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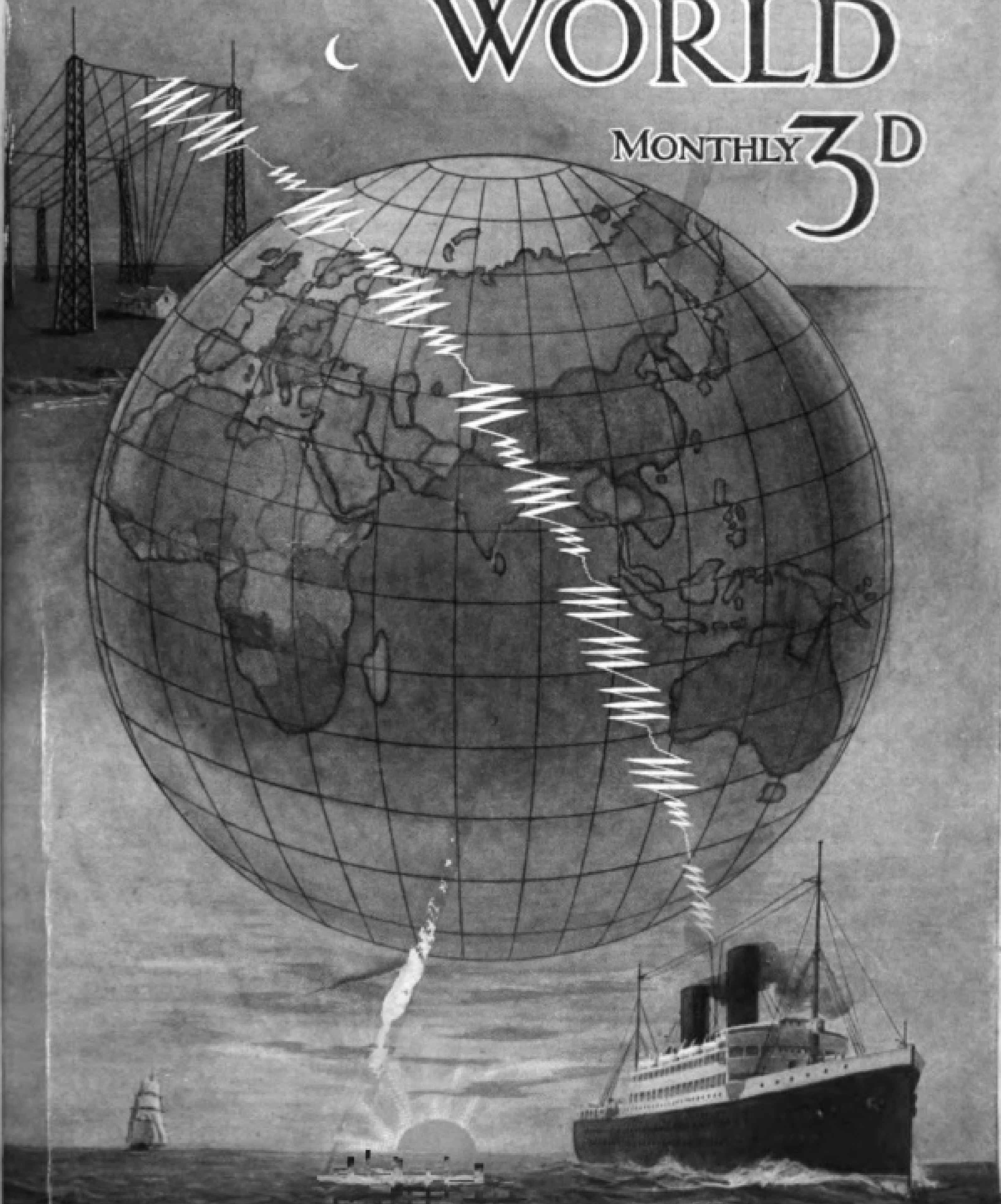
WIRELESS WORLD

MONTHLY 3D



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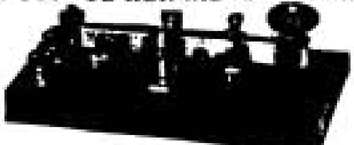

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THE
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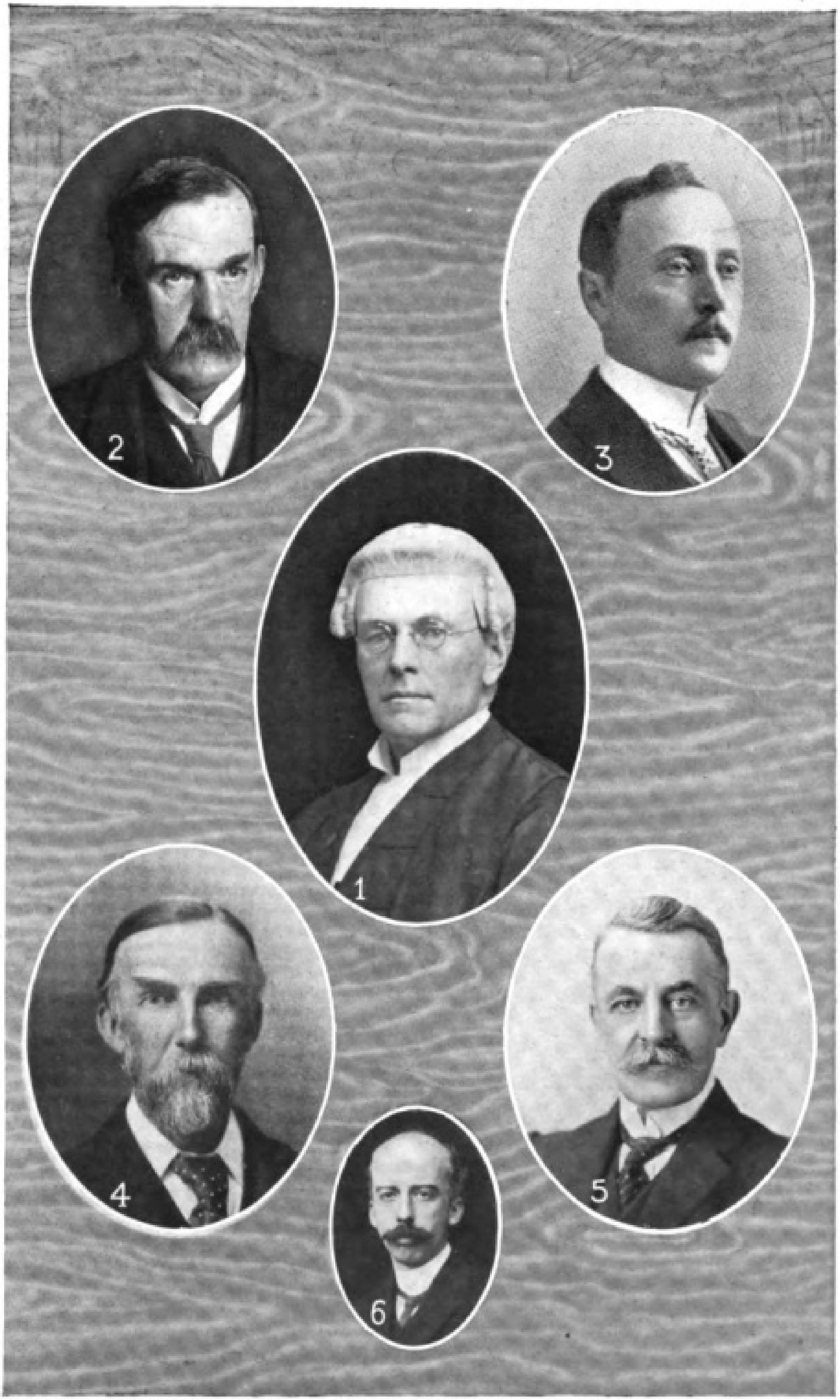
The Postmaster-General on the Imperial Scheme

THE speech in which the Postmaster-General presented his annual statement in the House of Commons on April 24th was packed with interesting matter. Its outstanding feature was the statement on the telephone service, but it also contained references to the scheme for an Imperial chain of wireless telegraph stations. Mr. Samuel said he had hoped to make much progress before now with the establishment of an alternative system of Empire communications by means of Imperial wireless stations owned by the British Government, by the Dominion Government, and by the Indian Government, but, owing to circumstances with which all were too familiar, this most desirable undertaking had been postponed. Nearly two years had passed since the sub-committee of the Committee of the Imperial defence reported that the project was urgent from the point of view of the strategical defence of the Empire. On January 14th the Select Committee of the House of Commons, investigating this subject, presented an interim report in which they came to the conclusion that the matter was one of urgency, and they asked that an advisory committee of experts should be appointed to report as to the best system to be adopted. The report of the advisory committee, which was not available at the time the Postmaster-General made his speech in the House of Commons, has now been published, and is dealt with fully elsewhere in this number. On January 29th, as Mr. Samuel informed the House, the Commissioners left this country to secure sites in Egypt and East Africa, but he pointed out that the Government could not yet definitely purchase sites for wireless stations, because they held that the contractor who built the stations should take the risk of any failure in their working, and if this very desirable condition was to be maintained it would obviously be necessary to obtain the contractor's approval for the site selected.

Touching upon another point in this speech, it is interesting to note that the wireless stations on the coast show a satisfactory increase in business. The traffic has grown by 15 per cent. last year, and has doubled during the last four years. New coast stations are being erected, and these should be of considerable service to the mercantile marine.



1. Lord Parker of Waddington. 2. Dr. R. T. Glazebrook. 3. Mr. W. Duddell
4. Sir Alexander W. B. Kennedy. 5. Mr. J. Swinburne. 6. Mr. E. H. Rayner

Photos.—1. Elliot & Fry. 2. Central News. 5. Vandyk.

The Wireless World.

With which is incorporated "The Marconigraph."

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All Editorial communications to be addressed to "The Editor, 'The Wireless World,' Marconi House, Strand, London, W.C."

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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JOHNSON & PHILLIPS L^D

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The Members of Scientific Advisory Committee

ON the opposite page appear the portraits of members of the Scientific Advisory Committee, which has just issued its report.

BARON PARKER OF WADDINGTON, the Chairman of the Committee, is perhaps better known as Mr. Justice Parker. For many years he was an eminent judge in the High Court, where he dealt mainly with Patents cases. The famous "Four Sevens" patent action was heard before him, and his judgment in favour of Mr. Marconi and the Marconi Co. was a masterpiece of clear reasoning and lucid statement. He was appointed a Lord of Appeal this year, only seven years after his elevation to the Bench.

DR. GLAZEBROOK started professional life under brilliant auspices. After study at Liverpool College he entered Trinity College, Cambridge, at the age of 18. Three years later he was elected foundation scholar, and the following year took his degree as Fifth Wrangler. Immediately afterwards he commenced the study of Physics at Cavendish Laboratory, under Clerk Maxwell. In 1880 he was appointed demonstrator of Physics by Lord Rayleigh, and ten years later became director of the Laboratory. This position he held until 1898, when he became Principal of University College, Liverpool. In 1882 he was elected Fellow of the Royal Society, and served on the Council from 1892 to 1894. He is Director of the National Physical Laboratory.

MR. DUDDELL served three years' engineering apprenticeship, and was afterwards engaged in research work at the Central Technical College, London. In 1896 he obtained the Whitworth Exhibition, and in the following year a Whitworth Scholarship. His work in connection with oscillographs has made him deservedly famous. He received a gold medal for Oscillographs at the Paris Exhibition in 1900, and at St. Louis in 1904. The Duddell arc, which is well known in connection with wireless telegraphy, was discovered by him. He is now President of the Institution of Electrical Engineers.

SIR ALEXANDER KENNEDY is one of the foremost engineers of the day. His apprenticeship to engineering lasted 4½ years, but he made such good use of his time that when he was only 25 he was already established as a consulting engineer in Edinburgh. In 1874, two years later, he was appointed Professor of Mechanical and Civil Engineering at University College, London, and when, in 1889, he was compelled to relinquish the position owing to the pressure of professional work, he received the honorary title of Emeritus Professor of Engineering from the Council of University College. He has published several books on mechanics and kindred subjects. In 1887 he was elected Fellow of the Royal Society, and received the honorary degree of Doctor of Laws of the University of Glasgow in 1894. He was appointed by Lord Goschen member of the Naval Boilers Committee and President of the Admiralty Machinery and Designs Committee. For these services he was knighted in 1905.

MR. JAMES SWINBURNE is well known as an inventor. He served his apprenticeship in engineering when he was quite young, and was soon distinguished for his attainments. In 1881, when he was only 23, he was returned as first in all England at the Examination of the City and Guilds in Gas Manufacture. Later he went to America, but returned to England to patent a glow lamp known by his name. From that time onwards his inventive faculty has never deserted him, so that a long list of successes stand to his credit. He was President of the Institution of Electrical Engineers from 1912–1913.

MR. E. H. RAYNER, the Secretary to the Committee, is an electrician of repute. He was educated at Cambridge, and served a very thorough apprenticeship with several engineering firms. He now carries on expert testing and research work at the National Physical Laboratory.

EPISODES OF THE MONTH

PORTABLE WIRELESS TELEGRAPH STATIONS IN THE BALKAN WAR. TELEGRAPHS IN THE NORTH OF SCOTLAND. WIRELESS TELEGRAPHY AND RAILWAYS. AERIAL TRAFFIC IN FRANCE. THE SHARE MARKET.

LAST month we published in THE WIRELESS WORLD a report of the siege of Adrianople, and the part that wireless played in that remarkable episode of the Balkan War. Fuller details have since come to hand, and these are of sufficiently interesting a nature to prove once again that fact is often stranger than fiction. Adrianople was only supplied with a 1½-kw. cart station, which happened to be shut up in the beleaguered town, and this fortunate circumstance alone enabled her to keep in touch with the Government at Constantinople, which would otherwise have been entirely ignorant as to the state of affairs in the besieged city. At no time did the station fail, and during the time that the city was invested over 450,000 words were transmitted to headquarters without a hitch. This, too, in spite of the difficulties the Allies attempted to create by placing one of their stations to the westward of Adrianople, and another to the eastward, so that they might come as nearly as possible in a direct line between the Adrianople and the Ok Meidan stations. As soon as the Ok Meidan station started calling up Adrianople, or *vice versâ*, the Allies hammered away at their two stations in a vigorous but vain effort to jam the Turkish signals. But the efforts of the Turks were entirely successful, and the calls were transmitted and received without the slightest inconvenience. It is acknowledged that the excellence of the instruments and the system of the Marconi Company are chiefly responsible for this phenomenal success.

* * *

The decision of the Postmaster-General to substitute wireless telegraphy for the existing overhead land lines in exposed parts of the north of Scotland will meet with general approval. Business in such important centres as Aberdeen, Dundee and Arbroath has frequently been interrupted, and the towns themselves at times isolated by the breakdown of telegraph lines during severe weather. A wireless station is to be established near Aberdeen which will be in touch with the station at Newcastle-on-Tyne, and so put an end to all inconvenience in the future. The local authorities of the areas concerned have agitated vigorously for the laying of underground lines, but the excessive cost of such a scheme has prevented its adoption. The opposition to the Post Office scheme is based upon a complete misapprehension, if not ignorance, of the everyday accomplishments of wireless telegraphy. A representative of the fish trade, who was a member of a recent deputation to the Postmaster-General on the subject, in communicating to the local Press his views upon the Post Office proposals, said his objection to wireless telegraphy was "that it is still an experimental means of transmitting messages as far as overland is concerned." We do not know where he obtained this remarkable information from; it betrays a curious lack of knowledge of current progress. Far from the overland transmission of wireless telegrams being an experimental matter, it is at present carried out on a very large scale, and in the Imperial wireless telegraph scheme which the British Government have proposed, the transmission of messages will be mainly overland. Wireless telegraphy has been thoroughly tested between London and Liverpool, and the business of maintaining regular communication between the north of England and the north of Scotland therefore cannot present any difficulty.

* * *

A serious attempt is now being made on the Lackawanna Railroad in the United States with a view of adopting wireless telegraphy as an aid to the operation of trains, and those who have charge of the experiments seem to be very sanguine as to the results. It may be said in favour of the project that the problem is being approached in a scientific manner, and from the advanced state of the art it is fair to presume that the element of chance in the attainment of results will be largely reduced, if not eliminated. The distance to be covered by the wireless in this instance is comparatively short, and if the system proves to be as successful as it is hoped it will be, it will mean a great deal to the railway services. The section of the road to be equipped is one which is frequently visited by storms, and wire communication suffers more or less in consequence. In order to be independent of such conditions, the railway officials find hope for relief in the wireless, and if they succeed in accomplishing what they have instructed the American Marconi Co. to carry out, a great stride will have been made in the development of the science of railway-train movement. The results of these experiments will certainly be awaited with deep interest.

* * *

The Bill for the Regulation of Aerial Traffic in France, which was tabled last month by the Minister of Public Works, holds a certain measure of popularity because it is framed not only to regulate the entry of foreign airships into France, and altogether to prohibit the circulation of aerial vehicles belonging to a foreign state over France, but to safeguard the landowner, and secure for him the privileges of private property and compensation for trespass thereon and damage thereto by descending aircraft. M. Thierry pointed out in the preamble to the Bill that the number of pilots' certificates issued by the French Aero Club had risen from 17 in 1909 to 359 in 1911, and 490 in 1912, and the number of aeroplanes constructed in France increased from 800 in 1910 to 1,350 in 1911, and 1,800 in 1912. To gain some security from the possible damage of such a flock of aircraft, the landowner is well content to forego his ownership to the air above his land. But there are other provisions in the Bill which may raise some misgivings. M. Thierry's figures regarding the increase in certificated airmen and aircraft are enough to justify legislation which will have a moderate controlling interest; but the French regulations resemble somewhat the measures taken in this country for the control of motor traffic—and incidentally the hampering of the motor industry. That every airship, aeroplane, or balloon, should carry a qualified aviator and have a special certificate, the letter and number of which must be marked upon the aircraft in legible characters, is reasonable enough. But such a system of identification, coupled with the provision that machines must, save in case of necessity, descend upon recognised flying grounds, would seem, as things stand at present, to provide sufficient safeguards against any danger of espionage, without prohibiting, as has been done, the carrying of carrier pigeons, photographic and wireless apparatus. The use of wireless apparatus on aeroplanes and like craft has just emerged from the experimental stage. Very few machines, certainly of a private character, carry such apparatus, and it seems feasible that the French Government, by having such machines specially registered, could, without handicapping useful experimental work or unduly oppressing an expanding industry, ensure no disclosure of its secrets to the prying eyes or ready ears of a foreigner.

The Share Market

London, *May 23rd.*

Inactivity of business and the weak tendency in prices have been the chief characteristics of the Share market during the past month. The prices of the various Marconi issues as we go to press are: Ordinary 4; Preference, $3\frac{5}{8}$; Canadian, 13s. 9d.; Spanish, $\frac{3}{4}$; American, 1.

CARTOON OF THE MONTH

Wireless Terms Illustrated

III.—Strong Atmospherics

The Training of Mercantile Marine Officers and Seamen

By FREDK. H. STAFFORD

The Development of Mercantile Marine Training. The Training Centres. The Preliminary Curriculum. Board of Trade Certificates. The Period of Apprenticeship. The Question of "Prospects." Pay of Mercantile Marine Officers. Life on a Training Ship. The Training of "Fo'c'sle Hands." Instruction in Wireless Telegraphy.

THERE are few callings that demand more varied and special qualifications to ensure success than that of the sea, and this applies with as much force to-day as it did in the old days of masts and yards, and before steam had evolved, so to speak, the modern type of merchant service officer; for it is with him that we will first deal.

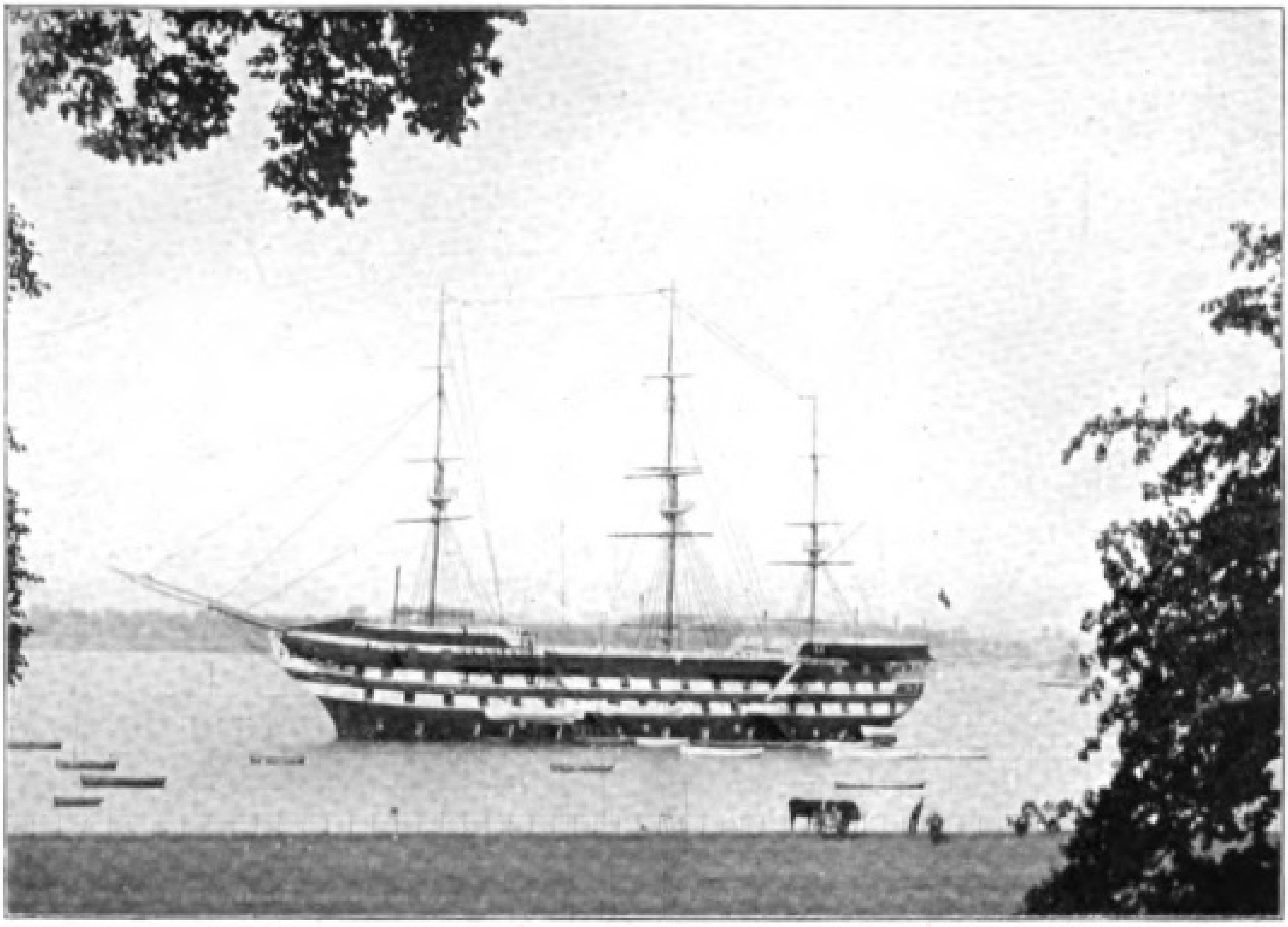
Although conditions of life afloat are so very different now, and the slow, old-fashioned sailing ship bears but little relation to the steamer with its speed and comfort, yet the same moral and physical attributes are required from the men who command the present-day steamer.

Sailors as a class are reticent, and, indeed, are apt to be considered a different sort of species from landsmen. There is so much that is beyond the understanding of the ordinary intelligence in their profession that they but rarely speak of it, and then generally only to indulge in a little "leg-pulling." Consideration, however, of the multifarious duties they have to perform, and the extent and varied knowledge they must possess, will at once show that the old-fashioned idea of the "fool of the family" being sent to sea does not apply nowadays, if, indeed, it ever did. Primarily the merchant service officer is a man who first learning to control himself must also be capable of controlling a whole ship's company—which in these days of floating palaces will often total 3,000 souls. He must be well educated and polished, tactful and courteous, and must display exceptional disciplinary ability. Further, he must be sober and calm, quick to act in an emergency; in short, to do the right thing at the right moment. These are a few of the moral qualities he must possess, whilst physically he must have a constitution capable of withstanding all climates and powers of endurance, for such qualities as these he, above all men, is called upon most frequently to display.

The great advance made in marine science calls for a scientific mind to deal with its intricacies, so that we have in the merchant service officer of to-day a man with an exceptionally wide range of knowledge comprising such diverse branches as steam, mechanics, the construction and stability of ships, wireless telegraphy, signalling, etc., with the addition of seamanship, navigation and nautical astronomy.

Sufficient has been said to show that to qualify for such a position much preliminary training is necessary. True, there are many officers to-day who have qualified without any training other than that afforded at sea, but these are the exceptions, not the rule.

Shipowners now generally recognise the necessity of employing officers who have received a course of instruction before going to sea, and to a great extent the passenger lines are officered by men drawn from the two nautical training colleges: *Worcester* in the Thames, and *Conway* in the Mersey; or from the sea-going cadet training ships. These two first-named vessels have between them turned out some 6,000 fully qualified cadets during the past 50 years,



H.M.S. "Worcester."
A Nautical Training College for Mercantile Marine Officers.

many of whom now hold command in the crack passenger lines, whilst others are serving in different capacities as junior officers or mates of tramp steamers.

The great mercantile shipping of this country is enormous, and its growth and magnitude can be best gauged by a few statistics. Taking the latest figures available, the total gross steam tonnage of vessels of over 100 tons is (according to Lloyd's Register) 17,730,940 tons, representing 8,524 British-owned steamers. These figures are instructive and serve to emphasise the necessity of having properly qualified officers to control the immense wealth they represent.

Some account, then, of the various training ships both for officers and seamen may be of interest and serve to enlighten the travelling public as to the qualifications possessed by those employed in this service.

There are five vessels devoted to the training of officers—viz., the Thames Nautical Training College H.M.S. *Worcester*, the School Ship *Conway*, in the Mersey off Rock Ferry (both stationary), the sea-going sailing ships of Messrs. Devitt & Moore—*i.e.*, *Port Jackson* and *Medway*—and the White Star Line's sea-going cadet training ship *Mersey*. As the education in the two first-named ships is very similar, we give details of the *Worcester* in the Port of London as an example.

The first consideration in entering a boy in the *Worcester* is one of physical fitness, with particular regard to a perfectly normal eyesight. This latter is of great importance, as owing to the new and very stringent tests which have recently come into force any failure in after life would mean the abandonment of the profession and the resulting disappointment and loss of time and money.

The best age to enter is about 14 years, which allows of a boy taking full advantage of the curriculum and of obtaining the necessary certificates.

To quote from the prospectus of the College :—

"The special object of the institution is the training of cadets for a seafaring life, under a captain-superintendent and experienced masters, with competent seamanship instructors. The cadets are exercised in all the duties of a first-class ship; they are taught practical seamanship, navigation and nautical astronomy, in addition to the usual subjects of a sound English education. Their training, in a word, is thorough, and always with the end in view that, after practical experience at sea, they may become efficient masters of their profession. The cadets are exercised in military and physical drill. Boys are accepted between the ages of 11 and 15½ years at annual terms of admission of 65 guineas, including uniform. There is no entrance examination, but a grounding in mathematics is desirable."

All applications for admission must be accompanied by a certificate of health (including test for vision and colour), certificate of birth, and testimonial of character from last school.

On the scholastic side the curriculum consists of :—English, history, geography, Scripture, French, drawing, arithmetic, algebra, geometry, trigonometry, theoretical and practical, Nautical astronomy, magnetism, the "Deviascope," meteorology, charts, nautical surveying; whilst the technical training includes practical seamanship in all branches, such as knotting, splicing, reefing and furling sails, heaving the lead, management of boats, etc., elementary steam, electricity, wireless telegraphy, and naval architecture, physical and other drills, swimming, hygiene, etc.

The introduction of wireless is a new feature in the training of the embryo officer. The *Worcester*, *Conway*, and the sea-going sailing ship *Mersey*, of the White Star Line, are all fitted with wireless. On the *Worcester* the cadets are given a good insight into its working and the method of dispatching and receiving messages. This is a much-appreciated branch of nautical instruction and demonstrates the up-to-date character of the training.

Photo by] [*Barratt*

"Sail Drill."

An important branch of seamanship. Manœuvres being carried out on H.M.S. "Worcester."

After he has spent two years on board and is sufficiently advanced in the various sections, 3rd, 2nd, and 1st nautical, the cadet is examined for his *Worcester* certificate, a document issued under the authority of the Board of Trade, which carries with it a year's sea service, so that instead of having to serve the full regulation period of four years at sea as an apprentice, the holder has only to serve three years.

Shipowners fully appreciate the value of this certificate, and no boy possessing it need have any fear of finding a berth in a good class line.

In addition to the foregoing, the ship is favoured by the Admiralty in the matter of commissions in the Royal Naval Reserve. Every year they grant ten appointments as midshipmen to cadets between the ages of 16 and 18. A first-class *Worcester* certificate is an essential in obtaining one of these appointments. The cadet subsequently undergoes twenty-eight days' training in one of the Home Fleet ships, and on the satisfactory completion of the qualifying period of sea service is advanced to the rank of sub-lieutenant, lieutenant, and, in some cases, to commander.

A special feature of the *Worcester* is the granting of a number of cadetships tenable in the ship by the P. &. O. Co. Realising, as so many other companies have, that something would have to be done to maintain the supply of junior officers, the P. & O. Co. a few years ago decided to make their own arrangements, and accordingly invited a number of applicants to pass an examination, arranged with the authorities, for the entry of some 15 or 20 young men annually, with the object of eventually becoming officers in their service. The P. & O. Co. accordingly advertise periodically that they will pay half the apprenticeship premium (amounting usually to about £50) for boys passing the test. On the expiry of the three years' apprenticeship such cadets pass automatically into the company's service as junior officers to work their way up through the various stages to command. This unique offer has resulted in a large number of boys adopting the profession, and has proved alike successful from the point of view of the boys and the company.

Other notable advantages are appointments in the Bengal (Hooghly) Pilot Service and the Indian Marine. Both these services offer good openings, with the possibility of a pension and a liberal scale of pay.

In the first-named service the scale of pay and allowances (which includes a second-class passage to Calcutta with a grant of £20 towards outfit) is as follows :—

Leadsman	Rs. 100 a month
Second mate leadsman	,, 125 ,,
First mate leadsman	,, 150 ,,
First mate leadsman passed as mate pilot	,, 175 ,,
Mate	,, 400 ,,
Master	,, 700 ,,
Branch pilot	,, 1,000 ,,

and in the Indian Marine :—

Commanders, ranging from Rs. 350 to Rs. 500 per mensem, in addition to staff or command pay.

Lieutenants on completing eight years' seniority	On Rs. 300 per men.
Lieutenants on completing six years' seniority	,, 250 ,,
Lieutenants on completing three years' seniority	,, 200 ,,
Lieutenants under three years' seniority	,, 150 ,,
Sub-Lieutenants	,, 125 ,,
Sub-Lieutenants	,, 100 ,,

It will thus be seen that for the boy fortunate to commence his nautical career under these auspices, there are several excellent appointments open should he tire of the merchant service and seek new fields.

APPRENTICESHIP.

Following the course of preliminary training comes the three years' sea service, requisite before the young man can sit for his Board of Trade examination as second mate—the first rung on the ladder that leads to command; and here some consideration of the particular method of sea training requires to be considered.

In the first place, as everyone knows, the picturesque sailing ship is fast disappearing from the waters, and it is to be anticipated that in a few years more it will have entirely vanished from the British merchant marine.

The more's the pity, for in these vessels the great body of present-day commanders were trained, and it is doubtful whether the facilities afforded by steam training will produce an equally excellent type of officer. At the same time there are many who hold the opinion that in an age in which mechanics play such a large part, the time spent in sailing ships is wasted. Witness the Navy, where masts and yards have long ago been displaced.

The boy, however, still has an opportunity of getting his first taste of sea life in sailing ships, and many take advantage of it.

Of the firms still owning these vessels, mention may be made of Messrs. Devitt & Moore's two fine vessels, specially designed for carrying apprentices; the Inver Line, owned by Messrs. George Milne & Co., of Aberdeen; the White Star Line, whose fine vessel the *Mersey* is also specially commissioned for sea training; John Stewart & Co., of London; Company, the British India Steam Navigation Company, the New Zealand Shipping Company, the Bucknall's Steamship Lines, and the Harrison Line of London, George Thompson & Co. of Aberdeen, Walter Runciman & Co. of Newcastle, the Wilson Line of Hull, and others too numerous to mention.

Sufficient has been said to show that there are numberless opportunities for boys to gain experience of sea life, with the added advantage of a good sound nautical education.

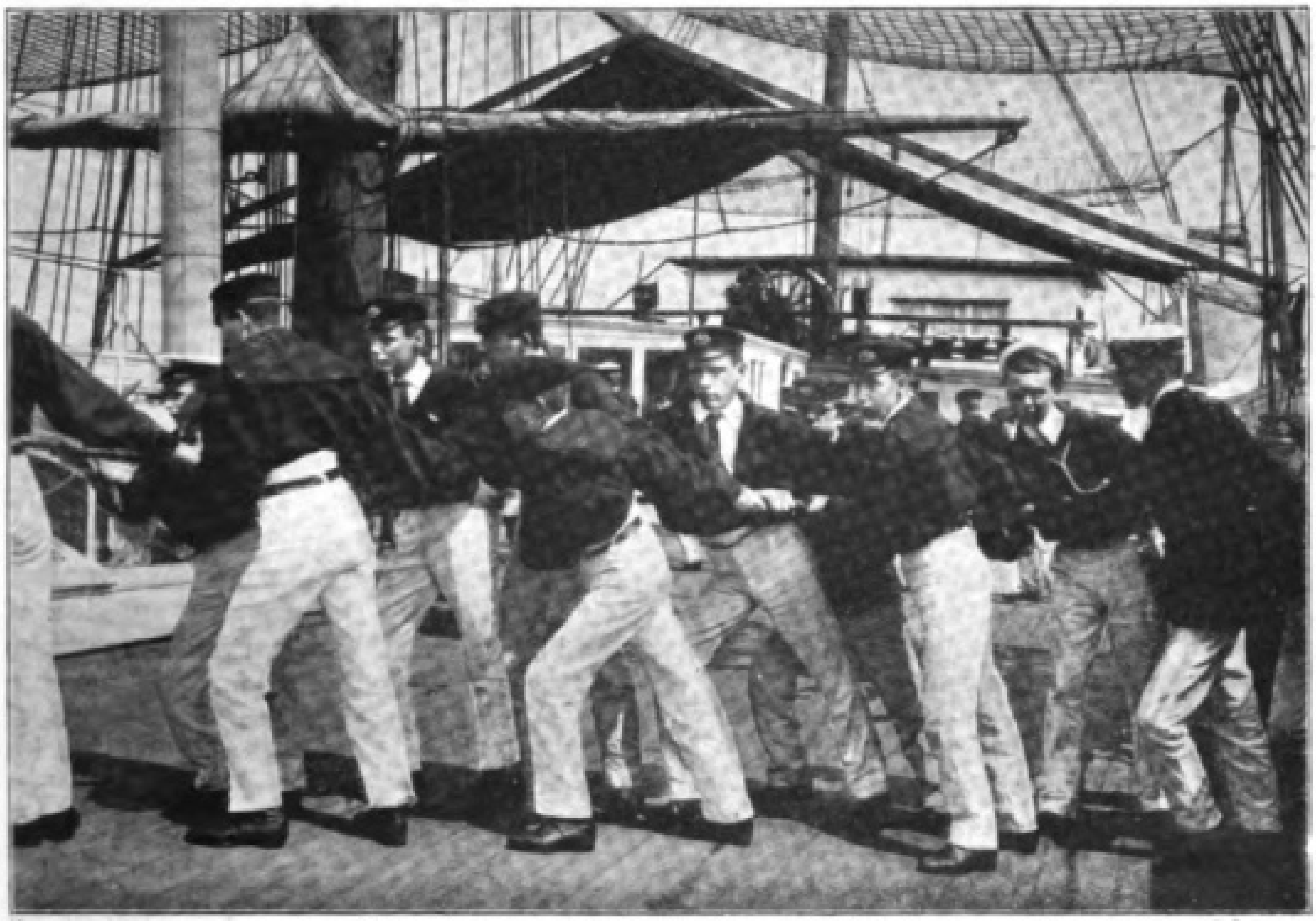


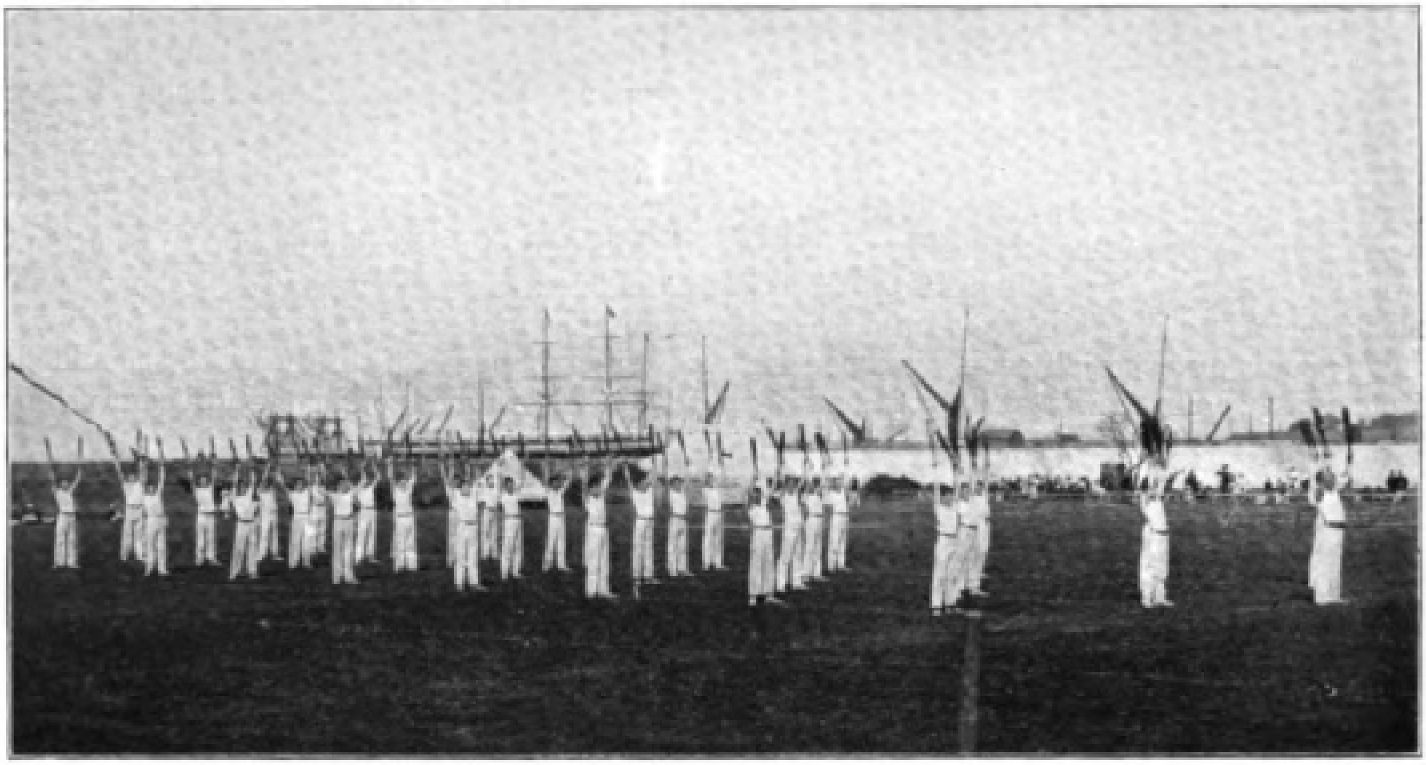
Photo by] *[Barratt*

Hoisting Boats on H.M.S. "Worcester."

Thomas Law & Co.; Crawford & Rowat, of Glasgow; and several others. All these afford a splendid training at varying premiums.

Until within the past few years few steamship companies carried apprentices, but with the rapid growth of tonnage more officers are required, and so many of the largest companies have taken upon themselves the training of their future officers. Particulars have already been given as to the steps taken by the P. & O. Company, and others have fallen in line. Such are the Royal Mail Steam Packet

As to the cost of apprenticeship, it is difficult to give any very definite figures. Some companies do not require premiums at all, others demand anything from £10 to £50 or £70, and return all or a large portion in the form of wages. In this respect the ships of Devitt & Moore's and the White Star Line are on a different footing, as these have special schemes which include a certain amount of scholastic as well as nautical training. Particulars, together with a deal of other useful information, will be found in "How to go to Sea in the Merchant Service," published by James Brown & Son, of Glasgow.



H.M.S. "Worcester" Boys on their Sports Field.
An Indian Club Display.

The question will naturally be asked as to what are the prospects, after spending time and money in equipping a boy for the sea? To this the reply may at once be given that for every youth who has a mind to give himself up to his profession, there is the possibility of obtaining command of a fine ship with a good income.

Pay of Officers.

The commander of a first-class passenger steamer can earn as much as £800, and in some cases £1,000 per annum, but these figures are only reached after many years' service, and naturally it is not every boy who can hope to arrive at the top of the tree. Still, the pay of the service has recently been increased, and the conditions generally open to these cadets are much better than obtained ten years ago. In good-sized passenger ships the pay of the various grades may be roughly summarised as follows:—Large passenger steamers: Chief officer, £14–£20 per month; second officer, £10–£13; third, £8–£9; fourth, £7–£8 10s.; fifth (where carried), £6. Cargo steamers: Chief officer, £10–£12; second, £8 10s.; third, £7–£8; fourth (where carried), £6 10s. In addition, some of the companies give annual bonuses of from £25–£50, according to rating.

Life on a Training Ship.

There is very little difference between the mode of life on the ships catering exclusively for officers. Each, of course, has its own little singularities of *régime*, but all are organised on similar lines. But to give an idea of such life we will take a particular example, and there is none better for this purpose than that of the *Worcester*. It is a model training ship, and in the same way as its system of education is typical of this class of training, so life on board, as the writer's personal experience can prove, is typical of all similar institutions.

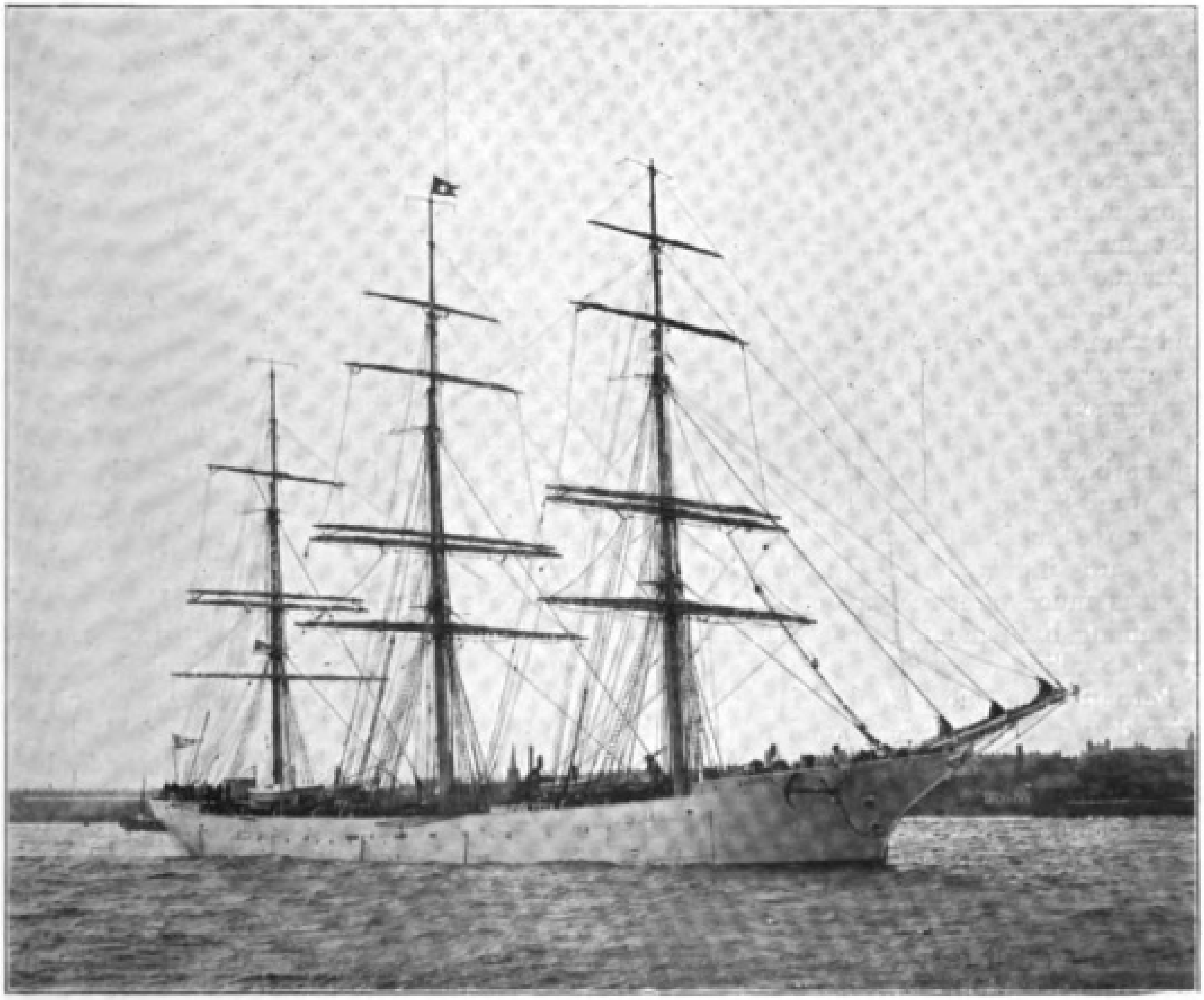
One of the old "wooden walls" of England, the ship presents an attractive sight as she lies slightly swaying on the waters at her moorings in the Thames off Greenhithe. She looks so spick and span with her white painted ports and spotless decks that it is difficult to believe she was laid down 80 years ago—in September, 1833, to be precise.

Since those days what wonderful changes have taken place in marine propulsion. To imagine the old ship now as a fighting machine with 74 guns is to conjure up an absurdity, yet for 26 years the noisome steam-engine knew her not; one might say she maintained her virgin purity until the year 1859, when she was fitted out as a screw steamer, and her original name of the *Royal Sovereign* was changed to that of the *Frederick William*.

She did not, however, long survive as a commissioned ship, for in 1868 she was paid off at Portsmouth, and later handed over to the *Worcester* committee to again undergo transformation. Her boilers and engines were taken out, and she was refitted in the style she now presents, being rigged aloft in modern sailing ship fashion in the main, and in the old style in the fore and mizzen masts. When in commission she had a complement of 418 men besides the captain and officers, whilst now she affords accommodation for some 170 cadets and a staff of 30. The first thing that strikes the visitor on stepping aboard is the cleanliness and orderliness of everything about her. Her stern is surmounted by the poop, where are the private quarters of the captain-superintendent. At the fore end is the topgallant forecastle, where the galley—equipped with the most up-to-date cooking arrangements—and the cabins and workshops of the carpenter and chief cook are situated.

The upper deck is broad and spacious, and in fine weather is a splendid playground for the cadets, offering as it does glimpses of the many interesting craft continually passing up and down the river. Here the usual nautical games, such as "sling the monkey," are indulged in. On the starboard side is a 4-inch breech-loading gun for exercising the Royal Naval Reserve cadets.

The classes are held on the main or school deck, each class being divided into divisions for scholastic work, and sections for seamanship. These latter are again divided into "tops," as main, fore and mizzen. The fore part of the main deck is taken up by the mess room, where all meals are served, being presided over by the cadet captains.



The White Star Line's Sea-going Training Ship "Mersey."

When meals are piped in true nautical fashion, the mess room becomes alive with dozens of strong healthy-looking youngsters, with animal spirits only equal to their appetites.

The lower or sleeping deck is reached by the ladder, and reveals a serrated row of neatly-slung bunks, which are hooked up in the daytime so as to leave plenty of space. Each cadet is responsible for the cleanliness and tidiness of his particular quarters, and thus early learns habits of discipline which should serve him in good stead when he once gets afloat.

Abaft the mainmast is a hatch that leads to the library and model room, and below this again are the gymnasium and engine room, fitted out with electric dynamos, which serve the double purpose of lighting the ship and affording a means of instruction for the cadets. Such, briefly, is the *Worcester*, and it is safe to say that no healthy boy could fail to enjoy his life amongst such surroundings.

The daily routine is carried out as near as possible to that of a sea-going vessel. The cadets are turned out at 7 a.m., and after breakfast stow hammocks and sweep decks. Then come three hours of schooling, with a short interval for amusement. Afterwards seamanship and drills are taken, and then dinner. The afternoon is again devoted to school work, followed by clearing decks, and then tea. The gymnasium and library occupy the rest of the day, with an interval for supper, and at 8.30 prayers and "lights out."

The boys are allowed ashore on Wednesday and Saturday afternoons, when they repair to the fields where cricket, football, etc., are indulged in. In the summer months much practice is obtained in the swimming bath moored near the ship, and by boat-sailing.

Perhaps the most looked-for event is prize day, when the friends and relations of the cadets, by the invitation of the committee, journey down the river to witness the distribution. On these occasions the ship is always visited by some distinguished person, who addresses the cadets; and many valuable prizes, granted by shipowners and others interested in the shipping industry, are regularly distributed.

Although the greater part of this article is devoted to the training of officers, we will—it would not do to finish without—glance at what is being done towards supplying fo'c'sle hands for the mercantile marine, and in considering the various ships devoted to this branch of the service, it is necessary at once to discriminate and classify.

They may be divided into two types—I., voluntary training ships; II., industrial school ships. A third might be added—*viz.*, the reformatory ships, but they scarcely come within the scope of this article. The first class cater entirely for boys of good character and poor parentage, and the second for boys who have committed some minor offence but have not been convicted. It is only fair to say that this last class make equally good seamen.

To the first type belong the *Arethusa*, *Warspite* and *Indefatigable*, and the shore establishments of the Lancashire Navy League and National Sea Training Homes and the Watts Naval Training School; to the second, the *Clio*, *Wellesley*, *Mount Edgcumbe*, *Southampton*, *Empress*, *Mars* and *Formidable*, the last a shore establishment. From this group of ships a very large proportion of the fo'c'sle hands are drawn, so much so that the remarks in the first part of this article applying to the necessity of preliminary training for officers may also here be made in the case of seamen. A glance at the education afforded in one of these ships, to each of which attaches a history, is typical of the majority. We select the *Indefatigable* at Liverpool. Here the boys are well grounded in the three "R's" under the rules of the Board of Education, and in addition such subjects as the following are taught: algebra, mensuration, mechanics, signalling, navigation, meteorology, rule of the road, advanced geography, seamanship, and wireless telegraphy, consisting of transmitting and receiving messages by the buzzer circuit, a 400-ft. silicon bronze wire (two-fold) being stretched between three masts, two feeders being brought down to the receiving office aft. Messages are read from Cleethorpes, Poldhu, Clifden, Eiffel Tower (Paris), and other stations, at the rate of 17 to 20 words a minute. It will be seen that the *Indefatigable* specialises in this last science, as it is generally recognised that smart boys can be well placed as assistant operators, with a surety of advancement at good wages. The period of training varies in the different ships from twelve months to three years, and on the completion of their training the boys are found berths at about £1 per month to start with, all found. After three years' sea experience they become able seamen at about £5 per month. The most intelligent of the lads do not, however, stop here. The education, both technical and scholastic, has enabled many of them to rise to the position of master of a ship, and indeed, in one case at least, to becoming a post-captain in the Royal Navy. The recent decision of the Government to make a grant of £10 per head per annum towards the training of these boys as seamen will enable the training ships to add to their sphere of usefulness, which, it may be mentioned, rely very largely upon contributions from the philanthropically disposed public. They are all in need of support, and, offering as they do a healthy, vigorous life to the youth of the nation, are most deserving.

Teaching Wireless on the "Lancashire."
This is one of the Navy League and Sea Training Homes.

CAPE RACE STATION

The wireless telegraph station at Cape Race, which is operated by the Marconi Wireless Telegraph Company of Canada for the Canadian Government, has been temporarily put out of action through a fire which occurred there on May 5th. Fortunately New York and Boston bound ships are now on the extreme southerly course, on which a number of them pass beyond the range of Cape Race station. The ships now on the southerly track communicate as usual with Sable Island, and by means of re-transmission by ships in the neighbourhood, the telegraphic communications will not adversely suffer. It is hoped that the Cape Race facilities will be restored some long time before the ships change to their northerly track.

Long Distance Wireless Telegraphy

Report of the Advisory Committee to the Postmaster General

ON January 23rd, 1913, a Committee was appointed by the Postmaster-General (the Right Hon. H. L. Samuel) to consider and report on the merits of the existing systems of long-distance wireless telegraphy, and in particular as to their capacity for continuous communication over the distances required by the Imperial chain. In view of the urgency of the question, the Committee was desired "to report as soon as possible, and in any case within three months from the date of their appointment."

The constitution of the Committee was:

The Right Hon. the Lord Parker of Waddington (Chairman).

W. Duddell, F.R.S.

Dr. R. T. Glazebrook, C.B., F.R.S.

Sir Alexander B. W. Kennedy, F.R.S.

J. Swinburne, F.R.S.

E. H. Rayner (Secretary).

The following is the report of the Committee, which is dated Royal Courts of Justice, April 30, 1913:

Report

To the Right Hon. H. L. Samuel, His Majesty's Postmaster-General.

SIR,—Under the terms of our appointment we are requested to report, within three months, on the merits of the existing systems of long-distance wireless telegraphy, and in particular as to their capacity to fulfil the requirements of the Post Office for the proposed Imperial chain of wireless telegraphic stations. These requirements involve continuous communication between station and station by day and night over land and water and over distances of between 2,000 and 2,500 miles.

2. Immediately after our appointment we took measures to ascertain what systems of wireless telegraphy there were in existence, and by whom such systems were controlled. These systems appear to be the following :—(1) the Marconi, controlled by the Marconi's Wireless Telegraph Company, Ltd. ; (2) the Telefunken, controlled in this country by Messrs. Siemens Brothers ; (3) the Poulsen, controlled in this country by the Universal Radio Syndicate ; (4) the Goldschmidt, controlled by the Anglo-French Wireless Company ; and (5) the Galletti, controlled by the Galletti's Wireless and Telephone Company.

3. We also advertised with a view to ascertaining whether there were any new inventions or improvements in apparatus employed in wireless telegraphy, the consideration of which might be useful for the purpose of our inquiry, but such advertisement led to no useful result.

4. It appears, however, that the Admiralty, while in the main making use for communication between his Majesty's ships and shore stations and between ship and ship, of apparatus similar to that employed by the Marconi Company, claim nevertheless to have introduced important improvements. These improvements may be of some materiality ; for the Admiralty desire that each station in the proposed chain shall be capable of communicating with His Majesty's ships. It should be considered, therefore,

whether any system adopted by the Post Office for the purposes of the Imperial chain ought not to be capable of being worked in conjunction with the Admiralty appliances, especially as to the wave lengths to be employed.

5. Having ascertained the various systems into the merits of which we had to inquire, we decided, after consulting the firms by whom such systems were controlled and with their approval, that our meetings should be held in private, and that all evidence given before us on their behalf should be treated as confidential. This was, in our opinion, necessary in order to obtain the fullest information from business rivals.

6. We have heard evidence on 11 days. In Part I. of the First Schedule to this report will be found the names of the several witnesses called on behalf of the firms controlling the several systems of wireless telegraphy to which we have referred. In Part II. of the same schedule will be found the names of the several witnesses who attended to give evidence at our request. We have also personally visited and inspected the several stations and works mentioned in the Second Schedule to this report.

7. For wireless telegraphy two kinds of plant are required; one for sending and the other for receiving. At the sending station there is power generating plant consisting of steam or internal combustion engines and their accessories or electric motors driven off some available power supply circuit. There is a generator of electric power giving the electrical pressure and current necessary for the devices used in the next step. The apparatus used in the next step may be called the high frequency generator and this takes many forms. Finally, there is the aerial to which the high frequency generator supplies energy, the supply being controlled by the operator's key or by automatic sending mechanism. At the receiving station there is also an aerial and some detector apparatus enabling the signals to be heard with a telephone or to be recorded automatically. Automatic recording apparatus is always necessary in the case of high-speed transmission.

8. The term "System of Wireless Telegraphy" is not really apt. Each company or firm engaged in working a wireless station uses apparatus protected by its own patents and has to avoid the use of apparatus and devices protected by the patents belonging to other companies or firms. The main differences in the apparatus and devices at present in use centre in the high-frequency generator; but there are other apparatus or devices protected by patents, such as special aerials, different types of automatic high speed transmitters and of receivers and recorders. Any company or firm which makes use of apparatus or devices which others are precluded from using because of the existence of some patent may claim to have its own system of wireless telegraphy, but the term "system" is misleading, inasmuch as by far the major portion of the buildings and plants could with minor modifications be used equally well with any high-frequency generator or other patented device.

9. The existence of a patent may seriously interfere with the normal development of an industry, for it tends to prevent the general use of the means best adapted for securing the end in view. It may well be that a competent engineer, if asked to erect and equip in the most efficient manner a chain of wireless stations such as the Post Office contemplates, would desire to combine apparatus, the combination of which is difficult if not impossible because of the existence of patent rights. In this connection we desire to lay stress on the fact that the Government is not fettered by considerations arising out of patent rights, but can use any patent on fair terms under section 29 of the Patents and Designs Act, 1907.

10. Subject to the above criticism on the use of the word "system" the existing systems of wireless telegraphy may be

divided into two classes according to the type of high-frequency generator used. In the first class, the production of high frequency currents depends on spark discharges giving groups of oscillations, and therefore intermittent trains of ether waves In the second class, the generator produces oscillations which for practical purposes may be treated as continuous, and therefore as giving continuous ether waves.

To the first class belong the Marconi and Telefunken systems, and to the second class the Poulsen, the Goldschmidt, and possibly the Galletti systems.

The Poulsen high frequency generator is a modification or development of the singing arc fed by direct current.

The Goldschmidt high-frequency generator is a dynamo, giving an alternating current of a fundamental frequency of the order of 10,000 periods per second. The frequency is increased by the use of suitably tuned oscillation circuits, each successive circuit adding the fundamental frequency of the machine.

The Galletti generator involves a series of spark gaps arranged to operate in a cycle so that the discharge of each causes, and is immediately followed by, the discharge of the next in the series, the sequence of discharges being so rapid that the resulting oscillations may be viewed as practically continuous.

11. Though at present making use of generators depending on spark discharges producing groups of oscillations, both the Marconi Company and the Telefunken Company are developing and experimenting with generators of their own, producing continuous oscillations. The Marconi continuous high-frequency generator consists essentially of a rapidly rotating contact maker in a direct current circuit with special dispositions of other circuits to give continuous oscillations in the aerial. The Telefunken continuous high-frequency generator consists of an alternator constructed to give as high a fundamental frequency as may be convenient in the first instance, the frequency being doubled or quadrupled by a polarised transformer method. In making use hereafter of the term Marconi system or Telefunken system, we do not include either of these generators.

12. In order to test the efficiency of the various systems to which we have referred for the purposes of the Imperial chain, we invited the companies or firms by which these systems are controlled to give us practical demonstrations thereof, if possible on a commercial scale, and if possible over distances of 2,000 miles and upwards. Except in the case of the Marconi system we did not, however, obtain any demonstrations on a commercial scale, or any demonstration over a distance of even 1,000 miles. It is right, however, to state that, according to the information given to us, it was in several cases impossible for the companies concerned to arrange for the demonstration as desired within the short period which we could allow for the purpose.

13. In order that we might test the Marconi plant at Clifden, the Postmaster-General permitted us to avail ourselves of the services of a small staff of skilled operators, who stayed there for a complete week, keeping continuous watch on the actual commercial working between Clifden and Glace Bay, and reporting to us very fully. These reports, for which the Committee acknowledge their indebtedness to Mr. S. E. J. Burrow and his assistants, contain full and valuable evidence as to the commercial working of the plant now in use.

14. We then went to Clifden, and the Marconi Company put the station at our disposal. Through the courtesy of the Canadian Government, we were represented at Glace Bay by Mr. C. P. Edwards, general superintendent of the wireless service of the Canadian Government, who had the assistance of one of his operating staff. Mr. Edwards was provided with a number of sealed messages by our Secretary, and he was instructed to open and superintend the

transmission of these when and as requested by the Committee at Clifden, and to take charge of similar messages sent from Clifden to Glace Bay, and to send them by post to the Secretary. Mr. Edwards made reports and comments from time to time during our visit, and despatched a detailed account to us later.

15. The Marconi Company use at their Clifden station a high-frequency generator, in which condensers charged from the high tension batteries are discharged by projections which are fixed on a rapidly rotating wheel, and which pass close to metal discs on each side of it. Each discharge produces a group of high-frequency oscillations in a primary circuit, according to the Company's usual practice. We observe that, for the purposes of the Imperial chain, they proposed to charge the condensers from an alternator through a high-tension transformer, as is their practice elsewhere, including the long distance station at Coltano. This method is in our opinion preferable.

16. At Clifden the Marconi Company use their directive aerial; and they have a second separate station for receiving from Glace Bay without being disturbed by the simultaneous sending at Clifden. They demonstrated duplex working while we were at Clifden and Mr. Edwards was at Glace Bay, all interference of the outward waves being eliminated, though the strength of the received signals was somewhat reduced.

17. The Marconi Company is, we are satisfied, working on a commercial scale between Clifden and Glace Bay, a distance of about 2,300 miles, though at present the number of messages transmitted either way is not so great as to require duplex working or high speed transmissions. We were, however, present when messages were transmitted automatically at the rate of 60 words (of five letters) a minute, and we see no reason why this rate should not be considerably increased if it becomes necessary. The communication is practically continuous, though there are, no doubt, periods when the signals become very weak, and even occasional periods when no signals can get through. Periods of this nature are due to natural conditions, and will be incident to the working of any system. During such periods communication can, in our opinion, be insured only by the use of great power in the aerial. We understand that for this reason, and having regard to the increased power required for high speed transmission, the Marconi Company proposed to employ for the Imperial stations practically double the power now used at Clifden. Even so we think there may be periods when communication is impracticable, especially in tropical regions where atmospheric disturbances may be expected to cause more difficulty than over the Atlantic.

18. With regard to the Telefunken system, which, like the Marconi, is largely used, its practicability on a commercial scale for distances of 2,000 miles has not yet been proved. Experiments are now being made between Nauen and Togo, a distance of 4,000 miles, and the results indicate that communication over this distance is already possible at night.

19. With regard to the Poulsen system, we are satisfied that it is practicable for short distances. The Poulsen arc has been tried between San Francisco and Honolulu, a distance of about 2,100 miles, but as to its practicability over this distance we have n. evidence except that which was in the possession of the Post Office long before our appointment. The results obtained do not appear to have been very satisfactory. In our opinion the power used was insufficient. No one tendered any evidence on behalf of the Company which is working between San Francisco and Honolulu, and the firm controlling the system in this country was apparently in ignorance of how it is now working in America. We have recently been informed of important experiments between Arlington and the U.S.S. "Salem"

and between Arlington and Gibraltar, using both the arc and spark transmission; but full details are not yet before us. We conclude that if the Poulsen system is to be so developed as to be practicable for commercial purposes over distances of 2,000 miles or upwards, the arc will have to be constructed so as to supply the aerial with higher power, or use will have to be made of a more sensitive receiver.

20. Similarly, with regard to the Goldschmidt system, it is no doubt successful over short distances, and the only thing required to make it practicable over long distances is a machine of the necessary power. When the Goldschmidt station near Hannover and the corresponding station on the other side of the Atlantic are complete and in working order, we expect that communication between them will be established by the use, either alone or in conjunction with improved receiving apparatus, of the Goldschmidt machine which we inspected at the station near Hannover, and which was admirable both in design and workmanship

21. Though continuous waves may be somewhat more efficient than intermittent trains of waves, and though the strength of the received signals may probably be increased by the use of improved receiving apparatus, we are of opinion that having regard to the experience of the Marconi Company, and in view of the demand likely to arise for high speed transmission, it would be desirable in the first instance to insist on high powers for the Imperial chain whatever system be adopted. At present, with the exception of the Goldschmidt machine at the station near Hannover, we have seen no continuous high-frequency generator capable of putting into the aerial as much power as is put in by the Marconi Company at Clifden for their Transatlantic service.

22. We may add that both the Poulsen arc and the Goldschmidt machine are admirably adapted for high speed transmission. Though we have not seen transmission by either at a higher speed than in the case of the Poulsen arc 70, and in the case of the Goldschmidt machine 60 words a minute, we have no doubt that these speeds could be increased.

23. We have had no evidence as to the practicability of the Galletti system even over short distances.

24. We report, therefore, that according to our investigation the Marconi system is at present the only system of which it can be said with any certainty that it is capable of fulfilling the requirements of the Imperial chain, but this must not be taken to imply that, in our opinion, the Marconi Company must necessarily be employed as contractors for all the work required for the Imperial chain. Indeed in some respects it might, we think, be better for the Government themselves to undertake the construction and equipment of the necessary stations, acting for that purpose under the best technical and scientific advice which can be obtained, and employing the most suitable contractors for the various portions of the work or plant. On the other hand, it may be said, and is no doubt the fact, that at the present moment the Marconi Company alone has had practical experience of the sort of long distance work required, including experience in putting down stations, in organising the traffic and staff and in coping with the difficulties that arise in a new industry, and the value of such experience and organisation may well outweigh other considerations, if rapid installation and immediate and trustworthy communication be desired.

25. Further, in our opinion, wireless telegraphy is in a condition of rapid development, and this development will in all probability involve the ultimate substitution of high-frequency generators producing continuous oscillations for high-frequency generators dependent upon spark discharges which produce groups of oscillations. Continuous oscillations should allow of more accurate tuning and greater selectivity, and may be better adapted for use in conjunction with improved receiving apparatus. The

need of high-frequency generators producing continuous oscillations has long been felt by telegraph engineers, and has led to the various devices for the generation of continuous high-frequency oscillations to which we have already referred.

26. The only continuous high-frequency generator we have yet seen tried with success over long distances is the Marconi continuous high-frequency machine to which we have already referred. For the purpose of witnessing transatlantic experiments with this machine we paid a second visit to Clifden, and experiments were made with it in our presence. Using it, Mr. Marconi, on the 26th and 27th of April, 1913, sent from Clifden to Glace Bay messages prepared by us for the purpose, such messages being at our request at once repeated from Glace Bay by means of the Company's ordinary plant and correctly received at Clifden. The power put into the aerial by this machine for the purpose of the experiments was not sufficient for commercial purposes, but there seems no reason why higher power should not be obtained.

27. These experiments, in our opinion, warrant the belief that all or any of the devices for the generation of continuous waves to which we have referred may at no distant date be shown to be capable of successful use for the purpose of long distance wireless telegraphy. Many engineering firms are also engaged in designing high-frequency alternators, and it seems probable that various other devices suitable for long distance wireless telegraphy may shortly be available.

28. Again, there is some evidence that the design of the aerial is in a transition stage. At present there are engineering difficulties in building perfectly satisfactory aerials for the longer waves which appear to be most appropriate to long distance telegraphy. Aerials, especially high aerials, are frequently blown down or damaged by wind.

29. The directive aerial used in the Marconi system has the advantage of not requiring very great height and of giving preference in the desired direction. Its use in connection with the separate receiving station comparatively close to the transmitting aerial makes duplex working practicable. We see no reason why this form of aerial should not be capable of use with any form of high-frequency generator. Moreover, the development of the aerial may facilitate the use of still longer waves for long distance work, and this may profoundly affect the problem of the high-frequency generator, by rendering possible the employment of simple alternators for the production of the frequency required, high though it must still be.

30. Receiving plant may take many forms. Thus the first receiver may be a crystal contact or some discharge valve on the lines of the Fleming valve, and this may work any one of various kinds of relay; and the record may be made by a Morse inker, by photography, by a phonograph, by simple telephone, or otherwise. There is a wide field here for experiment and development.

31. Having regard to these facts it is, in our opinion, undesirable that in constructing and equipping the stations of the Imperial chain the Post Office should be pledged to the continued use of any apparatus now used in any so-called system, or be subject to any penalty by way of continued royalties or otherwise for the disuse of any apparatus which may be installed in the first instance. It is, we consider, imperative that in any contract which may be entered into the Post Office should reserve complete liberty of action in this respect. Further, the stations should be constructed and equipped with a view to the possible and probably rapid development of the art, and we think it would be wise that at any rate two of the stations should be used at once, not only for commercial purposes, but as experimental stations in which the various high-frequency generators hereinbefore re-

ferred to, and also any suggested improvement in any part of the apparatus, should as far as possible be thoroughly tested. This would involve the employment of a highly trained staff with an engineer of special knowledge and of high standing at their head, but the information thus obtained would be invaluable for the construction and equipment or the improvement in the design of the stations.

32. Even when all the stations are constructed, equipped and in working order, we do not think it would be wise to cease using some of the stations for experimental purposes. We have already referred to the possibility that the existence of patents may fetter the normal development of an industry. A Government monopoly may stop its growth altogether, and is almost sure to do so unless the Government department which works the industry is ready to welcome and test any new invention or improvement, to adopt and use it if the test be satisfactory, and to pay for it on fair terms if it be adopted. For the purpose of testing, examining and, if necessary, further developing any new invention or suggested improvement in wireless telegraphy, a trained staff with an engineer of special knowledge and standing at its head will be necessary. Under the guidance of such a staff and engineer we see no reason why the Post Office wireless stations should not be ultimately equipped with apparatus far more efficient than that now used in any so-called system, more especially as the Post Office will be able to combine, in spite of existing patent rights, apparatus or devices which, because of the existence of such rights, cannot now be combined by anyone else.

33. We desire to add that the provisions of the Agreement, now the subject of inquiry by a Select Committee of the House of Commons, are not, in our opinion, within the terms of our reference; but nothing we have said in this report must be taken as expressing our approval of such provisions.

34. In conclusion, we wish to acknowledge our indebtedness to—

The Government of the United States, for placing the aerial at Arlington at our disposal for experimental work across the Atlantic and for other facilities and courtesies, and to the American Embassy for their kind offices in this matter.

The Government of the Dominion of Canada and the High Commissioner for their kindness in providing a representative of the Committee at Glace Bay.

The French Government, for offering the use of the Eiffel Tower for experimental work.

His Majesty's Foreign Office, for facilitating our journeys abroad.

The Lords of the Admiralty for permitting their officers to give evidence, and for showing us their stations and giving us various information.

The Post Office for the use of their station at Cullercoats; for allowing their officers to give evidence; and for lending us a staff of skilled operators to keep continuous watch at Clifden and to be present and assist us at other stations.

We also wish to acknowledge the hospitality of the Goldschmidt Company, who showed us their stations, and all their plant at Slough and at Neustadt near Hannover; the Marconi Company, who showed us their Clifden station, and allowed us to interfere very considerably with their commercial work; the Poulsen Company, who showed us their Lyngby station working, and their large generators at Copenhagen; and Messrs. Siemens, Bros. & Co., and the Telefunken Company, who showed us their station at Nauen.

We also wish to thank Messrs. Bergmann for allowing us to examine the large Goldschmidt machines during construction; to Messrs. Lorenz and to Messrs. Pedersen for showing us their works.

We also wish to express our thanks to the various witnesses. Many of them were eminent men whose time is very valuable.

We are also greatly indebted to the National Physical Laboratory for permission to avail ourselves of the services of our most efficient Secretary, Mr. E. H. Rayner, whose assistance has been of real value.

PARKER OF WADDINGTON.
W. DUDDELL.
R. T. GLAZEBROOK.
ALEX. B. W. KENNEDY.
J. SWINBURNE.
E. H. RAYNER, *Secretary*.

NAMES OF WITNESSES HEARD ON BEHALF OF THE COMPANIES OR FIRMS INTERESTED.

Dr. R. Goldschmidt (Goldschmidt).
Dr. J. Erskine-Murray (Goldschmidt and Poulsen).
Mr. Rappis (Galletti).
Mr. G. Marconi (Marconi).
Mr. Hird (Telefunken).
Professor Pedersen (Poulsen).
Mr. Campbell Swinton (Poulsen).
Professor Silvanus Thompson, F.R.S. (Poulsen).

NAMES OF WITNESSES INVITED BY THE COMMITTEE TO GIVE EVIDENCE.

Vice-Admiral Sir Henry B. Jackson.
Commander W. R. W. Kettlewell, R.N.
Lieutenant D. W. Roe, R.N.
Lieutenant J. A. Slee, R.N.
Commander Loring, R.N.
Mr. H. A. Madge.
Mr. J. E. Taylor.
Sir Oliver Lodge.

STATIONS AND WORKS VISITED.

The Admiralty Station, Whitehall.
The Admiralty High Power Station, Horsea.
H.M.S. "Vernon."
The Goldschmidt Station, Slough.
The Marconi Station, Clifden, Ireland.
Messrs. Bergmann's Works, Berlin.
Messrs. Lorenz's Works, Berlin.
The Telefunken Station, Nauen.
The Poulsen Works, Copenhagen.
The Poulsen Wireless Station, Lyngby.
The Goldschmidt Station, Neustadt, Hannover.
The Post Office Station, Cullercoats.

A View of Clifden Station

The Imperial Wireless Scheme.

MR. MARCONI'S EVIDENCE BEFORE THE SELECT COMMITTEE.

MR. G. MARCONI gave evidence before the Select Committee of the House of Commons on the Marconi agreement on Wednesday, May 7th, and he presented a long statement which gave in outline the history of wireless telegraphy.

At the commencement of his statement Mr. Marconi pointed out that all the distances referred to by him in his evidence were measured in sea miles, with some exceptions, which he mentioned. In passing, he drew the Committee's attention to the fact that many of the distances between certain points already cited by former witnesses to the Committee must have been given without any attempt at verification, and were wrong in nearly every instance—that was, they were greatly overestimated where they were mentioned in connection with other systems, and underestimated when dealing with the Marconi system. The distances referred to by Mr. Marconi had been measured by him, and his figures confirmed by both a sea captain and an ex-lieutenant of the Royal Navy. He recalled that it was no longer ago than 1896 that he took out in this country the first patent for electric-wave telegraphy. He traced the growth of the art from the days in which it was being tested over a distance of a few miles on Salisbury Plain until the present time. A notable occasion was that in March, 1899, when the first wireless message crossed the English Channel, and another was his discovery, as the result of an experiment, that the curvature of the earth did not interfere with the transmission of his signals. This it was which led him to attempt to send messages across the Atlantic, and he told how, when that feat had been accomplished, *The Times* availed itself of the new method of news transmission.

In a reference to his patents, he spoke of the directional horizontal aerial which he had devised and tested during the war in Tripoli. By this method, it would be possible to secure results equal to those with a mast of great height, some two or three times the height of the Eiffel Tower; but apart from the excessive comparative cost of such a mast, engineering science has not yet proved such a construction practicable, and were it so proved it would still lack the other advantages which are derived from the more economical system of a number of smaller masts which are used for the purpose of the directional horizontal aerial.

With regard to continuous waves Mr. Marconi said:

"During 1907 I patented and developed a system for producing and utilising continuous waves, and a long series of tests were carried out at Poldhu and other places to ascertain whether it would be best to adopt continuous waves or discontinuous waves for commercial long-distance work. The result of these tests showed that the efficiency of continuous or discontinuous waves in respect to the power employed was about equal, but the discontinuous waves or intermittent waves, radiated and received in the special manner which I had devised, proved conclusively that they possessed the advantage of being far less interfered with by other stations or atmospheric disturbances. For this reason we adopted discontinuous waves for the long-distance stations which my company was erecting in Ireland, Italy and Canada. I should, however, like to make it quite clear that the system of intermittent waves adopted at Clifden and Glace Bay is by no means the ordinary spark method of 'spasmodic impulses,' as referred to by Mr. Taylor, and it is surprising to me that one who should give evidence as an expert should have so exposed his complete ignorance of anything but elementary wireless telegraphy.

"Without going too much into technical matters, I may say that the high-speed disc dischargers which I patented in 1907 are one of the notable features of these stations, and possess the following advantages :—

"1. They cause to be radiated trains or groups of electric waves of low damping, which groups, in consequence of their high frequency and regularity, produce a clear musical note at the receiving end, which is easily distinguishable from the noises or notes produced by other stations or by the effects of free atmospheric electricity.

"2. Due to their high frequency and regularity, they also enable employment of high-speed senders and receivers, just as can be done by continuous waves.

"3. The spark gap is closed and, for all practical purposes, eliminated during most of the time in which one wishes to transfer the energy to the aerial.

"4. The primary circuit being suddenly opened, immediately quenches any further oscillations in the condenser circuit and prevents the reaction referred to by a witness, and which takes place under certain conditions between the aerial and the condenser circuit when the ordinary spark method is employed, with the result that by my disc system, instead of two bad waves, one pure wave is radiated ; but of these most important developments of my system for long-distance work neither Mr. Madge nor Mr. Taylor would appear to have any knowledge whatsoever, or if they had the knowledge they certainly abstained from mentioning it.

"In October, 1907, although I did not yet consider the stations complete, a service of Press messages was inaugurated between England and America. On February 3rd, 1908, the service was extended to ordinary commercial messages between London and Montreal. The commercial service across the Atlantic by my system has never been discontinued from that date until now, except for a few months in 1909 and 1910 in consequence of the station at Glace Bay being partially destroyed by fire. Although these stations at the commencement worked only a few hours daily, in order to allow for experiments, I found that by the end of February, 1908, about 119,945 words of Press and commercial messages were transmitted across the ocean by this means.

"A number of interesting tests with the Clifden installation were carried out in September and October, 1910, with a view of obtaining some data as to the maximum range of that station. These tests were carried out with an Italian ship, *Principessa Mafalda*, and it was found that short messages could be obtained without difficulty by day up to a distance of 3,473 nautical miles from Clifden, the ship being then in the tropics en route for Buenos Aires. Signals were received at night from Clifden at Buenos Aires, the distance being 5,849 miles. No failures to receive at Buenos Aires at night being recorded when tests had been arranged would indicate that the night range at Clifden is greater than 5,849 miles."

Mr. Marconi next gave the following information regarding his experience in the matter of wireless telegraphy :

"I have examined and been responsible for the designs and apparatus installed on over 1,000 ships ; I arranged all the details of the wireless plant of four stations of 2,000 and more miles range—namely, Clifden, Glace Bay, Coltana, and Massaua ; and at least twenty other stations in England, America, Italy, Africa, and Spain having ranges of 1,000 miles and upwards. I have crossed the Atlantic sixty times on ships fitted with wireless telegraphy, and have closely observed the working of such stations, and have also considerable experience of the working of wireless on British and other warships, the total time I have actually been embarked on warships running into years. I have also had the rather unique experience of assisting in and being in part responsible for the organisation and working of the wireless service on behalf of the Italian Government at sea and on shore during the recent war between Italy and Turkey, for which work I have just received one of the highest honours it is possible for the Italian Government to bestow. I have travelled over a large portion of the Mediterranean and north coast of Africa during the hostilities, and one of the most important problems with which I had to deal was the elimination of interference or jamming, intentional or otherwise, which was constantly resorted to by the stations worked by the enemy and others, and in this work I was generally successful.

"My four sevens patent of 1900 played an all-important part in the development of wireless telegraphy. It represents what was originally known as my syntonised system, which is the simple spark system, and serves most efficiently for ship and shore and short-distance communications. From then onward I devoted myself to long-distance work, and for that purpose my system differs widely from, although it also embraces, the four sevens patent. This patent alone, however, would be totally ineffective for long-distance commercial service. My long-distance system of to-day comprises a number of important patents, several of which for their purpose I believe to be as important as my four sevens patent, and these, together with my work, experience, and knowledge, combined with that of some 200 able engineers associated with my company, added to many long years of hard work and experiment, entailing an expenditure of £360,000, which amount our long-distance experience and work have cost, constitute to my mind the right which my company had in demanding and receiving what I regard to be but very reasonable terms for the long-distance stations required by His Majesty's Government.

"In addition, however, to supplying the long-distance stations required, His Majesty's Government receives what I contend is further very valuable consideration so long as this contract remains in force—viz., the benefit of all the experience in all parts of the world, in all climates, and in all conditions, of the 200 engineers engaged in our service, and who alone represent an annual cost to my company of close upon £40,000, plus the benefit of my services, advice and inventions, for whatever they may be worth."

Mr. Marconi referred to his own and his company's dealings with the Post Office and the Admiralty. He acknowledged the courtesy and encouragement he had received from the Post Office, but denied that he had been unduly favoured; and as regards the Admiralty, he took exception to the claim that it had evolved a wireless system of its own. In September, 1911, he had inspected the wireless equipment of a British warship, and he maintained that the system in use in it was the Marconi and none other.

He next dealt with the technical points, and particularly with continuous waves, and from this part of his evidence we make the following excerpts:

"My experience in regard to continuous waves covers actual personal experience of the following methods:—

"1. My own method.
"2. The Poulsen arc.
"3. High-frequency alternators.

"In order not to take up too much of the Committee's time I might say straight away that, taking the waves themselves, there appears to be nothing to choose between the relative efficiency over long or short distances, whether the waves are continuous or discontinuous or damped. In regard to wave-tuning pure and simple, in my opinion, when using suitable receivers, tuning is better with continuous than with discontinuous waves.

"But long-distance wireless telegraphy as worked by my company is not dependent only on wave-tuning for obtaining selectivity and the elimination of disturbances, but it relies also on the selective properties possessed to a high degree by the human ear in distinguishing and differentiating various notes and sounds, and also on the fact that a receiver can be accurately tuned to the period of a succession of regular groups of waves properly timed as well as to the period of the waves themselves."

By the help of a diagram, reproduced on p. 167, he further explained this point as follows:

"The first line in the diagram shows continuous waves; the second line shows the waves divided into regular groups, and the third line shows them in irregular groups. By these last waves group tuning is, of course, impossible.

"Assuming the frequency of the waves

is, say, 50,000 per second, if you are working on wave tuning alone, you can only tune to the period of 50,000 per second; but, assuming groups of waves succeeding each other at short and regular intervals of, say, 500 per second, you can tune your receiver also to the frequency of the groups—500 as well as 50,000 per second.

"One therefore has the very marked advantage by this system of being able to receive at two closely adjacent stations different messages transmitted by the same wave length, but each on different group tuning, without any interference the one by the other.

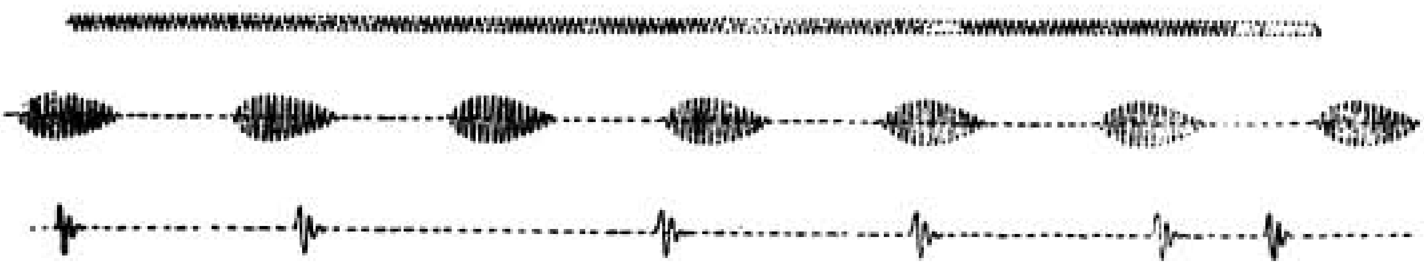
"It is impossible to do this with continuous waves, for obviously, they being continuous, there exist no groups to which a receiver can be tuned.

"The Marconi Company also attach considerable importance to other methods of mine contained in a patent granted in 1911 concerning the balancing of the receiver, which also tend to greatly minimise outside interference.

"It has been stated by a number of witnesses, including Mr. Madge, in his answer to question 6,310 on page 302 of the shorthand notes, that continuous waves require less power than discontinuous waves. (Mr. Madge, however, states in answer to question 5,487, on page 256, that he has no experience of continuous waves.) My personal experience obliges me to say that I am in absolute and unqualified disagreement with such an opinion.

"I may further add that there has never been submitted here or elsewhere one scintilla of evidence to prove that the continuous or undamped waves have any advantage over intermittent or feebly-damped waves for long-distance working in radio-telegraphy.

"Other workers of considerable practical and theoretical experience of wireless telegraphy are entirely in accord with me on this point. Count Arco, in a letter published in the *Electrician* of January 3rd, 1913, which I produce, goes further even than I do. He says that continuous waves require a larger amount of energy than a spark system, no matter whether the continuous waves are generated by arc or by high-frequency machine. Dr. Eccles, in the *Electrician* of January 10th, 1913, copy of which I produce, states in a long article, in which he is discussing purely wave tuning and resonance: 'The conclusion we reach is that the modern spark systems are capable of a very high standard of resonance. The room for improvement is so small that a generator of continuous waves must possess high efficiency inside the station if it is to prove more economical, as regards the prime supply of electrical energy, than the spark method.' In the same issue of the *Electrician* Mr. Llewellyn Preece concludes a letter on the point of undamped versus damped waves with this statement: 'We must conclude that the damped-wave system (that is, what has been called here the spark system) consumes 50 per cent. less energy than the undamped system, assuming equal speed of transmission.'



"Further, *Science Abstracts* of April 13th, 1912, which I produce, on page 203, paragraph 439, quotes Dr. L. W. Austin, who has been referred to in evidence as the expert adviser on wireless telegraphy to the United States Navy, as follows: 'Within the limits of the errors of observation, the ground absorption for the particular part of the country was the same in the case of the undamped and the moderately-damped oscillations.'

"The experience of the Italian Government officials in practical working of wireless telegraphy is second to none. Although the Marconi systems are officially adopted, they are in the habit of trying every other arrangement, which includes those devised by Poulsen, Bethenod, Moretti, and others. This is the only Government in the world which owns a long-distance station capable of communicating regularly a distance of 2,238·5 miles over land and sea, part of which distance is situated in the tropics. The Italian Government, moreover, possess more long-distance stations in actual operation than any other Government, besides eighteen coast stations for communicating with ships. Lieut.-Commander Pession, probably one of the officers who has the most practical and scientific experience of wireless telegraphy in the Italian Navy both in regard to long and short distances, in an article published in the *Revista Marittima*, issue of October, 1912, which I produce, on the subject of modern apparatus for wireless telegraphy, states in regard to the relative advantages and disadvantages of continuous and damped waves: 'It would seem that the best results should be obtained by the use of continuous waves (waves not damped or sustained waves), but one can say at once that the means which are at present known for producing them have not yet become practicable; but, on the other hand, it would appear that with the best receivers at present available it is neither economical nor useful to make efforts to employ such waves.' Count Arco, in a lecture delivered before the German Society of Naturalists and Doctors, which I produce, at their eighty-fourth annual meeting, held in 1912, comes to the conclusion that, in regard to the elimination of atmospheric disturbances or interference, discontinuous waves are very much more efficient than continuous waves. It has, I think, been generally understood by this Committee on the evidence so far given that the so-called Poulsen system is a continuous wave system. I wish to state that there is grave doubt as to whether it is anything of the kind. Professor Fleming, whose competence in the matter has already been referred to before this inquiry, in a lecture before the Royal Institution on May 24th, 1907, which lecture is reproduced in the *Electrician*, June 7th of that year, copy of which I produce, stated, referring to the Poulsen arc: 'It has been contended that these oscillations are undamped and continuous, but I can show you a remarkable experiment with a neon tube which proves that they are not always uninterrupted.' He describes his experiment, and concludes: 'It appears to me that this proves incontestably that the oscillations are not uninterrupted, but are cut up into groups of various lengths.' It might at once be said in criticism that if discontinuous waves are better than continuous waves by the evidence I adduce, Poulsen waves are discontinuous, which would be, therefore, in favour of the system; but I beg to point out, according to the researches of Dr. Fleming and others, the waves of the Poulsen system have been found to be 'cut up into groups of various lengths.' This nullifies at once any advantage of discontinuous waves, because, in order to obtain the great advantages of a discontinuous wave system, these waves should be cut up into regular groups of equal length, as I have shown in line 2 of my diagram, and not into irregular groups.

"My personal experience of the Poulsen arc has taught me that it is extremely difficult of regulation, and that the wave tends to vary continually. This variation of wave-length destroys the advantage which would be derived were the wave continuous and unvarying.

"A paper was published by K. Vollmer in the *Jahrbuch der drahtlosen Telegraphie und Telephonie*, published at Leipzig, issues of December, 1909, and February, 1910, which I produce, entitled 'On the Variations of the Frequency and Intensity of the Oscillations of an Electric Arc.' In this he discusses and describes in detail the variations which take place in the electrical waves produced by the arc method, and he states on page 249: 'These variations diminish in wireless telegraphy the distinctness of the syntonisation and the nominal effect of the current in the secondary receiving circuit.'

"I take it that it would be wrong for practical purposes to merely consider and discuss the abstract scientific question of the advantages of continuous waves. The first important point to ascertain is whether the appliances for producing undamped waves have yet reached the point of perfection in practice which is necessary to gain in reality the advantages claimed; secondly, to discover whether, given the means of producing the continuous waves, any advantage is gained thereby in the matter of efficiency of transmitting and receiving signals; and, thirdly, given that one be satisfied upon the question of efficiency, is it as economical?

"Lecturing before the Royal Institution on May 24th, 1907 (copy of which lecture I have produced), Professor Fleming stated in regard to the Poulsen arc:

"'No one who has worked practically with the apparatus can say that it is a simple and easy one to use. A very little want of exact adjustment causes the arc to be extinguished or else fluctuate greatly in current, and, compared with the extremely simple appliances required for spark telegraphy, the advantage in ease of working is largely on the side of the spark.'

"An interesting and practical proof of the opinions just quoted was demonstrated in a competition which was conducted by the Turkish Army in May, 1911, when the Telefunken system, the Poulsen system, and the Marconi system were in competition for the purpose of demonstrating which was the most efficient system for the Turkish Army to adopt. Trials were carried out during a period of ten days. The Telefunken system failed to get a complete message through until the last two or three days of the trial, and then only at night time; the Marconi system maintained good communication throughout the whole period; the Poulsen apparatus failed entirely; their arc blew out on the average once a minute. The Turkish Army adopted the Marconi system.

"I would draw particular attention to these tests in view of the evidence which has been given before this Committee, that the Poulsen system is believed to be more simple and efficient for short-distance communications. It is unnecessary for me, perhaps, to state that the first essentials for military stations are simplicity, efficiency, and reliability, and military stations such as these are short-distance installations.

"I must say, from my long experience of wireless telegraphy and engineering matters, that I rather hold with Commander Loring in his refusal to attach too much weight to opinions expressed by certain experts. At the Select Committee appointed in 1907 to consider the ratification of the Berlin Conference, eminent experts gave evidence on the subject, I believe, in this very room.

"Sir William Preece, F.R.S., Sir John Gavey, Engineer-in-Chief to the Post Office, and Mr. Nevil Maskelyne all stated that in their opinion the Poulsen system could be used for ships and could communicate or be made to communicate with other systems; and one of them went so far as to predict that it was likely that it would entirely supersede the spark method, and that as time goes on and the Poulsen system is extended, the number of vessels fitted with Poulsen apparatus would become more if not universal (page 182, 2,591). At that time, as far as I can ascertain, four or five ships were equipped with Poulsen apparatus, and 102 with Marconi apparatus. The Convention was ratified by Great Britain, and the alleged disabilities under which other so-called systems laboured were removed. What has been the result? According to the last official return of the systems employed on ships, issued by the Berne office (1911-12), which for the purpose of the working of the Convention represents all the Governments which signed the international agreement, there were then 803 ships fitted with the Marconi system (there are many more now), and not a single one stated to have the Poulsen system. I submit that some of the difficulties of regulation which I have referred to, and which Dr. Fleming described, have been responsible for the non-adoption of this method on ships which have to carry out a commercial service by means of wireless telegraphy, and at the same time must have apparatus on which they can absolutely rely in times of distress.

"As to what weight can be attached to the opinions hitherto given as to the amount of power required for Transatlantic communication, I may refer to the lecture delivered by Dr. Valdemar Poulsen at the Queen's Hall, London, November 27th, 1906, at which lecture Sir William Preece presided. At this lecture Mr. Poulsen stated that Transatlantic communication should be readily obtained by utilising a power of some 10 kw. I produce a report of this lecture. If he referred to occasional communication he was quite correct, for I had already done it with less than 10 kw., but if he was referring to constant communication, as it would appear he must have been, he must have altered his mind since, as I understand that Mr. Gandil, acting on his advice, now proposes to use 150 or 200 kw. for a distance of 2,000 miles (xxiv., page 583, 11,093), and I agree with him that he will require all this power or more if he be able to construct an arc of such a power, and, when constructed, if he can discover the means of effectively utilising that power.

"Although I have made diligent inquiry, I have failed to learn of an arc which has ever yet been constructed to effectively utilise more than 40 kw. of power.

"It is fair that I should admit that, in common with Dr. Poulsen and others, I started also with the idea that long-distance work could be conducted with small power, and it is only as a result of years of hard, active work, without any intermission, and continuous experiment, that I claim to have proved incontestably that, for an efficient commercial wireless telegraph service over long distances to meet the varying conditions of every day in the year, high power is an absolute essential.

"It is quite erroneous to come to the conclusion that the possibility of the application of continuous waves is in any way neglected by the Marconi Company. It at present possesses two methods, patented by myself, of producing and utilising continuous waves. The first is based on the employment of a discovery for producing undamped oscillations, in which discs revolving at a high rate of speed are employed. The second method is a high-frequency alternator. In regard to the first, which has been published and discussed in many technical papers and works dealing with the subject of wireless telegraphy, Professor J. A. Fleming, lecturing at the Royal Institution in 1907 (a copy of which lecture I have produced), stated as follows: 'In the production of continuous oscillations we are not limited to the arc method. Mr. Marconi has for some time past been engaged in developing an ingenious method of creating undamped electric waves for telegraphic purposes, which involved neither an arc nor alternator but is a new mechanical method of great simplicity.

"'This method is capable of producing astonishingly large alternating currents of very high frequency—in other words, so-called undamped or persistent oscillations. I have recently witnessed some of his experiments, and was surprised at the results obtained. Long distances have been telegraphically covered with every prospect of great efficiency.'

"This method was described by me before the Royal Institution, March 13th, 1908, and in my Nobel lecture, copies of which I produce. The experts who have given evidence before this Committee must either have forgotten all about these developments or have been in complete ignorance of them, for not a word did any one of them say in respect of them, yet mine was the only system of continuous waves successfully demonstrated to the Advisory Committee over a distance of 2,000 miles. [See paragraph 26 of Advisory Committee's Report, *Wireless World*, p.161.]

"In regard to the alternator method of creating continuous waves, I think I can say that, whilst experimental work has been done with the alternator generator producing undamped waves, no evidence has been adduced to show that regular communication is taking place by the above means between any distances of the order of even 1,000 miles. The difficulties of regulation of a high-frequency alternator are very great, the variations of speed due to variations of load destroying the advantage which one could otherwise gain in wave tuning by means of the continuous waves radiated, and even if we grant that a high-frequency alternator method for the direct production of the oscillations in the sending antennæ may be an ideal system of radio-telegraphic sending, yet, nevertheless, there is no proof that the practical difficulties of construction and use have yet been overcome, and no proof that these difficulties may not yet take years to surmount, whilst meantime the practically operative spark system and combined spark and disc system are conducting nearly the whole of the radio-telegraphic work in the world.

"I would point out that there has been no evidence before the Committee that any high frequency alternator or so-called continuous wave system has ever yet worked for twenty-four successive hours, and I have never yet heard of any high frequency machine which has done twenty-four hours' consecutive work. I am aware that Mr. Beach Thompson has stated in evidence that he has worked between San Francisco and El Paso, a distance which he has said was 1,150 miles, but which on measurement proves to be 863 nautical miles; but I have evidence that this statement was inaccurate. A manager of the stations of the Federal Telegraph Company, which is known as the American Poulsen Company, a Mr. J. M. Harrison, who has read the evidence of Mr. Beach Thompson, states that up to the end of June, 1912, the company had never communicated directly between San Francisco and El Paso in the daytime, and that their telegrams were normally sent viâ Los Angeles and Phœnix to El Paso —that is to say, by two re-transmissions. He further states that in the summer months the El Paso station was able to work to Fort Worth only during some four to five hours a day sometimes, and viâ Kansas City to Chicago. On some days communication was altogether impossible, and the messages received from the public at El Paso were sent over the land wires. Mr. Harrison also states that automatic high-speed working was never done successfully during the two years that he was in the service of the Federal Company. I understand that Mr. Harrison has written to this Committee submitting a *précis* of the evidence which he was willing to tender, a copy of which is in my possession, and signed by him. His evidence is a direct contradiction of the answers given by Mr. Beach Thompson to questions 3,223, 3,485, 3,487, 3,848 to 3,852, 3,609, and 3,698.

"It is not new, as the Committee would have been led to suppose; it was first used by me in my Transatlantic service, in evidence of which I would refer to Dr. Erskine Murray's book on *Wireless Telegraphy*, third edition, published in 1911 On page 149 he says:

"'The interesting photograph, of which the frontispiece to this edition is a reproduction, has been given to me by Mr. Marconi as a sample of what is now done at his Transatlantic stations. It is a portion of an actual message transmitted from Glace Bay and recorded photographically at Clifden. That an automatic record can now be made over so great a distance opens up great possibilities, such as, for instance, as the employment of speeds of sending much higher than those possible when the message is read by sound and written down by hand.'

"The frontispiece of the book is entitled *The First Published Photographic Record of a Transatlantic Message.*

"This system has not been generally employed by us in our Transatlantic work as the pressure of traffic has not hitherto demanded it. We have, however, had the automatic system of transmission at work for several years at our station at Cape Cod, Massachusetts, and we are now prepared at any time when pressure of work demands to both transmit and receive across the Atlantic automatically.

"There is one further point to which I think I ought to draw the attention of the Committee, and which I cannot help feeling a little surprised was not mentioned by Mr. Madge when he took the night to consider the pros and cons of the Poulsen system. Given that the Poulsen system were of the pure continuous wave which it claims to be, and were adopted for the Imperial stations, every one of His Majesty's vessels would require some modification of its wireless plant in order to be able to receive messages from the long-distance stations. The Admiralty might see their way to carry this out, but from a strategical point of view, it would appear to me to be very important that these long-distance stations should also be able to communicate in times of stress with the British mercantile marine, and particularly with all the important liners, and there is a very large number of them. All the wireless telegraph installations on board these liners are the property of my Company, and the service on board these ships conducted by my company. I think too, that in his pros and cons Mr. Madge might have stated whether he had ever heard of an arc utilising more than 40 kw. of power. I do not suppose that he would suggest that arcs should be used in series for wireless purposes.

"It has been stated in evidence that my company recently endeavoured to purchase the Poulsen patents. I give an absolute denial to this statement. My company has had more than one opportunity of purchasing the Poulsen patents in years gone by, and it has not purchased them, because, in my opinion, firstly, there was no advantage to my company to use the system; secondly, had there been, there has never been any reason why we should not have developed or used the system, for I believe it is not protected by any valid patent. In support of my opinion, the German Patent Courts, for which everybody who has to do with patents has the highest respect, has declared the Poulsen master patent to be invalid and has annulled the German patent. The case was taken to the German Court of Appeal, and in November last that Court affirmed the judgment of the Court below in respect of the chief claim of the patent."

Mr. Marconi referred to some of the questions and answers given in evidence before the Committee, and concluded his evidence as follows:

"I do not wish to conclude without expressing my resentment at the reflections which have been made upon my company and upon me for having innocently entered into a contract with His Majesty's Government. I resent the inquiry into and publication given to the affairs of my company which have had no relation whatsoever to the contract entered into with His Majesty's Government, and in this respect I would particularly refer to the business carried out by Mr. Isaacs and me in America, as related by Mr. Isaacs in his evidence, which I fully endorse and confirm; and I regret that the services which my company and I have for so many years rendered to the Post Office, the Admiralty, the Mercantile Marine, and, in fact, the whole nation, should not have been deemed worthy of higher consideration."

WIRELESS STATION IN THE PANAMA CANAL ZONE

A contract has been made with the Federal Wireless Telegraph Co. (Poulsen system) for the supply and erection of a 100-k.w. wireless station at Caimito, Canal Zone, for the United States Navy. The specification called for continuous waves, and was so framed as to make it difficult for other wireless companies to advantageously tender. Moreover, the price quoted by the Federal Wireless Telegraph Co. was an exceedingly low one, only one-fourth of that quoted by the Telefunken Co. It is stated that this station will have a range of 3,000 miles. If successful it will be the first time the Poulsen system has been able to work at such ranges commercially.

In our next issue we will deal with the Poulsen system as announced at the end of this month's article entitled "The Systems of Wireless Telegraphy" (pp. 173, etc.)

"THE WIRELESS WORLD"

It has been found necessary to increase the present number of THE WIRELESS WORLD to 104 pages, to enable us to publish in full the Report of the Technical Advisory Committee in Long-distance Wireless Telegraphy. Although we have been obliged to increase the size of THE WIRELESS WORLD after only three months, we are still unable to deal adequately with the various matters that require attention, and we must apologise to our readers for having to hold over this month some of the usual features of the Magazine, and to curtail others.

An Index to Volume II. of the "Marconigraph" has been prepared, and a copy can be obtained from the Publishers, Marconi House, Strand, London, W.C., on receipt of ½d. stamp to cover postage.

Binding Cases, price 1s., by post 1s. 3d.

Bound Volumes No. II. of the "Marconigraph," price 4s. 6d.–4s. 11d.

The "Systems" of Wireless Telegraphy

I.—THE GOLDSCHMIDT SYSTEM

By HUBERT DOBELL, M.A., A.M.I.E.E.

THE general public, reading of recent events connected with wireless telegraphy, has had its attention drawn to a number of new "systems"; and as the modern tendency—a natural one in this age of fresh marvels and constant improvement—is to assume that the things we hear about to-day are superior to the things we saw yesterday, some people have been inclined to jump to the conclusion that the Marconi system has been relegated to the background, and that it is only the start which the Marconi Company has, in point of time, that is enabling it to hold its own with the "new" systems.

If this were the case, then, indeed, the Marconi Company would be in a sorry state, and beyond doubt this would have been the case if the Company had contented itself with resting on its laurels and had occupied itself entirely by gaining such profit as it could earn with its original inventions.

But, as some Modern magnanimously remarked, "it does not follow that one's elders are *always* wrong"; and the fact is that the inventor of wireless telegraphy and his band of engineers have worked just as earnestly and with just as much skill and knowledge—to say the least of it—as the most recent of inventors of "new systems."

At the present moment, when public attention is being directed with so much interest to the various "systems," it will, we think, interest our readers to have a plain statement of facts placed before them in a form in which can be appreciated by all.

When an inventor announces that he has discovered a new system of wireless telegraphy he means that he has devised a new way of producing a certain effect which Mr. Marconi produced in his earliest experiments by sparking an insulated wire to earth—namely, the production and emission of electric waves.

No new system can claim a right to exist through the invention of a new way of "receiving" the electric waves; they must first be produced before they can be received. From time to time new "receivers" or "detectors" are invented and patented, but no new system is claimed or should be claimed for them.

What, then, is this process—the generation and emission of electric waves—which forms the basis of all "systems" of wireless telegraphy? Roughly speaking, it consists in charging-up a long insulated wire—preferably raised to a considerable height above the earth—and then allowing it to discharge to earth, charging it up again at once in the opposite direction, and again allowing the charge to escape to earth, the four processes forming a complete "cycle" of operations taking place in an infinitesimally small period of time, and one cycle following on another at a fixed and enormously rapid rate.

Each complete cycle produces one electric wave in the ether (that mysterious and little understood medium through the agency of which all such things as light, radiant heat and electric waves are transmitted), so that if the cycle is performed a million times in a second a million waves will be sent out in a second from the insulated wire into the surrounding ether.

These waves follow one another out into space, and they all travel with the same velocity, whatever the "system" and whatever the size and shape of the insulated wire or "aerial" may be—namely, the velocity of light, which is three hundred million metres per second.

Wave-lengths and Frequencies

If we perform the above processes at the rate mentioned—a million times a second—then in one second we cause the aerial to send out a million waves, and at the end of that second those waves will be stretching from the aerial to a distance of three hundred million metres. It is clear, therefore, that by so doing we have generated waves three hundred metres in length; so we see that, in order to produce waves of any required length, all we have to do is to perform that series of operations—charging the aerial, discharging it to earth, recharging it again in the opposite direction, and again discharging it to earth—the right number of times in a second.

Tuning and Resonance

But there is a point here which must be considered. It is well known that an ordinary pendulum has a certain rate of swing of its own. If the pendulum is lengthened it will swing slower, if shortened it will swing faster. If we take a pendulum which swings naturally once to and fro in a second, and keep on giving it a little push once a second, every time it comes to the end of its swing, we shall very soon work up quite a big swing. But if we were to give it a push too often—say, three times in two seconds—or too seldom—say, twice every three seconds—some of our pushes would catch it in the wrong direction, and we should soon bring the pendulum to rest, or, at any rate, keep it only swinging slightly and irregularly. So that to set a pendulum going, and to keep it going well, it is necessary to apply a force as many times in a minute as the pendulum performs complete swings.

Now, it is found that an insulated wire such as we have mentioned and which is called the "aerial" has a period of its own, just as a pendulum has—that is to say, it wants to perform the cycle—charge, discharge, recharge in the opposite direction, and discharge again—a definite number of times in a second; and this natural period of the aerial depends—very much as it does in the case of the pendulum—on the length of the aerial, among other things.

So it is only natural to find that in order to get the best results in generating electric waves from an aerial we must perform the cycle of operations described above at a rate which agrees exactly with the natural rate of the aerial itself. When this is the case, we are said to be "in resonance" or "in tune" with the aerial.

Alternators—

For many years past machines called "alternators" have been in use all over the world for the production of electricity for lighting and other purposes. An alternator is essentially a simple form of the equally or better known "dynamo," which is, in fact, an alternator with an additional piece of apparatus called the "commutator."

An alternator produces an electric current which starts from zero, increases to a maximum value in one direction, decreases again to zero, increases to a maximum in the opposite direction, and then again decreases to zero; repeating this process again and again continually. The commutator of the dynamo has the effect of changing this "alternating" current into a current always in the same direction; such a current being useful for purposes for which the more easily obtained alternating current is of no value.

For lighting purposes, however, and for driving trains, etc., the alternating current can be used; so that alternators are machines of great commercial importance.

For lighting purposes the alternations must follow one another at a fairly rapid rate, for otherwise the lamps would show an unpleasant and continuous "flicker," so that alternators for lighting are made to give alternations of current at rates which are usually 50 or 100 per second.

If we took an ordinary commercial alternator, giving, say, 100 alternations per second, and connected one of its poles to the aerial wire and the other to earth, it would start charging up the aerial discharging it, re-charging it in the opposite direction, and so on, at the rate of 100 complete cycles per second. From what we have already said it is clear that if the aerial were itself designed so as to have a natural frequency of 100 per second, all would go smoothly, and there is no reason to doubt that electric waves would be given out at the rate of 100 waves every second.

But what would be the length of those waves? Following our former line of reasoning, and remembering that in one second they have to cover a distance of three hundred million metres, we see that each wave would be three million metres long.

Now it has been found by experience that an aerial will not radiate electric waves at all well if its actual length—that is, the actual length of stretched insulated wire—is less than about a tenth of the wave-length it is asked to radiate, so with such an alternator the aerial, in order to be effective, would have to be about three hundred thousand metres long—nearly 200 miles.

High Frequency Alternators

Obviously, therefore, such an alternator would be impracticable as a generator of waves for wireless telegraphy. If we could induce the machine to give a frequency a hundred times greater than its normal frequency we could be content with an aerial two miles long.

Even for the most powerful wireless stations, a length of one mile would be considered the extreme limit for the length of the aerial; so even for these big stations we should have to modify the alternator so as to give a frequency two hundred times as great as that which we took as a reasonable example for a commercial machine; that is to say, we should have to devise an alternator giving a frequency of at least 20,000 per second: while for ordinary coast-stations or ships where the aerial could only be a few hundred feet in length, the alternator would have to give a current alternating at the rate of from some hundreds of thousand times a second to a million per second.

Now some twenty-five years ago, the lighting of streets and large buildings by arc-lights, worked with alternating current, assumed a considerable importance. We have mentioned that the frequency of an alternator for ordinary electric lamps has to be fairly high to avoid "flickering." With the arc-lamps, a new trouble presented itself; with frequencies of from 50 to 100 alternations per second the arc-lamps were found to "hum" unpleasantly, and strenuous efforts were made by men like Tesla and Elihu Thomson, with many others, to produce an alternator with a frequency of some 10,000—which would do away with the difficulty.

Even such a frequency—only one-half of that suitable for the largest projected wireless station—was found to be unattainable except on a very small scale. The power required at such a big station—for naturally big stations are only put up in order to accomplish big distances—would be measured in hundreds of horse-power; and of all the brilliant inventors working at the problem for twenty years, not one was able to produce a machine which would give more than one or two horse-power.

One of the most successful of the "high-frequency alternators" was that of Duddell, which gave a frequency of over a hundred thousand; but even this, though it carried out successfully the experiments for which it was designed, gave only a small fraction of a horse-power, and was therefore quite unsuitable for wireless telegraphy.

Theoretically, the problem presents little difficulty; the frequency of an alternator depends on the number of times in a second that the magnetic field through a coil is reversed; if the coils are rotating, increasing the speed of rotation increases the frequency; if the speed is fixed, increasing the number of coils increases the frequency; if both are increased together, the frequency is increased rapidly.

Nothing could be more simple.

But, practically, the difficulties are enormous.

Let us take a typical case. A frequency of 300 per second is a rather high frequency for a commercial alternator giving, say, 300 horse-power. Such an alternator might be driven at the rate of 1,800 revolutions per minute; in which case it would have the periphery of its moving-part divided into 20 "poles" wound with the coils of copper wire.

Now to get such a machine to give even a frequency of 1,000 per second, it would have to be driven at the rate of over 5,000 revolutions per minute—a dangerous speed for the heavy rotating part comprising copper wire, which is constantly liable to burst loose and cause disaster.

Even at this high speed, in order to get our minimum frequency of 20,000, we should have to multiply the number of "poles" by twenty. This means that 400 poles would have to be crowded into the periphery of the moving part. If the diameter of this latter is increased to make more room for this great number of poles, this increases the difficulties and dangers of high-speed rotation. Not only this, but a very great loss of power is caused by air friction and air churning.

Apart from such mechanical difficulties, a further and no less serious trouble is caused by the fact that iron—the material of which the magnets and cores of the ordinary commercial alternator are made, and on whose properties the efficacy of such a machine depends—begins to behave very badly when called upon to deal with such high frequencies. Its molecules get so hot in keeping up with the rapid alternations of current that a great deal of power is wasted in what is known as "hysteresis losses."

The Goldschmidt Alternator

The mechanical and other difficulties in the way of producing suitable high-frequency currents by such means as these have led to an attempt to abandon them—in part—by the inventor of the latest "high-frequency generator."

The Goldschmidt machine consists of an alternator in which the magnetic field is rotating, not mechanically, but electrically, while at the same time the armature is rotated mechanically in the field, in the opposite direction.

The result of this is to produce a frequency depending on the sum of the rates of rotation of the magnetic field and of the armature; and current at this higher frequency is carried back to the field and produces a more rapidly rotating field than the first. To this, again, is added the frequency produced by the rotation of the armature. This process is repeated several times, and, finally, the required high-frequency is reached.

A German author (F. Rusch) has described this machine as producing a medley of alternating currents, out of which only one emerges by reason of resonance.

Unluckily, there is a considerable and unavoidable loss of efficiency—that is, a waste of power—at each step, and the effect of each step on the frequency is only additive, and not multiplying. That is to say, if the frequency at the first step were 1,000 per sec., at the second step it would be only 2,000, at the third 3,000, and so on; so that to get from 1,000 frequency to our minimum value of 20,000 there would have to be so many steps and such a complication of circuits that by the time the required frequency was attained there would be no—or very little—power left to utilise for wireless telegraphy. With this machine, therefore, it is necessary to start straight away with as high an initial frequency as possible so as to keep the steps as few as possible; so that once more the difficulty of danger, and loss of power through air-friction, arises, and the designer is forced to choose between two evils—a large number of steps each involving a considerable loss of power, or a high initial frequency, introducing all the difficulties and dangers of high-speed rotation.

And when he has made his choice, or compromised, he is still faced with the fact that the iron of his machine insists on behaving badly with the high frequencies, and consumes a great deal of what should be useful power.

Luckily for the development of wireless telegraphy, there is another way—totally unlike those already referred to—in which high-frequency currents of any and every desired frequency can be obtained from an initial low frequency, and that in one step and without the introduction of any iron into the influence of the high-frequency currents and without any dangers and difficulties of rotating coils of wire.

The fact that this method, in its most crude form, was the original method used by Mr. Marconi, the inventor of wireless telegraphy, does not really detract from its merit, though it may tend to prejudice some minds against it.

One of the most valuable properties of an alternating current is the fact that it can be very readily transformed " up " or " down " to a higher or lower voltage or pressure. If we desire to change the pressure of a continuous current—say, to increase it—we are led to the necessity of using the current at our disposal to produce rotation of a motor, and then getting this motor to drive another machine which will generate continuous current at the higher pressure desired. If we want still higher pressure, we must employ two or more such machines " in series," and add their effects together, but in any case each machine must be designed to give a high initial pressure; and this, though it is possible, is by no means an easy thing to do, especially on a large scale. It usually involves the rapid rotation of a heavy armature wound with a very large number of turns of fine copper wire, and leads to some of the difficulties mentioned in connection with high-frequency alternators, with the added difficulty that the current in the windings of the machine are at a high pressure and effective insulation is difficult.

The same difficulties would arise in the production of alternating current at high pressure; luckily, the advantage referred to as being possessed by alternating currents comes in here and avoids all these difficulties. If an alternating current at low pressure—a thing easily obtained—is passed through a coil of a few turns, wound round an iron core, it will generate another alternating current in another coil wound on the same core, and if this second coil has a greater number of turns than the first the new alternating current will be at a greater pressure than the original current. So to get any pressure we require we have only to proportion our windings properly. No rotation is necessary; the fluctuations of the first alternating current take the place of the mechanical motion, and the coils, not being rotating, can be thoroughly insulated against the resulting high pressure by immersion in insulating oils.

Such an apparatus—known as a " transformer "—is one of the most useful, reliable, and widely used things in electrical engineering. It is largely used in various systems of wireless telegraphy for the convenient production of high voltages.

Every now and then we get correspondents writing to our " Question " column suggesting that the transformer could be relegated to the scrap-heap by the use of an alternator with a fine-wire winding of many turns rotating at a high speed and therefore generating current at a high initial pressure. These correspondents have met with transformers and taken them as a matter of course; then, having an inventive turn of mind, they have hit upon a way of getting the same result in another way, and this, being a new way, they are inclined to conclude must be a step forward. They do not realise that it would be actually a serious step backwards, and that if they had never seen a transformer and had had to work with a machine such as they suggest, they would have rejoiced exceedingly if, in a moment of inspiration, they had hit upon the idea of a stationary transformer which would do all that was required without any fear of breakdown or dangers of high-speed rotation.

Now, what the transformer is to the engineer who wants high pressure, the Marconi dischargers are to the wireless engineer who wants high frequencies. If the first experiments in wireless telegraphy had been accomplished by the use of high-frequency alternators, there is no doubt whatever that a newcomer who showed that he could obtain the same high frequencies without the use of rapidly rotating coils, without the complications and loss of power caused by a succession of steps, and without the use of any iron, with its attendant losses, in his high-frequency circuits, he would have been hailed as the latest and greatest inventor.

And this would be so even if his apparatus possessed the same limitations with respect to the amount of power it could give as the original method which he would claim to supplant. But if, as is the case with the Marconi dischargers, the amount of power which his apparatus could effectively use was shown to be apparently without a limit, then the chorus of approval would have been even more vociferous.

Even the primitive fixed discharger used by Marconi in his earlier work was capable of dealing effectively with about 70 h.p.; his later inventions, such as those used at Clifden and Coltano, deal regularly and effectively with over 150 h.p. when required to do so, and there is practically no limit to the amount of power which can be utilised effectively by increasing the dimensions of this apparatus.

We believe we are right in saying that the greatest power ever obtained from a high-frequency alternator for more than a minute or two is under 20 h.p.—and this after 25 years' work in the attempt to develop such a machine. From time to time attempts have been made to construct larger machines, but up to the present they have always broken down under test. The mechanical and other difficulties which we have already referred to have proved too potent.

The Early Marconi Discharger

The Marconi fixed discharger, referred to above as having dealt with 70 h.p., is perhaps the simplest piece of apparatus ever seen in an electrical station. It comprises nothing breakable and nothing which moves rapidly. In conjunction with a condenser and an inductance—apparatus common to every wireless station of whatever system—it takes ordinary alternating current at the frequency of an ordinary commercial alternator (anything from 25 to two or three hundred per second), and by one transformation changes it into high-frequency currents of any required frequency, from twenty thousand to a million per second. Moreover, it introduces no hysteresis losses in the iron for the simple reason that iron is not a necessary component of it. So even that primitive fixed spark discharger would have been hailed by the pioneers of wireless telegraphy if they had been labouring with many and many a breakdown, to get 10 h.p. or so out of a high-frequency alternator.

But the primitive Marconi fixed discharger, though it is excellent in its simplicity and efficacy, nevertheless has its weak points.

In the first place, it cannot be used satisfactorily with more than about 70 h.p., so that regular communication over very great distances is difficult; in the second the waves it produces die out rather rapidly, and thus the "cumulative" effect on the receiver which the best modern receivers are designed to utilise is not obtained; and in the third place, it sends out waves in groups which tend to be irregular in their spacing; that is, one group does not follow another always at the same interval.

The Modern Marconi Discharger

All these defects were in the mind of Mr. Marconi when he set about his all-important research at Poldhu, one of the results of which was the evolution of his famous disc-discharger.

In its present form this machine removes every one of the above-mentioned defects, and yet retains the strength, simplicity and absolute reliability of the old fixed discharger.

It is this machine to which we have referred above, as being able to deal with over 150 h.p., and capable of being enlarged without any difficulty so as to deal with practically any amount of power which may be required.

It produces waves which are very persistent, and therefore give the receivers a good chance to make use of the cumulative effect; and it sends these waves out in perfectly regular groups, which produce a musical note, and can therefore clearly be distinguished from the noises produced by atmospheric disturbances, and also enable the receiving circuits to be "tuned" not only to the frequency of the separate waves, but also to the frequency of the wave-groups.

It is, it is true, a rotating machine; but it rotates at a reasonable speed—the speed of a commercial alternator; and it is a strong, solid disc of steel, without any fragile windings of copper to break loose mechanically, or to "break down" electrically. Finally, it has solid bars of copper to carry the high-frequency currents, and so avoids the serious hysteresis losses found in a high-frequency alternator.

Enough, we think, has now been said to make it clear that the Marconi disc-discharger, at present in constant use on a large scale at the big stations at Clifden, Glace Bay, Coltano and Poldhu, and on a small scale at smaller stations throughout the world, is as much an advance on the high-frequency alternator (as a generator of high frequencies) as the stationary "transformer" (as a generator of high pressures) is an advance on the weird machine invented periodically by our correspondents, and referred to on page 210.

No practical engineer ever thinks of abolishing the transformer in favour of such a machine; how is it, then, that people are to be found who speak of the high-frequency alternator as if it were far in advance of anything ever invented by Marconi?

Have we omitted any material fact? Let us see what the proprietors of the latest high-frequency alternator have to say for their apparatus.

In July, 1912, we were told that the proprietors of the Goldschmidt patents were building four 200-h.p. alternators which would rotate at 8,000 revolutions per minute. By a succession of steps—each of which means a waste of power—and by a multiplication of circuits, these machines were to produce high-frequency currents suitable for long-distance wireless telegraphy.

What advantages would be presented by this machine?

It would give continuous waves.

It has long been a belief with some wireless engineers and scientific men in general that "continuous waves" were things to be sought after.

Mr. Marconi himself, it must be admitted, at one time shared in this belief. The present writer well remembers a strenuous period when each day meant from 12 to 15 hours' hard labour assisting in the search for continuous waves and their production, and still recollects with something of a thrill the telegram from Mr. Marconi, at the distant receiving station to which he had gone for the final test, "Entirely successful."

That was many years ago: a lot of water has passed under the bridge since then, and the praises of "continuous waves" are still sung by those who are striving to attain them.

Others, however, have gone on with the development of the persistent but non-continuous waves which experience has taught them are the best for wireless telegraphy.

It is for the production of such waves that the Marconi synchronous disc discharger is the last, and, so far as can be seen, the ultimate word.

The Marconi Continuous Wave System

The advantages of the "continuous wave" have been lately expressed so strongly that Mr. Marconi thought it wise to revive his developments in this direction, with the result that it is clearly shown in the verdict of the Advisory Committee: **"the only continuous high-frequency generator which we have yet seen tried with success over long distances is the Marconi continuous high-frequency machine."**

Obviously, therefore, if continuous waves were really superior, the Marconi Company would use them and discard non-continuous waves.

The fact that the Marconi Company does not propose to abandon its present system in favour of their continuous wave system for its Transatlantic work is due simply to the fact that "there is nothing," as Mr. Marconi expressed it in his evidence before the Select Committee, "to choose between the relative efficiency over long or short distances, whether the waves are continuous or discontinuous." This opinion is the result of actual personal experience of continuous waves generated by three systems —the Marconi system, the Poulsen arc, and the high-frequency alternator.

In another part of his evidence Mr. Marconi emphasises this: "I may further add that there has never been submitted here or elsewhere one scintilla of evidence to prove that the continuous or undamped waves have any advantage over intermittent or feebly damped waves for long-distance working in radio-telegraphy."

Mr. Marconi then goes on to deal with an important point. He says: "In regard to wave-tuning pure and simple, in my opinion, when using suitable receivers, tuning is better with continuous waves than with discontinuous waves."

Here we have the real reason for the preference of the "continuous wave." The continuous wave is no doubt very much more susceptible to accurate tuning at the receiver than the old original highly damped waves of the early Marconi transmitter, but it is only slightly more susceptible than the persistent but non-continuous waves of the Marconi disc-discharger. Now this property of very "sharp tuning" is a useful one in certain cases—where one station would be inclined to interfere with another close at hand. But the great and outstanding difficulty in wireless — and especially in long-distance wireless—is interference not from other stations but from atmospheric discharges. Sharp tuning is very effective in "cutting-out" an interfering station, because that station has a definite wave-length which is different from the wave-length which is being received. Unluckily, signals from atmospheric discharges have no particular wave-length of their own; if they had, they would present no difficulties; but, having no wave-length, they have to be dealt with by various other methods, the most perfect of which are those of the Marconi Company.

This fact was referred to by Mr. Marconi when he pointed out that "very weak coupling" (an attribute of very sharp tuning) "is only one of the methods employed in modern practice for avoiding atmospheric disturbance, and is by no means the one which is the most effective."

This leads us to an important and interesting point. The Marconi non-continuous system is not dependent only on "wave-tuning" for obtaining selectivity and for the elimination of disturbances. As we have already mentioned, this system sends out groups of waves following one another with absolute regularity, thus producing a musical note in the receiving telephones and enabling the receiving circuits to be tuned, not only to the wave-frequency, but also to the group-frequency.

Now, although atmospheric discharges are not suitable for "cutting-out" by wave-tuning, they are eminently suitable for cutting out by the other kind of tuning; for the most vicious "atmospheric" never thinks of disguising itself as a musical note. So, among other and important appliances for cutting-out atmospherics, this "note-tuning," as it may be called, forms a very important factor in the successful working of the Marconi system, and not only in connection with the elimination of atmospherics, but also in the production of selectivity; for, by its means, one station can be received while another, using exactly the same wave-length but a different group-frequency, can be "cut out."

Let us now consider a high-frequency alternator sending out continuous waves. If it is doing its work properly it sends a continuous stream of waves which can, it is true, be subjected to wave-tuning pure and simple, but are entirely incapable of group-tuning, for the simple reason that there are no groups, either regular or irregular. Moreover, as there are no groups to give either a noise or a musical note in the telephone receiver, in order to make signalling possible the continuous waves must be split up by some additional apparatus so as to cause audible sounds.

What is the effect if this is done at the receiving end? Obviously, an apparatus which will split up the soundless continuous waves into sound-producing groups will also split up any atmospherics into groups of the same frequency and therefore the same note; so that this misguided ingenuity will result in doing to an atmospheric what even the most malicious atmospheric would not do if left to itself—it will convert it into the same musical note as that of the signals themselves.

The other alternative is to cut up the continuous waves at the transmitting station into groups which will give a sound or a note in the receiver. That is to say, having laboured to produce continuous waves, we then have to proceed to cut them up, and make them hardly distinguishable from the waves of the Marconi disc-discharger.

It will be interesting to consider this point more fully. Let us consider two stations each sending on the same wave-length—say 6,000 metres—one (which we will call "A") on the modern Marconi non-continuous system, and the other ("B") on some continuous wave system—from a high-frequency alternator let us say.

Let us suppose, for the sake of argument, that the waves sent out from A and B are equal in strength (though here it is worthy of note that no continuous waves as yet produced have been able to vie in the matter of strength with the Marconi non-continuous waves).

This assumption is made in order that the only difference between the waves sent out in the case of A they are non-continuous, and in the case of B continuous.

The station A sends out a regular succession of groups of waves at the rate of several hundred groups in a second.

Each group consists of a certain number of waves, not all of equal strength. That is to say, the waves in a group start small, increase to a maximum, and gradually decrease till they become so small as to be negligible.

These groups, each of which "sums up" in the receiver and produces a single movement of the telephone diaphragm, follow one another at the regular intervals of a musical note, and thus cause that diaphragm to emit the same note.

The station B sends out a stream of waves all of the same strength. That is to say—and here is the great point claimed for them—there is no waxing and waning; they are all equally strong, and should therefore "sum up" or accumulate better, resulting in better "wave-tuning." But as there is no waxing and waning, they produce no sound in the telephone receiver if they are left to themselves.

In order that the signals from B may be audible, they must be cut up into groups either at the sending or the receiving end; and from what we have said about atmospherics it is to be presumed that the process will be applied at the sending end. Let us suppose that this is accomplished by the method adopted in a demonstration of the Goldschmidt generator—the use of an alternating current to excite the field of the generator. This results in the strength of the continuous waves waxing and waning as the alternating current in the field waxes and wanes, so that a note is produced in the receiver of a frequency depending on the frequency of that alternating current. For the sake of argument, let us suppose that the note produced has a frequency of 500 per second—a good note to listen to.

Let us return to station A, and suppose that it also is sending out groups of waves at 500 frequency. That is to say, the interval between the emission of each group is 1/500 second—*i.e.*, 0·002 second.

The number of complete waves in each group depends on the rate at which the waves decay or die down; taking a very average value for this rate (decrement per whole period = 0·045); and using Dr. Fleming's formula for the estimation of the number of effective waves in a train, we find that in this case there are more than 100 complete waves in each train or group. Now 100 waves of this wave-length will occupy a time of 0·002 second, which is the same as the 0·002 second which is the interval between the emission of each group. So that with the "non-continuous" waves, the time between the emission of each group is filled completely with waves which wax and wane just as the "continuous" waves do. Where, then, is the possible superiority of the latter?

Altogether, the fetish of the "continuous wave" seems to be in a bad way. The report of the Technical Committee shows no whole-hearted belief in it—"continuous waves may be somewhat more efficient than intermittent trains of waves" is hardly up to the standard of enthusiasm with which the merits of continuous-wave machines are generally extolled by their proprietors. The written opinions of Count Arco, of Dr. Eccles, and of Mr. Llewellyn Preece, which were quoted by Mr. Marconi in his evidence, go far to dispel the illusion that the "continuous wave" is a desideratum to be sought after.

At any rate, one thing is clear from the report of the Technical Committee: that the Marconi Company has in its possession a system for producing these continuous waves if it wishes for them: "the only continuous high-frequency generator," as the Committee reports, "which we have yet seen tried with success over long distances."

Let us get back to the high-frequency alternator, and particularly to the Goldschmidt machine.

It is clear, from what we have said at the beginning about the generation of waves by an alternator, that the length of the waves sent out by a high-frequency alternator of any kind depends entirely on the speed of the machine. If the machine slows down, the alternations become less rapid, and the wave-length correspondingly longer; if the machine speeds up, they become correspondingly shorter.

Any variation in speed, therefore, causes the waves sent out from the aerial to vary correspondingly in their length.

Now a very slight variation in wave-length would entirely upset all accurate tuning at the receiver, and would reduce the quality of even the most perfect continuous wave to the level of a crude and highly-damped wave.

With the high-frequency alternator it is apparent that the difficulty must appear.

It does. Every time that one of the "dots" or "dashes" of the Morse code is made at the transmitter the machine is called upon suddenly to give its full load. In signalling figures, for instance, the full load may be thrown on the machine for five successive "dashes," and may then be suddenly removed except for five short "dots."

The natural inclination of the machine, however well it may be governed, is to slow down in the first case, and to speed up in the second, with a corresponding disturbance of wave-length.

The wave-length of a Marconi transmitter is entirely independent of the speed of rotation of any machinery, so that this difficulty does not exist—a change of speed merely alters the musical note.

So serious is this difficulty, that the full load is kept permanently on the machine, and the dots and dashes are produced by varying the aerial wave-length so that at times it is in tune with the receiver, and at others it is so much out of tune that the receiver is not affected.

This is a simple and effective way out of the difficulty, but unluckily it means that about 40 per cent. more power is being used than if signalling were done in the Marconi way; and 40 per cent. more power means considerably more expense in fuel, without the least counterbalancing gain.

This has evidently been recognised as a somewhat serious objection, for the latest scheme of the experimenters with the Goldschmidt machine is to signal in the ordinary way, and to trust to an electric governor to keep the speed of the machine absolutely constant even when full load is suddenly thrown on it.

We have not heard that they have been successful in this.

We have referred to four machines of the Goldschmidt design which were being constructed in July, 1912.

As we said, they were each to be of nearly 200 h.p.; that is to say, they were to be about twice as powerful as the Marconi plant at Poldhu, which communicates, though not commercially, with America.

And yet the Technical Committee, nearly a year later, has to report that "except in the case of the Marconi system we did not, however, obtain any demonstration on a commercial scale, or any demonstration over a distance of even 1,000 miles."

In connection with this, it is interesting to note that the latest news of the Goldschmidt machine is that a new type is being constructed which will rotate at the rate of 3,130 revolutions per minute. That is to say, in this latest type the speed has been reduced to much less than half that of the four machines which were being made a year ago.

This new machine is to give an *initial* frequency of 10,000 per second; that is, the very frequency which we mention as having been sought after unsuccessfully for the last twenty-five years. It is only after this great frequency has been obtained by mechanical rotation that the special Goldschmidt process will be applied to it, and by three steps, each involving a loss of efficiency, steps it up to a frequency of 40,000.

It is of some interest to notice the arrangements which are being found necessary to use in connection with the working of this machine. Apparently a 500-h.p. steam-engine is to drive two dynamos of nearly 200 h.p. each, and the armatures of these machines are directly connected to a motor, which, finally drives the high-frequency alternator; the rotating part of which will have no fewer than 384 poles.

It would seem that the Marconi plan of driving the whole of the moving plant direct on one shaft from a steam-turbine is somewhat more simple and desirable.

In our next number we will deal with what is known as the "Poulsen System," and will further summarise the whole matter.

Efficiencies in Wireless Telegraphy

By W. H. ECCLES, D.Sc., M.I.E.E.

(Second Article.)

HAVING in the May number briefly sketched and defined the various efficiency co-efficients and the parts they play in the whole process of transmission and reception, we now proceed to discuss them one by one, and to assign rough values to them. In this way we may obtain some form of comparison between the various systems so far as efficiency is concerned, but neglecting all such commercially important points as convenience, reliability and speed in working, expense in installation and maintenance, and so on.

EFFICIENCY OF GENERATION.

To begin with, we take the Efficiency of Generation of Antenna Oscillations. We have to consider (1) the ordinary spark method of generating oscillations, (2) the quenched spark method, (3) the Marconi disc-discharger, (4) the arc method, and (5) the high frequency alternator.

(1) In the ordinary spark method, alternating current at 100 or 200 volts is supplied to the primary of a commercial transformer which raises the voltage tosparking-potential. In order to measure the efficiency, a mock antenna must be constructed by connecting a non-inductive resistance in series with a condenser of the same capacity as the actual antenna, and arranging that the mock antenna may be switched on to the secondary of the oscillation transformer in the place of the antenna-earth system. The non-inductive resistance must be in a calorimeter, so that the heat dissipated in it can be estimated. Then in making an experiment, the resistance is adjusted until a hot-wire ammeter (so connected as to be included in both circuits) reads the same in the mock antenna as in the real antenna. The calorimeter measurement gives the energy delivered to the antenna in a measured time, and the reading of a wattmeter at the supply terminals gives the input to the plant.

Many measurements of this kind in various countries agree in showing that the efficiency is of the order of 10 per cent. If a suitable air-blast be applied to the spark gap, the efficiency may be raised to 20 per cent. Of course these figures vary greatly according to the amount of series resistance used in the supply circuit, and where the alternating current is generated in the station, the alternator, transformer and condenser can be tuned to the alternator frequency and the efficiency brought up to 25 per cent. It is claimed that by shaping the pole-pieces of the alternator to produce a peaky wave-form, the efficiency may be pushed higher; but we may take 25 per cent. as a satisfactory figure for this kind of plant.

(2) If the quenched-spark apparatus be tested in the same way, the efficiency is found to be much higher. This arises from the fact that the quenching of the spark stops the current from running in the primary and therefore reduces the wastage. Actual measurements by the above method by independent observers have yielded results as high as 50 per cent. Owners of quenched-spark patents claim figures of the order of 75 per cent.

(3) The rotating disc-discharger method, which has been so highly developed by the Marconi Company in the production of musical signals, especially in high-power stations, effects the same operation as the quenched spark; but it breaks the primary spark by mechanical means instead of by cooling. Its efficiency has been measured as about 50 per cent. This figure may be increased by using the air-blast in addition.

(4) In the case of the arc method, the efficiency of generation of oscillations is very low. Poulsen's own figure is 14 per cent. The efficiency of the plant is greatest when the arc is connected directly in the antenna—a very usual mode of procedure.

(5) Lastly, the high frequency alternator must be considered. The Goldschmidt form of machine has been stated to give an

efficiency of 80 per cent. at a frequency of 10,000 per second—a frequency much below anything at present used in wireless telegraphy, and necessitating enormously long antennae; but at higher frequencies the efficiency is admittedly a much lower figure, and may be assumed as below 60 per cent. Besides the machine just mentioned, that of Alexanderson has proved itself of outstanding merit; but so far as can be gathered from published statements, the efficiencies of this and the best of the other machines in use are not more than 60 per cent. when generating even the longest waves used in wireless telegraphy.

The chief causes of the losses in these machines are the windage of the motor and the hysteresis of the iron.

The outstanding claim for high-frequency alternators is, of course, that they produce truly continuous waves, and therefore enable more exalted resonance to be obtained at the receiver. In this connection it must be noticed that when the continuous oscillations produced by an alternator are broken up in any way to produce a musical signal—as, for instance, when the field of the alternator is excited by an alternating current of acoustic frequency—the waves cease to be continuous, and they possess but slight, if any, advantage as regards resonance over those produced by the Marconi studded-disc.

EFFICIENCY OF RADIATION.

Turning now to the Radiation Efficiency of Antenna, we find that all systems are in this respect more or less on a par. The total resistance of an antenna may be measured by the use of the mock antenna already described. If this is made the exact equivalent of the real antenna as regards capacity, inductance and ammeter-reading, then its resistance must be the same. For example, this kind of measurement gives with the author's antenna a resistance of about 15 ohms at the minimum—the resistance varying with the wave length to which the aerial is adjusted. But by improving the "earth," as, for instance, by laying down a generous system of earth-wires, the resistance may be reduced to 5 ohms; or if the antenna belongs to a ship station, the resistance may be brought as low as 2 ohms. Even in this last case it is doubtful if the radiation resistance is as much as 1 ohm; it may probably be taken as 0·2 ohm for an average ship antenna. It is often argued that the "electrical counterpoise" method of working, in which, instead of the earth-wires and plates, a widespread insulated network of wires parallel to the earth is used (as originally described by Lodge) gives better radiant efficiency. But the comparison has usually been made with an earthed antenna of bad design—one where the earth-wires did not stretch to a sufficiently great distance. It is obvious that in order to be effective the earth-wires must be carried outwards, branching more and more finely as they go, if possible, to ensure that when the soil is left to carry the earth-currents the density of these may be very small.

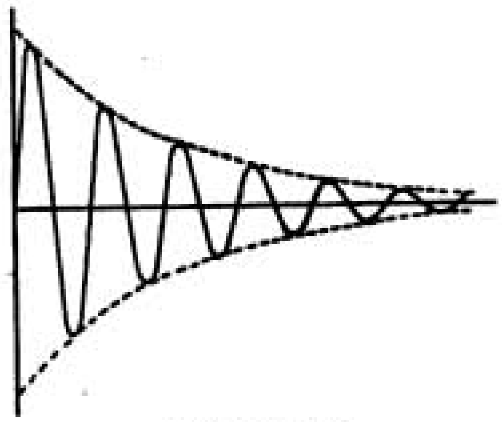
The difference between a land antenna and the equivalent ship antenna can lie in nothing but the earth resistance. Thus the radiation efficiency of an average antenna, where considerable expense has been incurred in laying earth-wires, may be only 4 per cent., while that of a ship antenna may possibly be 10 per cent., the wave-length being supposed to be not much greater than five times the length of the antenna. This fact probably accounts to a very great extent for the extensively credited belief that signals are propagated far better over sea than over land. It is not so much that the waves are propagated more efficiently, but rather that they are detached from the antenna more efficiently.*

EFFICIENCY OF PROPAGATION.

This leads to the discussion of the Efficiency of Propagation. After that remark the first thing to notice is that the trend of evidence is to show that absorption in the surface of land or sea is comparatively small. This is seen especially well in the records of such measurements as have been made over short distances. The same statement applies to absorption in the air—it is negligible over short distances. But when we consider long-distance signalling, then—whether this is accomplished mainly by surface-waves or mainly by refraction in the upper atmosphere

* This hypothesis is interesting; its truth could be judged by comparing the range of signals from, say, a high-powered ship-set off one coast of England sending across country to a second ship off another coast to a third ship out at sea.—ED.

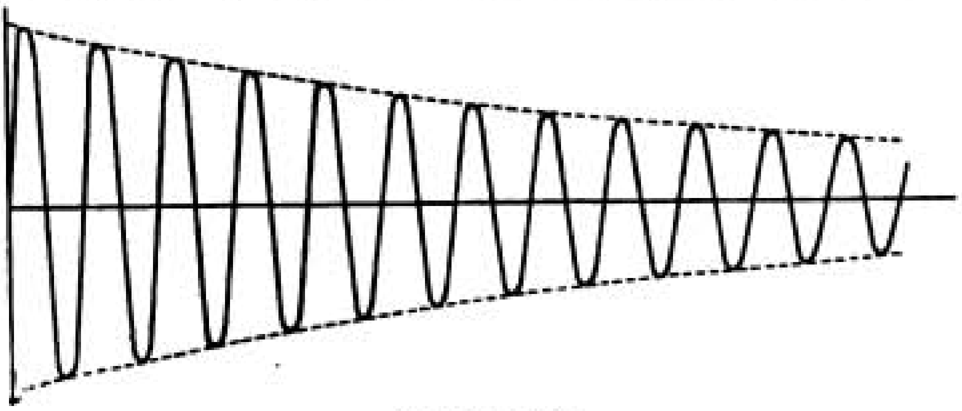
—the absorption at the upper surface of the globe or in the upper, somewhat conductive, layers of the atmosphere—as the case may be—probably becomes considerable. Accurate knowledge of these questions is still lacking.



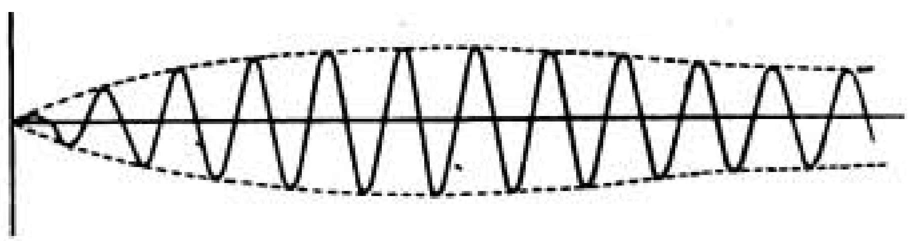
Decrement 0·5.
Fig. 1.

Another aspect of the matter which has been somewhat to the fore recently must, however, be glanced at. Is the efficiency of propagation greater with pure sine-waves than with damped waves?

In answer to this question we may take it as mathematically obvious that the difference is negligible for telegraphic purposes. But, fortunately, it happens that some recent measurements made by the Telefunken Company by the aid of the new high frequency alternator which they are putting on the market, has reinforced the verdict of commonsense on this point. Here it may be remarked that an analogous question might be asked about the radiation-efficiency; and there the answer is that from the theoretical point of view the damped waves would be slightly better than the sine-waves; in fact, the original "whip-crack" discharge might be the best of all.



Decrement 0·1.
Fig. 2.



Decrements 0·1 and 0·3.
Fig. 3.

RESONANCE EFFICIENCY.

We now come to the Resonance Efficiency. The resonance efficiency of sender and receiver deals directly with the question of the value of damped waves as against pure sine-waves; for the smaller the decrement of the waves reaching the receiving station the higher is the resonance effect. This has nothing to do, be it noted, with imperfection of tuning—that is a mere matter of adjustment of the receiving apparatus, and perfect tuning is assumed; it is concerned with the fact that the energy imparted to a vibrative system by another of substantially the same period is a more or less involved function of the damping of *both* systems.

In the early days of wireless telegraphy the decrements of the antennæ used were very great. The vibration of an early plain sending antenna, if plotted on a time base, would appear somewhat as in Fig. 1.*

Here the decrement is 0·5 per period—a decrement built up of radiation resistance, earth resistance and spark resistance. It seems probable that even with a good earth the decrement of a plain sending antenna may still be about 0·3 per period. Similarly a receiving plain antenna, when the coherer resistance is reckoned in, possesses a very high decrement.

When tuning coils were introduced, the decrements began to assume lower normal

* [We have to thank the Editor of the *Electrician* for the loan of the three blocks used to illustrate Dr. Eccles' article.—ED. *W.W.*]

values, and when large-capacity antennæ were used the decrements would again be reduced. It is possible that the Lodge antenna had sometimes a damping of about 0·1 per period, and consequently a vibration-curve such as shown in Fig. 2.

When tuned coupled circuits were introduced at the sending end, the train of oscillations took the form seen in Fig. 3—a form which can be represented well by supposing the oscillation to have a double decrement, one fairly large relatively to the other.

Taking the 100 per cent. resonance efficiency as that of continuous pure sine waves of perfectly uniform amplitude and period, calculation shows that the resonance efficiencies of the various types of waves mentioned are as given in the following table :

Type.	Decrements.		Resonance Efficiency per cent.
	Receiving.	Sending.	
Plain Antenna .	0.1	0.3	25
Lodge " .	0.1	0.1	50
Coupled Sending Circuit . .	0.1	0.1 0.4	60
Ditto	0.1	0.1 0.2	67
Ditto	0.1	0.05 0.1	92
Ditto	0.1	0.02 0.2	90
Continuous Waves	0.1	0 0	100

In making the comparison it is supposed that the receiving antenna is in all cases a modern plain antenna of the decrement 0·1.

EFFICIENCY OF RECEIVING ANTENNA.

Passing now to the Efficiency of the Receiving Antenna and its associated circuits, it is obvious from what has been said about the sending circuits that we are again concerned with the separation of the antenna and circuit resistance into its parts.

Looking at the matter broadly and avoiding detail, we may regard the modern coupled receiving circuits, with their variable coupling, as a mode of introducing a detector into the antenna with variable energy-absorbing power.

If the coupling is very close, a large proportion of the resistance of the detector is in effect introduced into the antenna ; if the coupling is very loose, only a small portion is introduced. In the former case the enhanced resistance of the antenna will probably prevent it working up into energetic oscillation under the action of the waves ; in the latter case the detector resistance is relatively so small that the detector gets an insignificant proportion of the energy of the train of oscillations on the antenna, which is thus nearly all wasted in earth-resistance and in re-radiation—though by the way a fallacy lurks here.

Between these extremes there is a best degree of coupling, where the fraction of detector-resistance effectively introduced into the antenna is not so great as to spoil the "working-up," nor so small as to lose its chance of getting a share of the energy.

It is difficult to calculate theoretically the proper closeness of coupling—largely for the reason that the variation of the coupling alters the tuning of the circuits ; but practically it is easy to find the best coupling, by re-tuning the circuits to the signal-waves as the coupling is varied.

Apart from these considerations, it is necessary to insert a certain minimum of inductance in the secondary or detector circuit—a minimum which is the higher, the higher the average resistance of the detector. This is in order to provide that the detector shall have a sufficient electromotive force applied to it to allow the oscillating current through itself to be worked up.

Now it is an old principle in connection with the distribution of electrical energy as Joulean heat in circuits comprising internal (or "working") and external (or "wasting") resistances, that the working resistance ought to be equal to the wasting resistance for the former to get its greatest share.

We may fairly apply this principle here, since the circuits are tuned to the e.m.f. applied by the waves, and are therefore devoid of impedance ; and hence in the case of the receiving station, the effective resistance introduced into the antenna by coupling the detector circuit to the latter ought to be equal to the sum of the radiation, earth and other resistances of the antenna. When this adjustment is made, the efficiency of the antenna and its associated circuits is about 50 per cent. From this it would appear that it does not matter how high the earth resistance is, as this would merely involve a detector of higher resistance or closer coupling. But the fallacy referred to above enters here.

Put very roughly, the re-radiation from a receiving antenna, while under the influence of electric waves, acts on the field of the waves so as to increase the energy-flow from the field to the receiver ; re-radiation is, in fact, advantageous to a certain extent. Consequently the lower the earth resistance the better. Beyond this consideration there remains, of course, the fact that any kind of resistance in the receiving antenna impairs the resonance efficiency.

It is clear that the above-mentioned limit of 50 per cent. efficiency applies to all systems of wireless telegraphy.

DETECTOR EFFICIENCY.

The high-frequency energy now enters upon its last transformation by passing to the detector.

For telephonic reception the detectors most widely used are the point coherers, the crystal rectifiers, the electrolytic detector, the vacuum valve, and the magnetic detector.

If the wave-trains follow one another very rapidly as in some quenched-spark apparatus, as in the Poulsen arc with magnetic blast, and as in the Marconi smooth-discs, or if the waves are continuous as when high-frequency alternators are employed, a beating gold contact—called a "ticker"—is used in some one of the receiving circuits, in order to cut up the too uniform currents into pulses that can affect a telephone diaphragm audibly.

A good point-coherer can be made by oxidising thinly a clean piece of sheet iron, and adjusting a needle or a piece of wire to touch—the sheet being one pole, the needle the other, of the detector; a voltage of about 0·3 volt must be applied to put it into the sensitive state. When a train of oscillations is passed through the contact, the teady current alters temporarily, and causes a noise in the telephone receiver in the circuit; the ratio of the energy conveyed to the telephone in this way to the energy supplied in the train of oscillations is called the efficiency of the detector. For the coherer, its value is about 2 per cent. for fairly loud signals.

The crystal rectifiers usually consist of a contact between a conducting fragment of crystalline natural mineral oxide or sulphide, and a metal or another mineral. A foliated specimen of the mineral is best, especially if a blunt smooth-ended piece of metal forms one side of the contact. The reason for this s that the metal rides across the minute natural ridges of the crystal, making very numerous chisel-edged contacts, and thus achieves in effect the working in parallel of a large number of ideally fine contacts.

Such a contact possesses the property that the current produced by a given e.m.f. in one direction is many times that due to an equal e.m.f. in the opposite direction. In virtue of this property, alternating currents are "rectified"; that is to say, an alternating e.m.f. yields unidirectional current.

There may be, and generally is, some coherer action mixed up with the true rectifying action. A true coherer does not rectify in the least when no steady current is running through it. The efficiency of a given detector under wireless telegraph conditions is best measured in exactly the same way as that of the coherer.

The values which have been obtained with the zincite-chalcopyrite and the carborundum detectors are about 10 per cent. Of course, these values are for particular detectors; other detectors made of precisely the same materials may give rather different values.

The electrolytic detector, which consists of two platinum electrodes in an electrolyte, one very large and well-immersed and the other very minute and barely entering the liquid, has an efficiency very nearly the same as that of the zincite detector. The efficiency of the Fleming valve has not been measured, nor has that of the magnetic detector.

Everyone interested in wireless telegraphy must have been at times surprised at the diversity of opinion about the relative sensitiveness of the various detectors.

These differences of opinion arise partly on account of differences of material and construction, and partly because of differences in the receiving circuits. Circuits with large inductance and small capacity will give a different order of merit to a number of detectors from the order given by circuits with small inductance and large capacity, other things being the same. These statements hold good also for comparisons between the ticker and various other detectors. Some observers say the ticker is less sensitive, others say that it is more sensitive, than particular crystal detectors. Both sides may be right—much depends on the circuits, the coupling and the telephone receiver.

TELEPHONE EFFICIENCY.

The further we go along the chain of transformations of energy, the less definite becomes our knowledge of the magnitudes of the successive energy streams.

When a rapidly-varying current passes through a telephone receiver, or through a combination of telephone-transformer and receiver, most of its energy is spent as Joulean waste in the windings, some goes in eddy-currents in the cores and diaphragm, other portions go, possibly, in hysteresis and other magnetic losses, a small portion is converted into kinetic energy of the diaphragm, and a fraction of this last is given to the air as sound waves.

Information is lacking as to the proportions. Some endeavour has been made to ascertain the proportion given to the air, by measuring the effective resistance of the instrument with its diaphragm free to move and with the diaphragm held motionless, but the smallness of the difference suggests the simile of weighing a needle in a haystack. Even if the difference is as large as 5 per cent.—which is not admitted—the amount appearing as sound—that is to say, the only useful and important part—remains still undetermined.

The best mode of approaching the matter is probably as follows :—It is known that a continuous musical sound of frequency 256 per second is just audible when conveying to the ear a stream of energy of the order of 0.4 by 10^{-6} erg per second. Now a good telephone receiver will give an audible note of 256 frequency when supplied with an alternating current of about 10^{-7} ampere, that is, with a power of 4 by 10^{-4} erg per second ; but if the telephone circuit and its diaphragm happens to be "in tune" with that frequency the alternating power for just-audible sound may be only 3 by 10^{-5} erg per second.

In the former case the efficiency is 0.1 per cent., and in the latter about 1 per cent.

Our survey of the numerous transformations of energy involved in the transmission and reception of signals is now finished.

It will be seen that the least efficient transformations are those occurring at the receiving end ; in fact, the conditions at the sending end are really highly satisfactory as compared with the conditions at the receiving end. At this end, then, we may hope and work for great improvement, though, indeed, it is questionable how far increase of sensitiveness of receiving apparatus ought to be pushed, so long as we are unable to prevent "strays"—*i.e.*, natural electric waves—from affecting the receivers.

It may be asked: What is the ideal minimum of power for communicating, by aid of wireless telegraphy, across a given distance? An answer may be obtained by applying simple arithmetic to the chain of efficiency co-efficients given in this article. If we take for the co-efficients, in order from the supply-circuit at the sending station, the values .5, .1,1,1, .5, .1, .01—the last being the telephone co-efficient—their product is 25 by 10^{-6}; and, therefore, if 100 per cent. efficiency were obtainable at each step, the power needed to span a given distance would be $(10^{-6} \div 25)$ times less, or 40,000 times less, than is used at present.

An answer may, however, be reached by the employment of a wider view of the matter which was advocated in a paper read by the present writer in 1908.

A wireless telegraph receiver may be regarded as an elaborate extension of the operator's ear for the purpose of catching the energy passing over the site of the station —a sort of speaking- (or rather "hearing-") trumpet, in fact. The operator hears, in effect, the distant spark, although the energy does indeed travel in the form of electric and not in the form of sound waves.

Now, if we take the fact that the ear can perceive a stream of energy of the order of 0.4 by 10^{-6} erg per second, and if we make the very moderate assumption that the air-wires collect the energy from an area of wave-front amounting to one square metre, we find, on applying the inverse-square law, that a sending station using two watts (not kilowatts) ought to be audible on a flat earth at a distance of 3,200 kilometres—the distance across the Atlantic. As a fact, it is found in wireless telegraphy that something less than 20,000 times this, namely, 40 kilowatts, can be heard over the *curved* earth at the distance mentioned, under favourable conditions.

The general agreement of this estimate with that obtained by tracing the efficiencies may fairly be taken as affording some support to the numerical values we have assigned to these co-efficients.

CORRESPONDENCE

Receivers

To the Editor.

SIR,—I should be interested to know whether any comparative tests have been made between an electromagnetic telephone and the ordinary polarised type now in use. The efficiency of a receiving station seems to depend on four components—(1) the absorption of the aerial, (2) the rectifying action of the detector, (3) the acoustic effect of the telephones, and (4) the sensibility of the operator's ear. The first two seem to have received very full consideration, whilst the last is, of course, mainly dependent on natural properties and training. Surprisingly little, however, seems to have been done towards increasing the sensitiveness of the telephones.

In the ordinary polarised telephones the pull on the diaphragm is proportional to

$$2NdN+dN^2$$

where N is the permanent pull on the diaphragm due to the polarised core, and dN the change produced by the received current. The quantity dN^2 obviously depends on the magnetic susceptibility of the core, but as it is extremely small compared with 2NdN it is generally sacrificed, and the core made of steel having low susceptibility in order to increase the value of N. If, however, the value N were produced by electromagnetic means in a soft iron core, the value of 2NdN would still be retained, but not at the expense of dN^2. By a suitable regulation of N the diaphragm should be rendered specially responsive to one-spark frequency. Makers usually advertise that their diaphragms are made to "best dimensions," but surely "best dimensions" can only be possible for a comparative short range of spark frequency? Tests with electromagnetic receivers on long distance telephone lines have given satisfactory results where the currents are small. Further, there would be no "ageing," which so often occurs due to the rough handling meted out to telephones. Has any best transformation ratio for telephone transformers used with high-resistance receivers yet been decided?

Possibly some of your readers would enlighten me on these points.

Yours, etc.,

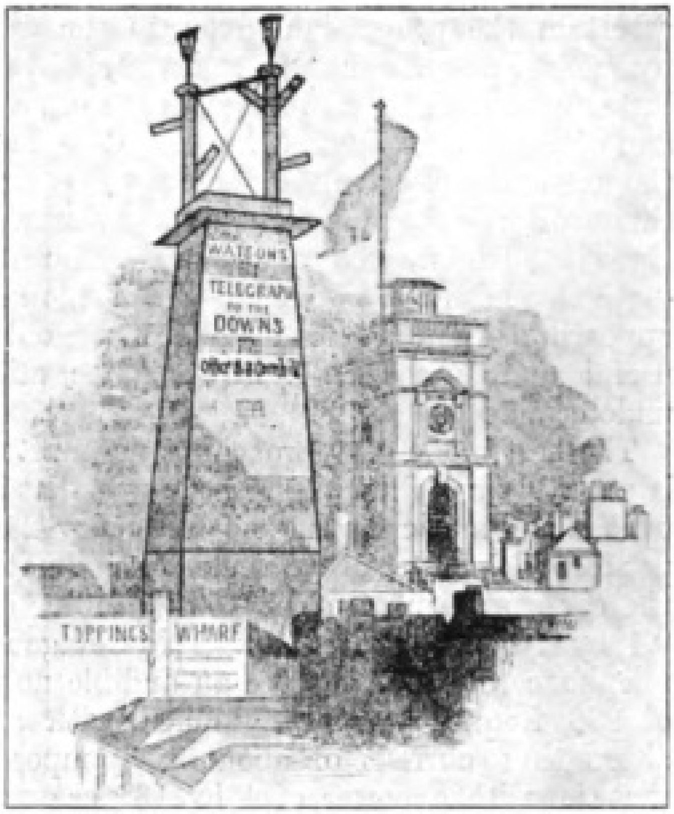
Valparaiso (Chili). C. H. K.

Semaphore Signalling

To the Editor.

SIR,—*Apropos* the article on "Signalling throughout the Ages," in your April number, the accompanying illustration and notes may be of interest to your readers.

A method of semaphore signalling was introduced by Messrs. Watson, of Cornhill, London, who erected several similar stations on the south coast of England, notably at Dover. The London station was originally an old shot factory, and served admirably for the purpose. Very little knowledge can be gleaned of the methods employed in signalling, but each station was provided with six movable semaphore arms, and



two iron braziers for the purposes of illumination at night; they followed practically the same methods of construction as the semaphore introduced into this country by Lord Murray, which was referred to in the April number of THE WIRELESS WORLD, with this difference that Watson's semaphore posts and arms were of cast iron and the whole equipment weighed ten tons. The shot tower, composed entirely of wood, was covered with slates.

Yours, etc.,

H. B. WILLIAMS.

Birmingham.

Scenes near Wireless Telegraph Stations

Nieuport on the "Littoral Belge"

BELGIUM was among the first countries to adopt wireless telegraphy, and considerable impetus was given by the progressive little State to radiotelegraphy generally in the creation, as far back as 1902, of the complete and thoroughly organised network consisting of the stations erected on the Dover-Ostend Packets and at Nieuport on the Littoral.

An admirable survey, historical and technical, of what was then and has since been achieved is to be found in Mr. Paul Dubois' book, "Aperçu sur la Télégraphie sans Fil," and so far as science and history are concerned we will content ourselves for the moment by merely referring to this interesting work.

But, associated with the erection of, or visit to, a wireless telegraph station in any part of the world, there are always other matters of interest, either in the adventures of the erecting engineers, in the life in the neighbourhood, or in the architectural and natural beauties of the place or its approaches.

Nieuport is rich in all these, but more especially in the remains one sees every-

Nieuport. Les Halles. [*Photo by G. E. T.*

E

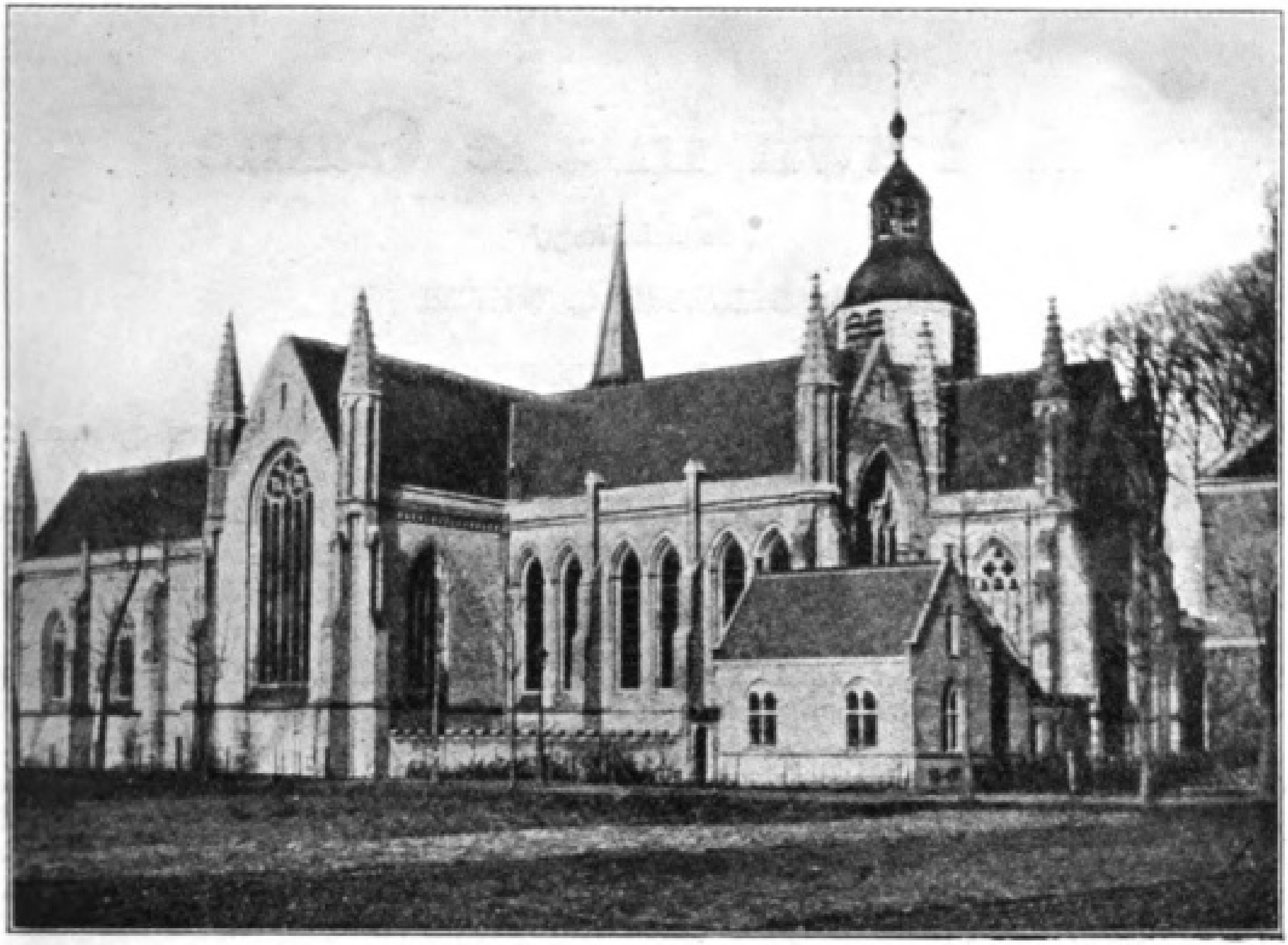
where of its former glory as a prosperous seaport. It was the port of Ypres when the latter ranked as an important commercial centre, and is situated on the Yser, about ten miles south of Ostend. It was strongly fortified during the turbulent middle ages, and its siege by the French in 1488–1489 is an episode of its heroic period. It was again the scene of battle in the year 1600, when Maurice of Nassau defeated the Archduke Albert of the Spaniards. Perhaps we may be permitted to make a slight digression into the past history of the country, to enable us to understand the events leading up to this important episode, which is recalled by a visit to the wireless station at Nieuport. The military skill and statesmanlike abilities of Alexander Farnese, Prince of Parma, had succeeded in bringing Belgium under the authority of Philip of Spain. Parma was appointed Governor-General in 1578, and later proceeded to make himself master of Brabant and Flanders by force of arms. In succession Ypres, Mechlin, Ghent, Brussels, and finally Antwerp fell into his hands. Thousands of its inhabitants made their homes in the Dutch Republic or in England. All commerce and history was at a standstill; grass grew in the streets of Bruges and Ghent, and the trade of Antwerp was transferred to Amsterdam. On Parma's death in 1592, the Archduke Ernest of Austria was appointed Governor-General, but he died after a short tenure of office, and was at the beginning of 1596 succeeded by his younger brother, the Cardinal Archduke Albert, who married in 1598 his cousin Isabel, eldest daughter of Philip.

[Photo by G. E. T.

An Eastern pedlar on the Strand at Nieuport.

Philip now transformed the Netherlands into a sovereign State, under the joint rule of Albert and Isabel. The advent of the new sovereigns, officially known as "the archdukes," though greeted with enthusiasm in the Belgic provinces, was looked upon with suspicion by the Dutch, who were as firmly resolved as ever to uphold their independence. The chief military event in the early years of their reign was the battle of Nieuport, in which Maurice of Nassau defeated Albert, and which led to the twelve years' truce.

But we must resist the call of history and legend made on every side, and turn reluctantly from the many famous battles that have been fought in the country now called Belgium, lest we be tempted to stray too far from that interesting town on the Yser, whose wireless telegraph station is a symbol of the commercial fortunes of the country. Nieuport is full of historical associations, and retains at every turn impressions left upon it by the Spanish. This, with the landscapes and the many interesting types of the Flemish race, and last but not least, its attractive Strand, draws every year to Nieuport numbers of artists. Once they have visited this quaint old place, and experienced the warm, genuine hospitality of its inhabitants, N euport is never forgotten. Its architecture, as exemplified in the types shown here, may not surpass in beauty the architecture of the famous edifices with which we are familiar elsewhere, but we can truly say of it, with Ruskin, that it is the manly language of a people inspired by resolute and common purpose, and rendering resolute and common fidelity to the legible laws of an undoubted Deity.



NIEUPORT.

The top picture shows a corner of the Church. The bottom, the old Tour des Templiers.

[*Photos by G. E. T.*

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.*

GWEN THRALE.—*Charles Summers's fiancée, a bright intelligent and original girl, the idolised daughter of the squire, and secretly the member of a Fabian Society.*

M. DUPONT AND HERR BEULNER.—*Foreigners, making a prolonged visit to England. Ostensibly belonging to the leisured and wealthy classes with no particular aim in life.*

DOSS AND SUK.—*Pedlars, for ever on the prowl, and the universally recognised purveyors of village gossip.*

Charles Summers, the only son of the Vicar of Sotheby, is an engineer and inventor. His peculiarities arouse comment among the villagers, and his workshop is the subject of so much curious speculation that Doss and Suk, two itinerant pedlars, make it their business to discover its secrets. They are, however, strictly warned off the premises. The only person "in the know" is Gwen Thrale, Summers's fiancée, a high-spirited girl, who often looks in to "help" him in his work. Gwen is no unsophisticated Miss; she has been a probationer at the Slade School, and is secretly a member of the Fabian Society, and in this connection has become acquainted with two foreigners, M. Dupont and Herr Buelner, who are discovered to be visiting the neighbourhood.

CHAPTER III.

GWEN OF THRALE HALL.

THIS little episode over, Summers went back to work in his den, mentally resolving that ground glass should be put into the lower window panes. He had scarcely settled again to the business in hand when Gyp began barking furiously. His outburst was followed by some quick steps on the gravel and a brisk tattoo on the door. Up jumped Charles, his face aglow with excitement, all the demeanour of the student cast away, and the spirit of the schoolboy awake again as he shouted "Coming," while he struggled into his coat. Seizing the key, he unlocked the door and flung it open wide. There, framed in the doorway, was the prettiest picture that could delight the heart of a man. A mass of soft fluffiness, a little head crowned with a mop of unruly curls which would not be domineered by hair pins, but made a riot of golden lights and ruddy shadows as they peeped out from under the broad summer hat. Eyes that were blue, or violet, or grey, according to the mood of the owner; lips that were made for kissing, but tried to be prim; a neck that would have been the despair of Juno, shown off by the loose turn-back collar of her pale blue linen dress, the skirt just allowing a neat little ankle to appear over the daintiest of white shoes. Such was Gwen Thrale, and if Charles Summers had remained unmoved at such a vision he must have had a heart of stone. But he didn't. Instead, he showed he was a young man and very ardently in love. When the first passage—shall it be called a passage of arms?—was over, he drew her into the workshop and made haste to discover a chair from under the accumulated débris of experimental science; but she, without more ado, pushed aside his tremendous calculations, and seating herself on the table began to draw circles with his compasses on any plane surface that came within her reach. All the time she chatted to him gossip of not the slightest interest to any but the person she addressed, scarcely waiting to receive his monosyllabic replies.

Gwen Thrale was an only child, and her father's darling. She showed it, too, not by haughtiness or waywardness, but by the wide open innocence of her blue eyes, and by an attitude of entire confidence and lack of consciousness which was her invariable characteristic. Like Charles, she too had lost her mother when she was very young; but that mother's place had to some extent been filled by a maiden aunt, her father's only sister, who had given her plenty of cossetting and affection, but who had wisely refrained) in view of her brother's passionate affection for his child and her own difficult position), from attempting to drill the little mortal to her own ideas. Had Gwen been a wilful or masterful child, this would have spelt her ruin. As it was it did her no harm, but allowed her to develop herself on her own lines, while a strong sense of humour and a naturally sweet disposition acted as the necessary correctives to her indulgent upbringing. Not that "Wen," as she called herself, was a model of all the virtues. She was a pickle in petticoats. No piece of mischief was left undone for the want of a try. How often did her poor aunt groan to see her niece descending in full career down the bannister rail, or to hear the piano shrieking in expostulation as the small lady rolled the footstool violently from one end of the keyboard to the other in her efforts to produce the maximum of sound with a minimum of effort. To the servants she was a terror. To the gardener, a hybrid between a fairy princess and a nymph. She would explore the garden holding his hand and discussing the flowers with an intelligence that made him wonder; but if the time of the early strawberries was at hand, or the prize sweet peas were in bloom, experience told him he must keep a sharp look-out over the coveted treasure, for, should his watchfulness be relaxed but for an instant, he would surely find his treasure vanished, and only the marks of little feet on the soft soil. But the limit came one day when he found his prize pumpkin, which was ready for the local show and only waited the picking, unceremoniously torn from its vine, and my lady seated cross leg on the bed vigorously hollowing it out with a kitchen knife, in order, as she said, to make a carriage for Cinderella. Poor old Ben had much to say about "them darned fairy stories," with a few supplementary remarks on the perversity of childhood. Nevertheless, when Gwen came a few days later, and asked to be lifted up to cut a bunch of grapes, the horticultural enthusiast, who, since the incident, had determinedly assumed an aloofness of demeanour in order to express his extreme displeasure, gave way ignominiously before the little golden-haired autocrat.

After that had come Gwen's school days, which for her consisted of one long campaign to escape the music mistress and thwart the evil designs of the teacher of mathematics, with an equally earnest study of French literature, French history, and French art inspired by an ardent devotion for Mademoiselle Brienne. Finally there was the "finishing off" school in Paris and home again to Sotheby, with Gwen a "young lady," heir to a considerable fortune, rather pretty, and of infinite charm.

But Gwen at this age had one pronounced idea. She wanted to see life, and was disinclined to accept the boundaries of the village as the horizon of her existence. As a matter of course she visited relatives in London, and was presented at Court, nor escaped the accompanying excitement of a season in town; but what was that to a girl who wanted to find out things for herself? True, she met a number of "good" people, but her individuality and independence of thought soon caused her to see through their fine assumption of knowledge and the shallowness of their mental outlook; so when some of her father's cousins—men of repute in the professional world—came down to spend a long holiday at Thrale Hall, she found herself in a world much more to her liking, and through them discovered a way of emancipation from the deadly routine. Why not, one of them suggested in the course of a conversation with Gwen on this topic, take up a course of sculpture at the Slade School? there were plenty of girls who did this. Why not, indeed? Why not, indeed? The more she thought of it, the more it seemed to her liking, so that the day came when she cajoled her father into giving his hesitating consent to the plan, and it was not long before she had established herself with friends in London and became "a Slade girl." She never once regretted her action, for her work gave her a new interest. There was so much to do, to see, to hear, to experience, that she found she was no longer obliged to make her own amusements in order to pass time away, but was swept along on the tide of strenuous effort, and learned to appreciate the exhilarating influence of ambition and the desire for progress. Not that she made a great hit in her work. She was well aware that, if anything, her ability was rather below the average, but it served as a nucleus of interest for the attraction of all the more important questions of the day. Social, political, philosophical, artistic, they all had some relationship with her occupation and had to be discussed, so that in this way the opportunity was given her of forming her own ideas on all the important issues of life.

Of course she never analysed the matter in this way. She simply "took to" the life, and there was an end of it. As a natural consequence she was soon on very friendly terms with her fellow students; they were attracted by her vitality and personal magnetism, and still more perhaps by her evident affluence; for though they would have strenuously denied the soft impeachment, Miss Thrale certainly did have money and to spare for any purpose, was it subscription dance or charity; and such a companion in a set which was as a whole unable to spend lavishly, was a consideration.

The result was, Gwen was given a rattling good time. She was taken out to all their entertainments and initiated into the Slade arcana. With her "pals" she visited places of amusement that would have horrified her elders had they known. But they did not know, while Gwen, on her part, was unaware of their reputation; and the net result was she often had an evening's innocent amusement at music-halls which ought to have been frankly indecent.

This was the lighter side of her life at the Slade; but there were other factors which brought her into touch with the deeper influences of intellectual life and social progress. In common with most youth of to-day, she was waylaid by the Progressivist—he who spells his name with a big "P," loudly proclaims a doctrine of universal discontent, and would alter the whole course of nature in twenty-four hours if he had his way. He flourishes well at art centres and at the universities, for youth is naturally rebellious and iconoclastic, and it is on these instincts that he works to bring about his effects. The result is that nearly every large centre of education is also a centre of Socialism.

But Gwen Thrale was only caught in the backwash of the progressive propaganda. Had its full significance been explained to her she would not have understood. She was too comfortably off to be anything but a hanger-on to such a movement. But it was due to this influence and the accompanying excitement of indulging in a mild form of mental gymnastics that caused her to become a member of the Fabian Society. Besides all this, her associations with such heterodox theories had a glamour of naughtiness. She daren't tell her people that she was a Fabian. Such an announcement would have brought the whole village of Sotheby, with all her uncles and aunts and cousins, buzzing like hornets about her ears. But, chiefest of all (and it was for this reason that she hesitated to make the disclosure), it would have troubled her father, who clung rigidly to the old opinions. Therefore when she wanted to attend meetings or take part in debates she had to contrive little schemes and subterfuges, and all this gave zest to the proceedings. How she did enjoy those informal meetings, to be sure, for there was plenty of mirth and pleasant society and clever talk, with a freedom from social restraint which was to be found nowhere else in social England; in fact, it was the nearest approach that England could offer to the Bohemianism of the *Quartier Latin* and the artist colony of Rome.

There she made heaps of friends, who really appreciated the girl for her naïveté and charm; and Gwen, at twenty, was not above being flattered at the delicate compliment. So it happened that when her three years of studentship were passed, and Miss Thrale was obliged to relinquish London life and take her place in Sussex society as the hostess of Thrale Hall and daughter of the Squire of Sotheby, she still managed by hook or by crook to attend the Fabian reunions, and keep up correspondence with the more intimate of her associates. Sometimes she was able to invite those who had the least pronounced opinions to a week's shooting or other entertainment at Thrale Hall; but the only time when she dared to introduce a whole crowd of these friends to the countryside was on the occasion of her twenty-first birthday. Then the entire village was *en fête* and prepared to enjoy itself, and Gwen thought that at such a time, and among the large company which assembled to honour the occasion, of any idiosyncrasies peculiar to such an unconventional set would pass unnoticed. Even as it was, the manners of some of them evoked the village curiosity and a certain amount of gossip, but Gwen's enjoyment outbalanced any slight difficulties of this nature. How she revelled in the picnics which took place without the accompaniment of flunkeys and hampers and champagne bottles, where plates were taboo, and lunch consisted of a few sandwiches wrapped in greasy paper bags, and stowed away in satchel or pocket! Never were dances more delightful than those improvised for the evenings, when some member of the party would rattle off tune after tune on a rather cracked old fiddle, the owner's Bible and missal and *vade mecum*, while another would thump out tunes on the piano with more goodwill than compassion for the instrument. Then, too, the boat-races on the ornamental lake, when the competing crews could only be distinguished by the Chinese lanterns they carried, and the shallows and weed-beds of the course had to be avoided more by luck than guidance. What echoes of cheering reverberated in the pine woods, and how scandalised the night owls were to hear French songs sung in good French, and sometimes, when the fun was fast and furious, the strains of the "Marseillaise!" Those *were* days! But Gwen realised that they must not come too often if the respectability of the family was to be observed. Therefore she wisely refrained from repeating the experiment, but contented herself with her occasional journeys to town, and screwed all the amusement out of life that Sotheby could afford her. Naturally circumstances threw her a good deal in the way of the vicar's son, and she did not take long to appreciate both himself and his work. He really was a jolly chap, despite his reserve, and already experience had taught her that she would have to go far afield before she could find another so genuine or with such integrity of purpose. Charles might be somewhat aloof and undemonstrative, and not altogether the *beau ideal* of a lover, but he would make a good husband, for he was sympathetic and loyal and tactful and interesting; wherefore Gwen elected to forego the poetry of love-making and be content with the gold of sincere prose, and "when," as she wrote in a letter to her favourite cousin, "Charles popped the question, she knew she had struck on a good thing, and would have been a silly to say 'No'!"

Now she was urging that good thing to accompany her into Chittingham.

"Dad is waiting outside," she said, as she jumped down from the table. "I can't keep him a moment longer. He will have finished his cigar, and then he hates waiting. Why don't you come along with us? You will be sitting over those figures until you're altogether wuzzy, and if I'm coming here this evening to help you with your work, I don't want to have to humour a bear with a sore head."

Here Summers expostulated: "I really must get on. These calculations of wave-lengths are the very deuce, and I shan't feel contented till I have worked them out."

"But you will never work them out this morning. It is nearly twelve o'clock now, and by the time you have settled yourself down to them again you will be wanted for lunch."

"Well, I'll have a try, anyhow. I really must."

"Why must?"

"They've got to be done."

"I don't see that there is any got about it. The world's not going to dissolve away because you leave your calculations over for half an hour. Besides, nobody's waiting for them. You have only got yourself to please, and *me*." In answer, Charles took her arm, and Gwen knew that her case was won.

"Well, I can't stop here any longer. We've got to go and choose partridges. Dad says he won't sit down to another meal unless he can get some partridges. Here's your chance of helping me. Come and pinch the poor little corpses, and give me your opinion of them. I detest the work. I daren't leave it to the housekeeper or aunt. They don't know a chicken from a woodcock, and would be sure to be swindled. I don't know much myself, but I pretend I do; but if you come along old Barlow will tremble for his reputation, and we shall get the pick of his stock; and don't forget you will have to help eat them to-morrow. There now, what further inducement could you want than that?"

By this time they had reached the vicarage gates and saw Mr. Thrale in a governess cart patiently walking the pony up and down. As soon as he saw them he increased his pace, and welcomed the pair with a nod.

"Dad," called out Gwen, "Charles is as stubborn as a mule. Don't you think he ought to come with us and help choose the partridges? I have been telling him so for the last half hour!"

"Half hour!" drawled Mr. Thrale, "I should think an eternity. I have smoked two cigars and worn this beast out with walking him up and down."

"Oh, I'm sorry, dad, but it's Charles' fault; he shouldn't be so obstinate. Now then (turning to Charles), jump in, and we'll be off to Chittingham."

Still Charles hesitated. He did so want to get on with wave-lengths, but Mr. Thrale finally decided the question. "Get in," he said, "you look as though you want an airing. Why, you look as white as a ghost, and as mopy as a broody hen."

Charles got in, the fat pony was whipped up, and the party drove down the narrow lane into the high road which led to Chittingham.

Mr. Thrale immediately handed over the reins to his daughter, and she was now dexterously steering the governess cart with its ample load through the narrow and tortuous roads of county Sussex. The high hedges on either hand were white with dust and only allowed the tops of the trees to show beyond them. The country through which they drove was largely composed of plum and apple orchards, and the red globes of the fruit would gleam here and there through the heavy foliage as the sunlight caught them. Occasionally a cottage would come into view, the front garden a blaze of gaudy flowers such as the autumn loves, and as often as not their approach to such habitation would be heralded by the expostulations of a clucking hen, who, wandering into the road, discovered at the eleventh hour that this was the broad highway leading incontinently to destruction. Occasionally a road hog passed them, its long grey body gliding warily by as though it were some swift and cunning emissary of hell. The Thrale party had journeyed about a mile when such a motor was seen approaching them. There was nothing particularly striking about the car, and it would have passed unheeded had not Gwen recognised the occupants and acknowledged them. In return they raised their hats, saluting with a deference that was almost obsequious, except that their action was rather flurried. Scarcely had they passed than the car seemed to swerve as though the chauffeur had lost control of the wheel. Then it gave a great lurch and made straight for the bank, landing half overturned in a wide ditch bordering the roadway. It was easy enough to see that the party were in difficulties, and immediately Gwen drew up, while Charles jumped out and ran to offer them assistance. Gwen, too, handed the reins to her father and came to see what was the matter. By this time the two young men had got out of the motor and were busy trying to remedy matters. With the aid of their helpers they were able to drag the machine along to a place where the ditch was less deep, and then the younger of the two men once more taking his seat in the car managed to guide it out again into the road. Immediately matters had been put to rights introductions were effected. Gwen introduced Charles to them as her *fiancé*, and they were announced to him as Monsieur Dupont and Herr Beulner. The former was dark and swarthy, his intelligent head and well-cut features set off by a regular towsel of coarse black hair. The other was his exact antithesis; fair, well made and small-boned, with a pink and white complexion and smooth damp hair brushed carefully to one side of his forehead. There was nothing to distinguish him from the typical English student, and his age might have been anything from twenty to twenty-six, certainly not more. He was clean shaven, and, in fact, might have been without original sin by all the beard that was indicated on his chin. He spoke English fluently and well, with scarcely a trace of foreign accent; and this again was in striking contrast to his friend, whose speech was punctuated with all the eccentricities of foreign pronunciation and enriched with frequent quotations from the French. They both made profuse apologies for troubling their helpers, mildly blamed themselves for their inexperience in motor driving, and, with professions of deep obligation, resumed their journey. Gwen and Charles turned back to Mr. Thrale, who had been watching proceedings between the puffs of another cigar as he leant comfortably back in the trap. As soon as they got up to him he wanted to know all about the young men, and Gwen told him she had met them at some of her College re-unions. This reply to his enquiries did not seem to entirely satisfy that gentleman, for all he said in response was, "Um, don't loo'; like art students, anyhow," as he meditatively chewed the end of his cigar. Then they continued their journey, Charles amusing himself by watching his prospective father-in-law as he was jostled up and down in his corner of the governess cart, which trundled energetically over the country roads in a way that governess carts have. Charles smiled. He looked so luxuriously content; the immaculate white waistcoat covered an ample form, the fat round face was so rubicund and so healthy, and the short grey beard gave such an air of fatherliness to the whole. What with whiskers and moustache and beard there was little enough to be seen of Mr. Thrale's face, and his mouth, that most tell-tale of character signs, was scarcely visible. But the eyes were scarcely in accord with the rest of his appearance. At the moment they certainly looked beneficent enough for Job as they peered lazily through the half-open lids, but Summers knew how quickly they could alter. Under the influence of excitement they seemed to shrink back into his head and glowed like fire. At such times, too, his attitude would change; no longer the leisurely contented pose, but a stiffening of the muscles, a set of the shoulders which betokened a certain reserve of animal cruelty, and the lazy drawl which he usually affected would become sharp and peremptory. Summers had noted this change when the motor car had passed them, and there again was a hint in the changed tone of voice in the way he made comment on Gwen's answer to his question. Now, however, that matters were comfortable once more, he had assumed his nonchalant attitude and contented air. He was absorbed in watching the passers-by, who became more numerous as they neared Chittingham. Soon they brought up at the principal inn, and giving the horse in charge of the ostler they went to make the proposed purchases. Mr. Thrale had some business with a local builder, so left the two young people to their own devices. Then followed the shopping of partridges and other household commodities, a process in which Charles took little interest, only troubling to utter a syllable when he knew he was expected to say yes or no as the case might be.

In the course of their wanderings Gwen told him all she knew about the travellers in the long grey car. She had met them several times at the Fabian Society, and they seemed to be rich young foreigners with plenty of money to spare and all their time on their hands. She knew they were to be at the meeting on the following day, and she had no doubt they would make a special point of speaking to her. They had always been rather friendly, and this would give them an opportunity of increasing the acquaintanceship. They were good conversationalists, well read, extremely polite, and in every superficial way desirable; but she was not sure whether she liked them or not and she rather hinted that Charles' escort at this particular meeting would be appreciated; but Charles scarcely took any notice of her suggestion, passing if off as a mere expression of opinion which was not meant to be taken in earnest—besides, he was thinking of "wave-lengths"—and Gwen, whose independence was notable even amongst such independent persons as art students, refrained from pressing her point. Nevertheless, a lurking sense of uneasiness possessed her with regard to these two men. She could not account for it and told herself it was ridiculous, but in spite of all her efforts it continued to haunt her.

CHAPTER IV.

A TRIAL TRIP.

That same evening Miss Thrale came again to the Vicarage, for Charles had arranged to sail his airship on a trial trip, in order that she might see how it worked. It was about 8 o'clock, and the light was beginning to wane, when an "Halloo" brought Charles out from the Vicar's study. This time there was no long gossip at meeting. Charles was anxious to get to work. He switched on the electric lights in his "lab.," and soon Gwen was half hidden in a ragged old mackintosh, an essential preliminary to "messing." Then final preparations began on a vast scale. The stable boy, the under-gardener, and a choir boy who happened to be about were pressed into the service. They had already had some sort of apprenticeship under "Maister Charles'" guidance, and they were now sent to different spots in the neighbourhood with fire balloons, and well drilled with instructions as to how, when, and where to send them off. Then Miss Summers was called to witness proceedings, and the Reverend found time to lay aside his book and join the curious crowd. The housemaid discovered she had important duties to perform which brought her into the vicinity of the window, while the cook, shelling the late autumn peas under the friendly asylum of a hedge, kept one eye fixed on the movements taking place on the Vicarage lawn. Charles, who had disappeared again into his workshop, now returned bringing the instrument which was to play the title *rôle* in this little drama. With infinite care he carried the airship from its steel hangar to a tripod fixed for its reception in the centre of the lawn. Its balloon was inflated to a nicety, the steel parts and wires shone brilliantly in the setting sun, and the whole machine looked ethereally lovely in the evening glow. Carefully he placed it on the stand with the nose slightly elevated. Then with deft manipulation the machinery was set in motion, and when the miniature engines had gained sufficient power, he turned a lever, and the little vessel gave a slight shudder and then darted forward. After this it appeared to heel over on one side, but swiftly recovered itself, and as the engine began to beat rhythmically, it soared gently into the air. The lever had been placed at a slightly acute angle, and the machine was soon flying some score of feet over the watchers' heads. Then Charles rushed into his "lab.," and switching off the lights seated himself at the table in the bay window. All was in readiness for operation. The dynamo was vibrating, and the miniature crackle of the sparking gap could be heard within the silence chamber. The pressure of a lever, a little tuning, and Charles was in touch with his airship. The toy responded to the note. He pressed one of the little knobs, and the watchers on the lawn saw the vessel lean slightly forward, and then assume the horizontal, taking a course as straight as the crow flies. Now Charles was watching it from what appeared to be an adjustable telescope fitted through the roof of the studio. This machine was fixed on a swivel which responded to a little lever placed close to the operator's left hand. It worked to a nicety, and wherever the vessel went Charles could follow it with perfect ease, while by this means he obtained a clear view over an immense expanse of sky. Once more he touched a lever, and the ship swung round. Then he played—or so it seemed to Gwen, who had come to watch him—a kind of tune on the black knobs.

"What's that for ?" she asked.

"I'm going to make it describe a circle."

Sure enough the model obeyed the call. Very gradually it took the form of a curve, and finally a complete circle was described.

"Now," said the operator, "I'm going to enlarge the circle." He pressed another of the brass keys, and the vessel darted out of its former course, swung round again once more, and was soon navigating a course similar to its first, except that it was of much larger circumference.

"Now we'll do a figure of eight."

Gwen, who was standing on a chair looking through the skylight, clapped her hands as she saw the movement carried out with complete success.

"Oh, Charles, it's really fine. It's beautiful. It looks just like some great white goblin prowling about in mid-air in search of its prey."

"Well, what is it doing now ? "

Gwen only replied "Oh," for she saw the little vessel suddenly leap forward, thrust its nose up into the air, and describe a grand spiral as it mounted up and up and up.

"Oh, Charles, if you don't look out it will disappear altogether. Why, it's getting so small it only looks like a bubble. Do stop it, or turn it round, for if it gets over the pine trees, you will never be able to get it back again."

Charles laughed. "Don't worry, chicko," he said. "It's as right as rain. Why it's *got* to obey me. Look here, I've only got to tap, and it will come along as I tell it to."

Even as he said this, the vessel in answer to his summons made a *volte-face* and swiftly returned. But Charles was now looking at his watch. It was about time for those outposts to be doing their work. Half-past nine were his instructions, and here it was to the very minute.

"Now look out, Gwen," he cried. "You're to see something worth seeing now. Something that's never been seen before, and I reckon won't be seen again unless I have the doing of it."

He was looking intently through his telescope, and the sight seemed to give him immense satisfaction, for he gave a short whistle. From behind the pine trees of the neighbouring hill came out a fire-balloon. The night was so still that it took an age to ascend, but when it got to a certain height the wind seemed to catch it, and it began to blow swiftly across the hills. Charles reached over the operating table, his long thin fingers stretched out as if to embrace all the points at one and the same time. He touched this lever, pressed that ebony key; reaching out to another switch, he made the dynamo hum the faster, and soon Gwen saw the little model racing across the sky. It passed out of sight of the skylight; so she jumped down and rushed out to the lawn. There she found all the household assembled, gaping upwards with their heads thrown well back and astonishment writ large on each countenance. They looked too funny for words; their faces silhouetted against the night—sharp nose, snub nose and roman nose, all pointing upwards, with every pair of eyes wide open as saucers. Gwen burst into a ripple of laughter, but her merriment was cut short, and she too had to assume the ludicrous posture, for as her eye followed the line of vision marked out by the others, she saw at once that great things were happening between the airship and the fire-balloon. There was no doubt about it. The race was keen, and the hunted was being swiftly overtaken. Before many minutes the bows of the ship were almost touching the balloon. Then a remarkable thing happened. Two jets of white flame flashed out from the protruding eye-sockets. The balloon burst into flame, and in a moment it disappeared completely. Then the airship returned, for all the world as if it had been some aerial pointer which had marked its quarry and then had returned to heel at the call of its master. As it came back it made another wide circle, passing behind the chimney-pots of the Vicarage. Then, as it re-appeared, it made a sharp curve, almost at right angles, its swift movement giving the watchers the idea that it had sighted the enemy. They turned to see, and there, sure enough, over the village rose another fire balloon. Like a flash the airship made directly towards it, and as it passed over their heads they could hear the faint whirr of the engines. Soon it came up with its second victim. Again there was a flash, and a second balloon was accounted for. Other experiments followed, and the results were dramatic enough to draw applause from the little crowd on the lawn. Then the performance came to an end. The machine was made to take narrowing circles in a descending flight till it hovered just above the heads of the watchers. Charles shouted to them to keep clear of the vessel, as it would be almost red-hot and likely to burn anyone unfortunate enough to come in its way. The warning was sufficient to scatter the group, and while they peered out from a safe distance the airship gradually lowered down; then quietly, as if stiff with its own exertions, it slipped on to the hangers of the stand placed ready to receive it. Now the spectators crowded round it once again, and a buzz of talk ensued.

But Gwen had disappeared into the studio, and was asking Charles such a lot of questions as to how it was all done, the why and the wherefore, that he found the only possible means of answering such a catechism was to let the fair questioner have a turn on her own account.

"Look here, I'll show you what I did. Suppose we start the thing again. It's all in working order. Wait a minute. You take this chair, and I'll set the motor going, but don't touch anything till I come back; then I'll show you what to do. It's awfully simple. The only thing is you've got to remember what stops to touch at the right time. There you are; now I won't be two tics."

Gwen waited, and presently heard the hum which told her the motor was at work again.

(*To be continued.*)

The Early Days of Wireless Telegraphy

How a Chess Match was Played

ANY incident that serves to remind one of the wonderful advance made in wireless telegraphy during the past decade will be read with considerable interest. About ten years ago there were comparatively few of the mercantile vessels fitted with wireless telegraphy, and the number of shore stations were even proportionately fewer. Only a few of the ships engaged in the North Atlantic routes were equipped with wireless telegraph apparatus, and it is not surprising that messages were not very numerous. The operators on board those vessels were then by no means overworked, and they were consequently only too ready to take part in anything that tended to keep them busy and relieve the monotony of periods which would otherwise have been idle. In the early days, it was not uncommon for passengers on two vessels sailing within wireless range to play chess matches by means of wireless telegraphy. We have the record of such a match played in July, 1902, between Mr. H. J. Stembridge and Mr. H. J. Reece, officers of the s.s. *Minnetonka*, on the one side, and four passengers of the s.s. *Etruria* on the other. These vessels were at the time travelling in the same direction, and were in communication over an extended period, so that there was an excellent opportunity of the game being played. Below is a record of the moves, in a match which resulted in a win by the officers of the s.s. *Minnetonka*:

CHESS MATCH.

Match played by "Marconi's Wireless Telegraphy" between H. J. Stembridge and H. J. Baker Reese, officers of the s.s. *Minnetonka* (winners) and four passengers of the s.s. *Etruria* (Cunard Line).

	WHITE. *Etruria.*	BLACK. *Minnetonka.*
1.	P—K4	P—K4
2.	B—Q B4	B—Q B4
3.	P—Q3	Kt—K B3
4.	K R P—K R3	P—K R3
5.	Kt—Q B3	P—Q B3
6.	Q—Q2	P—Q4
7.	B—Q Kt 3	P—Q5
8.	Q Kt—K2	Castles
9.	Kt—K B3	Q—K2
10.	P—Q R3	R—Q sq
11.	B—R2	P—Q R4
12.	Q—Q sq	P—Q Kt4
13.	Castles	B—Q Kt3
14.	P—Q Kt4	P takes P
15.	P takes P	B—K3
16.	B—R3	R takes B
17.	B takes B	R takes R
18.	Q takes R	Q takes B
19.	Q—R8	Q Kt—Q2
20.	Q—R3	P—Q B4
21.	P—Q B3	Q B P takes P
22.	Q takes P	Q—Q B3
23.	P takes P	P takes P
24.	Q Kt takes P	B takes Kt
25.	Q takes B	Q—Q Kt3
26.	Q—Q Kt4	Kt—Q B4
27.	P—Q4	Q Kt takes P
28.	Kt—K5	K Kt—Q4
29.	Q—Kt2	P—Q Kt5
30.	Kt—Q B4	Q—R2
31.	Kt—K5	Q—R6
32.	Q—K2	K Kt—Q B6
33.	Q—K B3	Q—R7
34.	Q—Q3	R takes P
35.	Q takes R	K Kt—K7 check
36.	K—R2	K Kt takes Q

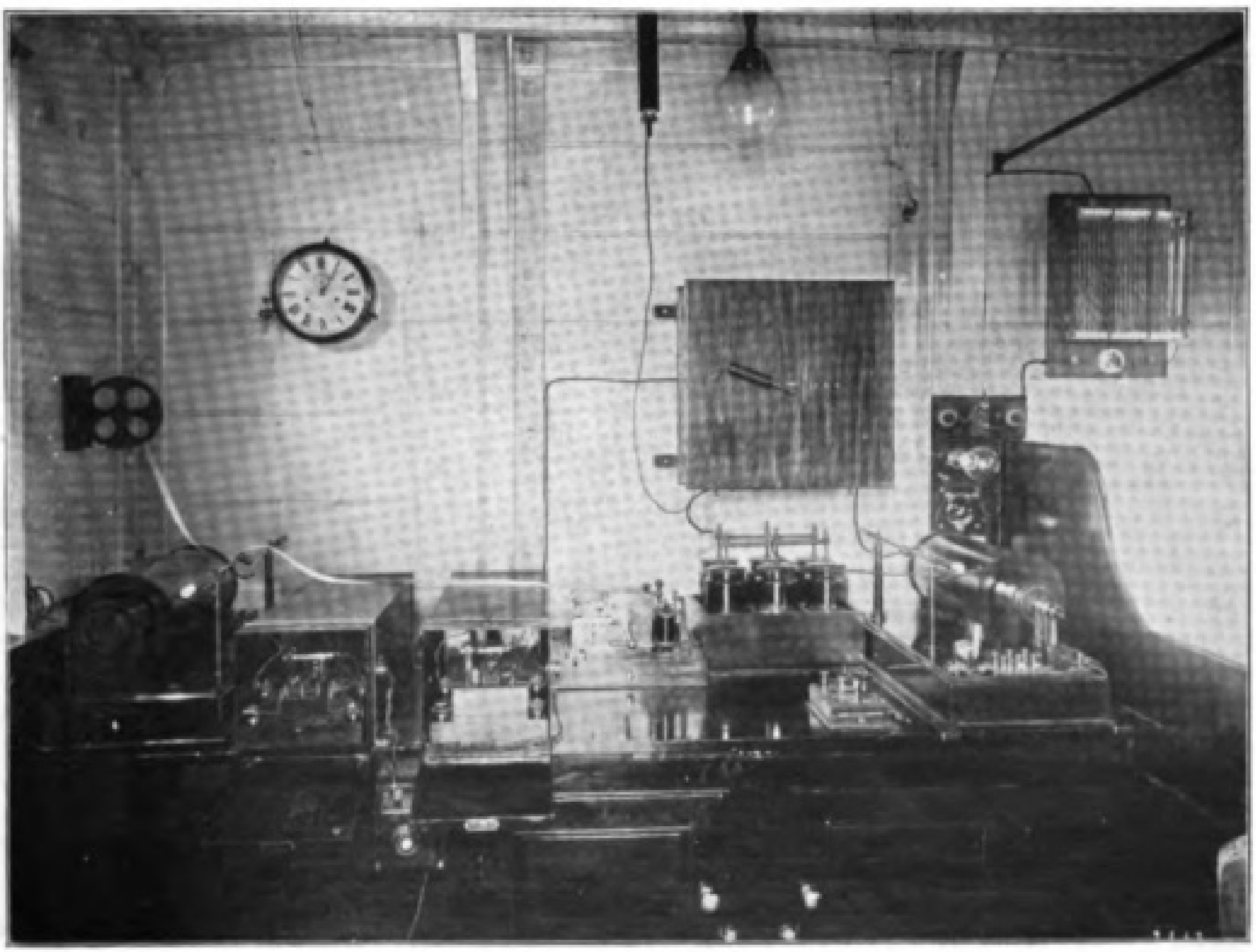
White Resigns.

It might be advisable to state the method of describing the moves shown in the accompanying table. Each player counts from his own side of the chessboard, and the moves are denoted by the names of the files and the numbers of the squares. Thus, when the player "White" for his first move advanced the king's pawn two squares it is described above as follows: 1. P—K4. "Black" responded with a similar move from his side; next "White" moved his bishop to queen's bishop 4. The various pieces are denoted by the following letters:

K	King
Q	Queen
P	Pawn
Kt	Knight
R	Rook

K B denotes king's bishop, and Q B queen's bishop. The same applies to rooks and knights.

It is a striking testimony to the efficiency and reliability of wireless telegraphy even in the early days that a game such as chess, which abounds in subtle variations, should be played to a finish by means of wireless telegraphy with almost the same convenience as if the combatants sat face to face, each calling to his aid all that he has of foresight, brilliancy and resource both in attack and defence. We are able to show below a photograph of the apparatus on board the *Minnetonka* at the time when this chess match was played. The apparatus then in use, though differing in design from the modern types of Marconi apparatus now installed in ship stations, contained all the essentials for commercial transmission and reception of telegrams, and the modifications of following years have only resulted in improving the apparatus for its original purpose by increasing the range through increase in power and increase in size and change in shape of aerial. Dynamo-electric machinery now take the place of the coil; self-acting detectors and telephones have replaced the coherer, tapper and relay of the original receiver; selectiveness has been increased by the introduction of independent resonating circuits; these and other improvements which are now sufficiently well known to require mention here have increased the speed and certainty of working, with the result that international marine communication has grown with extraordinary rapidity on every sea and on every ocean.



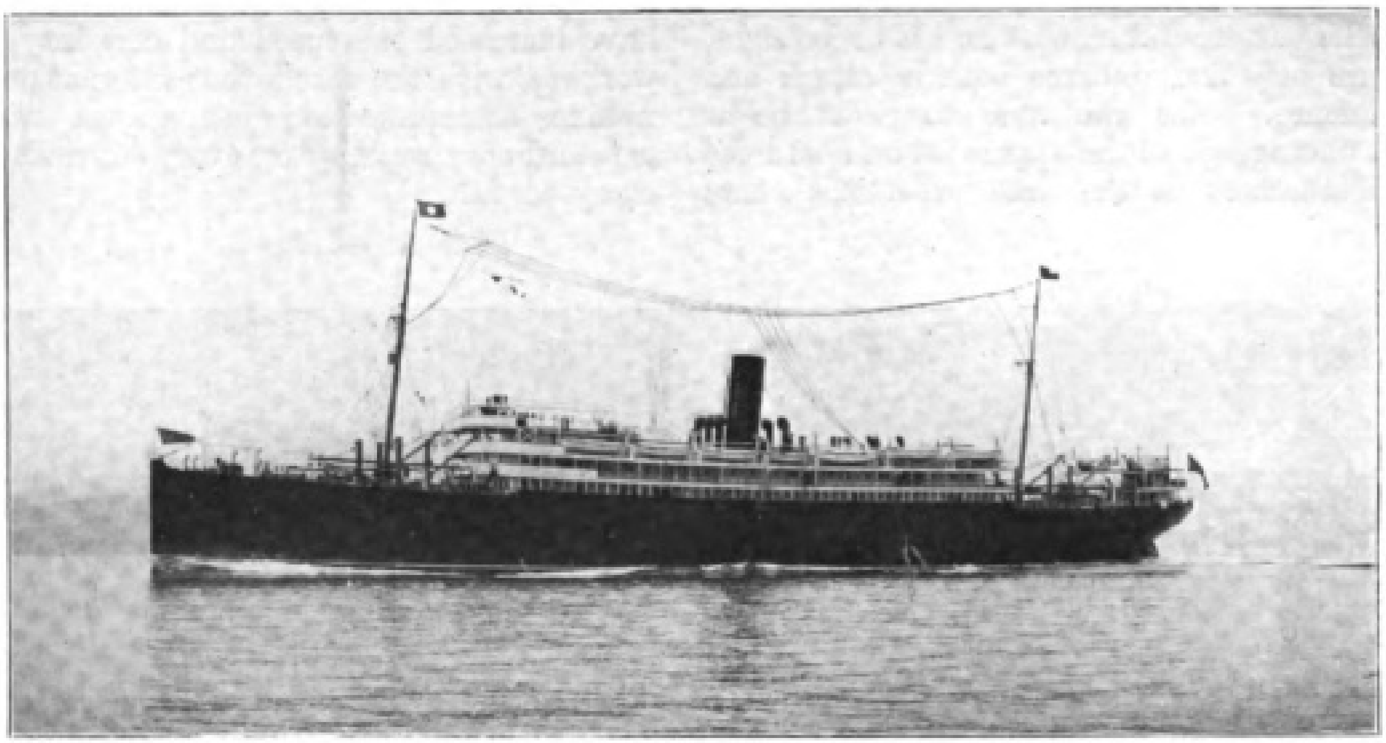
Interior of the Marconi Cabin on the s.s. "Minnetonka" in 1902

Maritime Wireless Telegraphy

AN instance of the value of wireless telegraphy to navigators is given by Captain Edward English, the representative of the Mercantile Marine Service Association, in a letter from the station at St. John's, Newfoundland, to the secretary. He reports: "I had a wireless from Captain Black of the steamer *Borderer* when he was about 350 miles from here, on a voyage from Immingham to New York, thence to China, asking about ice conditions, also the prospect of being coaled here. I replied immediately giving the desired information. He arrived on the 16th after encountering terrific weather throughout the passage. His coal supply was short, and, as there was a good deal of floating ice about, he must have had a very anxious time, for the season has been a most severe one." Then Captain English adds a note which should be appreciated by all ship masters, not only for the courtesy he offers, but for the safeguard to navigation which his offer embodies: "I mention this incident to say that at any time I shall be pleased to give information to any member of the Mercantile Marine Service Association should they find themselves in a situation similar to that of Captain Black."

* * *

The *Tamar*, which arrived at Hong Kong on May 12th, reports the reception of a wireless telegram from the Portuguese cruiser *Adamastor*. This vessel struck a rock in the north passage of Dumbell Island as she was making her homeward trip, viâ Macao, and was badly damaged, so much so that assistance was urgently needed. Immediately on the receipt of the intelligence the senior naval officer at Hong Kong despatched the destroyer *Otter* and the tug *Atlas* to the scene of the accident, while the Portuguese gunboat *Patria* also proceeded thither. Senhor Leiria, the Portuguese Consul, further despatched the tug *Edith*, with salvage gear, to the *Adamastor's* help at midnight. On their return from the scene of the stranding, the *Otter* and the *Edith* reported that the *Adamastor* was extensively damaged, and that her crew and war stores had been transferred to the gunboat *Patria*, but there was no loss of life.



The ss. "Infanta Isabel de Borbon." This vessel has been fitted with 5kw Marconi Station.

Instruction in Wireless Telegraphy

III. ELEMENTARY PRINCIPLES OF WIRELESS TELEGRAPHY.

BEFORE showing how the elementary principles of electricity and magnetism, which were explained in the last article in the May number (p. 114) are applied to wireless telegraphy, we must first explain the principles on which the science of wireless telegraphy is founded.

Let us make a simple experiment to illustrate these principles :

In a pool of water and at opposite sides of it two pieces of wood are floating. If we strike one of these pieces of wood with a hammer or in any other way cause it to disturb the water, it will be observed that a number of ripples or waves are sent out in all directions. Follow these waves until they reach the piece of wood at the far side of the pool, and it will be observed that this piece of wood is set in motion by the waves.

This is a simile of what occurs between two wireless stations. The piece of wood that is struck with a hammer corresponds to the transmitting station, the water to the transmitting medium, and the piece of wood at the far end of the pool to the receiving station.

20. **Wave Motion.**—A wave has the property of propagating itself radially from a given point, as can very easily be seen by dropping a stone into the middle of a pool of water. The displacement of the water by the stone starts a circle of ripples or waves, which circle gets bigger and bigger until either the waves die out or reach the edge of the pool. **The result is, therefore, that once a wave has been started it travels away from the point at which it was started.**

We see by the above that by producing waves we have a means of communicating signals from one part of a pond to another, and this is the principle underlying wireless telegraphy.

An interesting point to observe is that although the wave travels from one part of the pool to the other, the water itself does not do so, and, except for an up-and-down and to-and-fro motion while a wave is passing, remains where it was. This can readily be proved by placing something in the pond, such as a fishing float which lies in the water with its top just above the surface.

If a wave be started some little distance from the float, it will be seen to move up and down when the wave reaches it, but will not be carried along with the wave.

21. **Measurements of Waves.**—There are two dimensions of a wave which define its size ; they are called its "amplitude" and its "length," and are shown in Fig. 1. p. 206.

The amplitude of a wave is the distance of the highest point to the normal level. and it is usually denoted by the Greek letter α (alpha).

If we notice the surface of a pond over which a wave is travelling we see that part of the wave is above the normal level of the water, and there is a corresponding depression between the crests, and a complete wave consists of the half which is above and the half that is below the level.

The length of a wave is the distance from the crest of one wave to the crest of the next, and is usually denoted by the Greek letter λ (lambda).

The waves we have been considering travel along the surface of water, but another kind of wave called **pressure waves** can be formed which travel through the body of a substance, and if the rapidity with which these waves follow each other lies between 16 and about 32,000 per second, they are known as **sound waves,** because they affect and can be detected by the ear.

The rapidity with which waves follow

each other, or, in other words, **the number of waves that pass a given point in a second, is called the "frequency."**

Such pressure waves obey the following important laws:

(1) For any given substance the wave travels at a definite speed, and **the speed remains the same no matter how big or how small the waves may be.**

(2) **The speed or velocity is greater the greater the density of the substance.**

Thus in air the velocity is about 1,040 feet per second, in water it is 4,700 feet per second, and in steel it is 16,400 feet per second.

(3) The amplitude of the wave very rapidly gets smaller and smaller as the wave gets further from its starting point, until, if given sufficient room, it finally dies out altogether; in other words, **the amplitude decreases as the distance from the starting point increases.**

(4) The length of the wave—*i.e.*, the distance from the crest of one wave to the crest of the next wave, remains the same no matter how far it is from its starting point; in other words, the wave-length is constant, and is quite independent of the amplitude.

22. The next step is to consider the waves used in wireless telegraphy.

In order to explain the phenomena of light and radiant heat, physicists have imagined a substance or medium, called the "æther," and waves somewhat similar to the pressure waves we have just been considering produce rays having different properties, according to the wave-length.

The shortest wave-lengths known produce X rays, the next in length produce actinic rays causing chemical and photographic effects, then light rays and heat rays, and finally "electric" rays.

The following is a table of some of these wave-lengths*:

X-rays about 2·5 millionths of an inch.

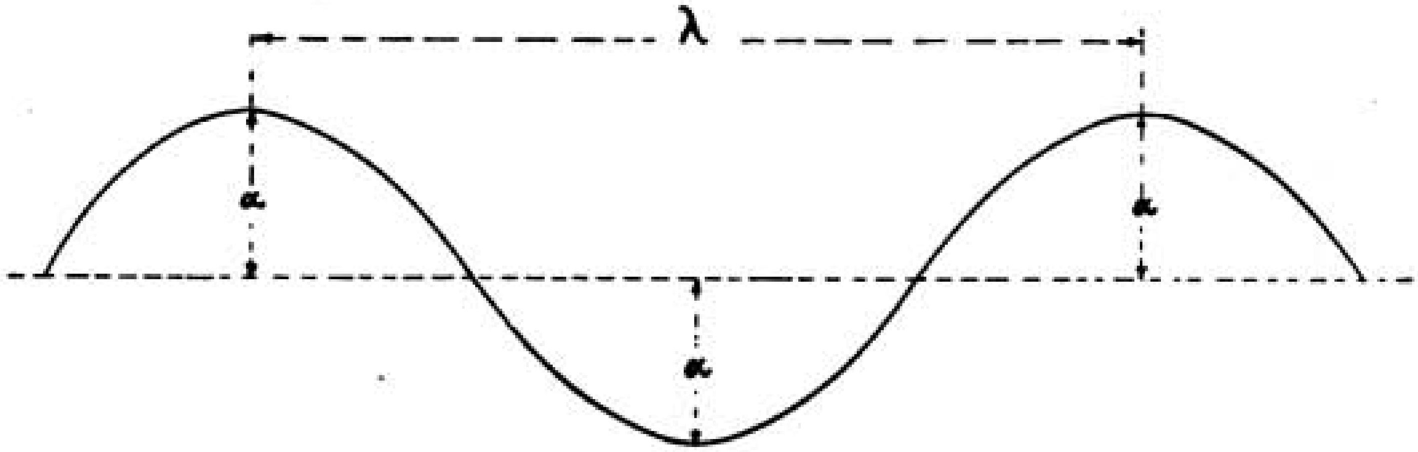
Actinic rays of maximum intensity, 10 millionths of an inch.

Light rays from 10 to 18 millionths of an inch.

Heat rays of maximum intensity about 15 millionths of an inch.

Electric Rays shortest measured 0·24 inch. 300 feet to 30,000 feet in practical use for wireless telegraphy.

All these waves obey the laws stated for pressure waves, and the velocity of all of them is that of Light—namely, 300,000,000 metres, or about 1,000,000,000 feet per second, equal to 186,000 miles per second.



The velocity of æther waves is thus seen to be far greater than that of sound waves, and it is for this reason that, if we watch a battleship from a distance firing guns, we see the flash of the gun long before we hear the report.

The surface waves on water only partially obey the laws given above, thus the velocity depends on the wave-length—*i.e.*, big waves travel faster than small ones; further, the amplitude is not independent of the wave-length. Hence caution must be exercised when surface waves are used to explain wireless telegraphy by analogy.

At the beginning of this article we explained how, by means of waves on the surface of a pool, telegraphy could be carried out; obviously pressure waves and æther

* The one-thousandth part of the thickness of a cigarette paper is about one-millionth of an inch.

waves can also be used in a similar manner for telegraphy, and, in fact, telegraphy or signalling is carried out by means of light waves, by using searchlights, heliographs and similar apparatus. The range, however, is small, and opaque intervening objects interrupt communication.

23. As stated above, **wireless telegraphy uses the long æther waves**, which are also known as Hertzian waves, because Prof. Hertz first experimentally proved their existence, and indicated how they could be produced by electrical means, for which reason they are also called "electric" waves. The longest wave he was able to make was about 30 feet long, but since then, by improved apparatus, such waves can be produced up to about 30,000 feet.

As aready stated, these waves have the same speed as the light waves, because they are travelling in the same medium—namely, the æther.

A further condition is, however, required for the propagation of these electric waves—viz., the space in which they travel must be a non-conductor of electricity—more strictly a dielectric. The waves cannot travel in a conductor, hence they are not propagated through water, and only imperfectly through dry ground and rocks. The upper layers of the atmospheres, say, about 40 miles above the earth's surface, are also conducting, hence the electric waves produced by suitable means at the sending station travel in a sheath about 40 miles thick surrounding the earth.

In order to detect their presence at the receiving station it is necessary to have some form of detector (corresponding to the ear in the case of sound waves) which will convert these long electric waves into something which will affect one of the human senses, and which, preferably, can either be seen or heard.

As a first step, advantage is taken of the fact that under certain conditions these waves cause an electric current to flow in a wire, and, as already described in the last article, there are many methods of detecting the presence of an electric current. We know, for instance, that when an electric current passes through a coil of wire it causes it to act as a magnet, and if this magnet is in a telephone the telephone will sound.

The foundation of wireless telegraphy is therefore an apparatus at the sending station that will produce electric waves, which are transmitted to the receiving station where their presence is made known by a "detector."

By sending a succession of such waves of long or short duration, the dash-dot of the Morse alphabet can be produced, and a system of telegraphy is thus established.

In the article which appeared in the May number, we gave the alphabet and numerals in Morse Code; below we give punctuations and general abbreviations commonly used in Morse communication.

Punctuation and other Signs.

Full stop (.)	· · · · · ·
Semicolon (;)	– · – · – ·
Comma (,)	· – · – · –
Colon (:)	– – – · · ·
Note of interrogation, or request for the repetition of anything transmitted which is not understood (?)	· · – – · ·
Note of exclamation (!)	– – · · – –
Apostrophe (')	· – – – – ·
Hyphen or dash (-)	– · · · · –
Bar indicating fraction ( ).	– · · – ·
Parentheses (before and after the words) ( )	– · – – · –
Inverted commas (before and after each word or each passage placed between inverted commas) ("" et "")	· – · · – ·
Underline (before and after the words or part of phrase)	· · – – · –
Call (preliminary of every transmission)	– · – · –
Double dash (=) (signal separating the preamble from the address, the address from the text, and the text from the signature)	– · · · –
Understood	· · · – ·
Error	· · · · · · · ·
Cross (end of transmission) (%)	· – · – ·
Invitation to transmit	– · –
Wait	· – · · ·
"Received" Signal	· – ·
End of work	· · · – · –

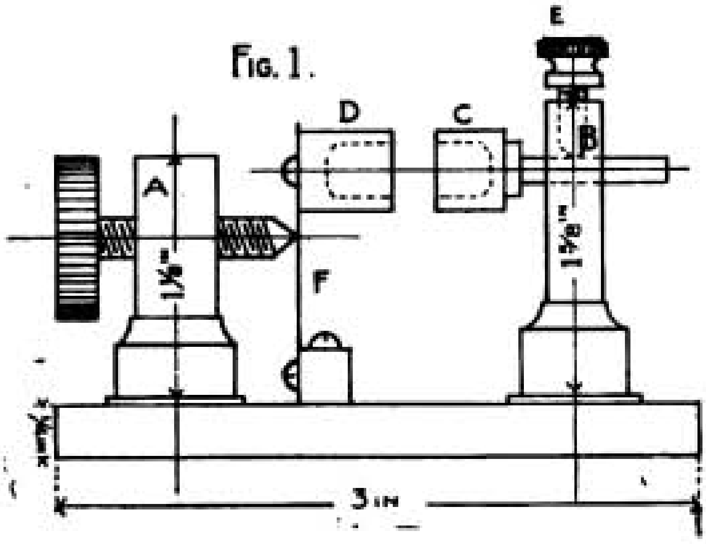
HINTS FOR AMATEURS.

A Detector and Potentiometer.

By A. L. Megson.

An amateur's wireless station depends to a large extent on the efficiency of the detector. In Fig. 4 is shown a detector which will be found to give excellent results and which keeps its adjustment well. With the detector is shown a potentiometer

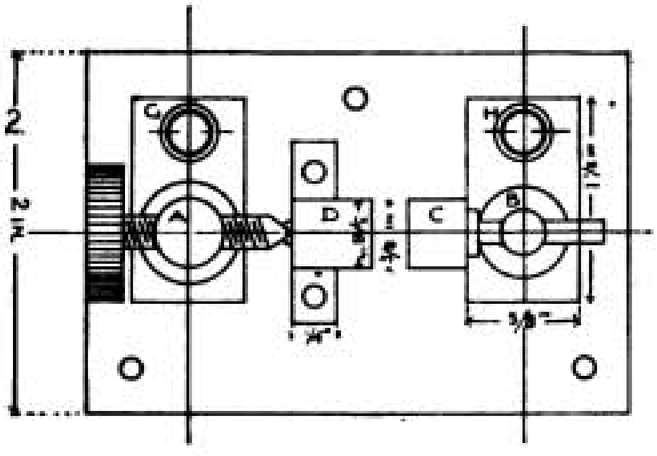
Fig. 1.



for applying through a battery a slight current through the detector. By applying this small current, signals are distinctly improved with nearly all crystal detectors, especially in picking up faint or far distant stations.

Construction.—The base is made from ebonite or hard wood, 3 in. by 2 in. and ¼ in. thick. Holes are drilled ⅛ in. diameter through the base for attaching the standards in the position shown. The foundation plates for the standards are made from thick sheet brass to sizes shown. The standard A is turned from ⅝ in. brass rod. A hole is drilled in the centre at the bottom and tapped ⅛ in. for attaching the standard to the base. The standard B is turned from

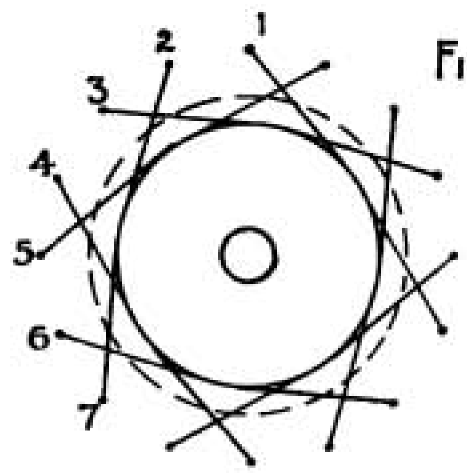
Fig 2.



½ in. brass rod, a hole being drilled and tapped ⅛ in. at each end. A hole is also drilled to enable the tag of the crystal holder C to pass through; the tag is then clamped by means of the screw E. A hole is also drilled and tapped $\frac{3}{16}$ in. through the standard A. The screw with the milled head passes through this to regulate the pressure on the spring F; this spring is made from hard brass and should be fairly stiff. Terminals G and H are screwed through the foundation plates.

The potentiometer is very simple in construction. The studs are ordinary stout pins, cut short and driven through the base of potentiometer, which is made from sheet ebonite, and projecting about half an inch underneath the base, the projecting portions of the pins being bent downwards. A brass spindle is forced through the centre and a flat reel $1\frac{3}{16}$ in. diameter and ¼ in. thick is turned

Fig. 3



METHOD OF WINDING POTENTIOMETER

to fit the spindle; a groove is turned in the reel $\frac{3}{32}$ in. deep, or a little deeper. To wind, use 47 gauge S.S. covered platinoid wire. Secure one end of the wire, after baring the insulation round pin No. 1, wind round the reel clockwise three or four times, then bring to pin No. 2, and after baring the insulation, twist a few turns round the pin, then take a few more turns round the reel, but in the reverse direction, and bring to pin No. 3, and so on until the last pin is arrived at. A switch is then mounted on the top of the spindle, and this rotates on the heads of the pins, according to how much battery current is required.

To connect up, one end of the wire from potentiometer is taken to the negative terminal of battery and also to the top side of condenser; the other end is taken to the

positive pole of battery. The centre switch is taken to one terminal of telephones, the other terminal being taken to earth side of condenser. The best battery to use is an old dry cell that has been discarded as use-

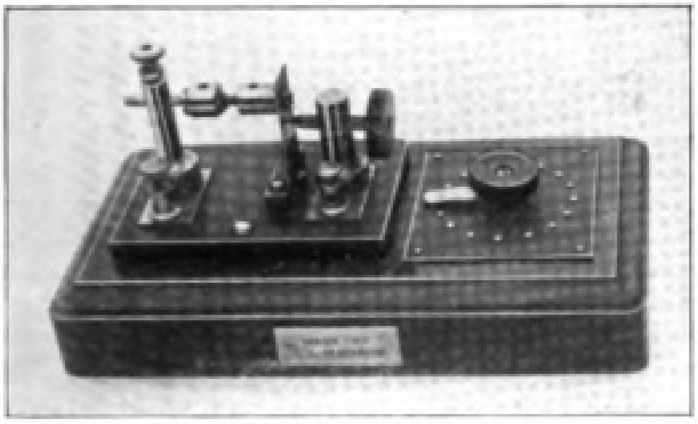


Fig. 4.

less; there is just sufficient current left in these cells to be useful. The detector and potentiometer are mounted together on a polished teak base, and if an old pocket flash-light battery is used, it can be fitted in the base.

AMATEUR NOTES.

As an outcome of the meeting held to enlist the interest of bank officials in the national movement of Boy Scouts, Sir Edward Holden has expressed his intention of presenting a complete outfit of wireless telegraphy to the 5th Westminster Troop, which has its headquarters at the Wesleyan Central Hall.

* * *

The usual fortnightly meeting of the Liverpool and District Amateur Wireless Association was held on May 8th. There was a very crowded attendance, and a number of new members were nominated. The members had been invited to bring some piece of apparatus for exhibition and discussion, and the request was well responded to. All present were delighted with the very interesting display. There was also Morse Code practice, elementary and advanced. A meeting of a similar character was held on May 22nd.

* * *

Another meeting of the Liverpool and District Amateur Wireless Association was held on Thursday, May 22nd. A number of new members were received. It was announced that Sir John Macpherson Grant, Bart., had agreed to become a vice-president of the Association.

* * *

The first part of the evening's programme was a wireless sending and receiving demonstration, arranged by Mr. J. Porshaw (Ormskirk). This was followed by a short lecture on "Electro-magnetism," illustrated by a number of experiments, given by a member. It was shown that every conductor conveying a current is surrounded by a magnetic field, and that such a field is proportion to the strength of the current, and varies with the current. The tangent galvanometer was also discussed, and the absolute measurement of an electric current by means of this instrument was also explained and demonstrated. On Saturday, May 31st, the members met at Seacombe Ferry for the first outing of the season.

* * *

For some time past some of the boys of Repton School, Derby, have shown considerable interest in wireless telegraphy, particularly H. Graham, who last term gave a lecture on the subject, and the chief science master, Mr. F. Brunskill, decided that its study should be encouraged. He took the matter up with the Derby Wireless Club, who undertook the fitting up of the station. The members of the club engaged on the work were Messrs. Trevelyan Lee, junr., and J. W. Downes, in consultation with Mr. S. Grimwood Taylor, the president. Mr. K. Seale Haslam, an old Reptonian, also assisted. The aerial consists of two parallel wires suspended across the ground from the science buildings to the class rooms on the west side, and is about 200 feet long. A special mast has had to be erected on the science block. The "lead-in" wires fall down to Mr. Brunskill's room, and are kept clear of the buildings by a special guy-wire.

The work was completed on May 3rd. Messages were received as soon as the instruments were attached to the aerial, Mr. Lee's portable set being used. A Derby station, "BXA," was detected communicating to "BXI," whose station is at Ruddington, in the south of Nottinghamshire.

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. To enable a reply to appear in the current number such questions should reach the Editor by the 12th of the month.

S. B.—*Aerials.*—I am using a 1-in. spark-coil, and the aerial or sky-rod consists of a brass rod a yard long, attached to the transmitter balls. Could I send and receive messages over a distance of half a mile? Would the walls of the room in which it is situated, and the houses between, have any effect? Must the aerial be longer, and must it extend to the roof and the open air, and must I have more than one aerial?

Answer.—The yard-long "sky-rod" you are using is only, we fear, suitable for experiments over a few yards—say from one room to another, or in the garden. For your half-mile you had better get as great a height as you can. The shorter your aerial, the shorter will be the wave which it can radiate efficiently; and the shorter the wave the more likely is it to be impeded by walls, etc. You must try and get a height of 30 or 40 feet at least for your "free end" of the aerial. Take care that it is well insulated where it enters the house. We do not quite understand what you mean by "more than one aerial." You must certainly have one aerial at each of the two places, but there is no particular need to have more than one at each place; a single wire aerial will probably be good enough, and can be used, by means of a change-over switch, for receiving as well as for transmitting. Make sure that you have got a really good earth-connection.

M. V. asks particulars in connection with a portable sending and receiving station using a 200-metre wave, a ½-inch spark coil, and a 30-foot mast.

He asks, among other things, whether the "umbrella" type of aerial would be most suitable, or whether the use of another mast, 10 feet high, in conjunction with the 30-foot one, would improve matters.

With regard to the last point, for general "all-round" use the umbrella type would be the best. On the other hand, an inverted L aerial, with the lower mast at the "free" end, would give a very directional aerial if long enough in comparison with its height, and might therefore be very useful for certain purposes.

With regard to the bulk of his queries, they fit in very well with the well-known "knapsack" station turned out by the Marconi Company, and he will find an interesting description of this and other portable stations in the book entitled "Portable Wireless Telegraph Stations," obtainable at Marconi House, Strand, at the price of 2s. 6d.

A. H. V. B.—*Coil Winding.*—How much black enamel wire should I want to wind a tuning coil 7 inches long and 6 inches diameter; size of wire, No. 28?

Answer.—Everyone who starts experimenting in "wireless" should make up his mind to obtain one of the innumerable "pocket books" which are brought out to provide certain data for engineers and electricians. Such books are brought out in all sizes and at all prices, and they all give particulars about wires of various standard gauges. Even if they do not happen to give the actual sizes of black enamel wire, they give the sizes of the bare wire, and the weight per mile, etc., and once this is known, it is a matter of simple arithmetic to find out roughly how many turns, and therefore what weight, of the wire will occupy a given length of coil. If you want to make any progress in experimental work in wireless or in anything else, you MUST find out things of this sort for yourself.

J. A. C. wants to simplify the Marconi magnetic detector by doing away with the permanent magnets, clockwork and moving band, replacing all this by a weak cell or thermopile so connected as to pass a constant current through the ordinary primary winding of the detector, and using a simple fixed iron core. He says: "Then the cell's current would keep the core magnetised to a certain fixed standard, but when an impulse came from the aerial it would change this standard and set up a current in the secondary which would work the 'phones."

He suggests that there is something wrong with this idea, but cannot see where the flaw lies. This is due to the fact that he has not quite grasped the principle on which the magnetic detector works; the whole crux of which lies in the movement of the iron band, which is constantly bringing fresh and unmagnetised iron into the magnetising influence of the permanent magnets, and then carrying it on, by the force of the clockwork, beyond that influence. Owing to "hysteresis" (see Glossary in the "Year book of Wireless Telegraphy and Telephony" just published) the moving iron refuses to give up its magnetism without a struggle, as it were; and as the clockwork drives it further and further from the field of the permanent magnets, we may picture the magnets trying to drag back the iron, and the iron trying to drag forward the field of the magnets. When signals arrive and pass through the primary winding which surrounds the moving band just where the struggle is going on, they destroy some of the "hysteresis"—that is, they weaken the iron's power to struggle against being robbed of its magnetism; with the result that it "lets go" of the field, which slips back towards the position it would have occupied if the band were not moving through it. In slipping back, the field cuts through the secondary winding and produces a current in this, and therefore in the telephones. It is clear from this description that the action of the magnetic detector depends entirely on the movement of the iron band. In the arrangement suggested by J. A. C., the constant magnetising force of the constant current would magnetise the constantly-fixed iron core to a constant extent which would be quite unaffected by the arrival of signals.

1791. C. S. S.—*Resistance Telephones.*—What resistance telephone receiver (single) is most suitable for receiving most commercial stations, including Poldhu, Cleethorpes, and Eiffel Tower; also that of a double telephone receiver? Is a double receiver better than a single receiver; and if so, why?

Answer.—It depends entirely upon the effective resistance of the crystal or other detector which is being used. The total resistance of the telephones should be about the same as that of the detector, when this is possible. For all-round work with various crystals, a total resistance of about 3,000 or 4,000 ohms is very suitable.

A double receiver is better in all cases, partly because most people are slightly more acute of hearing with one ear than with the other, and the best ear is unconsciously used in a double receiver. Moreover, the relative acuteness of the ears is inclined to vary from day to day, though this is by no means always the case. Some operators depend almost entirely on one ear, which is much more acute than the other; in their case it would probably pay them to concentrate all the windings of the telephones on to that one ear, and use the other part of the headpiece merely as a dummy to cover up the other ear and prevent external sounds from interfering. In the case of an operator with two ears of more or less equal acuteness, there is probably some additive physiological effect in the brain by which the signals heard by each ear add up and produce maximum effect. If a single receiver is used, it is clearly an advantage to have a dummy on the other ear to keep out the external noises.

H. L. N.—*An Example.*—We propose to take your letter as an example, and make some remarks about it to which we shall refer other correspondents when necessary. We hope you will not take it amiss that your letter should be chosen for dissection; it merely happens to contain several points to which attention would have to be called sooner or later.

The first point we would call attention to is the fact that it is written on both sides of the paper, and that paper ordinary folded note-paper. No business or scientific communication should ever be written on both sides of the paper, and the paper itself should preferably be in large sheets—either foolscap size, or at least the size of a sheet of note-paper opened out flat. In the second place, you ask far too much; a full answer to your letter would approximate to the size and value of a small text-book on Wireless Telegraphy. One long question, or perhaps two short ones, is the most we can offer to deal with from one correspondent at a time.

In the third place, you are infinitely too vague. What is an aerial of the Lodge-Muirhead type? If there is one aerial particularly associated with that name, it is the one composed of conical metal vanes, one vane for the aerial and the other for the balancing capacity; but in your case you speak of an earth connection, so you cannot mean that. You say it is 9 feet by 18 feet, hung 45 feet from the ground, but close to a slate roof. What does "close" mean? Then it is connected to a tuning inductance—maximum inductance quite unmentioned; from all you tell us, the maximum wave-length of your aerial circuit may be some hundreds of feet, while the waves of any of the big stations you refer to are measured in thousands or tens of thousands of feet. You very rightly give us the diameter of the former on which the primary of your "jigger" is wound, but you leave us in blank ignorance as to the number of turns, so that it might have a maximum value of a few microhenries, or of a few thousands. The same thing applies to your description of your jigger-secondary. The knowledge that it is wound on an 11-inch sieve is really not sufficient to suggest to us how many microhenries of inductance it represents. Across it is shunted a variable condenser of ·001 microfarads maximum capacity. You are better, here, than some people who write and tell us they are using a "small" or a "large" condenser, and if only you said what was the inductance of the jigger-secondary, we should really have something to go on, and should be able to guess whether you were tuned to a wave-length some hundreds of times too small or too long for the stations you wish to receive. We note with pleasure that you have adopted a really sensible way of connecting your receiver; here you are very much better than many of our correspondents. At the same time we must call your attention to the fact that to get the best results you must experiment with the particular detector you are using, and modify your circuits to suit it. Most high-resistance detectors are "potential-operated," and work best with as small a condenser as is possible across the jigger-secondary; so that—as that condenser has to form, with that secondary, a circuit tuned to the incoming wave—the secondary must be made long so as to have a large inductance. In such a case, the jigger-primary should only be coupled to the secondary at one end—namely, the end to which the crystal is NOT connected. Half your troubles would be removed if you would take the advice which we have repeated over and over again—USE A WAVE-METER. An experimenter in wireless, who goes about without a wave-meter and asks for advice to get him out of his difficulties, is as bad as a man who writes to *Nature* asking for the latest map of the heavens to be sent him because he cannot see some of the stars he has heard of—without trying the effect of a telescope. We do not like the shape of your "Admiralty" aerial—by the way, why "Admiralty?" The only type of aerial associated with the Admiralty, so far as we know, is the "bird-cage" type made up of a large number of wires spaced round a series of hoops of some kind. Yours, so far as the two wires are concerned, seems to be the ordinary "twin" aerial used by the Marconi Company on most of their ship-stations; though in shape it is original, and probably not very effective. We should be inclined to try an aerial stretched between the mast on the top of the house and as high a branch as possible of the trees shown in your picture, taking the down-lead off from the house-end, but not too near the house, and into a window at the bottom of the house. If this is impossible, try doing away with the lower branch of your aerial altogether, or combine it with the upper branch to form a quadruple aerial, and lead in to your window from the house-end. The rest of your letter asks for constructional details; these you must either wait for in THE WIRELESS WORLD, as such articles appear from time to time, or you must look for them in one of the many handbooks on such matters. You will find reviews of such books in THE WIRELESS WORLD, and in back numbers of the *Marconigraph*. One final word: you have no possible right to use gas-pipes as an earth-lead, and if you apply them to this use for your transmitting set, we run the risk of never hearing from you again.

[THE EDITOR REGRETS THAT OWING TO LACK OF SPACE REPLIES TO A NUMBER OF QUESTIONS MUST BE HELD OVER TILL NEXT MONTH.]

Contract News

The Société Anonyme Internationale de Télégraphie sans Fil of Brussels have equipped the following vessels with 1½ kw. and emergency gear during the past month: *Murjek, Torne, Kiruna, Sir Ernest Cassel, Vollrath Tham, Kalix, Morrbotten, Abisko*, and *Malmberget.*

* * *

All these vessels belong to the Rederi Aktiebelagt Luca, of Ofoten. They are employed in the iron trade between Narvik, Norway, and Rotterdam, and are all vessels of considerable size. This company is besides completing and buying several new ships, all of which are to be fitted with the 1½ kw. wireless sets. Another vessel fitted is the *Noorderdyk Nasm*, of Rotterdam.

The following vessels have been equipped with Marconi Apparatus during the past month.

Owners.	Name of Vessel.	Installation.	Remarks.
British India S.N. Co. ..	s.s. *Angora*	1½ kw. and emergency set	Trading in Eastern waters.
" " ..	s.s. *Egra*	"	Travelling in Eastern waters.
" " ..	s.s. *Ekma*	"	
" " ..	s.s. *Malda*	"	
Larrinaga & Co.	s.s. *Jose de Larrinaga*	"	For service between the West Indies and the United Kingdom.
" "	s.s. *Niceto de Larrinaga*	"	For service between the West Indies and United Kingdom, chiefly visiting Cuba.
The Johnson Line	s.s. *Rowanmore* ..	"	Passenger vessel travelling between Brindisi and Egypt.
Alfred Holt & Co.	s.s. *Nestor*	"	Passenger between Glasgow and Sydney, New South Wales.
The Royal Mail Steam Packet Co.	s.s. *Monmouthshire*	"	Engaged in regular services to South America, visiting West Indies, Pacific ports, New York, Bermuda, Morocco, Spain.
" " "	s.s. *Carmarthenshire*	"	
" " "	s.s. *Oruba*	"	
" " "	s.s. *Tagus*	"	
The Union S.S. Co. of New Zealand	s.s. *Aparima* ..	"	For service between America and Australasia.
" " "	s.s. *Wahine* ..	"	
Furness, Withy & Co. ..	s.s. *Rappahannock* ..	"	Engaged in general trade: no fixed destination.
" "	s.s. *Shenandoah* ..	"	
Norfolk and North American S.S. Co.	s.s. *Eagle Point* ..	"	Being part of an order to equip this line of steamers. They are engaged in North Atlantic service.
" " "	s.s. *Start Point* ..	"	
" " "	s.s. *East Point* ..	"	
The White Diamond S.S. Co.	s.s. *Sagamore* ..	"	Engaged in general trade.
J. P. Corry & Co.	s.s. *Star of Scotland*	"	Passenger between Australia and New Zealand.
The Atlantic Transport Line ..	s.s. *Minneapolis* ..	"	These vessels have been refitted with the latest type of apparatus. They carry passengers, and have an important transport service between England and New York.
" " "	s.s. *Minnehaha*	"	
" " "	s.s. *Mesaba* ..	"	Chiefly engaged in North American transport.
" " "	s.s. *Michigan* ..	"	Chiefly engaged in North American transport, but carrying limited number of passengers.
The Cunard Line	s.s. *Pannonia*	"	—
The Allan Line, Ltd.	s.s. *Carthaginian* ..	"	Part of an order to refit this fine fleet of passenger boats, which were among the first to be equipped with wireless.
" "	s.s. *Numidian* ..	"	
" "	s.s. *Grampian* ..	"	
" "	s.s. *Hesperian* ..	"	
" "	s.s. *Pomeranian*	"	
The Leyland Line	s.s. *Ozonian* ..	"	These vessels carry a limited number of passengers, but their transport trade between Liverpool and Boston is very considerable.
" "	s.s. *Winefredian* ..	"	
The White Star Line	s.s. *Cymric*	"	Passenger vessel between Southampton and New York.
" "	s.s. *Merion*	"	For service between America, Australia, and New Zealand.
" "	s.s. *Canada* ..	"	
Bucknall S.S. Lines, Ltd. ..	s.s. *Kioto*	½ kw. and emergency set	Cargo vessel with world-wide service.
The Petroleum Carriers, Ltd.	s.s. *C. A. Canfield* ..	"	Oil steamer.

Orders have been received during the past month to equip the following vessels with Marconi Apparatus.

Owners.	Name of Vessel.	Installation.	Remarks.
J. H. Welsford & Co.	s.s. *Indore*	1½ kw. and emergency set	—
Union Castle Line	s.s. *Llanstephan Castle*	"	Carrying Royal mail and making intermediate services between London and South and East Africa.
" "	s.s. *Llandovery Castle*	"	
Greenshields, Cowie & Co. ..	s.s. *Knight Companion*	"	—
" " " ..	s.s. *Knight Templar*	"	—
" " " ..	s.s. *Knight of the Thistle*	"	—
British India S.N. Co. ..	s.s. *Mashobra* ..	"	Passenger vessels between Calcutta, Rangoon, and United States.
" "	s.s. *Merkara* ..	"	
Cunard Steamship Co. ..	s.s. *Andania* ..	"	Passenger vessels sailing between Southampton and Montreal.
" " ..	s.s. *Alaunia* ..	"	
J. Chadwick & Sons	s.s. *Drumcliffe* ..	"	Cargo vessel between Liverpool and Buenos Ayres.
The Royal Mail Steam Packet Co.	s.s. *Caribbean*	"	Engaged on regular service to South America.
Harvey & Co.	s.s. *Bonaventure* ..	"	Cruising in Newfoundland. Hitherto engaged in seal fisheries.
"	s.s. *Bellaventure* ..	"	
Trinidad Shipping and Training Co.	s.s. *Matura* ..	"	Travelling between New York and Trinidad with fruit cargo.
The Atlantic Transport Co. ..	s.s. *Manhattan* ..	"	Passenger vessel between Antwerp and Boston, sailing under the direction of the Red Star Line.
The Tyne and Tees Shipping Co.	s.s. *New Londoner* ..	½ kw. and emergency set	Cargo vessel carrying limited number of passengers between London and Newcastle, making twenty-six hours' run.

The names of vessels appearing in the table below were held over from last month's record of contracts owing to lack of space.

Owners.	Name of Vessel.	Installation.	Remarks.
The Royal Mail Steam Packet Co.	s.s. *Magdalena* ..	1½ k.w. and emergency set	North Atlantic.
The Atlantic Transport Line	s.s. *Mesaba*	"	—
The Brazilian Government	s.s. *Carioca*	½ kw. and emergency set	South African and genera trade.
The Bucknall Steamship Co.	s.s. *Kansas*	"	—
		"	—
" " "	s.s. *Kafue*	"	—
" " "	s.s. *Karonga*	"	India.
The Hall Line	s.s. *Sandon Hall* ..	"	India.
" "	s.s. *Walton Hall* ..	"	—
The City Line	s.s. *City of Lincoln* ..	"	Calcutta and West Indies.
James Nourse & Co.	s.s. *Dewa*	"	Mexico.
The Petroleum Carriers, Ltd.	s.s. *Norman Bridge* ..	"	Honolulu and general.
Watts, Watts & Co.	s.s. *Ascot*	"	—
The Anglo-American Oil Co.	s.s. *Lackawanna* ..	"	North Atlantic.
The Viking Cruising Co.	s.y. *Atrato*	5 kw. and emergency set	—

Patent Record.

The following patents have been applied for since we closed for Press with the May number of this magazine :

No. 8,821. April 15th. Ges. fur Draht. Telegraphie, M.B.H. Receiving arrangement for use in wireless telegraphy and telephony.

No. 10,153. April 30th. Fabio Majorana. Wireless telephone.

No. 10,160. April 30th. Michael Corlon. Caller for wireless telegraphy.

No. 11,106. May 10th. Marconi's Wireless Telegraph Co., Ltd., and Cyril P. Ryan. Wireless telegraphy.

No. 11,371. May 15th. Guglielmo Marconi. Wireless telegraph transmitters.

No. 11,453. May 16th. Marconi's Wireless Telegraph Co., Ltd., and C. S. Franklin. Means for detecting continuous electrical oscillations.

Marconi Athletic Club

Weather permitting, there should be a record season for the Athletic Club. The ground at Acton is in good condition, and many improvements have been carried out. The tennis section now possesses three double courts and one single court, and these have been so arranged as to make the conditions of play practically perfect. Besides this a sub-committee has been organised to arrange for refreshments, and members will now be able to obtain excellent teas, or what else they may require, at reasonable prices on the ground. Cricket opened on Saturday, May 17th, with a match between the Marconi first XI and Coningsby Cricket Club at Neasdon. The visitors lost by 5 runs, the total scores being Marconis 49, Coningsby 54. On the same day the Marconi second XI were at home to Coningsby's second XI, and the scores were again with our opponents at 36 to 55. The swimming section is in full swing. Six new members are receiving instruction, and a large number are practising strenuously. On May 8th a one-length relay race was lost to the Bank of Montreal by 10 yards, and again, on May 20th, the Royal Mail Steam Packet Company won the honours after a strenuous struggle by a yard. Several more matches have been arranged, and as an incentive to the members, a prominent director of the Marconi Company has promised to present a cup for competition.

Friday, May 16th, was the anniversary of the establishment of Marconi's Wireless Telegraph Company in Marconi House, and the event was duly celebrated by a smoking concert given that evening in the school under the auspices of the Athletic Club. This is to be the first of a series of such concerts, and if the one held on the sixteenth is earnest of the future, they should prove bright particular events in the social life of Marconi House. Captain H. R. Sankey was in the Chair, and the artists were all drawn from the Marconi *personnel*. The programme was varied, well rendered, and heartily received, and the evening's entertainment was unanimously voted a complete success.

The Marconi Philatelic Society

On Friday, May 2nd, the inaugural meeting of the Marconi Philatelic Society was held, when Mr. Allen occupied the chair. The chairman, in opening the proceedings, explained that the club's *raison d'être* was the promotion of informal and friendly discussion among the stamp collectors of Marconi House, and he believed that such a society would provide excellent opportunities for the interchange both of ideas and specimens.

It was unanimously agreed that Mr. Everett should be secretary; while the proposal was adopted that the members should pay an annual subscription of 1s. a year, the amount so subscribed to form a fund for the purchase of all the more important Philatelic journals, and the most up-to-date catalogues.

It was further decided that corresponding members should be invited to join the society, and it is hoped that many of the Marconi engineer operators in all parts of the world will be able to avail themselves of this invitation. The secretary will be pleased to hear from any such intending members, and should they wish to exchange stamps with other members of the society, he is prepared to look after their interests in this respect. Lastly, any others of the staff who are interested in philately, whether as amateurs or experienced hands, will be welcome in the club. Meetings will be arranged for the third Friday of each month during the summer, and every first and third Friday during the winter.

Movements of Engineers

B. S. Benning has returned from Chili.

Messrs. Blackett, Dickson, and Oliver have been transferred from the London drawing office to Chelmsford works.

Lieut. M. Escolano has been transferred from the London drawing office to Valentia Island, S.W. Ireland, to assist Mr. D. H. Jones in the erection of a wireless telegraph station for the General Post Office.

R. J. Gilmour is now ship fitting in the Liverpool district.

C. James is fitting the Chilian transport *Rancagna* in Liverpool.

E. C. Montague is now stationed at Poldhu.

A. T. Pole is now assisting on ship fitting.

W. O. Ridley is now assisting in the drawing and design section at the London office.

H. J. Round has returned to London from Glace Bay.

H. E. Shaw is now at Poldhu station.

C. H. Taylor is temporarily in London from New York.

Movements of Operators

J. G. Wasley, *Campania* to *Campanello*.
L. Breen, London School to *Campanello*.
G. Madgwick, *Minnetonka* to *Isis*.
G. Thomson, *Sicilian* to *Sardinia*.
A. E. Hanson, *Hesperian* to *Corsican*.
A. Perlman, Liverpool School to *Empress of Britain*.
F. Milford, *Campania* to *Oropesa*.
J. Williams, Liverpool School to *Devonian*.
H. Mole, *Corsican* to *Baltic*.
H. T. Stubbs, *Worcestershire* to *Devonian*.
C. Robertson, *Galician* to *Mamari*.
J. E. Davies, *Canadian* to *La Blanca*.
F. Mitchell, *Canadian* to *Hypatia*.
T. G. Petersen, *Moldavia* to *Clifden*.
H. Hunt, *Arawa* to *Arabia*.
A. Kingsbury, *Moravian* to *Makarini*.
A. M. Entwistle, *Grantala* to *Oceanic*.
R. M. Owen, London School to *Oceanic*.
L. S. Newns, *Mechanician* to *Manco*.
H. T. Little, *Highland Warrior* to *Highland Loch*.
A. G. Angill, *Cymric* to *Canada*.
J. H. D. Lees, London School to *Oruba*.
W. Pitkeathly, *Tagus* to *Star Point*.
B. F. Aris, *Magdalena* to *Waipara*.
S. K. Alston, *Asturias* to *Itassuce*.
F. Arnott, *Ivernia* to *Saldanha*.
C. J. A. Gill, London School to *Corinthian*.
H. Cottam, *Minnetonka* to *Minnewaska*.
S. C. Summerlin, *Michigan* to *Star of Scotland*.
C. P. Litchfield, London School to *Minnehaha*.
N. Holker, *Antillian* to *Desna*.
W. J. Leche, Liverpool School to *Afric*.
J. G. Chadwick, Liverpool School to *Eagle Point*.
A. C. Lund, *Mauretania* to *Virginian*.
H. W. Rice, *Cestrian* to *Empress of Ireland*.
W. R. Bain, *Cestrian* to *Kelvingbank*.
E. Shayler, *Desna* to *Carmarthenshire*.
A. J. Gash, Liverpool School to *Michigan*.
D. O'Sullivan, *Adriatic* to *Rappahannock*.
R. M. Geldart, London School to *Minnewaska*.
R. Emanuel, London School to *Canadian*.
W. J. Donnan, London School to *Celtic*.
J. R. Bamford, *Guarany* to *Himalaya*.
W. Condon, *Montfort* to *Sicilian*.
J. Beckett, London School to *Amazon*.
C. V. Maudsley, *Karina* to *Mauretania*.
L. T. Barker, London School to *Parisian*.
H. R. Hoare, *Perugia* to *Hesperian*.
E. L. Rumbold, *Amazon* to *Moldavia*.
H. A. Whittaker, London School to *Arlanza*.
J. Lucey, *Grampian* to *Campania*.
W. H. Haywood, *Omrah* to Teneriffe Land Station.
J. Leverett, *Corinthic* to *Magdalena*.
R. Sweetnam, *Minnewaska* to *Highland Piper*.
A. W. Wyett, *Marmora* to *Orvieto*.
A. C. Williams, *Sardinia* to *Inkosi*.
J. Breen, *Sunda* to *Beacon Grange*.
T. L. Empson, London School to *Magdalena*.
O. P. Keane, London School to *Majestic*.
F. J. Smith, London School to *Cassandra*.
G. G. Chapman, *Highland Scot* to *Persia*.
A. G. Angill, *Boric* to *Cymric*.
T. H. Halsall, *Cassandra* to *Mongolian*.
A. E. R. Ballard, *Columbia* to *Mongolian*.