THE FUTURE OF WIRELESS TELEGRAPHY.

BY P. T. M'GRATH.

Now that the world is satisfied of the genuineness of Marconi's recent amazing exploit of signalling across the Atlantic, the time seems opportune to examine into the practical possibilities of a scientific departure so revolutionary in its essence and development.

In considering the various aspects which the subject presents, the fundamental fact must be borne in mind, that the base upon which Marconi has superimposed this alluring aspect of his discovery is one which has stood the test of the severest criticism in recent years, and about the stability of which there is no longer any question. In other words, the theory of electrical transmission of signals through space without wire or cable, is endorsed by every electrical authority; and the practical demonstration of this theory is also admitted, up to a certain point.

Starting with these postulates, some specific conclusions are legitimate, to wit: Wireless telegraphy is possible; also, it is practicable for, say, one to two hundred miles, between ship and ship or between ship and shore. But is it practicable for two thousand miles, under such exacting conditions as must be faced if it is to become of commercial utility? This is the root-fact of the whole problem which Marconi is now attacking. The young Italian has done much to make "aërography," if I may coin a word, an undisputed success, and his name will ever be the paramount one in connection with the future of this scientific discovery. The great majority of electrical investigators accepted without question his statement that he received prearranged signals across the Atlantic, and even those who doubted him displayed such a paucity of convincing argument as to warrant the conclusion that they were lacking in sincerity.

I may observe, for what the testimony is worth, that he permitted me to verify his statement as to the receipt of signals, by the perusal of his letters of instructions written to his assistants at Poldhu before leaving England; and, in the face of the obvious prearrangement which these revealed, to doubt his truthfulness was impossible. His later experiments on the steamer "Philadelphia" in midocean have, furthermore, proved beyond any dispute that he did receive audible signals on December 12th and 13th,—signals which, though faint, were conclusive in that they proved the theoretical feasibility of the project.

The energy required to send the electric impulses through the two thousand miles of space between Cornwall and St. John's was equivalent to thirty-eight horse-power, but still the signals were too faint to be indicated on an automatic recorder, and were only detected by means of a special telephonic apparatus, utilizing the unequalled mechanism of the human ear. Mr. Marconi, according to his public utterances, holds that the solution of the transatlantic problem (and, inferentially, of the problem of sending those electric waves circling right around the globe) is merely that of providing greater power. By doubling the power in his Cornwall station, he says, he will be able to transmit wave-beats of such energy as to actuate the recorder and tape on this side of the ocean, and thereby the efficient working of the system will be easily demonstrable. Theoretically, this may be so, and a few months may see "aërograms" daily passing between the two hemispheres; practically, however, no such result may ensue, even though signals and messages are actually transmitted. There is very considerable difference between experimental working and the giving of a regular daily service, just as there is between impelling prearranged signals from Calais to Dover, and speaking across the Atlantic. It does not in the least argue a disbelief in the genuineness of the Marconi experiments, or the future of wireless telegraphy, to venture the opinion that the world may have to wait some time yet before it sees the practical fruition of the schemes which are now being outlined in connection with this opening wonder of the twentieth century. A study of the slow and laborious processes by which inventive endeavor has attained an undisputed position in other departments of science, will disclose many instances to confirm that this new conquest of the Atlantic is not yet absolutely assured.

To premise, let us examine a parallel case, the applicability of which must be readily admitted. In 1851, the first submarine cable was laid across the English Channel, in itself no mean undertaking; the ensuing years saw some slightly longer ones put down elsewhere, and in 1858 Cyrus Field and his colleagues achieved the epochal feat of stretching an electric cable across the Atlantic bed, between Ireland and Newfoundland. This was, in its day, as wonderful an exploit as Marconi's is now, and the nations throbbed with pleasurable hopes of the wonders it would work. This cable was constructed and laid in accordance with the best knowledge which the world possessed at the time as to electric phenomena. It was theoretically perfect, and it proved the practical feasibility of the project, in as much as it did transmit messages. But it was not commercially efficient, because it marked too vast a leap, too rapid an evolution in the mechanical features of the enterprise. It worked spasmodically for a few weeks, 271 messages were sent by it, and then it failed altogether. Queen Victoria's message of ninety words took sixty-seven minutes to transmit. This collapse gave such a set-back to trans-oceanic cable schemes that it was not until eight years later, in 1866, that a second cable was successfully put down. This one, however, had better fortune; it worked effectively, if slowly, and it proved to be of some commercial utility because the world had, in the meantime, enlarged its store of knowledge of how to make and submerge these contrivances. But it was not until the cable of 1873 was laid that the full benefits of this means of communication were realized; because, prior to that, the current suffered serious retardation on the long deep-sea wires, and it would take two minutes, on an average, to send a single word. Here we have twenty-two years between the laying of the first Channel cable and the perfecting of the same agency for transatlantic work.

The parallel of this case with Marconi's is almost complete. In 1896 he was achieving a distance of two miles with his system. On March 27th, 1899, the first wireless signals were transmitted across the English Channel. In 1900 he was doing sixty miles along the English coast, and in July, 1901, with a specially powerful apparatus, he was making intelligible practice for 225 miles, between Poldhu (Cornwall) and Crookhaven (Ireland). Then, in December, 1901, at a single bound, he leaped the Atlantic. Is it unreasonable to predict that the fate of the first Atlantic cable

will be that of the first aërograph, or that an extended period—months or, may be, years—must elapse before the daring young inventor conquers the difficulties which beset him?

It must not be forgotten that the whole circumstances surrounding his Newfoundland experiment were exceptional and abnormal. His ordinary apparatus does not energize for more than 180 miles under the most favorable conditions, and a comparison of the data as regards ships exchanging signals with the shore will place the average below a hundred miles. Marconi himself, on his way to England in the "Philadelphia" on January 28th, 1902, was interviewed for the press when 120 miles off the Lizard. Returning to New York by her a month later, he received visible messages when in midocean, 1,551 miles from land, but he could not signal back to the shore when 150 miles out. That may be taken as a fairer example of the efficient range of the system than the transatlantic experiment, and while he is progressing rapidly in enlarging its scope, it must be some time before ships can speak with the shore from mid-ocean.

As another illustration of the impossibility of evolving these conceptions too rapidly, let us take the famous steamship, the "Great Eastern." She was theoretically perfect, and was merely a mastodonic enlargement of existing types, and she was practically feasible because she crossed the Atlantic and laid the cable of 1866. But, as a commercial venture, she was a complete failure. She represented too fast a growth, too great a leap from one extreme to the other. The result was a brief, inglorious career, a collapse, and her ultimate disappearance in the scrap-heap. But to-day ocean-liners as large as the "Great Eastern" are making weekly trips across the Atlantic as regularly as clockwork, and commercially are the best-paying ships afloat. It has taken the world about thirty-five years to evolve the liner to that stage.

The phonograph is another instance of an invention from which great things were hoped. It has been before the world in some form for over twenty years, and yet it is still only a toy to-day, having failed to realize any of the practical purposes for which it was thought to be eminently suited. Liquid air, when it was discovered a few years ago, was heralded as one of the great discoveries of modern times; but, after tons of ink and paper had been spent in advertising its merits to an interested

public in two hemispheres, it vanished from sight with almost the same rapidity with which it had broken upon the scientific firmament. Dr. Koch was understood to have discovered a lymph that would cure consumption; but, unfortunately for the afflicted, his "cure" did not attain the success which was looked for.

These few instances, out of many of like nature, may serve to indicate that while men of genius are constantly discovering new forces in nature which make for the betterment of the conditions of human existence, they are not always successful in giving substantial practical form to their inventions at the first efforts. No student of modern progress doubts that, ere many years have passed, the foregoing subjects will be numbered among discoveries of assured success and daily use, but just at present they have not reached the stage when they can be said to be of an efficiency beyond question; and with these in mind, it should occasion no surprise if the Marconi system did not at once prove a competing factor in transoceanic telegraphy.

The foregoing may be regarded as illustrating the scientific difficulties in the way of the successful attainment of the objects Marconi has in view. There are also what may be termed certain mechanical difficulties, the surmounting of which will involve considerable time and ingenuity.

The Marconi electric plant at Poldhu, now developing a force equal to thirty-eight horse-power, has instruments of his devising which utilize this store of energy to the fullest advantage. But the machinery is such that, when once it is started, the operators cannot approach within several feet of it without danger of injury. When the power is doubled it must follow that the danger-zone will be enlarged, unless new devices are provided to counteract the increased force.

On the corresponding station being put in operation on this side of the Atlantic, a similar equipment must be installed, and this will not be the work of a day or a month. Following upon that there must be a series of exhaustive experiments, conducted under the most diverse circumstances, until the assurance of practical efficiency for business purposes is absolute and unquestionable. Among the difficulties which his critics assert that Marconi will have to encounter in transmitting his signals across the ocean, will be that of the confusion arising through the intermingling of the ether waves from different "sending" stations

on land or on shipboard. The inventor meets this criticism with the answer that his "tuning" process insures absolute accuracy and secrecy, because only instruments in syntony will be able to respond to each other. To this the critics rejoin with the fact stated in the English papers, that in the naval manœuvres of the British Channel fleet last year, Admiral Watson sat in his cabin and read every one of the enemy's messages, which were intercepted by his own ship's instrument. The Marconi explanation of steamers having the same "tune" is that they may thereby summon aid if in distress; but it has been presumed that the two opposing British squadrons had their instruments tuned differently, and, if that was the case, the successful "tapping" by one fleet of the other's messages implies a serious defect.

The weak point in Marconi's system appears to be the inability to provide properly tuned instruments, or absolute secrecy in the transmission of messages. The difficulty of controlling radiant energy in its course through the atmosphere must be appreciated by the student. As the impulses spread out in great circular whirls, they would seem liable to be caught by any number of receivers, unless the tuning were absolutely perfect; and most investigators maintain that this drawback must be faced for a long time yet. Another point which is emphasized is, that if hundreds or thousands of these electric throbs are communicated to the same space, it may be no easy matter to insure their being recorded by only the one receiver for which a certain series of waves is intended. That Marconi realizes the force of these contentions is evident from the following statement given out by him in New York in January last, before sailing for England:

"I am more confident than ever that, when it is completed, I shall give to the world, as the first result of my labors in the transmission of power without wires to great distances, a system of telegraphy capable of infinite expansion and securing the absolute privacy of the messages. I shall shortly make known a novel principle, which will to a large degree remove the popular belief that it is impossible to attain that degree of secrecy which is practicable with cables."

On his arrival in England on January 31st, he was interviewed, and asked, among other things:

"What about the opinion of experts that there is no reliability to be placed upon wireless messages, and that they can be intercepted by any one who chooses to erect a station equipped with proper instruments?"

"That," said the inventor, "is a thing I am working upon now, with, I most firmly believe, the prospect of ultimate success."

From these admissions, and from the assertions of eminent authorities in many countries, it is clear that this feature of his system is as yet of only questionable accuracy.

Turning now to what may be called the competitive difficulty in the way, a rather serious situation will be found to present itself. Even if all the other obstacles are overcome, the fact remains that Marconi has no land connections on the American side, except a Canadian station in Cape Breton, and until he secures these, his ocean signals will serve no commercial purpose. In the British Isles, the telegraph lines are controlled by the Government, and when a ship sends messages to a Marconi station on that coast, a slight charge in addition to the Marconi tariff will insure the message being forwarded to its destination from the nearest telegraph office. But on the American side the land-lines are controlled by two great corporations—the Western Union and Postal Telegraph Companies, which also are allies of the several transatlantic cable companies. The latter "pooled" their interests some years ago to prevent ruinous rate-cutting, and they now divide the annual receipts of the whole ocean traffic in certain specified proportions among themselves. They will not take kindly to this competition of Marconi's, as the Anglo-American Cable Company made clear by its warning him out of Newfoundland, where it has exclusive rights. The land-wire companies must also see in him a formidable rival in days to come, and the two interests are more than likely to combine to prevent his obtaining any access to the American continent. In other words, he will invoke an electrical "Monroe Doctrine." He will be hamstrung if this occurs, for he will be unable to transfer his messages to the inland points for which they are destined. Clearly then, his evolution into a business enterprise in the Western Hemisphere depends upon the grace of the telegraph companies, who, if hostile to him, can erect a barrier which even wireless signals cannot leap for quite a long time. His only means of overcoming this obstacle would be to invade their territory and establish land stations in every hamlet in the United States. But this would prove to be the most difficult task that he could undertake, because the effective range of his system over land areas is only half what it is on sea, and the American con-

tinent is so dotted with telegraph offices, and so well served thereby, that his resort to such an expedient might be of dubious value.

If Marconi should venture upon the extension of his system to the other continents, and the lands beyond the seas, the competitive difficulties would be increased proportionately. Across the Atlantic Ocean are fourteen submarine cables with a total length of about 40,000 miles. Elsewhere in the world are 1755 distinct cables of all sizes and lengths, with a total mileage of 149,000 nautical miles. This makes a grand aggregate of 1,769 cables with a total length of 189,000 miles, of which all but 20,000 miles are owned and controlled by companies and corporations. It is difficult to estimate the full amount of the capital invested in these cables themselves and the subsidiary industries, such as construction-factories and repair-shops; but the London Stock Exchange estimates that British investors are interested to the extent of $100,000,000. The vastness of the cable as an institution is evident from the fact that the maintenance and repair of these submarine nerves provides constant work for forty ocean-going steamships specially equipped for the purpose, one of them—the "Anglia"—being of 6,500 tons. In Europe there are 425,600 miles of telegraph line, with 1,585,876 miles of wire strung thereon, and in the United States there are 222,587 miles of line, carrying 1,118,036 miles of wire. It will be no small matter for Marconi to face these conditions.

To suppose, then, that the cable and telegraph interests will submit to their own extinguishment in the manner inevitable from the employment of the "aërograph" along the lines indicated by the Marconi programme, is to assume that human nature has lost its chief attribute, that of self-preservation. On the contrary, is it not reasonable to conclude that the cable and wire companies will combine to fight what they regard as a common enemy, and that a financial battle rarely equalled in modern times will be the outcome of this menace by a wireless telegraph of the system at present in effective occupation of the business field?

Another consideration which must be taken into account is, that wireless telegraphy has not a distinct and unoccupied place among the scientific agencies contributing towards the world's convenience. When the electric telegraph was invented by Morse, there was a distinct and unoccupied place, an original outlet for business endeavor, for there was no other agency in existence to

accomplish anything like its purpose. It was the same with the Atlantic cable. Prior to its being laid, the two hemispheres depended for their communication on slow-going sail-ships and scarcely faster steam-ships. A peaceful revolution in commerce and intercourse was effected when London and New York were brought within a few hours of each other by the cable, instead of being separated a full fortnight by the ships of that day. Then there was "a long-felt want," and the telegraph by land and sea supplied it. But Marconi has no such advantageous circumstances in his favor to-day. He has no fallow field of science to till, no new department of industrial effort to develop. The electric wires by land and sea meet the needs of the world very fully, and the most that Marconi's system will do is to provide a cheaper medium for the same purpose. What this will result in may be gauged by considering the respective merits of kerosene oil, illuminating gas, and electric light. The introduction of gas did not displace oil, and although the electric light is a formidable competitor, the two older accessories still continue to maintain an increasing sphere of usefulness.

Therefore, it is clear that in competing with the cables and wires Marconi will only be able to attain success through his doing the same work very much more cheaply. But against this there is the fact, that these companies have in their possession hundreds of patents for improving the speed and efficiency of their equipment, which patents they purchased at various times from impecunious inventors, and pigeon-holed to prevent their being used by rivals, or to avoid too great dislocation of existing methods of working. It is only reasonable to assume that, when Marconi's system enters the field as a claimant for commercial recognition, all these contrivances will be brought to light, and such of them turned to use as will enable the lines to work at such a speed as to neutralize the disparity now threatened. To-day it costs twenty-five cents a word for a commercial message between New York and London, and Marconi claims that he will reduce this to two cents a word. The cable companies may be trusted to make an effort to face that changed condition.

It is clear, therefore, from an impartial survey of the whole field of possible operations, that the direction in which the chief advance in wireless telegraphy must take place will be that of the ocean. Here "aërography" has a vast and undisputed sphere of

usefulness, widening with the years and the simplifying of the apparatus, until every steamer and deep-sea sailer will be provided with this accessory; and signalling by flags, semaphores, or whistles, as now practised, will be relegated to the museums of outworn devices. The utilization, by the navies of the world, of one or other of the rival systems of wireless telegraphy of which we read from day to day, is a proof that the progressive directors of naval policy, to whom money is no object and who are ever on the alert for new devices, realize the trend of scientific activity in this respect, while the fact that the more conservative shipping companies are installing the appliances on their best liners, tends to confirm the same conclusion. One admiralty after another has adopted a wireless system, until it bids fair to become as indispensable in naval economy as the very ammunition itself.

It is needless for me to enlarge upon this aspect of the question. The world is receiving object-lessons every day in the growing efficiency of the new process of ocean communication. Of course, we are a long way yet from the time when it will be possible to keep in touch with a transatlantic liner during the whole course of her voyage, but, in view of what we have been seeing and hearing of late, who can doubt that this time is coming, surely, even if slowly? The period is rather more distant when the cargo-boat will be equipped, but that this, too, is well within the limit of achievement of the coming years, is quite as certain. The apparatus is not costly, $750 sufficing for an installation for the "Lucania" and ships of that class, and the dynamos already on board serve to charge the accumulators which give vitality to the apparatus.

Against long-distance sea-signalling at present this drawback exists: that it is impossible to provide sufficient energy to impel the formulas from the light-power stations on shipboard to the depot on land with which it is desired to communicate. For instance, with its greater stores of power, the Poldhu station, properly tuned, should be able to signal to any wirelessly-equipped craft in mid-ocean, but the latter, for lack of power, would not be able to respond thereto. Now, the chief value of the system must be in the reverse direction—in the ability of a ship to report herself at any time or under any circumstances, especially to appeal for assistance if she should be in trouble. At the present moment, about 150 miles is the record sea signal. To attain the full bene-

fits of the system, what is needed is a perfecting of the apparatus so that vibrations may be transmitted 900 miles. Then it will be possible for a ship in mid-ocean to communicate with Ireland or Newfoundland. The shortest stretch in the transatlantic highway is that between Cape Clear, on the west coast of Ireland, and Cape Race, on the east coast of Newfoundland. This is a distance of 1,760 miles, and a ship midway between could signal to the one coast and then to the other, if she had an apparatus effective for at least 880 miles. From Cape Race to Cape Cod is but 1,000 miles, and this leap would be a smaller one, because a radius of 500 miles would be ample. When the Atlantic is spanned in this fashion, ocean travel will take on a new aspect altogether, and ship will be speaking with ship and with the shore from the bosom of the rolling main, just as town speaks with town by the long-distance telephone on land.

But, interesting and novel as these aspects of ocean telegraphy are, the more utilitarian features which it presents are no less entitled to consideration. We are bidden from time to time to observe the terrible disasters which occur on shipboard from collisions, disablements, wrecks, and strandings. The "aërograph" will minimize collisions almost completely. It will enable the helpless or endangered ship to report her position and summon help, either from other ships or from the shore. It will warn craft approaching the land of the proximity of the coast and of the risks of shipwreck; it will advise them of the presence of ice-floes and bergs, of the direction of coming storms, and of changing currents, and it will be able to guide ships enveloped in fog past such danger-strewn headlands as Cape Race and Sable Island. In a word, it will undertake all the tasks now performed by the lookout, the fog whistle, the light-house, and the danger signal, and will accomplish them with far greater reliability than seems to be attainable at present.

In connection with this phase of the subject, it may be well to explain how these ends will be achieved. As an offshoot of Marconi's main system, he has devised an appliance whereby the electric rays are sent in a definite direction by means of a parabolic reflector of burnished copper. These rays are stopped by the curvature of the earth's surface, and are therefore only potent for a distance of four miles, and when the receiving reflector is in a direct line with the sending one. By a clockwork arrange-

ment, the reflectors move to and fro on a semicircular base, and as the apparatus on two ships, or on a ship and a light-house or signal station, would come into line with each other, an alarm would be given and steps could be taken to avert the danger. These signals might not be always effective, but such a provision should certainly result in very materially reducing the number of casualties at sea, which the world has to deplore with the existing imperfect safeguards against such contingencies. It is claimed by enthusiasts that the risks of ocean transit would be reduced by ninety per cent., and from what has already been demonstrated of the working of the system on the water, it is evident that as it is perfected it will give a new security to navigation, and materially lessen the terrors of those who go down to the sea in ships.

As Morse is identified with the telegraph, Field with the cable, Bell with the telephone, and Edison with the phonograph, so Marconi will be the human exemplar of wireless telegraphy. Perfection will only come in this, as in other devices which are being steadily added to the common stock of civilization's accessories, by slow and laborious advances. The system may be merely in its experimental stages, as some maintain; but it is no longer a chimera, and, though we may be years from a demonstration of its practical efficiency as a competitive enterprise, all observers agree that no obstacles are in the way which human ingenuity cannot overcome.

Therefore, all must hope that every success will attend Marconi and the other daring adventurers who are exploring this comparatively unknown scientific region. Our whole human existence is being transformed by electricity, and it is impossible to conceive of any use to which this wonderful fluid can be applied that is more pregnant with beneficial possibilities, or calculated to be a more helpful factor in advancing the existing order of the world's life, if it attains that practical success which its exponents claim is assured for it ere many years have passed.

P. T. McGrath.