line that it might be sufficiently accurate to draw a straight line through them.

Thus—

$x = 1{\cdot}99$	2	$2{\cdot}01$
$y = -0{\cdot}0399$	0	$0{\cdot}0401$

Plotting these values (Fig. 56) we see that the three points lie as nearly as possible on a straight line.

If, however, we had been dealing with points near the *peak* of the curve instead of on the straight part, then we should have found a greater disagreement between the curve and the straight line.

75. The next question to consider is the graphical solution of *Simultaneous Equations.*

Let us take—

$$(1)\quad 4x+3y=10$$
$$(2)\quad 3x+5y=13.$$

These equations, being of the first degree, will give straight line curves, and so we need only work out two pairs of values for each.

Rearranging them somewhat we get—

$$(1)\quad 3y=10-4x$$
$$\text{or } y=\frac{10-4x}{3}$$
$$(2)\quad 5y=13-3x$$
$$\text{or } y=\frac{13-3x}{5}$$

Tabulating—

$(1)\ y=\dfrac{10-4x}{3}$ $\qquad x=+10,\ y=-10$; $\quad x=-10,\ y=16\tfrac{2}{3}$

$(2)\ y=\dfrac{13-3x}{5}$ $\qquad x=+10,\ y=-3\tfrac{2}{5}$; $\quad x=-10,\ y=8\tfrac{3}{5}$

Plotting these two lines (Fig. 57) we see that they cross at the point (1,2).

Now every point on one curve satisfies the equation $4x+3y=10$, and every point on the other curve satisfies the equation $3x+5y=13$. Therefore *the point where the two curves cross will satisfy both equations*, or in other words will give us the solution of the simultaneous equations. Now at this point (1, 2) we have

$$x=1,\ y=2,$$

and so these values are the solution we require.

76. As a rather different example let us take the two equations

$$(1)\ xy=25 \quad \text{or } y=\frac{25}{x}$$

$$(2)\ 2x-y=4 \text{ or } y=2x-4$$

Tabulating—

(1) $y=\frac{25}{x}$

$x=10$	5	$2\frac{1}{2}$	0	$-2\frac{1}{2}$	-5	-10
$y=2\frac{1}{2}$	5	10	∞	-10	-5	$-2\frac{1}{2}$

(2) $y=2x-4$

$x=7$	-3
$y=10$	-10

Fig. 58 shows these two curves plotted out. One thing to notice is that the curve $xy=25$ occurs in two parts. These two parts, apparently separate, are really one curve, being joined together at infinity.

The two curves cut at the points (4·7, 5·4) and (−2·6, −9·4), and so the required solutions are—

$$x=4{\cdot}7,\ y=5{\cdot}4$$
$$x=-2{\cdot}6,\ y=-9{\cdot}4$$

Determination of Laws of Curves.

77. It often happens, after carrying out some experiment, that we have a set of readings of two quantities, the law connecting which has to be found. We will proceed to examine the case in which the curve plotted from the readings is a straight line.

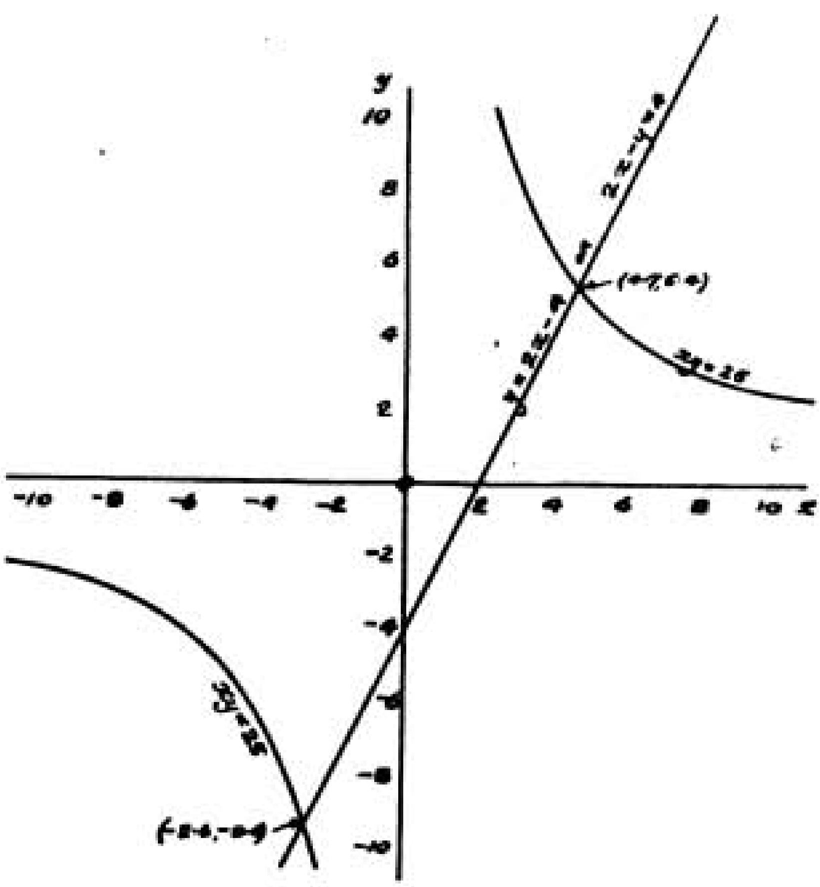


FIG. 58.

In Fig. 59 we have a curve AB passing through the origin, and lying in the first and third quadrants. If we take a point P on this curve we find that here

$x=2$ and $y=3$. Thus $y=\frac{3}{2}x$.

Taking a second point Q we find that here

$x=4$ and $y=6$. Thus, again,

$$y=\frac{6}{4}x=\frac{3}{2}x.$$

Taking the point R on that portion of the curve which lies in the third quadrant, we find here that $x=-3$ and $y=-4\frac{1}{2}$.

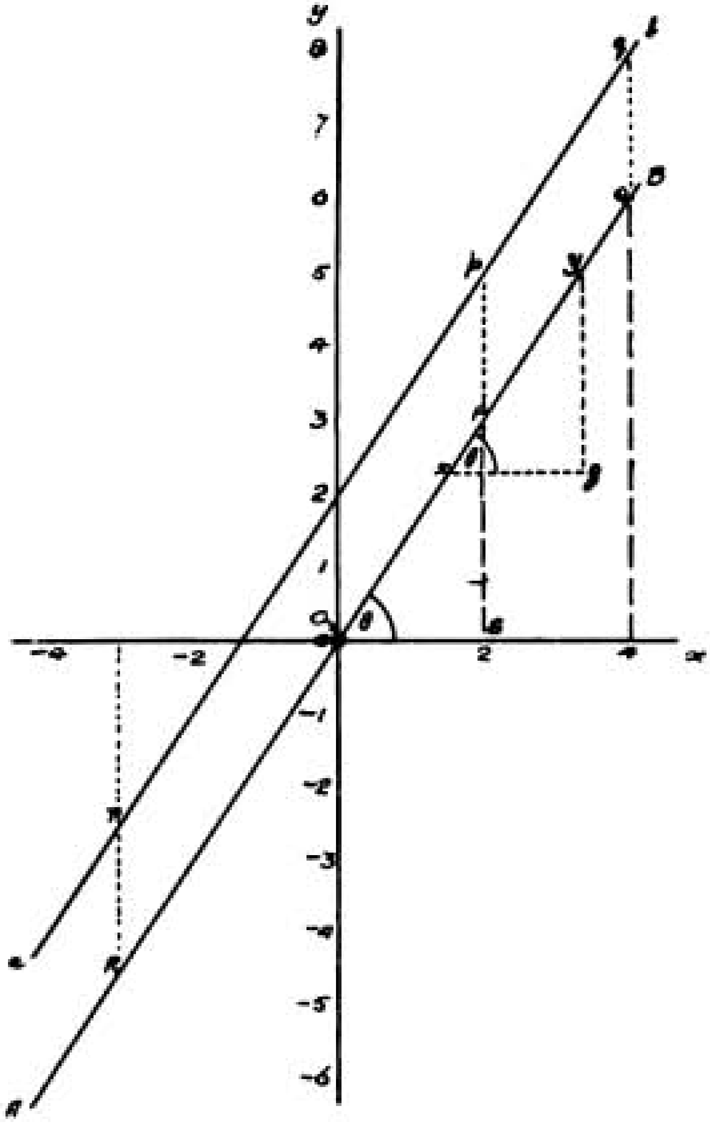


FIG. 59.

Thus $y=\dfrac{-4\frac{1}{2}}{-3}x=\dfrac{3}{2}x$ as before.

The law of this curve is obviously $y=\dfrac{3}{2}x$, or $2y=3x$, or $3x-2y=0$, and it has been found by the simple process of taking a point on the curve and reading off the values of x and y at that point.

Let us, however, consider the parallel curve ab which *does not pass through the origin*.

At the point p, $x=2$ and $y=6$.
Thus $y=3x$
At the point q, $x=4$ and $y=9$.
Thus $y=\dfrac{9}{4}x=2\frac{1}{4}x$.
At the point r, $x=-3$ and $y=-2\frac{1}{2}$.
Thus $y=\dfrac{-2\frac{1}{2}}{-3}x=\dfrac{5}{6}x$.

In this case, as all these three equations are different, we have not succeeded in finding any law for the curve.

Returning for a moment to our first curve AB, it is quite obvious that the ratio of y to x, or $\dfrac{y}{x}$ will be given by the ratio $\dfrac{PS}{SO}$ of the two sides of any such triangle as the triangle OPS. Now we know that $\dfrac{PS}{SO}$ is the tangent of the angle POS, or *the tangent of* the inclination θ of the curve to the horizontal axis. We need not take the x-axis as one side of the angle, but we can draw any such triangle as the triangle xyz, where xz is parallel to the x-axis and zy parallel to the y-axis. The ratio $\dfrac{yz}{zx}=\tan\theta$.

On comparing the two curves AB and ab we see that at the points P and p, say, the value of x is the same, but the value of y at p is equal to its value at P *plus* 2. This applies all along the curves, and so we can say that the values of y for the curve ab equal the corresponding values for the curve AB plus 2. But for the curve AB we have the law $y=\dfrac{3}{2}x$, and so the law of the curve ab is $y=\dfrac{3}{2}x+2$

or $y=x\tan\theta+2$.

To proceed a step further, we see that the last term 2 is the value of the intercept along the vertical y-axis from the origin to where the curve cuts this axis, and we infer from this fact that the law of the curve is

$$y=mx+c$$
where $m=\tan\theta$
and $c=$ intercept on y-axis.

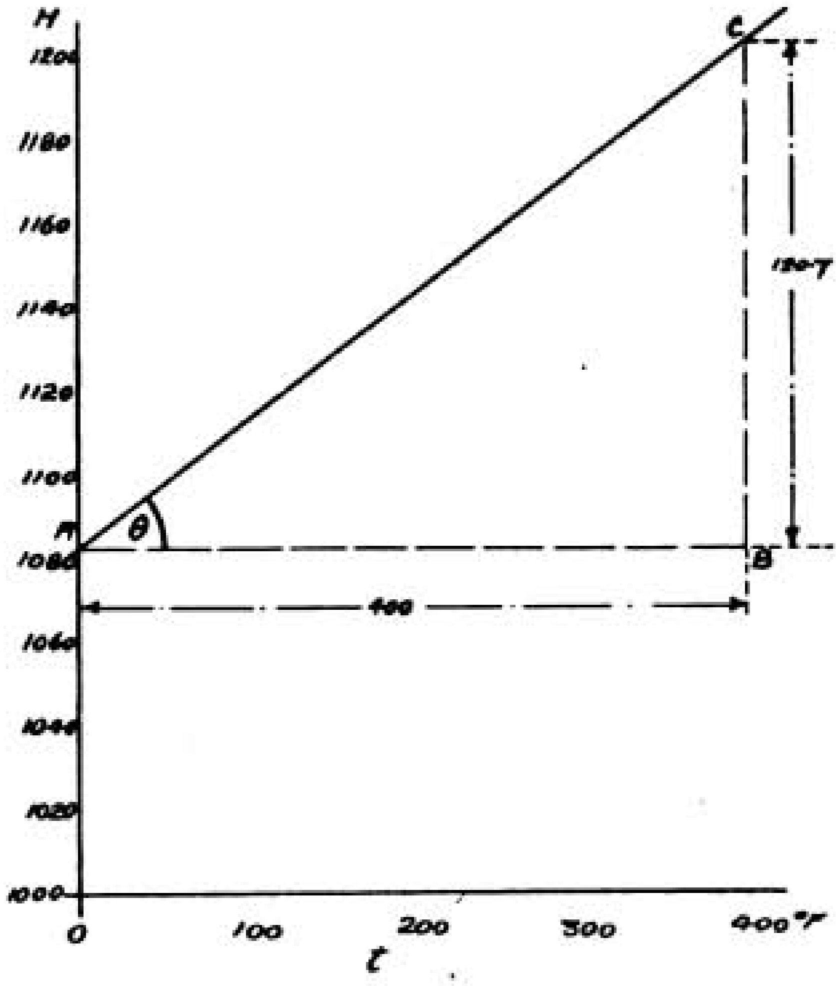


FIG. 60.

This form of the equation is a perfectly general one covering all cases of straight line curves.

The curve CD (Fig. 59) has the law

$$y = -\frac{1}{2}x - 1.$$

Example :—

The following values of the Total Heat (H) of 1 lb. of steam at various temperatures (t) are abstracted from steam tables. Find the law connecting H and t.

$t = 202°$ F., 250·3, 302·8, 350·0, 401·1

$H = 1143·6$ units, 1158·3, 1174·3, 1188·7, 1204·0

On plotting these we get the curve of Fig. 60. The first thing to notice is that $c = 1082·5$.

To obtain m we will take the triangle ABC, purposely making it as large as possible in order to obtain m with greater accuracy. The base AB should be made a convenient value (in this case 400) for dividing out.

To obtain the length of BC we subtract the vertical value or ordinate of B from that of C. This gives us $BC = 1203·2 - 1082·5 = 120·7$.

Thus $m = \tan\ \theta = \frac{121·5}{400} = 0·302$ (nearly).

From this we get the law as

$$H = 0·302t + 1082·5$$

[The correct result is $H = 1082 + 0·305t$.]

The biggest probability of error in this particular case lies in producing the curve such a long way back in order to obtain the intercept value c, in other words it lies in the exterpolation operation.

We could have avoided this exterpolation in the following way. Fig. 61 is the same curve plotted to a larger scale, and from it we get the following two pairs of values—

$t = 200°F$ $H = 1142·8$

$t = 400$ $H = 1203·2$

Thus in the 200°F from 400° to

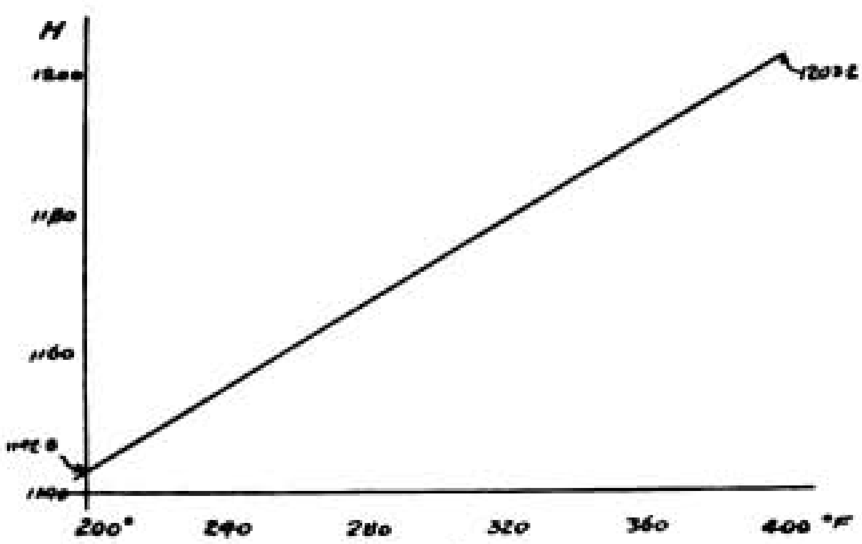


FIG. 61.

200°, H has been reduced by (1203·2 − 1142·8) or by 60·4 units. Therefore, since the curve is a straight line, in the next 200° down to where $t=0°F$, H will be reduced by a further 60·4 units, and will then be equal to 1142·8 − 60·4 = 1082·4 units. We have thus *calculated* the value of C instead of drawing the curve right away back and reading it off.

Recreations of a Wireless Operator

Lines inspired by the article on "The Banjo" which appeared in our April number.

Oh when upon the waters' crest
The heart cries out for music blest,
I seek—and find—sweet mental rest
Playing on me old banjo!
When the incessant buzzings cease,
Or blessed X's bring me peace,
The joys of life so swift increase,
Playing on me old banjo.

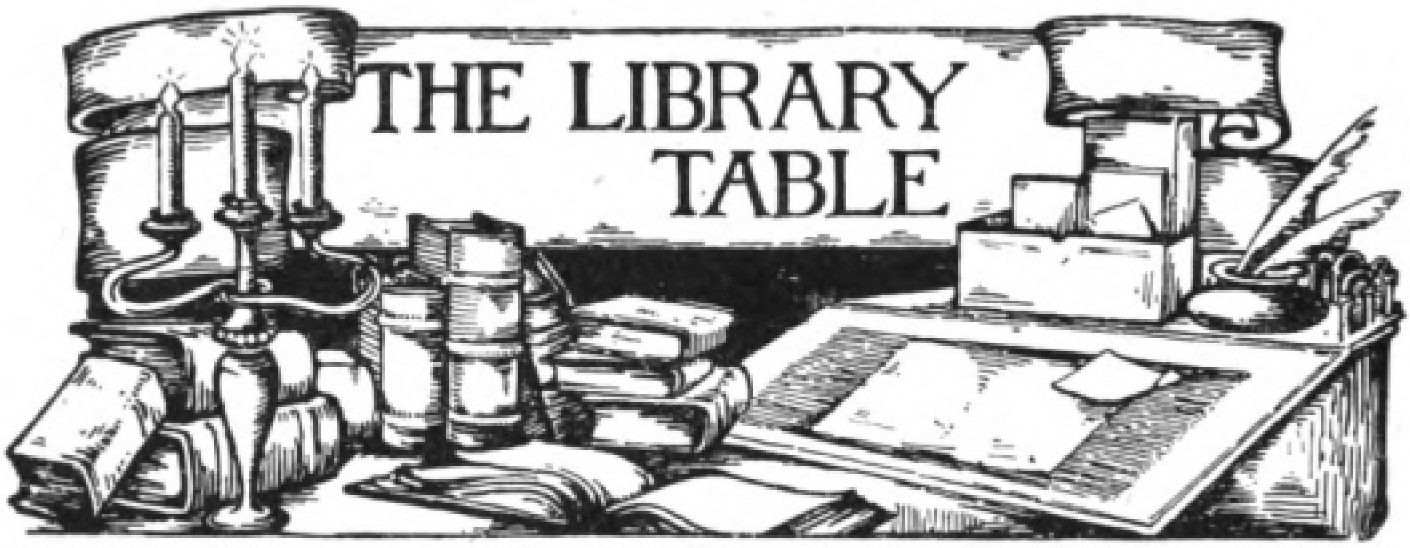
Ah, let the foolish cynics sneer,
No carping critics do I fear;
The sacred sounds I still hold dear,
Playing on me old banjo.
My thoughts are lost in wondrous sound,
I care for nothing that's around,
For calm forgetfulness I've found,
Playing on me old banjo.

No longer skins disturb my mind.
Mistakes and faults let others find,
For I am always wondrous kind
When playing on me old banjo.
Yet still the guilty sinners quake;
For, tho' my dreams long moments take,
On each occasion I awake
From playing on me old banjo.

PAN.

Readers, Please Note

Owing to pressure on our space it has been found necessary to hold over from the present issue our monthly article devoted to "Pastimes for Operators," as well as our account of the part played by radio-telegraphy in the recent trouble in Ireland.



"The Spy Hunter." By William Le Queux. London, 1916: C. Arthur Pearson, Ltd. 1s. net.

A more thrilling narrative of the chasing and cornering of German spies in England during the present war it would be hard to imagine. The stories form records of the adventures of Harry Nettlefield, an ex-wireless operator, and his *fiancée* Clotilde. Although, naturally, Mr. Le Queux has had to hide his personalities under fictitious names, the accounts are based largely on fact. They form eloquent testimony to the apathy of the British authorities in the earlier days of the war.

The whole country at that time was under the thumb of probably the cleverest spy organisation in the world, whose doings were controlled by the Master Spy, Steinhauer, in Berlin. In many instances the spies were found to be living the country life of ordinary English men and women, although it is a remarkable coincidence that these people almost invariably lived in houses standing alone in the middle of large grounds, and generally a fair distance from any main road.

Purely from the point of view of personal interest the book appeals to us, with one exception. We think that the prowess of Clotilde is very much overdone. It is somewhat wearisome to read in almost every chapter of her "exceeding great bravery." However, we do not wish this little piece of adverse criticism to assume undue proportion in the eyes of our readers. The book should afford much pleasure to those who peruse it.

* * * * * *

"Directions for Designing, Making, and Operating High-Pressure Transformers." By Professor F. E. Austin. Hanover, N.H.: Professor F. E. Austin. 3s. net.

This is an interesting and clearly written little book, particularly valuable to the serious student of wireless and to the operator who is anxious to understand thoroughly the principles and construction of the component parts of his installation.

The author introduces the subject by referring to the commercial demand and necessity for electric power at high pressure, and the reasons why alternating current is the most useful for this purpose. A simple but very practical explanation of the construction of the transformer then follows, after which we find an explanation of symbols and annotation, the various losses in a transformer, power factor, and other matters. The author next treats of the design of a-20,000 volt transformer, entering very carefully into practical details of calculation. Following this, we have a chapter entitled "Directions and Data for Constructing a 3-KW. 20,000-volt Transformer," the approximate cost of materials not being overlooked. A further chapter deals with data applying to a 4,000-volt transformer.

We do not remember having previously seen any small book dealing so thoroughly and practically with the construction of high-pressure transformers, nor one in which the diagrams and photographic illustrations were so happily chosen. The impression we have gained after reading the book is that the author knows exactly what he is talking about and how to express himself. The transformers described may not be of the very highest efficiency, but a study of their construction cannot fail to be of the greatest value to both wireless amateur and professional operator.

* * * * * *

"WIRELESS TELEGRAPHY AND TELEPHONY: A HANDBOOK OF FORMULÆ, DATA, AND INFORMATION." By W. H. Eccles, D.Sc., A.R.C.S., M.I.E.E. London: "The Electrician" Printing and Publishing Co., Ltd. 12s. 6d. net.

A handbook on wireless telegraphy from the pen of an expert of such standing as Dr. Eccles will be welcomed, we are sure, by a wide circle of readers. In the preface the author informs us that whilst the book is a classified collection of information, data, formulæ, and tables likely to be helpful to designers and investigators in radio-telegraphy, nevertheless, the intention has been not only to set out a bare statement of facts in an easily accessible form, but to give brief accounts of the position of modern thought and speculation; this is without allowing the book to become an expository treatise.

A glance through the volume shows that it is divided into four sections—the first containing tables; the second, formulæ; the third (by far the largest section), general information; and the fourth a glossary.

Prominent among the useful features in the first part of the book is an "abac" for rapidly finding the relations between the wave-length, self-inductance, and the capacity of a circuit. With the aid of a thread stretched across the abac chart, the wave-length of a circuit containing a given capacity and inductance can be ascertained in a moment, thus saving considerable time otherwise occupied in calculation. The inductance of a circuit with a given capacity and wave-length, and the capacity with a given inductance and wave-length can also be found equally rapidly. This "abac," which opens out to a size four times as large as the page of the book, is bound into the volume in such a way that it can be readily detached by tearing through a line of perforation. Other most useful abacs are interspersed throughout the book.

In compiling the two sections devoted to tables and formulæ, the author has consulted the chief standard books of mathematical and physical tables, as well as many original papers, and the mass of information so gathered is of great practical use. The third section is really a series of articles on various subjects, and will, we think, prove by far the most popular division. There are a few points which we would venture to criticise. For instance, on page 222, Fig. 148, showing the circuits used by Round with a single vacuum tube, the battery is missed out in the filament circuit, although the series variable resistance is shown.

Again, on page 242, under the heading "Methods of Mounting the Active Substance," we read the following: "In the case of the carborundum detector, a crystal . . . is grasped between two flat brass springs, so that it is held firmly," whereas at the present time in practically all the commercial forms of carborundum detector the crystal presses against a *steel* plate. On page 314, Fig. 255, the leads from the transformer are shown taken directly to condenser, a method abandoned by the Marconi

Company in favour of connections to the discharger, as in this way there is less risk of breakdown of transformer insulation.

On page 353 we find considerable confusion. Under the heading "United Wireless Telegraph Company's Plant" the following surprising statement occurs: "The United Wireless Telegraph Company was absorbed in 1912 by the American Marconi Company. The plant used by the former firm and its predecessor (The 'National') is of interest, though now out of date in certain details." Then follows a description of a 10-KW. Fessenden transmitter. The error is that the United Wireless Telegraph Company never had any connection whatever with the National Electric Signalling Co. (The "National"), and both ran in competition with one another for many years. The Fessenden apparatus here described is that exploited by the National Electric Signalling Company, and the heading should therefore be "National Electric Signalling Company's Plant." There is no description whatever of the United Wireless apparatus. These points, however, will doubtless be corrected in a subsequent edition.

The section of the book containing the glossary has not, we are afraid, received the careful attention that it merits. A number of definitions are missing; for instance, we find no mention of "Æther," "Converter" (although motor generator finds a space), "Insulator" or "Tuner." The definition of "recorder," although it apparently endeavours to be complete, entirely omits reference to photographic methods which have been used from time to time. The definition of relay, too, might well be modified to cover the well-known wireless relay of S. G. Brown. One other little matter we would draw to the attention of the publishers; on page 387 we find a footnote, "Glossary and Index *follow*," although the index is to be found in the *beginning* of the book.

Although of a size too large to be placed in the category of "Pocket Books," the volume before us is yet of a convenient form, a large amount of matter being compressed into a comparatively small space by the use of small type and thin paper.

Altogether the book merits considerable praise both for the amount of interesting and valuable matter contained therein, and also for the manner in which it has been edited. We do not know of any other book in which so much valuable and interesting information regarding the various so-called "systems" is brought together in such convenient form.

* * * * * *

"EXAMPLES IN MAGNETISM FOR STUDENTS OF PHYSICS AND ENGINEERING." By F. E. Austin, B.S., E.E. Published by the Author at Hanover, N.H. 5s. net.

This is a book similar in style to "Examples in Alternating Currents," by the same author, reviewed in our March issue. The plates are particularly interesting and helpful, as they show the lines of force surrounding magnets by means of actual photographs of iron filings. This is a great improvement on the old method of drawing an imaginary field with a few dotted lines, and should be much appreciated by the student.

The problems and examples seem carefully chosen and well worked out, and should furnish a guide to students who are beginning to study electrical engineering, and enable them to develop the process of correct and logical thinking.

The book is well produced, and will prove valuable to both students and instructor. As in the case of "Examples in Alternating Currents," we would register a mild protest against the use of green ink for the printing, and we think the book would be improved by the title being printed along the back, so that it could be rapidly identified amongst other similar books on the bookshelf.

Patent Record

1595. February 2nd. R. C. Galletti and Galletti's Wireless Telegraph and Telephone Co. Transmitting apparatus for wireless signals.

1597. February 2nd. Emile Girardeau and J. Bethenod. Radio-telegraphy. (Convention date, February 2nd, 1915, France). (*Open to public inspection.*) (Patent No. 100,058.)

1705. February 4th. British Thomson-Houston Co., Ltd. (General Electric Co.) Means for controlling alternating currents.

1825. February 7th. J. Gell. Electric arc generators for high frequency oscillations.

1827. February 7th. Basil Binyon. Apparatus for wireless telegraphy.

1861. February 8th. M. B. Rodriguez. Syntonisation, by frequency, of groups of electro-magnetic waves.

2066. February 11th. E. R. Clarke. Wireless telegraphy.

2065. February 11th. Emile Girardeau and J. Bethenod. Radio-telegraphy. (Convention date, February 11th, 1915, France.) (*Open to public inspection.*) (Patent No. 100,075.)

2329. February 16th. British Thomson-Houston Co., Ltd. (General Electric Co.) Means for producing alternating currents.

2402. February 17th. A. Artom. Signalling by electro-magnetic waves.

2524. February 19th. T. B. Dixon. Transforming motion into electrical waves or impulses. (Convention date, July 19th, 1915, United States.)

2598. February 21st. Ettore Bellini. Device for generating in an aerial for wireless telegraphy and telephony electrical oscillations having a strictly single frequency.

2639. February 22nd. British Thomson-Houston Co., Ltd. (General Electric Co.) Means for amplifying electrical variations.

2861. February 25th. Marconi's Wireless Telegraph Co., Ltd., and Frank P. Swann. Receivers for wireless signals.

2922. February 28th. M. J. Webb. Oscillatory machines.

2976. February 28th. Gogu Constantinescu and Walter Haddon. Variable capacity for wave transmission systems.

3006. February 29th. E. A. Lambert. Ship's telegraphic apparatus.

3036. February 29th. British Thomson-Houston Co., Ltd., and N. Shuttleworth. Polyphase alternating current commutator machines.

From the "Western Mail."

"I wish to heaven it was wireless telegraphy, that I do!" was the heartfelt growl of a workman at Lisvane as he wrestled with the awful tangle of wires and connection, the result of a blizzard.

Personal Notes

The first intimation of honours won received by friends of people serving in His Majesty's Forces is often a notice in the paper of the fact that the men are to be decorated with medals, or other distinction, as a reward for conspicuous bravery or gallantry. We publish a photograph of Warrant Telegraphist John Britten, who was invested at Buckingham Palace, by His Majesty the King, with the Distinguished Service Cross. We offer him our sincere congratulations.

* * *

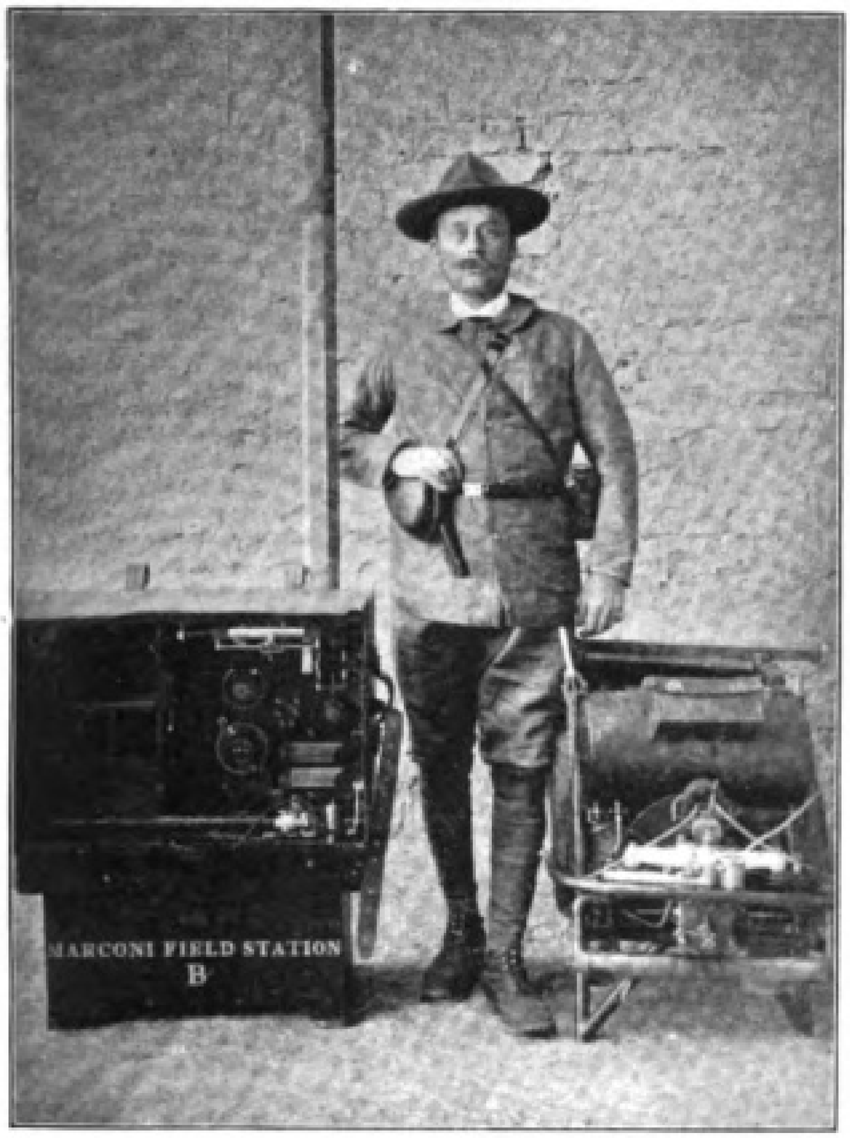
Photo: Central News.

WARRANT TELEGRAPHIST JOHN BRITTEN.

Shortly after the outbreak of war the staff at Marconi House was very considerably depleted; not only were reservists called to the colours, but with that patriotic instinct so characteristic of the Englishman many younger members of the staff joined His Majesty's forces. We have to record that Donald Marshall, a messenger, on the 17th of April last, enlisted in the 15th Lancers as a bugler. He joined the company on January 19th, 1915.

* * *

It is with regret that we have to chronicle the death on active service of Monsieur René Paul Demont, who prior to joining the French Army was an engineer in the service of the Marconi Company. At the time war broke out he was in Bolivia, energetically pursuing the company's interest in the South American Republic. Before leaving that part of the world, to take an active share in his country's fight for freedom, he rendered valuable service to the Allies' cause Immediately upon his return to his native land he was entrusted with the construction of an important wireless station in the south of France, and when that was completed he achieved the object he had had in mind for some time by joining the Aviation Corps of the French Army. By his own wish he was appointed machine gunner, and it was in fulfilment of this work that he met his untimely death. Monsieur Demont worked in several parts



MONSIEUR RENÉ DEMONT.

of the Western Front, but most of his time was spent in the Champagne District.

General Joffre, in Army Orders, eulogised him thus:

"He volunteered to serve his "country for the duration of the "war, although his military obli-"gations had long since lapsed, "and he asked to be appointed a "machine gunner in the Air "Service. On the 8th March, "1916, he met a glorious death "in the enemy lines during the "course of an aerial combat."

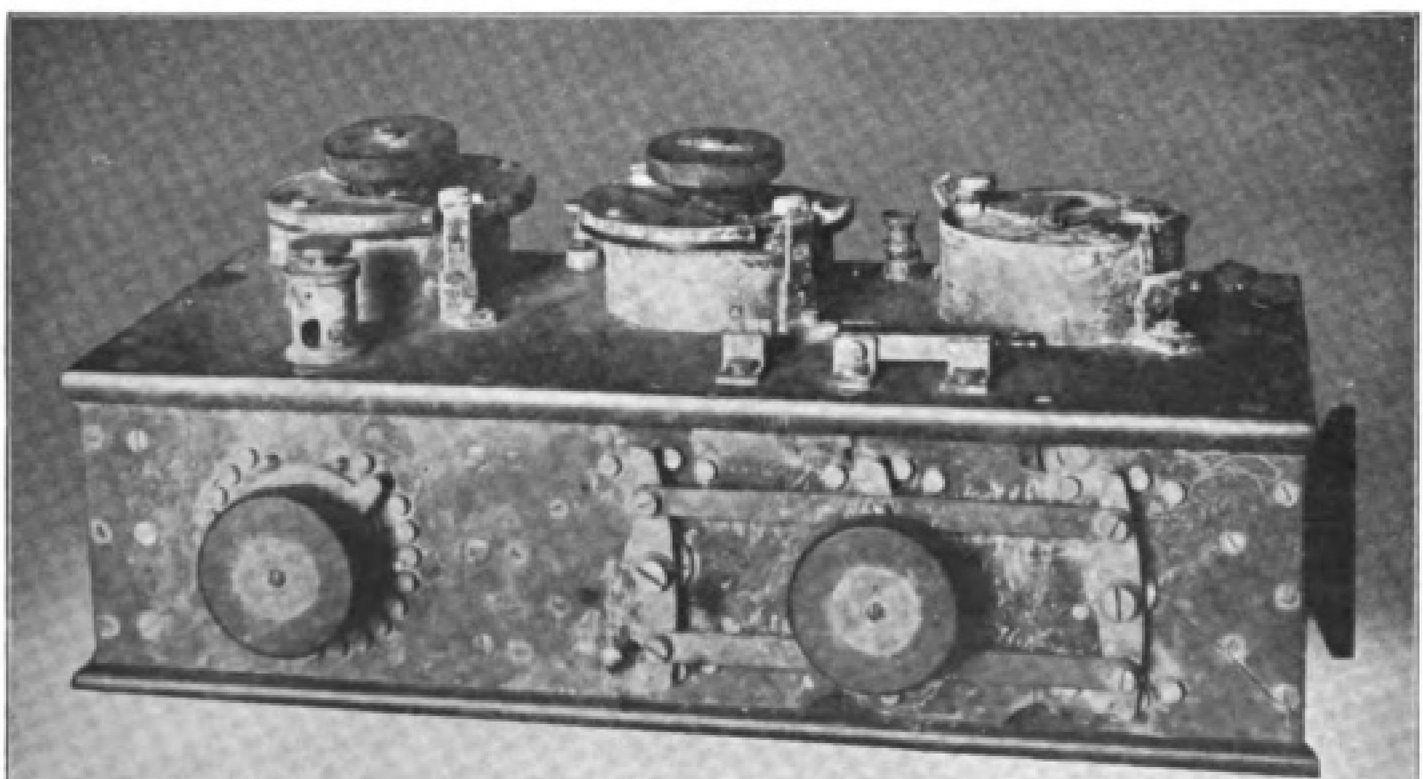
We are fortunate in being able to reproduce two photographs of the deceased gentleman. The former shows him as he appeared while prospecting in Bolivia, and the latter indicates him in the dress of an aviator at the Front. This was taken quite recently.

* * * *

The very magnitude and world-wideness of wireless telegraphy in its present stage has tended to obscure the fact that all the Great Powers owe their first realisation of its importance, and are indebted for their initial guidance in this applied science, to Senatore Marconi and the companies formed to carry out his ideas and his inventions. The biographical notice of Mr. W. W. Bradfield, which we publish with his photograph on page 175 of this issue, would, if space permitted, have demonstrated this fact. But, if we had attempted there to develop and adequately treat the subject, our biographical notice would have swallowed up every page of our present issue. Joining the Wireless Telegraph and Signal Company in 1897, within three months of its inception, Mr.

AVIATOR RENÉ DEMONT.

Bradfield took an active share during the course of 1899 in proving the value of wireless telegraphy not only to the British, but also to the United States Navy, the successful official demonstrations carried out on board H.M.S. *Juno* and the United States battleship *Massachusetts* having been conducted under his supervision. On page 173 we give an account of the first stations installed in Germany on the Borkum Lighthouse and the Borkum Riff Lightship. The first permanent ship installation, that on the *Kaiser Wilhelm der Grosse*, was also erected under his guidance. The French Government yielded to the conviction wrought by Mr. Bradfield's demonstrations in 1901, afterwards putting into his hands the erection of their first stations connecting Antibes, in the French Riviera, with Calvi, in Corsica. As far as Italy is concerned, Senatore Marconi has always taken the radio-telegraphic machinery of his Motherland under his own personal guidance. The Russian company founded in 1908, under the supervision of Senatore Marconi, was incorporated in the same year, and has supplied the Russian Government with a large number of radio-telegraphic stations. Thus it will be seen that all the Great Powers of the world owe not merely the practical application of the science, but also the inception of their own individual organisation thereof, directly to Senatore Marconi and those who have for so long been associated with him. Amongst these the subject of our biographical notice, Mr. W. W. Bradfield, takes high rank.

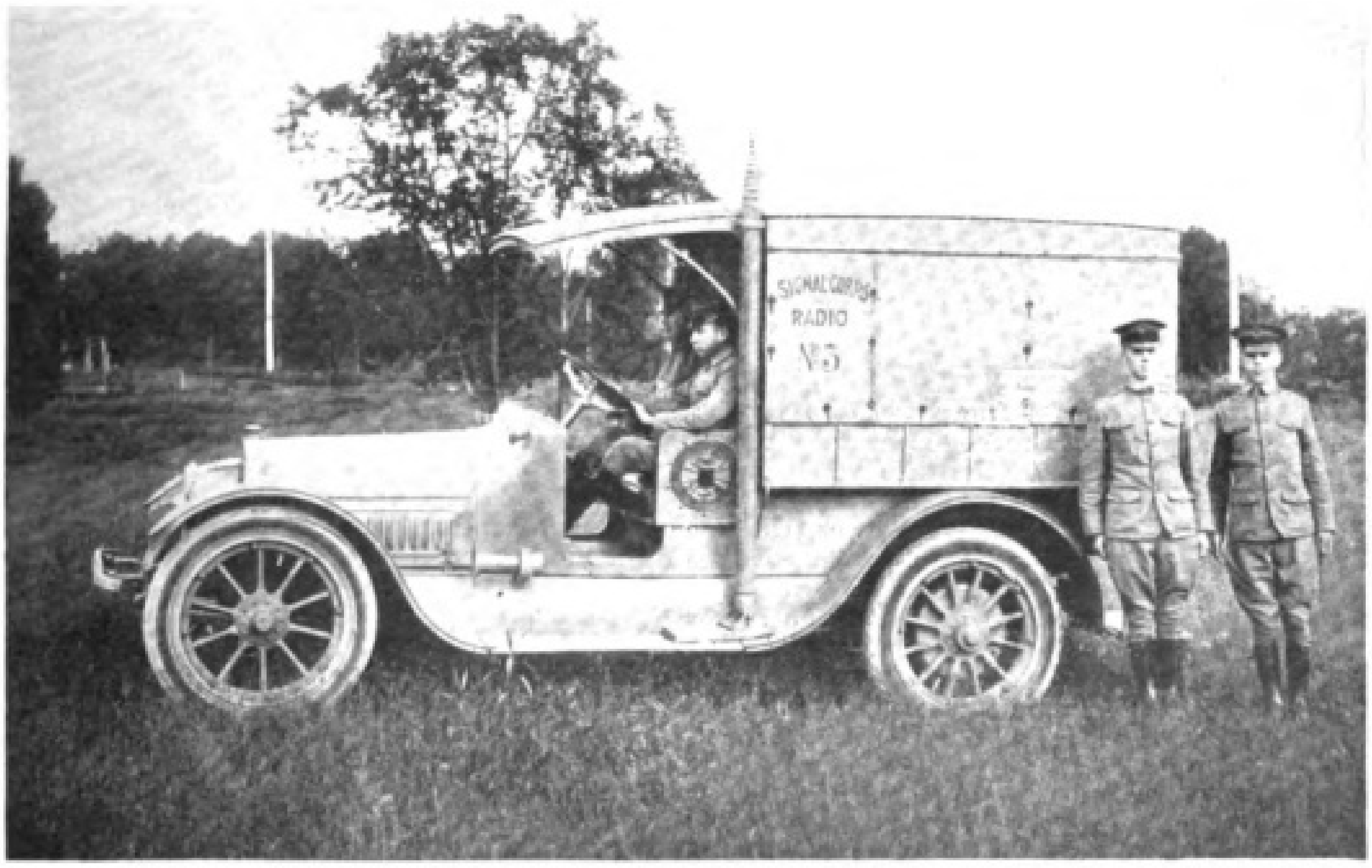


THE ABOVE PHOTOGRAPH SHOWS THE MULTIPLE TUNER OF THE ILL-FATED STEAMSHIP "FALABA," AFTER LYING ON THE BED OF THE OCEAN FROM MARCH 3RD UNTIL OCTOBER 29TH, 1915. ON THE LATTER DATE IT WAS PICKED UP IN A TRAWL AND DELIVERED TO THE RECEIVER OF WRECKS AT MILFORD HAVEN, SUBSEQUENTLY BEING FORWARDED TO THE LONDON OFFICE OF THE MARCONI COMPANY.

A "Wireless" Automobile

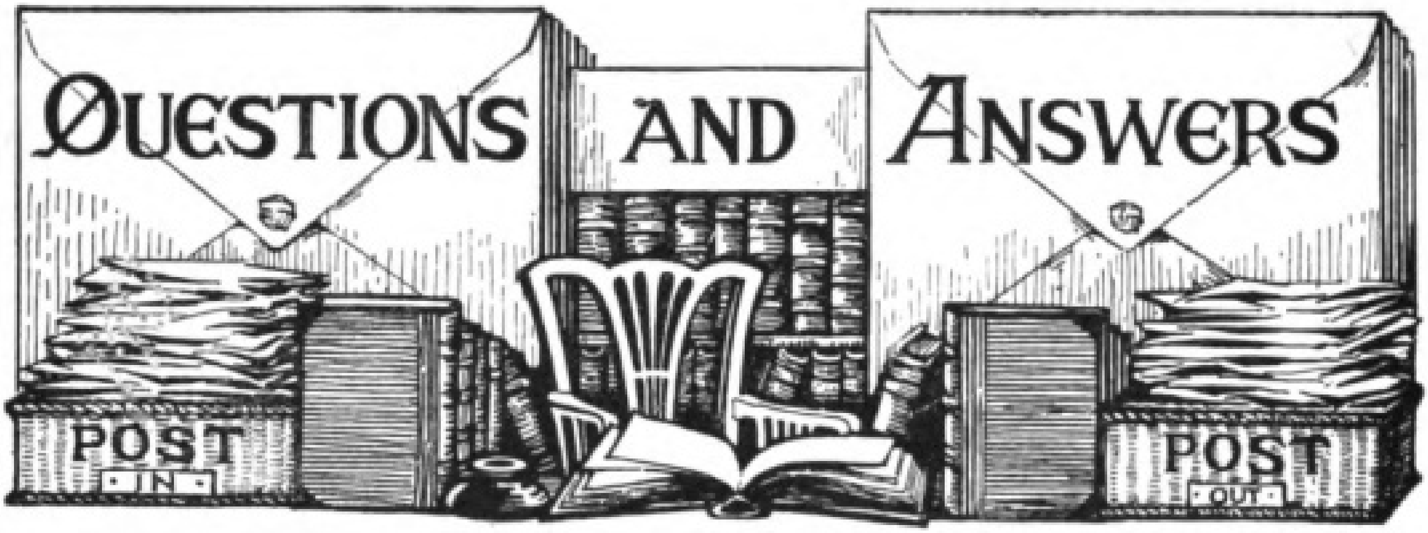
A New Military Car for the United States Army

We have in the pages of this journal from time to time commented on the progress made by wireless telegraphy in the field, and given illustrations of various sets of apparatus. These have included pack sets, cart sets, cycle sets, hand sets, and automobile sets. Of this latter we are enabled, by the courtesy of the Cadillac Motor Co., to publish a very fine photograph. The car in question forms one of a fleet of eight military cars belonging to the United States army. These motors left Chicago recently for the Pacific coast under the command of Col. R. P. Davidson, commandant of the North-Western Naval and Military Academy, accompanied by Lieut. E. G. Arneman, official observer for the War Department. These cars are equipped with complete wireless outfits, the telescopic mast of which is well indicated on the accompanying illustration. An electric generator, etc., has been installed on every car, and the whole in each instance mounted on a Cadillac eight-cylinder chassis. The present European war has demonstrated the utility of these mobile wireless units, and their adoption by the United States army marks a further important step in the manifold uses to which the science of radiotelegraphy has already been put.



[*Photo: By the courtesy of the Cadillac Motor Company.*

CADILLAC AUTOMOBILE FITTED WITH WIRELESS TELEGRAPHIC APPARATUS, AND BELONGING TO THE UNITED STATES ARMY.



Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study to the Editor,* THE WIRELESS WORLD, *Marconi House, Strand, London, W.C. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered : and it must be clearly understood that owing to the Defence of the Realm Act we are totally unable to answer any questions on the construction of apparatus during the present emergency.

NOTE.—***In view of the large number of questions which now reach us from readers, we regret that we cannot undertake always to answer queries in the next issue following the receipt of letters. Every endeavour will be made to publish answers expeditiously.***

W. J. (Newcastle-on-Tyne) writes : "I have "received a letter from the Postmaster-General "giving me permission to use 'a tapping key, "'buzzer and a telephone receiver, with a "'resistance not exceeding 200 ohms for prac- "'tising the Morse Code.'" He wishes to know if such an arrangement would be of any use, and if so, what the cost would be.

Answer.—The apparatus mentioned would certainly be of the greatest use in learning to send and receive. The cost depends upon the quality of the apparatus. Messrs. Graham & Latham, Ltd., 104 Victoria Street, S.W., whose advertisement will be found in this issue, make excellent apparatus of this kind, and we would advise our correspondent to write to them for particulars, mentioning that he has received the above permit.

P. W. (East Ham).—The power of a wireless installation is usually reckoned at the primary of the transformer. In the case you mention reference is made to the alternating current terminals of the generator. Power can be decreased by loosening the coupling of the jigger or by increasing the L.F.I.C.I. Reducing the speed of the machine decreases the power in certain circumstances by putting the low-frequency circuits out of resonance. You are not correct in your assumption that when the coupling of the jigger is loosened the condenser only partially discharges. With very loose coupling less energy is radiated because more is absorbed in resistance. If the coupling is moderately tight, the energy passes into the aerial fairly rapidly and there are not many oscillations in the closed circuit. If the coupling is so loose as to be negligible the oscillations in the primary will still cease after a time although practically nothing is radiated, as little by little the energy will be absorbed by the resistance of the spark and the rest of the circuit. You will now see that if the energy can be passed into the aerial and radiated quickly the loss in the closed circuit through resistance will be smaller, and the energy radiated will be greater. In reply to your last question, with a 50-cycle alternating current and a fixed discharger there will be at least 100 sparks per second, provided the circuit is not specially adjusted so as to give only one spark for two or more alternations.

S. J. M. (Tunbridge).—There is no medical test in the Postmaster-General's Examination, but the Marconi Company require all applicants to be medically examined before acceptance.

A. P. (King's Lynn) asks four questions, the first two of which are meaningless, as he has evidently become confused somewhere. In the remaining questions he asks : (1) For what purpose is the small condenser across primary of telephone transformer, also the condenser placed across telephones ? (2) He presumes the earth arrester gap would not be required in an aerial only used for transmitting.

Answer.—(1) The condensers placed across the primary and secondary of the telephone transformer are for the purpose of tuning, more or less exactly, these circuits to the frequency of the spark of the signals which are being received. (2) There is no need for an earth arrester gap in an aerial used only for transmitting, since its sole purpose is to provide the means by which the aerial can alternately be used for transmitting or receiving without a switch.

With regard to the questions which are unintelligible the reluctance of the core has nothing to do with the mutual inductance between two coils. The other question also cannot be answered, since the current in an inductance circuit never (theoretically) dies away to zero in a finite time when the applied voltage is removed from action. If you state that the current takes a tenth of a second to fall to a tenth or hundredth of its original value, the problem can be solved, but not if it falls to zero.

H. A. (Gibraltar).—Appointments to stations in Canada rest in the hands of Marconi's Wireless Telegraph Company of Canada, with whom you should communicate. They will be pleased to tell you whether they have any suitable vacancies. We cannot pass an opinion as to which is, the better of the two branches you mention, but we certainly think that you would be more interested in the work of the R.N.A.S.

H. S. (Hackney).—We would advise you to apply to the nearest Naval recruiting office for the particulars you ask for. We cannot say what your prospects would be, as we have no knowledge of the qualifications you possess. We hope to have an article on this subject shortly.

C. W. A. (Eastwood).—There are a number of schools of wireless telegraphy advertising in The Wireless World at which you would be able to take a course of instruction. We would suggest that you look through the advertisements, and, on finding a school near you, write to them for particulars.

N. H. E. (Tiverton).—Many thanks for your letter. Yes, it would have been better if the lines had been marked as you say.

A. E. J. (Harringay).—To the best of our knowledge appointments such as you mention in your letter are very rarely given except to men actually experienced in wireless work. Thus, if you had had considerable experience as a commercial operator and were found suitable otherwise, you would stand a fairly good chance. Without practical knowledge we do not think you would be likely to obtain what you want. Write us again if this information is not sufficient.

S. E. T. (East Finchley) writes: (1) When sending Morse does one tap twice on the key for a dot and once for a dash or *vice versa*? (2) How does one indicate when each letter is finished? Is it by pausing, or by giving a prolonged dash, or by using the sign indicated in the Morse Code Card? How does one indicate when each word and sentence is finished?

Answer.—The Morse Code is sent by depressing the key for a short time for a dot and for a period three times as long for a dash. A short pause is given between each letter and a longer pause between each word. Full stops as shown on the Morse Card are frequently used to punctuate sentences, and, when necessary, other signs of punctuation, such as the comma, etc., are used.

Cte. de la B. (Paris) asks: (1) What is the maximum capacity of condensers ordinarily employed as aerial condensers? (2) What is the maximum capacity of those ordinarily employed for tuning the secondary circuit?

Answer.—(1) The aerial tuning condenser fitted to most of the Marconi Co.'s tuners has a maximum value of 10,000 centimetres and is variable from this value down to zero. (2) The value of the condenser across the inductance of the detector circuit depends on the form of detector used. Thus, with the magnetic detector operated by current and not potential, this condenser in the multiple tuner is of the same size as that in the aerial circuit, whilst in the case of the valve detector (potentially operated) the maximum value of the condenser is but a fraction of this. To calculate the capacity for use across the inductance in a detector circuit using a crystal it should be borne in mind that the maximum efficiency is obtained when the capacity across the inductance is reduced to zero. Further, the maximum wave-length to which it can be efficiently tuned will be about three times the value of its minimum wave-length. When, however, a low resistance crystal is used, a larger condenser is permissible. We trust that this will give you the information you require.

J. E. (Bergen, Norway).—The switch of which you sent us a diagram is interesting and would we think, work, but a much more efficient piece of apparatus could be designed. It would not do to use iron for contacts, for, amongst other reasons, this metal would soon become covered with a filament of oxide, which would act as a high resistance. You will find working out such designs very helpful.

G. M. (Birmingham).—We do not think there is now a school of wireless telegraphy nearer to you than Manchester.

T. V. H. (Smethwick).—See answer to last question. If this answer should catch the eye of any reader in Birmingham who would be willing to give lessons in wireless, will he kindly communicate with us? We most strongly recommend you to obtain the *Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett, 3s. 10d. post free, as this will give you all the theoretical information you require and can readily be understood by anyone with a fair general education.

Will C. B. P. M., Delft, Holland, whose query was answered on page 532 of our issue for November last, kindly communicate with us, as we have the name and address of a correspondent in that town who would like to practise on a buzzer with him.

J. H. B. (B.E.F., France).—A knowledge of mathematics is very valuable in the study of wireless telegraphy, and to go deeply into its theory a very high degree of mathematical skill is required. However, a considerable theoretical knowledge and an excellent practical acquaintance with wireless can be acquired without any mathematical training, and, if the only portions of Hawkhead's book which you do not fully understand are those which require a mathematical knowledge, you should be fairly well advanced. For some time we have been publishing in our magazine a series of mathematical instructional articles, and these should be of considerable help to you. One of the best books we know for acquiring a good sound grounding in practical mathematics is that of Frank Castle, obtainable from our publishers. We can strongly recommend it to you.

A. C. (Deauville S-M.).—If the answers to your queries have not already appeared, they have not been received by us, and we would ask you kindly to repeat them, when they will receive immediate attention.

T. B. (Walker-on-Tyne).—There are no books on the subject of transmission of wireless waves through water. There is a method of signalling through water by sound waves, usually known as "Submarine Signalling," and recently a patent was taken out for the transmission of electric waves of extremely high frequency through water, but we do not think that any practical work has been done in this last direction.

X. Y. Z. (Portsmouth) says that he has several times been told (especially by one who is a seafaring man) that wireless operators become quite deaf after a period of three or four years' operating, owing to the electricity and the continual click of the telephones. This is utter nonsense and has not the slightest foundation in fact. The writer of this answer, who has had experience spreading over a number of years of wireless operating, has never yet heard of a case in which wireless operating caused deafness. Of course, if a man has bad ears the continual wearing of the telephones is likely to cause trouble, just as smoking is inadvisable for a man who has a bad throat, but for a man whose ears are healthy and hearing good the wearing of the telephones never causes any harm. This idea about operators becoming deaf is on a par with the statement that wireless waves cause neuralgia or blow up ships where they meet. We are glad to have this opportunity of dealing with the matter.

E. H. (Andover).—For particulars of wireless schools in London you should consult the advertisements in THE WIRELESS WORLD.

T. G. (Kingstown, Ireland) asks the following questions: (1) The power of the emergency set in watts and kilowatts and how to reckon it. (2) Why balls are used on the discharge rods, and why heating of same causes a faulty spark. (3) Why damping affects electricity. (4) Why the E.M.F. and current of an alternating current are at a maximum at different times. Questions 1, 3 and 4 indicate that our correspondent is not well acquainted with the principles of wireless telegraphy, and we would suggest that he procure a *Handbook of Technical Instruction for Wireless Telegraphists*, published by the Wireless Press at 3s. 10d. post free. With regard to question 2, balls are used on the discharge rod of the induction coil in emergency sets (we presume this is what our correspondent means) because an even spark is obtained in this way. Heating of the electrodes sometimes causes an arcing spark, which is bad, but this can be quickly put right. We do not think it necessary to give a full explanation on this point, as, from the other questions, we judge that our correspondent would not be able to understand it.

F. M. (Cahirciveen) also asks questions which show that he does not understand elementary principles. We would advise him to obtain Bangay's *Elementary Principles* and study it carefully, for until he understands the principles on which wireless work is based it would be useless for us to answer his question.

G. B. (Port Blair, India).—An aerial can respond to more than one wave-length, whether it be plain or with inductance or capacity in series, but the most important wave-length to which it responds is its fundamental.

If a diagram of the voltage distribution with a condenser in series be plotted for the aerial when oscillating at its fundamental wave-length, the general form of the curve will be as shown in Fig. 1.

When the condenser in series has a very small capacity the curve becomes like Fig. 2, which has a node of potential at the middle for the case where the capacity is zero. It is clearly impossible to obtain a smaller fundamental wave-length than this, which is equal to half the natural wave-length of the plain aerial.

The aerial can, however, respond to overtones, as shown by the voltage curve of Fig. 3, which represents the first overtone of the aerial with a condenser in series; or Fig. 4, which represents the second overtone.

Therefore to tune an aerial whose natural wave-length is 2,000 metres to 300 metres the capacity in series is adjusted till one of the

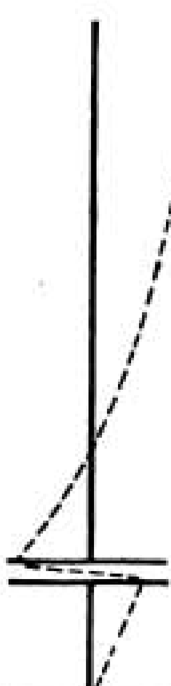


FIG. 1.

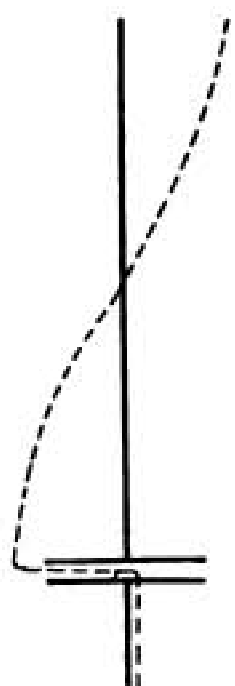


FIG. 2.

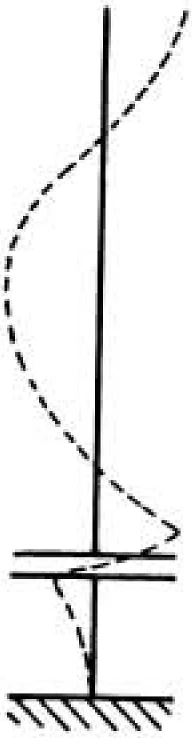


FIG. 3.

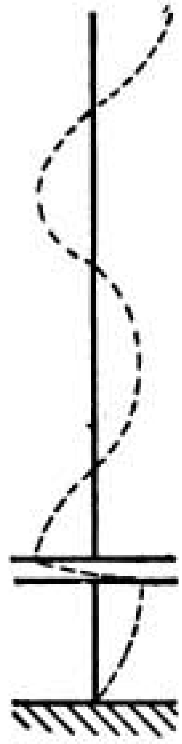


FIG. 4.

overtones of the aerial becomes 300 metres. It is impossible to make the fundamental wave-length so small as this, so that in this condition the aerial will respond strongly to at least one other wave-length besides 300 metres.

The amount of capacity required can be calculated from a formula given in Dr. Eccles's Handbook, page 123.

First calculate

$$\theta = \frac{\pi}{2}\frac{\lambda_0}{\lambda_1}$$

where λ_1 is the altered wave-length,
λ_0 is the natural wave-length of the aerial. Then obtain the value of $\tan\theta$, where θ is expressed in radians. Then

$$\frac{\tan\theta}{\theta} = -\frac{C}{C_0}$$

where C is the capacity of the condenser and C_0 that of the aerial. The ratio $\frac{\tan\theta}{\theta}$ will have the same value for a number of values of θ, so that a given value of $\frac{C}{C_0}$ will tune the aerial to a number of wave-lengths.

In calculating the voltage to which a condenser is charged by means of a transformer it must be remembered that the transformer circuit is adjusted to be practically in resonance to the frequency of the alternating current supply. It can be shown that due to this the voltage to which the condenser is charged is $\frac{\pi}{2}E$, where E is the maximum value of the voltage of the transformer working on a non-resonating circuit such as a non-inductive load.

Since transformers are usually specified by the R.M.S. volts given under these conditions, and the R.M.S. volts are given by $\frac{E}{\sqrt{2}}$ the voltage to which the condenser is charged is given by $\frac{\pi}{2}\sqrt{2}\times$ working voltage of transformer.

The factor $\sqrt{80}$ in your equation does not enter the above theoretical equation, and we do not know to what it refers, as you do not mention the book from which your formula is taken.

The transformer circuit is turned to resonance with the supply frequency by adding inductance to either the primary or secondary circuits of the transformer. Except in this sense, the inductance has no effect on the condenser voltage of such a circuit.

J. K. H. (Plymouth) asks for an explanation of the fact that (before the war) he was able to receive signals on 2,400 and 2,800 metres although his aerial was quite a small one, dimensions of the apparatus being given in the query.

We are not able to reproduce the details of your apparatus in these columns, and you have not stated the capacity of your primary condenser, nor do you state whether it was connected in series or parallel with the coil.

The two stations which you state you were able to receive are of considerable power, and therefore signals can be received although the arrangements used may not be the most efficient. The figures given in the text-book you mention are no doubt intended as the dimensions of apparatus to receive signals of the given wave-length in an efficient manner.

If your primary condenser be connected in parallel with the inductance a longer wave-length can be received with a given aerial than by using the coil without any condenser, although the signals are not quite so strong as if tuning is effected by means of inductance alone.

2. We are unable to give you any idea as to what further restrictions are likely to be put in force with regard to amateur stations after the war.

W. M. (Bradford).—French is by far the most useful language to know in the wireless profession. Spanish is a good second. Italian and Portuguese are also useful, and, judging by some of the magazines which have recently reached us from across the Atlantic, it will soon be necessary for everybody to learn a new language called American. By all means perfect your French and Spanish; you will find them most useful.

F. J. B. (B.E.F.).—The science of wireless is too young for us to be able to say the average number of years during which an operator is fit for service. It is a healthy occupation. The prospects of obtaining any other appointment in wireless after having served as an operator depend entirely upon the individual. Good men are continually being taken from the ranks of the operators to fill the positions of inspectors, instructors, etc., though naturally the number of such vacancies is not large compared with the number of operators. With regard to your third question regarding deafness, see our reply to X. Y. Z. (Portsmouth). In connection with your desire to transfer into a wireless section of the Army, we would suggest that you renew your application, pointing out that a similar application was sent in three months ago with the sanction of your officer.

J. J. M. (West Meath).—F. Castle's *Practical Mathematics* is just the book your brother requires, and if he studies this in conjunction with the other books you mention he should make excellent progress. He should not attempt more than a superficial study of the theory and calculation of electro-magnetic waves until he has obtained a thorough knowledge of mathematics. Write to us again if we can give you any further information.

D. J. D. (H.M.S. ——) inquires: (1) Whether in the formula for the power in a condenser circuit quoted in "Questions and Answers" for February, 1916, should not be

Power in watts $=\frac{1}{2} NCV^2$,

where N = frequency of discharge per second,

V = voltage of charged condenser,

C = capacity in farads.

The formula as stated above is correct, the capacity should be measured in farads, and not microfarads, as stated in our reply.

(2) The three formulas given in Mr. Hallborg's paper on "Low Frequency Resonance" are correct:

$$C^1 = (\text{Ratio})^2 C^2.$$
$$L^2 = (\text{Ratio})^2 L^1.$$
$$R^2 = (\text{Ratio})^2 R^1.$$

The fact that the form of the equation for capacity is inverse to the other two can, as stated by Mr. Hallborg, be seen by reference to the vector diagrams of an ideal transformer, as given in text-books.

From these equations it follows that a large capacity in the primary (low voltage) circuit is equivalent to a small one in the secondary circuit, but the opposite holds for inductance and resistance.

The resistance of the circuit is not the high frequency resistance, since the circuit is a low frequency one, but it is the resistance of the circuit at the frequency of the current flowing through it—*i.e.*, of the alternator or other supply. This will be somewhat larger than the D.C. ohmic resistance.

J. W. (H.M.S. ——) asks: "Can a 10-inch coil be tuned to a 600 metre wave from a dynamo supplying 25 volts and connected direct?"

Answer.—This question is not at all clear. The tuning of a circuit has nothing to do with the supplied voltage of the coil charging it. If you will make your question clearer we will endeavour to answer it.