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THE WIRELESS WORLD

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Wireless v. Wire in the Jungle

Fleming Valve and de Forest Audion

Military Telegraphists: Their Life & Training

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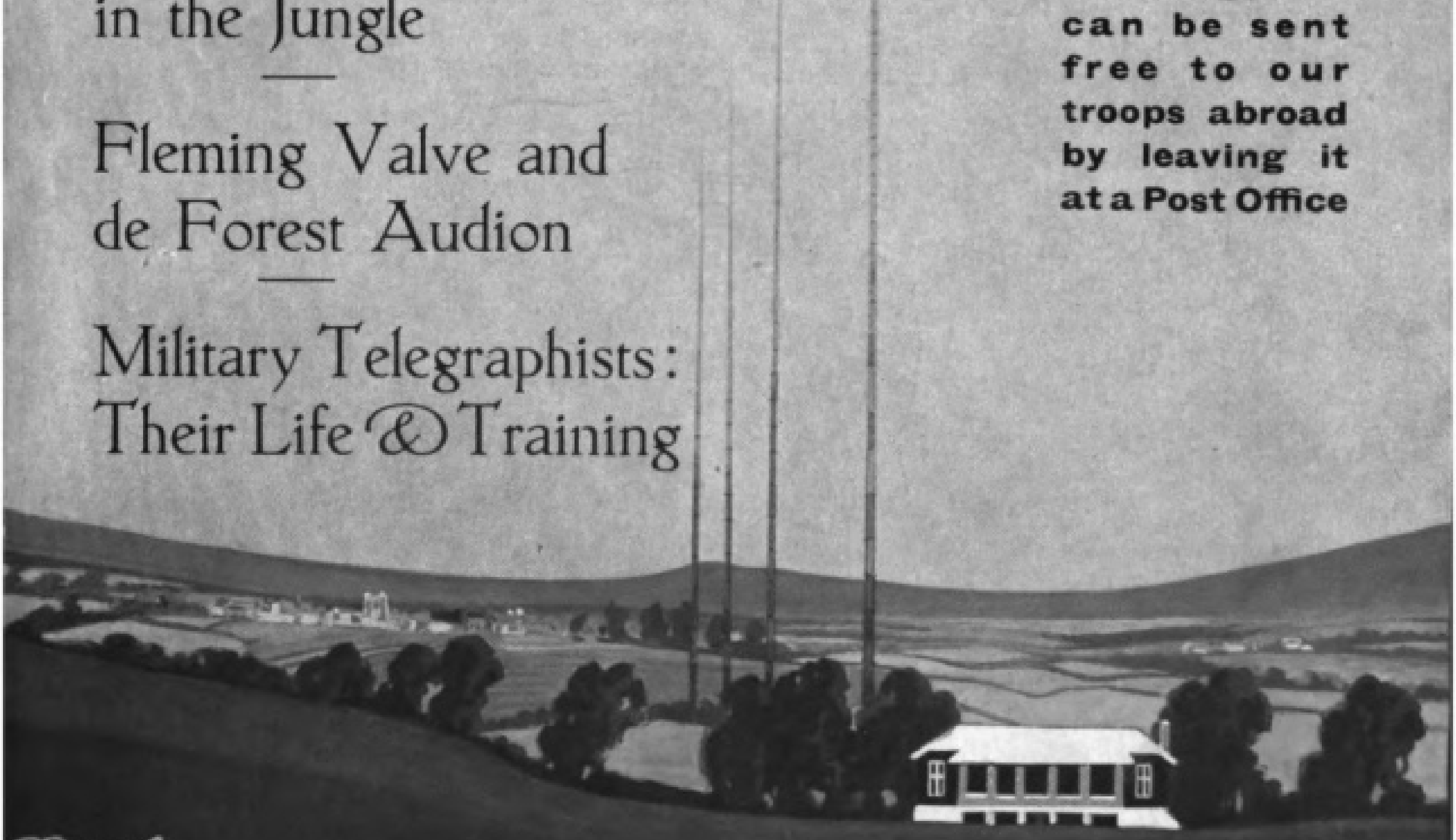


Wireless versus Wire in Jungleland

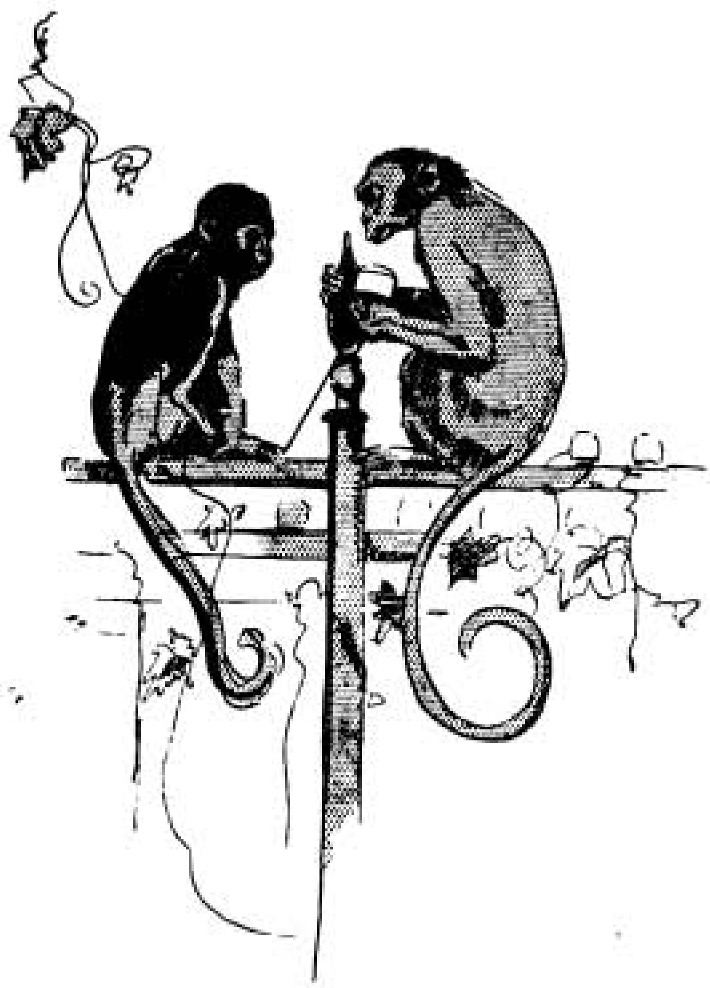
A GLANCE at a map of the world on which is marked the distribution of vegetation will immediately reveal the fact that dense tropical forests occupy considerable portions of South America and Africa. India, too, has its fair share, together with a number of islands scattered throughout the Southern Pacific Ocean.

Now it happens in many cases that where these jungles exist there is also to be found immense natural wealth, be it in rubber, timber, copra, or other forms. Some of the most romantic adventure stories have been written around the exploits of early traders who, pushing their way towards the interior with a small following of trusted natives, succeeded in tapping a portion of this wealth, only to be plundered on their homeward voyage across the southern seas by the Barbary pirates, or cast on a desert shore.

The adventures of the modern trader are, perhaps, no less exciting, even if they have lost an element of the picturesque. No longer are great bales carried on the shoulders of weary slaves who wind their way down to the sea through the fevers and morasses of the dark continent, and rarely do we hear nowadays of a trader falling victim to wild beasts. The pioneer of to-day carries with him modern machinery by which great clearances are made, and, mile by mile, the ever-lengthening railway track provides an easy means of transport from settlement to sea.

In order that trade can be carried on to the best advantage some well-organised means of communication must be at hand, so that the inland trader may be able to keep in touch with his agents at the ports or in other settlements throughout the country. The days of the native runners who carried the letters in a cleft stick and who as often as not lost either the messages or themselves, is long since past, and nothing less than the almost instantaneous electric telegraph will satisfy the modern business man. As a consequence, thousands of miles of telegraph wire have been used to form a network of communication throughout equatorial and tropical regions. So long as these wires are able to carry messages everything is satisfactory, but, unfortunately, there are immense difficulties confronting the telegraph engineer who attempts to maintain a line through the jungle, and for days and sometimes for weeks on end the line is " down " and the trader isolated. It is because of these difficulties that the wireless telegraph is so rapidly displacing the wire telegraph in "jungleland," for the wireless telegraph can communicate across the jungle as easily as across the sea.

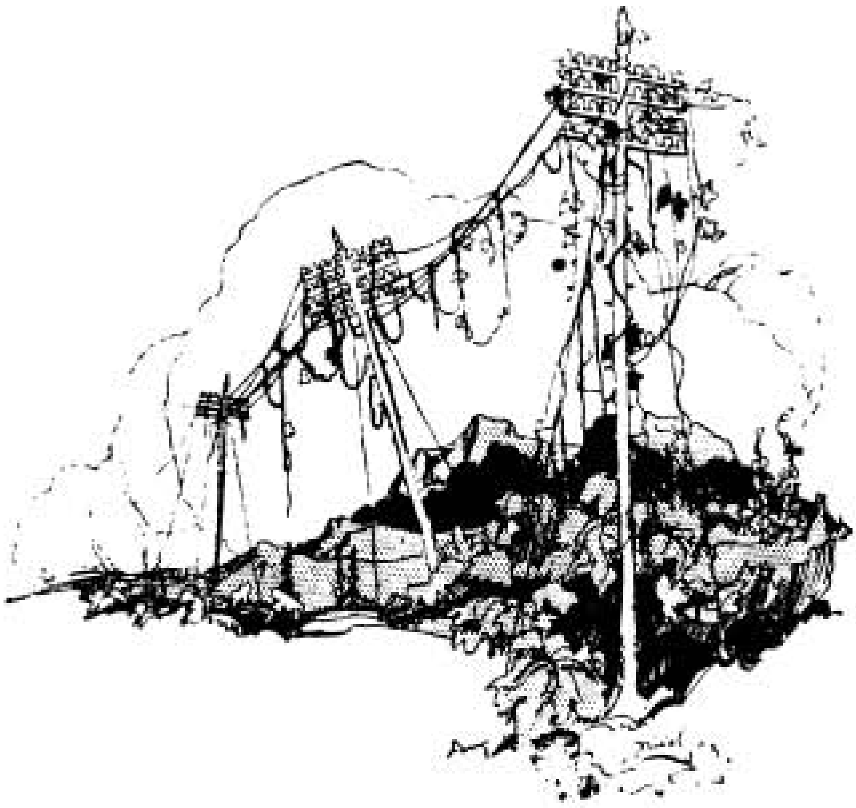
A little consideration of the problems which face the line telegraph engineer who is ordered to connect up two settlements separated, let us say, by a couple of hundred miles of dense vegetation will bring out very clearly the advantages of the wireless telegraph over its older brother. Having built his two terminal offices, with their equipment of telegraph instruments, the line engineer will have to survey the intervening country and decide the track to be taken by the long wire. This survey alone may take more than a year, and, in any case, considerable time will elapse before the first poles can be erected. It is obvious that it is not sufficient merely to dig a hole and plant a telegraph pole therein; a wide clearance must be made along the whole track, so that the wire may be clear of the surrounding trees and vegetation. Sometimes a mountain chain has to be crossed and frequently a wide detour has to be made to avoid the swamp or lake, for, of course, one cannot plant a pole in water or in any place where the foundation is insecure.



UNSCREWING INSULATORS IS GREAT FUN.

Clearing a path through the jungle for a mile is a work not lightly to be undertaken; clearing the jungle for 200 miles is a feat which taxes the ingenuity of the greatest civil engineer. And the task is not lightened or improved by the knowledge that new vegetation will sprout almost as fast as the old is cut down. Even when the almost insuperable difficulties of clearance have been overcome and an army of labourers are occupied for their whole time in keeping the track open, the telegraph engineer is still struggling with further problems and wishing he had never undertaken the task. There is, for instance, the comparatively small problem of poles. Sometimes, it is true, the ingenious engineer is able to utilise trees already in position to carry the wire, but in most cases poles have to be erected along a great proportion of the track. Generally, we may say a distance of 100 yards will separate these poles, although frequently they may be only half this distance apart. Even if we assume but 20 poles to the mile, and if again we make our track quite straight between the two points and allow for no detours, there are four thousand poles to be provided!

Our worried engineer, for his telegraph posts, can now choose between metal and wood. Each substance has its disadvantages. Metal will corrode and rust away in the hot, damp mists arising from the swamps; wood, on the other hand,



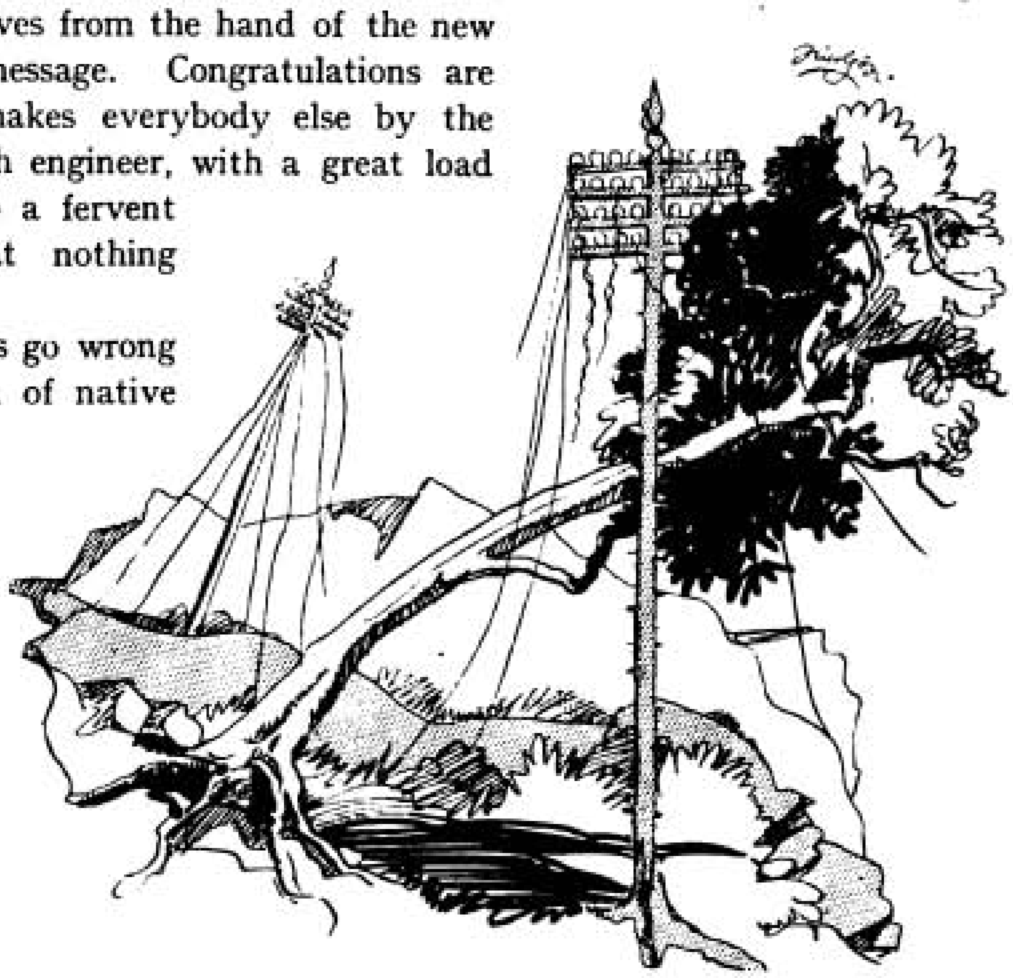
THE CREEPER IS PRETTY BUT INEFFICIENT.

will sooner or later fall a prey to the innumerable insects which bore their way even into the living trees.

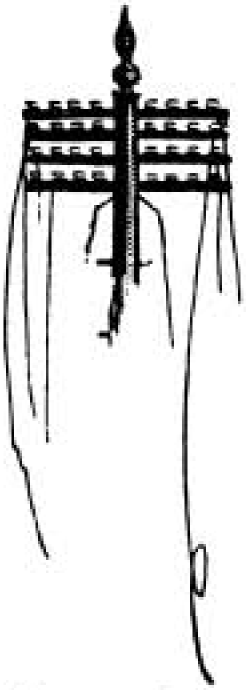
Innumerable patents for making wood poles proof against the ravages of insects and rot have been taken out and processes tried, such as impregnation with creosote, but the trouble still exists, even if it has to some extent been reduced.

Once the posts are in position (and the engineer will heave a sigh of relief when this part of the work has been completed), insulators must be fitted to keep the wire away from the wood or metal supports, and finally the wire itself has to be fixed in place. The instruments will now be connected at the terminal station, and the patient trader, delighted to be rewarded for his long period of waiting, receives from the hand of the new telegraphist the first message. Congratulations are exchanged, everyone shakes everybody else by the hand, and the telegraph engineer, with a great load off his mind, sends up a fervent prayer to heaven that nothing may go wrong.

But something does go wrong inevitably. The patrol of native linesmen whose duty it is to see that the wire is kept clear from obstruction, is new to its work and fails to notice how thousands of little forest spiders, building cosy little nests in the hoods of the insulators, are spreading a film of gossamer over the surface of the porcelain and along the



FALLING TREES ARE A FREQUENT SOURCE OF TROUBLE.



wire. These tiny threads are invisible from ground level, and the insulator will appear to be in perfect condition, but directly the heavy dew rises, the whole surface will be covered with a film of moisture in the form of tiny globules, such as one sees on any misty morning on a spider's web in the garden. As soon as this happens all insulating properties are gone and the line becomes "dead" to all traffic.

While a gang of linesmen are busy evicting the spiders from their new homes, a happy family of monkeys forty or fifty miles away are perhaps using their best endeavours to unscrew the insulators in a quiet part of the jungle. It may be very amusing, but it does not make for efficiency!

If fortune should favour our friend the engineer communication may be re-established in a few days when some of these minor faults have been traced and remedied. But he will be an extremely lucky man if he misses trouble with falling trees, which may break the wire and uproot half a dozen poles at a time.

Day by day the forest creeper will be putting forth its tendrils, embracing the poles in its growth and covering them, even as it covers the dead tree trunks, with a layer of delicate green. Gangs of linesmen will be occupied in cutting down this plant, which, if once it reaches the wire, will conduct the current to the ground and stop communication. The undergrowth, sprouting fast, will threaten to choke the track in a wonderfully short time, and any section left for more than a week or two will appear even as the virgin forest.

More pages than are contained in this magazine could easily be occupied in recounting the hundred and one difficulties of the wire telegraph in jungleland. The few we have already mentioned will serve to indicate to some extent what has to be faced when such lines are erected. We have so far made no reference to the predatory instincts of the wily native, who knows of no better substance than telegraph wire for making elaborate bangles, earrings, and other ornaments. It is a common occurrence in Africa to find whole stretches of the line cut away and stolen by the blacks, and, as a linesman cannot be in two places at once, such robberies are hard to detect. Wild animals are not behindhand in aiding the natives to ruin this frail system for linking up the distant communities. It needs to be a very strong pole, and still stronger wire, which will stand up to a charging elephant, and a crowd of monkeys holding earnest consultation on the stretch of wire between two poles is no light weight to support!

THE NATIVE EXHIBITS A FONDNESS FOR WIRE.

If all the troubles above detailed have been avoided (and it is certain that some are bound to come the way of the worried engineer), there still remains the ever-present danger of the forest fire, which in its relentless progress may destroy at the same time half of the system and the work of years.

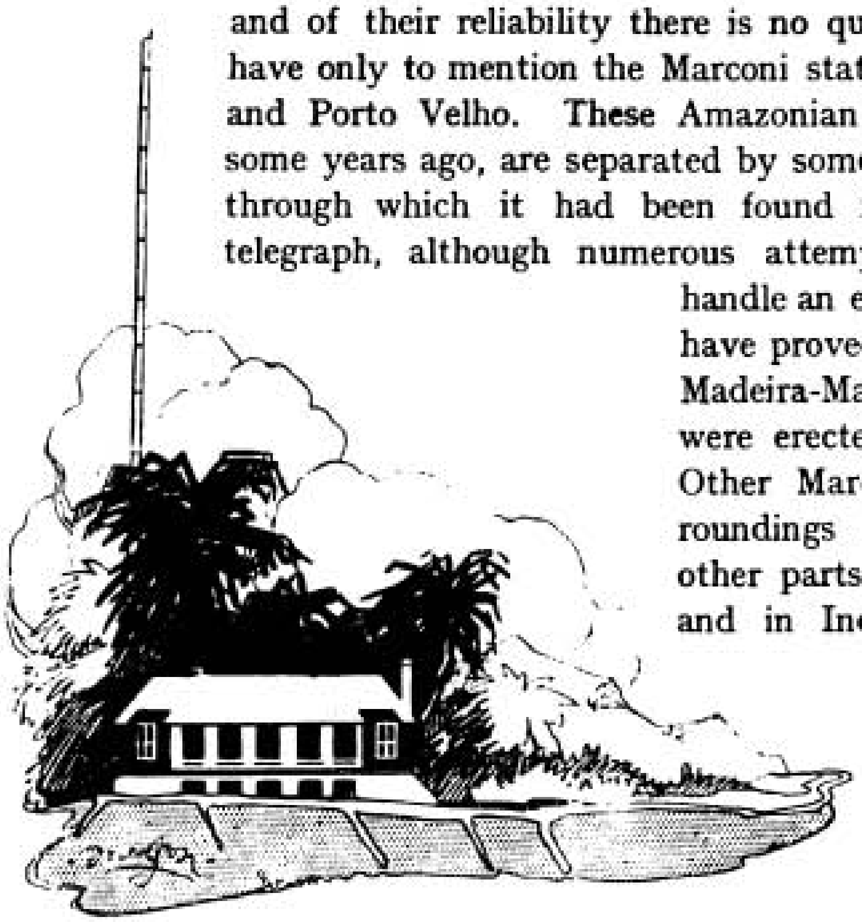
Let us now see how admirably the wireless telegraph serves as a means of communication in these tropical regions. Considering again our imaginary case of two communities separated by a distance of 200 miles, we have no long pole line to worry about and no winding track through the jungle. If it is decided to erect a wireless telegraph system the Marconi engineer will inspect the ground at each terminal and quickly decide upon suitable sites. In most cases there will be sufficient open ground near the townships (only comparatively small areas are required), but, even if a site has to be cleared in the jungle, the space needed is so small that the whole preliminary work can be quickly carried out. Experience will immediately indicate what power and type of station are required, and in a short time a neat station

A FOREST FIRE MAY DESTROY THE WORK OF YEARS.

IN SOME REGIONS WILD ANIMALS ARE VERY TROUBLESOME.

building will be erected with accommodation for the instruments and the staff. Tall steel masts, arriving in sections and merely requiring bolting together, will soon rear themselves above the sea of trees, and in a shorter time than the wire telegraph engineer would take to make his preliminary plans the new wireless station will be ready to work. No falling trees or charging animals can break down the system, for the messages will be flashing through the ether unhindered, and with the speed of light. The myriad of insects boring their way through rotting wood will now be left undisturbed; no army of linesmen will patrol the malarial swamps of the primeval forest; the worst that could happen would be a severe atmospheric storm, which might interrupt communications for a few hours, but even this trouble will probably be overcome before long.

Wireless in jungleland is no new proposal. Very many stations are now working in various parts of the world in conditions every whit as difficult as those described in this article. Success has invariably attended them. It is as easy to erect a pair of stations to communicate over a thousand miles as over a couple of hundred, and of their reliability there is no question. As a typical case we have only to mention the Marconi stations now operating at Manaos and Porto Velho. These Amazonian stations, which were erected some years ago, are separated by some 700 miles of tropical forest through which it had been found impossible to carry the wire telegraph, although numerous attempts had been made. They handle an enormous volume of traffic and have proved of the greatest value to the Madeira-Marmoré Railway, for which they were erected by the Marconi Company. Other Marconi stations in similar surroundings are working successfully in other parts of South America, in Africa, and in India, and the day is not far distant when this form of communication will rule supreme throughout the jungle. The old and abandoned wire telegraph, with its rotting and creeper-covered poles, will then be left to the denizens of the forest.



THE WIRELESS MAN, IN HIS SNUG LITTLE STATION, CAN WORK UNHINDERED AND UNWORRIED.

Wireless Training in Canada

The Canadian Marconi Company's School in Montreal.

WE reproduce below a photograph of one of the classrooms of the new Marconi school in Montreal. The school was opened on June 1st last, and is proving very successful. Mr. Douglas R. P. Coats, the instructor in charge, is well known to many of our readers by his contributions to THE WIRELESS WORLD, and is seen in the photograph standing behind the back row of students.

In order that the training in reception may be made to resemble as closely as possible actual working conditions, specially designed apparatus and circuits have been fitted, together with automatic transmitting devices. The latest type of 1·7 kw. apparatus is available for the instruction of students in the handling of the actual apparatus, and other installations will be fitted as required.

Mr. Coats informs us that he will be delighted to show the school to any Marconi operators who may happen to find themselves in Montreal with an hour or two to spare.

INTERIOR OF THE MARCONI COMPANY'S TRAINING SCHOOL IN MONTREAL, CANADA.

PERSONALITIES IN THE WIRELESS WORLD

Photo] [*Harris & Ewing.*

DR. LOUIS W. AUSTIN

TO all who follow the technical progress of wireless telegraphy the name of Dr. Louis Winslow Austin will be very familiar. Dr. Austin, who holds the important position of head of the United States Naval Radiotelegraphic Laboratory at Washington, is the son of Professor L. A. Austin, of Middlebury College. He received his education at Middlebury College, Clark University, and the Universities of Strassburg and Berlin. For a time Dr. Austin acted as Assistant Professor of Physics at the University of Wisconsin, and later took up a position on the staff of the Physikalisch-Technische Reichsanstalt, Berlin. In 1908 he was appointed to his present position, where he has proved of the greatest service to his Government in the many researches and investigations which have been officially undertaken.

At the International Radiotelegraphic Congress of London, Dr. Austin was one of the United States representatives, and he has many friends among the wireless workers in this country. He was President of the American Institute of Radio Engineers for 1914 and has been a frequent contributor to the Proceedings of that Society.

Dr. Austin is specially interested in quantitative high-frequency measurements, and has spent a considerable time in carrying out tests between the well-known stations at Arlington and Darien. In a highly interesting paper recently presented to the Institute of Radio Engineers under the title of "Experiments at the U.S. Naval Radio Station, Darien, Canal Zone," he gave the results of some of these tests, and added much to our knowledge of long-distance communication.

Some Characteristic Curves of a Poulsen-Arc Generator

By N. W. McLACHLAN, B.Sc.Eng., A.M.I.E.E.

Read 7th September at Newcastle-on-Tyne, before Section G of the British Association.

Introduction.

It has been shown by Mercer * that with a carbon-copper arc burning in an atmosphere of hydrogen, without a magnetic blast, having a condenser (the capacity not exceeding a certain limit) and a variable inductance shunted across its terminals, there is a certain inductance, and, therefore, frequency, for which the shunt current is a maximum. The present investigation was undertaken to determine whether this condition is applicable in the case of a Poulsen-arc generator: (1) When energy is absorbed in the shunt circuit by a variable non-inductive resistance; (2) when the energy absorbed in the shunt circuit is as small as possible. In both these cases there is a loss in the Moscicki condensers, this being unavoidable, unless air condensers are used. (*See* Appendix.)

Methods of Measurement.

The main and shunt circuits of the Poulsen generator were arranged as shown in a recent Paper by the author.† The test ring and the rheostats were removed and a sandstone resistance moistened with copper sulphate solution was connected between the variable inductance and the primary of the current transformer (*see* Fig. 1 in Paper, *loc. cit.*). This type of resistance is constant in magnitude and inductionless at high frequencies.‡ The resistance could be altered by varying the amount of moisture in the sandstone or the distance between the copper plates to which the terminals were soldered. An iron-cored (stalloy discs) current transformer § was arranged to obtain a transformation ratio of 100 : 3 or 100 : 1, so that shunt currents up to 10 amperes could be measured.

Voltages greater than 40 volts were measured by an electrostatic voltmeter connected across the terminals of the sandstone resistance. The capacity current of the voltmeter was small, and since it was 90 deg. out of phase with the current through the sandstone, its effect on the shunt current could be disregarded. For voltages less than 40 volts a hot-wire instrument was used, the small errors of which at the frequencies employed in these tests, were found by the method detailed in the author's Paper to which reference was made above. In this case the total power

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* F. Mercer, "The Arc as a Source of Oscillations," *Proceedings of the Physical Society*, London, Vol. XXVI., p. 372, 1914.

† N. W. McLachlan, "An Investigation into the Magnetic Behaviour of Iron at very High Frequencies with the Aid of a Poulsen-arc Generator," *Journal I.E.E.*, Vol. LIV., p. 480, 1916.

‡ *See* Paper by author, *The Electrician*, Vol. LXXVI., p. 875, March 24th, 1916.

§ A. Campbell and D. W. Dye, *Proc. Roy. Soc.*, "A" Vol. XC., 1914; also McLachlan, *loc. cit.*

expended between the terminals of the sandstone resistance was taken—*i.e.*, power to voltmeter + power to sandstone. The frequency of the oscillations in the shunt circuit was measured, as in the other experiments (*loc. cit.*), by means of a Lorenz wavemeter. Frequencies between $1 \cdot 3 \times 10^5$ and $8 \times 10^5 \sim$ per second were employed, the range of frequency in any experiment depending on the magnitude of the capacity.

Keeping the frequency and the capacity constant, the following readings were taken for different values of the resistance in the shunt circuit (including resistance of connecting wires and inductance):

1. Direct current supplied to generator.
2. Current in shunt circuit (R.M.S.).
3. Voltage on arc (excluding ohmic drop in magnetising coils) (R.M.S.).
4. Voltage across terminals of sandstone resistance in shunt circuit (R.M.S.).

Sets of readings were taken of the same quantities at various frequencies. The whole of the foregoing procedure was repeated with several different capacities. The resistance used varied from 70 ohms to 6 ohms, and the capacity from 0·0009 mfd. to 0·009 mfd.

STRENGTH OF THE MAGNETIC BLAST.

The field strength at the centre of the gap where the arc was formed between the electrodes—*i.e.*, the strength of the magnetic blast—was measured by using a narrow search coil of small resistance wound on an annular groove cut in the centre of a wooden bobbin. The bobbin was securely fixed between the conical pole-pieces of the electro-magnet, and the ends of the coil were connected to the terminals of a Grassot fluxmeter, the deflection being observed on reversal of the current through the field coils. The search coil was calibrated, using a mutual inductance and a ballistic galvanometer. Although the reading of a fluxmeter with a sufficiently long period and weak control is almost independent of the time taken for the flux linkages through the magnetic circuit to change, the time of reversal of the current was reduced by connecting the magnet-coils to a 240-volt circuit, the excess voltage being taken up by a non-inductive rheostat. Details of the conical pole-pieces and a curve connecting the field strength in the gap and the magnetising current in the field coils are shown in Fig. 1. The angle of the cones is

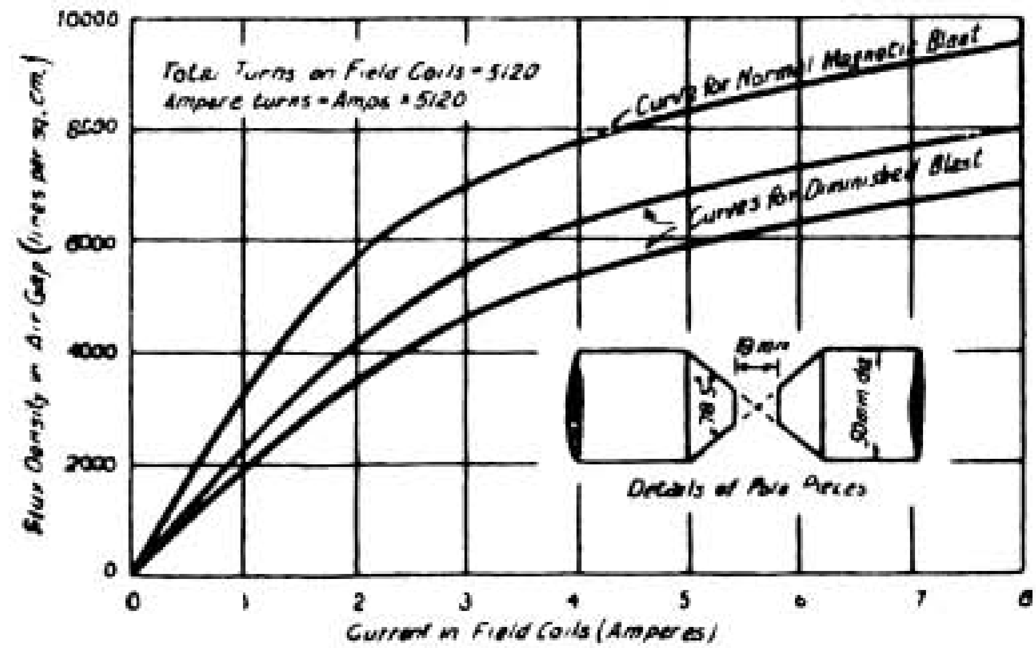


FIG. 1.—CURVES SHOWING THE RELATION BETWEEN THE FLUX DENSITY IN THE GAP AND THE CURRENT THROUGH THE FIELD MAGNET COILS.

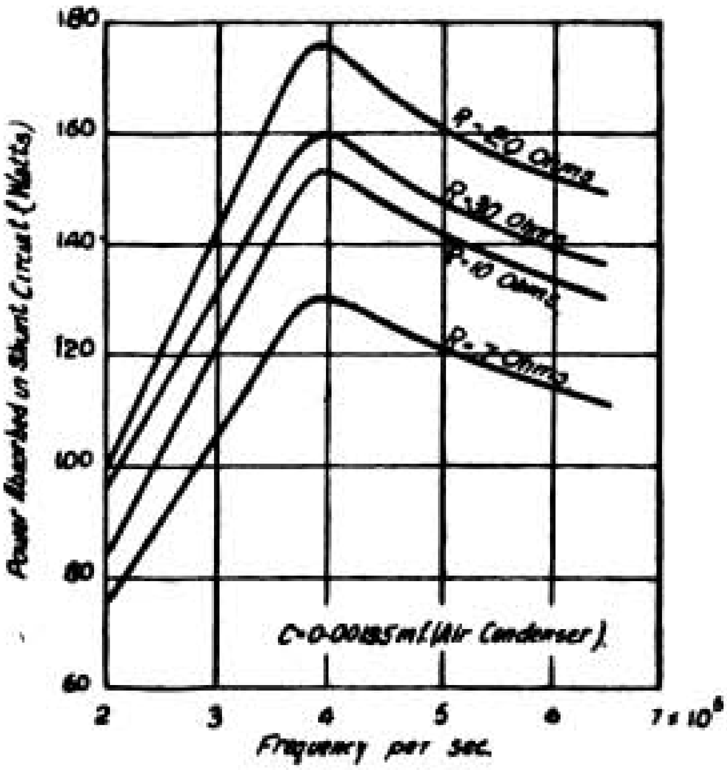


FIG. 2.—CURVES SHOWING THE TOTAL * POWER ABSORBED IN THE SHUNT CIRCUIT AT DIFFERENT FREQUENCIES FOR VARIOUS VALUES OF THE RESISTANCE AND A CAPACITY OF 0·00195 MFD.

* The curves showing the power obtained from "oscillations of fundamental frequency" for a capacity of 0·00195 mfd. are almost identical with those shown in Fig. 2, excepting that for frequencies greater than $4 \times 10^5 \sim$ the ordinates of the former curves are slightly smaller than those of the latter. An agreement of a similar nature exists between the corresponding sets of efficiency curves.

such as to produce a fairly uniform magnetic field in the gap.*

ANALYSIS OF SHUNT CURRENT.

The current in the shunt circuit was analysed, using the method described in the author's Paper.† For the various capacities tested the most prominent harmonic was the second, other harmonics being comparatively small. With a capacity of 0·00924 mfd. the R.M.S. values of the second and third harmonics were, respectively, 30 per cent. and 9 per cent. that of the fundamental when the frequency was $3 \times 10^5 \sim$ per second.

With capacities of 0·00924, 0·00368 and 0·00195 mfd. the second harmonic increased with decrease in inductance, and therefore increase in frequency. With a capacity of 0·00091 mfd. the second harmonic was practically non-existent at all frequencies. It was difficult to measure the harmonics to any degree of accuracy, especially when the ratio L/C was small. In this case the number of turns of the variable inductance in circuit was small, and in order to obtain sufficient energy in the wavemeter circuit, to secure reliable readings, the coupling between the two circuits must be fairly close. Under this condition the maximum value of the current in the wavemeter circuit (as read on the thermoammeter) was not always sharply defined, and the frequency of the oscillations could not be definitely determined. Since the distance between the inductances in the shunt and wavemeter circuits was small, it is probable that the mutual reactions of the oscillations in these circuits would affect the frequency. Moreover, it was impossible in some cases to analyse the shunt current. The magnitude of the harmonics compared with the fundamental depends to a certain extent on the length of the arc, the condition of the copper and graphite electrodes ‡ and the ratio of the shunt current to the arc current.§ (This ratio for given conditions is partially dependent on the length of the arc.) This ratio increases with increase in capacity, and the magnitudes of the second and other harmonics, compared with that of the fundamental, increase with the capacity. Throughout the experiments the arc length was adjusted to

* *See* J. A. Ewing, *Magnetic Induction in Iron and other Metals*, Third Edition, p. 148.

† *Loc. cit.*

‡ The second harmonic is more prominent when the graphite is badly burnt and the arc is burning irregularly. Both electrodes should have sharp edges.

§ McLachlan, *loc. cit.*

obtain maximum current and power in the shunt circuit for good burning. The graphite was carefully ground up for each set of observations, so that the burning was as steady and quiet as possible.

Observations were also made of the effect of resistance in the shunt circuit on the harmonics—*i.e.*, the effect of absorption of power in the shunt circuit. It was found that with a capacity of 0·00924 mfd. the resistance in circuit had no appreciable effect on the harmonics. With capacities of 0·00195 mfd. and 0·00368 mfd. the effect of resistance was to increase the second harmonic, chiefly at the higher frequencies.

Results of Experiments.

Figs. 2 and 3 show the power absorbed in the shunt circuit plotted against the frequency for capacities of 0·00195 mfd. and 0·00924 mfd. and different values of the total resistance, including I^2R losses. In Fig. 2 each curve has a maximum ordinate, which shows that, with fixed capacity and resistance, there is a certain inductance, and therefore frequency, for which the power absorbed in the shunt circuit is a maximum. In Mercer's experiments the power absorbed in the shunt circuit was small (I^2R and condenser losses), and the curve showing the relation between shunt current and frequency was peaked like a resonance curve, there being more than one peak in certain cases. The direct current voltage used was almost double that in the present experiments, being 475 as against 240. The absence of a sharply defined peak in the current and power curves obtained in these experiments is probably due to the effect of the magnetic blast and to the fact that the direct-current voltage across the arc is least when the shunt current, and, therefore, the power, is a maximum, owing to the increased volt drop in the field coils.

With large values of the capacity say, 0·00924 mfd., the curves, as plotted in Fig. 3, have no maximum values for the range of frequency used in the tests; but the power gradually increases with the frequency. Curves showing the relation between the frequency and the power obtained from oscillations of fundamental frequency for a capacity of 0·00924 mfd., appear to have a maximum value between $f=2{\cdot}5\times10^5\sim$ and $3{\cdot}5\times10^5\sim$ per second. At the latter frequency, however, L/C was small, and the arc did not burn regularly, making it impossible to obtain reliable readings of current and voltage, or to analyse the shunt current accurately.

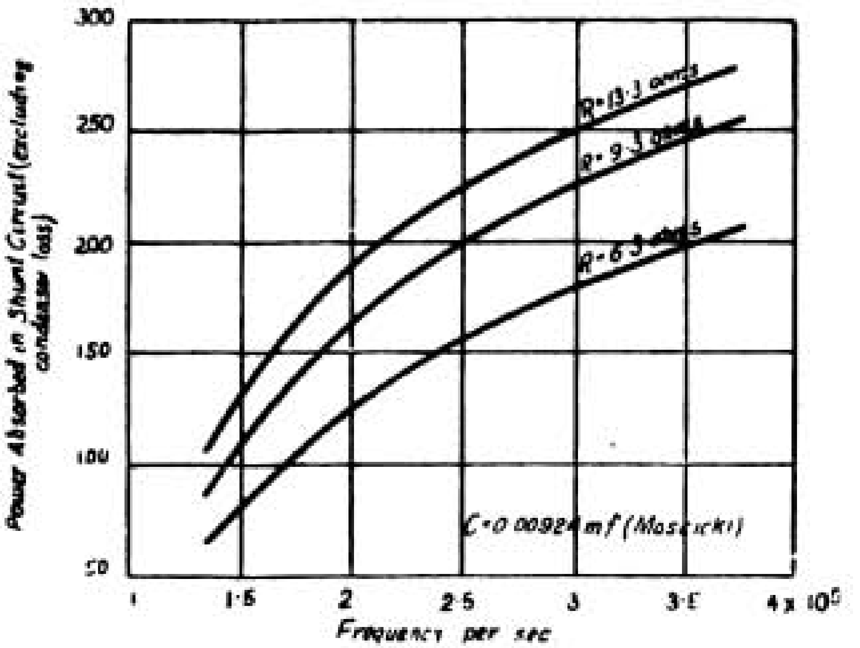


FIG. 3.—CURVES SHOWING THE POWER (FROM OSCILLATIONS OF FUNDAMENTAL FREQUENCY AND THE VARIOUS HARMONICS) ABSORBED IN THE SHUNT CIRCUIT AT DIFFERENT FREQUENCIES FOR VARIOUS VALUES OF THE RESISTANCE, AND A CAPACITY OF 0·00924 MFD.

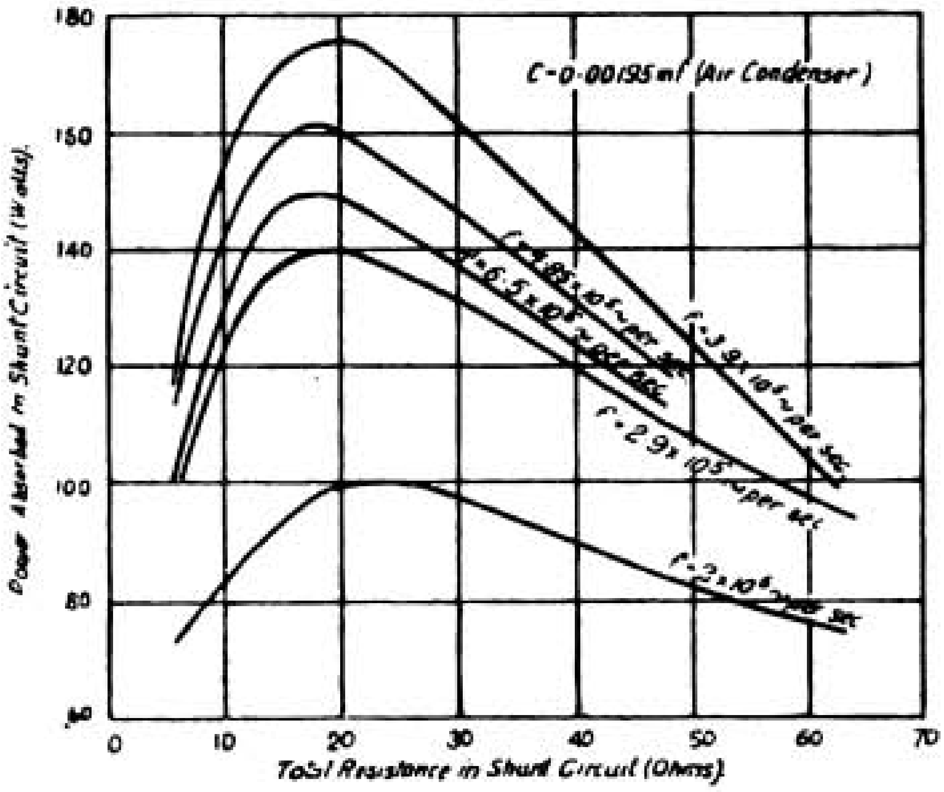


FIG. 4.—CURVES SHOWING THE TOTAL POWER ABSORBED IN THE SHUNT CIRCUIT PLOTTED AGAINST THE RESISTANCE FOR DIFFERENT FREQUENCIES, AND A CAPACITY OF 0·00195 MFD.

The curves in Fig. 4 show the power obtained with various resistances plotted against those resistances for different values of the frequency. When the resistance is small the curves rise quickly, reaching a maximum value ; as the resistance increases the curves fall away more gradually. Hence there is a definite resistance, for which the power absorbed in the shunt circuit is a maximum. For large capacities (0·00924 mfd.) the curves are more flat topped.

With a fixed resistance in the shunt circuit the power absorbed at any given frequency increases with the capacity. If, however the ratio L/C is small, the burning of the arc is not so regular as it would be with a smaller capacity and a reduced output.

The curves showing the relation between the direct current supplied to the generator and the frequency, for a given resistance in the shunt circuit, are similar in shape to those in Fig. 5. The maximum value of the direct current supplied to the generator corresponds to maximum shunt current and to minimum voltage across the arc. The reason for the simultaneous occurrence of maximum shunt current and minimum voltage across the arc is probably due to the increased ohmic volt drop in the field coils (which are in series with the arc), due to the direct current being a maximum, thus reducing the direct-current voltage across the arc.

The strength of the magnetic blast was lessened by making an air-gap between the top of the electromagnet, carrying the conical pole-pieces, and the two vertical limbs on which the field coils were wound. By this means it was possible to ascertain the performance of the generator with different strengths of magnetic blast, without altering the resistance of or the number of turns on the field coils. Two different field strengths were employed, the characteristics being shown by the two lower curves in Fig. 1. A diminution in the strength of the blast did not cause any appreciable alteration in the fundamental frequency of the oscillations in the shunt circuit ; but there was an increase in the second harmonic with the larger capacities (0·00368 mfd.) and small inductances. For any given resistance in the shunt circuit the power obtained at the lower frequencies was increased (owing to increased direct current supplied to the generator), the maximum value occurring at a lower frequency than with the normal blast—*i.e.*, the curves in Fig. 2 were shifted horizontally backwards. The maximum power and the corresponding efficiency of the arc were almost the same as the values obtained with normal blast.

It has been shown by Poulsen * that the amount of energy radiated from an antenna is increased considerably by using a magnetic blast. No details, however, are given regarding the strength of the blast.

A resistance of 20 ohms in the shunt circuit with a diminished blast caused very unsteady burning at the higher frequencies. At the lower frequencies the burning was improved by diminishing the blast. If, however, the blast is diminished beyond a certain value, the burning is unsteady. With normal blast the oscillations were irregular and the burning noisy when the resistance in the shunt circuit was large enough to cause a substantial reduction in the shunt current. This was especially the case when the ratio L/C was small.† Without the blast, and with resistance in circuit, oscillations could not be obtained. This confirms observations made by Austin, using an arc without a magnetic blast burning in an atmosphere of hydrogen.‡ With diminished blast and zero sandstone resistance the maximum value of the shunt current (capacity=0·00195 mfd.) occurred at a lower frequency than with the normal blast, and the curves showing the relation between the shunt current and the frequency were shifted backwards relatively to those shown in Fig. 5. There was only a slight difference between the maxima currents for different strengths of the magnetic blast as indicated by the curves in Fig. 1. The burning of the arc was more regular at the lower frequencies, but less regular at the higher frequencies with diminished blast. At the lower frequencies the active length of the arc was greater, but the proportionate variation in the shunt current and in the direct current, caused by an alteration in the arc length, was less than with the normal blast. If, at the lower frequencies, the blast was decreased beyond a certain value (smaller than the values indicated by the curves in Fig. 1), the burning was irregular. It is possible, therefore, to maintain the shunt current approximately constant and the burning regular over a fairly wide range of frequency by suitably varying the strength of the magnetic blast.

(To be continued.)

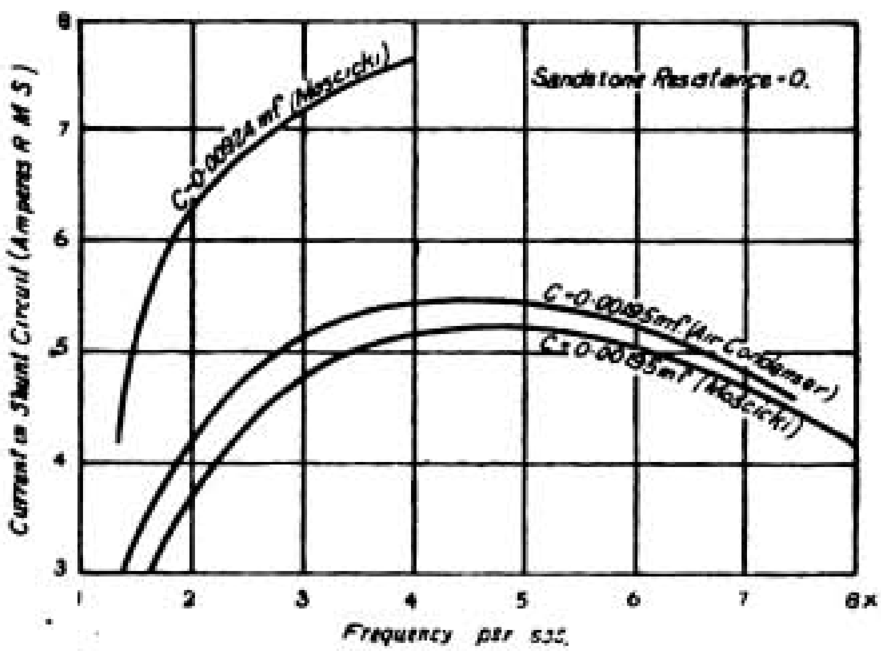


FIG. 5.—CURVES SHOWING THE CURRENT IN THE SHUNT CIRCUIT PLOTTED AGAINST THE FREQUENCY FOR DIFFERENT VALUES OF THE CAPACITY, THE RESISTANCE OF THE SANDSTONE BEING ZERO.

* V. Poulsen, "A Method of Producing Undamped Electric Oscillations and its Employment in Wireless Telegraphy," *The Electrician*, Vol. LVIII., p. 166, 1906.

† V. Poulsen, "Production of Continuous Electrical Oscillations," *Trans. Int. Cong.*, St. Louis, Vol. II., p. 963, 1905; also *Science Abstracts*, 1620 A, 1905.

‡ "On the Production of High-frequency Oscillations from the Electric Arc," *Bulletin of Bureau of Standards*, Vol. III., No. 2, 1907; also *The Electrician*, Vol. LIX., p. 632, 1907.

Digest of Wireless Literature

A "WIRELESS" ORGAN.

THE *Wireless Age* for September contains an article on "The Desilets Wireless Organ," invented by the Rev. Georges Desilets, of Nicolet, Quebec. It operates on the principle of the rotary spark-gap, the note of which, it is well understood, depends mainly upon the number of sparks made per second. In the simplest form of the Desilets apparatus eight rotary spark-gaps emitting notes corresponding to the musical octave are mounted on a single shaft, which is revolved by a motor. The current is switched through one or more of the gaps by means of an arrangement like a piano keyboard.

The inventor writes that this music has been heard by trans-Atlantic liners in the St. Lawrence River and by the Marconi stations at Montreal, Three Rivers, and Quebec. At present, however, his set is silenced by the war regulations.

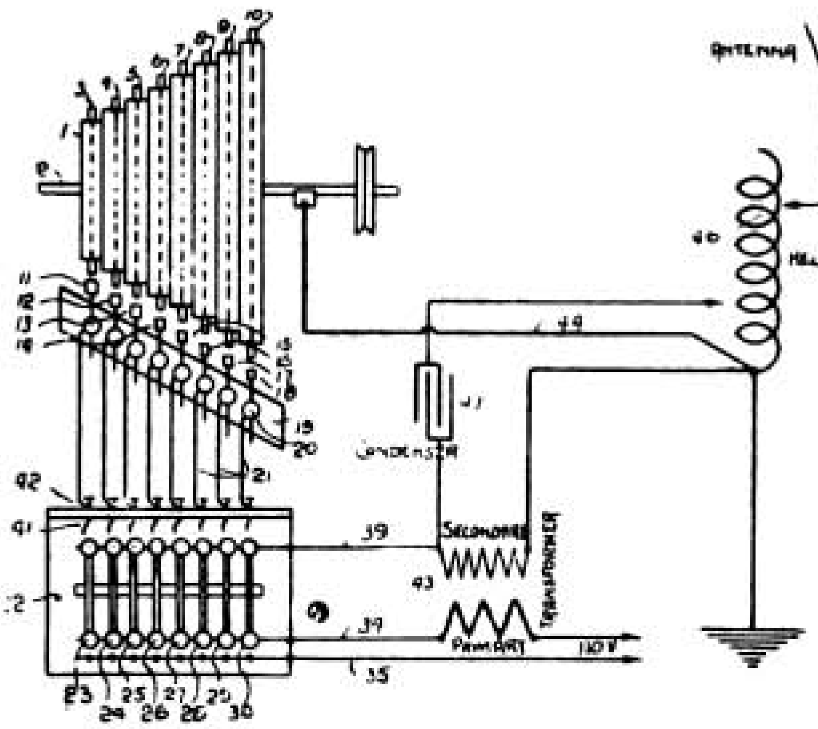
Ordinary wireless sending and receiving apparatus is employed, except that in place of the ordinary sending key a plurality of keys are employed, the operation of any one of which will cause a certain musical note to be transmitted, different notes being obtained according to which key is operated. The various musical notes are obtained through the medium of annular rows of rotating spark-gaps, each row producing sparks of greater or less frequency than the adjacent rows. A most convenient way of obtaining this result is to provide the annular rows of spark-gaps in the form of points or studs projecting radially from the surface of a conical or frusto-conical rotor, the points in one row being the same distance apart as the points in any other row. Thus the points in the row of greatest diameter would be more in number and would travel at a greater speed than the points in the row of smallest diameter and produce sparks with greater rapidity. In order to produce a regular scale of musical sounds the number of points on each row is determined by the following relation between the number of points in two adjacent rows well known in acoustics:

$$1, 9/8, 5/4, 4/3, 3/2, 5/3, 15/8, 2$$

The invention will be better understood with the aid of the accompanying drawing, which illustrates a diagrammatic view of the apparatus.

The points belonging to each of the annular rows and the different rows before mentioned are electrically connected to each other and to the shaft, 2. Further, the points of one row are the same distance apart as the points on the other rows, and as an example it may be mentioned for purposes of comparison that, if the row 3 contains twenty-four points, the row 4 contains twenty-seven, the row 5 thirty, the row 6 thirty-two, the row 7 thirty-six, the row 8 forty, the row 9 forty-five, and the row 10 forty-eight, according to the relation before mentioned.

The points form poles and operate in conjunction with a plurality of fixed poles, 11, 12, 13, 14, 15, 16, 17 and 18, one for each row of spark-gaps, and carried by a suitable insulator, 19, provided with terminals, 20, to which and the fixed poles are connected electric wires, 21, leading from the keyboard, 22.



The keyboard, 22, comprises a set of keys, 23, 24, 25, 26, 27, 28, 29 and 30, each of which is pivoted intermediately to a fixed wooden bar, 31. The underside of the outer end of each key carries a contact, 32, electrically connected by means such as the spring, 3, to one of the wires, 34, of the line circuit and the other wire, 35, of the line circuit being provided with a contact, 36, beneath each key, adapted to co-operate with the contact, 32, to close the line circuit. Both ends of a key are insulated from each other by the joining arm made of suitable insulating material.

The outer end, 37, of each key is provided with a contact, 38, at its upper end, which is also connected beneath the key to one of the high tension wires, 39, by means of the spring, 40. Forty-one are spring contacts insulated from each other, respectively extending from terminals, 42, to which the wires, 21, are connected. All the contacts, 38, are normally away from the contacts, 41, and, in pressing the key, the contacts are adapted to be closed just a little before the contact, 32, of the other end of the key touches the contact, 36. Thus the high-tension contacts are closed before the low-tension and opened after the opening of the low-tension contacts, which prevents sparking at the high-tension contacts.

The wire, 34, is connected with the primary coil of a transformer, 43, while the wire, 39, supported by an insulator, is connected to the secondary coil of the transformer. The shaft, 2, is also connected by a wire, 44, to the ground wire, 45, of the ordinary wireless outfit, while the usual helix, 46 (an oscillation transformer may also be used) and condenser, 47, are employed, the former being connected with an antenna in the usual manner.

Speaking of the apparatus, the inventor remarked: "This system is quite simple, and may be operated with any sending station using a transformer. Moreover, it can be constructed with any number of notes and of any size to suit the power of a particular station. I have a home-made working model playing thirteen notes on one rotor: do, mi, sol, la, si, do, re, mi, fa, sol, la, si, do."

Those who have heard it agree that it is real music. Chords are produced by pressing two or three keys, and if the feeding transformer can supply the necessary power we have surprising results and pleasant effects. Obviously a more elaborate machine constructed on the lines suggested would give even better effects.

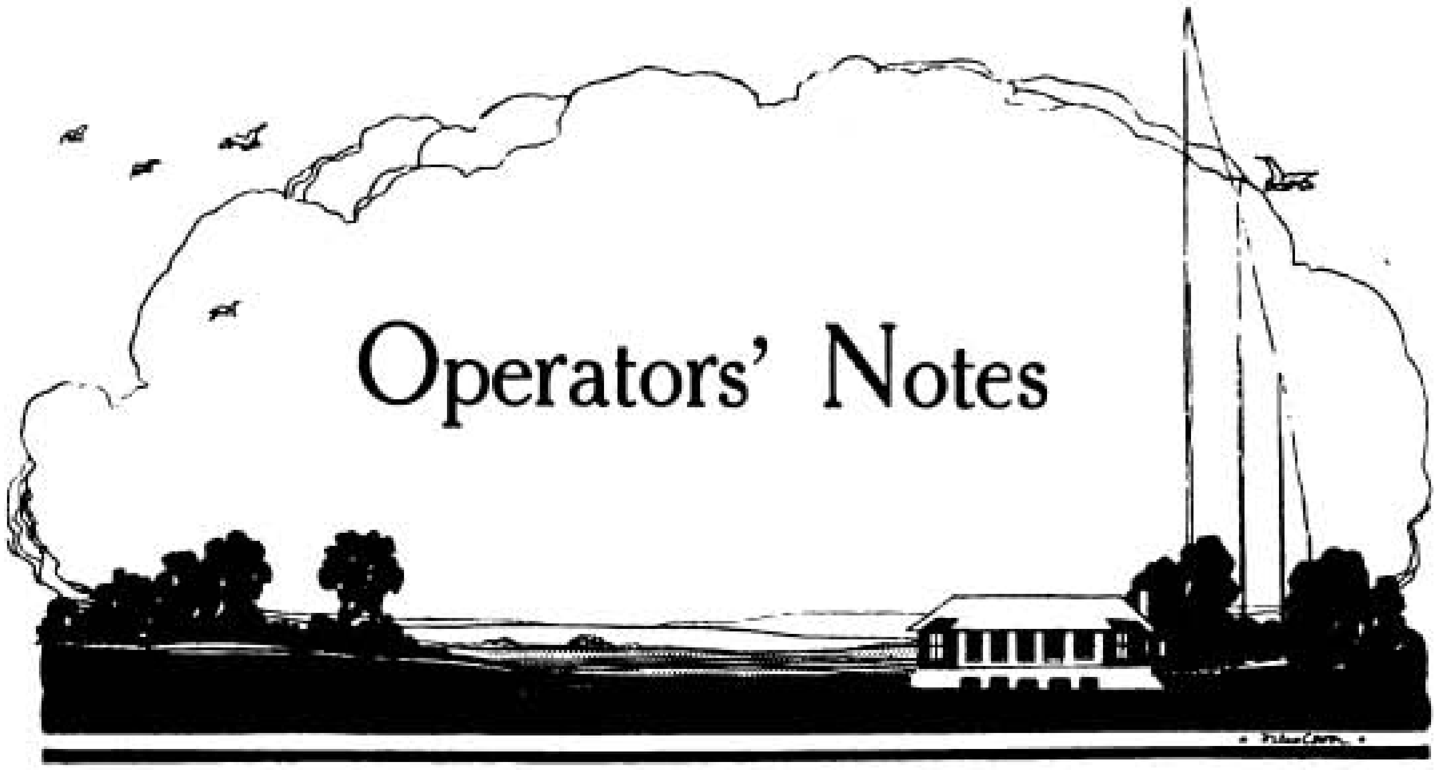
WIRELESS PROGRESS.

In the 2,000th number of the *Electrician* Dr. J. A. Fleming contributes in his usual lucid and interesting style a valuable article entitled " Radiotelegraphy : A Retrospect of Twenty Years." Dealing with the production of continuous waves —a subject of great interest to wireless men at the present time—Dr. Fleming says that a promising line of advance has been opened by improvements in high-frequency alternators. Starting from early work by Tesla and Elihu Thomson, R. A. Fessenden constructed high-frequency alternators of the Mordey type driven by De Leval steam turbines about the year 1907. In the same year R. Goldschmidt described a type of alternator in which by reactions between the fields of a stator and rotor each shunted by condensers and inductances frequency was multiplied up. Machines of this type have now been made up to 100 kw. in size, which can augment frequency from, say, 10,000 to 50,000.

E. F. W. Alexanderson, says Dr. Fleming, has, however, by careful attention to mechanical details, built improved inductor alternators giving frequencies up to 100,000 and output up to 50 kw., the necessary high speeds being obtained by step-up helical gearing running in oil. High-power stations for trans-Atlantic working have been constructed at Tuckerton, U.S.A., and Hanover, in Germany, in which Goldschmidt alternators are employed. These continuous wave generators necessitate special receivers. With the Poulsen arc a form of rotating chattering contact called a tikker is used. Goldschmidt has invented a tone wheel receiver which reduces the radio-frequency of received waves to an audio-frequency suitable for affecting a telephone. R. A. Fessenden devised a very ingenious method of beat-reception called a heterodyne receiver. The principle involved is that the high-frequency oscillations in the receiving antenna are made to create beats of frequency 300-500 by interference with a local service of high-frequency oscillations, and these beats can affect a telephone. The methods of undamped wave generation have rendered wireless telephony possible, and much interesting pioneer work has been done in this by Fessenden, Poulsen, Colin and Jeance, Vanni, Marconi and Round, and by Japanese workers. Speech has been transmitted 1,000 km. by radio methods by Vanni, and in one gigantic experiment conducted in the United States it was transmitted from Arlington, U.S.A., to the Eiffel Tower, Paris ; and also to Honolulu. Radiotelephony is, however, still in the experimental stage, and has not yet been brought into a condition for commercial and regular use. Dr. Fleming concludes by saying that we are still looking for a more simple, cheap, easily managed yet powerful generator of undamped waves.

Wireless and Meteorology

A WIRELESS station has been established on Dickson Island, at the mouth of the Yenisei, by an expedition under the leadership of Dr. Kuchakov, for the purpose of sending meteorological telegrams to the physical observatory in Petrograd. The value of these telegrams will be felt chiefly in Siberia.



Operators' Notes

Faults on 1½ kilowatt set

By W. D. LACEY

CANDIDATES for the Postmaster's Certificate are required to demonstrate their practical knowledge of tracing and clearing faults.

The following notes have been penned with the object of aiding the student in this branch of the examination. The following is the order in which to attend to the various parts of the apparatus.

It is needless to mention that a thorough knowledge of diagrams is absolutely essential in tracing faults and connecting apparatus.

Main Switch.—See the fuses are in place, and that the switch blades are making proper contact in their sockets.

Motor Starter.—See the lead from the main switch is connected to the terminal marked *L*, and also note that the connection to the armature from the " A " terminal is joined. Next attend to the field connections. The no-volt release may be disconnected at one of the small terminals underneath it. The lead from the field terminal (marked *I*) should be connected to the field regulator, and the remaining terminal of the field regulator to the field connection of the motor. The return line from the motor joins direct to the main switch. The overload release on starter may be set in such a way as to short circuit the no-volt release, in which case the starter-handle will not adhere to the release. To remedy this, adjust the small brass scale until the pivoted armature is loose.

Field Regulator.—Attend to the connections mentioned above, and take care that the whole of the resistance is not in circuit, as this would cause the motor to gather too great a speed.

Motor.—Attend to *all* the brushes, see they make good contact with the commutator and slip rings. Note that the end of the field winding is connected to the return line, thus making a complete field circuit.

After attending to the foregoing the motor may be started. The following are the indications of faults in the motor connections :

" Arcing flare upon release of starter handle denotes a disconnection in " the field circuit."

" Long thin spark at starter handle denotes disconnection in the armature " circuit."

" No sparking at all usually denotes a disconnection in both the field and " the armature circuits."

Guard Lamps.—If one or both lamps do not light when motor is running, examine the lamps, see the board is properly connected, replace the lamps, substituting new for faulty lamps.

Iolanda Switchboard.—Test both fuses with cell and galvo, see if pilot lamp glows (with motor running), if not, examine the lamp connections behind board, and see if lamp is burned out. If the A.C. guard lamp glows there is no reason why the pilot lamp should not, provided the above points are attended to. It is unlikely the mains between the slip rings and Iolanda board will be disconnected.

Low-Frequency Circuit.—From the bottom left-hand terminal of the Iolanda board a connection goes to the low-frequency iron core inductance, and from thence to the terminal of the manipulating key marked " MAIN."

The connections between the key and magnetic key are very easily attended to, all terminals being numbered, and each joins to its corresponding number. From the terminal of the magnetic key marked " TRANSFORMER," a connection goes to the transformer primary. The two primaries are connected in parallel by joining connections diagonally across the four outer terminals, thus :

From the opposite terminal of the transformer primary a connection returns direct to the bottom right-hand terminal of the Iolanda switchboard (as shown in sketch), thence through fuse, ammeter, and back to the main A.C. switch.

A.C. Voltmeter.—One terminal of the voltmeter is connected to the bottom right-hand terminal of Iolanda board, and the other is connected through a key to the transformer primary, as shown in the sketch, thus placing the voltmeter directly across the transformer primary.

Faults on Key and Magnetic Key.—Before attempting to get a spark (even when *all* circuits are connected correctly), the manipulating and magnetic keys should be searched for faults. When connected, as described under " Low-Frequency Circuit," the following faults may be found :

(1) The back contact of manipulating key may be screwed down, thus shorting the key.

(2) The armature of magnetic key may be screwed down at the adjusting pillar.

Both these faults would result in a continuous spark discharge upon closing A.C. main switch (with motor running).

(3) See there is sufficient tension on armature of magnetic key, as otherwise, upon making the first spark, the armature will stick down and make permanent contact with the bottom contact pillar, accompanied by flaring.

When properly adjusted the armature should vibrate to the changes of the applied alternating current.

(4) Note that the bottom contact of magnetic key is not screwed back out of reach of the armature contact, as in this case the magnetic key is rendered useless for preventing sparking at the manipulating key.

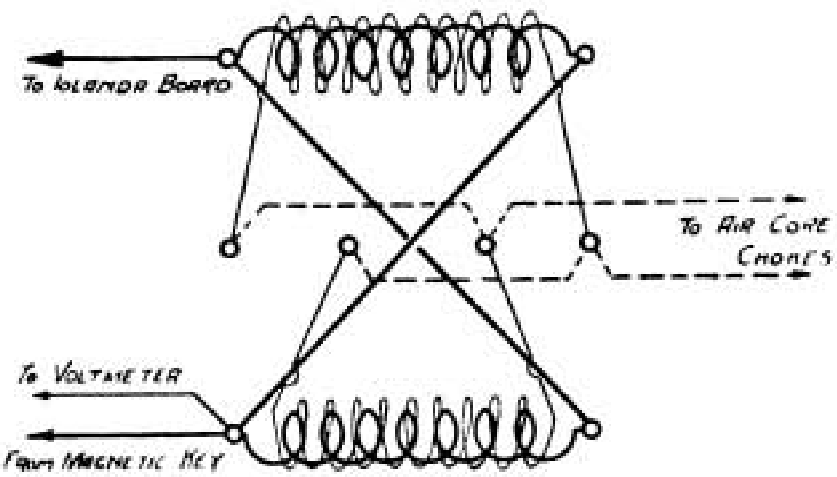
(5) Take care the side lever of manipulating key is not insulated.

High-Tension Leads.—The secondary windings of the transformer are connected in parallel (for 600 metres), as shown in sketch by dotted lines, and from the secondary terminals to the air-core chokes. The chokes can be tested by means of a cell and galvo, but it is unlikely anything will be found amiss with them.

From the chokes two leads go to the spark discharger, one to either terminal. It is highly important that all H.T. leads should be kept well clear of each other, and from low-tension conductors.

For 300-metre wave the transformer secondaries are connected in series. This is done by joining the two right-hand terminals of secondaries together, previously disconnecting the parallel connections.

If the secondary windings are short-circuited the motor will speed up upon depressing the manipulating key. A short circuit on the secondary may be caused by shorting the spark discharger or main transmitting condenser.



Closed Oscillatory Circuit.—All the connections of this circuit are made by heavy copper bus-bars, which are so made as to fit very closely together, and are insulated with wide strips of ebonite. If any of the bus-bars are removed it is an easy matter to replace, as its absence should be noticed immediately. Take care to observe the ebonite separators are in position, and that no points or edges are exposed to neighbouring bus-bars.

The spark gap (if of the fixed type) should be adjusted to 3 mm. (for 600-metre wave), and the condensers in parallel. The condensers are adjusted by means of a switch, which changes over the connections across the terminals.

Aerial Circuit.—One terminal of the jigger secondary is connected to the top plate of the earth-arrester gap, the opposite terminal of the jigger secondary connects to the aerial tuning inductance, or aerial direct (according to size of aerial). The tuning lamp should be connected between the earth terminal of jigger secondary and a point about four feet along the earth lead, usually the top plate of E.A. gap. It is not essential to transmission, and is only used to indicate when the aerial circuit is radiating maximum energy, and consequently is in resonance with the closed oscillatory circuit.

The Emission of Electricity from Hot Bodies

By PROFESSOR O. W. RICHARDSON, F.R.S.

REVIEWED BY DR. J. A. FLEMING, F.R.S.

THIS book of 300 pages is one of the excellent series of Monographs on Physics edited by Sir J. J. Thomson and Professor F. Horton, in each of which the physical student finds some special department of physics treated by a writer who has made it a particular study. The subject of the emission of electricity from hot bodies has an especial interest for radiotelegraphists, because one of the well known and much used forms of wave detector is based on this phenomenon. Apart, however, from its technical application, the whole subject is of great physical, and indeed we may say cosmical, importance.

Professor Richardson has not included in his book any but the very briefest mention of the technical application of this thermionic emission, as it is now called. In his Preface he states expressly that he considered it undesirable so to do. No doubt he was wise not to enter upon the thorny path of discussion as to questions of priority in inventions. In fact, it is only since the publication of this book that an important legal judgment in the United States has cleared the air a little and given an authoritative decision on this matter of the technical application of thermionic facts in telegraphic apparatus. Neither does he discuss at all the problems in cosmical physics which are related to these thermionic phenomena.

The book is restricted to the consideration of the subject from a purely physical and modern research point of view.

It is divided into nine chapters, which are respectively headed: I. Mainly Considerations of a General Character; II. Theory of the Emission of Electrons from Hot Bodies; III. Temperature Variation of Electron Emission; IV. The Effect of Gases on the Emission of Electrons; V. Energetics of Electron Emission; VI. The Emission of Positive Ions by Hot Metals; VII. The Effect of Gases on the Liberation of Positive Ions by Hot Metals; VIII. The Emission of Ions by Heated Salts; and IX. Ionisation and Chemical Action. The author writes, therefore, for physicists who have some acquaintance with modern research, and does not expend any space on explanations of a popular character.

Moreover, owing to the wide expanse of knowledge on the subject, certain portions of it are excluded, such as the electrical properties of flames, which has already been treated in a monograph by Professor H. A. Wilson.

The chief topic of Professor Richardson's book is therefore the emission of electricity from hot bodies, generally in the form of an incandescent wire, in vacuo, or at least in rarefied air or other gases.

It has been known for nearly two centuries that the air near an incandescent solid body is a conductor of electricity, but an important contribution to knowledge was made by the late Professor Guthrie, in 1873, who showed that an insulated red-hot iron ball in air could retain a negative charge but could not retain a positive charge.

Matters are, however, complicated when we work in air or gases at ordinary pressure, and hence Elster and Geitel began about 1880 to examine the potential of the air in the neighbourhood of electrically heated wires in air of varying pressure up to so-called good vacua.

A discovery by Edison in 1884 formed the starting point for fresh research. Edison sealed into an incandescent lamp, made with his horseshoe-shaped bamboo filament, a platinum plate carried on a wire sealed through the glass; the plate being placed between the legs of the horseshoe. He found that when the filament was made incandescent by a continuous or direct current, a galvanometer connected in between the negative terminal of the filament and the terminal of the middle plate indicated little or no current, but when connected in between the positive terminal and the middle plate it indicated a current which might amount to one or two milliamperes.

Edison gave no explanation of this fact, nor did he make any application of it. Certain lamps made in this manner were given to the late Sir William Preece and he described experiments made with them in 1885 to the Royal Society, but neither did he carry the investigation to a point at which any sufficient explanation of the phenomenon was presented, though he made a number of new and interesting observations. The writer's attention had been drawn in 1882 to the phenomenon, subsequently called by him "molecular shadows," in incandescent lamps which indicated a radiation of matter in straight lines from certain overheated parts of the filament, and accordingly he examined more fully the Edison effect in researches described to the Royal Society in 1890 and to the Physical Society in 1896.

The general result of this work was to show that "the Edison effect" was closely connected with the radiation of matter of some kind from the incandescent filament. At that time electrons were unknown, for it was not until 1899 that Sir J. J. Thomson announced his epoch-making discoveries concerning masses smaller than atoms, which he called corpuscles, but which are now generally called electrons and regarded as units or ultimate elements of negative electricity.

In the writer's experiments it was shown that if the negative leg of the incandescent filament was included in a glass or metal tube, the Edison effect vanished, and several other experiments of like nature proved that the current which flows through the so-called vacuum was carried from the incandescent carbon to the middle plate by matter of some kind. The writer attributed this convection to negatively charged carbon atoms. Sir J. J. Thomson's classical experiments proved, however, that the negative electricity emanating from an incandescent carbon filament was carried by corpuscles having not more than about 1/1800 of the mass of a hydrogen atom. Hence it may be said that when a metallic wire or carbon filament is made incandescent in a high vacuum there is a continual evaporation or emanation of negative electricity from it in the form of electrons. The question, therefore, arises: What is the relation between the temperature of the wire and the number of electrons emitted per second per centimetre square of the surface of the wire? This is now called the thermionic current. Professor Richardson's researches have enabled him to give two formulæ, either of which is capable of approximately representing the facts, viz.

$$N = a\sqrt{T}\, e^{-b/T} \text{ and } N = cT^2 e^{-d/T}$$

where N is the number of electrons emitted per centimetre square per second, T is the absolute temperature and a, b, c, d are constants.

The second formula has a rather better theoretical basis than the first.

The constants have been determined for various substances, and on page 69 Professor Richardson gives for carbon, $a=10^{34}$, $b=7{\cdot}8\times 10^4$ and for platinum, $a=7{\cdot}5\times 10^{25}$, $b=4{\cdot}93\times 10^4$. It will thus be seen that the thermionic emission is greater for carbon than for platinum. The writer showed in a Royal Society Paper in 1890, that the "Edison effect" was very much greater for a carbon filament lamp than for one made with a platinum wire as the incandescing filament.

It has been shown, however, that when we heat a metallic wire up to about a dull red heat, the first effect consists in the production of positive ions round the wire, and these increase in number with the temperature. The negative ions do not make their appearance at first in great number, but they increase faster than the positive as the temperature rises.

The phenomenon is therefore much influenced by the nature of the gas in which the wire is immersed. Hydrogen seems to have a very marked effect in increasing the number of the negative ions. This part of the subject is treated in the fourth chapter of Professor Richardson's book, and it will be seen that there is some conflict of evidence as to the facts. It will be evident that we labour under great difficulty in not being able to exclude entirely the effect of the surrounding atmosphere. We are in the habit of speaking of "good vacua" or "high vacua" as if the spaces referred to were empty of matter. If we recall to mind that at atmospheric pressure there are in every centimetre cube about 10^{19} or 10^{20} molecules of air, it is easily seen that a so-called vacuum of one-millionth or even one-hundred millionth of an atmosphere is a space crowded with molecules.

It is, therefore, not remarkable that many experimentalists have come to the conclusion that the ions emitted by a wire, at least the positive ions, are the result of some ionisation of occluded gas. Professor Richardson has, however, shown in his interesting fourth chapter that there is no good reason to believe that the emission of negative electrons from metallic wires is due to chemical action between the metal and the occluded or surrounding gas. This electronic emission increases at an enormous rate with temperature, and in the case of a most refractory metal like tungsten with a melting point of about 3267° Centigrade, the emission may even amount to as much as 4 amperes per centimetre square. But a current of 1 ampere is 1 coulomb per second, and 1 coulomb is 3×10^9 electrostatic units. Hence, 4 amperes is 12,000 million electrons per second.

The question then arises, Where do all these electrons come from?

According to one theory of electric conduction in conducting solids, there are within the solid free electrons which are moving irregularly like the molecules of a gas. The effect of an impressed E.M.F. is to superimpose on this indiscriminate electronic motion a regular drift in one direction. These free conduction electrons are in most cases about as numerous as the atoms of the metal, that is, there are about 10^{23} per c.c. According to this theory rise of temperature increases the velocity of motion of these electrons, and may therefore give some of them sufficient kinetic energy to carry them right out of the surface of the metal into the external region. There are some difficulties in the way of this hypothesis of permanently free electrons, but there is much to be said in favour of the view that the thermal electronic emission involves the same class of electrons as those involved in electric conduction. Generally speaking, the heating of the wire experimented upon is effected by means of an electric current. It is desirable that more extensive experiments should be made on the thermionic emission from substances which are heated, not electrically, but by radiant heat, as, for instance, by a powerful mirror or lens. Such experiments would have to be conducted in a tropical climate.

Returning then for a moment to the question of the emission of positive ions from a heated wire we find this part of the subject carefully treated in Professor Richardson's sixth chapter. The chief characteristic of this positive emission, as he points out, is its transitory character. This means that if a metal is heated at a constant temperature, not too high, the emission of positive ions falls off rapidly with time. The rate of decay increases rapidly with temperature. A wire which has lost the power of emitting positive ions through frequent heating can, however, have this quality restored by several methods which Professor Richardson describes, various experiments tending to elucidate the origin of these positive ions.

The eighth chapter of this book gives a long and interesting account of the emission of ions from heated salts. As is well known, Wehnelt discovered that certain oxides, such as those of calcium and barium, when heated in vacua on a platinum strip yield a very large electronic emission. The same thing occurs in the case of very many other salts. Curious to say, the function which connects temperature with thermionic current in the case of these salts is of the same mathematical form as in the case of metals and carbon. Nevertheless, the information collected on the subject raises more questions than it settles, and there is room for much work before the phenomena are fully understood.

The whole subject in fact is very closely connected up with that of chemical action generally, and hence it is quite appropriate that the last chapter of the book under review should be entitled "Ionisation and Chemical Action." There are many simple cases of chemical action in which the resulting compounds or substances exhibit electrification. Thus a rod of carbon burning in air acquires a negative charge whilst the air itself in the neighbourhood is positive. When iron is dissolved in sulphuric acid, the hydrogen liberated is positively charged. An enormous number of facts have been collected, but the general principles which can be traced in connection with them are so far few.

Before these more complicated effects can be explored it will be necessary to have more light upon the mechanism of simple thermionic emission from pure metals in the highest vacua.

The book before us, however, is a carefully collated record of much valuable research, and is, therefore, a very welcome addition to the literature of the subject.

Thermionic rectifiers and amplifiers have already proved themselves to be appliances of great value in connection with radiotelegraphy and radiotelephony, and any improvements to such appliances can only be brought about by a careful study of the physical phenomena involved. Towards this study Professor Richardson's book is a valuable contribution. The book is published by Messrs. Longman, Green & Co., and therefore it is needless to say that the printing and general appearance of the book are all that could be desired from the point of view of the reader and student.

C

Wireless Telegraphy In the War

"NOTES" IN THE AIR.

"WHEN found make a note of," says Captain Cuttle in Dickens's famous novel, *Dombey and Son*. We learn from wireless operators who ply their occupation at sea under present war conditions that the various notes which they are continually finding are almost infinite in their variety. A man on duty in the North Sea, for instance, after answering the deep note of the high-power station, as he is in course of adjusting his instrument, will often be quite dazed by the medley of notes which he is obliged to tune out before he hears the high, chirpy voice of his patrol leader. After breaking off from this he perhaps finds himself receiving the hoarse, rough note of a destroyer talking to the Admiralty. In quaint contrast comes later the piping tones of a paddle sweeper making his report to his superior ashore. By and by comes the clear small voice of a seaplane reporting "All is well," varied by a shrill but scratchy note, with a tone like that of tearing paper, which indicates that British submarines are out "nosing for the foe." Later on the flagship may call for attention with its dominating note, eloquent, by the very sound of it, of authority and importance. When a vessel is sinking, torpedoed by an enemy submarine, the ether is vibrant with notes, pitched in every imaginable key, and this continues until the matter is finally adjusted. So the day wears on to dark, when signals become louder and the operator listens eagerly for the Press News from Poldhu and Eiffel Tower, as well as for the fanciful tale radiated from Norddeich. Each of these stations is characterised by its own peculiar note.

Such is the epitome of a typical day's work carried through, all the time, by wireless operators at sea. We have summarised it from an account written *in extenso* recently by a correspondent of a Liverpool contemporary, since it does in fact, to our own first-hand knowledge, give a very fair outline of what wireless operating at sea is like in these strenuous days. Of a truth, the advice put by Dickens in the mouth of Captain Cuttle was conceived in a truly prophetic vein; wireless operators at sea are always finding fresh notes, and of "making notes" about them there often seems to be "no end."

CO-ORDINATION AND WIRELESS LINKS.

A most noteworthy feature in the present Grand Offensive of the Allied Forces consists of the immensely improved co-ordination of the various branches of military activity. The enemy himself has expressed admiration for the way in which the French infantry, artillery and air-craft work in unison; whilst, to judge from recent results, the same *desideratum* appears to be more and more realised in the case of our own gallant Army, whose initial difficulties—owing to their more recent organisation—were far greater in this respect. Interwoven with all of them are the wireless sections, which form the connecting links, and enable the observation officers to guide the operations of the whole offensive. Our illustration on this page will (taken in conjunction with those printed in former issues) enable readers to follow in detail the items which go to make up this effective whole. Mobile wireless stations follow the airmen and infantry as they move from one place to another, and are not liable to the interruptions caused by enemy artillery through the severance of wires essential to the old form of field telegraphs. The illustration overpage will specially arrest attention, as it depicts a French field wireless installation on the Somme in the act of transmitting a message to Headquarters.

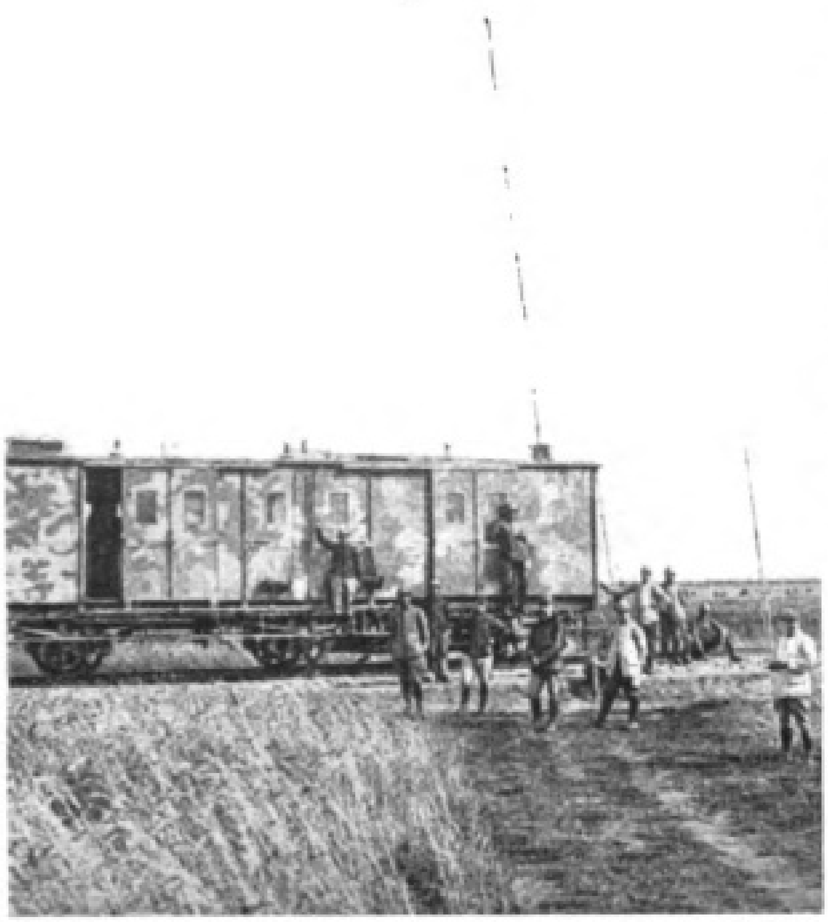


Photo by] [*Newspaper Illustrations.*
FRENCH WIRELESS RAILWAY INSTALLATION.

An excellent example of the importance of maintaining continuous "touch" between Divisional Headquarters and the front lines was recently furnished by the despatch of the German General von Armin. He lamented the deficiencies in this respect under which the Germans on the Somme were suffering, and pressed urgently for the issuing to the Staffs of infantry regiments and battalions of an increased number of light wireless stations. Moreover, on the Austro-Italian front we have been recently treated in one of our Allies' *communiqués* to a description of the "drum fire" inflicted by the Italian long-range guns. These concentrate a heavy bombardment upon areas far behind the line of battle with the express object of severing the enemy's telephone and telegraph wires. Austrian *communiqués* recently admitted the success of their adversaries in this respect, but claim that "connections were not altogether dislocated." Such incidents as these constitute an eloquent commentary on the growing superiority of the Allies.

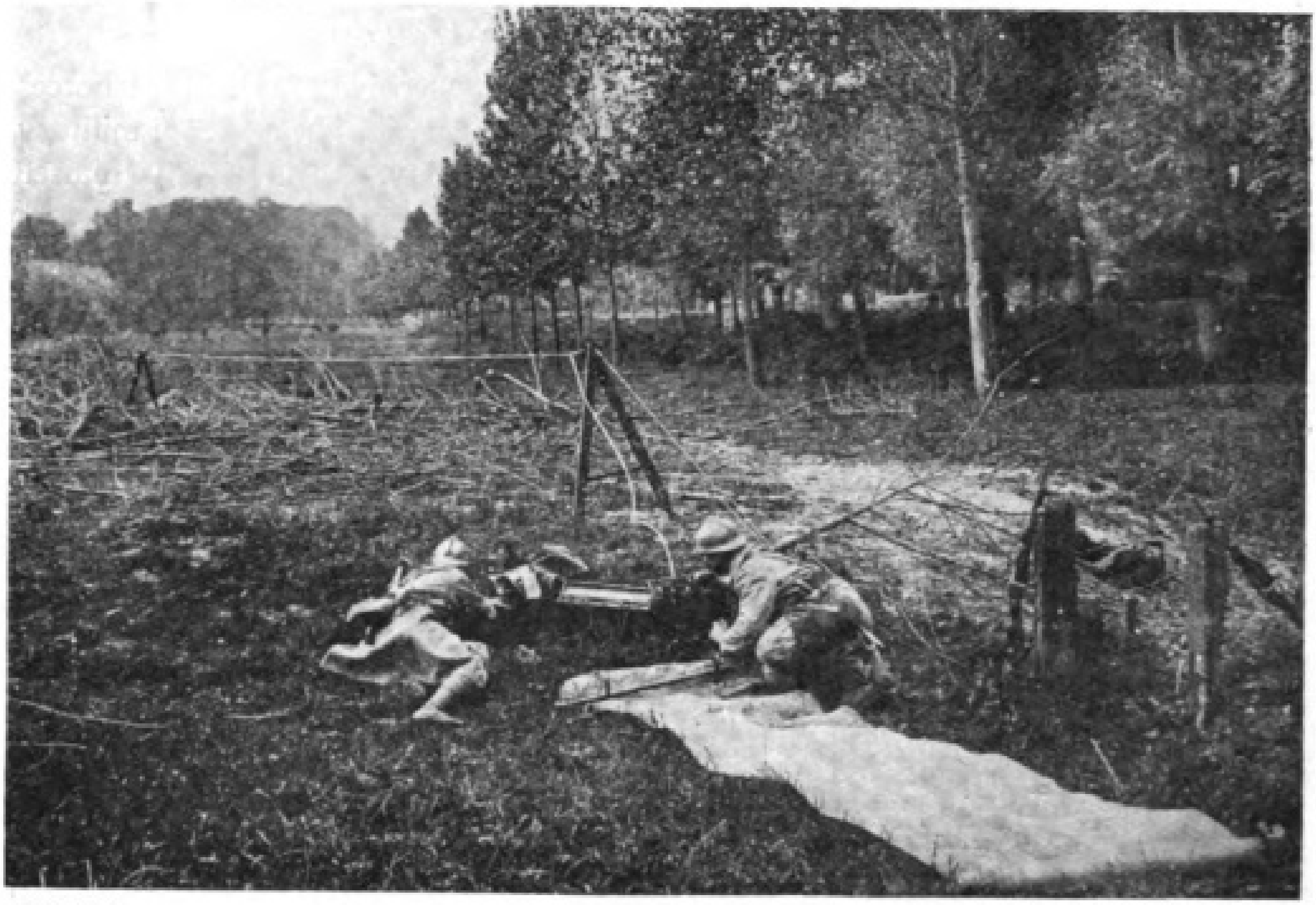


Photo by] [*Newspaper Illustrations.*

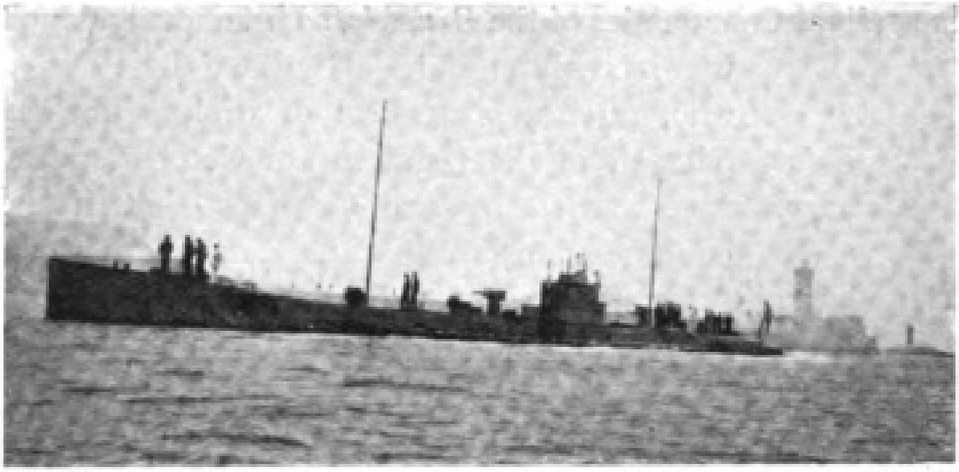
(*c*) FRENCH WIRELESS OUTPOST ON THE SOMME.

A FAMOUS BRITISH JOURNALIST.

Nothing strikes the imagination so much as the unexpected. Queen Victoria's favourite statesman, Lord Beaconsfield, was well aware of the fact, and made such use of his knowledge as to earn from the satirists of his day the soubriquet of "Our "Startling Man." Lord Northcliffe belongs to the same intellectual order as Benjamin Disraeli, and as soon as he had extracted all the pungent "copy" available out of Verdun, he turned his attention to astonishing the public by his revelations of the success of Hun propaganda in Spain. From the little fortified city of Pampeluna, in the northern section of the Iberian Peninsula, he addressed a series of articles to the *Times,* giving full details of the way in which the Germans utilise their practised skill in "wireless" (and other) propaganda work to capture public opinion there. "Their chief methods seem to be," says Lord Northcliffe, "the transmission of a "daily stream of wireless *communiqués* from Berlin and Austria discrediting the "Allies, continuous activity on the part of the Church and Carlists, and the influence "of the German colony, together with steady work on the part of the University "professors and skilled masters on behalf of the Central Powers—the chief channel "being, of course, the Press." This process has been going on ever since the war started, and, despite the disadvantages under which the Teutonic mind must work when in contact with so totally dissimilar a point of view as that of a Latin race, they seem to have succeeded to such an extent that "one is doubtful of the lasting "effect of anything short of a smash and palpable military defeat of Germany, one "that cannot be disproved by wireless."

U-Boat "Heroes" in Spain.

It will be remembered that this last summer Cartagena was honoured with a sensational visit from the German submarine U 35. We are now able here to reproduce two pictures taken on that occasion: (*a*) Showing the German under-water craft entering the harbour in the early morning, and (*b*) a part of the same submarine lying alongside the Spanish cruiser *Cataluña*.



Phot.] [W. B. Cole.

U 35 ENTERING CARTAGENA HARBOUR.

The Wireless Aerials are of "Inverted L" type.

A correspondent informs us that the U 35 was plainly expected, for the numerous members of the German colony were all waiting for her. Indeed, Germanophil news is so prompt in reaching the Peninsula, despite its total isolation by land from the Central Powers, that there is every reason to believe that the Spanish authorities, with the best will in the world towards maintaining the etiquette of neutrality, are not able to prevent the use of illicit Teutonic wireless. The whole U-boat affair was conducted in the most theatrical manner; the German officers paraded the city at all hours, acknowledging salutes in an extravagantly dramatic manner. Gaping crowds followed them all over the place, and watched the "Cabelleros" take their refreshment in the open-air cafés.

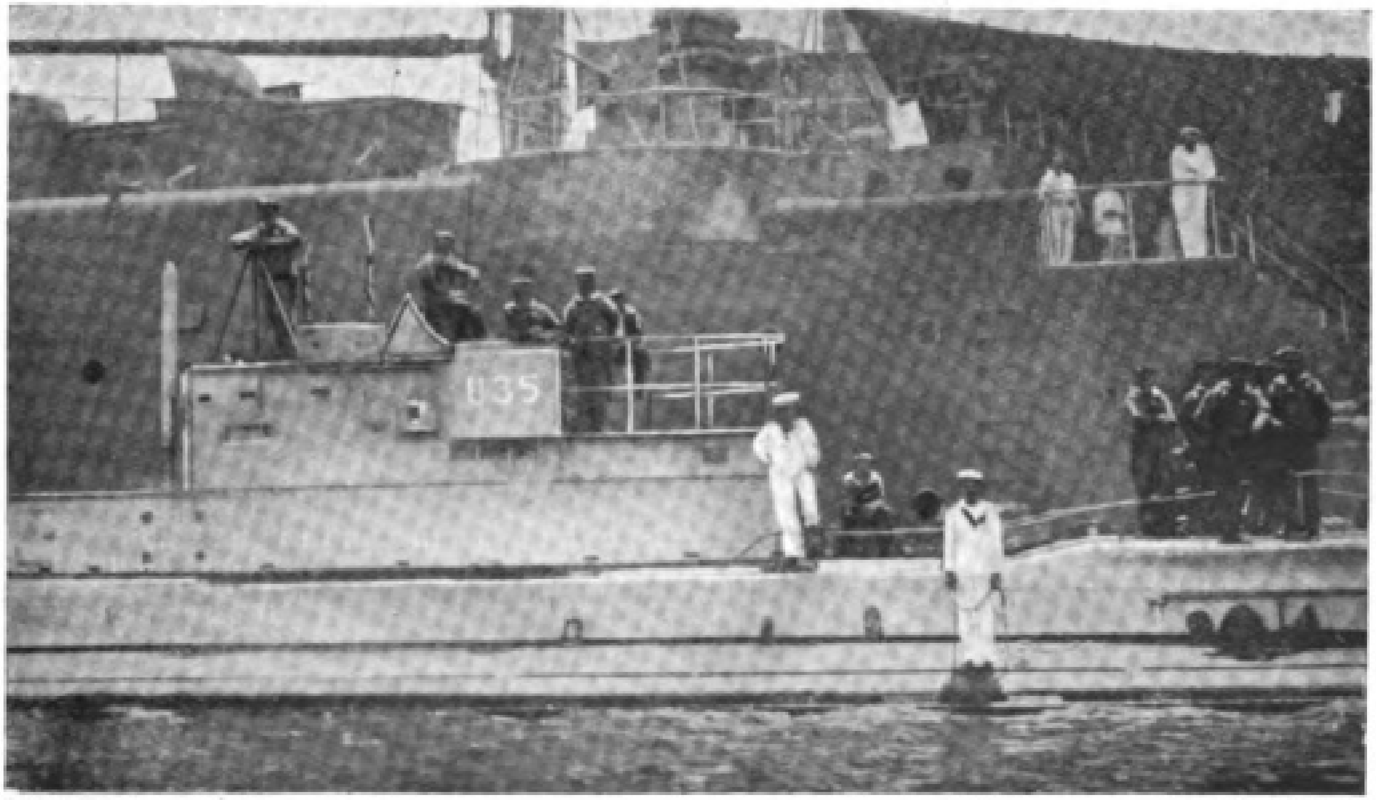


Photo by] [W. B. Cole.

GERMAN SUBMARINE ALONGSIDE SPANISH CRUISER "CATALUÑA."

War Notes

A VERY touching little posthumous incident connected with Captain Fryatt, the gallant Commander of the *Brussels*, so infamously done to death by the Germans, was recently chronicled by the daily Press. The English stewardesses who, after a great deal of diplomatic *pourparlers*, were at length released in the beginning of October, narrated that Captain Fryatt was warned by the Germans that if he employed his wireless equipment his vessel and all on board would be sent to the bottom. Therefore when the wireless operator asked, as the Germans clambered on board, whether he should summon aid the chivalrous seaman answered, "No, I don't care "what they do with me, but I must think of the lives of the women I carry." In view of the recent haul of German and Dutch spies made by the Netherlands Government, the further statement of the stewardesses that movements of the *Brussels* were signalled by flashlight to a German submarine lurking in Dutch waters, and retransmitted by wireless to the German torpedo boat, assumes an air of verisimilitude.

A Sailor's Chivalry.

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The Norwegian newspapers often contain very illuminating little notes concerning the procedure adopted by the enemy. We recently observed a statement, made in the *Tidens Tegn* of Christiania, to the effect that our enemies are taking advantage of the longer range of the more powerful wireless apparatus carried by the latest type of Zeppelin. This wider range enables the German Admiralty to dispense with any other North Sea patrols beyond their airships, which "are watching day and night "all commercial steamers passing to and fro, and communicate the intelligence they "gather by wireless to their submarines."

Zeppelin Scouts.

* * * * * *

We learn from the representative of the Advisory Committee for Aeronautics, presided over by Lord Rayleigh, that many improvements in the detail of aircraft equipment have recently been made. Included in the list of developments recorded by the Committee is the provision of fresh designs of wireless sets of a very light weight for use on aeroplanes. These have been duly decided, and satisfactory results obtained.

Aeroplane Equipment.

* * * * * *

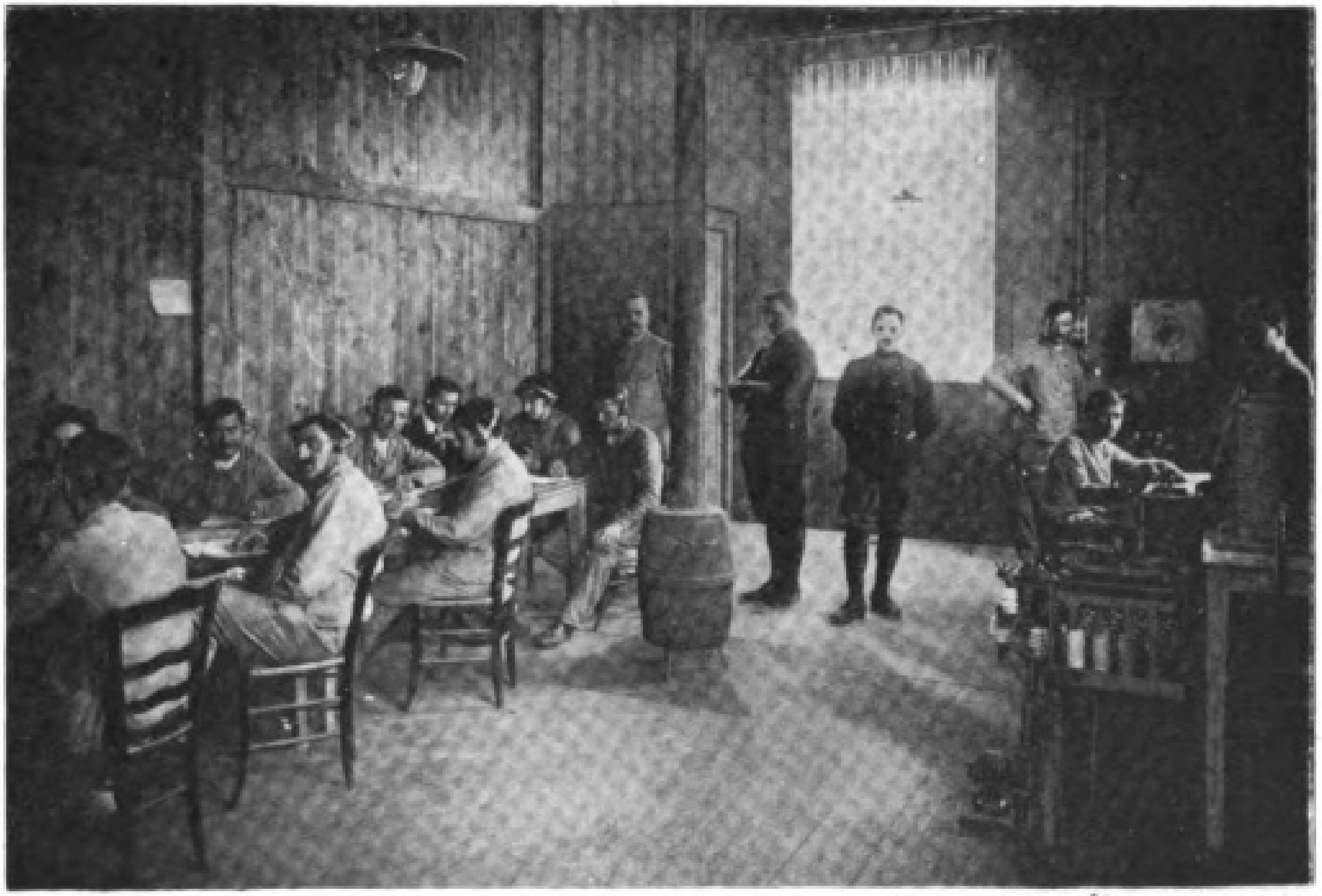
It would appear that a neutral observer was recently visiting Belgium on behalf of the *Matin*. Amongst other interesting items of information brought back by him is the statement that the Germans continue to be extremely nervous with regard to wireless telegraphy, and maintain a ceaseless search with a view to discovering signs of its employment. Indeed, they have recently carried out a campaign of prosecutions and imprisonment throughout Belgium.

Afraid of Wireless.

Re-arming Disabled Soldiers for the Battle of Life

How the Mayor of Lyons re-fits Men Maimed in the Present War for their Return to the Ranks of Industry

A GROUP of men were once gathered together watching a sight which stirred the emotions of them all. Various expressions of feeling came from different spectators, and one of them, a Quaker, thus brought matters to a head. " Friend,"



[*Cliché de l'École de Tourvielle.*

TEACHING WIRELESS TELEGRAPHY AT THE LYONS SCHOOL.

said he, addressing one of those who had given freest play to his expressions of pity, " I sympathise £10 ; how much is thy sympathy worth ? "

The moral of this apologue is that sentiment loses its value unless every endeavour be made to translate it into practical activity. Sympathy for war-sufferers abounds in England ; but are we as practical in our expression of it as our gallant Allies across the Channel ? The following account of their good works may give us " furiously to think " in this respect.

There probably never was a war which will leave so large a legacy behind it of men whose industrial activity might at first sight appear to be ended for ever. If this were *actually* the case to the extent to which it is *apparently* so, an enormous amount of misery would result for the victims themselves, and a vast economic loss to the community at large. Philanthropic sympathy for the individual and patriotic zeal for the community therefore combine to impress us with the desire to bring this incapacitation within as narrow limits as possible. A most notable effort in this direction is due to the far-sighted initiative of Mons. Herriot, the public-spirited *Maire* of Lyons, who, from the moment when the stream of wounded started flowing in during the autumn of 1914, realised the extreme desirability of taking action at once, and refused to postpone his efforts until the end of the war. The Lyons Industrial Schools for the wounded are the result of his action. By their establishment—like the Quaker above referred to—this noble Frenchman has translated his sympathy into terms of active assistance.

Wounded men, especially those with amputated limbs, are usually unable to follow the occupation by which they earned their bread in times of peace. Mons. Herriot realised that they must, therefore, be trained afresh, and proceeded to establish an organisation for so doing. He was confronted with two alternatives :

(*a*) He could follow the principle of the Day School, allowing the pupils to make separate arrangements for board and lodging ; or

(*b*) He could proceed on the lines of the Boarding School, taking charge of their whole existence, and not merely of those hours devoted to training and study.

[*Cliché Meurisse.*

A ONE-ARMED PUPIL STUDYING CARPENTRY AND WOOD TURNERY.

In view of the peculiar circumstances of the case, his choice fell upon the latter, and he has set up establishments in which wounded soldiers who have been finally discharged from hospital can, after but one week's furlough, be received and trained completely, free from any distracting influences incidental to their being partially out of the control of their School of Administration.

It was on November 30th, 1914, that Mons. Herriot induced the Municipal Council of Lyons to authorise the establishment of such a school in his town. The Minister for War granted

[Cliché de l'école de Tourvielle.
ONE-LEGGED TAILORING PUPILS.

the necessary confirmatory authorisation on December 29th; but so rapid was the action taken that pupils had already started coming in on the 16th of the same month. The principle upon which students are chosen is that only those should be accepted who are completely and definitely cured, *i.e.*, that they should belong to the class which is known in France as men entitled to discharge No. 1. The greater number are those who have been incapacitated through amputation, although some of the pupils suffer from paralysis or cramp. As soon as the candidate is discharged from hospital, the School Authorities first of all make sure that he is capable of standing the strain of labour and he is subjected to a careful course of interrogation, conducted with the utmost kindliness and tact, in order to ascertain not merely the occupation which he followed before the war, but also his personal habits and constitution. Over and above this, the interrogator endeavours to ascertain the general tendency of his moral attitude and character. The object of this latter procedure is to make sure that he possesses the necessary will-power for profiting by the opportunities which the school affords. Even after these preliminary tests, great care is necessary before the candidate is started upon the course destined to fit him for the battle of life. Once started along particularised lines no deviation is possible, and it is therefore of the utmost importance that mature consideration should be given before the individual selects his future occupation. This fact is realised and acted on by the School Authorities.

The good work has been located in two different buildings, one in the centre of the town known as the École Joffre (41 rue Rachais), the other in a suburb of Lyons, which is entitled the École de Tourvielle. The former is the original establishment and the centre of administration. Pupils are boarded, lodged and instructed free, and existence is made as agreeable as possible to them by an extremely paternal supervision. They remain as long as is necessary for acquiring a knowledge of the trade selected, and in fact pass through so complete an apprenticeship as to be assured of finding work under advantageous and remunerative circumstances as soon as they are ready to leave the establishment. Moreover, Mons. Herriot has decided to allow a small daily wage of 1 franc 25 cents, which the students can either allocate to family needs or put by in order to constitute a little hoard which may be useful to him in settling down to outside life.

For the convenience of those who desire to find employment straight away without passing through any school curriculum, an Employment Bureau has been established, which keeps in constant touch with private firms and public bodies likely to have suitable places to offer. Experience up to the present has shown that, in the case of these Employment Bureaux, the demand for workers considerably exceeds the supply.

The first class to be constituted was that of Dactylography; and, apropos of this, Mons. Herriot remarks that he has been extremely surprised by the rapidity with which men who have lost their right arm acquire the art of writing with the left hand. The other subjects for which facilities for study have been provided are as follows:—In the École Joffre, 41 rue Rachais, pupils receive instruction in accountancy and toy making, besides education in the art of book stitching and binding; at the École de Tourvielle (situated in a suburb of Lyons) the curriculum comprises boot-making, tailoring, carpentering, horticulture, clog-making and Radio-Telegraphy. *Instruction in Wireless Telegraphy* was initiated in November, 1915, under the management of Commandant Peri, the head of the Military Wireless Station at Lyons. Two special teachers have been appointed, and, at the moment of writing, there are 30 pupils in training there. Besides technical instruction and courses in the theory

[*Cliché Meurisse.*

TOYS MADE BY PUPILS AT THE LYONS SCHOOL.

of the science, general education forms part of the course, so that pupils receive tuition in Geography, Modern Languages, Orthography, etc. Some special courses in Electricity are, moreover, given to them by a Professor of the *Faculté des Sciences.* Up to the present, thoroughly satisfactory results have been obtained, and already some of the pupils have taken up duties in good Wireless Stations. A short while ago one of them received an appointment as Wireless Telegraphist in Konakri, French New Guinea.

In our illustrations we show (*a*) the Wireless School, (*b*) a one-armed pupil at the Carpenter's Bench, (*c*) a group of one-legged tailors, and (*d*) a group of toys manufactured by students. France in pre-war days shared with England the anomalous position of finding the pushful Teuton ousting her own sons from enjoying the fruits of labour in their own country. A notable result of the present war will be (at all events, we all hope so) to sweep away these disgraceful anomalies. The toy-making industry in particular had been practically monopolised both here and on the other side of the Channel, and no better object-lesson can be afforded to English and French children than these toys manufactured by France's maimed soldiers. Illustrations of these are shown on page 618. They will therefore afford British and French little ones not only the intrinsic delight they possess in themselves, but the extrinsic interest of being symbols testifying to the reawakening of national spirit, a reawakening all the more precious for having been accomplished through suffering.

We are sure that readers of THE WIRELESS WORLD will appreciate the noble work undertaken by this patriotic *Maire* of Lyons and his coadjutors, especially in view of the fact that, thanks to their exertions, men who would otherwise have been derelicts from this great world-struggle have been enabled to take an active part in the work of Radio-Telegraphy, despite all the ravages that war has been able to work upon their bodies. The schools are carried on, moreover, without calling upon State or Municipal aid, being *entirely supported by private benevolence.* The present writer recently received a communication written by this distinguished Frenchman with his own hand, and cannot close this brief summary better than by quoting from it. Mons. Herriot states that :—

" I have as yet none but French soldiers, but I should be delighted to receive " here the brave wounded warriors of Great Britain. Such comradeship might " produce extremely happy results. My schools being entirely supported by private " generosity, I should moreover welcome any material aid which any of my English " friends might find it possible to give. For the rest I would be responsible. The " sons of Great Britain would be received and welcomed in our French Home with " a warmth equal to that with which we cherish our own children."

The spirit of humanity and patriotism which finds expression in these words constitutes an object lesson for us all. Not least notable is the fraternal feeling towards Great Britain which breathes through this letter. We welcome the " Brotherly Love " of the civic chief of this historical French city, and share in his remarkable enthusiasm for closer union and co-operation from this side in the work he has so much at heart.

NEW UNITED STATES MOTOR PETROL CRUISER.

THE Naval Department of America has recently prepared specifications for two motor patrol boats. The larger of the two was to cost 28,000 dollars, and have a speed of at least thirty miles an hour. Provision was to be made also for a full load of fuel, stores and munitions, the necessary crew and a 3-pounder gun. The boat is of the hollow-bottom, wave collecting type. She is 66 feet overall, 13¼ feet beam and 4½ feet draught. A wireless room, about 4 feet square, is included in the design, and the ship will be fitted with wireless telegraph apparatus. The American Naval Authorities consider the ship eminently suitable for patrol service and the chase of submarines.

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CANADIAN ICE-BREAKING STEAMER.

On May 15th last the ice-breaking steamship *J. D. Hazen*, built for the Dominion Government, was launched at Montreal. The christening ceremony was performed by Lady Borden, wife of the Canadian Prime Minister, and the whole proceedings were crowned with success. The *Canadian Railway and Marine World* gives the following particulars: The vessel which is intended for work on the St. Lawrence river, possesses a length over all of 292 feet, a moulded breadth of 57½ feet, a moulded depth of 32 feet, and a draught of 19¼ feet. She is of the twin-screw type, designed to work through the ordinary sea ice formed in the river from 12 to 30 inches thick, and also pack ice which accumulates in certain parts of the river, particularly at Cape Rouge. She is of very massive construction, necessitated by the nature of the work she will perform, and, as might be supposed, is fitted with a complete wireless telegraphic apparatus and a searchlight of 25,000 candle power. Electric current is supplied by two direct current compound dynamos driven by high-speed enclosed compound engines.

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GALE SINKS AMERICAN SHIP.

How the *s.s. Ramos* went down is fully and interestingly told by Mr. Ray Green, a wireless operator, in the September number of our contemporary, *The Wireless*

Age. The ship was on a trip from Philadelphia to Cartagena, Colombia, but on the way out she ran into very dirty water, huge seas rising and breaking with tremendous force on the ship's forecastle. Matters got to such a pitch that the captain instructed the operator to send out the SOS signal. Although he could hear Miami station working, for some reason or other he was not able to get in touch with it, and it was only after another steamer had picked up his message and broadcasted it that Miami replied to his call. The result was that two or three vessels, who were within 100 to 150 miles of the distressed steamer, wirelessed that they were proceeding to her aid with all haste. Troublous times were, however, ahead for the crew of the *Ramos*. She was sinking quickly, and the captain ordered the men to the boats. Whilst Mr. Green and some others were sitting in a lifeboat which was being lowered, the *Ramos* rolled to such an extent that men and boat were precipitated into the sea. They subsequently managed, however, to get back into the boat, which was very fortunate as they were within a shark-infested area. After keeping the boat's head to the wind for many hours, they subsequently sighted a vessel which took them aboard and eventually brought them safely to land. It was not an experience which any of them would wish to undergo a second time.

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FOOD FOR HUNGRY ANIMALS.

Another curious incident of the application of wireless telegraphy to the needs of the moment is apparent in the following: A ship bringing wild animals from

3 K.W. TRANSMITTING APPARATUS ON BOARD THE SPANISH GUNBOAT "BONIFAZ."

RECEIVING APPARATUS ON BOARD THE SPANISH GUNBOAT "BONIFAZ."

London to Brooklyn, U.S.A., found herself towards the end of the voyage with an insufficient quantity of food for them. Matters were getting serious, as owing to the lack of nourishment the beasts commenced to attack each other. The captain, therefore, sent a wireless message asking for food to be sent to the ship, and a fast tug was laden with meat and despatched to meet the vessel.

* * * * * *

WRECK OF THE "MATATUA."

The 6,000 tons steamer *Matatua* was in distress off Cape Race, Newfoundland, and was compelled to send a wireless message asking for aid. It was during a very wild gale and the worst fog of the season that the liner *Stephano* was making her way when she received the *Matatua's* call. Although the *Stephano* herself was so close to the rocky cliffs of the land, she immediately started searching about for the distressed steamer. The *Matatua* was, however, beyond help, as she was firmly aground. Her passengers had fortunately been able to get to land.

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SURGEON CALLED BY WIRELESS.

Whilst the steamer *Centralia* was transferring cargo in the harbour at Mazatlan, one of the crew was hit by a sling load of freight and knocked into the hold, sustaining a broken left arm and a serious fracture of the ankle. The operator of the ship immediately called the United States gunboat *Annapolis*, which was lying at anchor a short distance away, and obtained surgical aid within a very few minutes.

NOTES OF THE MONTH

One of the consequences of the *Titanic* disaster in 1912 was an arrangement made between the British and United States Governments for providing ice-patrol vessels on the North Atlantic route to give wireless warnings of the presence of icebergs. Under arrangement with the British Government the U.S.A. have been performing this service single-handed since the outbreak of war, and the Washington authorities send regularly to London reports on the operations of the patrol vessels. The latest of these reports deals with the period from February to the end of August, and it is interesting to note that one of the largest icebergs encountered was located only forty miles north of the steamship lines in the earlier part of June. This natural phenomenon was so huge that the U.S.A. patrol ship *Seneca* found it necessary to stand by for eight days radiating wireless warnings, which caused the deviation of many steamships from the route taken by the iceberg, whose pinnacles when first found were more than 200 ft. in height, whilst the whole mass measured about 400 yards long.

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On pages 615 to 619 of this issue we publish an article dealing with the way in which France handles the problem of the disabled soldier, and we have recently had our attention called to efforts on somewhat similar lines which are being made in Canada and at Tipperary. Readers of The Wireless World will note that a certain number of the maimed patients of the French Schools are being instructed in wireless telegraphy. It gives us the greatest pleasure to realise that it is possible for men, maimed whilst fighting for the cause of humanity, to so far overcome their disabilities as to become expert telegraphists. There is every reason for affording such men suitable opportunities for employment, but it is perhaps not inadvisable to remind both trainers and pupils that *for service at sea full physical fitness is absolutely essential*. The conditions under which they have to work at sea may make at any time the fullest demands upon the physique of wireless operators, so that it would be a mistaken policy to expect this sound regulation to be modified even in favour of our war-disabled heroes.

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On pages 460 and 461 in our September issue we printed the text of the new Government Regulation imposing compulsory wireless upon all steamers over 3,000 gross tons. Action is already being taken under this new regulation, and the vessels belonging to this category are being granted the necessary licences (which involve the obligation of wireless installations) as rapidly as the supply of apparatus, etc., permits.

It is interesting to note in this connection that about the middle of September the French Mercantile Marine Committee appointed nine Commissioners, who, in conjunction with the delegates of Naval and War Committees, will consider measures for ensuring the security of French mercantile vessels by the installation of wireless telegraph apparatus, their equipment with armament and the laying down of regulations for navigation.

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We would call the attention of WIRELESS WORLD readers to the appeal recently issued in the Public Press by Lady Marconi on behalf of the Italian Red Cross in London. She points out that the recent extremely heavy fighting on the Northern Italian front has caused a great influx of wounded men, and imposed a very severe strain upon the funds of the Society. The advent of winter weather with its consequent demand for warm woollen clothing (of which there is great scarcity in Italy) still further increases the drain upon the financial resources of this noble institution. Lady Marconi refers any who may desire further details to the Italian Red Cross, 14 Weymouth Street, Portland Place, London, W., and asks that all who can see their way to demonstrate their sympathy with our Italian Allies in a practical manner, may remit donations to that address.

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Among the relics of the wrecked Zeppelins now being exhibited in London we find portions of wireless apparatus. Wireless telegraphy has been very useful to the Huns in their airship raids on England, for by it the gasbags have been able to keep in touch with one another and with Germany. Writing on wireless on Zeppelins reminds us that in the window of an Oxford Street showroom there hangs a model of a British "Zeppelin" on which the wireless aerials are fitted in rather a peculiar manner. Instead of the usual trailing wire suspended from the centre of the airship, antennæ of the conventional ship type run parallel with the sides of the balloon. It is not stated whether this is the model of a real airship or merely an advertising novelty.

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The Manchester School of Technology is to continue during the winter its war-research work on behalf of the Government, and the scientific training of fit men for army commissions. The course in the first year will be specially to prepare the students for accepting commissions, and will include training in mechanics, methods of calculating ranges, explosives, mining, sanitation, water, searchlights, telephones, wireless, poison gas, field sketching, and gunnery. Truly a comprehensive list!

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Commencing from October 27th, Dr. J. A. Fleming, the well-known scientist, is giving a course of six lectures on "Long-Distance Telephones." The lectures will take place at University College at 5 p.m. on Friday. The sixth lecture will be of particular interest to our readers, as it deals with radiotelephony, its methods, and achievements. The course is open both to members and non-members of the University, and the fee is £1 11s. 6d. Application for tickets of admission should be made to the Secretary, University College, Gower Street, W.C.

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At King's College the new term began on Wednesday, October 4th. The Faculty of Engineering have arranged a course of study, extending over three or four years, in civil, mechanical, and electrical engineering for the engineering degrees of the University of London, and for the diploma and certificate of the College. Provision is made at the college for research work in wireless telegraphy.

Naval and Military Wireless Telegraphists

Their Status and Conditions of Training

* PART II.

RADIO-TELEGRAPHISTS IN THE ARMY.

WIRELESS telegraphy constitutes an important branch of the Army Signal Service, and the officers, non-commissioned officers and men of this branch, as in the rest of the Signal Service, all form part of the Royal Engineers.† The technical personnel of the Wireless Section R.E. may in the main be classified under the following three headings:

(*a*) Wireless operators.
(*b*) Wireless electricians and instrument repairers.
(*c*) Wireless fitters and engine-drivers.

[Photo: Gale & Polden.

A SAPPER (ROYAL ENGINEERS)

The names of the two former classes are self-explanatory, while the men of the third class are responsible for the care and repair of the petrol engines which furnish the power for the larger types of portable Army wireless station. Men who are accepted for service in this trade should have a thorough knowledge of petrol engines and be used to carrying out small repairs. A certain number of good engine fitters without special knowledge of petrol engines can also be employed.

Wireless telegraphy in the Army has a very wide scope, and it has been successfully made use of in the present war on all fronts. Mobile stations may have motor or horse transport, or may be carried by the men who operate them themselves. A knowledge of petrol engines is therefore useful to operators, electricians and other tradesmen as well as to the fitters and engine-drivers themselves, while familiarity with horses and ability to ride across country are invaluable qualifications, since at least a fifth of the wireless personnel in the field is likely to be used at one time or another with horsed sections. To suitable men who are not able to ride on enlistment this accomplishment is taught while they are undergoing their preliminary training at home.

No man is enlisted specifically for wireless service in the Army unless he is already in possession of specialised knowledge. The majority of the recruits taken

* The first part of this article appeared in our October issue.

† For the separate organisation of the Royal Flying Corps and particulars thereof, see final section of this article.

have already some acquaintance with either radio-telegraphy, ordinary telegraphy, electrical science, dynamo engineering, fitting or lorry driving.

Recruits wishing to be trained as wireless operators have to pass the ordinary Army medical examination and physical tests, and then, if they are approved for service in the wireless section, are drafted to a school or training centre, and are put through an initial course of instruction.

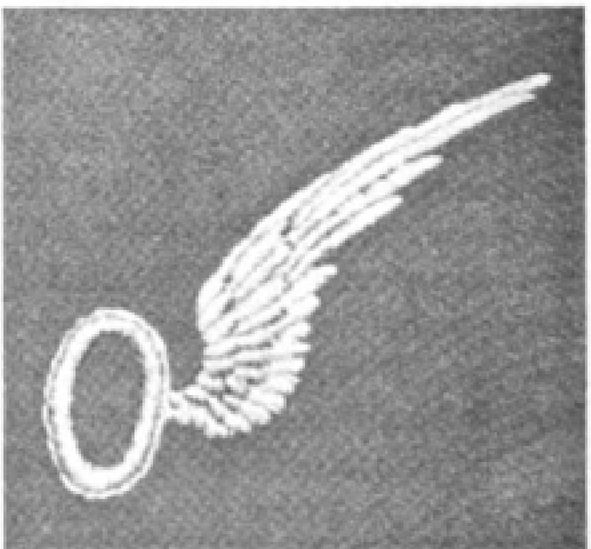
PILOT'S BADGE OF THE R.F.C.

This course covers both practice and theory, and an additional attraction to intelligent men who are anxious to make their way in the world is afforded by the fact that while serving their country they are learning a new trade with constantly increasing scope, and are thus gaining highly specialised knowledge which may be very useful to them in later life.

The practical side of the course is, at this initial stage, confined to operating, and beginners are taught to send and receive in plain language up to 20 to 25 words, and in code at 15 words per minute. Special practice is given in the reception of weak signals and the formation of block letters.

The theoretical side includes the first elements of electricity and magnetism, including electrostatics and dynamics, and the function and properties of conductors, insulators, condensers, primary and secondary cells, etc. This elementary grounding is followed by instruction in the principles underlying wave motion, the functions and properties of the various forms of oscillating circuits, and the simpler types of sending and receiving circuits. The construction and utilisation of the apparatus employed in actual working in the detectors, and other portions of the wireless stations are dealt with at length and demonstration is carried on side by side with the lectures, the students being given every opportunity of handling and working with the various types of apparatus.

This course may be taken either at the Army Wireless Training Centre or at an approved outside school, and when he has finally satisfied the authorities of his proficiency in the subjects laid down, the recruit, who up to this time is drawing Army pay at the rate of 1s. 2d. per day, now commences to draw Engineer pay as a technically trained soldier at the rate of 6d. per day in addition. Further instruction on the Army wireless sets and in the duties of a soldier leads to further tests, and if these are satisfactorily passed, the Pioneer becomes a fully fledged Sapper and draws Engineer pay at 1s. per day in addition to his Army pay.



BADGE OF OBSERVATION OFFICER, ROYAL FLYING CORPS.

From this stage of his career increase of pay may come either through increased technical proficiency with a rise to the "Skilled," "Superior," or "Very Superior" rating of Engineer pay (respectively 1s. 4d., 1s. 8d., 2s. per day), or by efficiency as a soldier leading to rise to N.C.O. or even Warrant Rank, with consequent increase of Army pay from 1s. 6d. as a lance-corporal to 3s. 3d. as a sergeant, and so on, while N.C.O.'s also draw Engineer pay according to their technical abilities.

The final stage in the promotion of a thoroughly efficient man is to the commissioned ranks of the Army. Such appointments will, as a rule, be made by selection from non-commissioned officers who, in the opinion of their Commanding Officer, are qualified both technically and in a general sense to be nominated as cadets and put through a special course at the training centre.

With regard to BADGES, there are not (as in the Navy) authorised distinguishing badges for the wireless men of the Royal Engineers, they merely wear the insignia of their Army rank in the ordinary way. Any special distinguishing marks that may be worn are adopted on the authority of the Commanding Officer.

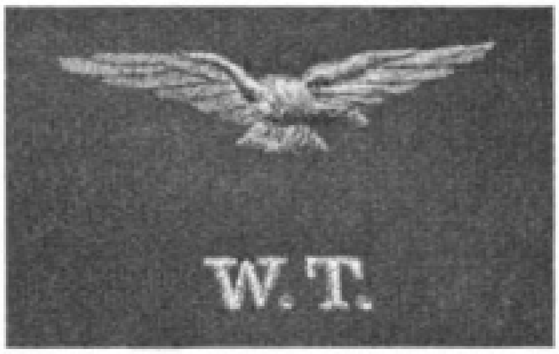
Radio-Telegraphists in the Flying Services.

In the case of the Air Services we find two divisions:

(*a*) The Naval Flying Corps, and

(*b*) The Army Flying Corps.

The latter is officially known as the "Royal Flying Corps." In both cases they really constitute separate branches and require separate treatment.



DISTINGUISHING BADGE OF THE ROYAL NAVAL AIR SERVICE.

Naval Air Service Operators.—Wireless operators for the Royal Naval Air Service are recruited from two sources:

(1) Boys between the ages of 17 and 17½, who are usually required to have had at least a year's secondary school education.

(2) Men over the age of 18, who are required to be in the possession of a first-class Postmaster-General's Certificate, or its equivalent in knowledge of wireless and Morse speed.

Further instruction is carried out at the R.N.A.S. Central Training Establishment in Lincolnshire, and it is here Class (1) receive all the training necessary to fit them for their positions. These lads are paid at the rate of 1s. per day and undergo a period of instruction varying from six to twelve months. On reaching the age of 18, if they succeed in passing their qualifying examinations, they are rated as air mechanics of the 2nd grade, and proceed along the regular lines detailed below.

The men belonging to Class (2) above undergo a period of training of approximately three months, and receive instruction in all forms of air service wireless apparatus. All air service wireless telegraph operators are liable to be called upon to make ascents in aircraft of any description—aeroplanes, seaplanes or airships, and are required to possess, before being regarded as proficient, such a sufficient knowledge of naval and aeronautic matters as will render them of value in the capacity of observers, and put them in a position to render assistance to the pilot in cases of necessity.

The following constitute the grades of the R.N.A.S., and promotion from one to the other goes by selection and proved efficiency. The pay of the rank is appended in each case. Air Mechanics, 2nd grade, 2s.; acting air mechanics, 1st grade, 3s.; air mechanic, 1st grade, 4s.; leading mechanic, 5s.; petty officer mechanic, 6s.; chief petty officer mechanic, 3rd grade, 7s.; 2nd grade, 9s.; 1st grade, 10s. 6d.; warrant officer, 2nd grade, 11s.; first grade, 12s.

The BADGES for the R.N.A.S. Service are indicated in our illustration. They consist of a pair of wings surmounting the letters W.T. These distinguishing badges are worn on the right sleeve, whilst the rank held by the wearer is indicated in the usual manner on the left sleeve.

Royal Flying Corps.—The story of the formation of the Royal Flying Corps possesses in itself a great deal of interest, but must not detain us here further than is warranted by its connection with wireless operating. The men who have become familiar objects in the streets of London through attendance at Marconi House and the Regent Street Polytechnic for wireless instruction are not, except in very special cases, required to make aerial ascents. Their duty is to stand by the gunnery officers and receive aeroplane messages, besides erecting the aerials in order to enable this to be carried out. As a general rule, the arrangements are that the men shall work in gangs of three. They are enlisted at the Regent Street Polytechnic, where over 16,000 R.F.C. men have been enrolled, and thence go to Farnborough for two or three weeks' strenuous drill, after which they are entered for a course of instruction in one of the schools, either at Farnborough or in London. The course of instruction given them consists of a course in elementary electricity and magnetism, besides technical training in the manipulation of wireless apparatus. This scholastic work proceeds *pari passu* with instruction in wireless operating, flash-lamp signalling, and aerial erection drill. The length of the course is determined by the capacity of the student, and varies from three to six months. These men are enlisted usually between the ages of 17½ and 19. The proficiency required is not up to the standard of the first-class Postmaster-General's Certificate, but only that of the third class. After they have finished their courses, the men enter the service as second-class air mechanics, at a pay of 2s. per day, rising subsequently as they prove themselves worthy of promotion to be first-class air mechanics with a pay of 4s. per day. From privates they may become corporals at 5s. and sergeants

GROUP OF ROYAL FLYING CORPS.

at 6s. per day, flight sergeants at 7s. per day, second-class warrant officers at 8s. per day, or first-class warrant officers at 9s. per day. Promotion goes by seniority and merit. The men who do the actual flying are commissioned flying *officers*, divided into two branches, (*a*) pilots, and (*b*) observation officers, both of whom receive their training at Farnborough. Pilots wear on the left breast a badge consisting of two wings with R.F.C. in between them; the observation officers bear on the left breast a badge with one wing springing from an O. These badges figure in our illustrations on page 626.

The commissioned ranks in the Royal Flying Corps comprise: Second-lieutenants, lieutenants and flying officers (observers) with the pay respectively of 7s. 6d., 8s. 6d., and 12s. daily, *plus* an additional flying pay of 5s. per diem in each case; adjutants, who receive 17s. per diem; flying officers, whose pay varies according to service, between 12s. and 16s.; flight commanders, with pay rising from 17s. to 23s. daily; and squadron commanders, whose ordinary pay amounts to 25s. The four last mentioned ranks have an additional flying pay of 8s. per diem.

Patent Record

6329. May 3rd. R. D'Antonio. Telegraphic transmission devices.

6256. May 2nd. J. Hettinger. Aerial conductors for wireless telegraphy.

6700. May 10th. J. T. Morris and A. F. Sykes. Means for locating subaqueous sounds.

6998. May 16th. W. A. Solomon. Systems of wireless telegraphy and telephony.

7088. May 18th. F. Rosso. Systems of radio-telegraphy for multiple simultaneous transmission. (Convention date, Italy, May 18th, 1915. *Open to public inspection.* Patent number, 100,495.)

7456. May 25th. S. Ford and A. F. Sykes. Electro-chemical microphone for wireless telegraphy and telephony.

7488. May 26th. W. H. Bragg. Apparatus for determining direction of sounds in water.

7543. May 27th. C. M. Bostock and R. N. Coke. Morse signalling for air-craft.

8011. June 6th. British Thomson-Houston Co., Ltd. (General Electric Co., U.S.A.). Wireless signalling systems.

8042. June 7th. I. J. Trim. Ear protectors for wireless telegraphic head receivers.

8303. June 12th. T. B. Dixon. Transforming motion into electrical waves or impulses. (Convention date, U.S.A., July 19th, 1915.)

8633. June 19th. British Westinghouse Electrical and Manufacturing Co. Alternating current commutator. (Convention date, U.S.A., June 19th, 1915.)

8845. June 23rd. C. H. Burdon (Siemens & Halske A.G.). Electro-magnetic relays.

9076. June 28th. H. Munro. Means for determining direction from which sounds proceed and distance at which it originates.

9105. June 28th. F. G. Simpson. Electric spark gap. (Convention date U.S.A., March 20th, 1915.)

The Government and Inventions

AN INTERESTING ORDER IN COUNCIL

The following Order, which we reprint from the "London Gazette," will, we think, interest all of our readers.

At the Court at Windsor Castle, the 7th day of September 1916.

PRESENT:

The King's Most Excellent Majesty in Council.

WHEREAS by an Order in Council, dated the twenty-eighth day of November nineteen hundred and fourteen, His Majesty was pleased to make Regulations (called the "Defence of the Realm (Consolidation) Regulation 1914") under the Defence of the Realm Consolidation Act, 1914, for securing the public safety and the defence of the realm:

AND WHEREAS the said Act has been amended by the Defence of the Realm (Amendment) Act, 1915, the Defence of the Realm (Amendment) (No. 2) Act, 1915, and the Munitions of War Act, 1915:

AND WHEREAS the said Regulations have been amended by various subsequent Orders in Council:

AND WHEREAS it is expedient further to amend the said Regulations in manner hereinafter appearing,

Now, therefore, His Majesty is pleased, by and with the advice of His Privy Council to order, and it is hereby ordered, that the following amendments be made in the said Regulations:

1. After Regulation 8c the following regulation shall be inserted:

"8cc.—It shall be lawful for the Admiralty or Army Council or Minister of "Munitions with a view to the more efficient or increased production of war material "to require any person to communicate to a person nominated for that purpose "by the Admiralty, Army Council or Minister of Munitions all such particulars "as may be in his possession of any invention, or process or method of manufacture, "or of any article manufactured or proposed to be manufactured, and to furnish "drawings, models, or plans thereof, and to explain and demonstrate the same to "such person in all or any of its uses and workings; and if any person fails or "neglects to comply with any such requirement he shall be guilty of an offence "against these regulations; and if the requirement is addressed to a company, "every director, manager or officer of the company who fails or neglects to comply "with such requirement shall also be guilty of an offence against these regulations.

"If any person, except as authorised by the Admiralty or Army Council or "Minister of Munitions discloses or makes use of any information obtained in conse- "quence of any requirement made under this regulation or communicated to him "by the person by whom it was so obtained, he shall be guilty of an offence against "these regulations.

"No communication of an invention made in consequence of any requirement "under this regulation, or the use thereof by any person authorised under this "regulation to use it, shall prejudice any right of the inventor or owner thereof "subsequently to apply for or obtain a patent for the invention."

2. After Regulation 19 the following regulation shall be inserted:

"19a. If any person, having in his possession or under his control any document, "note, photograph, sketch, plan, design, model, pattern, specimen, or article (in-"cluding any key or other instrument affording means of access to information) of "such a nature as is calculated to be, or might be, directly or indirectly useful to "the enemy:

"(*a*) without lawful authority destroys, makes away with, or allows any person "to inspect or to be in possession of such document, note, photograph, sketch, "plan, design, model, pattern, specimen, or article as aforesaid: or

"(*b*) loses, fails to take reasonable care of, or so conducts himself as to endanger "the safe custody of such document, note, photograph, sketch, plan, design, model, "pattern, specimen or article as aforesaid: or

"(*c*) retains such document, note, photograph, sketch, plan, design, model, "pattern, specimen, or article as aforesaid in his possession or control when he has "no right to retain it, or when it is contrary to his duty to retain it: or

"(*d*) fails to comply with any directions issued by lawful authority with regard "to the custody, production, or the return of such document, note, photograph, "sketch, plan, design, model, pattern, specimen, or article as aforesaid; he "shall be guilty of an offence against these regulations, and if any person, without "lawful authority or excuse, has in his possession or under his control any document, "note, photograph, sketch, plan, design, model, pattern, specimen or article as "aforesaid, he shall be guilty of an offence against these regulations."

3. After Regulation 40b the following regulation shall be inserted:

"40c. If any man of His Majesty's reserve forces not for the time being subject "to the Naval Discipline Act or to Military Law, when under orders to report himself "for medical examination, malingers or feigns any disease or infirmity, he shall be "guilty of an offence against these regulations.

"If any such man produces any disease or infirmity in himself, or maims or "injures himself or causes himself to be maimed or injured or takes or uses any drug "or preparation, or does any other act, calculated or likely to render him, or to "lead to the belief that he is, permanently or temporarily unfit for service, he shall "be guilty of an offence against these regulations unless he proves that he did not "so act with the intent of escaping service.

"If any person:

"(*a*) wilfully produces any disease or infirmity in, or maims or injures, any "such man of His Majesty's reserve forces, or any man belonging to any other "of His Majesty's forces, whether or not he knew that the man was such a man as "aforesaid: or

"(*b*) with the intent of enabling any such man to render himself, or induce the "belief that he is, permanently or temporarily unfit for service, supplies to or for "such a man any such drug or preparation as aforesaid;

"he shall be guilty of an offence against these regulations.

4. After Regulation 42 the following regulation shall be inserted:

"42a. If any person attempts to induce a member of any of His Majesty's "forces to act in a manner which such person knows to be in contravention of the "King's Regulations and Admiralty Instructions or Admiralty Orders as respects "the Navy, or the King's Regulations or Army or other Orders as respects the "Army, he shall be guilty of an offence against these regulations."

ALMERIC FITZROY.

British Association and Radio-Telegraphic Investigations

IMPORTANT OBSERVATIONAL WORK.

THE observational work done for the British Association Committee on Radio-Telegraphy during the past year has, it is reported, been carried out at about 25 stations distributed in Australia, the United States of America, Canada, New Zealand, Ceylon, Trinidad, Dutch East Indies, Fiji and the Gold Coast.

Of the four kinds of forms issued by the Committee for the collection of statistics, the first, relating to the number and strength of the strays at 11 a.m. and 11 p.m. Greenwich mean time, has been in most regular use, and the stock is almost exhausted. No further edition of this form will be issued during the war, and thus the collection of statistics will come gradually to an end. The difficulty of obtaining clerical assistance for the work of reducing the forms has greatly impeded progress; but a certain amount of work has been accomplished and has yielded results of interest. So soon as the several sections of the work are rounded off the results will be published.

The reduction of Form I. is proceeding by the collation of records and reports of excessive atmospheric disturbance since August, 1914, in North America and Australia, and by their examination in conjunction with meteorological data from the corresponding daily weather charts.

The reduction of Form II. is proceeding by the correlation of instances of exceptionally good or bad transmissions with meteorological data, and by analysis of statistics from Cocus, Fiji, Lagos, Malta and Sierra Leone.

. Several important exceptional phenomena have been reported which will, after discussion, be published. These include reports of—Aurora, Strays and Signals in Alaska and Hudson Bay; severe atmospheric disturbances in Malta; simultaneous strays on both sides of the Atlantic; and Effect of Tropical Storm in the Gulf of Mexico—September 30th, 1915.

Transpacific Wireless Communication

A TELEGRAM dated 5th October from San Francisco announces that in the course of a preliminary test direct wireless communication has been effected between the wireless station there and the Japanese Government plant at Ochiishi.

The Calculation of the Capacity of Radio-telegraph Antennæ, including the Effects of Masts and Buildings

By PROFESSOR G. W. O. HOWE, D.Sc., M.I.E.E.

Paper read before the British Association for the Advancement of Science at Newcastle, 7 September, 1916.

(Continued from p. 556 of October Issue.)

It should be pointed out that the capacity here considered is that which would be measured by electrostatic or low-frequency methods, and is not necessarily the same as the effective capacity at radio frequencies. The latter will depend on the wave-length employed and on other factors which are beyond the scope of this Paper. To electrostatic measurements a wooden mast will act as an earthed conductor, whereas at radio frequencies its high resistance will considerably modify its effect on the capacity of the aerial. If the masts be of iron or steel and not insulated, and if, as is now common, the wave-length employed is considerably greater than the fundamental wave-length of the aerial, the effective capacity will agree closely with that calculated by the method here described.

We shall now apply the method to the inverted conical aerial of 160 wires, to which reference has already been made. We shall assume that it is supported by a ring of 10 masts 105 ft. high and 18 in. diameter, situated on a circle of 116 ft. diameter, as shown in Fig. 5. It is assumed, as before, that the induced charge on the masts is uniformly distributed and equal to q units per centimetre of length. To determine q, we have the average potential of the mast

due to its own charge		$= -\ 9{\cdot}27\,q$
,,	the other masts	$= -\ 11{\cdot}74\,q$
,,	the antenna	$=\ 240$
,,	the image of the antenna	$= -135$
,,	the image of the masts	$=\ 8{\cdot}9\,q$

Of these five items, the first two and the last can be found accurately from Fig. 3 of this Paper; the other two are approximate, although they could be determined accurately if necessary. It is unfortunate that in this case the items which can be readily obtained with great accuracy are relatively unimportant. Since the mast is assumed to be earthed, its resultant potential must be zero, and therefore

$$(8{\cdot}9-9{\cdot}27-11{\cdot}74)q+240-135=0$$

and $$q=8{\cdot}67 \text{ units per centimetre.}$$

We can now find the potential of the aerial, and we shall consider an average wire and not one situated close to a mast.

The average potential of a wire		
due to the nearest mast	=	− 22
,, all other masts	=	−117
,, the image of the mast	=	85
,, antenna without masts (previously found)	=	381
Total	=	327

Hence the effect of the masts is to lower the potential from 381 to 327, which will increase the capacity 16·5 per cent., *i.e.*, from 1,423 to 1,660 micro-microfarads. This is still only 62 per cent. of the measured value given for this antenna. Our calculation is based, however, on the assumption of 10 masts of 18 in. mean diameter; a greater number would, of course, still further increase the capacity. We have here neglected any horizontal wire from which the 160 wires may be suspended; we have already seen that such a wire might increase the capacity by 20 per cent.

The Capacity of Wires Near Buildings.

We shall consider in the first place a single vertical wire running close to the wall of a building. If the planes of the ground surface and of the wall be continued, and three images drawn symmetrically with regard to their intersection as shown in Fig. 6, then, on giving these images charges equal to that of the wire and of the signs shown in the figure, the planes will be equipotential surfaces, and will consequently have no effect on the potentials of the system. The potential of the wire will be made up of four components—viz., that due to its own charge, and those due to the three images. That due to its own charge can be read off Fig. 3 in the original Paper; that due to the earth image we have shown to be 1·38, if the lower end is almost touching the ground, but about 1·0 if the lower end is 3 ft. or 4 ft. above the ground. The potential of the wire due to its image in the wall can be read off Fig. 3 in this Paper, while that due to the diagonal image can also be obtained from Fig. 3 in the following manner. If two parallel vertical wires of length $2l$ are separated by a distance $2D$, the average potential of one due to unit charge per centimetre on the other can be read off Fig. 3; it is a function of the ratio l/D, which we may write $f(l/D)$. From considerations of symmetry, it is obvious that this is also the average potential of the upper half of the wire due to the whole length of the charged wire, whereas that due only to the upper half of the charged wire is $f(l/2D)$, which can also be read off Fig. 3. The difference, viz., $f(l/D)-f(l/2D)$ must be the average potential of the upper half of one wire due to the charge on the lower half of the other, and it is therefore the average potential of the aerial due to its diagonal image.

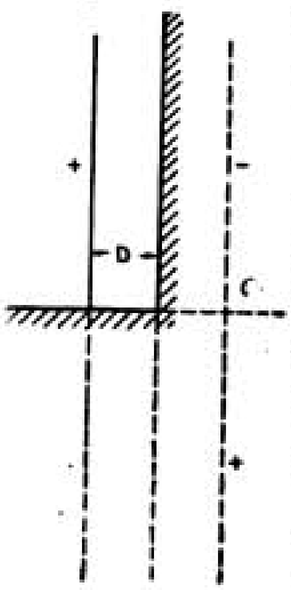


FIG. 6.

As an example, let $l=100$ ft. of 0·1 in. diameter, and let $D=6$ ft., then we have $l/r=24{,}000$; $l/D=16{\cdot}67$; and $l/2D=8{\cdot}33$,

and $V_{av.}=19{\cdot}53$ due to its own charge,
$-1{\cdot}38$ due to its earth image,
$-3{\cdot}85$ due to its wall image,
$+(5{\cdot}14-3{\cdot}85)$ due to its diagonal image.
$=15{\cdot}6$.

Hence its capacity is increased 16 per cent. by the proximity of the wall.

As a further example we may consider the case of four vertical wires 45 ft. long, 3 ft. apart, 0·1 in. diameter and 3 ft. from the wall.

$V_{av.}$ due to their own charge = 29·9 $\left(=\frac{135·6}{4·5}\right.$, *see* Fig. 10 in original Paper$\left.\right)$

„ earth image = − 4·0 (approx.)

„ wall image = −13·3 (Fig. 3 in this Paper)

„ diagonal image = + 4.0 (approx.)

Total = 16·6

The charge = 4 × 45 × 30·5 = 5,490, and the capacity is therefore

$$\frac{5{,}490}{16·6 \times 0·9} = 368 \text{ micro-microfarads.}$$

If the distance from the wall be decreased to 1 ft., the capacity will be increased to 500×10^{-6} mfd.

This example is illustrative of an antenna mentioned by Professor Fleming, viz.: " Four vertical wires 0·1 diameter, each 45 ft. long, placed fan-shape in front of a building 6 ft. apart, bottom ends 10 in. apart, connected to a copper 'bus bar = 485 micro-microfarads." The distance from the wall and the details of the copper 'bus bar not being given, it is impossible to calculate the capacity accurately, but the above example shows that, given the necessary data, such cases can be calculated very readily.

As a further example of the method, we shall make an approximate calculation of the effect of the Eiffel Tower on the capacity of the antenna which is supported from it. The principal dimensions are shown in Fig. 7. The antenna consists of six wires of 7 mm. diameter. Each wire is about 330 metres long, and the average distance between adjacent wires is assumed to be 22 metres. Hence $l/d = 15$ and $d/r = 6{,}300$, and

$$C = \frac{16·94n}{n\left(\log_e \frac{l}{d} - 0·31\right) + \log_e \frac{d}{r} - B} = 5·2 \times 10^{-6} \text{ mfd. per foot.}$$

(For B *see* Table IV. in the original Paper.)

The capacity of the antenna, apart from the effects of the earth and of the tower, would therefore be $5{,}620 \times 10^{-6}$ mfd. If charged with 1 unit per centimetre of wire, its average potential would be

$$\frac{6 \times 33·9}{5·2} = 39·1 \text{ due to its own charge,}$$

and $$-\frac{6 \times 33{,}000}{27{,}500} = -7·2$$ due to its image in the earth, giving a resultant potential of 31·9 and a capacity of

$$5{,}620 \times \frac{39·1}{31·9} = 6{,}900 \times 10^{-6} \text{ mfd.}$$

The proximity of the earth increases the capacity 22·7 per cent.

To form an estimate of the effect of the tower itself it is sufficient to assume that it is a vertical cylinder 300 metres high with a diameter of, say, 20 metres. (It is actually a lattice structure about 10 metres square near the top, 24 metres square in the middle, supported on four legs each 15 metres square, the centres of which form a square of 104 metres side.) Let the antenna be charged with 1 unit per centimetre of wire, and let this induce a charge of $-q$ units per centimetre of height of the tower.

The potential of the tower

Due to its own charge	$= -6{\cdot}27\,q$ (*see* Fig. 3, $l_m/r_m = 30$)
,, its own image	$= +1{\cdot}38\,q$ (*see* Fig. 21 *et seq.* in original Paper)
,, the antenna	$= +16{\cdot}5$ (approx.)
,, the image of antenna	$= -7{\cdot}0$ (approx.)

Since the tower is earthed, its potential is zero and $9{\cdot}5 - 4{\cdot}89\,q = 0$; therefore $q = 1{\cdot}94$.

The potential of the antenna due to the induced charge on the tower will be about $-2{\cdot}5\,q$, while that due to the image of the tower will be $1{\cdot}1\,q$, giving a resultant potential due to the tower and its image of $-1{\cdot}4\,q$ or $-2{\cdot}72$. The previously found potential of $31{\cdot}9$ will be reduced to $29{\cdot}2$, causing the capacity to be increased about 9 per cent. to $7{,}540 \times 10^{-6}$ mfd. *The actual measured capacity has been given as* $7{,}300 \times 10^{-6}$ mfd., but it must be remembered that the above calculation has only been carried out approximately upon very meagre data. To show the effect of a different assumption as to the equivalent diameter of the tower, it may be mentioned that taking 10 metres instead of 20 merely reduces the increase of capacity from 9 to 7 per cent.

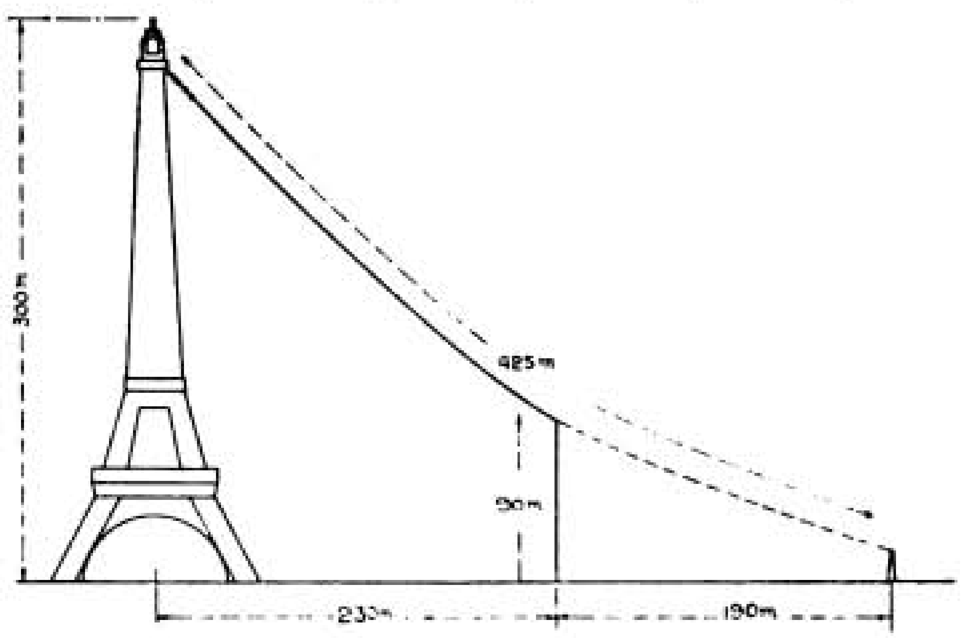


FIG. 7.

EXPERIMENTAL.

Seeing that the calculated values of the capacity differed very considerably in many cases from the values given as the result of actual measurement, and that sufficient data were not available to enable the effects of the masts, etc., to be allowed for in these measurements, it was thought essential to make some crucial tests to determine the accuracy which one might expect. For this purpose wires were stretched between insulators as shown in Fig. 8. The uprights and cross bars were of iron. The distance between the wires could be adjusted, and the separate wires could be insulated, earthed or connected together as desired. All the dimensions were accurately measured, and the capacity determined by a bridge method, using a buzzer and a telephone. Two of the arms consisted of a Paul inductionless ratio box with 1,000 ohms in each arm, while the other two consisted of variable air condensers.

The capacity to be measured was substituted for one of these air condensers which had been accurately calibrated.

Length between supports	=114 ft. 5 in.
Length of each wire	=113 ft. 6 in.
Width between uprights	= 6 ft. 8 in.
Diameter of supports	=2·2 in.
Diameter of wire	=0·085 in. =0·21 cm.

The effect of the supports on the capacity of the wires was calculated but found to be negligible. The height of the wires above the ground was measured at different

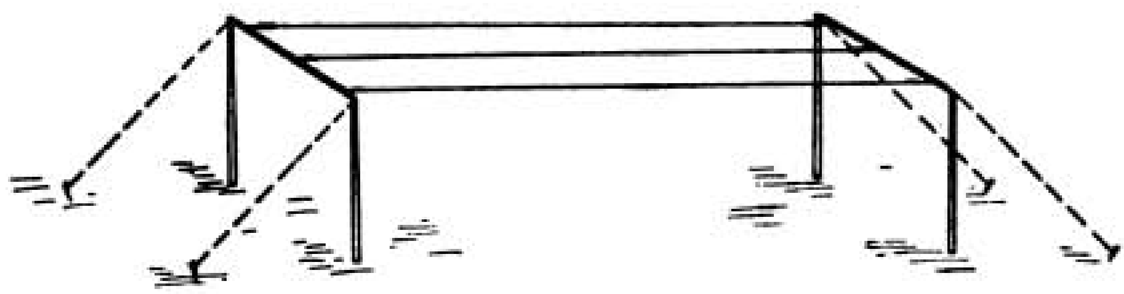


FIG. 8.

points and the mean taken in calculating the effect of the earth. The average height was about 1 metre. The results were as follows :—

Distance d Between Adjacent Wires.	Arrangement of Connections.	Capacity.		Percentage Difference.
		Calculated, 10^{-6} mfd.	Measured, 10^{-6} mfd.	
- -	Single solid wire (0·072 in.) ...	250	248	−0·8
- -	Ditto, but only 73 ft. 2 in. long ...	164	162	−1·2
- -	Stranded wire (7 × 0·028 in.) ...	256	260	1·6
4·7 cm.	Two ditto connected...	350	357	2·0
4·7 „	Cap. of one, the other earthed ...	341	330	−3·8
0·745 „	Three wires connected	310	335	8·0
0·745 „	Middle only, outers earthed... ...	770	788	2·3
1·65 „	Three wires connected	362	375	3·0
1·65 „	Middle only, outers earthed... ...	539	520	−3·5
2·8 „	Three wires connected	396	395	−0·25
2.8 „	Middle only, outers earthed... ...	454	450	−0·9
5·55 „	Three wires connected	432·5	425	−1·7
5·55 „	Middle only, outers earthed... ...	381	380	−0·26

It will be seen that the difference between the calculated and the measured value does not exceed 4 per cent., except in the very extreme case where the wires are only 7·45 mm. apart. Considering the difficulty of measuring such small capacities, the uncertainty introduced by connecting wires, and the difficulty of accurately determining the dimensions when stranded wires 113 ft. long are suspended in the open at distances of 1 cm. or 2 cm., the agreement must be considered very good with the exception of the case referred to. Here, however, the values of l/d and d/r are very extreme, and quite outside the range of the curves given in the original Paper for three-wire antennæ. The assumption of equal distribution of charge between the three wires is, therefore, far from true ; but it is a relatively simple matter to apply the method which we have already employed for finding the distribution of the charges in the cases in which the two outer wires were earthed. It is only necessary to determine the necessary distribution of charge between the three wires in order that they may all have the same average potential, as they must have, seeing that they are all connected.

Let the middle wire have a charge of 1 unit per centimetre, while the outer wires have q units per centimetre length. The potential of an outer wire

due to its own charge $= 20{\cdot}12\, q$ (Fig. 3 in original Paper)
,, the other outer $= 14{\cdot}9\, q$ (Fig. 3 in this Paper)
,, the inner wire $= 16{\cdot}28$ (Fig. 3 in this Paper)
,, the earth image $= -5{\cdot}48\ (1+2q)$ (Fig. 3 in this Paper)

(NOTE.—The average height above ground $= 87$ cm.)

The resultant potential of an outer wire $= 24{\cdot}06q + 10{\cdot}8$.

The potential of the inner wire

due to its own charge $= 20{\cdot}12$
,, the outer wires $= 2 \times 16{\cdot}28\, q$
,, the earth image $= -5{\cdot}48(1+2\, q)$

giving a resultant potential of $21{\cdot}6q + 14{\cdot}64$.

Since the two wires must have the same potential, we have

$$24{\cdot}06q + 10{\cdot}8 = 21{\cdot}6q + 14{\cdot}64$$

and

$$q = 1{\cdot}56.$$

Hence the charge on the outer wires has a density 1·56 times that on the middle wire.

The potential $= (24{\cdot}06 \times 1{\cdot}56) + 10{\cdot}8 = 48{\cdot}4$, and the charge per centimetre run of antenna $= 1 + 2q = 4{\cdot}12$ units. Hence the capacity

$$= \frac{4{\cdot}12 \times 3{,}450}{48{\cdot}4 \times 0{\cdot}9} = 326{\cdot}5 \text{ micro-microfarads,}$$

which differs by less than 3 per cent. from the measured value. A similar accurate calculation would also reduce the error of 3·6 per cent. found in the case of the three wires spaced at 1·65 cm. An accurate determination of the differences between the calculated and measured values obviously calls for measurements of far greater precision than those here recorded, but these are sufficient to show that, even in extreme cases, the author's method of calculating static capacity gives results of greater accuracy than is usually obtained in technical measurements of such small capacities.

[Photo · Bassano.

A RECENT PHOTOGRAPH OF PROF. HOWE.

Among the Operators

INSPECTOR A. COBHAM.

S.S. "FRANCONIA."

ON this well-known Cunarder, recently reported by the Admiralty as sunk in the Mediterranean, two operators were carried—Travelling Inspector Alfred Cobham and Operator Hartley Smith. Inspector Cobham, who is 32 years of age, joined the Marconi Company in 1906, and was attached for some time to the Italian Agency. Upon returning from Italy he was appointed to the s.s. *Caronia*, and from this ship transferred, in August, 1911, to the s.s. *Franconia*, where he had remained ever since. In 1913 he was appointed travelling inspector.

The assistant operator, Mr. Hartley Smith, who is 21 years of age, received his P.M.G. Certificate at the Manchester Training College, Fallowfield, and joined the Marconi Company in January, 1915. He was first appointed to the *Adriatic*, and from this ship was transferred to the *Franconia* in September, 1915.

We are happy to say that, so far as we know, both men were rescued uninjured.

* * * * * *

S.S. "DEWA."

Another vessel recently sunk was the s.s. *Dewa*. Mr. John Geary, the operator-in-charge, is a Glasgow man, and received a preliminary wireless training at the North British Wireless School in that city. After a period of training in the Marconi Company's school in the Strand, he was appointed to the s.s. *Cassandra*, and from this ship was transferred to the s.s. *Orthia*. He later joined the s.s. *Tuscania* and the s.s. *Kioto*, transferring to the s.s. *Dewa* in April of this year. We are glad to say that he was rescued and is none the worse for his exciting experience.

OPERATOR HARTLEY SMITH.

* * * * * *

S.S. "SECONDO."

The s.s. *Secondo*, recently lost, carried as operator Mr. James Kilgannon, a native

OPERATOR J. GEARY.

of County Sligo. Mr. Kilgannon is 23 years of age and a comparatively recent recruit of the Marconi Company, having joined in February, 1916. He was first appointed to the s.s. *Athenia*, afterwards to the s.s. *Calonne*, and in September of this year to the s.s. *Secondo*. We congratulate Mr. Kilgannon on escaping uninjured from the wreck.

* * * * * *

S.S. "AARO."

Our readers will have learnt from the daily Press of the sinking by the enemy of the Wilson liner *Aaro*. We are glad to report that the operator of the vessel, Mr. Alfred Hardcastle, of Barnsley, Yorkshire, was among the saved, although he is now a prisoner of war in the internment camp at Brandenburg. Operator Hardcastle received his P.M.G. Certificate at the Manchester Wireless College, Fallowfield, and joined the Marconi Company about eighteen months ago. His first voyage was to America, on the s.s. *Feliciana*, and from this ship he transferred to s.s. *Shenandoah*, on which he served for some seven months. We sincerely trust Mr. Hardcastle will receive good treatment in the hands of the enemy.

OPERATOR J. KILGANNON.

OPERATOR A. HARDCASTLE.

* * * * * *

DEATH FROM APOPLEXY.

We deeply regret to report the death of operator James Fennessy, who passed away on September 8th, after an attack of apoplexy. Mr. Fennessy, who was but 20 years of age at the time of his death, trained for the wireless service at the Atlantic Wireless School, Cahirciveen, and upon receiving his P.M.G. Certificate entered the Marconi Company just after the outbreak of war. His first ship was the s.s. *Numidian*, of the Allan Line, and he subsequently served on the s.s. *Ausonia, Holbein, Scandinavian, Brodmount, Cambria, Niwaru,* and *Colonian*. We take this opportunity of offering to Mr. Fennessy's relatives, both on our own part and on behalf of many friends among our readers, the sincerest sympathy in their great bereavement.

OPERATOR J. J. FENNESSY.

A New Use for the "Marconi Records"

Successful Demonstration at Preston

At the annual exhibition in connection with the Astro-Physical Section of the Preston Scientific Society, held October 9th-13th, Mr. J. H. Morris contributed to the exhibits a series of Marconi official gramophone records. Following our hint in a previous number of this magazine, a Deckert telephone transmitter was mounted on an arm attached to a battery box containing two Leclanche cells, a telephone induction coil and a switch to disconnect the cells completed the equipment at one end, and placed in an ante-room with the transmitter in the mouth of the trumpet of the gramophone. A twin line ran from this to the lecture hall and attached to terminals on a batten on which five telephones were connected in parallel. The signals were an exact replica of those heard on wireless installations, and proved a great source of interest to the visitors when telegraphists were transcribing the messages.

Special Notice

The December issue of The Wireless World will contain an important and highly interesting article on the famous wireless station at Arlington, near Washington. The article will not only be profusely illustrated with photographs and diagrams of connections, but will be based upon information officially supplied by the American Government.

American Letter

New York, September 27th, 1916.

UNQUESTIONABLY the most important event of the present month is the decision rendered by His Honour Judge Mayer, of the United States District Court, regarding the suit which was tried before him covering the patents involved in the Fleming Valve controversy between the American Marconi Company and the De Forest Radio Telegraph and Telephone Company. The decision was handed down September 20th, 1916, and is a complete victory for the Marconi Company. (See page 674.—ED.) Unbiased technical and legal men in this country consider this decision as one of the finest and most technically correct opinions rendered from the Bench. This case should be of particular interest in Great Britain because the inventor, Professor Fleming, is a British subject.

The next meeting of the Institute of Radio Engineers will be held on Wednesday, October 4th, 1916, in the building of the American Institute of Electrical Engineers. A highly interesting paper will be presented by Mr. Edwin H. Armstrong, of Columbia University. The subject of the paper will be "The Heterodyne Theory of Amplification and its Relation to the Oscillating Audion." The paper is an expansion of the valuable results laid before the membership of the Institute by Mr. Armstrong in 1915. A large attendance is expected.

Much interest has been shown by persons connected with wireless and its allied subjects in the suit recently filed by the American Marconi Company against the United States Government. In its petition filed in the Court of Claims, the American Marconi Company asks $1,000,000.00 from the United States Government in payment of its patent rights, which it considers infringed.

Of particular interest to residents of Alaska is the fact that the American Marconi Company had made a substantial reduction in its telegraph rates, effective October 1st, 1916. The rate previously charged for messages from Seattle, Washington and Astoria, Oregon, to Juneau and Ketchikan, Alaska, was $1.25-12c. whereas the new rate is $1.00-10c.

It is a little over a year since the Marconi Company opened its Alaskan chain of wireless stations for public service, and the appreciation of the public doing business in that territory is evidenced by the volume of traffic handled by these stations. It is expected that the reduction in rates will popularise the service to an even greater extent.

Mr. Charles J. Pannill, who was formerly superintendent of the Southern Division of the American Marconi Company and later was appointed Commercial Traffic Superintendent of the Naval Radio Service, has recently been appointed Aide to the Director of Naval Communications at Radio, Virginia. Mr. Pannill recently visited the Pacific Coast branch of the Naval Communication Service.

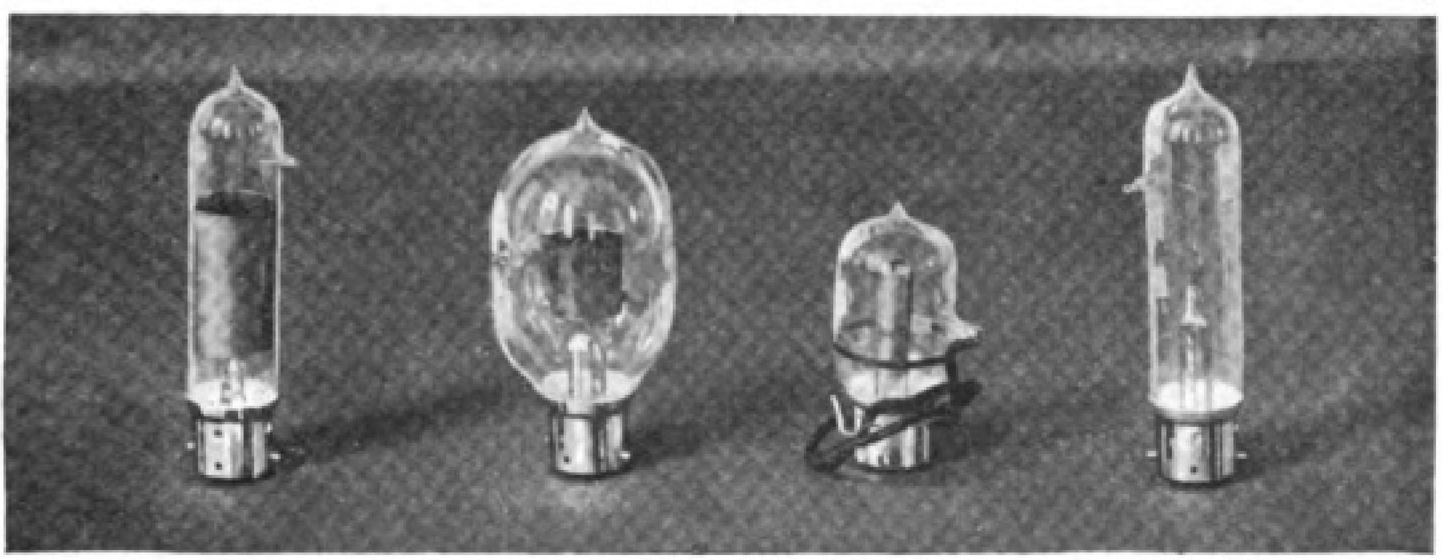
DAVID SARNOFF.

The Fleming Valve and the De Forest Audion

Important Patent Decision in the United States

Much of the recent progress in wireless telegraphy and telephony is due to modifications of the well-known Fleming valve detector, the construction and working of which will be familiar to most of our readers. In its three-electrode form it has proved to be the most sensitive of all receivers, and by special arrangement of circuits it can be made to produce continuous oscillations for wireless telegraph and telephone transmission. As an amplifier, too, it has great value, and it is safe to say that in one form or another it is used in practically all long-distance radiotelegraphy. Further, by utilising at the same time its properties as a detector and generator, it is possible to use it as a receiver for continuous waves, the circuits being arranged so as to give a " beat " effect, and consequently a pure musical note. For some years the Marconi engineers have been perfecting the Fleming valve in its various forms, particularly as an amplifier and oscillation generator. In this latter form it enabled Mr. Marconi, in the early part of 1914, to carry out some highly successful wireless telephone experiments between vessels of the Italian Navy. It will be remembered that with only a very limited energy a distance of 45 miles was easily attained.

Before the outbreak of war considerably greater distances than this had been achieved, and it is practically certain that had not the European conflict diverted the energies of the Marconi Company into other channels, transatlantic wireless telephony would have been an accomplished fact much earlier than was actually the case. As, however, the United States were free to continue wireless experiments while Europe was engaged in the gigantic struggle, to that country fell the honour of the first transatlantic wireless telephone communication, which was reported in



SOME FORMS OF THE FLEMING VALVE.

our December issue. The success of these experiments was due entirely to the use of the oscillation-generating form of the Fleming valve.

At an early date we hope to publish a technical article, describing in detail the various modern forms of the vacuum valve and just how the circuits are arranged to produce the various effects referred to above. Enough has been said here, however, to show that this piece of apparatus is of the utmost importance in the science of wireless communication.

For a considerable time the Courts of the United States had been occupied in an action brought by the Marconi Company against Dr. Lee De Forest for infringement of their Fleming valve patents, and a counter-action by De Forest claiming damages for infringement by the Marconi Company. Dr. De Forest is well known in connection with radiotelegraphy in the United States, as for some years he has manufactured, demonstrated and sold various modifications of the Fleming valve, to which he has given the title of audion, ultraudion, oscillion, etc. He has also claimed the credit for inventing this form of apparatus. The long law action has now, however, been concluded, and on September 21st judgment was given in favour of the Marconi Company, Dr. Fleming's patents being declared to be master patents and not anticipated by De Forest or anybody else. The De Forest audion was held to be an infringement of the Marconi Company's Fleming patents.

In Germany and at German stations abroad considerable use has been made of the improved Fleming valve, and what success the Germans have attained in transatlantic communication has largely been due to its use. The Atlantic Communication Company of America, a subsidiary company of the Telefunken Company of Berlin, and the firm responsible for the working of the giant Sayville station at Long Island, has infringed a number of patents in order to obtain a wireless service across the Atlantic, and fearing the action by the Marconi Company against them, which is pending, recently purchased the De Forest patent rights for the sum of £30,000. They will now have reason to regret their bargain.

This is not the first patent action which the Marconi Company has brought against Dr. De Forest. In 1905 Judge Townsend, in New York, decided in favour of the Marconi Company in its action against the De Forest Wireless Telegraph Company for infringement of certain fundamental patents.

The Basis of Promotions

MANY employés labour under the belief that they are entitled to promotion to higher positions by reason of long service alone, without any reference to ability and general fitness, but when the time comes for the selection of one to fill a higher position they are always side-tracked.

Telegraph and telephone companies are strictly business concerns and do not fill positions of responsibility with persons who are not qualified to fill them. Operators themselves are subject to the same law. They hold their positions because they are able to perform the duties of their positions, and so it is all along the line up to the highest place. Experience stands supreme yet, and always will.—*Telegraph and Telephone Age.*

Foreign and Colonial Notes

FRANCE.

THE French Marine Commission has decided to appoint nine Commissioners, who, with the delegates of the French Navy, shall control the installation of wireless telegraphy and armaments of mercantile ships and the rules for the navigation of such ships (*The Times*).

* * * * * *

SWEDEN.

The Swedish Press is urging the Government to take steps to prevent the misuse of the Swedish wireless stations by foreign ships trading in the Swedish waters. It is reported that the telegraph authorities have now taken such measures as will make the use of the Swedish wireless system for trade espionage impossible.

* * * * * *

UNITED STATES.

The power plant of the field wireless station at General Pershing's headquarters in Mexico was doubled recently, inaugurating one of the first of the military improvements suggested by the Mexican campaign.

The sending of naval wireless messages on both coasts of North America can be read nightly by this station, but on account of lack of sufficient power it usually has been unable to send even as far as Columbus at night. Daylight conditions are better for wireless operations, owing to the incessant rattle of static at night.

* * * * * *

A course in wireless telegraphy is to be added to the curriculum of the University of Kansas next year. Laurens E. Whittemore, a Fellow in the department of physics, will conduct the course, and he intends to make the wireless station in Lawrence one of the largest in the State outside of those owned and controlled by the Government.

The present outfit established by Whittemore is capable of sending messages more than 1,000 miles, and has picked up parts of messages from as far as Key West. The course is expected to prove extremely popular in the next two years.

* * * * * *

A wireless station has been installed, and is now in operation, at Navassa Island Light Station, West Indies, now under construction. This radio station is operated at present by the contractors for the erection of a light station, and it will be worked by the United States Lighthouse Service when the light station is completed.

* * * * * *

A new type of American aeroplane, with a special helmet for the pilot designed to muffle the deafening motor explosions and make possible the receiving of wireless messages, was recently tested in the United States, says the *Daily Express*. Reception of wireless messages on aeroplanes is no new thing, and a suitable receiving apparatus has been in use at the front for a long time.

Instructional Article

NEW SERIES (No. 15).

The following series, of which the article below forms the fifteenth 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.

Trigonometrical Ratios of the Sum of Two Angles.

98. In Fig. 87 the line QR, "hinged" at Q, has, starting from the position QP, swept out an angle $PQR=A$, and has then gone on further and swept out a second angle $RQS=B$, thus describing the total angle $PQS=(A+B)$. We will now set to work to find convenient expressions, giving the values of sin $(A+B)$, cos $(A+B)$ and tan $(A+B)$ in terms of the sine, cosine and tangent of A and of B.

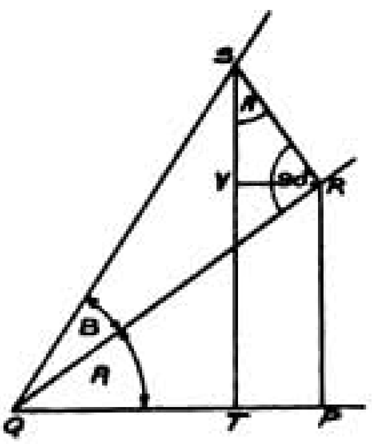


FIG. 87.

From any convenient point S on the final position QS of the radial line, drop perpendiculars ST and SR on to QP and QR respectively. Next draw RP perpendicular to PQ; and then RV parallel to PQ, cutting ST at V. We see that RV is perpendicular to both ST and RP.

In the triangle RSV we know that the sum of the three angles is 180°, and we also know that the angle $SVR=90°$. Therefore

$$V\hat{S}R+V\hat{R}S=180°-S\hat{V}R$$
$$=180°-90°=90°$$
$$\text{or}\quad V\hat{S}R=90°-V\hat{R}S.$$

But we made $\quad Q\hat{R}S=90°,$

and therefore $\quad V\hat{S}R=90°-V\hat{R}S$

$$=Q\hat{R}S-V\hat{R}S=Q\hat{R}V.$$

But we also drew VR parallel to PQ, and therefore

$$Q\hat{R}V=R\hat{Q}P=A.$$

Therefore $\quad V\hat{S}R=A.$

Having settled this, we can now go ahead with our proofs.

$$\sin(A+B)=\sin P\hat{Q}S=\frac{ST}{SQ}=\frac{SV+VT}{SQ}=\frac{SV+RP}{SQ}=\frac{SV}{SQ}+\frac{RP}{SQ}.$$

$$\cos(A+B)=\cos P\hat{Q}S=\frac{QT}{SQ}=\frac{QP-PT}{SQ}=\frac{QP-VR}{SQ}=\frac{QP}{SQ}-\frac{VR}{SQ}.$$

Now if we multiply the numerator and the denominator of a fraction by the same quantity, the value of the fraction remains unchanged.

Multiply $\frac{SV}{SQ}$ by SR

and $\frac{RP}{SQ}$ by RQ

Then $\sin(A+B)$

$$=\frac{SV.SR}{SR.SQ}+\frac{RP.RQ}{RQ.SQ}$$

$$=\cos A\,.\,\sin B+\sin A\,.\,\cos B$$

or

$$\sin(A+B)=\sin A\,.\,\cos B+\cos A\,.\,\sin B.$$

Multiply $\frac{QP}{SQ}$ by QR

and $\frac{VR}{SQ}$ by SR

Then $\cos(A+B)$

$$=\frac{QP.QR}{QR.SQ}-\frac{VR.SR}{SR.SQ}$$

or

$$\cos(A+B)=\cos A\,.\,\cos B-\sin A\,.\,\sin B.$$

Now

$$\tan(A+B)=\frac{\sin(A+B)}{\cos(A+B)}$$

$$=\frac{\sin A\,.\,\cos B+\cos A\,.\,\sin B}{\cos A\,.\,\cos B-\sin A\,.\,\sin B}.$$

In order to obtain this formula in the tangent form we divide all along the numerator and denominator by ($\cos A\,.\,\cos B$). Thus—

$$\tan(A+B)=\frac{\dfrac{\sin A\,.\,\cos B}{\cos A\,.\,\cos B}+\dfrac{\cos A\,.\,\sin B}{\cos A\,.\,\cos B}}{\dfrac{\cos A\,.\,\cos B}{\cos A\,.\,\cos B}-\dfrac{\sin A\,.\,\sin B}{\cos A\,.\,\cos B}}=\frac{\dfrac{\sin A}{\cos A}+\dfrac{\sin B}{\cos B}}{1-\dfrac{\sin A}{\cos A}\,.\,\dfrac{\sin B}{\cos B}}$$

$$=\frac{\tan A+\tan B}{1-\tan A\,.\,\tan B}.$$

Trigonometrical Ratios of the Difference of Two Angles.

99. We can quite easily employ the method of Section 98 to finding the sine, cosine and tangent of $(A-B)$ instead of $(A+B)$. We shall, however, require a slightly different geometrical construction.

In Fig. 88 the radial line has swept out an angle $PQR=A$, and has then *reversed* and swept out an angle $RQS=B$. We thus have the angle $PQS=(A-B)$.

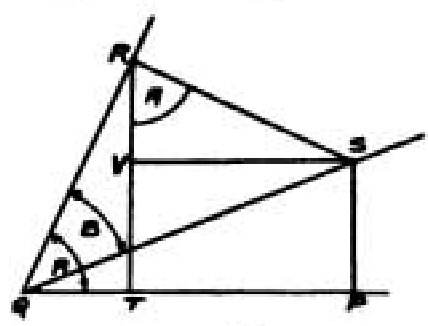


FIG. 88.

As before, we take some convenient point S on the final position of the line, and from this point drop perpendiculars SP and SR on to QP and QR respectively. RT is then drawn perpendicular to PQ, and SV parallel to PQ. Then

$$V\hat{R}S=Q\hat{R}S-Q\hat{R}T=90^\circ-Q\hat{R}T=R\hat{Q}T=A.$$

The proofs which follow are very similar indeed to those in the preceding paragraph

$\sin(A-B)$

$$=\sin P\hat{Q}S$$

$$=\frac{PS}{SQ}=\frac{VT}{SQ}=\frac{RT-RV}{SQ}$$

$$=\frac{RT}{SQ}-\frac{RV}{SQ}$$

$$=\frac{RT.QR}{QR.SQ}-\frac{RV.RS}{RS.SQ}$$

$$\sin(A-B)=\sin A\,.\,\cos B-\cos A\,.\,\sin B.$$

$\cos(A-B)$

$$=\cos P\hat{Q}S$$

$$=\frac{PQ}{SQ}=\frac{PT+TQ}{SQ}=\frac{SV+TQ}{SQ}$$

$$=\frac{SV}{SQ}+\frac{TQ}{SQ}$$

$$=\frac{SV.RS}{RS.SQ}+\frac{TQ.QR}{QR.SQ}$$

$$\cos(A-B)=\sin A\,.\,\sin B+\cos A\,.\,\cos B$$

or $\cos A\,.\,\cos B+\sin A\,.\,\sin B.$

Again,

$$\tan (A-B)=\frac{\sin (A-B)}{\cos (A-B)}$$

$$=\frac{\sin A . \cos B-\cos A . \sin B}{\cos A . \cos B+\sin A . \sin B}=\frac{\frac{\sin A . \cos B}{\cos A . \cos B}-\frac{\cos A . \sin B}{\cos A . \cos B}}{\frac{\cos A . \cos B}{\cos A . \cos B}+\frac{\sin A . \sin B}{\cos A . \cos B}}$$

$$=\frac{\frac{\sin A}{\cos A}-\frac{\sin B}{\cos B}}{1+\frac{\sin A}{\cos A} . \frac{\sin B}{\cos B}}=\frac{\tan A-\tan B}{1+\tan A . \tan B}.$$

Example :

If $\sin A=\frac{4}{5}$ and $\tan B=\frac{9}{40}$, find $\cos (A+B)$.

In Fig. 89 (*a*) we have our usual right-angled triangle PQR. Angle $Q=90°$, and angle $P=A$. As we know that $\sin A=\frac{4}{5}$, we know that $QR=4$ and that $PR=5$.

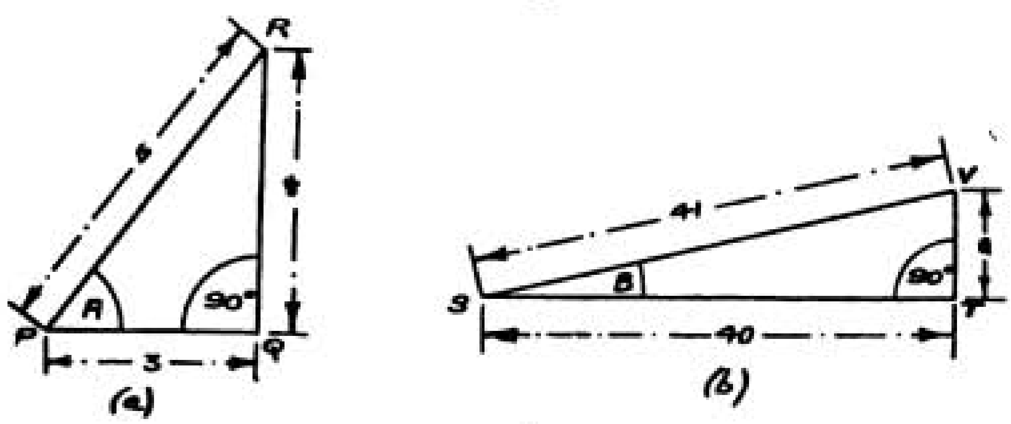


FIG. 89.

Thus $PQ=\sqrt{PR^2-RQ^2}=\sqrt{25-16}=\sqrt{9}=3$.

From this $\cos A=\frac{3}{5}$.

Similarly, in Fig. 89 (*b*) we deal with angle B, and we see that if angle $S=B$, then $VT=9$ and $ST=40$.

From this we get

$SV=\sqrt{(40)^2+(9)^2}=\sqrt{1600+81}=\sqrt{1681}=41$.

Therefore $\sin B=\frac{9}{41}$

and $\cos B=\frac{40}{41}$.

Thus $\cos (A+B)=\cos A . \cos B-\sin A . \sin B$

$$=\frac{3}{5} . \frac{40}{41}-\frac{4}{5} . \frac{9}{41}$$

$$=\frac{120}{205}-\frac{36}{205}=\frac{84}{205}=0{\cdot}41.$$

From tables $(A+B)=\cos^{-1} 0{\cdot}41$

$=65° 48'$ (approx.).

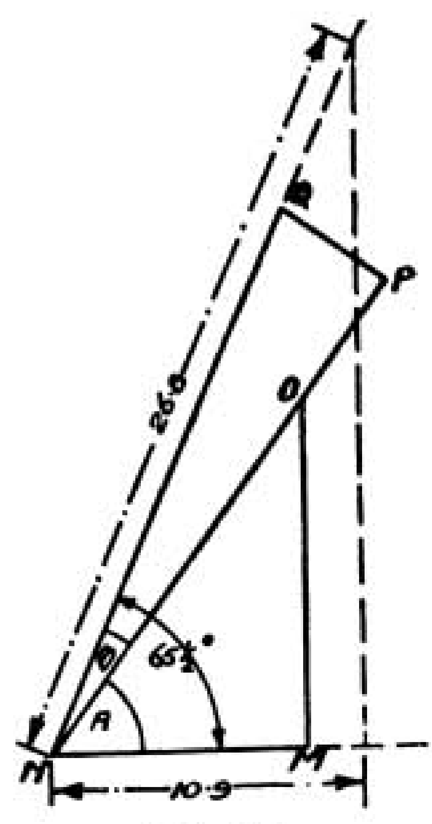


FIG. 90.

These results are verified in Fig. 90.

Here $M\hat{N}O$ is drawn, to scale, as angle A, and on NO produced is erected the angle $PNQ=B$. The obvious way to do this is to make $N\hat{M}O=90°$, and make $MO=4$ and $NM=3$. (Then NO *must* equal 5.)

Similarly $NP=40$, $PQ=9$ and $N\hat{P}Q=90°$. (In this case NQ *must* equal 41.) Note that different scales are used, for convenience, for drawing A and B.

Scaling off from this figure, we get

$$(A+B)=65\tfrac{1}{2}° \text{ and } \cos(A+B)=\frac{10{\cdot}9}{26{\cdot}8}=0{\cdot}407.$$

Example :

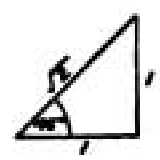
Find (i.) sin 75° and (ii.) tan 105°.

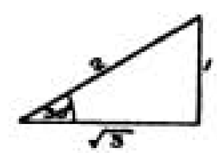
(i.) $\text{Sin } 75°=\sin(45°+30°)$

$$=\sin 45°\,.\cos 30°+\cos 45°\,.\sin 30°.$$

Now $\sin 45°=\frac{1}{\sqrt{2}}$ $\cos 45°=\frac{1}{\sqrt{2}}$

$\sin 30°=\frac{1}{2}$ $\cos 30°\,.\,\frac{\sqrt{3}}{2}$





Therefore $\sin 75°=\frac{1}{\sqrt{2}}\cdot\frac{\sqrt{3}}{2}+\frac{1}{\sqrt{2}}\cdot\frac{1}{2}$

$$=\frac{\sqrt{3}}{2\sqrt{2}}+\frac{1}{2\sqrt{2}}=\frac{\sqrt{3}+1}{2\sqrt{2}}$$

$$=\frac{1{\cdot}732+1}{2\times 1{\cdot}414}=\frac{2{\cdot}732}{2{\cdot}828}=\underline{0{\cdot}966 \text{ (approx.)}}.$$

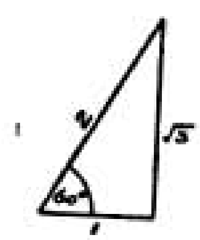
[From Tables—sin 75° = 0·9659.]

(ii.) $\text{Tan } 105°=\tan(60°+45°)$

$$=\frac{\tan 60°+\tan 45°}{1-\tan 60°\,.\tan 45°}.$$

Now $\tan 60°=\frac{\sqrt{3}}{1}=\sqrt{3}$

and $\tan 45°=\frac{1}{1}=1.$



Therefore $\tan 105°=\frac{\sqrt{3}+1}{1-\sqrt{3}\times 1}=\frac{1{\cdot}732+1}{1-1{\cdot}732}$

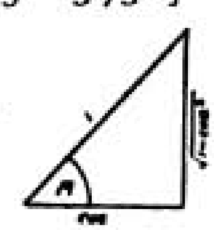
$$=\frac{2{\cdot}732}{-0{\cdot}732}=-\frac{2{\cdot}732}{0{\cdot}732}=\underline{-3{\cdot}73} \text{ (approx.)}.$$

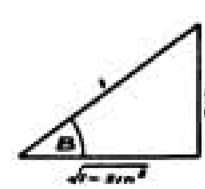
[From Tables—tan 105° = −tan 75° = $\bar{3}{\cdot}732$.]

Example :

Given that $\cos A=0{\cdot}2$ and $\sin B=0{\cdot}4$, find $\tan(A-B)$.

Working as in Article XIV., we have—





$$\tan A=\frac{\sqrt{1-\cos^2 A}}{\cos A}=\frac{\sqrt{1-(0{\cdot}2)^2}}{0{\cdot}2}=\frac{\sqrt{1-{\cdot}04}}{{\cdot}2}=\frac{\sqrt{{\cdot}96}}{{\cdot}2}=\frac{{\cdot}98}{{\cdot}2}=4{\cdot}9.$$

We have also

$$\tan B=\frac{\sin B}{\sqrt{1-\sin^2 B}}=\frac{0{\cdot}4}{\sqrt{1-(0{\cdot}4)^2}}=\frac{0{\cdot}4}{\sqrt{1-0{\cdot}16}}=\frac{0{\cdot}4}{\sqrt{0{\cdot}84}}=\frac{0{\cdot}4}{0{\cdot}9165}=0{\cdot}436.$$

Thus $\tan(A-B)=\frac{\tan A-\tan B}{1+\tan A\,.\,\tan B}$

$$=\frac{4\cdot 9-0\cdot 436}{1+4\cdot 9\times 0\cdot 436}=\frac{4\cdot 454}{1+2\cdot 14}=\frac{4\cdot 454}{3\cdot 14}=1\cdot 42.$$

Thus $(A-B)=\tan^{-1} 1\cdot 42$
$=55^\circ$ (nearly).

Examples for Practice:

21. Evaluate the following by means of the foregoing addition and subtraction theorems:

(*a*) $\cos 75^\circ$ (*c*) $\sin 105^\circ$
(*b*) $\tan 75^\circ$ (*d*) $\sec 195^\circ$ ($195^\circ=135^\circ+60^\circ$ and $135^\circ=90^\circ+45^\circ$).

22. Given $\sin 55^\circ=0\cdot 82$ and $\cos 20^\circ=0\cdot 94$, find (*a*) $\sin 75^\circ$, (*b*) $\cos 35^\circ$ and (*c*) $\tan 75^\circ$.

100. In the preceding paragraphs we obtained the following important formulæ:

$$\sin(A+B)=\sin A\cos B+\cos A\sin B \quad . \quad . \quad . \quad (1)$$
$$\sin(A-B)=\sin A\cos B-\cos A\sin B \quad . \quad . \quad . \quad (2)$$
$$\cos(A+B)=\cos A\cos B-\sin A\sin B \quad . \quad . \quad . \quad (3)$$
$$\cos(A-B)=\cos A\cos B+\sin A\sin B \quad . \quad . \quad . \quad (4)$$
$$\tan(A+B)=\frac{\tan A+\tan B}{1-\tan A\,.\,\tan B} \quad . \quad . \quad . \quad (5)$$
$$\tan(A-B)=\frac{\tan A-\tan B}{1+\tan A\,.\,\tan B} \quad . \quad . \quad . \quad (6)$$

Now let us take formulæ (1) and (2)

$$\sin(A+B)=\sin A\,.\,\cos B+\cos A\,.\,\sin B$$
$$\sin(A-B)=\sin A\,.\,\cos B-\cos A\,.\,\sin B$$

Adding— $\sin(A+B)+\sin(A-B)=2\sin A\cos B$. (7)
Subtracting—$\sin(A+B)-\sin(A-B)=2\cos A\sin B$. (8)

Now let us put C for $(A+B)$
and D for $(A-B)$

Then $\left(\frac{C+D}{2}\right)=\frac{(A+B)+(A-B)}{2}=\frac{2A}{2}=A$

and $\left(\frac{C-D}{2}\right)=\frac{(A+B)-(A-B)}{2}=\frac{2B}{2}=B.$

Substituting these values in equations (7) and (8), we get—

$$\sin C+\sin D=2\sin\left(\frac{C+D}{2}\right).\cos\left(\frac{C-D}{2}\right) \quad . \quad . \quad (9)$$

and $$\sin C-\sin D=2\cos\left(\frac{C+D}{2}\right).\sin\left(\frac{C-D}{2}\right) \quad . \quad . \quad (10)$$

Similarly, dealing with formulæ (3) and (4)—

$$\cos(A+B)=\cos A\cos B-\sin A\sin B$$
$$\cos(A-B)=\cos A\cos B+\sin A\sin B$$

Adding— $\cos(A+B)+\cos(A-B)=2\cos A\,.\,\cos B$

Subtracting— $\cos(A+B)-\cos(A-B)=-2\sin A\sin B=2\sin A\,(-\sin B)$

$=2\sin A\sin(-B)$ because $-\sin B=\sin(-B)$ (Art. 7.)

Substituting as before—

$$\cos C+\cos D=2\cos\left(\frac{C+D}{2}\right)\cos\left(\frac{C-D}{2}\right) \quad . \quad . \quad (11)$$

and $$\cos C-\cos D=2\sin\left(\frac{C+D}{2}\right)\sin\left\{-\left(\frac{C-D}{2}\right)\right\}$$

or $$\cos C-\cos D=2\sin\left(\frac{C+D}{2}\right)\sin\left(\frac{D-C}{2}\right) \quad . \quad . \quad (12)$$

Answers to Questions in Art. XIV.

13. $\begin{cases} x=0,\ y=-1 \\ x=3,\ y=8. \end{cases}$

14. $\begin{cases} x=-3,\ y=4 \\ x=\frac{4}{7},\ y=\frac{131}{14}. \end{cases}$

15. $\begin{cases} x=\frac{7}{2},\ y=-\frac{5}{2} \\ x=-\frac{24}{7},\ y=\frac{89}{42}. \end{cases}$

16. $\frac{x}{9}=\frac{y}{-17}=\frac{z}{-7}.$

17. $\frac{x}{3}=\frac{y}{1}=\frac{z}{11}.$ (Note that the coefficient of z is 0.)

18. $\frac{x}{13}=\frac{y}{1}=\frac{z}{11}.$

19. (a) $\sin\theta=\frac{1}{\sqrt{1+\cot^2\theta}}.$

(b) $\tan\theta=\frac{\sqrt{1-\cos^2\theta}}{\cos\theta}.$

(c) $\cot\theta=\sqrt{\operatorname{cosec}^2\theta-1}.$

20. (a) $\cos\theta=0\cdot8.$ (b) $\sec\theta=4\cdot12.$ (c) $\cot\theta=9\cdot95.$
(d) $\cos\theta=1$ (approx.) $\sin\theta=0\cdot01$ (approx.) (e) $\tan\theta=0.$

Wireless Only

How the Bahamas were Saved from Isolation.

According to a Colonial Office report published recently, last year the sole means of telegraphic communication which the Bahama Islands enjoyed was by radio, which, during twelve months in which business was far greater than in any previous year, proved a very excellent substitute for the broken cable between Nassau and Florida.

"EXPERIMENTAL WIRELESS STATIONS, THEIR THEORY, DESIGN, CONSTRUCTION AND OPERATION." Third Edition. By Philip E. Edelman. Published by the Author at Minneapolis, Minn., U.S.A. $1.50.

This is one of the best books on practical wireless that we have seen, and the new edition under review will doubtless meet with the same wide sale as the previous ones. It is evident upon first perusal that the author is thoroughly acquainted with his subject, and the designs of apparatus given are theoretically sound and thoroughly practical. Commencing with a brief chapter on theories of transmission, the author then deals with the design of aerials and earths, general features of transmitter resonance, damping, and allied subjects. Chapter V.—a particularly valuable one—is devoted to planning the transmitter, and here the reader will find clear instructions for the calculation of wave-length, capacity and circuits. Transformers and spark coils are then treated, after which we come to a consideration of auxiliary apparatus, including keys, electrolytic interrupters and aerial switches. Other chapters deal with transmitting condensers, inductance, spark coils, and hot wire ammeters.

Continuous waves and continuous wave apparatus have a chapter to themselves, and we then find some valuable information on the construction and working of receivers.

In order that the book may be brought right up to date the author has added a "1916 Supplement" dealing with aeroplane wireless, balancing aerials, the various new receivers which come under the general heading of "Vacuum Valves" (audions, pliotrons, etc.), transatlantic wireless telephony, long-wave stations, and a very useful little section on long-wave receivers.

Not the least valuable part of the book is the section devoted to the United States patents on wireless telegraphy, telephony and control. In this patents from 1881 to January 1st, 1916, are classified under various headings, such as general apparatus, receiving systems, secrecy systems, various forms of detectors, wave-meters, wireless telephony, and so on. We do not remember having seen such a classification before, and we are sure that many readers will welcome it with enthusiasm.

The book is profusely illustrated with diagrams which are both clear and practical. As soon as the war is over, and amateur wireless enthusiasts are able to re-erect their apparatus, we are sure that a large number of them will profit by the excellent information contained in this book, and greatly improve their installations.

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"ENGLISH-FRENCH COMMERCIAL CORRESPONDENCE." By William Chevob-Maurice and C. Laroche. London: E. Marlborough & Co. 1s. net, wrapper; 1s. 6d. net, cloth.

One of the minor effects of the great war is to bring home to the British business man the need of a thorough knowledge of foreign languages, if he wishes to capture much of the trade which, prior to the outbreak of hostilities, was in the hands of the Germans. The aim of this handbook is to supply the commercial equivalent in French and English, and not merely a literal translation one of the other. In this way the correct phraseology is assured to the correspondent, whether he writes in English or in French. In the 126 pages of the book will be found practically everything that is required in general business correspondence—good, sound, common-sense letters, free from the affectation which mars so many books of this type. We can warmly recommend this little volume to all who require assistance in their correspondence with France and French-speaking countries.

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"ARITHMETIC FOR ENGINEERS." By Charles B. Clapham. London: Chapman & Hall, Ltd. 5s. 6d. net.

This book, which forms one of the "Directly Useful Technical Series," bears a title which is, to some extent, misleading. A glance at the index shows that not only general arithmetic but simple algebra, logarithms, graphs, and the slide rule are dealt with, so that the book would be far better entitled "Elementary Mathematics for Engineers." However, this title has apparently been used before.

The volume is designed to fill the place between theoretical books which have been written more for the training of college students than for the supply of information to men in practice, and the practical books which often run to the other extreme, omitting the scientific basis upon which all good practice is built. The explanations of all the subjects are clear and to the point, and the examples and exercises admirably chosen. For home students this work can be particularly recommended, and, indeed, the author has borne this section of the public in mind when preparing the course. The numerous illustrations are well drawn, and we are glad to see that the final chapter contains answers to all the exercises.

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"ITALIAN GRAMMAR SELF-TAUGHT." By A. C. Panagulli. London: E. Marlborough and Co. Paper wrapper, 1s. net; cloth, 1s. 6d. net. Key to Italian Grammar, 6d. net.

This little elementary work will be found very useful on account of its simplicity and brevity. The author's aim has been to eliminate that which is not absolutely essential. The grammar constructions can be easily reproduced by the pupil, numerous exercises being set on these constructions. The vocabulary is principally composed of words of frequent use and considerable stress has been laid on the idiomatic structure of Italian. A lucid key is published separately for the exercises contained in the Grammar. We heartily commend the work to those who wish to teach themselves Italian.

* * * * * *

" THE NEW BREED." By Andrew Firth. London : T. Fisher Unwin, Ltd. 6s.

This is a tale of love, adventure, scheming and investigation, with all the other ingredients of a good modern novel. There is more than a passing reference to wireless telegraphy, and, in fact, this science plays quite an important part in the book. Contrary to the usual practice in modern novels, there is a direct connection between the story and the title. When the hero, ascending in an aeroplane, was being watched by his mother as the great machine soared over the trees, the author says, " she recognised these young men for a new breed. They said so much less than what they meant and undertook Titanic tasks without the flicker of an eyelid."

The character of Yolande Vaughan, the spoilt Australian beauty to whom the hero has just become engaged on the opening of the book, is very cleverly drawn, and we must confess that we do not burn with indignation when her ears are boxed on page 49. However, opinions on this point will doubtless differ !

Altogether the book is an excellent one for passing away the hours off watch at sea, and we can recommend it to all who are looking for a good, interesting novel to pack in their kit-bag.

* * * * * *

" AERIAL RUSSIA : THE ROMANCE OF THE GIANT AEROPLANE." By Lieutenant-Colonel Roustam Bek. John Lane. 2s. 6d. net.

We must confess to a feeling of disappointment after the perusal of this volume. Judging by its title, we had expected to add to our knowledge of the giant Sikorsky aeroplanes, but, after careful reading, we close the book merely with a somewhat confused idea that the credit for these mighty machines must be shared equally between Sikorsky himself and a Scot, Mackenzie-Kennedy. As a series of interesting armchair chats on Russian aviation generally, however, this volume certainly makes very interesting reading. Few Englishmen are acquainted with the great strides in aerial navigation which have been made in Russia, and still fewer realise how that country has kept to the front in aviation from the very first.

The portion of the book dealing with Mr. Chessborough Mackenzie-Kennedy, who has spent many years in Russia, and to whom perhaps more than anyone else Russia owes her present position in the aeronautical world, is a story of keenness and a fight against difficulties which will make a strong appeal to all Englishmen.

It should be mentioned that the profits from the sale of this book are to be devoted to a fund for the families of British aviators who have died in the cause that is Russia's as well as theirs.

Personal Notes

A VERY pretty wedding took place recently at All Saints' Church, Oakham, the contracting parties being Miss Edith Everlyn Geeson, daughter of Lieutenant and Mrs. G. H. Geeson, and Sergeant George Merritt Burgham, of an important wireless station engaged on Government work. A reception was subsequently held at the residence of the bride's parents, and later in the day Sergeant and Mrs. Burgham left for Weston-super-Mare, where the honeymoon was spent. On behalf of our readers we wish Sergeant and Mrs. Burgham every happiness.

* * * * * *

Another interesting wedding ceremony took place on October 2nd, at St. Michael's Church, Boldmere, Birmingham, when Mr. J. T. Marler, of the Marconi International Marine Communication Co., Ltd., was married to Miss Elsie Allen, of Hackney. Mr. Marler, who is a very popular member of the Marconi House staff, has served with the company for ten years—practically half the lifetime of the Marconi Company—and during this period has seen many changes.

After the ceremony the happy couple proceeded to Matlock for their honeymoon, which we trust proved as enjoyable as such occasions usually do. Mr. Marler's many friends among our readers will, we are sure, join with us in offering the newly married couple heartiest congratulations and best wishes for a happy married life.

* * * * * *

According to the *Lincoln Echo*, Mr. J. W. Wilson, Postmaster of Ruskington, has received notice that his son, Mr. W. B. Wilson, is interned as a prisoner of war at Affum-Kara-Hissar, in Asia Minor. He was acting as chief wireless operator on board the ill-fated *Zaida* when it was sunk in the Mediterranean. The news was received from Switzerland, through the Prisoners of War International Agency.

* * * * * *

In our September issue we referred to the award of the Croix de Guerre to Mr. Frederick Thomasson, who prior to the war was a member of the Marconi Company's staff. We are now able to reproduce a photograph of Mr. Thomasson wearing this decoration which he earned by conspicuous bravery in action.

PRIVATE FREDERICK THOMASSON.

We have pleasure in reproducing here a photograph of Observer J. A. Hood, who prior to the war was engaged on the marine operating staff of the Marconi Company. "The Observer ignorant of wireless is no longer classed as an observer," says Mr. Hood; "he has become a back number. It stands to reason that if a British seaplane sights a hostile squadron, say 40 miles from her base or from the nearest unit of the Home Fleet, then a precious 14 minutes at least is going to be lost if the observer does not understand wireless telegraphy." Mr. Hood will have many exciting experiences to relate when the war is over.

OBSERVER J. A. HOOD.

* * * * * *

At a Scotch Tribunal recently a wireless student, who was said to be engaged all day on munition work, appealed against the refusal of his claim. In view of the fact that that was his fourth appearance, it was moved that the appeal be dismissed. The majority of the tribunal approved this, and as a consequence the claim was disallowed.

* * * * * *

Mr. J. P. Edmond, organist of Cardross Parish Church, and now serving with the Russian Legion, in a letter to a relative in Glasgow, describes his experience with the British armoured cars on their way to the fighting line. "The journey," he writes, "was one which I would not have missed for worlds. It took us through ——, and the scenery was grand and varied. The road was fairly good but full of hair-pin bends and reached to a great height (8,000 feet above sea level). We erected our wireless station at this height one night in the dark. It was very lonely and eerie, and very cold, being above the clouds."

* * * * * *

The body of a naval wireless operator named Charles Turner has been washed ashore at Charleston, on the east coast of Scotland. He was drowned through the swamping of a motor-boat.

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Mr. David Wyllie, Bangor, who before the war was employed at the *North Wales Chronicle* office, has been awarded the D.S.M. He is a wireless operator in the Navy.

Company Notes

The Marconi Wireless Telegraph Company of Canada, Ltd.

ANNUAL REPORT FOR THE YEAR ENDING JANUARY 31ST, 1916.

THE Directors, in submitting their annual report and statement of accounts for the year ending January 31st, 1916, state that the company's business continues to show substantial expansion. The most gratifying feature during the year just concluded has been the steady development of the company's transatlantic traffic. In spite of the general dislocation of business created by war conditions, the work being done by the Glace Bay station in maintaining direct communication between Canada and Europe shows a satisfactory increase in traffic handled, and in income resulting from that source. There is every evidence of this improvement being maintained during the current year.

The unique value of Marconi wireless in every phase of the present war is a matter of common knowledge; its supreme value during possible isolation of any country during interruption of cable communication has been demonstrated on two occasions during the past year when the business community of Canada was to a large extent dependent on the Marconi Service between Glace Bay and Ireland.

The company's plant in Montreal has been kept fully occupied in supplying the demand for additional installations on board ships and commercial stations, as well as in meeting increased Government requirements. A growing sentiment is apparent amongst progressive shipowners that no vessel engaged in coastwise or ocean trade is fully equipped unless furnished with a Marconi wireless installation, and wireless stations aboard ship are now being viewed with favour even on vessels exempt by law from compulsory equipment. A total of some 2,300 mercantile vessels have up to the present been fitted with Marconi wireless stations by the various Marconi companies.

The directors appreciate that the goodwill of the public constitutes a most valuable asset to the company, and have accordingly extended the facilities of its marine department in order to give the best possible service to its patrons by creating divisional offices and stores in the more important centres of St. John's, Newfoundland, Toronto and Vancouver. Owing to the constant demands on the operating staff caused by the war, a school of instruction for operators has been established in Montreal under the direct control of the company, and equipped with the latest type of standard apparatus.

The adverse effect caused to the company's normal traffic to and from ships, owing to the stringency of censorship imposed on commercial messages, has unfortunately continued in evidence throughout the current period. The basis of remuneration from the Government for the use of a number of the company's coast stations taken over by the Department of Naval Service since the commencement of hostilities and for other services rendered is still under consideration, and an equitable settlement is awaited in the near future.

The profit for the year is $110,226, as compared with $50,020 for the preceding year, and, after deducting interest on advances, the balance carried forward is $80,815, against $5,727 brought in.

Amalgamated Wireless (Australasia), Ltd.

THE sixth half-yearly ordinary general meeting was held at the registered office of the company, "Wireless House," 97, Clarence Street, Sydney, on Thursday, August 17th, 1916, at 12.30 p.m., Mr. Hugh R. Denison in the chair.

The directors' report states that trading for the period had again suffered from the continued effects of the war, and showed a falling off from the previous half-year.

With regard to ships' message traffic, notwithstanding the very stringent war regulations, the revenue from this source showed an increase, and the directors looked for still further improvement in the future.

The manufacturing department has been handicapped during the period by a shortage of skilled labour, but the work being done is of the highest class. Installations made by the company in its Australian factory have been spoken of in the highest terms by the inspecting officers of the United States Government.

Subsidy ships have increased to 90, and a further increase in this number is forecasted for next year. The company has made long contracts with most of the shipping companies.

The training school still continues its good work, and shows a small but regular profit on its working. The efficiency of the company's operators is the best test of the value of this school, as most of them have received their wireless education under its auspices.

During the half-year the company has secured the sole licence and agency for the Poulsen system of radiotelegraphy, and this should become an important adjunct to the business. The sole agency of the automatic relay telephone has also been obtained by the company.

In accordance with the Articles of Association, Mr. C. P. Bartholomew, one of the directors, retired from the board, and offered himself for re-election.

The net profit for the period under review amounted to £4,692 1s. 9d., which, with £3,331 12s. 1d. brought forward from the previous half-year, left a balance to the credit of profit and loss account of £8,023 13s. 10d.

The directors proposed to recommend a distribution of a dividend at the rate of 5 per cent. per annum on the capital of the company, absorbing £7,000, and to carry forward the balance of £1,023 13s. 10d. to the next account.

Share Market Report

LONDON, *12th October*, 1916.

BUSINESS in the Share Market has been very quiet during the past month, but there has been a fair demand for shares by small investors. The prices as we go to press are: Marconi Ordinary, £2 18s. 9d.; Marconi Preference, £2 8s. 9d.; Marconi International Marine, £2 2s. 6d.; American Marconi, 17s. 6d.; Canadian Marconi, 9s. 6d.; Spanish and General Wireless Trust, 10s. 6d.

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.

POSITIVELY NO QUESTIONS ANSWERED BY POST.

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.*

P. R. (Wireless Station, Peshawar) (1) states that the following formula is quoted, in a pamphlet on wireless, for the voltage to which the condenser is charged by the secondary transformer circuit

$$E_c=\frac{\pi}{2}\sqrt{\cdot 80}\sqrt{2}\,E_s$$

E_c being the condenser voltage, and E_s the virtual voltage of the secondary. He inquires what the factor $\sqrt{\cdot 80}$ represents. (2) When using a Marconi 30-kw. 350-cycle set to transmit short waves, he notices a flaming at the spark-gap, which cannot be got rid of by any adjustment of the low-frequency tuning inductance or adjustment of the phase position of the spark discharger.

Answer.—The theoretical formula for the condenser charging voltage is that given by you without the factor $\sqrt{\cdot 80}$. This, however, implies that the ratio of the voltages of the transformer is constant under all conditions of load, so that the factor $\sqrt{\cdot 80}$ is probably intended to correct for the fact that in the actual transformer in use this does not hold, the secondary volts being lower in consequence. It is written in the square-root form as a matter of convenience, since for a transformer the relationships between the two circuits often involve the square of the various quantities, such as inductance, etc. (2) The flaming at the gap is probably due to insufficient low-frequency inductance, since you state you are using all that has been provided. This transformer, being designed primarily to work with a large capacity, would require more inductance when charging the small capacity used for short waves. (3) We do not know of any book in which the transformer is treated of fully, showing vector diagrams of the relative effects of capacity, etc., in the two circuits as referred to in Mr. Hallboy's paper. This is, of course, a fairly recent application of the transformer, and the discussion does not yet appear to have found its way into the textbooks. A short article, by L. B. Turner, appeared in the *Electrician*, August, 1912, and is quoted in Dr. Eccles' "Handbook."

F. W. G. (H.M.S. ——).—The article in the Proceedings of the Institute of Radio Engineers to which you refer will, we think, give you all the information you require.

H. L. (Bradford).—A wireless operator in the Marconi Company is required to provide his own uniform. When a candidate is accepted for the Marconi Company's school for completion of training, he is not required to pay any fee. On the contrary, he is paid a salary during training dependent upon the extent of his knowledge when he enters. The duration of his stay in the school also depends upon the extent of his knowledge. We shall be pleased to give you any other information you require on this subject.

P. G. (London).—Particulars of conditions of employment and rates of pay can be obtained on application to The Traffic Manager, Marconi International Marine Communication Company, Limited, Marconi House, Strand, W.C. See answer to H. L. (Bradford).

INTERFERENCE (Margate).—It is quite possible to work a sensitive wireless receiving station in a building containing electric lifts, motors, lights, bells, etc., provided suitable precautions are taken. Modern passenger liners such as the *Olympic*, *Aquitania*, etc., contain hundreds of electrical devices such as those mentioned by you, and no trouble is experienced. The whole of the low frequency wiring of the Marconi installation is lead covered, the covering being earthed. This is a very effective means of preventing interference from the sparking of auxiliary electrical apparatus.

R. S. T. (Queen's Park, W.A.).—(1) The armature of the magnetic key is drawn down and released at the frequency, which is the same as that of the alternating current which passes through the coils of the magnet. If a low frequency alternating current is passed through a telephone receiver, the diaphragm will be drawn towards the magnets and released in exactly the same way, giving a hum which depends on the frequency. It is only when the frequency is much higher than that at which it is possible for the diaphragm to vibrate that alternating current will not operate the telephone receiver. (2) We are afraid we cannot give you any information on your second question unless you inform us of the type of rotary converter to which you refer.

H. E. P. (Leicester).—(1) Marconi Operators are not bound by their agreement to serve for any definite period, although of course it is expected that a man will not enter the wireless service with the intention of leaving it after a short period. Question 2 is answered in Question 1. (3) Wireless operating has no injurious effect whatever upon the operator's health; on the contrary, most men benefit considerably by taking up this profession, as it enables them to get the benefit of the sea air. (4) As you say you can send and receive at 20 words a minute, we would suggest that you should apply to The Traffic Manager, Marconi International Marine Communication Company, Limited, Marconi House, Strand, W.C., stating your qualifications and asking if there is any vacancy which can be offered you. (5) The agreement can be terminated by one month's notice. (6) No.

C. H. P. (Harrogate).—There is no premium to pay for becoming a wireless operator in the Marconi Company. (2) Yes. (3) The cost of becoming a wireless operator after the P.M.G. certificate is obtained is very little. If a candidate is otherwise suitable, he will probably be able to obtain employment in the Marconi Company immediately upon obtaining his Postmaster-General's Certificate, provided, of course, there is a vacancy at the time. In this case as soon as the man is accepted he will be paid a salary, and practically the only expenses he will be put to are the cost of living while he is finishing his training in London, the fee to the doctor for medical examination and the cost of his uniform and outfit.

E. E. S. C. (Manchester).—(1) *The Handbook of Technical Instruction for Wireless Telegraphists*, by J. C. Hawkhead and H. M. Dowsett. (2) Yes, the same amount of knowledge can be obtained by attending evening classes as by day classes, but naturally it will take longer to learn in the evening classes as these are shorter than those of the day. (3) Some of the back numbers of THE WIRELESS WORLD are still obtainable and some are not. If you will send a list of the back numbers you require, we will inform you which of them are still obtainable. (4) The new volume of THE WIRELESS WORLD commences in April. There are twelve numbers to each volume, and volume 1 opened in April, 1913. (5) The school you mention is not controlled by the Marconi Company and is a private institution. It is, however, fully equipped with the necessary apparatus for training wireless operators. (6) Yes.

P. R. (County Wexford).—The address of the Postmaster-General is General Post Office, London. (2) You should be able to obtain a good style of sending by copying the signals of the Marconi Official Records on the key connected to a buzzer.

H. C. K. (Tottenham).—(1) The angle should be *minus* 135° or *plus* 225°. This is seen much more readily by the diagram on page 144 than by your calculations. You will always find it a great help to draw out these problems roughly, even when solving by calculation. (2) This point should be quite clear from Article 7 in the March number of THE WIRELESS WORLD.

H. M. (Barrow-in-Furness).—The statements made are not correct with regard to the Marconi Company. There is no rule that a man away from a home port for three months or more receives extra pay. In certain cases of *foreign* service additional salary is paid, however. Did the school in question give the particulars you mention as applying to the Marconi Company?