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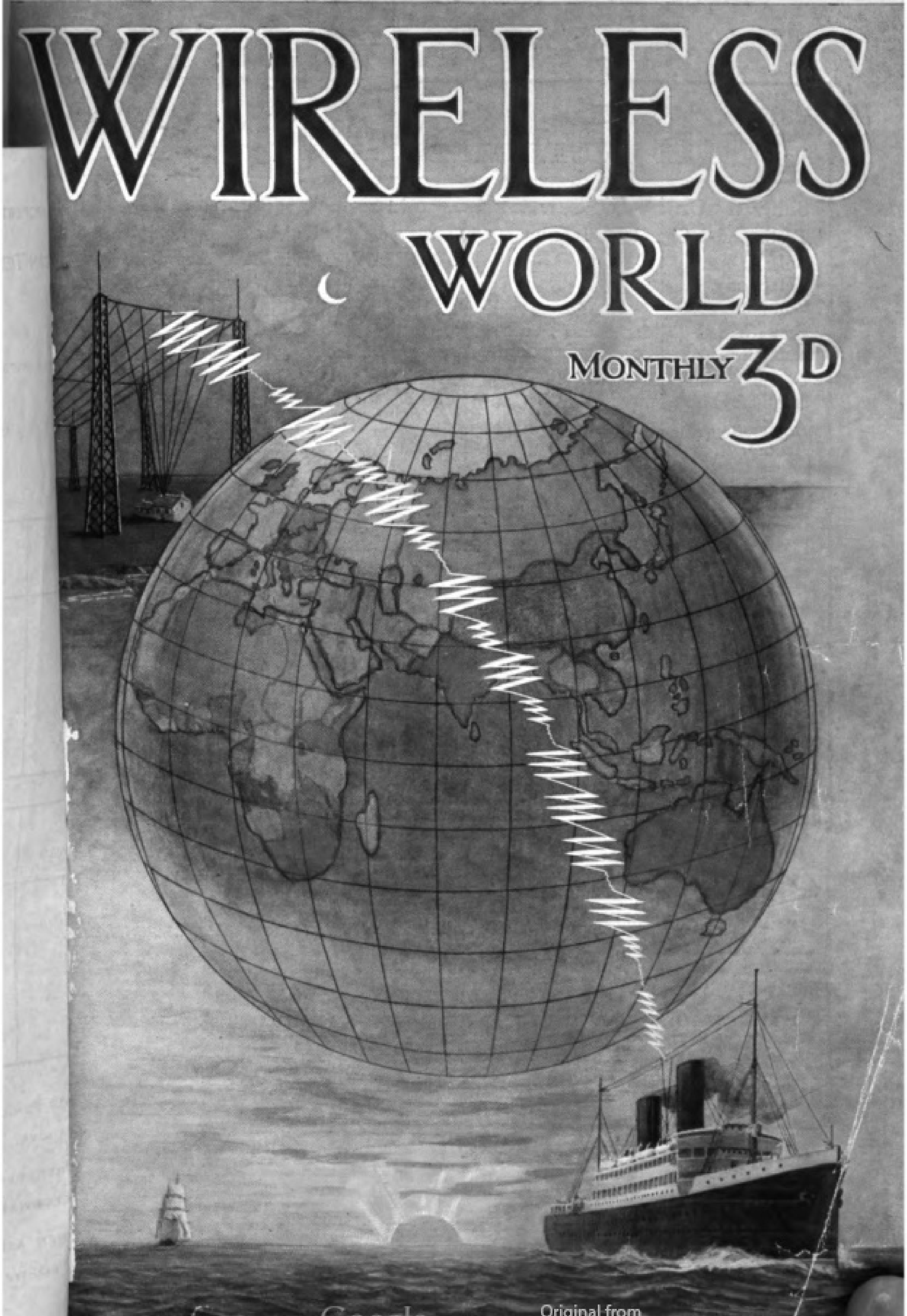

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The Editor will be pleased to receive contributions; and Illustrated Articles will be particularly welcomed. All such as are accepted will be paid for.

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The MARCONIGRAPH

Vol. 1.—No. 8. (New Series) November, 1913. Subscription 5/0 per annum post free. Price 3d. Post Free 5d.

The Magic of Wireless

"It seems to me beyond question that the name of Marconi will be associated for ages to come with one of the greatest conquests of the human spirit—a conquest whose full significance we can as yet, perhaps, but dimly perceive."—MR. WILLIAM ARCHER in "THE DAILY NEWS AND LEADER."

THE past month, which has furnished a terrible reminder how fire, the most powerful of the friends of man, may become his most terrible enemy, suddenly arising amid the quietude of earth or water to overwhelm him, has left an ineffaceable record of man's power to control the blind rebellion of the elements through the means which Mr. Marconi has placed at his disposal. In the burning of the *Volturno* in mid-Atlantic, and the rescue of 521 souls, we have an impressive example of the beneficent effects of wireless telegraphy which, had it been foretold fifty years ago, would have been regarded as incredible. The thought of ten great ships converging on the scene of the disaster, summoned thereto by the "S.O.S." appeal sent quivering through the storm over hundreds of miles of sea, raises a thrill of gratitude to the great man whose genius has made such a thing possible. For there can be no doubt that but for wireless telegraphy every one of the 657 lives on board the *Volturno* would have been lost. Indeed, the death roll would have been greatly reduced if the people had put more faith in the saving efficacy of the Marconi apparatus, and had not plunged panic-stricken to their doom.

The salvation of the greater part of the *Volturno* passengers and crew, it is observable, was due to the fortunate chance that one of the ten vessels within the Marconi call happened to be carrying an oil-tank. The *Narragansett*, which is the vessel referred to, belongs to a class of steamship among which the installation of wireless telegraphy is just beginning to make considerable headway, and the assistance which she was able to offer on this occasion proves the value of wireless telegraphy, not only for passenger vessels, but for freight vessels of all kinds.

The amount of traffic passing between the *Volturno* (working after the failure of the electric current entirely upon her emergency gear) and the rescuing ships, and between these ships and the shore stations, bespeaks volumes of praise for the reliability of the wireless apparatus under most trying circumstances. There was no failure, no confusion, no interference; in all cases the stations worked splendidly, and fully merited the concluding words of Mr. Arthur Spurgeon's first wireless message from the *Carmania*, briefly announcing the facts, which were: "Triumph Marconi."

It is indeed a marvellous object-lesson to the world in the beneficent power of wireless. What would have been a disaster without a gleam of brightness in the dreadful story, has been miraculously mitigated by the rescue of the 500 odd lives. The story impresses once again upon the world that the perils of sea travel have had more than half their terrors destroyed by wireless telegraphy.

MR. HENRY SPEARMAN SAUNDERS.

Personalities in the Wireless World

HENRY SPEARMAN SAUNDERS

Director of Marconi's Wireless Telegraph Co., Ltd.;
Director of the Marconi International Marine Communication Co., Ltd.;
Director of the Spanish and General Wireless Trust.

MR. SAUNDERS was born in April, 1841, and is the son of the late Hon. Frederick Saunders, who was Treasurer of Ceylon, an office which was occupied later by his eldest son, Sir Frederick Saunders, K.C.M.G., the brother of the subject of our sketch.

Mr. Henry S. Saunders early in life went out to Ceylon, and for twelve years interested himself in coffee planting, the most important industry of the island. He then determined to start an estate agency, and acquired large interests in different parts of the island. His reputation for energy and keen business faculties soon made him a *persona grata* with the most influential residents on the island, and amongst other positions of trust he was offered, and accepted, the Chairmanship of the Planters' Association of Ceylon. The island has good reason to be grateful for his interest and zeal, for it was due to his untiring efforts that the railway extensions in the mountainous regions of Ceylon were carried out, in spite of strenuous opposition.

As Chairman of the Ceylon Planters' Association, Mr. Saunders organised a London Agency, which has since developed into the Ceylon Association of London. Later Mr. Saunders was largely instrumental in obtaining the co-operation of an important firm of railway engineers, who offered to construct a network of light railways over the island. The Government, however, decided to carry out the work themselves on the broad gauge. This has been the means of developing important tracts of land now utilised as large tea and rubber estates. But the energies of Mr. Saunders were not yet exhausted; he next turned his attention to the upkeep of the roads in the hilly country, securing and fulfilling large contracts from the Ceylon Government in such a way as to obtain official congratulation.

But Mr. Saunders still had time to engage in social activity. He started and organised the Colombo Club, which is now one of the most important institutions of its kind in the country, and on his retirement from the Hon. Secretaryship he was made the recipient of a very handsome presentation.

In sporting circles in Ceylon Mr. Saunders will be remembered as taking a keen interest in racing; amongst his cups is that of the Ceylon Turf Club Plate. His coach, with team of English horses, is still referred to as the only one ever seen in Ceylon.

Fourteen years ago, Mr. Saunders became acquainted with Mr. Marconi, and he was then invited to join the Board of Marconi's Wireless Telegraph Co., Ltd. He accompanied Mr. Marconi to America on board the *Philadelphia* in 1902, when the first trials of wireless were carried out on the American liners, and a message was received during that voyage from Poldhu, in Cornwall, over a distance of 2,000 miles. It was owing to these successful results that contracts were made with the Canadian Government for the erection of wireless telegraph stations in Canada, and it was then that the American Marconi Company was formed, to be followed shortly afterwards by the inauguration of the Marconi Wireless Telegraph Company of Canada.

It was in this connection that Mr. Saunders' abilities for finance and organisation showed themselves to the full advantage, as, in co-operation with financiers in London and on the Continent, who were quick to recognise its immense importance and the likelihood of its far-reaching effects, the formation of the Marconi International Marine Communication Company was established, of which Company Mr. Saunders is still a director.

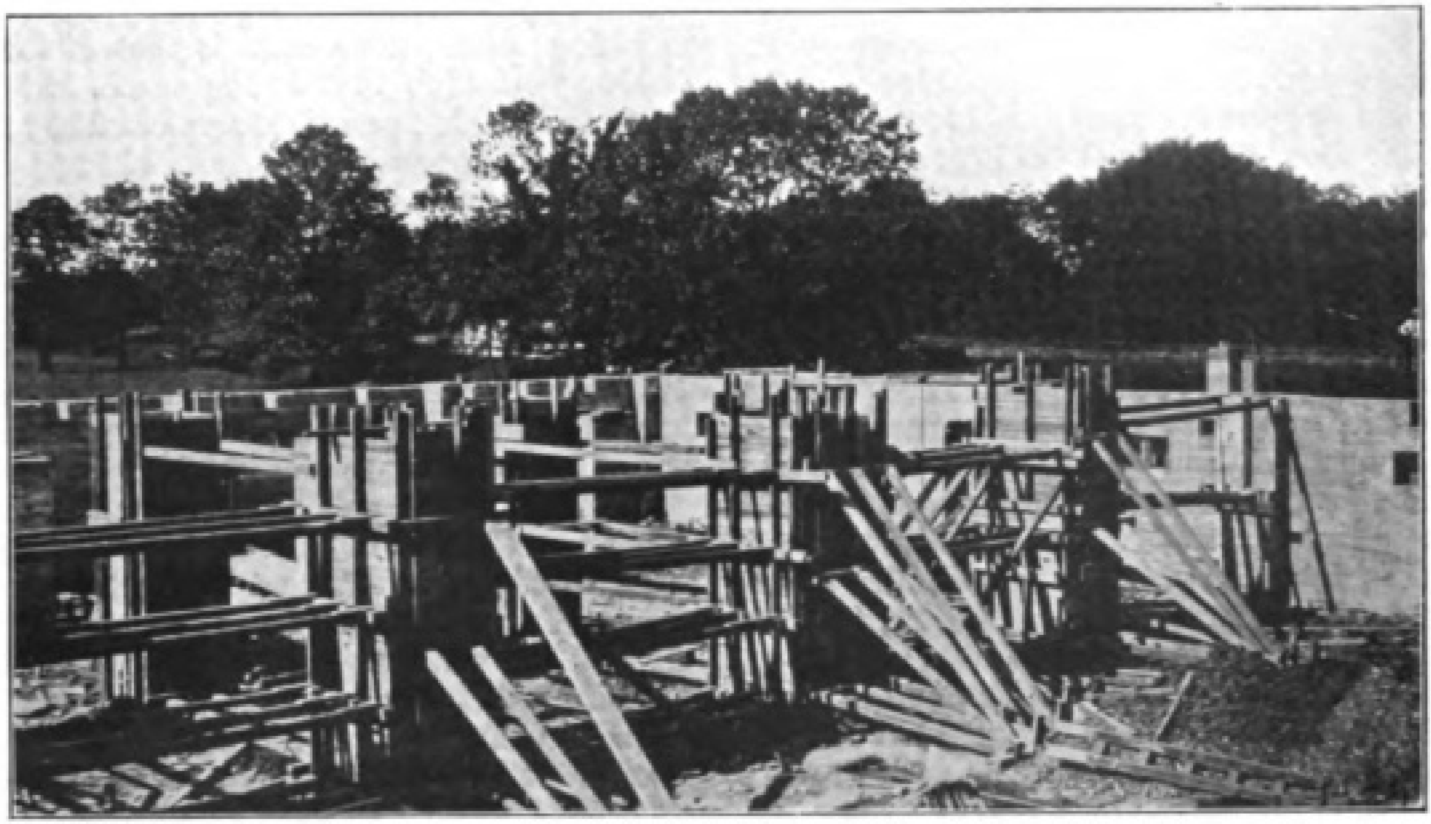
Mr. Saunders is married to Grace Maynard, daughter of the late Colonel Charles Oldfield, and widow of F. N. Evans-Freke, barrister-at-law.

Transatlantic Wireless Telegraphy

THE NEW JERSEY STATION

GOOD progress is being made with the construction of the high-power stations which, when completed, will add enormously to the public facilities for the use of transatlantic wireless telegraphy. The Clifden-Glace Bay service, which, since 1908, has been in regular continuous communication, day and night, carrying commercial, public, and press messages, has hitherto been the only service in existence affording direct wireless communication between the Eastern and Western hemispheres. But it will not long enjoy its "splendid isolation," for other stations are now being erected which will bring the North American Continent nearer (in a telegraphic sense) to England and other European countries, thus relieving the pressure of traffic upon the Clifden-Glace Bay stations, and coping with the enormously increased use of transatlantic telegraphic communication which the cheapness and efficiency of the Marconi service has made possible.

From time to time we hope to be able to furnish our readers with details of the stations which are being erected on both sides of the Atlantic in fulfilment of this scheme. In the meantime, a few preliminary notes concerning the stations now being erected near New York may be of interest.



Site of the Transmitting Section of the New Jersey Station, New Brunswick.

Two miles out from the historic city of New Brunswick, N.J., on a road that follows the banks of the Raritan river and the Raritan canal, lies the transmitting section of the wireless station which will bring the United States in direct communication with England. Approaching the site from the south one sees a beautiful meadow stretching from the road to the canal bank. In this meadow are located the power-house, the auxiliary transmitting office, and the first set of two masts. To the west of the road the land rises sharply for about a thousand feet, and then runs nearly level for a mile or more. Looking up this rise the two cottages for the chief engineer and the assistant engineer are to be seen, and, further up the hill, the building which will accommodate the engineering staff, the operators required to work the auxiliary receiving apparatus and the riggers who keep the aerials and the mast system in shape.

The power-house is now beginning to take shape, for the concrete work is completed up to the first story and ready for the brick work. The foundations for the motor generators are well under way, and the steel girders and beams for the first floor are being erected. A feature which cannot fail to be noted is the permanent and fireproof nature of the work on all of the buildings.

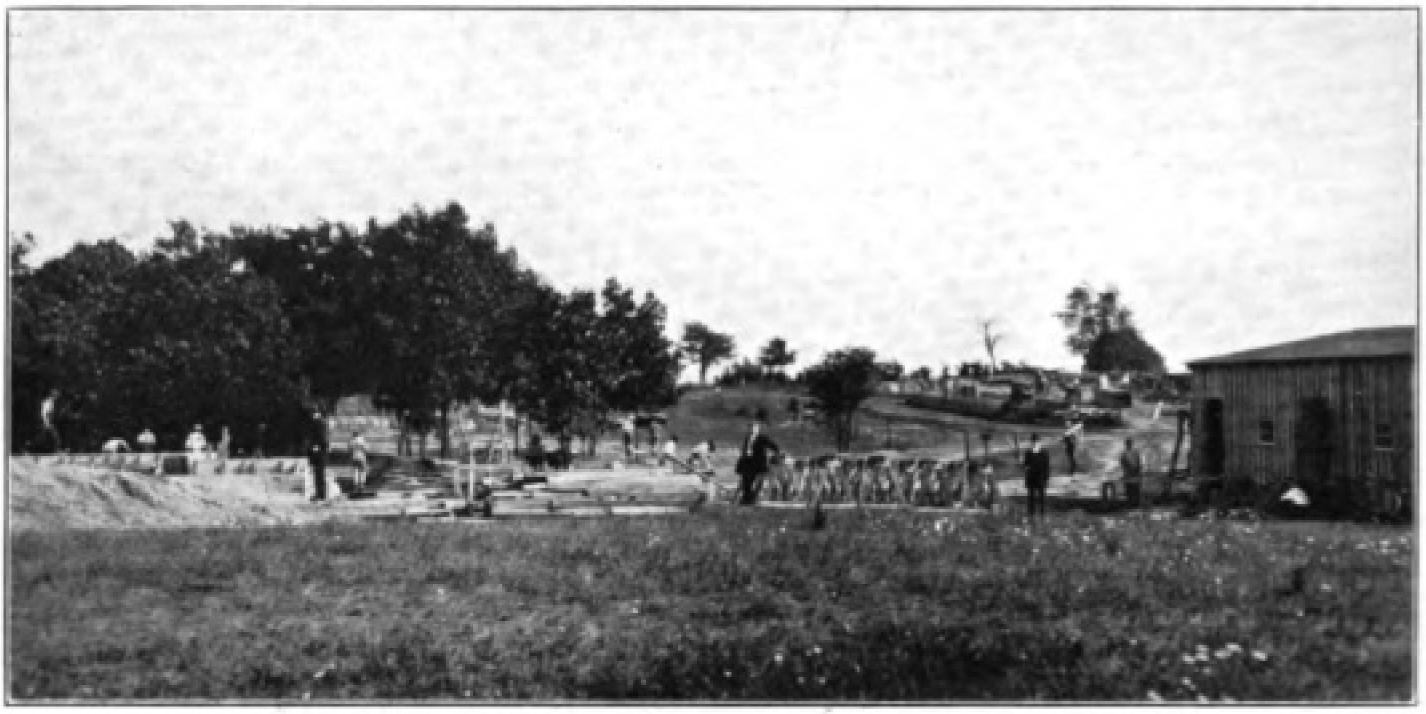
The auxiliary operating building is about 100 feet north of the power-house, has the brick work completed to the roof, and awaits the steel and roof tile to finish the structure of the building. All the buildings at this station are of rough tapestry brick, laid up with a wide joint in black mortar. With red tile roofs and an attractive design they make a handsome appearance.

An old historic farmhouse, long since past its prime, is being utilised as the construction office. This house has stood for more than one hundred and fifty years, and, judging from the appearance of the huge hand hewn timbers, will stand for another century or so. In revolutionary days this dilapidated house was a mansion of importance, having been at one time the paymasters' office of the Revolutionary Army; and rumour has it that Lafayette had his headquarters here for a time during the American War of Independence.

The receiving section of the New Jersey station is at Belmar, the road to which leads along the Shark River, a famous salt water inlet, which, during the summer months, is the resort of launches and other pleasure craft. The countryside looks rather deserted as one travels to the Marconi Station. At the station, however, all is life and bustle.

The operating house is at the foot of the

"Lafayette House." An historic dwelling converted to the use of the Staff erecting the New Brunswick Station.



Digging Foundations for the Receiving Station at Belmar, N.J.

hill close to the river. From this building the receiving aerials will rise to the first mast located on top of the hill. Crossing the road at nearly right angles, and stretching westward for almost a mile, the aerials will be carried on the top of six masts, each 300 feet high. The back ends of these aerials will be carried down at an angle of thirty degrees, being insulated near the mast top and having steel running ropes attached. These ropes come down to the anchors, which consist of a pillar 15 feet high, with heavy iron weights free to slide up and down on them.

These weights balance the pull of the wires and are calculated to keep a definite tension in the aerial wires at all times, so that when the wind blows or sleet incrusts the aerials, the spans between the masts will sag down and the counterweights rise, keeping the tension constant. This straining pillar anchorage, as it is called, is an ingenious device which is a new departure in cable suspension.

At Belmar a large force is required to handle the operating work, and much will be done to make the residential quarters attractive to live in. Summer boating on Shark River is a pastime which is looked forward to with pleasure, while tennis and outdoor sport will be encouraged; in fact, a happy little community will soon be thriving in this neighbourhood.

AN ALASKAN CHAIN.

As we announced last month, the American Marconi Company have in hand the erection of stations at Ketchikan and Juneau. Stations are already in existence at both of these points, but only ship business is handled. An entirely new station will be erected at Ketchikan, consisting of a 15-kw. synchronous rotating gap transmitter of the latest type and the usual receiving apparatus. Four skeleton steel towers will be erected, and the antenna so arranged as to work efficiently with Seattle, a distance of some six hundred miles to the south.

Ketchikan station will also work to the north to a distance of more than two hundred miles with the station at Juneau, Alaska. This latter station will be entirely rebuilt, and will be fitted with a 10-kw. transmitter and two skeleton steel towers.

These two stations are intended to be the first links of a chain to provide Alaska with a commercial wireless service connecting it with the United States. As business develops, the chain will be developed and provided with feeders further north.

The existing cable rate between Juneau and Ketchikan is 6 cents per word, and between Ketchikan and Seattle 19 cents per word. It is probable that the rates for communication between these points will be considerably reduced when the Marconi service is inaugurated.

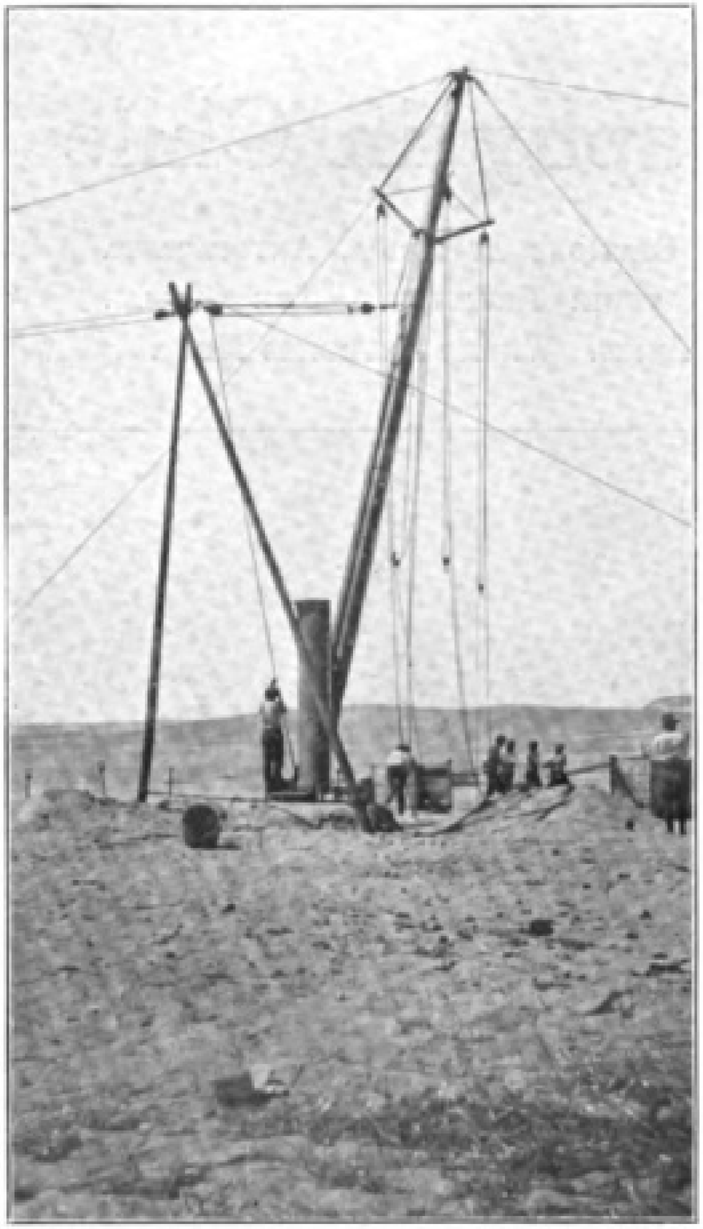
Wireless Telegraphy in Chile

COMPLETION OF THE SMALLER COAST STATIONS AT ARICA, ANTOFAGASTA AND COQUIMBO. INCIDENTS DURING THEIR ERECTION. THE CHILIAN WORKMAN. DISCOVERY OF INDIAN MUMMIES. WHERE EXTREMES MEET.

THE three smaller coast stations in Northern Chile, erected by the Marconi Company, have just been turned over to the Government. The installations are of interest, being, from a wireless point of view, by far the most luxuriously equipped stations yet erected. The plant and staff are housed in one building, suitably designed for the climatic conditions. The apparatus, as usual, is located in different rooms, the battery being interposed between the transmitting and receiving apparatus rooms, thereby ensuring a minimum of extraneous sound in the latter. The design of the transmitter is such as to ensure great flexibility of wave-length with high radiation efficiency and extreme reliability in every detail. At one end of the Antofagasta plant are located the wireless switchboards, which control all wave and coupling changes and also indicate the amount of energy radiated. Two aerials are provided in order to obtain full range of waves, from 600 to 1,600 metres, without the use of an unduly large tuning inductance. The condenser bank is of fixed capacity, and therefore a constant spark power is used for all waves. A compound motor with remote control drives alternator, disc discharger and ventilator on one shaft. A normal spark frequency of 400 is used, but adjustment above or below may be obtained by varying the speed of the motor. The alternator switchboard is provided with safety switch, frequency and voltmeters, the latter normally reading 300. The usual attendant primary inductance, transformer, signalling key with its blower and protecting chokes are of special design, preference being given in all cases to porcelain and marble insulation on account of their greater hardihood in the climate they have to withstand. Accumulators are used, the cells being burnt together, thus eliminating any possible trouble from acid fumes. The battery room

Lowering the base of the N.W. mast of the Arica Station into its pit. In the distance is seen the famous hill-fort, El Morro. The town of Arica lies immediately behind the hill.

door, wisely, opens to the outside of the building. A still is provided to prepare pure water for topping the cells. The prime mover is a 13 h.p. oil engine, which drives a $7\frac{1}{2}$-kw. inter-polar dynamo. The accumulator switchboard is provided with the usual instruments, including minimum current breaker and central zero ammeter. The



Raising the topmast of the middle mast at Antofagasta.

stations possess a complete and useful lighting system, wired with Simplex fittings and twin-conductor lead-covered cable. A valve receiver of rather longer range than usual is used for receiving.

Spares to cope with every possible breakdown are provided, as well as a very useful tool kit and set of testing apparatus.

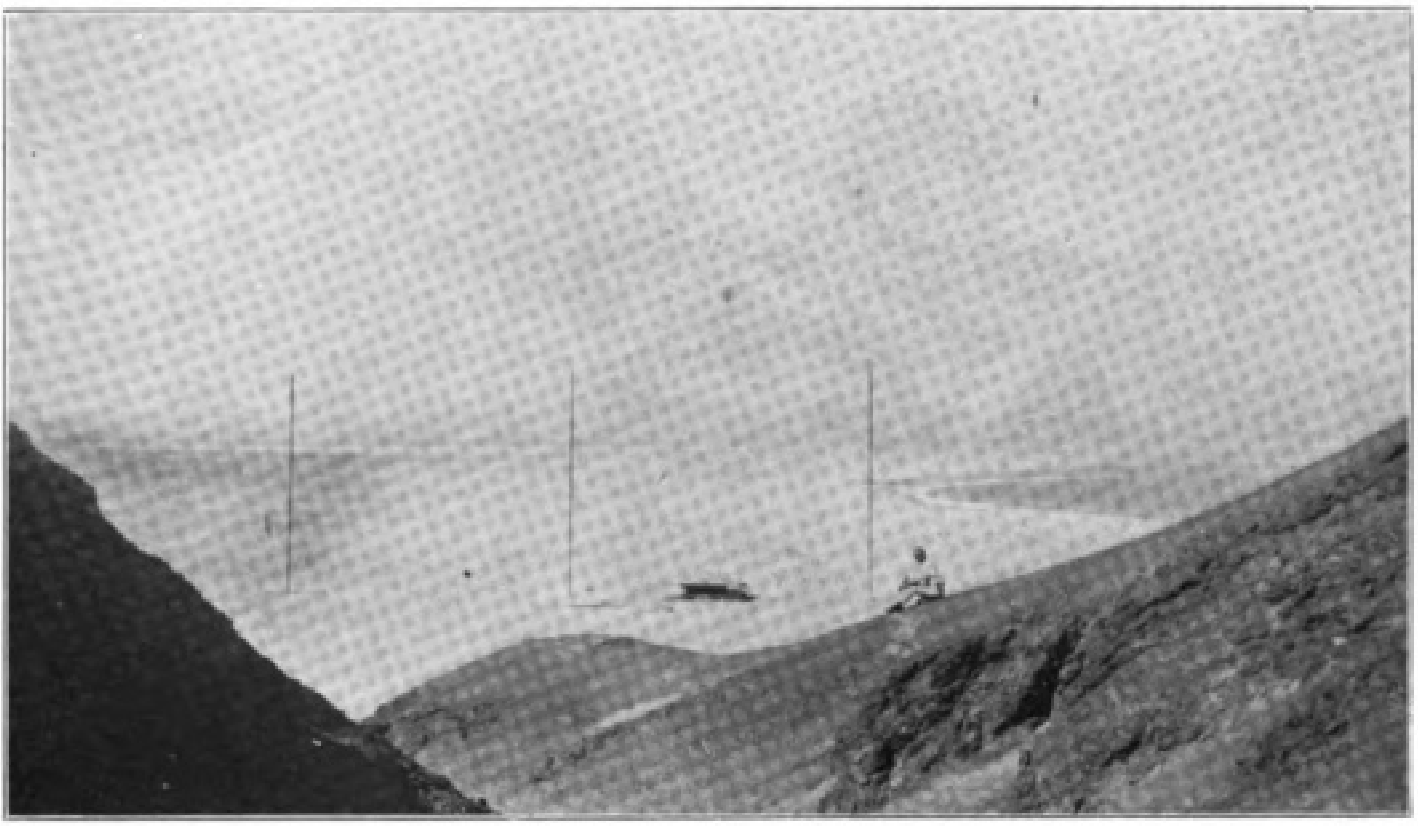
Arica station, with its masts painted an invisible drab, lies under the shadow of El Morro, a famous and strongly fortified saddle of rock which rises abruptly between the town and the station. Antofagasta installation, to those who are on the station, seems an infinite distance from anywhere! It lies in a plain of white sand to the north of the town, twelve miles across the bay. Coquimbo is more pleasantly situated, being but two and a half miles from the town. The sites have evidently been chosen with due regard to their wireless working and the menace of a possible enemy.

Transport caused some difficulty and much work, whilst lack of water and provisions at Antofagasta did not make matters too pleasant. Further, though an earthquake shock is a very tame affair when experienced in a town of single-storied houses, those living under the shadow of a couple of steel masts are apt to regard such matters more seriously.

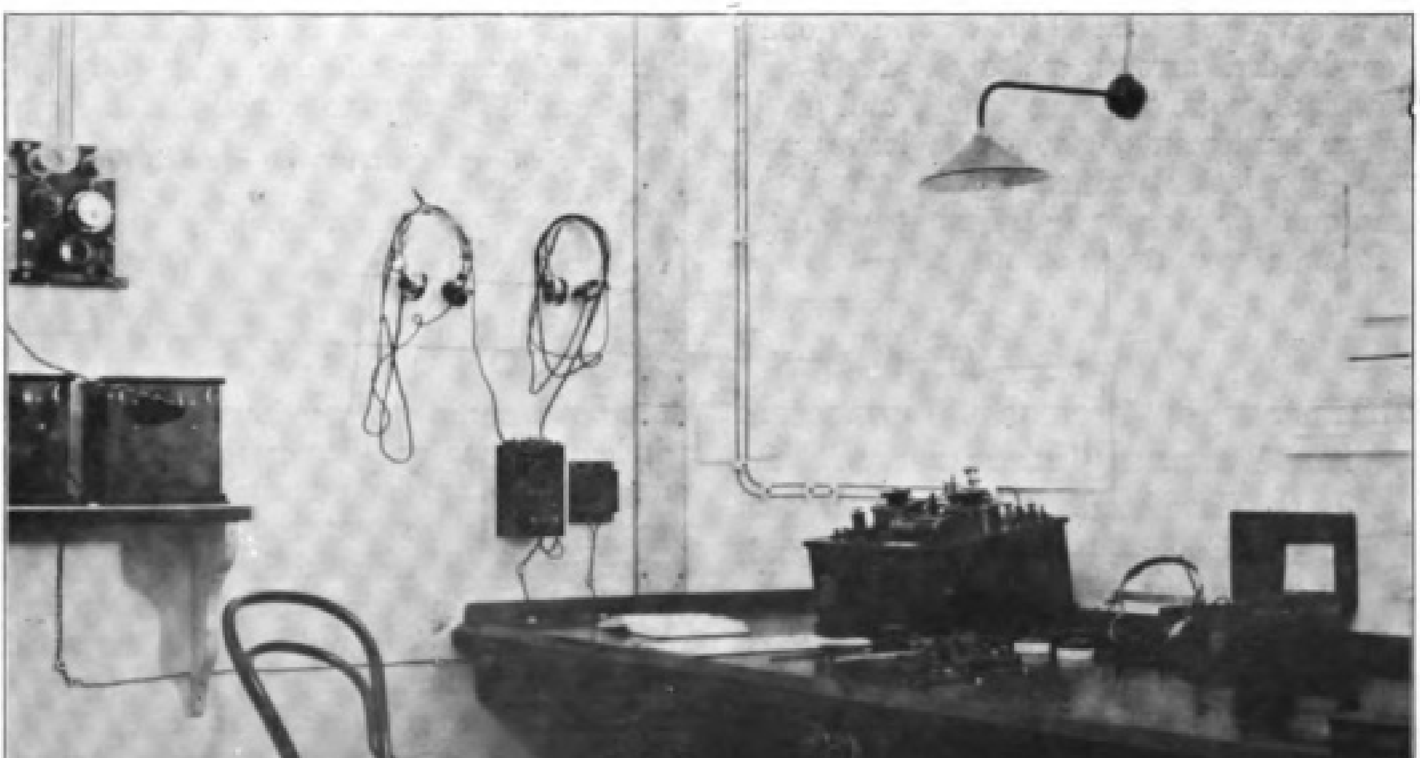
The country of Northern Chile, so famous for its mines and nitrate fields, can scarcely be described as interesting, though it enjoys what must be one of the most perfect climates in the world. Never too hot and never too cold, the long days of golden sunshine would bring contentment to the most exacting, if only there were some few patches of green to relieve the eternal monotony of mile after mile of rock and sand. Coquimbo is blessed with a little green, and it was a happy relief to get there after the dust and dreariness of Antofagasta.

The Chilian is an excellent workman, though all in a greater or lesser degree are subject to unduly excessive "celebrations" when they finish their week's work and receive their pay. Monday, if a full gang be needed, is a sorry day, and sorrier still if the cook is missing! These men seem to believe very strongly in the "bending reed" principle and their ready acquiescence does not mean all it ought to unless someone is on hand to remind them. They shine on contract work, and it is then that their giant strength and staying powers are brought home to one. When working day-work six men will pitifully stagger along with a case, whilst, on contract, these same men will run with it. When a contract is ended they disappear, and for days it is impossible to find one. Then after perhaps a week they begin to crawl around looking, and probably feeling, "like nothing on earth." They invariably club together after receiving their contract money and hold a celebration followed by a dance. All, or nearly all, dance, and when going through the fantastic steps of their native Cueca their enthusiasm knows no bounds.

Whilst putting in the earth plates at Arica, the men dug into a burial ground and discovered a number of Indian mummies. Perfectly preserved, but shrunken to an



Exterior view of Antofagasta Station, taken looking towards the East. This station is situated at Caleta Vieja, which takes its name from the bay shown on the reader's right. From the station to the foot of the distant hills is a 10-mile stretch of soft white sand.



The Receiving Room of Antofagasta Station. From this room the transmitting apparatus is controlled by a system of remote control switches. The receiver used is the Fleming Valve, with necessary tuning condensers and inductances to render it responsive over very long range of wave length.

Mummies of ancient South American Indians discovered whilst burying the Arica "earth." The view shows the stone-headed arrows, pots, corn and spinning instruments used. Most of the human remains discovered had stones tied round their necks, indicating that the bodies were those of slaves. Native chiefs were buried with precious stones in their mouths.

almost absurd size, each was strung up in rough canvas with a rope passing under the knees and knotted behind the neck. In their laps were placed all their worldly goods, stone-headed arrows, poisoned darts and blowpipes, pots, weaving spools, and crude copper implements, also cocoa leaves and corn—the latter presumably to speed the dead on their journey to their happy land.

It is a case of extremes meeting—the fact that these ancient, and to us savage, bodies are making the "earth" of the Arica station and helping in its mission of harnessing the powers of Nature. It is apt to make one think and wonder whether a like occasion will occur in the ages to come!

> . . . "Ourselves must we beneath the Couch of Earth
> Descend, ourselves to make a Couch—for whom?"
> (*Kháyyám*).

A New Text-Book

"HANDBOOK OF TECHNICAL INSTRUCTION FOR WIRELESS TELEGRAPHISTS." By J. C. Hawkhead. (London: Marconi Press Agency, Marconi House, Strand, W.C.) 3s. 6d.

We are frequently asked by prospective wireless operators and amateurs to recommend a text-book which, while within the means of a slender purse, will nevertheless serve as a sound and trustworthy guide through a course of instruction on wireless telegraphy. Mr. Hawkhead's book can be confidently recommended for this purpose. It is written in a style which will enable the student to thoroughly understand the subject with a minimum of difficulty, and it does not assume any previous knowledge of wireless telegraphy. It possesses the further advantage that it embodies the most modern practice. The author has had practical experience in the construction and operation of all classes of commercial wireless apparatus, and, as is only to be expected under the circumstances, the work bears the impress of thoroughness and accuracy. That it will satisfy a large and growing demand cannot be gainsaid, and the multitude of students and amateurs are to be accounted fortunate in having such an invaluable and, in a sense, unique text-book placed within their reach. The numerous illustrations of apparatus and diagrams form a useful feature of the book.

Early Methods of Signalling

WHEN contemplating the marvels of wireless telegraphy from the physical point of view and in the simplest way, the startling suggestion presents itself that there is no essential difference between the flickers of the light used as signals by a savage tribesman when he waves a beacon to warn his friends a few miles away of the approach of danger, and the invisible signals that sweep across the ocean from one Marconi station to another.

In all ages, men have resorted to signals to quicken intelligence, and an interesting account of the early methods of signalling between distant points is given in Reid's "The Telegraph in America."

The first application of what is called a "telegraph," although that word (meaning "writing at a distance") belongs to the modern times, was a system of wooden blocks of various shapes, to indicate letters, arranged by Dr. Hooke, in 1684. A century later, in 1794, three brothers, named Chappé, were confined in schools in France, situated some distance apart, yet within sight of each other. Free communication, under the rigorous rules of these schools, was denied them. They yearned for intercourse. Finally, affection suggested a plan by which a pivoted beam could be used to convey the signs of letters, by pointing it in different directions. The variety of signals was enlarged by adding small movable beams at the ends of the main beam. In this way these brothers arranged 192 different signals, and, by correspondence, thereby relieved the tedium of their confinement. After their release, the system they had devised for communication with each other was exhibited to the Government of France, and adopted for a service of signals. One of the brothers Chappé became telegraphic engineer for the Government. Semaphoric signal houses and signals were rapidly established along the whole French coast, in 1803, with Chappé as manager. These were continued in use for a number of years, until electrical discovery provided the modern means for that purpose.

In 1795 Lord George Murray, of England, improved on Chappé's original plan by using two frames in which six Venetian blinds were inserted, thus adding greatly to the ease in operating and translating, as well as to the variety of the signals. Murray's system was adopted by the British Government and continued in use until 1816.

In 1807 General Pasley, and in 1816 Sir Home Popham, contrived modifications of the Chappé and Murray systems, introducing lamps for night service. Jules Guyot, of France, and Treutler, of Berlin, also perfected similar systems, but with little practical advantage over those previously in use.

In the American Revolutionary War, one of the signals employed was a flag-staff, surmounted by a barrel, beneath which a flag and basket could be so changed in their combinations that a number of announcements could be thus communicated. It will be remembered, also, how the farmers of Middlesex, Essex, and Worcester, on the night of April 18th, 1775, sprang to arms to meet the foe, having been aroused by Paul Revere, who having seen the signal agreed upon in the North Church tower, which told the movements of the British troops from Boston, had started on his famous ride to warn the people that the storm had burst.

It is a curious circumstance that, as late as 1846, signals, on Murray's plan, erected on high or prominent points of land, were used between New York and Philadelphia by some enterprising street brokers, who long kept the matter secret, using it even after the introduction of the Morse electric telegraph, and whose means of information for a long time confounded the members of the Stock Exchange. One of these gentlemen, known as Bull Bridges, when at last the Morse instrument began, in 1845, to click in the second story of the Philadelphia Merchants' Exchange, was able, by practising privately on telegraphic sounds, to catch by ear the messages coming over the wires. He could also, with his large lustrous eyes, wink a figure to a confederate conveniently waiting for the information.

Lessons from the Army Manœuvres

THE MILITARY USES OF WIRELESS TELEGRAPHY

ALTHOUGH, from a spectacular point of view, the British Army manœuvres of 1913 have not been so effective as those of previous years, there can be no question that they have furnished much valuable instruction in the various branches of campaign work, and that they have not been devoid of results may be gathered from the speech made by His Majesty the King, who, at the close of the exercises, declared: "The lessons learned must have been particularly numerous and valuable, because of the close nature of the country, and the consequent difficulty of intercommunication and of obtaining information."

His Majesty's speech was preceded by a report on the results of manœuvres, by Sir John French, who also laid stress on this important feature of intercommunication, and we quote the passage in that speech which bears directly on the subject:

> "The system of connection between units in formation throughout the 'Brown' force was satisfactory, but the important principle of ensuring rapid communication between all parts of the force left a good deal to be desired. So many instances of this failure came under notice that I have no time to refer to them in detail. They will duly appear in the published report. In the meantime it would be advisable to turn our close attention to effecting improvement in this most necessary service."

Such an important statement was not likely to pass unnoticed, and the *Times* military correspondent, in an article which appeared later on the result of these manœuvres, enlarged on this point. He has taken the occasion to remark that it was disappointing to find on several occasions that troops in one part of the field were not aware of what was going on in another part.

The writer makes some comment upon the training of the new signalling staff, which he considers is at present inadequate. At the Army staff tour no signal companies came out, and the work of all staffs is too much divorced from that of the companies, which follow a favourite practice of the Engineers and usually seek a sequestered spot where they can train alone. It would be better were the staffs and companies, which should complete each other, to work more frequently in unison. But, even so, the writer is not convinced that the signal companies alone can be trusted to keep commanders in touch in all circumstances. Cables are frequently broken by heavy guns and wagons—a cow was found peacefully eating a cable at the Army exercise—and, in any case, it is the well-established practice of all staffs who know their business to send important messages in duplicate and triplicate by different hands and different routes.

It will be noticed that he makes no reference in the foregoing extracts to the use of wireless telegraphy in this connection. But the military correspondent of the *Morning Post* in his report states that the wireless communication worked well, but seems to have been little used.

"The reason for this," he declares, "is obvious. Wireless messages have to be sent in cipher if of any importance, and coding and decoding is unquestionably a nuisance. In time of war cipher has constantly to be used in all forms of telegraphy, and it would be well perhaps if more practice in such work were to be afforded during future peace exercises. Cryptography and its elucidation appeals to some, and officers who take an interest in such things ought to receive every encouragement to make a study of the subject. The expert can almost always decipher a message of the enemy's which has fallen into his hands in the end. But he is apt to take a good deal of time over the task, and it must often be the case that unless the purport of the message can be discovered speedily the thing ceases to have importance."

Why these remarks should be made with regard to wireless telegraphy more than to any other system of signalling is not very obvious. Coding and decoding must always have a place in whatever system is used, and with an expert the time taken in deciphering a message is only a moment. This being so, wireless has advantages belonging to no other system of communication. It can be the least interfered with of any system, for with the invention of the wave-switch, whereby the wave-length can be altered, even during the transmission of a single sentence, the likelihood of the message being picked up by the enemy is reduced to a minimum. Again, the enemies must have a wireless station in a suitable position, and an extremely expert operator, if they are to attempt anything of this kind, and these two necessaries often preclude all danger of interference. Now, with signalling, any sharp-witted fellow with a pair of field glasses can secure the message; and as for code, it is as easy or as difficult to decipher that used in signalling as it is in telegraphy.

So it comes to this, for all practical purposes, wireless telegraphy is the nearest means of absolute security to intercommunication that the Army possesses, and its use and practice is a matter which calls for strict attention if the British Army is to attain an adequate war efficiency.

There is yet another reason why the use of wireless telegraphy should not be neglected. It is the only means of communication with airships and aeroplanes, also with the Fleet. More particular emphasis should be laid on the need for aeroplanes to be fitted with wireless, for the results of the manœuvres go to show that these are the most effective for reconnoitering purposes, as the following report proves:

More aeroplanes and airships were used this year than ever before, and the rival fleets consisted of three airships—the *Delta*, *Eta* and *Astra Torres*—with 25 aeroplanes belonging to the White troops (the defenders), and 13 aeroplanes, including four monoplanes, but no airships, belonging to Brown's troops (the invaders). By means of wireless telegraphy the *Delta* was able to send reports of the movements of the Brown troops to White's headquarters.

Cavalry Wireless Station in the Bodyguard of H.I.M. the Tsar of Russia.

Radio-Telegraphic Investigations

Work of a British Association Committee

By W. ECCLES, D.Sc. (*Secretary to the Committee*).

AT the Dundee meeting of the British Association (September, 1912) an interesting debate, opened by Prof. Fleming, took place on the problems raised by Wireless Telegraphy, and as a consequence the Mathematical and Physical Section of the Association appointed a Committee, with Sir Oliver Lodge as Chairman, to see what could be done in the way of furthering radiotelegraphic investigation. One of the facts that appealed strongly to the Committee when they met was that there were numerous amateurs scattered about the country who were waiting, one might say, for a lead in wireless telegraph investigation. Without some lead, such as might be offered by the Committee—or alternatively in occasional instances by a friendly expert or man of science—many an amateur will do little with his apparatus except tap the messages that happen to fly over his station, or take down the time, or play at telegraphy with another amateur in the locality. The Committee, when they came to survey the field open to radiotelegraphic research, kept in mind the possibility of obtaining the assistance of amateurs, and in arriving at a decision they tried to settle upon branches of research that were both important and, in the circumstances, feasible.

Every point of view that occurred to the Committee urged them to promote the investigation of such of the mysteries of wireless telegraphy as are met with by observers distributed over a wide area—that is to say, of such phenomena as occur on the grand scale.

Chief among these universal phenomena is that of the natural electric waves which have coursed about the globe since the most remote ages, but the existence of which was completely unsuspected till very recent times. These natural electric waves cause erratic and troublesome noises in the telephone receivers of a wireless telegraph station, or cause erratic and confusing marks on the tape of a coherer and inker set. They are only too familiar to everyone who has worn the 'phones of a wireless operator for even a brief interval. For brevity they were christened " strays " or " X's " in the years 1897, 8 and 9 in England, and were later given the name " atmospherics " in the United States. Another and more recent Americanism is " static." The best name appears to the writer to be " strays," for the word exactly describes their vagrant nature, and does not commit one to any opinion as regards their origin. The much-used word " atmospheric " suggests that they are wholly due to discharges of atmospheric electricity, and no doubt the word " static " is intended to convey the same idea. " Atmospherics " is, besides, a dreadfully long word to have to write often. From the point of view of brevity " X's " is the best term, but it is not quite accurate. On the whole, from the point of view of priority, of accuracy, of freedom from ambiguity, and of the absence of bias—not to mention reasonable brevity—the writer favours the term " stray " as the best short term for a natural electric wave-train, with " X " as a good variant. The latter term may be held to include, as " stray " does not, the noises caused by discharges of local atmospheric electricity down the antenna.

Now, to the scientific mind, the chief claim of stays to promptness of attention is that nobody knows completely what they are or whence they come. The study of strays was begun by Popoff shortly before the rise of practical wireless telegraphy. In 1895 Popoff made use of a long vertical conductor (such as a lightning rod) in combination with a coherer, in order to follow the motions of lightning storms across the country. A filings coherer was used, and was automatically tapped back after registering the effect of each lightning stroke. In 1898 Boggio Lera improved on Popoff's apparatus as regards sensitiveness, and arranged that feeble and strong disturbances should be recorded separately. His experiments with this apparatus in 1899 showed that the approach of electrical storms was heralded by frequent operation of the apparatus several hours in advance of their arrival in the locality of the observing station, and showed also that every visible flash operated the apparatus infallibly. These results were confirmed in 1900 by Tommasina using his carbon auto-decoherer. In 1901 Fenyi showed that the thunderstorms occurring within 100 kilometres of his station at Kalocsa, Hungary, were all recorded by his coherers. Finally, Turpain, in 1903, made a long series of observations which proved the possibility of utilising radiotelegraphic apparatus in the forecasting of thunder weather for hours and even days in advance.

But even when there is no thunder weather recorded over the whole continent of Europe and the adjacent seas, X's may be received almost perpetually by a receiving antenna adjusted to a great wave-length. This is quite a distinct matter from the X's due to local atmospheric electricity utilising the antenna as a lightning rod, and different again from the hum or sizzle or fizz caused by a white squall at sea or by glow discharge to high peaks. These perpetual strays are characterised by the fact that they are heavier and more frequent, in general, the longer the wave to which the receiving antenna is adjusted, so far as has been tried up to the present. It is natural, but it is not scientific, to jump to the conclusion that these strays are all due to lightning strokes occurring probably at great distances somewhere on the earth's surface, or possibly in the free atmosphere between one bank of ionised air and another. This, however, ignores the possibility that the source of the strays may be far outside the earth. There is nothing unreasonable in supposing that the sun, let us say, may send us occasional electric waves. For example, in the colossal movements of matter associated with the formation of a solar prominence—movements that appear to take place with enormous velocities—electric discharges may be brought about of magnitude far transcending anything that can happen on the earth. These would give rise to electric waves which might reach the earth in perceptible intensity and constitute a proportion of our strays. On the other hand, we must not forget that we on the earth's surface may be protected by our ionised atmosphere from these extra-terrestrial waves. It is just such problems as these that the British Association Committee has set itself to inquire into as soon as they can persuade a sufficient number of widely-dispersed observers to co-operate. The exact method to be pursued in this matter will be described fully in an early announcement by the Committee.

Another and distinct inquiry which urgently needs pursuing has regard to the part played by the earth's atmosphere in causing variations in signal strength. The laws of these variations, especially in respect of their connection with weather conditions, with the time of day, and with position on the earth's surface, require investigation. The time of day has effects that include the now well-known sunset and sunrise variations; and, as regards the other points mentioned, we only know at present that the barometric height does affect signals, and that the barometric height is associated with geographical position in very definite and remarkable ways. In order to learn more we must have observations made simultaneously at various parts of the world and collated at a central office.

As has been said before, the Committee is bound to look very largely to amateurs for the collection of data on these and kindred subjects. But it has been a matter of extreme gratification to the Committee to find that the Imperial Navy and the British Post Office each were willing to lend a hand. Not only that, the Marconi Company also has, with most commendable public spirit, promised to give its powerful assistance to the Committee. Thus the Committee can already make tolerably sure that data will be collected by ships in every sea; and it is hoped that similar data will before long be collected at many fixed points of the globe. All these data will be collected and analysed by the Committee; and it will be disappointing indeed if great additions are not rapidly made to our scientific knowledge of the problems that have been raised by this great new branch of engineering.

Electromagnetic Waves employed in Radio-Telegraphy*

By Prof. G. W. O. HOWE
City and Guilds (Engineering) College, South Kensington.

If power be transmitted by means of continuous current from one point to another, not, as is usual, by two parallel circular conductors, nor by a concentric cable, but by two wide strips of thin copper placed face to face and close together, both the magnetic and the electric fields will be approximately uniform throughout the space between the strips in any plane section normal to the direction of transmission. For this reason the consideration of such a transmission line proves an excellent method of approaching such conceptions as are involved in Poynting's theorem and electromagnetic wave phenomena. Although this method has its limitations it will be seen to yield important results. After considering the continuous current case, it will be shown that by using the same transmission line for alternate currents one is led to a clear conception of the nature of those gigantic electromagnetic waves which, emanating from a "wireless" aerial, spread over the earth in every direction. It will be shown that some of the fundamental ideas commonly accepted and taught in text-books on radio-telegraphy are fallacious.

Considering first the transmission of energy by means of continuous currents, let i be the current in amperes and e the P.D. in volts. If the resistance of the strips be neglected, the latter will be constant from end to end of the line. If b is the width of the strips and d the distance between them, the strength of the magnetic field between the strips is easily shown to be

$$H=\frac{4\pi}{10}\frac{i}{b}.$$

If the strips are very close together H will be constant in the space between them and zero elsewhere. The same is true of the electric field, the strength of which is given by the formula

$$E=e/d \text{ volts per centimetre.}$$

H and E are evidently at right angles and their product

$$HE=\frac{4\pi}{10}\frac{ie}{bd}.$$

Now the power transmitted is ie watts or joules per second, and this power is transmitted through the dielectric space between the strips and not through the strips themselves, which merely act as guides. The walls of a speaking tube act in very much the same way in guiding the energy which is transmitted as sound waves.

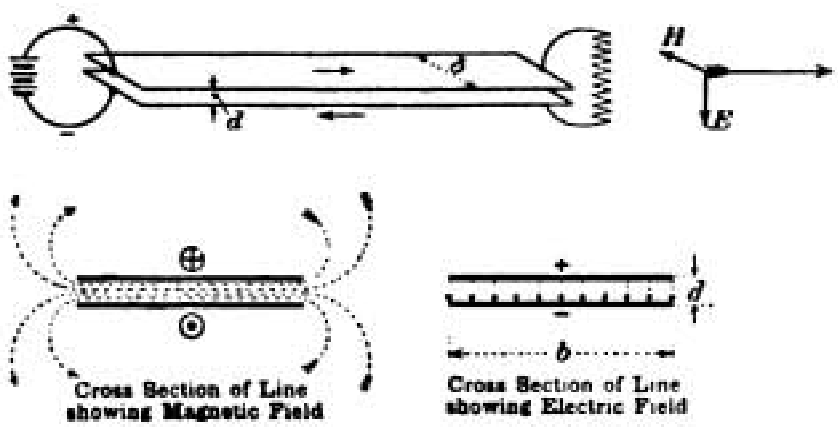


FIG. 1

The energy transmitted across each square centimetre of dielectric cross-section will be

$$\frac{i.e}{bd}=HE\times\frac{10}{4\pi} \text{ joules per second.}$$

Thus, at any point in space where there is simultaneously a magnetic field, H, and an electric field, E, at right angles, there is a transmission of energy in a direction at right angles to the plane of H and E, equal to

* Read before the British Association.

$\frac{10}{4\pi}$HE joules per second or watts, where E is expressed in volts per centimetre. This is Poynting's theorem. The relative directions of H, E and the transmission of energy can be seen from Fig. 1 to be represented by the first and second fingers and the thumb respectively of the left hand, set mutually at right angles.

If the line is opened at the receiving end the current ceases and there is no magnetic field, but only the electric field. If the line is short-circuited the P.D. between the strips falls to zero, and with it the electric field, leaving only the magnetic field. In neither case, however, is there any transmission of energy. For energy to be transmitted the electric and magnetic fields must exist simultaneously in the same space, and must be, to some extent, at right angles to each other. This is an important point often overlooked when considering the nature of the electromagnetic waves by which energy is radiated from an antenna; we shall return to it later.

The inductance of the line per centimetre of length—that is, the flux produced in the space between the conductors by unit current—is evidently $\frac{4\pi d}{b}$ absolute units, or

$\frac{4\pi}{10^9} \cdot \frac{d}{b}$ henries.

The capacity between the strips per centimetre of length is $\frac{b}{4\pi d}$ absolute units, or $\frac{b}{4\pi d} \cdot \frac{1}{9 \times 10^{11}}$ farads if the dielectric is air.

We shall now assume that the dynamo or battery is replaced by an alternator with a frequency of $\sim$ cycles per second, and that the load at the far end of the long line is non-inductive. Every centimetre of the line has a certain inductance, L, and a certain capacity, K, the values of which we have

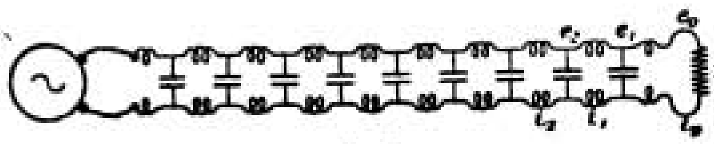


Fig. 2.

just seen. The actual line could be replaced approximately by a number of inductances and condensers arranged as in Fig. 2. The conductor resistance and the leakage are both assumed to be negligible. A vector diagram can now be built up by assuming a current through the non-inductive load and gradually working back along the line in the usual way. The vector diagram is greatly simplified, however, if the resistance, r, constituting the load at the end of the line, is made equal to $\sqrt{L/K}$. (This ratio is a very important characteristic of the transmission line; it is sometimes called its surge impedance. By German writers it is called its "Wellenwiderstand"—*i.e.*, wave-resistance.)

If $r=\sqrt{L/K}$, the vectors of both current and voltage maintain a constant length—that is, an ammeter placed anywhere in the line will give the same reading, as will also a voltmeter connected between the lines at any point. In addition to this the two vectors will be in phase at every point. This can be readily seen from a consideration of Fig. 3. If i be the root-mean-square current at any point, the voltage drop per

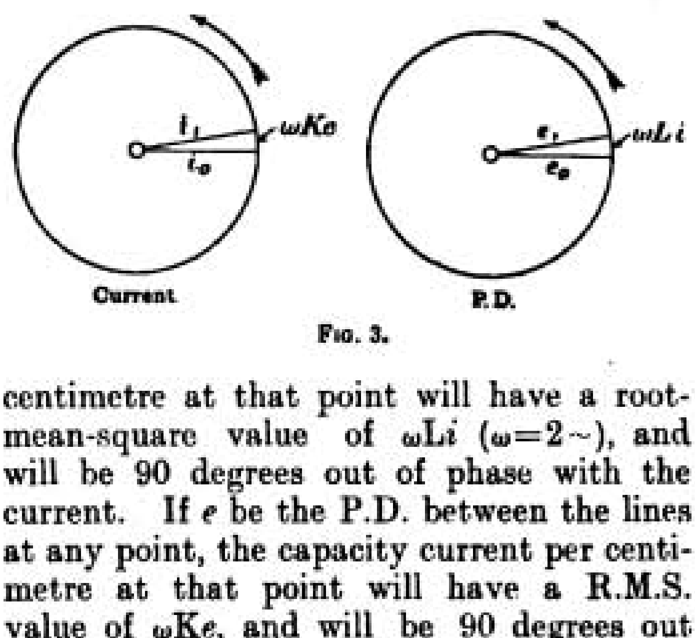


Fig. 3.

centimetre at that point will have a root-mean-square value of ωLi ($\omega = 2\sim$), and will be 90 degrees out of phase with the current. If e be the P.D. between the lines at any point, the capacity current per centimetre at that point will have a R.M.S. value of ωKe, and will be 90 degrees out of phase with e. For the current and voltage vectors to maintain a constant length and rotate together it is obviously necessary that $\omega Ke/i = \omega Li/e$.

Since $e/i = r$, this is equivalent to $r = \sqrt{L/K}$. With a load of this value the energy is absorbed as fast as it arrives, and there is no reflection back along the line to cause stationary waves. The result is just the same whether the line is short or long. At those points along the line where the current, and therefore the value of H, is a maximum at any moment the P.D., and therefore also the value of E, will be a maximum at the same moment (Fig. 4). The rate of energy transmission in watts per square centimetre is given at every point, at every moment, by the formula $\frac{10}{4\pi}$HE.

If the non-inductive load be replaced by a choking coil of negligible resistance, or by

FIG. 4

a condenser with negligible losses, the voltage and current vectors will be 90 degrees out of phase, not only at the end, but all along the line. This is easily proved, because the voltage drop is at right angles to the current vector and the capacity current is at right angles to the voltage vector at every point. The current in the line at any moment is a maximum when the P.D. is zero, and *vice versa*, so that we have alternately a storage of magnetic energy and a storage of electrical energy, but no resultant transmission of energy. In this case we have stationary waves on the line.

Returning now to the case of the non-inductive load, the velocity of the wave along the line is easily found from Fig. 3. The inductive drop per centimetre is ωLi; for a length l the drop is ωLil, and this is set off around the circumference of the circle described by the vector e. If we take such a length along the line that $\omega Lil = 2\pi e$, we arrive at a point where the phase is the same as at the end; this value of l is therefore the wave-length λ.

Hence,

$$\lambda = \frac{2\pi e}{\omega Li} = \frac{2\pi}{\omega\sqrt{KL}} = \frac{1}{\sim\sqrt{KL}},$$

and the velocity of the wave

$$= \lambda \cdot \sim = \frac{1}{\sqrt{KL}}.$$

Substituting the values of K and L, we have

$$\frac{1}{\sqrt{\frac{b}{4\pi d}\cdot\frac{4\pi d}{b}\cdot\frac{1}{9\times10^{20}}}} = 3\times10^{10}\text{cm. per second.}$$

Hence, the electromagnetic wave travels along the line with the velocity of light.

We have seen that the ratio e/i is constant all along the line and equal to $\sqrt{L/K}$; therefore, $\frac{Li^2}{2} = \frac{Ke^2}{2}$, that is, the total energy in each cubic centimetre of the dielectric space is at every moment equally divided between the magnetic and the electric fields. The total energy in 1 cm. of the line is $Ke^2_{in.}$, where $e_{in.}$ is the instantaneous value of the P.D., and the average value of the energy per centimetre is Ke^2, where e is the R.M.S. value of the P.D. This energy is being transferred with the velocity $v = \frac{1}{\sqrt{KL}}$, and the amount of energy arriving at the far end in a second will be

$$Ke^2 \times \frac{1}{\sqrt{KL}} = e^2 \times \sqrt{\frac{K}{L}} = \frac{e^2}{R} \text{ joules.}$$

The electromagnetic waves in the space between the two strips are of the simplest possible type—viz., plane waves. If the two strips are made several hundred miles wide and several hundred feet apart, and if the lower strip is replaced by the earth, no essential change is made in the nature of the waves; it is simply a matter of scale. We should then have sweeping over the surface of the earth plane electromagnetic waves. In many problems connected with radio-telegraphy it has been assumed for the sake of simplicity that the waves employed are of this type.* It may be objected that, in the case of radio-telegraphy, we have not a transmission free from loss with a non-inductive load of a certain definite value at the far end. In the theory of the propagation of telephone currents it is a well-known and easily proved fact that for a long line in which the energy is dissipated before it arrives at the far end, where it might otherwise be reflected, the apparent impedance of the line is equal to $\sqrt{I/Y}$, where $I = R + j\omega L$ is the impedance of unit length of the line and $Y = G + j\omega K$ is the admittance of unit length (G is the reciprocal of the insulation resistance, $j = \sqrt{-1}$ and $\omega = 2\pi\sim$). If R and G are small compared with ωL and ωK, the apparent impedance of the line will be simply $\sqrt{L/K}$, and the current at the sending end will be in phase with the applied P.D. so that the line

* Zenneck, "Annalen der Physik," 1907, Vol. XXIII, p. 846.

appears to be non-inductive. This will also be true if $R/L=G/K$, which is the condition for Oliver Heaviside's distortionless transmission line. In the case of radio-telegraphy the damping is small, especially over the sea, and we make little error in assuming that the current and P.D., or, as we must say if we refer to the space between the conductors and not to the conductors themselves, the magnetic and electric fields are in phase.

We can, however, approach much more closely to the actual radio-telegraphic waves by assuming that the two parallel strip conductors radiate from the alternator in all directions. The upper strip now becomes an upper disc and the lower strip a lower disc, or merely the earth, while the alternator is imagined to be connected between the centres of the discs. All round the edges of the discs, which we imagine to be of enormous diameter, we can assume a non-inductive load of the correct value to be uniformly distributed, or, more in accordance with facts, the resistance of the lower disc (the earth) may be assumed to dissipate the radiated energy so that none ever reaches the limits of the discs. The transmission will, however, be no longer perfectly distortionless, unless we assume that the leakage bears the necessary relation to the resistance, but this is a point of minor importance.

The magnetic flux will be distributed concentrically around the generator in alternate belts in opposite directions, there being no flux except between the discs. Passing outwards from the centre of the disc one would pass through successive belts of current flowing alternately radially outwards and radially inwards. At every point in either disc there is an alternating radial current.

The radiation of energy is in this case strictly cylindrical, but is otherwise identical with the radiation from a "wireless" antenna. The electric and magnetic fields in the neighbourhood of the lower disc are identical in their nature with those near the earth, but the variation with the distance from the generator is different.

This want of agreement is entirely removed by making the height of the upper disc above the lower vary directly as the distance from the centre, or, in other words, by replacing the upper disc by an inverted cone, as shown in Fig. 5. The alternator is connected between the apex of the cone and the point of the earth almost in contact with it. This supposititious arrangement not only gives a radiation of electromagnetic waves almost identical with that of wireless telegraphy, but at the same time lends itself to very simple calculation. Contrary to the case of the two parallel discs, the inductance per radial centimetre of this new multi-directional transmission line is constant—*i.e.*, independent of the distance from the origin—as is also the capacity per centimetre. In this respect the inverted cone arrangement is similar to the ordinary telephone line or the two flat strips already considered, and leads to the same simple formulæ and the same vector diagrams.

CALCULATION OF THE ANGLE a BETWEEN THE CONICAL SURFACE AND THE EARTH.

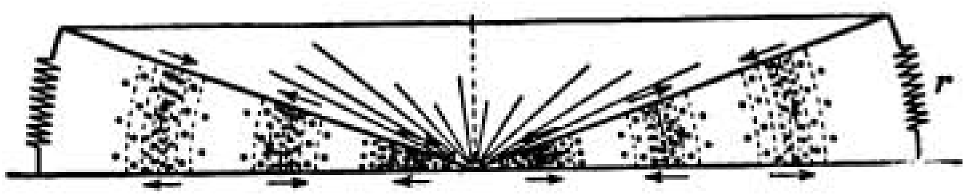


FIG. 5.

To calculate the inductance per radial centimetre we have to find the flux per radial centimetre when unit current flows steadily outwards in the cone and returns radially to the centre of the lower disc. Let a be the angle between the cone and the lower disc, x the distance from the centre, and d the distance between the cone and the earth, measured along the circular arc, then $d=ax$. The length of the magnetic path is $2\pi x$, and the flux per radial centimetre for unit current is $\frac{4\pi d}{2\pi x}=2a$, and the inductance per centimetre is, therefore, $2a \cdot 10^{-9}$ henry. The capacity per radial centimetre is obviously that of a plate condenser with plates of area $2\pi x$, separated a distance d, which is

$$\frac{2\pi x}{4\pi d}=\frac{1}{2a} \text{ absolute units, or } \frac{1}{2a\times 900{,}000} \text{ mfd.}$$

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Hence, apart from damping, the current and the P.D. will vary from point to point exactly as in an ordinary telephone line with these values of inductance and capacity per unit length. The strength of the electric field E at any point is found by dividing the P.D. at the point by the distance between the cone and earth, which varies as the distance from the generator. Now we have already proved that, apart from damping, the P.D. has the same amplitude all along the line, hence the strength of the electric field E will vary inversely as the distance from the centre. Again, since the length of the magnetic path varies directly as the distance from the centre, the magnetic field strength H must vary inversely as the distance. This agrees with the results obtained for the radiation of electro-magnetic waves from a Hertzian oscillator or antenna. It is seen, therefore, that, taking the earth as the lower disc and replacing the upper atmosphere by the perfectly conducting inverted cone, a system of electromagnetic waves is generated and propagated, and these waves are identical in their nature and properties—at least, in the neighbourhood of the earth—with those electromagnetic waves employed in radio-telegraphy, and vary in intensity from point to point on the earth's surface in exactly the same way. This radiation cannot be called cylindrical, but is essentially spherical, the wave fronts being approximately portions of spheres.

Although this supposititious arrangement gives the correct values of E and H, near the surface of the earth, this cannot be so for the upper atmosphere, where, instead of ending normally on an upper conical surface, the electric field forms loops as shown in Fig. 6.

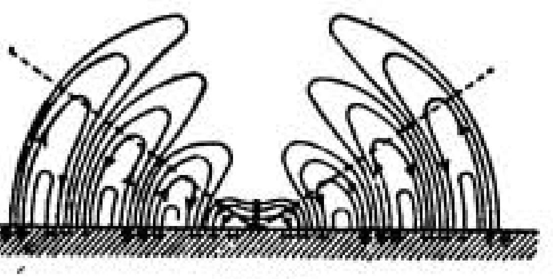


FIG 6.

If one is merely considering the question from a qualitative point of view, the slope of the upper conical surface is immaterial. To make quantitative calculations, however, the angle must be so chosen that the total amount of energy in the advancing wave bears the same relation to the values of H and E near the earth's surface as it does in the actual radio-telegraphic wave. The correct value of this angle is easily calculated. On the assumption of a perfectly conducting flat earth, the strength of the electric and magnetic fields at the earth's surface due to a vertical aerial is given by the following equation*:

$$E = H = \frac{2i_{max.}}{10} \cdot \frac{\cos\left(\omega t - \frac{\omega x}{v}\right)}{x},$$

where $i_{max.}$ is the maximum aerial current in amperes,

$\omega = 2\pi \sim$,

x = distance from aerial in centimetres,

and v = velocity of light in centimetres per second.

$$\text{Therefore, } E_{max.} = H_{max.} = \frac{i_{max.}}{5x} \text{ c.g.s. units,}$$

$$\text{or} \qquad E_{max.} = \frac{i_{max.}}{5x} \times 300 = \frac{60\, i_{max.}}{x} \text{ volts}$$

per centimetre.

Again, the total power radiated from a vertical aerial is $\frac{0{\cdot}61\ I^2}{v}$ ergs per second,† where I is the amplitude of the antenna current in electrostatic units. Putting the current in amperes and $v = 3 \times 10^{10}$, we have

$$\frac{0{\cdot}61 \times i^2_{max} \times 9 \times 10^{18}}{3 \times 10^{10}} \text{ ergs per second}$$

$$= 18{\cdot}3\ i^2_{max.} \text{ watts}$$

$$= 36{\cdot}6\ i^2_{R.M.S.} \text{ watts.}$$

Now in the supposititious case of the inverted cone and the perfectly conducting lower disc, the amplitude of the total radial alternating current is the same at all distances from the centre, and the length of the magnetic path is $2\pi x$. The strength of the magnetic field at a distance x will therefore be

$$H_{max.} = \frac{\frac{4\pi}{10} i_{max.}}{2\pi x} = \frac{i_{max.}}{5x}$$

and the electric field

$$E = \frac{P.D.}{d} = \frac{i\sqrt{\frac{L}{K}}}{ax}$$

$$= \frac{i}{ax} \sqrt{\frac{2a\ 10^9}{\frac{1}{2a} \cdot \frac{1}{9 \times 10^{11}}}} = \frac{i}{ax} \sqrt{3{,}600a^2},$$

* Abraham, "Theorie der Elektricität," Vol. II. p. 300

† Abraham, loc cit., p. 304.

and $E_{max.} = \frac{60}{x} i_{max.}$ volts per centimetre.

(Note.—$H_{max.} = E_{max.}$ if the latter is expressed in electrostatic units.)

Now the apparent resistance of our transmission line is $\sqrt{L/K}$, and the power supplied to it by the alternator, and therefore transmitted along it is

$$i^2_{R.M.S.} \sqrt{\frac{L}{K}} = i^2_{R.M.S.} \times 60a \text{ watts.}$$

In the case of the actual aerial the power radiated is $36 \cdot 6\ i^2_{R.M.S.}$ watts. Hence, for the radiated power to be the same in each case, we must have

$$60a = 36 \cdot 6, \text{ or } a = 0 \cdot 61 = 35 \text{ degrees.}$$

This angle can be found in another way without considering the apparent resistance of the transmission line. We have seen that by Poynting's theorem the power transmitted across a square centimetre is equal to $\frac{10}{4\pi} H . E$ watts. The maximum power per square centimetre will therefore be

$$\frac{10}{4\pi} \cdot \frac{i_{max.}}{5x} \cdot \frac{60\ i_{max.}}{x} = \frac{30\ i^2_{max.}}{\pi x^2} \text{ watts,}$$

and this will be the radiation at any point at the moment when H and E have their maximum values at that point. Since both H and E vary according to a sine law, the average rate at which energy is transmitted across each square centimetre is equal to half the maximum—viz., $\frac{30 i^2_{R.M.S.}}{\pi x^2}$ watts. The total radiation is

$$\frac{30 i^2_{R.M.S.}}{\pi x^2} \times 2\pi x \times a x = i^2_{R.M.S.} \times 60a \text{ watts,}$$

as found by the other method.

Hence, if the arrangement of inverted cone and lower disc is to give a correct representation of the actual radio-telegraphic waves, as regards both H and E and the total radiated energy, the angle a cannot be such a small angle as in Fig. 5, but must be exactly 35 degrees, as shown in Fig. 7.

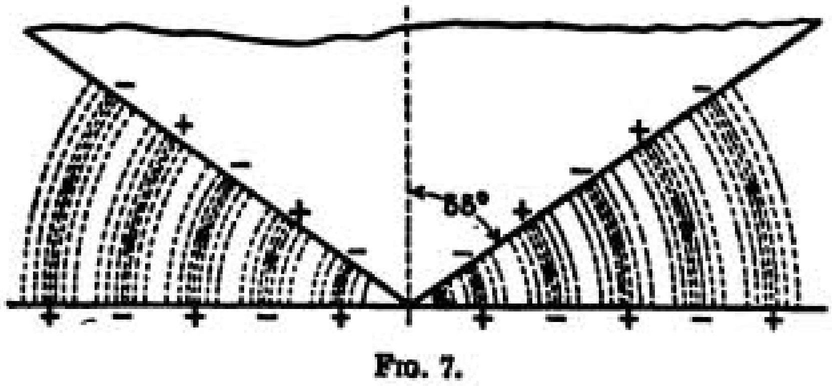


FIG. 7.

It will be evident from the foregoing, and especially from Fig. 4, that the vertical electric field is a maximum at any point at the same moment that the magnetic field at the same point is a maximum. The writer has found that there is a prevalent idea that the successive bands of vertical electric flux sweeping out from the antenna with the velocity of light *alternate* with bands of magnetic flux. This is not so; the electric and magnetic fields occupy the same space at the same moment, and the successive bands are separated by spaces in which both H and E fall simultaneously to zero. This is only true, however, if we avoid the immediate neighbourhood of the antenna. The current in the antenna, and therefore its magnetic field, are zero at the moment when the P.D., and therefore also the electric field, are approximately at a maximum. It is important to notice, however, that if the current and P.D. were exactly 90 degrees out of phase, the antenna oscillation would be wattless, and there could be no radiation of energy. The radiation has a similar effect to the introduction of an additional resistance in the antenna, and constitutes the useful load on whatever may be used to maintain the oscillation. In the immediate neighbourhood of the aerial there are powerful magnetic and electric fields, which are nearly 90 degrees out of phase, and which produce, for the most part, an oscillation, as distinct from a transmission of energy. It is only the components of H and E that are in phase which can cause a transmission of energy, and the other components are negligible beyond a certain distance from the antenna.

If there were no radiation the antenna could be represented by an equivalent inductance, capacity and resistance forming a closed oscillatory circuit, as in Fig. 8, where I is the spark-gap circuit and II the equivalent aerial circuit. In Fig. 8 a new cause of damping can be introduced into circuit II by opening the switch s, viz., a transmission line, which, if infinitely long and free from losses, acts exactly as an additional non-inductive resistance in the circuit. Here it is evident that a part of the oscillating energy is now transmitted away along the line and

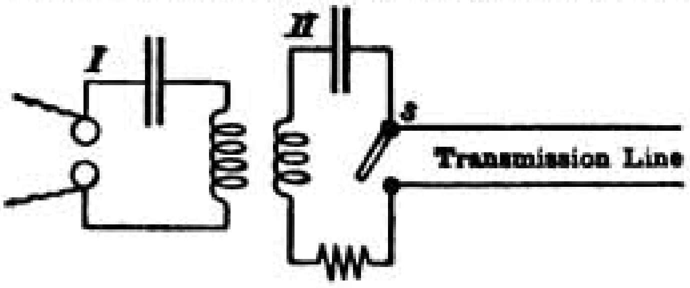


FIG. 8.

that in this line current and P.D. are in phase.

As a striking example of the prevalence of the idea that the electric and magnetic fields succeed one another alternately at any given point, it may be mentioned that in the first edition of Professor Fleming's "Elementary Manual of Radio-telegraphy," the fourth chapter, dealing with electro-magnetic waves, was permeated with this fallacy, as the following quotations show. (This has been corrected in the second edition, published three years ago.) "At the same point in space the electric component is a maximum at the instant when the magnetic component is zero and *vice-versa*; in other words, the two vectors differ 90 degrees in phase," and again, "we should detect these regions of magnetic flux and electric strain alternately succeeding one another at that place." It is interesting to notice how this view was given the appearance of mathematical support. The two fundamental equations are:

$$\frac{d^2H}{dt^2}=\frac{1}{\mu K}\cdot\frac{d^2H}{dz^2}$$

and

$$\frac{d^2E}{dt^2}=\frac{1}{\mu K}\cdot\frac{d^2E}{dz^2}$$

where z is measured in the direction of propagation. The error was then made of taking as their solutions:

$$E=E_0 \sin 2\Pi\left(\frac{z}{\lambda}-\frac{t}{T}\right)$$

and

$$H=H_0 \cos 2\Pi\left(\frac{z}{\lambda}-\frac{t}{T}\right)$$

which, of course, supports the view that E and H are 90 degrees out of phase. The use of the *sine* in one solution and the *cosine* in the other is quite arbitrary, however, and in order to satisfy the equation

$$-\mu\frac{dH}{dt}=\frac{dE}{dz}$$

the same function, sine or cosine, should be used in the solutions for E and H.

The physical meaning of this is easily seen from Fig. 9, which represents the values of H and E at various distances from the source at any moment. The arrow shows the direction of propagation. At A the flux through the small stationary rectangle is not changing, while at B the rate of change is a maximum. The E.M.F. or the line-integral of E around the rectangle is zero at A—*i.e.*, the value of E is the same along each of its vertical sides—whereas at B dE/dz is a maximum. Hence H and E are in phase.

The same is true in a sound wave. Our sending antenna is here replaced by an organ pipe in which we have stationary waves, with a stationary distribution of pressure at one moment, succeeded after a quarter of a cycle by an equal-pressure distribution of velocity. The maximum velocity occurs at points a quarter of a wave-length away from the points of maximum pressure. When sound waves travel through space, however, the conditions are different: the compressional waves are in phase with the velocity waves, *i.e.*, the air particles which have the maximum compression or maximum rarefaction at a given moment are those which are moving with the greatest velocity.

Returning now to the electromagnetic waves travelling over the earth's surface, we have seen that the calculated strength of the

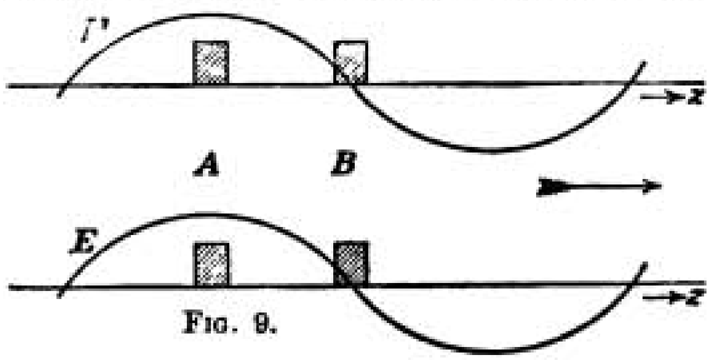


FIG. 9.

electric field near the surface is $60i/x$ volts per centimetre, where i is the current in the sending antenna. This field is normal to the surface—*i.e.*, it is a vertical field. These results are confirmed by experiment if the distance from the sending antenna is not too great. The distance at which marked discrepancies appear depends on the wave-length employed and especially on the nature of the earth's surface. These discrepancies are to be expected because we have made three assumptions:

(1) That the earth is a perfect conductor, whereas dry soil might be better described as a poor insulator; (2) That the earth is flat; and (3) That the atmosphere is a perfect and uniform dielectric at all heights.

The Goldschmidt Wireless Patents

Acquired by the Marconi Company—Important New Concessions

AN extraordinary general meeting of Marconi's Wireless Telegraph Co., Ltd., was held on October 4th for the purpose of submitting to the shareholders a resolution authorising the increase of the company's capital by the creation of a further 500,000 Ordinary shares of £1 each to rank *pari passu* with the existing 750,000 Ordinary shares except as regards dividends declared for the period of the current year. This resolution was passed unanimously, and subsequently confirmed at the further meeting held for that purpose on October 20th. The directors of the company decided to make an immediate issue of 250,000 of the shares and offer them to the shareholders at the price of £3 5s. per share. Of the remaining 250,000 shares part will be issued for cash in connection with the arrangements which have been made with respect to the shares to be acquired in the Cie. Universelle de Télégraphie et Téléphonie sans Fil of France, and the balance for the present will remain unissued.

Mr. G. Marconi presided over the meeting and moved the resolution, which was seconded by Mr. G. C. Isaacs, who made an important statement in regard to it.

Important Concessions.

The recommendation to increase the company's capital did not come as any surprise to the shareholders, for it was general knowledge that wireless telegraphy had become a very important industry not only in this country and in Europe, but in nearly every country in the world. It is destined to play a very important part in the future telegraphic business of the world, and shareholders were aware that the policy of the Marconi Company aimed at conducting that telegraphic business for its own account wherever it might be possible. Considerable progress has been made in that direction in recent times, and a number of important concessions have been secured, which will provide to the company the means of organising telegraphic services with some of the busiest commercial centres of the world. Negotiations are pending with other countries, and, said Mr. Isaacs, they had every reason to believe that they would be brought to a satisfactory conclusion in the near future. To fulfil the terms of the concessions and create such telegraph services a number of stations have to be built, requiring a substantial expenditure. As each station is opened and a satisfactory telegraphic service conducted, for which he thought they could safely rely upon their scientific advisers and engineers, an additional important, regular and continuously increasing revenue would accrue to the company.

To illustrate the scope for wireless telegraphy, Mr. Isaacs said :

" Additional and cheaper means of communication between all the busy centres of the world, together with the ever-increasing commerce, should add very considerably to the sum which is to-day expended upon the world's telegraph messages. I think I am right in saying that the money expended yearly for telegraphic communications across the seas is already sufficient to pay satisfactory dividends upon a capitalisation which I believe exceeds £100,000,000 sterling, independently of the increase which may be reasonably expected through the advent of wireless telegraphy and the general development of the world's trade ; and when we shall have completed the work which lies before us, and secured, if only a small share of the telegraph business, it should prove sufficient to enable us to earn substantial dividends upon what I think we shall be able then to regard with our million and a half sterling as a very moderate capitalisation, considering the extensive telegraph routes which we shall control. Given efficient management of our company's affairs during the next two or three years, I am confident we shall then find that we own one of the biggest and most important industries in the world, capable of holding its own against any competition, and furnishing remunerative returns to those who have supplied the capital and aided in the creation of an enterprise carrying the name of one with whom we are all proud to be associated."

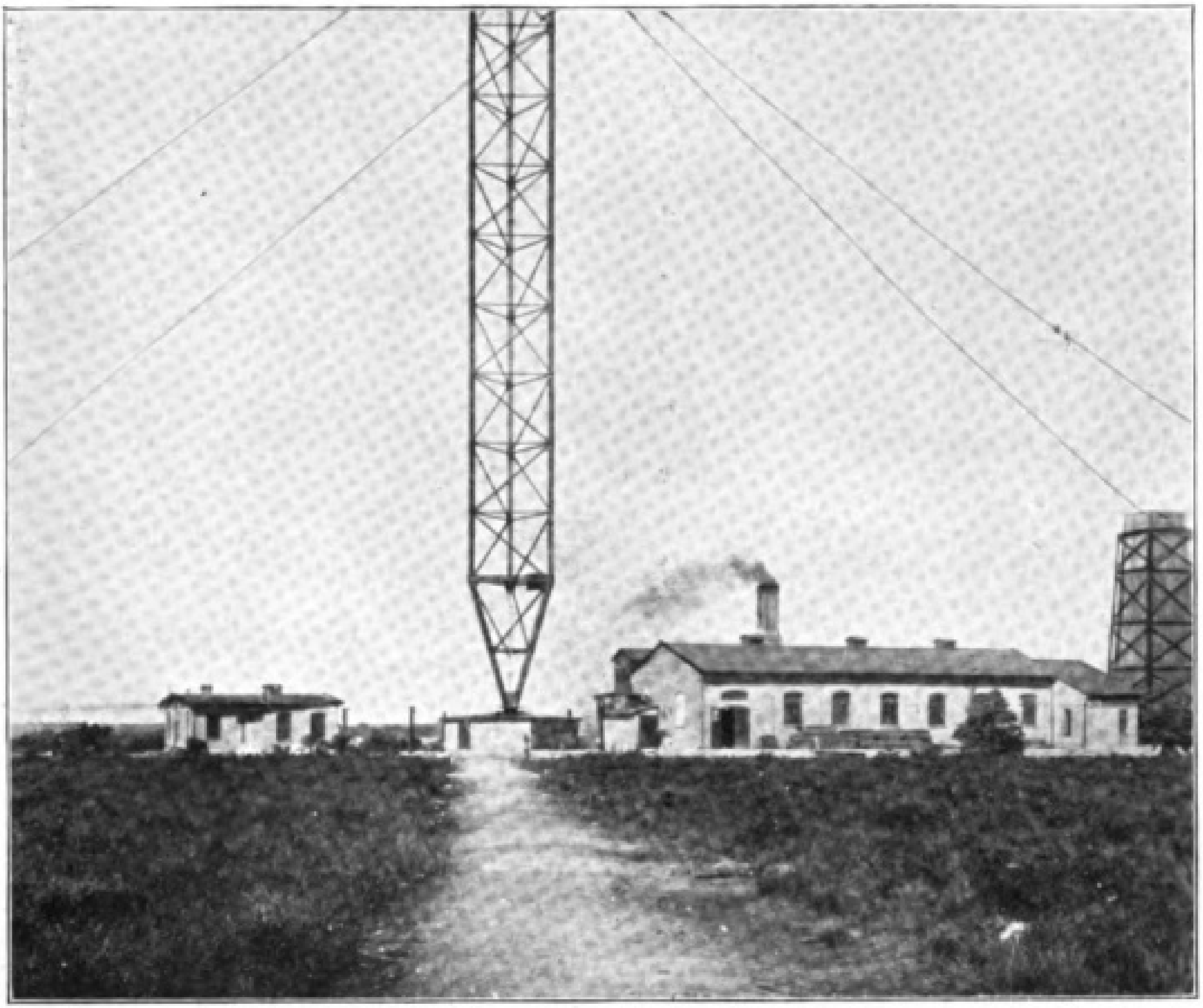
The remainder of Mr. Isaacs' statement concerned the acquisition of the Goldschmidt patents. He said:

"You will have learned also from the circular sent to you that we are acquiring a large number of shares in the Cie. Universelle de Télégraphie et Téléphonie sans Fil, which company owns the rights throughout the world, with the exception of the interior of Germany, of Dr. Goldschmidt's high-frequency alternator and his other wireless patents. I wish to say a word or two to you with reference to these arrangements in order that there may be no misunderstanding. The Cie. Universelle de Télégraphie et Téléphonie sans Fil is a company registered in France with a subscribed capital of 10,000,000 francs, in 100,000 shares of 100 francs each, and 100,000 *Parts Bénéficiares*, or founder shares, which participate in the profits to the extent of 45 per cent., thus making the capital equal to nearly 20,000,000 francs, or £800,000. This capital was subscribed by a few important and very influential persons, who wield considerable power in certain countries abroad. Their board is composed of men of eminence and ability in France, Germany, and this country, and their support of the Goldschmidt system, no matter what might be its merits—and upon this subject I shall have a word or two to say later—represented a serious menace to our programme in certain countries. We did not fear their competition, but we were anxious that they should not prevent or delay our obtaining certain concessions to which we attached the utmost importance. The company is in possession of some 7,500,000 francs, or £300,000, in liquid capital, and therefore in this respect also carried no small weight in the foreign countries to which I have referred.

"From every point of view—and in using these words I mean to cover something more than the interests of our Company—it appeared to your directors to be of the utmost importance that we should assure the telegraph services which are embraced in our programme becoming an English enterprise under the control and direction of an English company. These are some of the considerations which induced us to make the arrangements we have made with the Compagnie Universelle de Télégraphie et Téléphonie sans Fil. We are satisfied with the conditions we have obtained, and believe we have entered into transactions which will prove beneficial to the Company. All the shares in the Compagnie Universelle de Télégraphie et Téléphonie sans Fil which were previously held in Germany pass into our hands, and all the German directors retire from the board—a consideration of no small importance in France, and one which we hope will enable the Compagnie Universelle, who will also probably hold the Marconi long-distance licence for France and the French colonies, to secure the whole of the important business in wireless telegraphy which is comprised in the programme of the French Government. It is probable that the Goldschmidt patents for the rest of the world will become the property of the Marconi Company."

The Goldschmidt High Frequency Alternator.

"Now with regard to the Goldschmidt high frequency alternator, this is an extremely clever machine for the generation of continuous waves. It has been erected in a station near Hanover which Mr. Marconi, one of his ablest engineers, and I visited a few weeks back. There is great merit in the invention, and Professor Goldschmidt is no doubt a very able engineer. But it should be understood that he has not invented and does not claim to have invented a system of wireless telegraphy, but a machine for the generation and utilisation of continuous waves. The station in Hanover is well designed, and of great promise; it has succeeded in sending across the Atlantic signals and even messages, but, as we have told you on frequent occasions, there is a great difference between sending signals and messages and conducting a continuous telegraphic commercial service; and the Hanoverian station, in our opinion, without the assistance, experience, and patents of the Marconi Company, is still a very long way



The Power House of the Hanover Station. The Receiving House is shown on the left.

Tuckerton Station, showing the foot of the Steel Tower.

from being able to conduct such a service. In saying this I do not want to be understood to be taking from Professor Goldschmidt one whit of the merit to which he is entitled—on the contrary, his is the only method other than those of the Marconi Company of which we have any knowledge, which, in our opinion, has any prospect of success; but it is natural that a long period of tests, experiments, and further inventions would be necessary with Professor Goldschmidt, as they were with Commendatore Marconi. However, there were many considerations which caused us to make the arrangements we have, some of which I have already referred to."

The House of Commons Committee and the Company.

"There is one about which I must say a few words. We have had, as you know, a Select Committee of the House of Commons and an Advisory Committee composed of scientific men. That Committee reported that the Marconi Company alone was able to carry out the Government work at the present moment, but it nevertheless spoke of Professor Goldschmidt's machine in words which would have served the Compagnie Universelle as a certificate with any foreign Government, and consequently provide the means of seriously impeding, if not damaging, this Company's programme. It would have been little or no satisfaction to us to see the Cie. Universelle obtain a contract or a concession abroad, and fail two or three years later to fulfil it; for even though it fell subsequently to us to carry out, it would not have compensated us for the delay or the prejudice we should have suffered meantime. These are considerations of importance which obtain to-day, but in a very short time, we hope, they will no longer exist; the important foundations of our business will have been securely laid, and no interference with our programme can then arise.

"It has been stated that one of the reasons which induced us to enter into this transaction was that the station at Hanover had succeeded in transmitting wireless messages to Tuckerton, U.S.A., at a regular rate of 100 words per minute for hours at a stretch. There is not an atom of foundation for that statement, for no better reason than that the Hanoverian station has not done anything of the kind, nor anything approaching it. It has also been said by a paper, which is usually more accurate in its statements, that Lord Parker's Committee reported that the future is likely to belong to continuous waves, which is the Goldschmidt and not the Marconi system, whereas what in fact the Committee reported was that the only continuous wave machine which they had seen tried with success over long distances was the Marconi continuous wave machine. A good deal more has been written upon this subject, mainly with the object of attacking the Government in connection with the contract for the Imperial stations, but these are matters which do not concern us—they are political, and the Marconi Company has no politics."

Continuous and Non-Continuous Waves.

"But when the public is told, as one paper has told them, that the nation's interests have been sacrificed, I for one protest, for it would seem to me that the course we have taken will prove to be of very marked advantage to the nation, and that for the following reasons. We do not know, and nobody yet knows, whether continuous waves will be able to do a continuous long-distance commercial service. If they can, will they prove superior in any way to the non-continuous waves? Those who have no experience of long-distance wireless telegraphy may be willing to express their opinions, but Mr. Marconi and his engineers who have such experience decline to express themselves. Before doing so they wish to see what we are about to do—namely, work the continuous and non-continuous waves side by side across the Atlantic, and compare them at all times and in all weathers. Similarly, we shall be able to test the Goldschmidt continuous wave machine, and compare it in every respect with the Marconi continuous wave machine. If the continuous wave prove to be superior to the non-continuous, we shall be in a position to decide which of the two machines is the better; we shall preserve an absolutely open mind, and adopt whichever offers the greater advantage, and Mr. Marconi will be the first to insist upon that course.

"Should the Goldschmidt machine prove the better, the nation will have the benefit of it under the contract with our Company without any extra cost, and without having run any risk whatsoever. Had the arrangement which we have entered into not been made, the Government would not have had the opportunity of such a comparative test, but if it had, does anybody suppose, if the superiority proved to be with the Goldschmidt machine, that the German and French interests would have been willing to furnish it on any better terms, if as good, as those entered into with this Company? The Government has dealt with an English company; if the foreign machine prove of advantage, the Government still get the benefit of it through an English company. Is that how the nation's interests have been sacrificed? And, again, if the Goldschmidt machine prove to be of the value that some contend, and markedly superior, as it pleases others to say, to the Marconi machine, the commercial wireless telegraph business of the world would have been in the hands of foreign companies, whereas by our arrangements it will be in the control of an English company. Is that a sacrifice of the nation? I will say no more upon that subject. I hope I have said enough to convince you that whether the Marconi continuous wave machine, or the Goldschmidt continuous wave machine, or the combination of the two, prove the best in wireless telegraphy, the Marconi Company will possess them all, and under the contract the nation will have the benefit of them."

PORTABLE METEOROLOGICAL STATION.

AT the recent French Army manœuvres an interesting adjunct to the aviation corps was a motor-car ingeniously fitted up with apparatus for the observation of meteorological conditions. It was used to give the military aviators serviceable indications regarding the direction and velocity of the wind at different altitudes up to about 10,000 ft.

Comprised in the apparatus are :—(1) Two instruments called "dhéodites," which are used in conjunction with a telescope for observing the angle of elevation of a small pilot balloon, and which enable graphs of the speed and direction of the wind to be issued within a quarter of an hour of the time of making the observation; (2) several pilot balloons and cylinders of hydrogen for inflating them; (3) a pneumatic mast, which can be run up to a height of 75 ft., and which serves to carry an anemometer and also acts as a receiving antenna for wireless telegraphy, the wireless weather reports being thus received from the Eiffel Tower; (4) two kites with winders and about 14,000 ft. of steel wire; (5) the usual instruments for meteorological observations, such as hygrometer, barometer, and anemometer; (6) a dynamo; (7) an instrument for determining the velocity of the clouds; (8) a writing table; and (9) a pneumatic inflator.

The engine of the car is used to actuate the winders, run the dynamo, and work the pneumatic inflator when the mast is being erected.

SAILORS AND WIRELESS.

AN emergency committee meeting of the Executive Council of the National Sailors' and Firemen's Union of Great Britain and Ireland was held at Maritime Hall on October 14th, at which, according to reports appearing in the Press, it was decided to consult the members as to whether they would be prepared on and after May 1st next year to refuse to engage on any ocean-going cargo vessels unless they were equipped with wireless telegraphy.

The council, it is added, were convinced that, but for the fact that the *Volturno* and the ten rescuing vessels were equipped with wireless, the whole of the lives on the *Volturno* would have been lost, and were of opinion that many lives that are now lost on cargo vessels could be saved under similar circumstances were all vessels fitted with wireless.

At a meeting of the Institute of Radio Engineers (New York), held on October 1st, at Columbia University, Mr. Roy A. Weagant, Engineer of the Marconi Wireless Telegraph Co. of America, read a paper entitled "Some Recent Radio Sets of the Marconi Company." The paper discussed the design and construction of modern efficient quenched spark apparatus.

Modern Wireless Apparatus

The Marconi Short-Range Multiple Tuner

The installation of wireless telegraphy on cargo vessels, and even small tramp steamers, has necessitated the design of special instruments, a form of which is described below.

IN all departments of physics in which we are concerned with vibrating bodies or systems of any kind we find ourselves confronted with the phenomena which are generally described by the term "resonance." This term was originally coined in connection with certain effects noticed in acoustics, but, its real significance being dynamical, it has been generalised and extended. In wireless telegraphy it is known as "tuning." A receiving circuit consisting only of an aerial with a magnetic detector connected between it and the earth would not be of very much use in actual practice. It is necessary also to introduce some means of varying the time-period of the circuit, in order to place it in resonance with the frequency of any particular transmitting station with which it may be desired to communicate. In 1908 the "standard" Marconi multiple tuner was designed. This instrument contains the inductances, capacities, and coupling arrangements required in a tuned receiving station. The whole is included in a case little over a foot long, and on the outside of which are dials indicating wave-lengths and other measurable quantities such as inductance by coupling directly. Since that time, however, the range of applications for wireless telegraphy has considerably increased, and with it has grown the demand, for certain purposes, for smaller instruments. The successful development of the $\frac{1}{2}$-kw. marine set is in the main responsible for the production of the short-range multiple tuner which forms the subject of the present article.

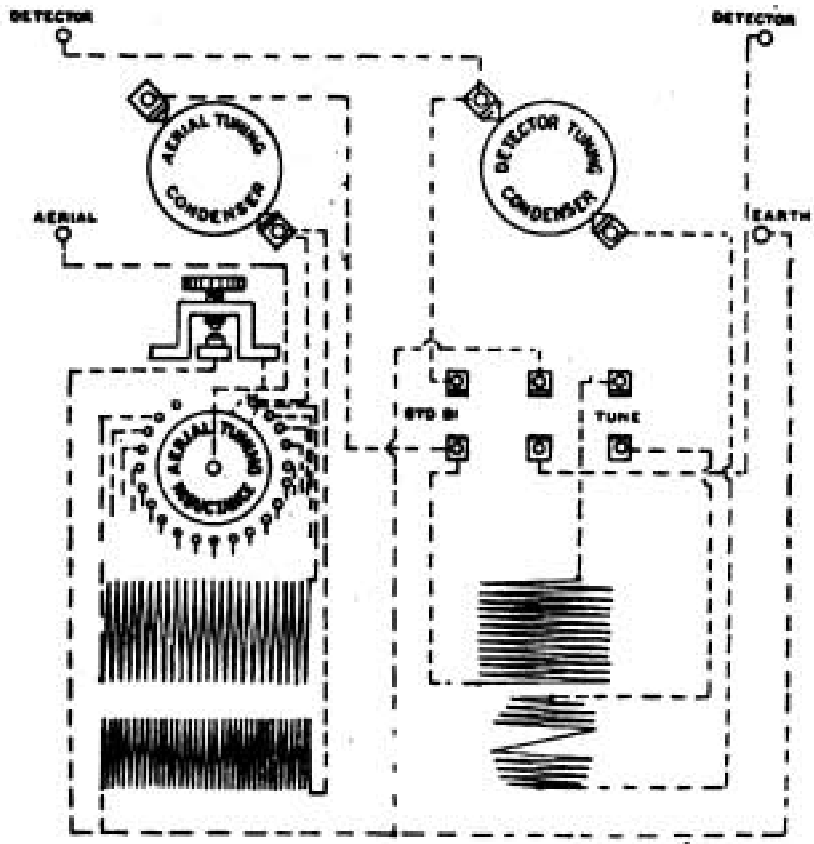


Fig. 1.—Diagram of Connections

The Marconi multiple tuner is the outcome of many years' experimental work and experience, both in regard to the scientific principles involved and the manner in which they have been carried out, the electrical and mechanical design being such that, while the instrument fulfils its functions accurately and easily, it will stand severe climates and comparatively rough usage. The principal function of the instrument is to "tune" the receiver or render it immune from interference from other stations; but it may also be used for measuring the lengths of the received waves.

The design of the instrument is such that it is completely protected from all electrical discharges, and is adequately insulated wherever required, while all switches and contacts are of the most substantial character and easily accessible for cleaning. Further, it is strongly constructed, and all electrical connections are carefully soldered so that it is unaffected by the severest vibration. The general appearance of the instrument is shown in Fig. 2 and a complete diagram of the connections in Fig. 1. The whole instrument fits into a plain wooden travelling case, measuring approximately 1 ft. 2 in. by 9 in. by 11 in. high, and is suitable for all wave-lengths from 250 to 750 metres.

The instrument contains two separate circuits, which are known as the aerial and detector circuits, the former being so called because it passes from the aerial through the aerial tuning inductance, tuning condenser, and inducting coil to the earth. The detector circuit consists of inductance in series with the detector tuning condenser and the detector. Both the aerial tuning inductance and the condensers are adjustable, and by this means the circuits can be tuned to the received wave-length. The oscillations in the aerial circuits then induce oscillations in the detector circuit.

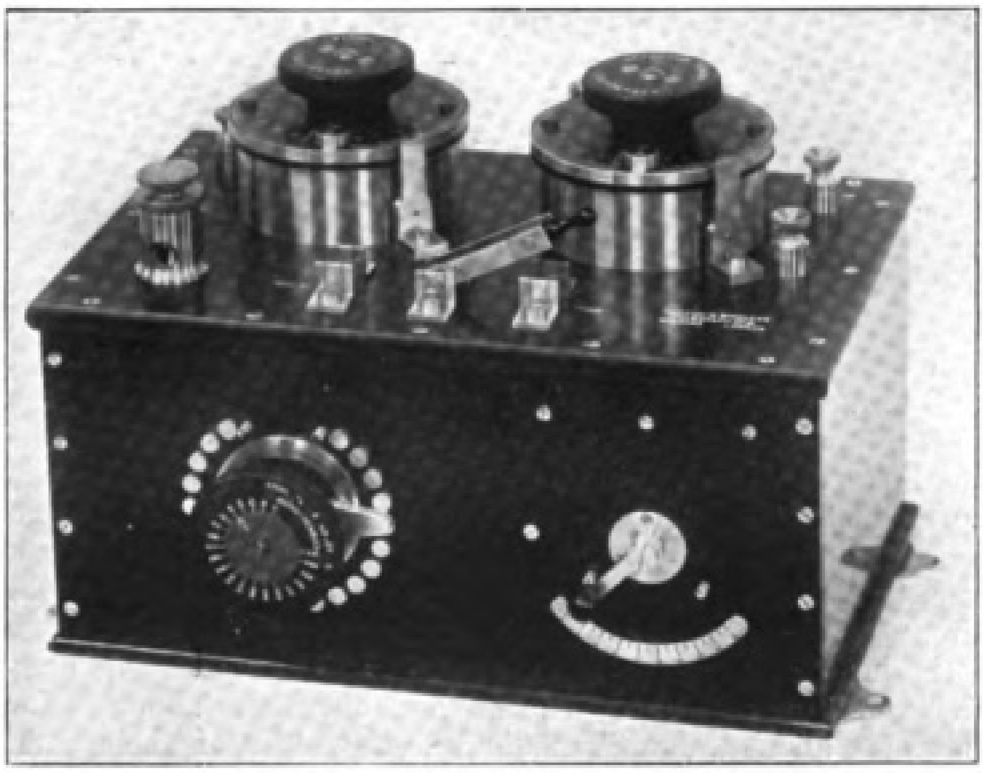


Fig. 2. Short-Range Multiple Tuner

The instrument is further fitted with a micrometer spark-gap and shunt inductance, connected between the aerial and the earth terminals to prevent the accumulation of any electrostatic charge in the aerial.

A change switch is provided, and by means of this the whole of the tuning circuits may be cut out.

When in use the tuner is on a table in front of and close to the magnetic detector.

The terminals in the tuner marked "Detector" are connected up by short pieces of wire to the primary terminals of the magnetic detector.

The aerial and earth should be connected to the terminals of the tuner marked "Aerial" and "Earth" respectively.

By turning the micrometer spark-gap screw (left-hand thread) until the contacts meet, then turning the screw back one complete turn, a gap of about one-hundredth of an inch is obtained. With the change-over switch on the "Stand-Bi" side the aerial is now connected directly through the aerial tuning condenser and inductance and the magnetic detector to the earth, and the operator will hear any station that happens to be working. Unless the aerial is very long, the aerial tuning condenser is kept "shorted" while "standing bi."

When the signals are heard from the station with which it is required to communicate, it is necessary to adjust first the aerial tuning inductance and then the aerial tuning condenser till the strongest signals are obtained.

The intensifier handle should be set to 90°, and the change switch thrown over to "Tune," and the detector tuning condensers varied till the best signals are obtained. It is then that the aerial tuning condenser should be again adjusted to give the strongest signals, and if interference is found, the intensifier handle should be adjusted to a smaller value, and the condenser again adjusted.

It will be found that the further the intensifier handle is turned from 90° the sharper will the adjustments of the condensers become, and the greater will be the freedom from interference.

Wireless—The Life Saver

How it brought Aid to the Burning "Volturno"

THE world was horror-stricken with the fateful news it received on October 11th, that the *Volturno* had been burnt out, and 136 souls had been lost in the disaster. But terrible as this loss is, it is not the destruction of life which makes the tragedy notable in the annals of the sea; it is the fact that over 500 were saved, through the instrumentality of wireless telegraphy, out of the fiery jaws of death, when the elements, as it seemed, were combining together for their destruction. It is the most wonderful story of rescue that has yet been recorded, for the odds against which humanity fought to save humanity were as fearful as imagination could conceive. But it is a triumph for wireless telegraphy. For by this agency alone was it possible to carry out the work of rescue and bring relief to the doomed ship.

While in mid-Atlantic the *Volturno*, a British steamship carrying over 600 emigrants from Rotterdam to New York, and a heavy cargo, took fire. The extent of the damage was only too apparent. Swiftly the flames spread throughout the hold, and soon the forward part of the vessel was enveloped in flames. This was about 7 o'clock on Thursday morning, October 9th, and already the loss of life was considerable, for it is recorded that 50 or more of the *Volturno's* passengers and crew had been lost. Then the captain ordered the wireless operator to telegraph a call for help, and the first to receive the intelligence was the Cunard Liner *Carmania*, whose captain immediately set out to her rescue. A stiff gale was blowing, but in spite of this hindrance the ship covered the 78 miles which lay between her and the *Volturno* in a little more than four hours. Immediately Captain Barr received the call, he used the wireless telegraph installation on his vessel to repeat the appeal for aid over a wider range, with the result that shortly after the *Carmania* arrived at the burning ship other vessels steamed up. They were the Norddeutscher Lloyd steamships *Grosser Kurfurst* and *Seydlitz*; later arrived the Atlantic Transport liner *Minneapolis*, Furness, Withy & Company's *Rappahannock*, the Russian Steam Navigation Company's *Tzar*, the Leyland Company's *Devonian*, the International Mercantile Marine Company's *Kroonland*, and the French steamer *La Touraine* of the Cie. Générale Transatlantique. They found the forward end of the *Volturno* burning fiercely and the ship rolling heavily. Already they had learnt from the captain, by wireless, that six boats had been launched, but only two had got safely away, the other four had been smashed to pieces by being dashed against the ship's sides, and the occupants had been either killed or drowned, while the *Volturno's* screws had been fouled and rendered useless by the tackle used in lowering the boats. But the worst feature of the situation lay in the fact that the onlookers could render no effective aid. The seas ran so high under a north-westerly gale that no boat could approach the burning vessel and live. One crew from the *Carmania* made a gallant effort to reach her, but after labouring for two hours and losing most of their oars, they were forced to return. Then Captain Barr made a daring attempt to manœuvre his own ship close to the *Volturno*. He got within a hundred feet of her, but in the storm it was impossible to pass a line. As a matter of fact, even if this feat had been accomplished, it would have been to little purpose, for with the ships rolling as they were in the turbulent sea, the strongest cable would have snapped like thread, and as for working a cradle, that was beside the question. Towards nightfall the gale moderated slightly, and the rescue vessels were able to lower boats, but it was still impossible to get alongside, and all they could do was to look for struggling swimmers in the water, and they were aided in their work by the searchlights of the *Carmania*. About 9 o'clock that night the flames burst through amidships from the engine-room and bunkers; then came an explosion, and a flight of rockets from the doomed ship was the signal that hope had been abandoned, and that the vessel herself was in the last extremity.

How awful the scene was, the words of one of the onlookers on the *Carmania* affords some indication. "The spectacle," he says, "of the *Volturno* burning, with over 600 souls on board, surrounded by the huge hulls of this trans-Atlantic fleet, crowded with thousands of spectators, all out had been organising the relief with wonderful skill and energy, realising that the only chance of effecting a rescue lay in the abatement of the storm, or by calming the waves by pouring oil on them, ordered his operator to ask by wireless far and wide: "Is there any oil-tank boat in the neighbourhood?" A reply, which will long be remembered in the annals of ocean disasters, came from the skipper of the *Narragansett*: "Yes, will come with the milk at six in the morning." She was seventeen hours' steam

The spectacle of the blazing ship on the ocean waves. This illustration appeared exclusively in the "Daily Sketch," and is reproduced here by kind permission of the Editor.

eagerly anxious, but unable to help owing to the mountainous seas, beggars description."

At 9.20 the wireless operator of the *Volturno* had to change over to the emergency batteries, as the fire, reaching the boilers and engine-room, put the pumps and dynamos out of commission. Then he sent the last despairing message, poignant with agony, which must have burned into the ears of all that received it, "For God's sake help us, or we perish." But there was little to be done until Captain Barr, who through- from the spot where the *Carmania* was standing by the burning ship. "Can't you make it an hour earlier?" interrogated the wireless. "Yes," came the reply, "I will be with you by five o'clock."

And she was. At day-break on Friday morning she took up a position a little to windward of the *Volturno*, and, opening her oil tanks, poured two large streams of oil on the water, and this enabled a flotilla of boats to gather at the stern of the *Volturna*, and rescue work was carried on apace. By 9 o'clock the remaining 521 passengers and crew had been taken safely off, and a feat of rescue work was accomplished which will stand high in the records of heroism and life saving, and must be a lasting tribute to the efficacy of wireless telegraphy. Had it not been for this, the greatest invention of a great age, the *Volturno* and all aboard her must have inevitably perished, for she would have been burnt out, and the lonely ship with her living freight would have been consumed by the greedy flames, with only a wide waste of waters to give an added horror to approaching dissolution.

This story of rescue emphasises in a particular way the value of the emergency gear, which is supplied with all ship installations. The gear consists of a set of accumulators capable of transmitting messages over distances of 100 miles. Had it not been for such a gear the *Volturno's* apparatus would not have been able to work as long as it did, as the ship's dynamo was put out of action. As it was, the operators were enabled to send messages up to the very last. That is to say, until the cabin became too hot for further occupation. This gave the vessels coming to the assistance of the *Volturno* the advantage of arranging the course they were to pursue long before they reached the disabled ship, so that not a moment was wasted in effecting rescue work. The Marconi Company inaugurated the system of emergency sets many years ago, and the advantages of this practice were later recognised by several States, who made the equipment of passenger vessels with this emergency gear compulsory.

The reports of the operators on board the various ships which went to the relief of the *Volturno* make vivid reading. Any one of these, printed in detail, would be too long for insertion in THE WIRELESS WORLD, but the general report of the operator on the *Carmania*, Mr. Maltby, is too interesting a document to be overlooked, and we print it practically in its entirety, to give some idea of the amount of work entailed in the reception and dispatch of messages at such a crisis. It may be stated that 95 messages passed through the hands of the operator on board the *Narragansett*, and many of these were a hundred words in length. The heaviest work fell to the operators on the *Carmania*, as this vessel was in touch with all the other vessels at one time or another, and the report that "the working of all stations concerned was excellent, and that of the *Volturno* especially so. The operator worked with all his power until the dynamo had ceased running, and then on the emergency gear until he was forced by heat to leave the cabin," speaks volumes for the Marconi apparatus.

The operator on the *Minneapolis* confirms this statement, for in his report he says: "I may say that the wireless work has been splendid, all ships working well, no jamming, no repetitions, and at good speed. The operators on the *Carmania* and *Volturno* did famously."

We conclude with Mr. Maltby's report:

"On Thursday, October 9th, 1913, at 10 a.m. GMT, I received an S. O. S. call from the s.s. *Volturno*, giving his position '49.12 N-34.51 W. Nr. 1 and 2 holds blazing furiously please come at once.' I immediately replied to him, and then informed the captain, who told me to tell him we were coming at once. The watch in stokehold and engine-room was immediately double banked, and instead of doing 15½ knots as previously, we started on our journey towards him on about 20 knots, as can be seen when we covered the 78 miles which separated us in four hours. A tremendous N.W. gale was blowing and a very high sea. Arriving there at a little before 2 p.m. GMT, the *Volturno* was smoking very heavily forward of the funnel, and all the time seemed to be lying in a trough, never rising on the waves. I told all ships in the vicinity to stand by, as the *Volturno* was in distress. Messages were sent from all those within range of us to the captain, asking for information, and when given it, also hurried to the spot.

"Immediately we got to her we went as close as possible and lowered a boat, but it was impossible to reach her, and after a dangerous and strenuous two hours returned unsuccessful.

"The *Volturno's* aerial was now earthing badly, of which fact I informed him, and according to later reports it was repaired by the second officer, who fell from a height of 20 feet on to the deck. After having been asked by the *Volturno* to look for the two missing boats, we had only gone about 5 miles when he asked us to return, saying,

H. P. HUNT
Minneapolis

K. MACRAE (Junior)
Minneapolis

J. NEELEMANS
Kroonland

J. H. JEPPESEN (Junior)
Kroonland

. . . — — — . . .

"S O S"

W. SEDDON
Volturno

C. J. PENNINGTON (Junior)
Volturno

P. B. MALTBY
Carmania

J. E. WOODWARD (Junior)
Devonian

J. A. BELL (Junior)
Carmania

R. B. NORWOOD
Devonian

D. O'SULLIVAN
Rappahannock

M. QUÉVILLON
La Touraine

M. PIERRE (Junior)
La Touraine

Some of the Operators who took part in the thrilling tragedy of the sea.

'Come as quick as possible, she may go down any minute, plates buckling.' We returned, and went dangerously close to her, and lowered six rafts, to no avail. Nothing could be done, so we stood by.

"Gradually one by one all the other ships arrived, till at midnight eight were around her, our captain having kept all well advised as to the position, which was constantly changing. In the 25 hours that we were there she drifted over 40 miles.

"It was one of the most heartrending sights I have ever seen. To see the *Volturno*, one mass of flames from funnel to forecastle, surrounded by all these ships incapable of doing anything. Men and women on our ship were seen in tears, and if the captain had thought it advisable and called for volunteers, the whole ship would have volunteered undoubtedly. At 10.50 the *Volturno's* lights went out, and the operator was working on accumulators. The operator on the *Volturno* deserves all praise, for he stuck splendidly to his post, even when the flames were as high as the funnel, and all the time worked with a steady head and a coolness which under the circumstances was remarkable.

The Operators on the German Vessels.

"Almost his last message ran: 'We can't last much longer, can't anything be done to help us?' One felt like going out and getting in a boat and attempting to get to him by oneself. Before daybreak the seas subsided somewhat, and ships began to lower their boats, one of the first, I believe, being the *Devonian*. The *Carmania* now lay a little further away, and gave way to more navigable and smaller vessels. By 9 a.m. all had been taken off, and after the ships had cruised around on a fruitless look-out for the missing boats, they proceeded on their diverse journeys.

"It was certainly one of the most nerve-racking experiences I have ever had, and all who saw it will certainly agree with me.

"(Signed) P. B. MALTBY,
"s.s. *Carmania*."

Some Press Comments

"THE TIMES."—The grief and horror which the fate of the *Volturno* must everywhere cause will be mitigated in part by the reflection that but for the recent application of modern science the disaster would have been yet more terrible than it is. . . . Had it not been for the invention of wireless telegraphy and the equipment of so many great liners and others with it, it is almost certain that all the 657 human beings on board the *Volturno* must have perished.

"THE DAILY TELEGRAPH."—Owing to the miraculous intervention of science ten liners are bearing to different ports no fewer than 521 survivors. Who could have foreseen when first the wonders of wireless telegraphy were whispered in incredulous ears that in a few short years it would have made the Atlantic ring with anguished calls for succour and to have led to the salvation of scores of lives?

"MORNING POST."—The beneficent part which wireless telegraphy now plays in the saving of life at sea has again been demonstrated by the disaster to the *Volturno*. The distress signals sent through space brought to the aid of the burning liner quite a fleet of steamships. Owing to this equipment it is now well-nigh impossible for a passenger vessel to disappear from human ken without the slightest indication of her fate, as has occurred in former days, as practically all liners of importance carry an installation.

"DAILY MAIL."—The immense value of wireless telegraphy in protecting life at sea is demonstrated once more in the tragedy of the *Volturno*. . . Grievous as is the death roll of 136, but for wireless telegraphy, the world might have had to mourn the loss of every soul on board the *Volturno*.

P.O. Wireless Telegraphists

THE minutes of evidence given before the Select Committee which was appointed to inquire into the wages and other conditions of employment of the principal classes of Post Office servants are interesting to us inasmuch as they deal with the claims put forward on behalf of wireless operators by representatives of the Postal Telegraph Clerks' Association.

The Committee recommend that the staff should be recruited from telegraphists, counter clerks and telegraphists, and sorting clerks and telegraphists of not less than 21 years of age or over 24 years of age, and that an officer before being transferred on probation to the wireless staff must be a thoroughly competent telegraphist, and before transfer on probation, but not necessarily before selection, must show proof of such knowledge of French and German as is necessary for communicating with foreign ships. Every officer transferred to the wireless staff should be regarded as a probationer for two years, and be liable at any time during those two years to be returned at the discretion of the Post Office to the class from which he has come without loss of seniority.

Every wireless operator must, in addition to his purely operative duties, render to the officer in charge of the station every assistance in his power which may be required towards keeping the wireless station in an efficient condition or to effect temporary or permanent repairs in the plant.

As the watch must be continuous throughout the year, the Committee see no reason to discriminate between day and night hours, Sundays, Bank Holidays, or ordinary working days. They accordingly recommend that a wireless operator be required to perform 45 net hours duty per week by day or night, spread over six days in each week, but that on one day he should be entirely off duty, and if called upon to work on that day should receive pay at rate and a half, as recommended for other classes on Sunday.

The Committee recommend that the wireless staff should be allowed one calendar month's leave in every year, inclusive of Bank and other general holidays.

The overseer or other officer in charge of the station should perform such manipulative duties, including the keeping of a wireless watch, as the exigencies of the service may require, but he should not under normal circumstances be scheduled to perform these duties for more than 4 hours per diem.

The Committee consider that the Department ought, wherever necessary, to provide official residences for the staff, for which a reasonable rent should be charged, and where it is found that the convenience of the staff is best met by placing these residences in a village some little way off rather than at the station, there should be at every station comfortable accommodation for rest, including, in case of emergency, sleep.

The following scale of pay is recommended :—

Wireless Class.—1st year, 32s. ; 2nd year, 35s. ; 3rd year, 40s., on passing technical and manipulative examination and being accepted on the staff ; then by annual increments of 3s. to 70s.

Wireless Overseers.—£200 by £7 10s. to £230, and that the overtime should be paid on the system recommended in the report.

Finally, the Committee recommend that officers at present employed on wireless duties should be transferred to the new Wireless Class with all the conditions attached on the following basis :—

(*a*) Manipulative officers to enter the new class at the minimum of the new scales, or at the actual pay they are at present receiving unless they have two years' service on the class, in which case, on passing the technical examination, or if they have already obtained the certificates required for the technical allowance and are certified by the Inspector of Wireless Telegraphy as fully efficient, they may be accepted on the staff and proceed on the scale of pay recommended for officers on passing the technical examination and being accepted on the staff.

(*b*) Wireless overseers to enter the new scale of pay carrying the pay they are actually receiving and proceed on the scale recommended.

More Answers to Correspondents

BY OUR IRRESPONSIBLE EXPERT

N. PARKER (Lowestoft).—What you want is a library, not an answer to a question.

* * *

WILLIAMS (Bristol).—For an explanation of why the night range of a wireless station is greater than the day range, see answer to TOMPKINS (Londonderry) given below.

* * *

QUERIST (Stratford-on-Avon).—A buzzer is an electric bell with the irritating parts amputated.

* * *

MISS N. (Wimbledon).—Yes, there *have* been lady operators, but the last one we heard of got killed in the rush to send messages.

* * *

TOMPKINS (Londonderry).—See answer to WILLIAMS (Bristol) given above.

* * *

F. L. (Launceston) and JAMES K. (Ealing).—The only way to receive Eiffel Tower signals is by means of a bedstead. (See Electrical Papers, etc.) We have not yet tested the Charlady or Bucket receiver, but believe it gives good results.

* * *

JONES (Chester).—Full particulars of how to make a wireless birdcage will probably be given at an early date.

* * *

EXPERIMENTER (Liverpool).—You ask us how to make a "loose-coupler." We abhor the term. Why don't you call it a Reciprocally Inductive Oscillatory Current Transformer? It's so much easier to say.

* * *

N. A. (Tobermory).—To find the wavelength of a tubular aerial, firstly, take what you assume to be the approximate wavelength, in feet, multiply by 3π, divide by 3·14159, and you will get the answer in yards. By a simple algebraic calculation this can be reduced to feet or metres.

* * *

ENTHUSIAST (Dundee).—We thank you for forwarding to us your new receiver with which you claim to have received strong signals without either aerial or earth. Since removing a half-dead fly from the telephones we have heard nothing, so we are returning the instrument to you for readjustment.

* * *

G. F. R. (Carnarvon).—No; Noah's Ark was not fitted with the system you mention. We believe they had a difficulty in getting a good earth.

* * *

ENGINEER (Edinburgh).—The principle of the high-frequency alternator is as follows: Firstly, an alternator with a frequency of about 2,000 is constructed. This is coupled up to a steam turbine. The station engineer then sits on the safety valve and speeds up the machine to about 20,000. Condensers are next shunted across any part through which the current is likely to squirt out. Every now and again a current achieves liberty, rushes into the condenser, is disappointed, and has to rush back again. This excites the armature and increases the frequency to about 200,000. The aerial is then connected to any odd terminals across which a condenser has not been shunted, and as a result a violent oscillatory current rushes up and down the aerial. This excites the engineers. Everybody and everything gets excited. The present great disadvantage of these high-frequency machines is that, if the station engineer shifts his position on the safety valve, the frequency alters its value like a mining share. Further, at these high speeds most alternators have rag-time propensities.

CARTOON OF THE MONTH

The Experiences of an Amateur.

FROM A SUBURBAN CORRESPONDENT

With 20ft. of ordinary copper wire, a garden rake, a bicycle, a few odds and ends valued at 5s. and a pair of telephones, I easily read wireless time signals from Eiffel Tower. My wife and children were greatly interested in my experiments," etc., etc.

NOTES OF THE MONTH

COMPLETION OF CAPE RACE STATION. STATIC DISTURBANCES. STATIONS AT AMERICAN GULF PORTS. THE LICENSING OF AMATEURS. A NEW POST OFFICE ORDER.

THE re-opening of the Cape Race wireless telegraph station calls for more than passing notice. The geographical position of this Newfoundland coast station renders it of special importance to ships in one of the most dangerous portions of the Atlantic Ocean, and its services as an aid to navigation have made it renowned. It was not without a feeling of dismay that the world received news of its destruction by fire on May 5th. But the Canadian Marconi Company lost no time in setting to work with the object of restoring the service. Immediately after the fire, work was commenced on the erection of a temporary station, and, on permission being obtained from the Department of the Marine and Fisheries of the Canadian Government, the Cape Race Lighthouse engine was belted to the wireless transmitting apparatus, and the temporary installation put in running order. Within three days of the date of the fire a continuous twenty-four hour service was again established, and the station was able to effect communication with all vessels on the Canadian route. In the meantime, new plant was installed in a building of special fireproof construction. This was completed on October 17th, and the station, which has a wave-length of 600 metres and an average daylight range of 500 miles over sea, is now in full operation.

* * *

The development of the great commercial service between the constantly moving ship stations and provision for their increase in numbers has required one of the most carefully devised organisations in the country, and what amounts to practical standardisation of Marconi apparatus. Engineers of long experience are constantly making inspection trips not only aboard the ships, but to all parts of the country where land stations are located. Prominent among the problems that these men have been dealing with is the elimination of the static disturbances which are sometimes encountered. One of the inconsistencies of Nature is to endow a certain locality with all the necessary advantages in geographical position and formation so that it may grow into a flourishing shipping centre and then hamper its operations with adverse atmospheric conditions. A notable instance of this kind was the prevalence of static disturbances in the region of the Gulf Ports. The chief inspector of the American Marconi Company has just returned from a trip through this section, and reports that the effect of these disturbances has now been reduced to a minimum, and they no longer interfere with message transmission. Improvements in the design of apparatus have been responsible for this desirable condition, the importance of which may be best illustrated by a glance at the work in progress at the Gulf ports.

* * *

New Orleans, which few realise is an American port second only in importance to New York, is to have one of the most powerful stations in the country. It is being erected for the United Fruit Company, and forms a link in their service chain located in Swan Island, Santa Marta and San Antonio, Cuba. The stations are located about eight hundred miles apart, and have two 25-kilowatt sets installed, which can be coupled together at times when higher power is needed. The New Orleans station is about completed, and the Swan Island installation will be in operation within a few weeks, when it will become the principal relaying point of the chain, working with San Antonio, Cuba. Communication will also be had with New Orleans, which the static formerly prevented. Santa Marta, the site of the station completing the chain, is an important port for the United Fruit Company, for here are some of the largest plantations. Its station is completed and working. On the roof of the Grunewald Hotel, in New Orleans, two 125-foot towers are being erected in place of the small masts formerly employed, and a new and improved set is being installed. This station is perhaps the most important of the Gulf land stations engaged in ship-to-shore traffic, and with its new equipment will not be hampered by static disturbances.

* * *

The Post Office have recently issued a communication to all Post and Telegraph Engineers and Police Authorities, specially dealing with the use of portable wireless apparatus by unauthorised persons. In this order such officials are allowed to ask any such persons as they may see experimenting to produce their credentials, and failing these, they can forbid the further use of the apparatus. As is already known to all interested in wireless telegraphy, no amateur may equip and make use of wireless apparatus without having special authority from the Postmaster-General. The object of the provision was to protect the privacy of messages, and to prevent mischievous interference by irresponsible persons. It was never the intention of the Government to prevent any serious study of the science, but to free serious exponents from any unnecessary interference. At first it was only necessary to advise the Postmaster-General of the intention to erect a wireless station, and to fill in a form giving particulars of such installation, when an inspector would be sent to view the station and a permit for its use would be handed to the owner. Later, the number of applications became so great and entailed so great an increase in departmental work that it was found necessary to institute an initial fee of One Guinea, which was to be forwarded with the application for a private station certificate. But it soon became obvious that no provision had been made for the portable station. It was not to be supposed that anyone using such a station would carry about with him the Postmaster-General's certificate. Nevertheless, it was thought advisable, and rightly so, that there should be some hold of the Government over such persons, for they are equally capable, and perhaps more so, of using the apparatus carelessly and maliciously, and interfering with messages, especially, as might likely happen, if they were within range of manœuvres, and similar official experiments. Therefore, a ticket has been issued, which is to be forwarded to all applicants who, at the time that they register their station, inform the Postmaster-General that they have a portable wireless set and require the necessary permission to use it. They will then receive, not only their Certificate of permission, but this ticket, which they will be expected to carry with them whenever they are making use of their portable set. It is of convenient size, easily enough to slip into the waistcoat pocket, and will ensure the owner free use of the apparatus.

* * *

The reception of the Order referred to in the foregoing Note reveals a considerable amount of public uncertainty as to the Postmaster-General's right to issue regulations. It is well to point out, therefore, that by the Wireless Telegraphy Act of 1904 the Postmaster-General is vested with the control of wireless telegraphy in this country, and no person may establish a wireless station or installation without a license. The license granted, says the Act, shall contain the terms, conditions, and restrictions, and if a person establishes a wireless telegraph station, or installation, or works any apparatus for wireless telegraphy without a license, he shall be deemed guilty of misdemeanour, and be liable on conviction under the Summary Jurisdiction Acts to a penalty not exceeding £10, or, on conviction under indictment, to a fine not exceeding £100, or to imprisonment, with or without hard labour; and in either case to be liable to forfeit the apparatus which has been installed or worked without a license. If there is reason for supposing that a wireless station has been established without a license a search warrant may be obtained, authorising the police to enter and inspect, search, or seize any unauthorised apparatus. Licenses are granted for persons to conduct experiments in wireless telegraphy, subject to special terms, conditions, and restrictions, and the Postmaster-General may grant special licenses, at reduced terms, for the establishment and working of wireless telegraph stations to be used exclusively for the transmission, within the United Kingdom, of news to be published in registered newspapers. The Postmaster-General also has the power to close any wireless station at any time.

Maritime Wireless Telegraphy

TWO sensational rescues at sea have recently excited public interest. The one was that of the Johnston liner *Templemore*, which was abandoned on fire in mid-Atlantic, and the other was of the steamer *Spokane*, which was wrecked off Cape Lazo, and would have been a total loss but for the use she made of her wireless.

The *Templemore* was on a passage from Baltimore to Liverpool. She was one of Messrs. Johnston's largest liners, and was regularly engaged in trade between these two ports. She sailed from the Mersey on September 6th, and arrived at Baltimore on September 17th. After a stay of ten days at the latter port, discharging her Liverpool cargo and loading a full cargo of United States produce, she sailed from Baltimore on Saturday, September 27th, for Liverpool. On Monday evening a wireless message was received in Baltimore from the *Templemore*, stating that she was on fire in lat. 39·27 N., long. 65·27 W., and requiring immediate assistance. All the steamers in the vicinity were quickly communicated with by wireless, and early on Tuesday morning the Hamburg-America liner *Arcadia*, on a passage from Hamburg to Baltimore, reached the *Templemore*, and took off the whole of the crew who were taken on to Baltimore.

Mr. R. Emanuel Operator on the "Templemore"

Thus again has the value of wireless telegraphy been demonstrated, for had the *Templemore* not been equipped, it is possible that she would have been completely destroyed, and the danger of the crew accentuated before assistance arrived on the scene. As it is, immediately the fire was discovered to have broken out on board wireless communication was effected with the shore stations, and in this way news of the disaster was telegraphed to Liverpool, together with the information that the whole of the crew had been rescued, while the steamers which happened to be in the vicinity were apprised of the casualty, and were given the position of the *Templemore*, and requested to hurry to the spot in order to render assistance.

The *Templemore* was under the command of Captain Isaac Jones, who had been in charge of the vessel since 1910, and she carried a crew of 54 men all told. The position at which the vessel was abandoned is about 520 miles from Cape Henry. The *Templemore* was a steel screw four-masted steamer of 6,344 tons gross and 5,156 tons net, built in 1894 by Messrs. Harland and Wolff, of Belfast, and classed 100 A1 at Lloyd's. Her dimensions were 451 feet by 48 feet 3 inches by 26 feet 8 in., and she was owned by the Templemore Steamship Co., Ltd., Messrs. Wm. Johnston & Co., 18 Water Street, Liverpool.

According to Captain Jones the fire was started by spontaneous combustion in some bales of cotton amidships, and the smoke was first seen at 11.50 on Monday night. Twenty minutes later the wireless operator, Raphael Emanuel, flashed out the first signal of distress, which was picked up by the operator of the *Arcadia*, fifty-two miles away. Efforts to put out the blaze were soon abandoned, and the crew began taking to the boats. The fire quickly destroyed the dynamo operating the wireless apparatus, but, with the aid of candle-light, Emanuel got his reserve storage batteries working, and for another fifteen minutes continued to tell the *Arcadia* the exact position of the burning ship.

"My men appeared to be unmindful of the danger," said Captain Jones, "and fought the blaze until it was foolhardy to continue. Emanuel stuck to his post until the storage batteries refused to work, and he and I were the last to leave the doomed vessel. No man left the ship until he received instructions from me.

"Our experience in three small boats was the worst of all. A storm was raging, and the wind nearly upset our slender craft. By three a.m. on Tuesday, when the *Arcadia* arrived, many of the crew were sea sick and exhausted. Some were so weak that they had to be lifted out of the boats. When the *Arcadia* started towards Baltimore the *Templemore* was aflame from bow to stern."

* * *

The United States steamer *Spokane* was wrecked off Cape Lazo, on the Vancouver Coast, on Friday, September 27th. Immediately the disaster occurred she sent out a wireless message, calling for assistance and urging vessels to rush to her rescue, as she was sinking fast. Her message was immediately responded to by the *Latouche*, with the result that the passengers and crew were all taken off in safety, and not only that, but the *Spokane* herself was found to be capable of refloating, and after this was effected she proceeded for Seattle under her own steam. The *Spokane* is a well-known passenger vessel belonging to the Pacific Coast Steamship Company. She was built in 1901, and is of 2,036 tons burden. Her cargo was valued at £41,000.

* * *

This story of the saving of both life and a valuable cargo by means of wireless is in striking contrast to the story of the loss of the *Gardenia*, which was reported at the same time. The *Gardenia* was a valuable vessel of 1,800 tons burden, and was fully laden with a cargo of copper ore, of about 2,800 tons, and this, if the price of copper ore be taken at only £36, or one half the current price of pure copper, represents a value of over £100,000. As the *Gardenia* was making its way across the North Sea for Middlesbrough she came into collision during a fog with the London collier steamer *Cornwood*. On hearing the approach of a steamer, the Captain of the *Gardenia* stood off the Middle Cross Sands and sounded his syren, but the oncoming vessel struck the *Gardenia* on the starboard side, cutting five or six feet into the depth. She sank in four minutes, carrying down with her every soul on board, and of these only four were rescued—the master, one of the engineers, and two of the crew, so that eighteen lives were lost in the disaster.

Neither of the vessels was fitted with wireless, and all they could do was to attract the attention of any passing vessel by whistles. It happened that the *Valoris* of Banff was passing near and was able to save the four men. But it is possible that had a wireless call been sent out the loss of life need not have been so heavy.

* * *

While carrying out manœuvres in the North Sea, the new destroyer *Jackal* came into violent collision with the Super-Dreadnought *Thunderer*. Great damage was done to the destroyer's bow, which was holed above and below the water-line. She made water rapidly, and the situation was so serious that a wireless message was sent to Dundee, the submarine base, for all available help. Two battleships and two tugs set off to the assistance of the disabled vessel, which they found with her bows almost under water, her bulkheads serving to keep her afloat. The rescuers took the *Jackal* in tow, and the perilous voyage was successfully made.

* * *

Last month, the Dutch steamer *Willis* ran aground near Calella on the Spanish Mediterranean coast. As soon as the accident occurred the captain of the vessel reported the matter to the Marconi station at Prat de Llobregat (Barcelona), which transmitted the message to the Dutch Consul in Mataro, and, the naval authorities also having been informed, they sent out the tugs *Cataluna* and *Monserrat* with life-saving apparatus of every description on board. During this time the Prat de Llobregat station kept up continuous communication with the *Willis*, and was informed that the position of the ship was not considered such as to endanger the lives of the passengers or crew.

Administrative Notes

Newfoundland.

THE "Marconi Wireless Act, 1913" (No. 24 of 1913) which has just been issued, confirms an Agreement entered into on April 20th, 1912, between the Government of Newfoundland and the Marconi Wireless Telegraph Company of Canada, Ltd., and at the same time provides that all instruments, apparatus, supplies and stationery required and used by the Company in installing, maintaining and operating various wireless telegraph stations in Newfoundland and Labrador shall be admitted into the Colony free of duty during the term of the Agreement, viz., until April 6th, 1926. It is, however, provided that this exemption shall not be held to include provisions or household goods, furniture or supplies of any kind for the personal use of any of the Company's employees.

* * *

Gold Coast Regulations.

A BILL has been proposed which provides for the regulation of wireless telegraphy in the Gold Coast colony. The object of the Bill is to define more clearly the requirements as to the use of telegraphy by ships, and to codify the law and make it uniform with the Ordinances of other West African colonies. By section 3 of the Bill it is provided that only with regard to ships registered in the Colony is it necessary to obtain a licence before installing wireless apparatus on board them. But, by section 4, it is required that all merchant ships, whether British or foreign, shall, while in the Colonial waters, work their apparatus in accordance with the prescribed regulations. It is proposed to repeal the Wireless Telegraphy Ordinances of 1903 and 1913.

* * *

The United States & the Convention.

THE Minister of Marine of the United States of America has notified to the Berne Bureau that the following information is to be published:

1. The Departments of the United States Government which are concerned with wireless telegraphy regret that they have not yet been able to make arrangements with the land telegraph of the United States owing to the fact that these are in the hands of commercial companies, and have nothing to do with the Government. The idea was to arrange for the free transmission over the land telegraph, in accordance with Article 14, paragraph 2, of the Rules of Service of the London Convention. The information to be transmitted free of charge was all such as related to the date and the hour of the handing in of radio-telegrams on board ship. But the transmission of such information over land lines being subject to a tax, the Goverument of the United States cannot, at present, conform strictly to this rule of the Convention. The declaration of the American delegation contained in Article 2 of the Final Protocol made provision for such a possible outcome, although its exact nature was not actually set forth.

2. Multiple radio-telegrams, such as are mentioned in Article 38, paragraph 5, of the Rules of Service, will be accepted as multiple messages in all wireless transmission between ship and shore stations, but all the companies operating land telegraph lines in the United States will consider, and will charge for a multiple wireless message as consisting of so many individual telegrams, as the addresses it bears may indicate.

3. The United States is not a member of the International Telegraphic Union, and consequently is not bound to execute the rules laid down in Article 38, paragraph 8, of the London Convention Rules of Service concerning urgent radio-telegrams. The laws of the United States regulating all reciprocal arrangements between the States forbid the use of the privilege, and consequently all telegraph companies will not allow any priority in favour of telegrams for which an additional tax may have been paid.

* * *

MAKING use of the faculties allowed in Article 16, paragraph 1, of the Radiotelegraphic Rules, the American Administration has authorised certain shore stations to charge any taxes above the maximum of 60 centimes.

Contract News

La Société Anonyme de Telegraphie sans Fil have received orders to equip three cargo vessels, the *Zaire*, the *Bolama* and the *Ambaca*, with half-kilowatt and emergency gear. They are also installing a 1½ kilowatt set for a whaling factory at Hull.

* * *

The Compañia Nacional de Telegrafia Sin Hilos have received orders to equip two battleships for the Spanish Government, one with a 15 kw. set, the other with a 5 kw. set. They are also erecting a 1½ kw. set for the *Escuela de Applicacion*.

* * *

The Marconi Wireless Telegraph Company of Canada are installing ½ kw. sets on the steamers *Montcalm*, *Lady Grey*, *Druid* and *Simcoe* for the Canadian Government. They are also fitting wireless on the lightship *Lurcher*, while the *Princess Maquinna*, a steamship engaged on West Coast service in connection with the Canadian Pacific Railway, which has recently been fitted with a 1½ kw. installation, has been allotted the call letters V G T.

* * *

The Royal Mail Steam Packet Company are having their liner, the *Pembrokeshire*, fitted with a 1½ kw. Marconi set.

* * *

The Spanish Government have purchased another 5 kw. and emergency set from the Compañia Nacional de Telegrafia Sin Hilos.

* * *

A ½ kw. and emergency set has been purchased from Marconi's Wireless Telegraph Company by Mr. M. Fitzgerald, who intends using it for instructional purposes.

The following Vessels have been equipped with Marconi Apparatus since the last issue of the *Wireless World*.

Name.	Owners.	Installation.	Call Letters.
Swanmore	Johnston Line	1½ kw. and emergency	MAE
San Dunstano	Eagle Oil Transport Co.	,,	MAN
San Tirso	,, ,, ,, ...	,,	MAO
San Urbano	,, ,, ,, ...	,,	MCC
Invertay	Law, Leslie & Co.	,,	MAT
Botanist	Harrison Line	,,	MAP
Musician	,, ,, ...	,,	MAD
Ludwig Weiner	Union of South Africa	,,	—
Snaefell	Isle of Man Steam Packet Co.	,,	MCS
Ulysses	Alfred Holt & Co.	,,	GBU
Maryland	Atlantic Transport Line	,,	MBW
Llandovery Castle...	Union Castle Steamship Co.	,,	MCO
Desabla	Andrew Weir & Co.	,,	GYV
Toronto	Wilson Line	,,	GBS
Salmo	,, ,, ...	,,	GYI
Charles E. Harwood	Petroleum Carriers, Ltd.	½ kw. and emergency	GYU
Brighton	L.B. & S.C. Railway	,,	MOV
Dieppe	,, ,, ,, ...	,,	MRL
Den of Airlie	Charles Barrie & Sons	,,	GBK
Cyclops	John Fullerton & Co.	,,	—
Matoppo	Bucknall Steamship Line...	,,	MAM
Kasama	,, ,, ...	,,	GBP
Bloemfontein	,, ,, ...	,,	GBN

A Pawn in the Game

(Serial Story)

By BERNARD C. WHITE

CHARACTERS IN THE STORY.

CHARLES SUMMERS.—*Inventor and engineer. Son of the Vicar of Sotheby, and affianced to Gwen Thrale, daughter of the squire. His most recent invention is an airship worked by wireless, which is likely to revolutionise aerial warfare. Negotiations are proceeding with the War Office for its purchase from the inventor.*

GWEN THRALE.—*Charles Summers' fiancée, a bright, intelligent and original girl, the idolised daughter of the squire, and secretly a member of a Fabian Society. She coaxes Summers to teach her "wireless," and soon becomes a proficient operator and a bit of an engineer.*

DOSS AND SUK.—*Pedlars, for ever on the prowl, and the universally recognised purveyors of village gossip. They are discovered and "tapped" by——*

M. DUPONT AND HERR BEULNER.—*Foreigners, making a prolonged visit to England. Ostensibly they belong to the leisured and wealthy class; but in reality they are secret agents for a foreign Government sent over to England for the purpose of securing military or naval secrets. Their attention is directed to Summers' work, and they determine to get possession of the airship's plans.*

CHAPTER VII. (*contd.*).

APPARENTLY the person in question was walking away, for she slightly shifted her position as if she were anxious to obtain a last glimpse; then, she suddenly made up her mind to speak to this acquaintance, for she reached out quickly for her gloves, put down the money for her bill, and with a swiftness which caused even the sleepy-eyed attendant to wonder, passed downstairs and out into the street.

She did not wait to fetch her dog or to take her carriage. She walked quickly along the pavement in a desperate effort to catch her friend up, but he seemed to be unaware of her presence. He simply stopped to post a packet in the pillar-box just outside Westminster Cathedral, and then he made his way to Victoria Station. He had not much time to spare, for as he hurried along he looked at his watch. It was nearly two o'clock. He broke into a brisk trot, which left his follower far behind; but, for her part, the race had already lost its interest and she gave it up. Summers had disposed of his postal packet, and this was all she cared about. By a strange coincidence, however, his action of posting his long blue envelope had reminded her that she too had a letter to post, for she immediately produced one from her reticule and put it in the box. First of all she looked to see when the next post was collected. The little tin plate indicated 2.15. She seemed to have no time to lose, for she hurriedly beckoned her carriage, and without remembering to take her dog, drove away. Her coachman took her down some side streets which led out into Victoria Road. There she found the little horsey man waiting her as if by appointment, for the carriage stopped immediately, and he took his place beside her. They held a short but earnest conversation, the result of which was that the man went back again to the A.B.C. and the woman disappeared into one of the unprepossessing looking houses which are the outstanding feature of this *démodé* thoroughfare. Scarcely a quarter of an hour had elapsed before out of the same house came a neatly-dressed young lady in coat and skirt, with high brown boots and a general businesslike air. She bustled along with short, quick steps which would have been long had it not been for the narrow walking skirt. She, too, carried a reticule, and also a brief envelope containing what must have been a bundle of papers, for it looked fat and heavy. Quickly she made her way through the side streets to Westminster Cathedral, and then crossing the road went to the same pillar-box that Summers had previously visited. In it she thrust her envelope, but the package was almost too large for the aperture and she had to crush and squash it. It seemed to give way suddenly, as though something had broken within it, and when at last she succeeded in squeezing it into the box she ruefully looked at her gloves, which bore great corrosive stains. Hurriedly she took them off, stuck them in her hand bag, and walked away. It was well she did so, for a sickly smell attracted the attention of the passers-by to a dark fluid which issued from the bottom of the box, and spread in a thick stream over the pavement. An enterprising messenger boy ran up to the nearest policeman, who seized his note-book and made various hieroglyphics therein. Then he told the boy to call his colleague of the neighbouring beat, and by-and-bye the second custodian of the law appeared. By this time quite a little crowd had collected, and word was passed between them with a flutter of excitement that suffragettes had been at their pranks again. One of the most interested of the onlookers was the short horsey man, who seemed only too glad of this mild excitement to while away an idle half hour. He waited till the postman came up, and the letters were collected. He was so curious that he forced his way through the street urchins, who had managed to get in front of everybody else, and watched operations so closely that he positively hung over the postman's shoulder until one of the policemen motioned him back, and told him not to get so near. This seemed to disgust him, for he walked away in a surly mood. Still his ill-humour did not last long, for by the time he had reached Victoria Road he was all smiles. Eventually he entered the house inhabited by the young suffragette who had returned only a few minutes before. He must have been another member of this strange household, for he used a latch key, and slamming the door behind him, he quickly made his way up the narrow, creaky stairs, where the well-worn linoleum did little to diminish the sound of his quick footsteps and the gaudily papered walls only emphasised his unequal breathing. Without any preliminary he made his way into the bedroom, and there he found the young lady of the walking costume. But it was a curious spectacle which met his eyes. The young lady was undressing. She had already divested herself of her outer garments, and was standing in her high-heeled boots with brown stockings, short white pants, corsets, and an untidy mass of short fair hair. She was busy at the looking-glass trying to affix on her upper lip a fair moustache, and when she saw Dupont she gave a loud, manly laugh.

"I'm thankful to get off these beastly things," she groaned, as she proceeded to squeeze herself in to undo the stay busks, and then with an exclamation at their discomfort she tossed them on to the bed.

"Eh, *mein freund*, think you not I make a most excellent fraulein? A fraulein suffragette? But we must get rid of this property. There's no knowing who may have seen us come in here. I think the best thing is a bonfire. You've got some turpentine. Don't you think we had better set to and destroy them now?"

"*Non, non,*" said Dupont, "*Nous ne sommes pas encore échappe le bois.* We must to the Post Office to claim our poor spoilt letter. We must not let the war devils take it from us. Let us go now, now at once, for we can say that we have heard how much the letters are spoilt. They will believe us, and it is best that they should not have time to think at all about it. We must get it this evening, for if we don't, then we shall have a thousand and one questions to answer, and papers, papers, papers to sign, and silly old gentlemen to see. So, come along, change as quickly as you can into the English gentleman and I will get rid of these ugly clothes and make myself somebody else."

With these words Dupont pulled a trunk from under the bed, and hauling off his queer garments he changed himself into a most curious specimen of the learned class. Imagine a professor with something of a stoop, a straggly beard, thick gold rim glasses, a shabby Inverness, and an equally shabby green hard felt hat, and you will have a fair idea of Dupont in his latest disguise. But when he put on a pair of very weatherworn and ill-fitting gloves and tucked an equally weather-worn walking stick under his arm, he looked the part of a seedy professor to perfection.

Negotiations with the Post Office were a matter of some difficulty. One thing was certain, however—the letter was sufficiently damaged for the address to be undecipherable. Dupont had made himself certain as to this when he leaned over the postman who had collected the letters. Nevertheless, there was no knowing what questions might be asked by the authorities, and although Dupont might be able to answer all the chief facts of the case, there were many minor points and details, which, if they were unlucky, might prove their downfall. Moreover, Dupont,on account of his unsatisfactory English, was obliged to leave the matter entirely in Beulner's hands. The German was a very good accomplice, but he had not the clear wit of the Frenchman, and was more easily thrown off his guard. Speed in this case was everything, and therefore when a sufficient time had elapsed to make it probable that the damaged post-bag would be in the hands of the chief authorities, Beulner and Dupont made their way to King Edward Street. Beulner had been well coached up in the part he was about to play, and he and Dupont hurried into the building. As chief spokesman, and presumably an Englishman, he was dressed something after Summers's style —grey suit, a grey squash hat, and a bundle of papers in his hand, besides a bulky pocket-book in his dress pocket. The elaborate Frenchman was not to be recognised in the transformed Dupont. He had assumed a droop of the shoulders which made him look inches shorter and this effect was accentuated by his shabby Inverness cape, and it would have required a very astute observer to have penetrated his disguise. The two men invaded the Central Post Office, showing all the signs of suppressed excitement. They asked to see the official who looked after the damaged correspondence. A red-coated commissionaire invited them into the interior of the vast building, and they were taken along corridors, up lifts, and through various ways to the apartments where a morose-looking, sleepy gentleman was busy at a huge mahogany desk, looking over varieties of papers done up in bundles with the usual red tape embellishment. Beulner immediately explained the object of their visit. He spoke volubly and quickly, really much too quickly for his hearer, whose mental activity had long since been lulled to repose by the quiet of office, and who had to exert his intelligence in a most unwonted degree in order to make out their purpose. As to the excitement of these strangers, he put it down to their anxiety for the safety of their document. Beulner explained to him that he had only just posted his letter when the outrage had occurred, so that it had inevitably been damaged. It was a most important affair. There must be no delay, and he had promised the War Office to bring them the document as soon as it was recovered. Therefore he would be glad of the officials' assistance in the matter. Could he manage to get hold of the letter? It was written on a similar paper to this, and here Beulner produced the specimens taken by Dupont from Charles's den. In an off-hand way Beulner added the general import of the missive and an outlined description of the airship. Now and then he turned to Dupont for corroboration of his statements, and it is needless to say that the "scientist" supported him in everything. For some time the official was disinclined to take any steps in the matter. The letter, he explained, would be returned in due course as damaged, but Beulner pointed out that this was a particular letter of great importance and a Government document. He offered to ring up the authorities to support his case, and mentioned names high up in Parliament, hinting that if the matter could not be cleared up now he would approach the Postmaster-General through his friend, "——," and here he named a Cabinet Minister. This had an effect on the staid servant of the Post Office. He was not anxious to have his name mixed up in an affair of discourtesy. He saw vistas of a long and unpleasant inquiry when he would be bothered to distraction, and his orderly soul revolted against such a strain, so that in the end he took the path of least resistance and summoned an attendant.

"Was Mr. So-and-So in?"

He was.

"Could he see him for a moment?"

The answer came back that he could, and the three men paraded through further corridors to another similar in orderly detail to the one they had just left, where sat in state a benign and courteous personage, with hands carefully manicured, and his fair hair smoothed carefully over his high head in a skilful effort to conceal a premature baldness. He listened to the evidence of his subordinate, and then meditated a considerable time, rising and pacing the room with his hands neatly folded behind his back. Now and then he looked down into the courtyard below, and seemed to study intently the coming and going of the Post Office vans. Once or twice he put forward a question not very difficult to answer, but sufficient to keep Dupont and Beulner on the rack of excitement. But now the hour of tea was approaching. He noted this by the watch on his wrist, and the fact urged him to decisive action. He ordered the post bag in question to be brought in to him. Another subordinate was called in to witness the cutting of the seals, and finally the letters were spread out on the broad table. The damage was fairly extensive. Many of them had their envelopes practically destroyed by the corrosive fluid. The long blue envelope which Beulner and Dupont instantaneously spotted and remarked upon was eaten almost in two by the chemicals. Still, when it was opened there was not much damage found to have reached the document itself. One or two holes in places, and one stream across the front page, that was all. The rest of it was easily decipherable. After satisfying himself as to its contents, and verifying the letter accompanying it with the notepaper Beulner had handed him, the official passed it to the claimants. These were asked to sign a receipt for its delivery to themselves in person, a request which they immediately and willingly complied with. Then with a word of thanks the two were ushered out by an attendant, and made their way once more through the intricacies of corridors till they at last found themselves in the street. The success of their mission now practically assured, the two accomplices felt a keen desire to execute a triumphant war dance then and there, but neither dared so much as breathe freely, lest their action might arouse even passing comment. Instead they walked quickly to Newgate Street, where they hailed a taxi and drove to Charing Cross Station. Arrived there, they claimed some luggage from the booking office, and, brandishing Cook's Tourists' tickets, took the five o'clock train for Boulogne. Their work was over. They had secured a document of infinite price to their Government, and they were not likely to return to wander up and down Victoria Street or rusticate in Sotheby again, at least not as Monsieur Dupont and Herr Beulner.

CHAPTER VIII.

On the Horns of a Dilemma.

Charles was all this time blissfully unconscious of these happenings. His few days' holiday were not disturbed by cares of any kind. He was one of those fortunate individuals who, as soon as he had finished his business, could throw off his preoccupation and enter whole-heartedly into his pleasures. It was only on his return to Sotheby that he received the first intimation that all was not well. Awaiting him was an official-looking document from the Post Office. In it he was informed that his specification was awaited with anxiety, and that Lord —— would be glad if he could forward it at his earliest convenience. Immediately Charles replied, stating that the document they referred to had been posted several days before, and he would be glad if they would make inquiries as to its reception or not. On this a reply came back that the letter had never been received, and inquiries were being instituted at the Post Office. Needless to say, by this time Charles was greatly perturbed. The Dupont incident had rankled in his mind, and he felt that the present delay was not entirely due to accident. There was no reason why the letter should not be found before long, but the question was—where was it at the present moment? Charles thought to himself that these foreigners could possibly answer this question, but as it was impossible to get at them, he determined to acquaint the authorities with his suspicions. Forthwith he journeyed to the War Office, and his card was sufficient to gain him an interview with the Under-Secretary. The Under-Secretary was a keen, intellectual, hard-mouthed man, one who was not likely to let things slip. As soon as Charles had explained the object of his visit, he rang a small electric bell, and an attendant appeared. He might have been an aide-de-camp. Young, well built, fair haired, with striking black eyes, smooth skin, dark eyebrows, and a little dark moustache over weak but full-blooded lips, he, too, was certainly alert and intelligent, for in a twinkling his lively glance had taken thorough stock of Charles from the tip of that worthy's travel-stained boots to his unkempt locks. But he betrayed by no sign that he had even observed the visitor, only showing a soldierly obedience to his superior and waiting for his instructions with as much immobility as any sergeant to any colonel.

"Braithwaite," said Sir Henry Dever, "this gentleman is making inquiries with regard to a specification which he posted here more than a week ago. Let me see"—and here he interrogated Charles—"July the twenty-third, wasn't it, to be exact?" It seems that the letter has gone astray. Make inquiries at the Post Office."

"By the way," he said, turning to Charles, "can you tell me where you posted it? It might be of help to the officials."

"Yes," said Summers, "it was at that post office nearly opposite Westminster Cathedral, at the turning down Victoria Street, and the time I posted it was about one o'clock, for I caught the one-thirty to Louth."

"Sir," said Braithwaite, "if I remember rightly, that was one of the pillar boxes raided by the suffragettes. There was a report in the paper of it which I remember to have read."

"Are you sure?" said Sir Henry, interrupting him.

"Yes, Sir Henry, I am practically certain, but I will verify my statement if you wish."

"You had better make absolutely sure before we get any further. Come back again as quickly as possible. This matter has got to be settled at once."

Braithwaite retired, and Sir Henry turned to Summers. "If you don't mind waiting I think it would be best for you to stay here till Braithwaite returns. He won't be very long; but it looks to me as though this business will take a lot of clearing up. It's odd, if what my assistant says is true, that the very post box in which you posted your letter should have been attacked."

With that he turned to some correspondence at his elbow, and Summers was left to while away the long tedium as best he could. When the young subordinate reappeared he brought no very definite news. What he had previously intimated was true—the pillar box had been tampered with, presumably by a suffragette—a woman, at all events—who had dropped some corrosive fluid through the opening. The police had been warned almost directly the incident had taken place, and a special postman had been dispatched to take charge of the letters. He had been told that these letters were sent straight to the authorities at the post office, and he had made inquiries there. He had found out that most of the letters had been forwarded to the respective consignees, a few had been too badly damaged to be decipherable, and one or two had been called for. A search through the remaining letters showed no such document as Summers had described, but the head of the department had informed him that on the afternoon of the outrage two men had called, and taken away such an envelope as was wanted. He had been shown the receipt for it, which gave the address of the consignee as Sotheby Vicarage, and according to this receipt it had been handed over to the writer himself—Charles Summers. Ownership, so the official had assured him in reply to his inquiries, had been established, not only by private cards, but by specimens of the paper used and by the seal used for the letter. Furthermore, the recipients had given an accurate and general detailed account of the subject of the specification. Charles leaned back with a low whistle.

"The deuce!" he exclaimed. "There's no doubt about it. That's my letter. Those foreigners have got hold of it. They must have watched me all the time. I expect by now they are out of England. Here's a pretty kettle of fish."

CHAPTER IX.

A Strategic Move.

Dumbfounded though he was by the discovery, Charles could not realise how great the loss was that he had suffered. As a matter of fact, his temperament was such that the whole force of the circumstances and their consequences would never strike home to him. He was one of those philosophical and impracticable people who are always living in a world outside everyday circumstances, building phantom cities and constructing great engineering feats with only dreams for substance from plans mapped only in the imagination.

(*To be continued.*)

INSTRUCTION IN WIRELESS TELEGRAPHY

Wireless Telegraph Receivers

(Seventh Article.)

[The first article of this series appeared in the May number of THE WIRELESS WORLD, in which number there also appeared particulars of the examinations to be held when the course is completed, and full details of the prizes offered by the Marconi Company to successful candidates. A further announcement appeared on page 461 of the October number].

THE word receiver is usually applied to that part of the apparatus of a wireless telegraph station by means of which the electric waves which are picked up by the aerial are sorted out and converted into some audible or visible sign.

The aerial, however, is just as much a part of the receiver as it is a part of the transmitter, and must be in tune with the waves it is receiving, just as the transmitting aerial must be in tune with the waves it is radiating.

We have just said that the aerial "picks up" the electric waves, but this is not strictly accurate. When electric waves travelling through the ether pass across a conductor, they produce oscillatory currents in that conductor, and these oscillatory currents will have the same frequency as the waves which produce them.

By means of an aerial wire, therefore, we can convert the electric waves which are being radiated from a transmitting station into oscillatory currents, and we have only to detect the presence of these currents to enable us to "read" the message which is being transmitted.

51. **Essentials of a Receiver.**—We have already explained that an aerial forms an "open" oscillating circuit and has a natural time period of its own. We have also shown that an oscillatory current will not flow easily in a circuit unless the natural time period of that circuit is the same as that of the oscillatory current—that is to say, in this case the aerial circuit must be in tune with the wave which is to be received.

The first essential of a receiver, therefore, is a variable inductance and a variable condenser, which can be connected in series with the aerial by means of which the latter can be tuned to the desired wave-length.

Fig. 1 illustrates these connections where A and E are the aerial and earth terminals of the receiver, I the inductance, more or less of which can be included in the aerial circuit, by means of the switch, S_1, and C the variable condenser across which is fitted a short circuiting switch, S_2.

The inductance, I, is called the "**Aerial tuning inductance,**" and the condenser, C, the "**Aerial tuning condenser.**"

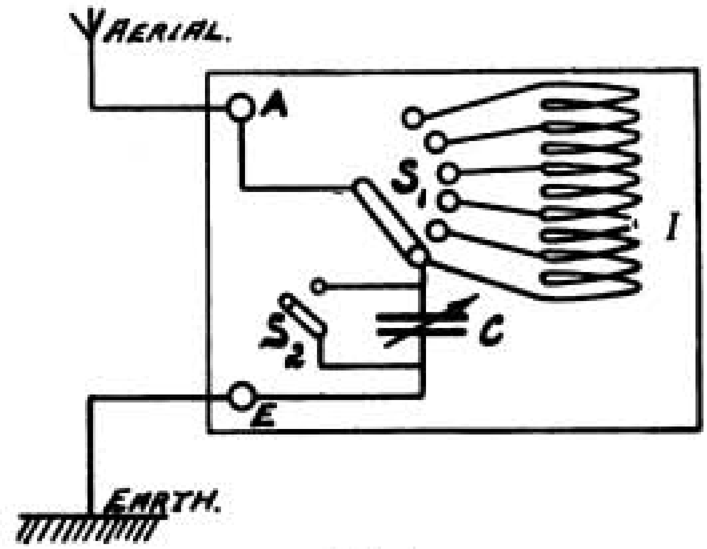


Fig. 1

We know that by placing a condenser in series with the aerial we reduce the wave-length of the aerial, and by placing an inductance in series with the aerial we increase the wave-length of the aerial. If, therefore, the wave-length which it is required to receive is shorter than the natural or "fundamental" wave-length of the aerial, we must cut out all the inductance in the circuit by means of the switch, S_1, and we must reduce the value of the adjustable condenser, C, until the correct wave-length is obtained. The switch, S_2, will in this case be open, as shown in the diagram (Fig. 1).

If, on the other hand, the wave-length which it is desired to receive is longer than the fundamental wave-length of the aerial, in order to bring the wave-length of the aerial into tune, we must first short circuit the condenser, C, by means of the switch, S_2, thus leaving no capacity in series with the aerial, and we must increase the inductance in the circuit by means of the switch, S_1, until the correct wave-length is obtained.

The next essential of the receiver is some device whereby the presence of the oscillatory current can be detected.

52. **Methods of Detecting the Oscillatory Currents.**—In the article which appeared in the October number of THE WIRELESS WORLD we showed how this could be done, in the case of a wave-meter, by placing across the condenser of the oscillatory circuit a pair of telephones in series with a crystal. The telephones in series with a crystal constitute a detector. This method can be adopted in the receiver by placing the detector across the aerial tuning condenser, but it is not an efficient method for the following reason.

The aerial tuning condenser forms only a part of the capacity of the whole aerial circuit, so that although the detector may be extremely sensitive it is not being used to the best advantage.

Another method is to apply the detector across the aerial tuning inductance, but this method has also the same disadvantage—viz., that we are only applying the detector

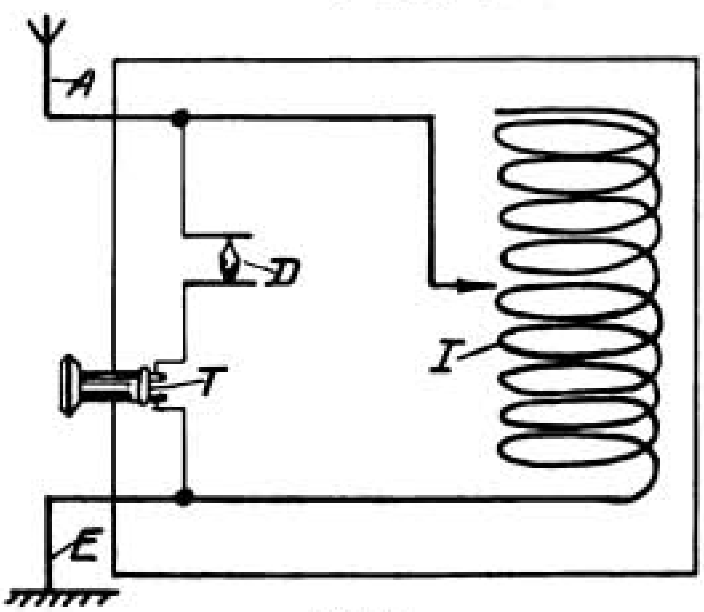


Fig. 2

to a portion of the whole inductance of the aerial circuit.

If, however, we are receiving a wave very much longer than the natural wave-length of the aerial, in order to tune up the latter we naturally have to use a large amount of inductance, and if this inductance forms (as it may easily do) the greater part of the inductance of the whole aerial circuit we may quite efficiently apply the detector across the inductance. This makes one of the simplest and cheapest forms of wireless telegraph receivers and is shown diagrammatically in Fig. 2, where A is the aerial, I the variable tuning inductance, E the earth, D the crystal, and T the telephones.

Most of the amateur stations, more especially those in towns, have very small aerials for obvious reasons, and as they are chiefly used for "picking up" signals from stations using long wave-lengths, this form of receiver is particularly appropriate. With such short aerials even the waves transmitted from ship stations are sufficiently long to necessitate the use of a comparatively large inductance in series with the aerial, so that the receiver may also be used fairly efficiently for receiving signals from ships.

53. **Use of the Battery and Potentiometer.**—Some crystals, such as carborundum, become more sensitive to minute currents when a slight initial voltage is applied across them. This voltage must be regulated exactly to suit the particular crystal which is being used, and this regulation is accomplished by means of a potentiometer.

A potentiometer, shown in Fig. 3, consists of a resistance coil, R, connected across a battery, Q, and provided with a sliding contact, S, by means of which a lead can be connected to any point along the resistance.

The resistance of the coil should be kept sufficiently high, so that the current passing through it from the battery is not sufficient to discharge the battery rapidly. Too high a resistance becomes impracticable, as either the resistance wire with which the coil is wound would have to be so fine that it would easily become broken or cut, or the resistance coil would have to be of such a length that it would not be convenient on account of its size. In practice suitable resistance coils can be wound having a resistance of about 200 ohms, and this connected across a battery of 4 volts will only allow about $\frac{1}{80}$th of an ampère to pass through it, so that a battery consisting of three Q size dry cells would be sufficient to maintain its voltage for many weeks with continuous working.

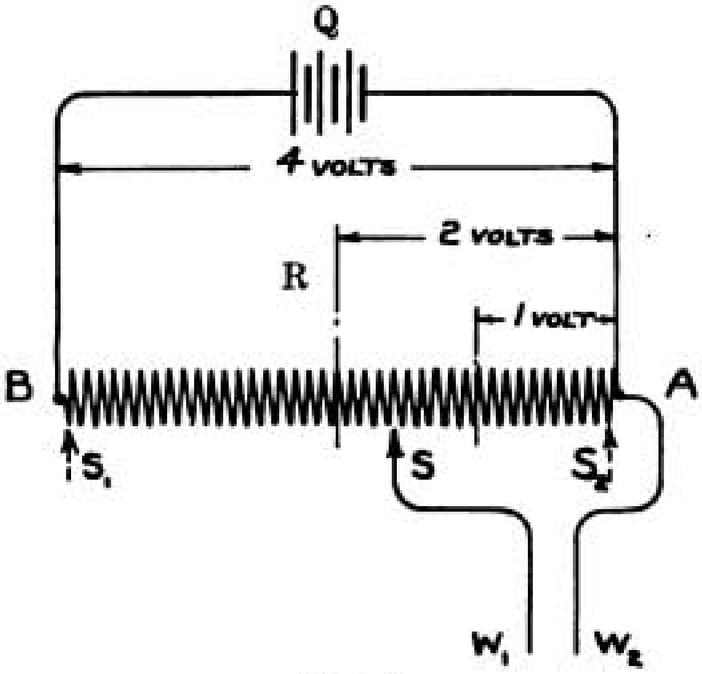


Fig. 3

On referring to the diagram (Fig. 3), and assuming that the voltage of the battery is 4 volts, we have a difference in potential between the two ends of the resistance coil, A and B, of 4 volts; therefore, if we connect a wire, W_1, to A, and another wire, W_2, to the sliding contact, S, and move the latter to the far end of the coil shown in dotted lines and marked S_1, the voltage between the two wires will be 4 volts. If, however, we slide the contact nearer towards the end of the coil marked A, the voltage between the two wires diminishes until the voltage becomes zero, when the slider occupies the position S_2. It is obvious that the voltage across the two wires will be in proportion to the distance the sliding contact is from the point A, and that by moving the slider to any point between the two extreme ends of the resistance we can regulate the voltage between the two wires to any intermediate value between 0 and 4 volts.

With most carborundum crystals the voltage which should be applied across them to bring them to their most sensitive state is somewhere between 2½ and 3½ volts, so that by applying this potentiometer to our crystal we have a simple means of bringing the latter to its most sensitive state.

54.—Method of Applying the Potentiometer to the Crystal.—The method of applying the voltage obtained from the potentiometer to the crystal is not as straightforward as it might at first appear to be. The most obvious way of doing it is shown in Fig. 4, where the two wires from the potentiometer are connected one to either side of the crystal. But it will be immediately seen that this entirely neutralises the value of our crystal as a rectifier, for the oscillatory currents, instead of trying to pass through the crystal to the telephones, thus becoming rectified into uni-directional currents, will pass through the resistance of the potentiometer to the telephones.

It is obvious, therefore, that we must devise some means of applying the voltage to the crystal without making a bye-pass for the oscillatory currents induced in the inductance coil.

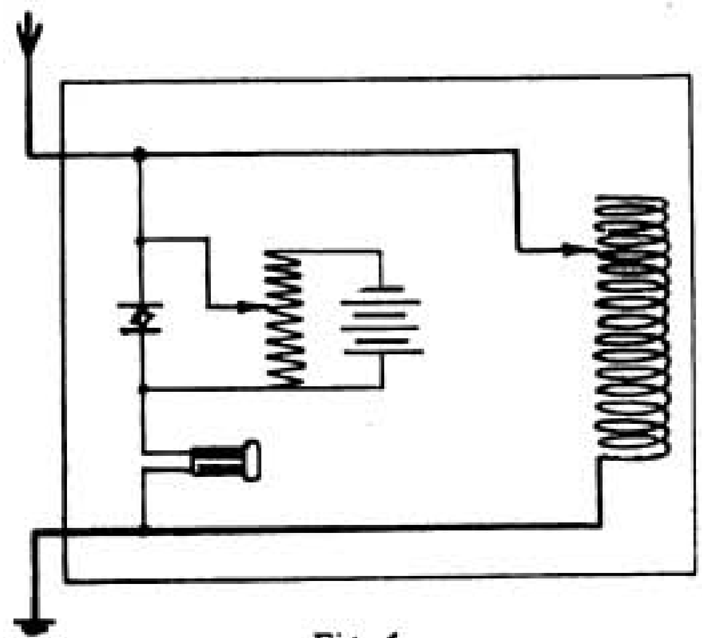


Fig. 4

This can be accomplished by connecting up the circuit as shown in Fig. 5, where the junction of the battery and the resistance coil is connected to the earth side of the crystal. One side of the telephones is then connected to the earth terminal, and the other side to the sliding contact of the potentiometer.

Assuming that the common junction of the battery, resistance coil and crystal, J, Fig. 5, is the negative side of the battery, the sliding contact, S, is the positive, and this positive E.M.F. is conducted to the other side of the crystal through the telephones and through the aerial inductance, as indicated by the arrows.

Thus it will be seen that we have accomplished what we desired—*i.e.*, to apply an adjustable voltage across the crystal without forming any short cut for the oscillatory currents, which must therefore pass through the crystal and there be rectified before they reach the telephones.

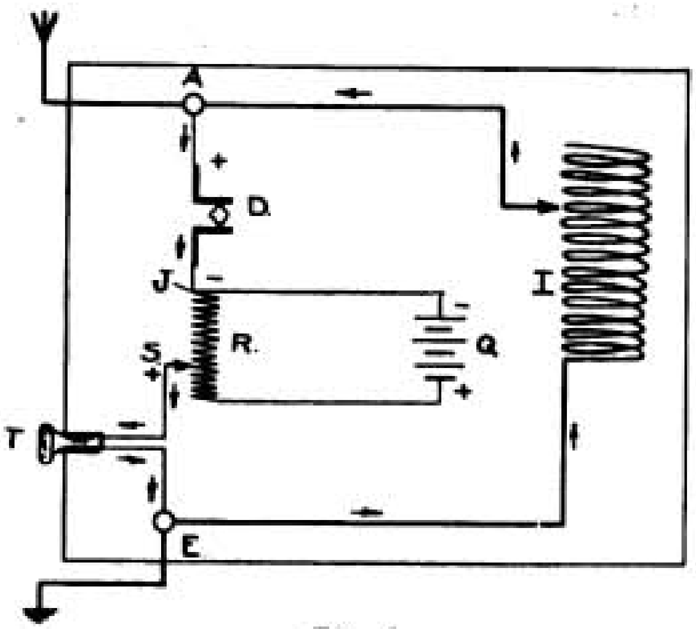


Fig. 5

55. **The Two-Circuit Receiver.** — As already explained, the single circuit receiver just described is quite efficient for stations that are receiving comparatively long wave-lengths on short aerials, but it would be obviously useless for stations which might be required to receive messages on wave-lengths as short or shorter than the fundamental wave-length of the aerial.

If we can cause all the energy in our aerial circuit to be transferred to a secondary circuit and apply our detector across the whole of the inductance or capacity of this secondary circuit, it is obvious that the size of the aerial will not limit us as to the value of the wave-length for which such a receiver can be efficiently used.

56. **The Primary and Secondary Circuits.** —Such a receiver will have two distinct oscillating circuits, both of which must be in tune with the wave-length which it is desired to receive. These two circuits are called respectively the primary circuit and the secondary circuit.

The primary circuit will consist of an aerial, an adjustable inductance, and an adjustable condenser for tuning up the circuit, and a primary coil, by means of which the oscillations can be induced into the secondary circuit, thus transferring the energy from the primary to the secondary circuit.

The secondary circuit will consist of an inductance coil with a variable condenser connected across it, by means of which the wave-length of this circuit can be adjusted so as to be in tune with the primary circuit and at the same time with the wave-length which it is desired to receive.

The inductance coil of this secondary circuit must be so placed relatively to the primary coil that the oscillatory currents occurring in the latter will induce similar oscillations in the former: that is to say, the axes of the two coils must be in line with one another, and the two coils must be sufficiently close together.

These circuits are shown diagrammatically in Fig. 6, where A is the aerial, I the aerial tuning inductance, C the aerial tuning condenser, P the primary coil, and E the earth, forming the primary oscillating circuit. The secondary oscillating circuit is formed by S, the secondary coil, and B, the secondary tuning condenser; the common axis of the primary coil and the secondary coil is indicated by the dotted line XY. The method of applying the potentiometer to the crystal in this case is shown in Fig. 7.

By applying our detector, as shown in the diagram, across the secondary inductance coil, we shall be applying it in the most efficient manner possible, since no matter to what wave-length the secondary circuit is adjusted the detector will be applied to the whole of the inductance in that circuit.

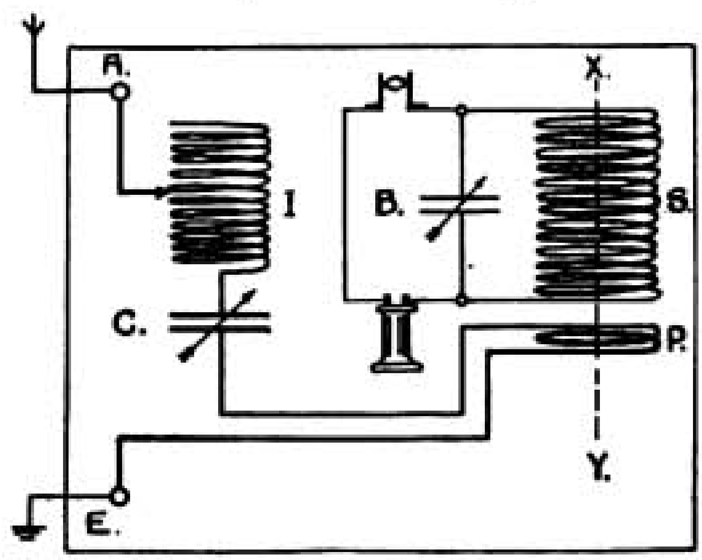


Fig. 6

57. **Proportion of Inductance and Capacity in Secondary Oscillating Circuit.**—

Another point, however, which we have not yet touched upon, affecting the efficiency of the crystal detector, is the proportion of the inductance to the capacity of the oscillating circuit to which the detector is applied. In addition to the fact that to obtain maximum efficiency it is necessary that the detector be connected across the whole of the inductance, it is found in practice that the greater the inductance of that circuit compared with its capacity, the more efficient will the crystal become.

The reason for this will be explained in the next article, but for the time being we must take it as a fact and develop our receiver accordingly.

At first sight it would appear that there is no limit to the amount by which we can increase the inductance of the secondary coil, S, so long as we reduce the capacity of the condenser, B, in proportion. This, however, is not the case, for by increasing the number of turns on the inductance, S, we not only increase the inductance of the circuit, but also the capacity.

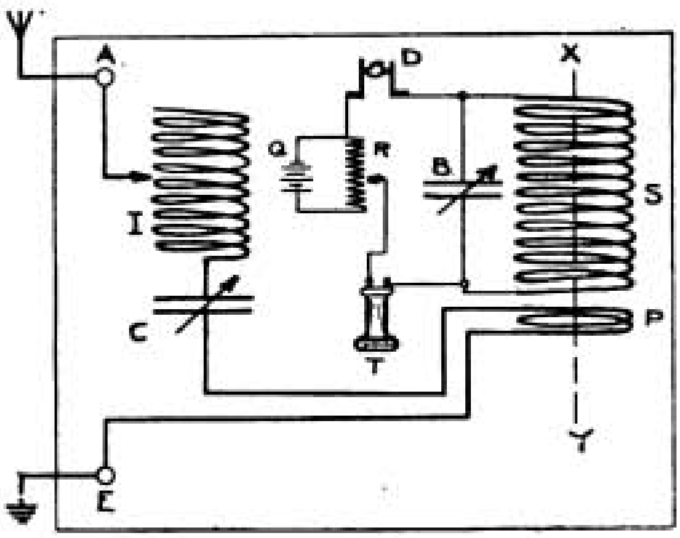


Fig. 7

Up to the present we have regarded coils of wire as having only the quality of inductance. As a matter of fact, however, every coil of wire has self-capacity, and for this reason it is found that every coil of wire, even without a condenser connected across it, forms an open oscillating circuit and has all the essentials of an oscillating circuit—that is to say, the two qualities of inductance and capacity. This self capacity then immediately limits the amount of inductance we can use, for in increasing the inductance we cannot avoid increasing also the capacity of the circuit.

The most efficient coil that we can design for the secondary circuit of the crystal receiver is therefore one whose wave-length by itself will be the required value without the addition of any extra capacity. Our adjustable condenser, however, is necessary in order to enable us to increase the wave-length of the secondary circuit, but again we are limited to the extent to which we can vary it by the fact that as we increase the capacity across the inductance so do we decrease the efficiency of our detector when applied to that circuit. (*See paragraph* 57.)

In practice it is found that without materially affecting the efficiency of the detector we can connect a sufficiently large capacity across the inductance to increase its wave-length to about two and a half times its original wave-length. If we go beyond this point the reduction in the efficiency of the detector becomes noticeable.

We may say then that with a two-circuit receiver in which a crystal is used as a detector, **the maximum efficiency is obtained when the capacity across the secondary condenser is reduced to zero.** Further, we may say that **the maximum wave-length to which it can be efficiently tuned will be about two and a half times the value of its minimum wave-length.** Thus, if the shortest wave-length which a station is required to receive is 300 metres, the receiver will be designed so that the minimum wave-length to which it can be adjusted will be 300 metres, and its maximum wave-length will then be about 750 metres.

Where longer ranges of wave-length than these are required, special arrangements have to be made by which the secondary inductance coil can be changed; thus if a receiver is required to receive wave-lengths of any value between 300 and 1,500 metres, it will have two secondary inductance coils, one of which will allow the receiver to be tuned up from 300 to 750 metres and the other from say 600 to 1,500 metres.

Share Market.

LONDON, *October* 21, 1913

The prices of the various Marconi issues show little change, and are as follows.—Ordinary $1\frac{3}{8}$, Preference $\frac{1}{8}$, Canadian 9/6, Spanish $\frac{9}{16}$, American $1\frac{1}{8}$. Rights on New Shares, 1/1½.

Practical Hints for Amateurs

Home Made Long-Distance Apparatus

By "A. TINKER"

THE following account of a receiving apparatus which I set up recently may interest many of your "amateur" readers. I believe the designs are rather novel, especially the condenser and the potentiometer.

The condenser which I describe is easily made, and can be produced by an amateur carpenter, without any special tools; on the other hand, the rotary condenser is difficult to make satisfactorily.

Fig. 1 shows the apparatus partly as a sketch and partly diagrammatically.

It was made chiefly from old boxes, photo frames, earthenware drain pipes, and some pieces of spring brass. In use it has been found most successful.

The chief point about it is that it has no sliding contacts, the point switches being easily made with brass screws and a piece of spring brass. The box-shaped transformer is more easily made than a cylindrical one, and with photo frames at the ends looks quite neat.

Instead of using insulated wire, bare copper wire was used, with string wound alongside to keep the turns of the coils from touching, but no doubt it would have been better to use enamelled wire and no string.

Though not shown in the diagram, to avoid confusion, there were several separate drainpipe coils on both primary and secondary, with tappings led to the point switches.

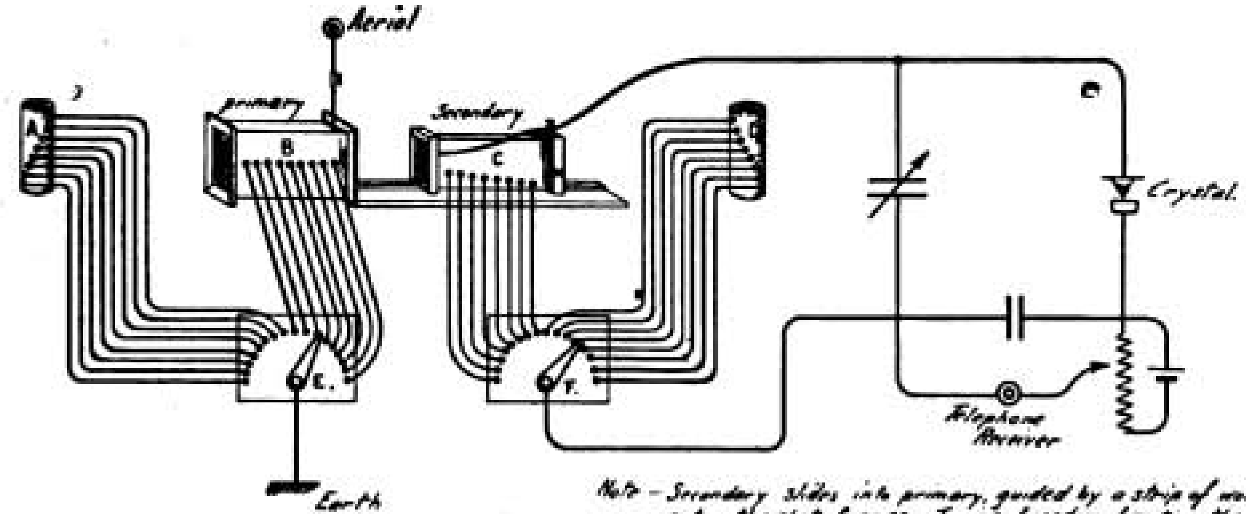


Fig. 1.

Note—Secondary slides into primary, guided by a strip of wood; slots being cut in the photo frames. To give freedom of motion, the leads from it are fixed to the right of the frame at X, and coiled into spirals between that point and the point switch to allow them to extend, as the secondary is pushed in.

The following articles were bought:

Receiver and blocking condenser.

Carborundum crystal.

Dry cell.

A few binding screws.

4 yards electric bell wire.

Some zinc sheet for making variable condenser.

20 S.W.G. and 23 S.W.G. copper wire for coils and aerial.

The cost of this amounted to two guineas in all, but I do not include the value of such things as brass screws, pieces of spring brass, and other small items which I found about the house or in the tool shed.

Fig. 2 is a sketch of the variable condenser, which is made of zinc plates and the glass of old full-plate photo negatives. By using glass as a dielectric, instead of air, the capacity is increased about seven times for the same area of plates. I used six sliding plates and seven fixed ones, with eight glass plates, in order to have glass on the outside of the whole lot, as well as between the plates. By making the fixed plates shorter than the glass and arranging the stop so that the

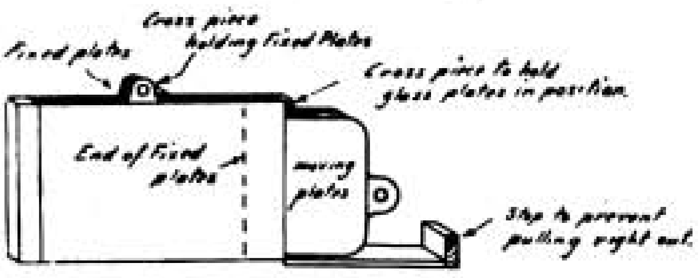


Fig 2

moving plates pull nearly right out, a very small capacity can be obtained for short wave lengths.

It is necessary to have washers between the plates where the bolts pass through the lugs to keep them properly spaced.

The setting up of the crystal needs no description, as there is nothing novel in the design of it. It was mounted on a piece of brass by dropping it into a pool of molten solder.

The potentiometer is shown in Fig. 3. This is on the point switch principle, in order to avoid the difficulty of making an efficient sliding contact.

I used ½ in. brass nails, and 23 feet of that

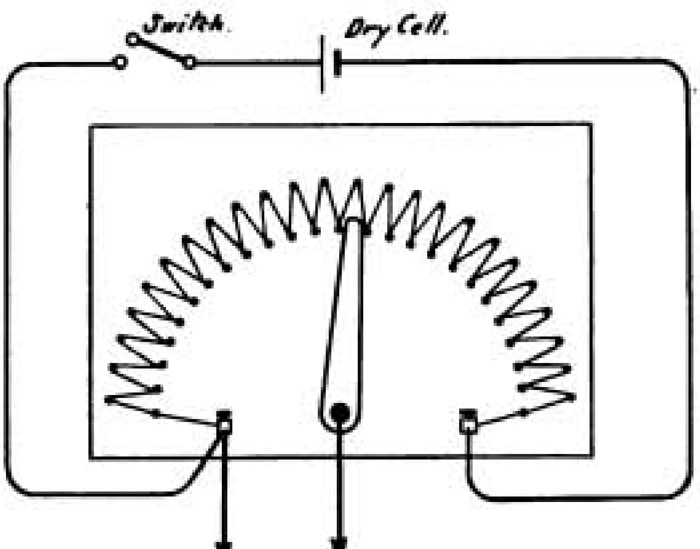


Fig 3.

thin wire which is used for making up nosegays.

This form of potentiometer can be made in half an hour, and is very successful.

The aerial is double, 240 feet long, average height 30 feet, slung from two fir trees with jam pots as insulators

I found that I could bore holes in jam pots with a file fixed in a brace.

The apparatus which I have described is very efficient, but the great point about it is that it can be made up with the ordinary tools that are generally found about a house. As I have no lathe or drills for cutting metal, I had to design the apparatus to suit the tools available.

AMONG THE AMATEURS

Association Topics

THE Wireless Society of London has just come into existence with the determination to carry out a very ambitious programme, upon the success of which the amateur wireless world should reap considerable benefit. The Society has received the blessing of Sir Alexander King, the secretary to the Post Office, who, on behalf of the Postmaster-General, wrote "welcoming the formation of such a society, and indicating that certificates of its advisory committee would be accepted by him as qualifications for the granting of licences."

* * *

At the inaugural meeting held recently Mr. F. Hope-Jones, who presided (and whose election as chairman of the Society was confirmed), explained that the first object of the Society was to guard the interests of all their fellow-workers in wireless telegraphy by securing the granting of licences, their permanency or free renewal in the case of all *bona fide* and competent experimenters. Applications for licences had increased so enormously during the last six months that there was a distinct fear lest the Post Office authorities should take drastic steps to repress the irresponsible amateur. A deputation from the Society recently interviewed certain officials at the General Post Office, and he (Mr. Hope-Jones) was satisfied that they would have the support and goodwill of the Postmaster-General if they took care that no more complaints were received of interference with commercial and Government stations by the use of excessive powers and untuned aerials, such as were now frequently used by irresponsible experimenters, and if they exacted from their members an undertaking that they would keep within the limits of their licences. More than this, they had been unofficially informed that such an organisation would be welcomed by the authorities, and it was easy to see that, in the very indefinite state of the

Mr. F. Hope-Jones, Chairman of the Wireless Society of London

law, they could be of great assistance in discriminating between those who should and should not be trusted with licences.

* * *

There is ample scope before the Wireless Society of London for work which can be extremely beneficial to the community. But to achieve any substantial measure of success it must co-operate with the provincial societies already in existence, whose influence in organising and controlling the operations of amateurs has tended to instil in them a due sense of responsibility in the handling of apparatus. Writing of amateur associations in the August number of this magazine we said: "We are probably only at the beginning of what will ultimately become a very large and useful movement, with associations of amateur experimenters in every important centre co-operating for the common benefit of their members." The means for organising a national federation of amateur wireless societies foreshadowed in that sentence is available in the establishment of the Wireless Society of London if the Committee will avail themselves of their opportunity.

* * *

Incidentally, we must congratulate the new Society upon its excellent choice of title and upon the good taste of the committee in avoiding the word "Club," which is apt to convey a misleading impression concerning the functions of the body it designates. The Wireless Society of London owes its inception to Mr. R. H. Klein, to whom is mainly due the successful launching of the Society. In addition to Mr. Hope-Jones and Mr. Klein, the following gentlemen form the committee: Messrs. H. F. Brand, L. McMichael, W. J. Shaw, V. W. Delves Broughton, W. J. Fry, E. W. Kitchen, L. F. Fogarty, A. G. Hansard, and Dr. F. C. Knight. Mr. A. A. Campbell Swinton is the Honorary President of the Society.

* * *

It is some little time since we recorded the doings of the Derby Wireless Club, but it has not been idle in the meantime. Indeed, it has been indulging itself in new achievements and appears to be considered quite an authority in the world of amateurs. In addition to experimental work, the club has recently started a systematic course of elementary electricity and magnetism as applied to wireless. Mr. R. A. Briggs has undertaken to give a half-hour lecture each Wednesday on this topic

Mr. R. H. Klein, Hon. Sec., Wireless Society of London

The Liverpool and District Amateur Wireless Association is one of the most energetic societies of its kind in this country, and a good deal of useful work is carried out at many of the numerous meetings held. At a recent meeting the chief subject under consideration was that of "Loose coupled receiving sets," remarks being contributed by Messrs. Coulton and Frith, the former giving the outlines of a set he has at present in use, and commenting upon the much better signals he is now receiving. The subject was raised of dividing the members into groups, so that each group might devote itself to experiments in specific directions and report results from time to time. A proposal was also put forward that the meeting night should be changed from Thursdays to Tuesdays, so that any members who desired may attend the "Wireless Lectures" at the Liverpool University, which are held on Thursdays.

* * *

The Cheshire Radiographic and Scientific Society propose holding a public exhibition in December next, at which a complete transmitting and receiving set will be shown working, and members' apparatus exhibited. This society was formed in February last by a number of experimenters in wireless telegraphy, the objects being the association of its members for mutual assistance in all scientific studies, and in particular radiotelegraphy and high-frequency electricity.

* * *

At the usual monthly meeting of the Northampton and District Wireless Club a successful attempt was made to get Eiffel Tower signals on an indoor aerial. Although the connecting up of the apparatus was not commenced until 7 p.m., Eiffel was heard plainly enough to be taken down. The aerial was a single wire about 30 ft. to 40 ft. long, and was fastened to a chair-back, from there to a nail in the wall about 7 ft. to 8 ft. from the floor, and brought back to the table. The room was an upstairs room at the grand stand of the racecourse, and the meeting was held on October 1st. Rubber bands were used as insulators, and a Perikon detector and double-slide inductance, with blocking condenser, and 8,500 w. phones, and 18 S.W.G. bare copper-wire aerial, earth to a water-tap.

* * *

The members of the Birmingham Wireless Association were recently favoured with a demonstration and brief lecture by Mr. J. H. McKeever and Mr. W. D. Sell, both of the Birmingham Wireless School. These gentlemen stepped in at very short notice to take the place of the lecturer who had been announced to attend, but who was unavoidably prevented from fulfilling his engagement. The lecture dealt with the early history of wireless telegraphy and the development of the syntonic theory.

An effort is being made to form a wireless society for the districts of Croydon, Sutton and Epsom, and as there are a number of experimenters in these districts there seems ample room for a useful society. We would advise those interested to communicate with Mr. Stanley J. J. Holmes, of Yelverton, Court Road, Sutton, Surrey. Mr. Holmes proposes to erect a wireless station for experiments to be carried out by members of the society.

* * *

The station which the Committee of the Dublin Wireless Club are erecting at their headquarters is making satisfactory progress. It has been decided to erect two 33 foot poles, held in position by bolts through the wall and raised about 7 feet from the ground, thus making the height about 40 feet. The aerial is to be of the four-wire Admiralty pattern and 150 feet long. Mr. Britton has undertaken the erection and painting of the poles and to supply the necessary wire and fittings for the aerials and lamps for the illumination of the club rooms in the evenings. Various members offered to supply apparatus.

* * *

We have little room left to deal with the display of amateur wireless apparatus which was shown at the *Model Engineer* Exhibition held during the past month. Some interesting models were shown, and among the exhibitors of wireless were the British Telegraph Instrument Co., Ltd., whose exhibit of wireless apparatus was one of the most attractive features of the exhibit. Messrs. A. W. Gamage, Ltd., and the Static Scientific Co., and Messrs. Richard Melhuish & Co., Ltd., were among the other exhibitors. We hope to refer to this exhibition again in our next number.

* * *

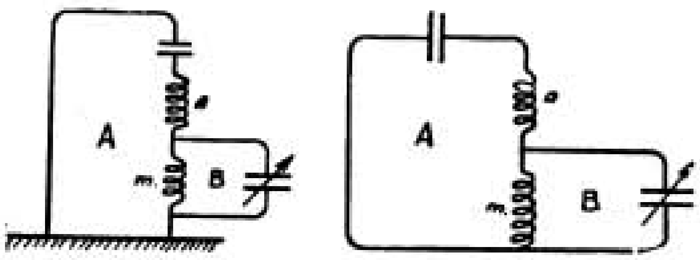
At a meeting of the Leicester Association held on October 14th a paper was read by Mr. Skeets on "Wireless in Theory." The members are busy preparing for their exhibition, to be held on November 8th in the Large Hall of the Vaughan College. The Hon. Secretary is Mr. H. Wildbore, 1, Bosworth Street, Leicester.

QUESTIONS AND ANSWERS

Readers are invited to send questions on technical and general problems that arise in the course of their work or in their study. Such questions must be accompanied by the name and address of the writer, otherwise they will remain unanswered.

J. F. L. (Eltham).—*The Condenser in Parallel and Series.*—What is the effect of placing a condenser in parallel with an inductance, compared with placing the same condenser in series with the same inductance?

Answer.—For the purpose of bringing the question under simple mathematical treatment, we may regard an aerial as being similar to a closed oscillatory circuit—*i.e.*, as having all its capacity to earth situated at its summit and all its inductance in the earth-lead. The effect of inserting a condenser in the earth-lead is then clear, for we are placing it in series with the aerial capacity to earth, and thus reducing the effective capacity of the aerial to earth. As the inductance remains unchanged, the effect is, of course, that the wave-length is shortened. In the case of the condenser shunting the inductance the action is more complicated. Adopting our former assumption, we can represent the conditions diagrammatically thus:



Here we have two oscillatory circuits, A and B, of different wave-lengths coupled together in "auto-jigger" fashion. Now, whenever two circuits are coupled together, the lengths of the waves emitted are affected.

If λ_1 be the wave-length to which A is tuned,
λ_2 " " " " B "
then the actual wave-lengths emitted would be

$$\lambda_1{}^1 = \sqrt{\frac{\lambda_1{}^2+\lambda_2{}^2+\sqrt{(\lambda_1{}^2-\lambda_2{}^2)^2+4k^2\lambda_1{}^2\lambda_2{}^2}}{2}}$$

$$\text{and } \lambda_2{}^1 = \sqrt{\frac{\lambda_1{}^2+\lambda_2{}^2-\sqrt{(\lambda_1{}^2-\lambda_2{}^2)^2+4k^2\lambda_1{}^2\lambda_2{}^2}}{2}}$$

where k is the coefficient of coupling, depending on the proportion which the inductance m, common to both A and B, bears to the total inductance $a + m$. Two waves are therefore radiated (or conversely, received), one long and one short; it is the long wave which is utilised in the "shunt-capacity" method of tuning. This "shunt-capacity" method will give fairly good results in expert hands, but it is not one to be recommended to the amateur. An ordinary tuning-inductance is effective and at the same time much simpler to use.

"OMEGA" (London).—Your down-leads must either come from one end of the horizontal part or from the centre. As you have them in the drawing, they form a quite unsymmetrical T aerial. Best to take them down from A, using rope and insulator from ground to about the height of window. All wires separate everywhere except where they enter, and all of the same length. We would rather have two wires spaced, say, 8 feet, than five spaced a foot each. If you bring your down-leads from the end, A, then your natural wave-length in metres would be (approximately) length of horizontal part *plus* down-lead *plus* earth-lead (all in feet) all multiplied by 1·35. Your coils wound in discs with waxed blotting-paper between are unsatisfactory, because of the capacity from disc to disc. The air-gap between the primary and secondary of a loose-coupled tuner is to avoid this effect. The air-gap need not be *too* big. We hardly think your failure to get many short waves is likely to be due to any idiosyncrasy of your crystal. Perhaps you are a long way inland? Are you sure your tuner can tune properly to the short waves? And that when so tuned, the coupling is not unduly weak, owing to so few turns of the primary being in the circuit? Or, perhaps, those turns which *are* in the circuit are at the end of the coil which is right away from those turns of the secondary which are in the circuit—thus producing a very weak coupling. In fact, without further information, we can only advise you to try tightening your coupling for these short waves.

H. B. L. (Wetherby).—Your arrangements for aeria seem quite good. Use a two-wire aerial at least 5 feet apart. A single wire will do for down-lead, but two are better. The only place where the two wires should join is where they enter the house. For comment on diagram of connections, see reply to W. A. M. in this number. Aerial connections all right; slightly better to connect aerial to terminal 6 and earth to terminal 5, thus keeping earth as far away as possible from crystal-end of secondary. Your ten-way switch on secondary will be all right, since you are going to have a variable condenser as well, for fine adjustments. No. 28 for primary, No. 36 for secondary, will do. Single 2,000 ohms telephone might be more sensitive, but the double (1,500 ohms) will be more convenient. Zincite and pyrites is good enough; but carborundum with battery is really the most satisfactory.

W. A. M. (Liverpool) gets inconsistent results with ship signals on his crystal receiving set, and fails to get any of the long-distance stations. He suggests that the fault lies with his telephones, which are only of 100 ohms resistance.

Answer.—The telephones are quite enough to account for your failures. To see whether they are the only weak points in your set, borrow a motor-car trembler coil and connect up as a step-down transformer to your telephones. But, referring to your diagram of connections, why *will* you amateurs insist on ruining your oscillating circuits by putting the crystal—some thousands of ohms in resistance—in series with the circuit? Its place is in series with the telephone *across* the condenser of the oscillating circuit.

P. K. S. (Rugby).—Is there any remedy for an aerial which is near to some 2,300 volt alternating mains, and which, therefore, gets disturbances from these which prevent proper reception?

Answer.—Such mains should not produce serious trouble unless they are supplying power to tramcars, when the sudden fluctuations due to the starting of the cars may upset the aerial. If you are using crude receiving circuits with little power of selectivity, you will be liable to get interference which would entirely vanish if you used a proper syntonised arrangement. If, in spite of using such an arrangement, you still find interference, your only plan will be to try a "balancing aerial," so arranged as to be affected by the mains, but not, to any appreciable extent, by the signals from the distant stations; the effects from the mains on the two aerials being made to oppose one another in the receiving circuits.

H. E. M. (Canadian Central Wireless Club, Winnipeg).—It is contrary to our rules to give such details as you ask for of a patented article. We will help you as far as we can without breaking this rule. The design of the receiver will depend almost entirely on the nature of the detector you intend to use it with. The receiver you mention is designed to work specially with the Marconi Magnetic Detector, which may be called a "current-working" device of low resistance. Therefore in this receiver the condensers are all large, and the inductances small; whereas, in the corresponding receiver designed to work with a valve or crystal detector, the condenser in the detector circuit is very small, and the inductance correspondingly high. The first receiver, however, will work very well with very low-resistance crystals, if properly adapted. Except for the lack of ease in adjustment, your suggested plan of using a small, continuously-variable condenser in parallel with a larger condenser variable in steps—as a substitute for a larger continuously-variable condenser—is all right. If you have a thorough grasp of the elements of the subject, and have and use skilfully a suitable wavemeter, you should be able to get the right values for the various circuits. If you have no wavemeter, then we think the best use to which you could put that variable condenser would be to make a wavemeter out of it.

G. A. J. (London).—I am erecting a wireless set; the aerial will be suspended from a poplar tree (12 feet high) at the end of the garden to the roof of the house (40 feet), and will comprise about 100 feet of wire. Will this be suitable for receiving from Eiffel Tower and other stations?

Answer.—Your aerial is not a good one, being very low at the one end, and rather short; but in skilful hands it ought to give signals from several stations. Could you not put a mast up in that tree and so raise that end of the aerial? No; a variable condenser is not absolutely necessary in a receiving set; quite good signals can be received without the use of even a fixed condenser.

B. H. B. (Ware).—(1) I have a detector with three crystals, graphite, copper pyrites, and silicon on the stand, and a zincite crystal in the upper cup. I was told to use the zincite with the graphite and copper pyrites, but a brass point with the silicon. I can get no result with the brass point, but find the zincite acts on the silicon. Would a sharp steel point do better? and can you explain why I get no results with brass (I use a potentiometer)? (2) I do not get short wave-lengths very loud, even with my condenser right out. Primary and secondary are both box shaped, sliding one into the other, about 10 inches square and one foot long each, primary No. 20 enamelled wire, secondary No. 22. The longer wave-lengths I get quite plainly. Would it be better to have a separate transformer of smaller size for the 100 to 300 metre stations?

Answers.—(1) We can no more answer for the behaviour of these "fancy" crystals than we could prophecy or account for the actions of anything whose conduct is *varium et mutabile semper*. Silicon, in particular, is notoriously difficult to deal with. Why not devote yourself to carborundum, and get hold of some really good specimens? They take a lot of beating.

(2) Yes; we have no doubt that you ought to have a separate receiving jigger for the short wave stations. The self-capacity of the coils of your big set would be so great that it is quite probable that even with your condenser right out the circuits are tuned to too long a wave.

L. W. P. (Pomfonne, France).—Can I work a morse writer with my wireless set to receive Eiffel Tower signals, which is only about 30 miles from my house. I have already a pair of relay magnet coils of a resistance of 4,500 ohms. each. Would these be any use to me?

Answer.—The easiest way would be for you to use the old-fashioned coherer. With such strong signals as you would obtain you could use a very insensitive coherer, and this would tend to make it quite reliable and far less troublesome than those used in the old days when the great object was to attain as great distance as possible. Your relay magnet coils would come in useful for making the relay for working the coherer-tapper and the Morse inker. The whole apparatus need not be at all expensive. If you do not like the idea of a coherer, you might try to make a very sensitive relay which would work off the current through a crystal-receiver. This is only practicable with very strong signals, but your case should be a favourable one. If you could borrow a microammeter and see for yourself what current you can get from these signals through a crystal-receiver, you would know more or less whether a home-made relay could do the work.

W. N. (Wokingham).—If we are to take your sketch as strictly representing your connections and arrangements, your jigger-secondary is coupled all the way along with the primary, so that there is no "high-potential end to be kept away from the earth-connected primary." In this case you would get no change by altering the connections round. In a properly-designed receiver there is so much difference between the high-potential end of the secondary (the end right away from the primary) and the low-potential end, that a touch of the finger on the former will entirely stop signals, while on the latter it will barely affect them at all. The crystal should be connected to the side of the condenser which goes to this high-potential end; and it is this potential which drives the signal-current through the crystal. With a jigger-secondary wound in more than one layer, not only do you not get this free end, but also one layer has a distinct capacity to the other, and this interferes with the tuning.

A. A. (Glasgow).—It is desired to work small wireless sets over hilly country for a distance of about 14 miles with hills of about 600 feet intervening. The sets work satisfactorily oversea for a distance of 30 miles.

Answer.—We think there should be satisfactory communication up to a distance of about ten miles, but we greatly doubt whether it would be uniformly satisfactory over the full distance of 14 miles under all conditions—with a dry earth, for instance.

A. S. (Liverpool).—In the third paragraph in "Questions and Answers," in September issue, you say that an old motor-cycle ignition coil will do for the transmitter. Do you mean a trembler coil?

Answer.—Yes. What is wanted is a means for producing a spark, and to get an induction coil to do this it is necessary to have some kind of rapid make-and-break—hence the necessity for a trembler or some similar arrangement.

BEGINNER (Forest Gate) asks for "instructions for making a two-slide tuning coil," which we regret we cannot give in an answer to a question. He has a cylindrical (solid) piece of wood 7 inches long by 6 inches diameter, and asks whether that will do as well as a cardboard tube for winding the wire on. The wooden cylinder will do quite well; he had better wind two or three layers of paraffin-waxed paper round it before putting on the winding.

ZETA.—Sorry, but in order to understand your query we must have fuller particulars; a diagram of connections is necessary, also the gauge of wire in the various coils. A 9 inch by 3 inch inductance coil might have any value, depending on the number of turns which it contains. Moreover, your fixed and variable condensers might be of any value, and it is impossible to get an idea of what is happening unless we are told more about them. If you could tell us that you have a wave meter, that you use it properly, and that you are certain that your circuits are capable of tuning properly to the waves you refer to, then, of course, we should have something to go on. Your aerial seems all right; if everything else is correct you should get strong signals from the stations which you mention as coming in weak, and there is no reason why you should not get Poldhu. The fact that you get Cleethorpes clearly does not show that your apparatus is really working well, since the distance is so small. Thank you for your kind remarks about THE WIRELESS WORLD.

Personal Items.

Mr. John Beecroft Beaumont, late Cadet Sergt., Leeds University Contingent, Senior Division, Officers Training Corps, has been appointed Lieutenant in the Northern Wireless Signal Company, Northern Command Signal Companies, Royal Engineers (Army Troops).

By an arrangement just effected, Mr. Edward J. Nally will become Vice-President and general manager of the Marconi Wireless Telegraph Company of America. Mr. Nally, who is still in his prime, has been for more than thirty-five years connected with the telegraph business, starting as a messenger boy with the Western Union Telegraph Company. He recently resigned as vice-president and general manager of the Postal Telegraph and Cable Company, after a service of nearly twenty-five years. Mr. Nally's experience and reputation as a telegraph man fit him in an eminent degree for the position which he has just accepted, and will be especially valuable to the company in connection with the Trans-Atlantic and Trans-Pacific telegraph service, which it is expected will be opened to the general public by the close of the present year.

Marconi Philatelic Society.

Another very interesting evening was spent on October 17th, when Mr. A. W. Torode, by special request, read a paper on "The English Stamps of King George." Doubtless it will be news to many readers, equally as much as it was to some of the members present, to learn that since the accession of King George there have been no fewer than 26 varieties of our own English halfpenny stamps and 25 varieties of the penny. Many specimens of the different varieties of watermarks were exhibited by Mr. Torode, and he received the warmest thanks of the members present, who fully appreciated both the reading and the exhibition. It is hoped that during the coming season one or two other members will follow the example of Mr. Torode and give the Society the benefit of their researches in the particular countries in which they have specialised.

Swimming.

The Swimming Club finished the summer season's programme with the Club Championship contest of 220 yards, which proved to be a very exciting affair. The entries totalled eleven and the heats took place on the 9th and 10th inst. when the first three of each heat passed into the final.

This took place at the headquarters on Thursday, October 16th, and was won by Mr. A. S. Free, of the Accountants Department, Mr. Castle and Mr. Litteur being second and third respectively. Mr. Free is to be congratulated upon his excellent win, by which he holds the cup for one year and receives a gold medal.

Orchestral and Choral Society.

The Orchestral Society has been continuing its weekly practices. Overtime work and night classes have once or twice played havoc with the attendance, but the calibre of the orchestra has, notwithstanding, improved greatly. In association with the above three singing practices have been held in the last three weeks. They have proved increasingly attractive, and last week the number of performers reached the grand total of thirty. There is reason to hope that this record will be beaten in the near future, while the enthusiasm shown over such items as the "Soldiers' Chorus" and "Queen of Angels" augurs well for rapid advance in musical development also.

Buyers' Guide.

It has been truly said that "of the making of books there is no end," and certainly the reading of publishers' catalogues, which at this time of the year appear in battalions, is likely to become wearisome to the flesh. But this evidence goes to prove that we of the twentieth century are dependent more than in all preceding ages on book-learning and book-reading. Nevertheless most of us have no time to test the merits or demerits of new literature, and often it is dangerous work to buy a new textbook on any subject we may fancy merely on the authority of a review or of an advertisement. Further, it is, in nine cases out of ten, best to stand by recognised authorities and old favourities, and if this plan be followed there is the added advantage of possibly being able to procure such books second-hand, which means the maximum value at a minimum outlay, and there is no firm which has so fine a collection of first-class books, and more especially technical and scientific works, as Messrs. W. & G. Foyle, of 121 to 123 Charing Cross Road, W.C. Their catalogue can always be obtained on application, and is worthy of the perusal of all wireless operators and engineers.

* * *

One of the most important articles in a wireless operator's kit, and, in fact, in all travellers' kits, is the waterproof, and it is an article on the purchase of which the greatest care must be exercised if it is to be a satisfactory investment to the purchaser. One does not want to be constantly buying waterproofs, a good one will last years, and withstand heavy wear, but it must be good, and, as with all articles in which rubber plays an important part, the purchaser is bound to rely chiefly on the credit of the firm with which he is dealing. Therefore he cannot do better than deal with such a well-known business house as Anderson, Anderson & Anderson, Ltd., of St. Paul's Churchyard, E.C., for their goods are known throughout the world as bearing the hall mark of excellence in manufacture, while their india-rubber regulation waterproofs—and without rubber or oilskin you can have no real waterproof—have always been officially sealed as the authorised standard garment by the naval and military authorities.

Vol. I. N

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