THE NEW TELEGRAPHY – An Interview with Signor Marconi (March 1897)

By H. J. W. DAM

Guglielmo Marconi, whose name will doubtless be often heard in the years which lie before us, is a young Anglo-Italian. He was born in Bologna, Italy, and will be twenty-two years old next April. His father is an Italian gentleman of independent means, and his mother is an English lady connected with several well-known English families. He is a tall, slender young man, who looks at least thirty, and has a calm, serious manner and a grave precision of speech, which further give the idea of many more years than are his. He is completely modest, makes no claims whatever as a scientist, and simply says that he has observed certain facts and invented instruments to meet them. Both the facts and the instruments are new, and the attention they are at present exciting is extraordinary.

This attention is largely due to the enterprise and shrewdness of Mr. W. H. Preece, the able chief of the electrical department of the British postal system. Marconi's invention is a year old, but he could obtain no satisfactory recognition of it in his own country. Mr. Preece, however, had for a long time been at work upon the problem of telegraphing through the air where wires were not available. Last year the cable broke between the mainland and the island of Mull. By setting up lines of wire opposite each other on the two coasts, he was enabled to telegraph by induction quite successfully over the water and through the air, the distance being four miles and a half. He sent and received in this way 156 messages, one of them being 120 words in length. Ordinary Morse signals were used, the dispatches being carried by the ether in the air. In a late lecture at Toynbee Hall, Mr. Preece admitted that Marconi's system, which is electro-static, far surpassed his own, which is electro-magnetic. He expressed the fullest faith in Marconi, describing his inventions as new and beautiful, scientifically speaking, and added that he (Mr. Preece) had been instructed by the postal department to spare no expense in testing them to the fullest degree. It will be understood, therefore, that it is due to Mr. Preece that Marconi has received the fullest recognition in England and that engineers from four different departments of the English government are now supervising his work.

Marconi was educated at Leghorn, Florence, and Bologna, and has more recently been following his special study at his home in the last named city. He speaks English perfectly, and said, in his London home, in Westbourne Park: "For ten years past I have been an ardent amateur student of electricity, and for two years or more have been working with electric waves on my father's estate at Bologna. I was using the Hertz waves from an apparatus which you may photograph, a modified form of the apparatus for exciting electric waves as used by Hertz. My work consisted mainly in endeavoring to determine how far these waves would travel in the air for signalling purposes. In September of last year, working a variation of my own of this apparatus, I made a discovery."

"What was the discovery?"

"I was sending waves through the air and getting signals at distances of a mile, or thereabouts, when I discovered that the wave which went to my receiver through the air was also affecting another receiver which I had set up on the other side of the hill. In other words, the waves were going through or over the hill."

"Do you believe that the waves were going through the hill?"

"That is my present belief, but I do not wish to state it as a fact. I am not certain. The waves either went through the hill or over it. It is my belief, based on many later experiments, that they went through."

"And what was the thickness of the hill?"

"Three-quarters of a mile."

"And you could send a dispatch with Morse signals through this hill or over to some one on the other side?"

"With ease."

"What followed?"

"What followed was the conception and completion of my special invention, the instruments I have been using at Salisbury Plain in the presence of the Royal engineers. I find that while Hertz waves have but a very limited penetrative power, and other kind of waves can be excited with the same amount of energy, which waves I am forced to believe, will penetrate any thing and everything."

"What is the difference between these and the Hertz waves?"

"I don't know. I am not a scientist but I doubt if any scientist can yet tell. I have a vague idea that the difference lies in the form of the wave. I could tell you a little more clearly if I could give you the details of my transmitter and receiver. These are now being patented, however, and I cannot say anything about them."

"How high an alternation were you using?"

"About 250,000,000 waves per second."

"Do these waves go farther in air than Hertz waves?"

"No. Their range is the same. The difference is in penetration. Hertz waves are stopped by metal and by water. These others appear to penetrate all substances with equal ease. Please remember that the amount of exciting energy is the same. The difference is in the way they are excited. My receiver will not work with the Hertz transmitter, and my transmitter will not work with the Hertz receiver. It is a new apparatus entirely. Of course the Waves have an analogy with the Hertz waves and are excited in the same general way. But their power is entirely different. When I am at liberty to lay my apparatus and the phenomena I have observed before the scientists, there may be some explanation, but I have been unable to find any as yet."

"How far have you sent a telegraphic dispatch on the air?"

"A mile and three-quarters. We got results at two miles, but they were not entirely satisfactory. This was at Salisbury Plain, across a shallow valley between low hills."

"What battery were you using?"

"An eight-volt battery of three amperes, four accumulators in a box."

"Did you use a reflector?"

"Yes. It was a roughly-made, copper parabolic reflector with a mistake of an inch in the curve. I shall not use one in future, however. A reflector is of no value."

"Nor a lens?"

"Nor a lens."

"Why not?"

"Because the waves I speak of penetrate everything and are not reflected or refracted."

After Professor Röntgen's distances of a few yards and limitations as to substances this was rather stunning. Marconi, however, was entirely serious and visibly in earnest in his statement.

"How far have you verified this belief?"

"Not very far, but far enough, I think, to justify the statement. Using the same battery and my transmitter and receiver we sent and received the waves, at the General Post-Office building, through seven or eight walls, over a distance of one hundred yards."

"How thick were the walls?"

"I can't say. You know the building, however. It is very solidly constructed."

"And you sent an ordinary telegraphic dispatch by those signals?"

"No. We did not do that, though we could have done so. We were working with agreed signals, and we obtained the taps which we sought and repeated them till there was no room for doubt."

"Do you think that sitting in this room you could send a dispatch across London to the General Post-Office?"

"With instruments of the proper size and power, I have no doubt about it."

"Through all the houses?"

"Yes."

We were in a drawing-room in Talbot Road, Westbourne Park, a distance of about four and one-half miles from the General Post-Office.

"And how far do you think a dispatch could thus be sent?"

"Twenty miles."

"Why do you limit it to twenty miles?"

"I am speaking within practical limits, and thinking of the transmitter and receiver as thus far calculated. The distance depends simply upon the amount of the exciting energy and the dimensions of the two conductors from which the wave proceeds."

"What is the law of the intensity at a given distance?"

"The same as the law of light, inversely as the square of the distance."

This means that whatever the energy with which the waves are sent out, their power at, say twenty feet, when compared with their power at ten feet would be in the proportion of 10 x 10 to 20 x 20, or one-fourth, in this special instance.

"Do you think they are waves of invisible light?"

"No; in some respects their action is very different."

"Then you think these waves may possibly be used for electric lighthouses when fog prevents the passage of light?"

"I think they will ultimately be so used. A constant source of electrical waves, instead of a constant source of light waves, and a receiver on the vessel would indicate the presence of the lighthouse and also its direction."

"But would not the fog interfere with the passage of the waves?"

"Not at all."

"Nor metal?"

"Nothing affects them. My experience of these waves leads me to believe that they will go through an ironclad."

"Concerning the size of the apparatus, how large is it?"

"The transmitter and receiver we have been using at Salisbury Plain and at the post-office are each about"--he held up his hands to indicate the dimensions--"say fifteen inches by ten by eight. Small ones, effective enough for ordinary purposes, can be made of half that size."

"What are you working on at present?"

"Mr. Preece and I are working at Penarth, in Wales, to establish regular communication through the air from the shore to a light-ship. This will be the first direction in which my apparatus is utilized--communication with the light-ships. The light-ships lie off this coast at any distance from half a mile to twenty miles or more."

"What length of waves have you used?"

"I have tried various lengths, from thirty meters down to ten inches."

"Why would not these waves be useful in preventing the collision of ships in a fog?"

"I think they will be made use of for that purpose. Ships can be fitted with the apparatus to indicate the presence of another ship so fitted, within any desired distance. As soon as two approach within that distance the alarms will ring on each ship, and the direction of each to the other will be indicated by an index."

"Do you limit the distance over which these waves can be sent?"

"I have no reason to do so. The peculiarity of electric waves, which was noted, I believe, by Hertz, is the distance they travel when excited by only a small amount of energy."

"Then why could you not send a dispatch from here to New York, for instance?"

"I do not say that it could not be done. Please remember, however, that it is a new field, and the discussion of possibilities which may fairly be called probabilities omits obstacles and difficulties which may develop in practical working. I do not wish to be recorded as saying that anything can actually be done beyond what I have already been able to do. With regard to future developments I am only saying what may ultimately happen; what, so far as I can now see, does not present any visible impossibilities."

"How large a station would be necessary, assuming the practicability, to send a message from here to New York?"

"A station the size of this room in square area. I don't say how high." The room was twenty feet square.

"What power?"

"Fifty or sixty horse-power would, I think, suffice."

"What would be the cost of the two stations completed?"

"Under £10,000, I think."

"Would the waves go through the ether in the air or through the earth?"

"I cannot say with certainty. I only believe they would go that distance and be recorded."

"You say that no lens or reflector is of value. Then the waves would go outward in all directions to all places at the same distance as New York?"

"Yes."

"Do you think that no means will ever be found to stop this progress in all directions and concentrate it in one direction?"

"On the contrary, I think that invention will give us that."

"Do you see any way of accomplishing this?"

"No, not as yet."

"In what other directions do you expect your invention to be first utilized?"

"The first may be for military purposes, in place of the present field telegraph system.

There is no reason why the commander of an army should not be able to easily communicate telegraphically with his subordinate officers without wires over any distances up to twenty miles. If my countrymen had had my instruments at Massowah, the reinforcements could easily have been summoned in time."

"Would the apparatus be bulky?"

"Not at all. A small sender and receiver would suffice."

"Then why would it not be equally useful for the admiral of a fleet in communicating with his various ships?"

"It would," said Marconi, with some hesitation.

"Is there any difficulty about that?"

"Yes," said he, very frankly, but in a way which set the writer to wondering. "I do not know that it is a difficulty yet, but it appears to be."

The writer pondered the matter for a moment. Then he asked: "Do you remember Hertz's experiment of exploding gunpowder by electric waves?"

"Yes."

"Could you not do the same from this room with a box of gunpowder placed across the street in that?"

"Yes. If I could put two wires or two plates in the powder, I could set up an induced current which would cause a spark and explode it."

"Then if you threw electric waves upon an ironclad, and there happened to be two nails or wires or plates in the powder magazine which were in a position to set up induction, you could explode the magazine and destroy the ship?"

"Yes."

"And the electric lighthouses we are speaking of might possibly explode the magazines of ironclads as far as light from a lighthouse could be seen?"

"That is certainly a possibility. It would depend on the amount of the exciting energy."

"And the difficulty about using your instruments for fleet purposes--"

"The fear has been expressed that in using the instruments on an ironclad the waves might explode the magazine of the ship itself."

It is perhaps unnecessary to say that this statement was simply astounding. It is so much of a possibility that electric rays can explode the magazine of an ironclad, that the fact has already been recognized by the English Royal engineers. Of all the coast defences ever dreamed of, the idea of exploding ironclads by electric waves from the shore over distances equal to modern cannon ranges is certainly the most terrible possibility yet conceived.

Such are the astonishing statements and views of Marconi. What their effect will be remains to be seen. In the United States alone, considering the many able experimenters and their admirable and original equipments like Tesla's dynamos, the imagination abandons as a hopeless task the attempt to conceive what--in the use of electric waves--the immediate future holds in store. The air is full of promises, of miracles. The certainty is that strange things are coming, and coming soon.

Because, underlying the possibilities of the known electric waves and of new kinds of electric waves which seem to be numerous and various--underlying these is still the mystery of the ether. Here is a field which offers to those college students of to-day who have already felt the fascination of scientific research, a life work of magical and magnificent possibilities, a virgin, unexplored diamond field of limitless wealth in knowledge. Science knows so little, and seems, in one sense, to have been at a standstill for so long. Lord Kelvin said sadly, in an address at Glasgow the other day, that though he had studied hard through fifty years of experimental investigation, he could not help feeling that he really knew no more as he spoke than he knew fifty years before.

Now, however, it really seems that some Columbus will soon give us a new continent in science. The ether seems to promise fairly and clearly a great and new epoch in knowledge, a great and marked step forward, a new light on all the great problems which are mysteries at present with perhaps a correction and revision of many accepted results. This is particularly true of the mystery of living matter and that something which looks so much like consciousness in certain non-living matter, the property which causes and enables it to take the form of regular crystals. Crystallization is as great a problem as life itself, but from its less number of conditions will perhaps be easier and earlier attacked. The best conception of living matter which we have at present, completely inadequate though it be, is that of the most chemically complex and most unstable matter known. A living man as compared to a wooden man responds to all kinds of impulses. Light strikes the living eve, sound strikes the living ear, physical and chemical action are instantly and automatically started, chemical decomposition takes place, energy is dissipated, consciousness occurs, volition follows, action results, and so on, through the infinity of cause and infinity of results which characterize life. The wooden man is inert. There is no chemical or physical action excited by any impulse from without or within. Living matter is responsive, non-living is not. The key to the mystery, if it ever comes, will come from the ether. One great authority of to-day, Professor Oliver Lodge, has already stated his belief that electricity is actually matter, and that if the ether and electricity are not one and the same, the truth will ultimately be found to be near that statement. If this be true, it will be a great and startling key to the now fathomless mystery of life.

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# MARCONI'S ACHIEVEMENT.
## TELEGRAPHING ACROSS THE OCEAN WITHOUT WIRES.

By RAY STANNARD BAKER.

[Immediately upon the announcement of Mr. Marconi's success in signaling across the Atlantic Ocean, Mr. Baker went to St. John's, Newfoundland, where he visited the inventor and the scene of his experiments, afterwards accompanying him to Nova Scotia, and obtaining from him a complete and accurate account of his extraordinary achievements. McCLURE'S MAGAZINE printed, in March, 1897, the first article ever published about the young inventor, and, believing in him from the first, has followed his work step by step. In June, 1899, appeared a description of his successful signaling across the English Channel. The present paper is the authoritative story, obtained from the inventor himself, of his crowning triumph--THE EDITOR.]

IT is not at all surprising that Mr. Marconi kept his own counsel regarding his plans in coming to Newfoundland. So much hung on his success; and his project, in its bare outlines, was of a nature to balk human credulity. Think for a moment of sitting here on the edge of North America and listening to communications sent *through space* across nearly 2,000 miles of ocean from the edge of Europe! A cable, marvelous as it is, maintains a tangible and material connection between speaker and hearer: one can grasp its meaning. But here is nothing but space, a pole with a pendent wire on one side of a broad, curving ocean, an uncertain kite struggling in the air on the other--and thought passing between. And the apparatus for sending and receiving these transoceanic messages costs not a thousandth part of the expense of a cable. It is true that Marconi had already convinced the world of his ability to transmit messages for short distances without wires; yet his earlier successes seemed in no wise to prepare the public for his greater achievement. Earlier in the year he had communicated about 250 miles between stations on the British coast, but who imagined that he would suddenly attempt nearly eight times that distance? Even famous scientists and inventors refused at first to believe that signals had been actually transmitted from England to America. The project was too daring for public announcement. No one knew better what its success might mean to the world than the inventor: the entire reconstruction of the present methods of transoceanic communication, the possible rejection as waste of millions of dollars' worth of the costly and cumbersome cable apparatus now in use, new possibilities opened in commerce and politics, war made more difficult, nations brought into closer and more sympathetic relationships--in short, the very shrinkage of the earth. Supposing the inventor had heralded his plans--and failed!

Very quietly, therefore, on December 6, 1901, Mr. Marconi landed at St. John's, with his two assistants, Mr. Kemp and Mr. Paget. It was understood that he would attempt communication with the transatlantic steamships as they passed back and forth 300 miles away. He set up his instruments in a low room of the old barracks on Signal Hill, which stands sentinel at the harbor mouth half a mile from the city of St. John's. So simple and easily arranged is the apparatus, that in three days' time the inventor was prepared to begin his experiments. On Wednesday, the 10th, as a preliminary test of the wind velocity, he sent up one of his kites, a huge hexagonal affair of bamboo and silk nine feet high, built on the Baden-Powell model; the wind promptly snapped the wire and blew the kite out to sea. He then filled a 14-foot hydrogen balloon, and sent it upward through a thick fog bank. Hardly had it reached the limit of its tetherings, however, when the aërial wire on which he had depended for receiving his messages fell to the earth, the balloon broke away, and was never seen again. On Thursday, the 12th, a day destined to be important in the annals of invention, Marconi tried another kite, and though the weather was so blustery that it required the combined strength of the inventor and his assistants to manage the tetherings, they succeeded in holding the kite at an elevation of about 400 feet. Marconi was now prepared for the crucial test. Before leaving England he had given detailed instructions to his assistants for the transmission of a certain signal, the Morse telegraphic S, represented by three dots (. . .), at a fixed time each day, beginning as soon as they received word that everything at St. John's was in readiness. This signal was to be clicked out on the transmitting instruments near Poldhu, Cornwall, the southwestern tip of England, and radiated from a number of aërial wires pendent from masts 210 feet high. If the inventor could receive on his kite-wire in Newfoundland some of the electrical waves thus produced, he knew that he held the solution of the problem of transoceanic wireless telegraphy. He had cabled his assistants to begin sending the signals at three o'clock in the afternoon, English time, continuing until six o'clock; that is, from about 11.30 to 2.30 o'clock in St. John's. his plans--and failed!

At noon on Thursday (December 12, 1901) Marconi sat waiting, a telephone receiver at his ear, in a room of the old barracks on Signal Hill. To him it must have been a moment of painful stress and expectation. Arranged on the table before him, all its parts within easy reach of his hand, was the delicate receiving instrument, the supreme product of years of the inventor's life, now to be submitted to a decisive test. A wire ran out through the window, thence to a pole, thence upward to the kite which could be seen swaying high overhead. It was a bluff, raw day; at the base of the cliff 300 feet below thundered a cold sea; oceanward through the mist rose dimly the rude outlines of Cape Spear, the easternmost reach of the North American Continent. Beyond that rolled the unbroken ocean, nearly 2,000 miles to the coast of the British Isles. Across the harbor the city of St. John's lay on its hillside wrapped in fog: no one had taken enough interest in the experiments to come up here through the snow to Signal Hill. Even the ubiquitous reporter was absent. In Cabot Tower, near at hand, the old signalman stood looking out to sea, watching for ships, and little dreaming of the mysterious messages coming that way from England. Standing on that bleak hill and gazing out over the waste of water to the eastward, one finds it difficult indeed to realize that this wonder could have become a reality. The faith of the inventor in his creation, in the kite-wire, and in the instruments which had grown under his hand was unshaken.

"I believed from the first," he told me, "that I would be successful in getting signals across the Atlantic."

Only two persons were present that Thursday noon in the room where the instruments were set up--Mr. Marconi and Mr. Kemp. Everything had been done that could be done. The receiving apparatus was of unusual sensitiveness, so that it would catch even the faintest evidence of the signals. A telephone receiver, which is no part of the ordinary instrument, had been supplied, so that the slightest clicking of the dots might be conveyed to the inventor's ear. For nearly half an hour not a sound broke the silence of the room. Then quite suddenly Mr. Kemp heard the sharp click of the tapper as it struck against the coherer; this, of course, was not the signal, yet it was an indication that something was coming. The inventor's face showed no evidence of excitement. Presently he said:

"See if you can hear anything, Mr. Kemp."

Mr. Kemp took the receiver, and a moment later, faintly and yet distinctly and unmistakably, came the three little clicks--the dots of the letter S, tapped out an instant before in England. At ten minutes past one, more signals came, and both Mr. Marconi and Mr. Kemp assured themselves again and again that there could be no mistake. During this time the kite gyrated so wildly in the air that the receiving wire was not maintained at the same height, as it should have been; but again, at twenty minutes after two, other repetitions of the signal were received.

PREPARING TO FLY THE KITE WHICH SUPPORTS THE RECEIVING WIRE. MARCONI ON THE EXTREME LEFT.


FACSIMILE OF MESSAGE RECEIVED FROM AN INCOMING STEAMER BY WIRELESS TELEGRAPHY AT STATION ON NANTUCKET—A DESPATCH TO THE N. Y. HERALD.

Thus the problem was solved. One of the great wonders of science had been wrought. But the inventor went down the hill toward the city, now bright with lights, feeling depressed and disheartened--the rebound from the stress of the preceding days. On the following afternoon, Friday, he succeeded in getting other repetitions of the signal from England, but on Saturday, though he made an effort, he was unable to hear anything. The signals were, of course, sent continuously, but the inventor was unable to obtain continuous results, owing, as he explains, to the fluctuations of the height of the kite as it was blown about by the wind, and to the extreme delicacy of his instruments, which required constant adjustment during the experiments.

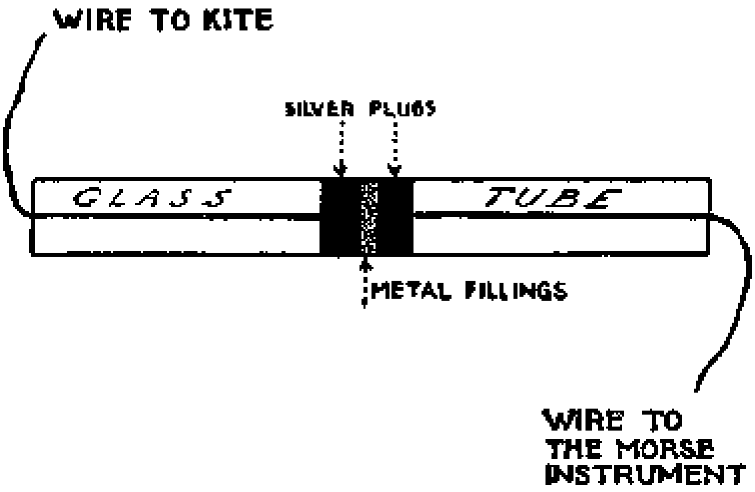
Even now that he had been successful, the inventor hesitated to make his achievement public, lest it seem too extraordinary for belief. Finally, after withholding the great news for two days, certainly an evidence of self-restraint, he gave out a statement to the press, and on Sunday morning the world knew and doubted; on Monday it knew more and believed. Many, like Mr. Edison, awaited the inventor's signed announcement before they would credit the news. Sir Cavendish Boyle, the governor of Newfoundland, reported at once to King Edward; and the cable company which has exclusive rights in Newfoundland, alarmed at an achievement which threatened the very existence of its business, demanded that he desist from further experiments within its territory, truly an evidence of the belief of practical men in the future commercial importance of the invention. It is not a little significant of the increased willingness of the world, born of expanding knowledge, to accept a new scientific wonder, that Mr. Marconi's announcement should have been so eagerly and so generally believed, and that the popular imagination should have been so fired with its possibilities. One cannot but recall the struggle against doubt, prejudice, and disbelief in which the promoters of the first transatlantic cable were forced to engage. Even after the first cable was laid (in 1858) and messages had actually been transmitted, there were many who denied that it had ever been successfully operated, and would hardly be convinced even by the affidavits of those concerned in the work. But in the years since then, Edison, Bell, Röntgen, and many other famous inventors and scientists have taught the world to be chary of its disbelief. Outside of this general disposition to friendliness, however, Marconi on his own part had well earned the credit of the careful and conservative scientist; his previous successes made it the more easy to credit his new achievement. For, as an Englishman (Mr. Flood Page), in defending Mr. Marconi's announcement, has pointed out, the inventor has never made any statement in public until he has been absolutely certain of the fact; he has never had to withdraw any statement that he has made as to his progress in the past. And these facts unquestionably carried great weight in convincing Mr. Edison, Mr. Graham Bell, and others of equal note of the literal truth of his report. It was astonishing how overwhelmingly credit came from every quarter of the world, from high and low alike, from inventors, scientists, statesmen, royalty. Before Marconi left St. John's he was already in receipt of a large mail--the inevitable letters of those who would offer congratulation, give advice, or ask favors. He received offers to lecture, to write articles, to visit this, that, and the other place--and all within a week after the news of his success. The people of the "ancient colony" of Newfoundland, famed for their hospitality, crowned him with every honor in their power. I accompanied Mr. Marconi across the island on his way to Nova Scotia, and it seemed as if every fisher and farmer in that wild country had heard of him, for when the train stopped they came crowding to look in at the window. From the comments I heard, they wondered most at the inventor's youthful appearance. Though he is only twenty-seven years old, his experience as an inventor covers many years, for he began experimenting in wireless telegraphy before he was twenty. At twenty-one he came to London from his Italian home, and convinced the British Post-Office Department that he had an important idea; at twenty-three he was famous the world over.

The inventor is somewhat above medium height, and though of a highly strung temperament, he is deliberate in his movements. Unlike the inventor of tradition, he dresses with scrupulous neatness, and, in spite of being a prodigious worker, he finds time to enjoy a limited amount of club and social life. The portrait published with this article, taken at St. John's a few days after the experiments, gives a very good idea of the inventor's face, though it cannot convey the peculiar luster of his eyes when he is interested or excited--and perhaps it makes him look older than he really is. One of the first and strongest impressions that the man conveys is that of intense nervous activity and mental absorption; he has a way of pouncing upon a knotty question, as if he could not wait to solve it. He talks little, is straightforward and unassuming, submitting good-naturedly, although with evident unwillingness, to being lionized. In his public addresses he has been clear and sensible; he has never written for any publication; nor has he engaged in scientific disputes, and even when violently attacked he has let his work prove his point. And he has accepted his success with calmness, almost unconcern; he certainly expected it. The only elation I saw him express was over the attack of the cable monopoly in Newfoundland, which he regarded as the greatest tribute that could have been paid his achievement. During all his life, opposition has been his keenest spur to greater effort.

Though he was born and educated in Italy, his mother was of British birth, and he speaks English as perfectly as he does Italian. Indeed, his blue eyes, light hair, and fair complexion give him decidedly the appearance of an Englishman, so that a. stranger meeting him for the first time would never suspect his Italian parentage. His parents are still living, spending part of their time on their estate in Italy and part of the time in London. One of the first messages conveying the news of his success at St. John's went to them. He embarked in experimental research because he loved it, and no amount of honor or money tempts him from the pursuit of the great things in electricity which he sees before him. Besides being an inventor, he is also a shrewd business man, with a clear appreciation of the value of his inventions and of their possibilities when generally introduced. What is more, he knows how to go about the task of introducing them.

No sooner had Marconi announced his success than critics began to raise objections. Might not the signals which he received have been sent from some passing ship fitted with wireless-telegraphy apparatus? Or, might they not have been the result of electrical disturbances in the atmosphere? Or, granting his ability to communicate across seas, how could he preserve the secrecy of his messages? If they were transmitted into space, why was it not possible for any one with a receiving instrument to take them? And was not his system of transmission too slow to make it useful, or was it not rendered uncertain by storms? And so on indefinitely. An acquaintance with some of the principles which Marconi considers fundamental, and on which his work has been based, will help to clear away these objections and give some conception of the real meaning and importance of the work at St. John's and of the plans for the future development of the inventor's system.

In the first place, Mr. Marconi makes no claim to being the first to experiment along the lines which led to wireless telegraphy, or the first to signal for short distances without wires. He is prompt with his acknowledgment to other workers in his field, and to his assistants. Professor S. F. B. Morse, the inventor of telegraphy; Dr. Oliver Lodge and Sir William Preece of England; Edison, Tesla, and Professors Trowbridge and Dolbeare of America, and others had experimented along these lines, but it remained for Marconi to perfect a system and put it into practical working order. He took the coherer of Branley and



COHERER; ACTUAL SIZE.

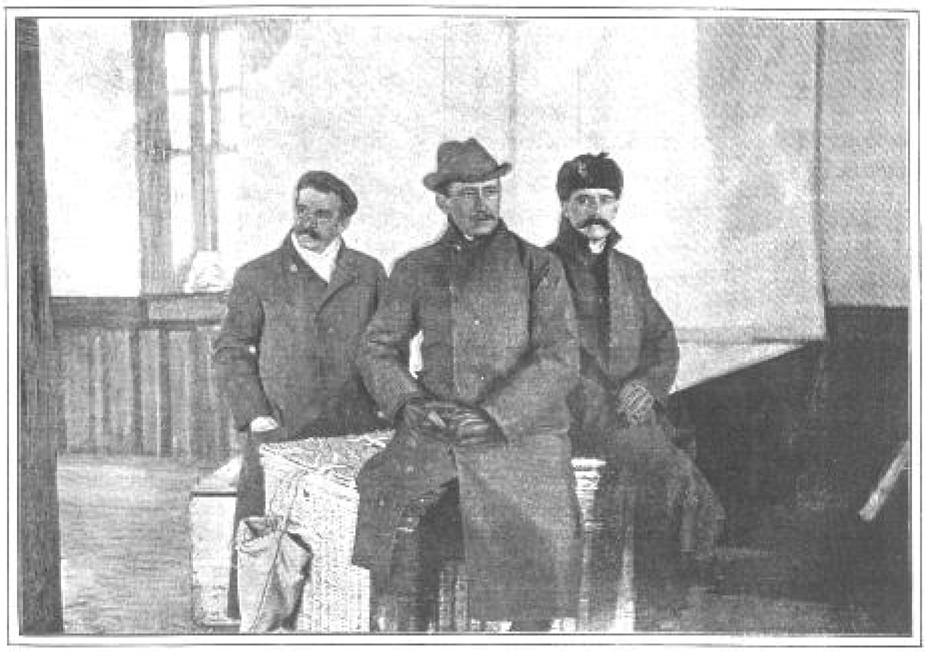
Calzecchi, the oscillator of Righi, he used the discoveries of Henry and Hertz, but his creation, like that of the poet who gathers the words of men in a perfect lyric, was none the less brilliant and original.

In its bare outlines, Marconi's system of telegraphy consists in setting in motion, by means of his transmitter, certain electric waves which, passing through the ether, are received on a distant wire suspended from a kite or mast, and registered on his receiving apparatus. The ether is a mysterious, unseen, colorless, odorless, inconceivably rarefied something which is supposed to fill all space. It has been compared to a jelly in which the stars and planets are set like cherries. About all we know of it is that it has waves--that the jelly may be made to vibrate in various ways. Etheric vibrations of certain kinds give light; other kinds give heat; others electricity. Experiments have shown that if the ether vibrates at the inconceivable swiftness of 400 billions of waves a second we see the color red, if twice as fast we see violet, if more slowly--perhaps 230 millions to the second, and less--we have the Hertz waves used by Marconi in his wireless-telegraphy experiments. Ether waves should not be confounded with air waves. Sound is a result of the vibration of the air; if we had ether and no air, we should still see light, feel heat, and have electrical phenomena, but no sounds would ever come to our ears. Air is sluggish beside ether, and sound waves are very slow compared with ether waves. During a storm the ether brings the flash of the lightning before the air brings the sound of thunder, as every one knows.

Electricity is, indeed, only another name for certain vibrations in the ether. We say that electricity "flows" in a wire, but nothing really passes except an etheric wave, for the atoms composing the wire, as well as the air and the earth, and even the hardest substances, are all afloat in ether. Vibrations, therefore, started at one end of the wire travel to the other. Throw a stone into a quiet pond. Instantly waves are formed which spread out in every direction: the water does not move, except up and down, yet the wave passes onward indefinitely. Electric waves cannot be seen, but electricians have learned how to incite them, to a certain extent how to control them, and have devised cunning instruments which register their presence.

Electrical waves have long been harnessed by the use of wires for sending communications; in other words, we have had wire telegraphy. But the ether exists outside of the wire as well as within; therefore, having the ether everywhere, it must be possible to produce waves in it which will pass anywhere, as well through mountains as over seas, and if these waves can be controlled, they will evidently convey messages as easily and as certainly as the ether within wires. So argued Mr. Marconi. The difficulty lay in making an instrument which would produce a peculiar kind of wave, and in receiving and registering this wave in a second apparatus located at a distance from the first. It was, therefore, a practical mechanical problem which Marconi had to meet. Beginning with crude tin boxes set up on poles on the grounds of his father's estate in Italy, he finally devised an apparatus from which a current generated by a battery and passing in brilliant sparks between two brass balls was radiated from a wire suspended on a tall pole. By shutting off and turning on this peculiar current by means of a device similar to the familiar telegrapher's key, the waves could be so divided as to represent dashes and dots, and spell out letters in the Morse alphabet. This was the transmitter. It was, indeed, simple enough to start these waves traveling through space, to jar the etheric jelly, so to speak; but it was far more difficult to devise an apparatus to receive and register them. For this purpose Marconi adopted a device invented by an Italian, Calzecchi, and improved by a Frenchman, M. Branley, called the coherer, the very crux of the system, without which there could be no wireless telegraphy. This coherer, which he greatly improved, is merely a little tube of glass as big around as a lead pencil, and perhaps two inches long. It is plugged at each end with silver, the plugs nearly meeting within the tube. The narrow space between them is filled with finely powdered fragments of nickel and silver, which possess the strange property of being alternately very good and very bad conductors of electrical waves. The waves which come from the transmitter, perhaps 2,000 miles away, are received on a suspended kite-wire, exactly similar to the wire used in the transmitter, but they are so weak that they could not of themselves operate an ordinary telegraph instrument. They do, however, possess strength enough to draw the little particles of silver and nickel in the coherer together in a continuous metal path. In other words, they make these particles "cohere," and the moment they cohere, they become a good conductor for electricity, and a current from a battery near at hand rushes through, operates the Morse instrument, and causes it to print a dot or a dash; then a little tapper, actuated by the same current, strikes against the coherer, the particles of metal are jarred apart or "decohered," becoming instantly a poor conductor, and thus stopping the strong current from the home battery. Another wave comes through space, down the suspended kite-wire, into the coherer, there drawing the particles again together, and another dot or dash is printed. All these processes are continued rapidly, until a complete message is ticked out on the tape. Thus Mr. Kemp knew when he heard the tapper strike the coherer that a signal was coming, though he could not hear the click of the receiver itself. And this is in bare outline Mr. Marconi's invention--this is the combination of devices which has made wireless telegraphy possible, the invention on which he has taken out 132 patents in every civilized country of the world. Of course his instruments contain much of intricate detail, of marvelously ingenious adaptation to the needs of the work, but these are interesting chiefly to expert technicians.

In his actual transoceanic experiments of last December, Mr. Marconi's transmitting station in England was fitted with twenty masts 210 feet high, each with its suspended wire, though not all of them were used. A current of electricity sufficient to operate some 300 incandescent lamps was used, the resulting spark being so brilliant that one could not have looked at it with the unshaded eye. The wave which was thus generated had a length of about a fifth of a mile, and the rate of vibration was about 800,000 to the second. Following the analogy of the stone cast in the pond with the ripples circling outward, these waves spread from the suspended wires in England in every direction, not only westward toward the cliff where Marconi was flying his kite, but eastward, northward, and southward, so that if some of Mr. Marconi's assistants had been flying kites, say on the shore of Africa, or South America, or in St. Petersburg, they might possibly, with a corresponding receiver, have heard the identical signals at the same instant. In his early experiments Marconi believed that great distances could not be obtained without very high masts and long,



MR. MARCONI AND HIS ASSISTANTS: MR. KEMP ON THE LEFT, MR. PAGET ON THE RIGHT .

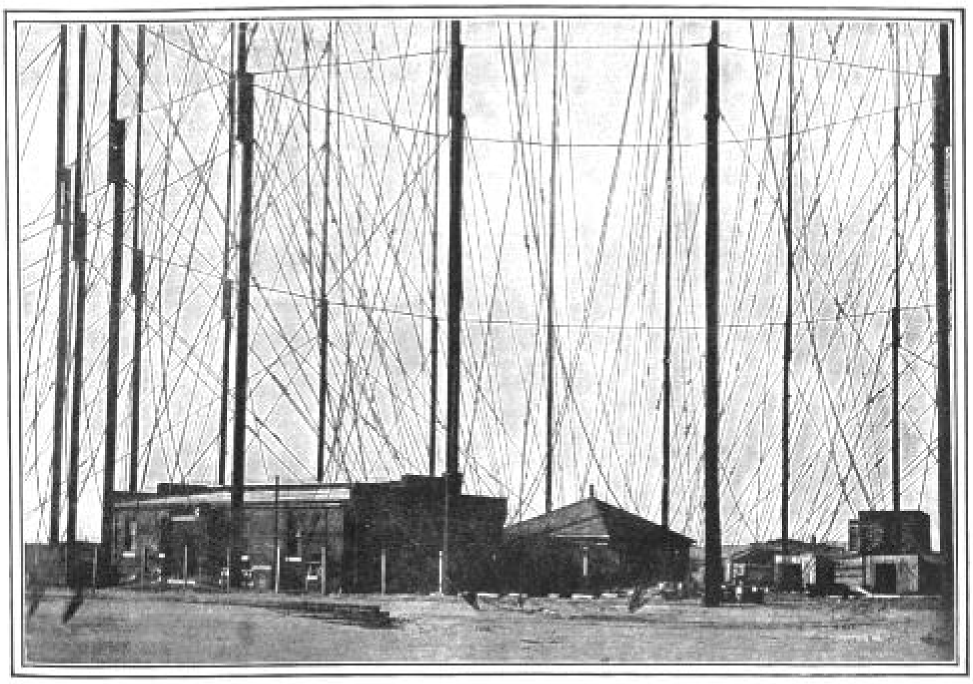
*They are sitting on a balloon basket, with one of the Baden-Powell kites in the background.*

suspended wires, the greater the distance the taller the mast, on the theory that the waves were hindered by the curvature of the earth; but his later theory, substantiated by his Newfoundland experiments, is that the waves somehow follow around the earth, conforming to its curve, and the next station he establishes in America will not be set high on a cliff, as at St. John's, but down close to the water on level land. His Newfoundland experiments have also convinced him that one of the secrets of successful long-distance transmission is the use of a more powerful current in his transmitter, and this he will test in his next trials between the continents.

And now we come to the most important part of Mr. Marconi's work, the part least known even to science, and the field of almost illimitable future development. This is the system of "tuning," as the inventor calls it, the construction of a certain receiver so that it will respond only to the message sent by a certain transmitter. When Marconi's discoveries were first announced in 1896, there existed no method of tuning, though the inventor had its necessity clearly in mind. Accordingly the public inquired, "How are you going to keep your messages secret? Supposing a warship wishes to communicate with another of the fleet, what is to prevent the enemy from reading your message? How are private business despatches to be secured against publicity?" Here, indeed, was a problem. Without secrecy no system of wireless telegraphy could ever reach great commercial importance, or compete with the present cable communication. The inventor first tried using a parabolic copper reflector, by means of which he could radiate the electric waves exactly as light, which, it will be borne in mind, is only another kind of etheric wave, is reflected by a mirror. This reflector could be faced in any desired direction, and only a receiver located in that direction would respond to the message. But there were grave objections to the reflector; an enemy might still creep in between the sending and receiving stations, and, moreover, it was found that the curvature of the earth interfered with the transmission of reflected messages, thereby limiting their usefulness to short distances.

In passing, however, it may be interesting to note one extraordinary use for this reflecting system which the inventor now has in mind. This is in connection with lighthouse work. Ships are to be provided with reflecting instruments which in dense fog or storms can be used exactly as a searchlight is now employed on a dark night to discover the location of the lighthouses or lightships.

For instance, the lighthouse, say, on some rocky point on the New England coast would continually radiate a warning from its suspended wire. These waves pass as readily through fog and darkness and storm as in daylight. A ship out at sea, hidden in fog, has lost its bearings; the sound of the warning horn, if warning there is, seems to come first



MARCONI WIRELESS-TELEGRAPHY STATION ON CAPE COD, NOW PARTLY STORM-WRECKED.

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tuning system to some degree of perfection, though very much work yet remains to be done. For instance, in one of his English experiments, at Poole in England, he had two receivers connected with the same wire, and tuned to different transmitters located at St. Catherine's Point. Two messages were sent, one in English and one in French. Both were received at the same time on the same wire at Poole, but one receiver rolled off its message in English, the other in French, without the least interference. And so when critics suggested that the inventor may have been deceived at St. John's by messages transmitted from ocean liners, he was able to respond promptly:

"Impossible. My instrument was tuned to receive only from my station in Cornwall."

Indeed, the only wireless-telegraph apparatus that could possibly have been within hundreds of miles of Newfoundland would be one of the Marconi-fitted steamers, and the "call" of a steamer is not the letter "S," but "U."

The importance of the new system of tuning can hardly be overestimated. By it all the ships of a fleet can be provided with instruments tuned alike, so that they may communicate freely with one another, and have no fear that the enemy will read the messages. The spy of the future must be an electrical expert who can slip in somehow and steal the secret of the enemy's tunes. Great telegraph companies will each have its own tuned instruments, to receive only its own messages, and there may be special tunes for each of the important governments of the world. Or perhaps (for the system can be operated very cheaply), the time will even come when the great banking and business houses, or even families and friends, will each have its own wireless system, with its own secret tune. Having variations of millions of different vibrations, there will be no lack of tunes. For instance, the British navy may be tuned to receive only messages of 700,000 vibrations to the second, the German navy 1,500,000, the United States Government 1,000,000, and so on indefinitely.

Tuning also makes multiplex wireless telegraphy a possibility; that is, many messages may be sent or received on the same suspended wire. Supposing, for instance, the operator was sending a hurry press despatch to a newspaper. He has two transmitters, tuned differently, connected with his wire. He cuts the despatch in two, sends the first half on one transmitter, and the second on the other, thereby reducing by half the time of transmission.

A sort of impression prevails that wireless telegraphy is still largely in the uncertain experimental stage; but, as a matter of fact, it has long since passed from the laboratory to a wide commercial use. Its development since Mr. Marconi's first paper was read, in 1896, and especially since the first message was sent from England to France across the Channel in March, 1899, has been astonishingly rapid. Most of the ships of the great navies of Europe and all the important ocean liners are now fitted with the "wireless" instruments. The system has been recently adopted by the Lloyds of England, the greatest of shipping exchanges. It is being used on many lightships, and the New York "Herald" receives daily reports from vessels at sea, communicated from a ship station off Nantucket. Were there space to be spared, many incidents might be told showing in what curious and wonderful ways the use of the "wireless" instruments has saved life and property, to say nothing of facilitating business. Though it is not generally known, messages are now received in England at the rate of twelve cents a word for transmission to vessels that have already sailed from port. The inventor informed me that his company was now actually doing a profitable business on a commercial basis, though all profits are expended as fast as earned in new experiments.

Mr. Marconi, indeed, since his experiments in Newfoundland have been successful, assured me that the time when messages would be regularly flashing between Europe and America was much nearer than most people realized.

"It will be a matter of months rather than of years," he said.

And, indeed, the simplicity and ease of installation of his apparatus would certainly argue a speedy accomplishment of that end. He informed me that he would be able to build and equip stations on both sides of the Atlantic for less than $150,000, the subsequent charge for maintenance being very small. A cable across the Atlantic costs between $3,000,000 and $4,000,000, and it is a constant source of expenditure for repairs. The inventor will be able to transmit with single instruments about twenty words a minute, and at a cost ridiculously small compared with the present cable tolls. He said in a speech delivered at a dinner given him by the governor at St. John's that messages which now go by cable at twenty-five cents a word might be sent profitably at a cent a word or less, which is even much cheaper than the very cheapest present rates in America for messages by land wires. It is estimated that about $400,000,000 is invested in cable systems in various parts of the world. If Marconi succeeds as he hopes to succeed, much of the vast network of wires at the bottom of the world's oceans, represented by this investment, will lose its usefulness. It is now the inventor's purpose to push the work of installation between the continents as rapidly as possible, and no one need be surprised if the year 1902 sees his system in practical commercial operation. Along with this transatlantic work he intends to extend his system of transmission between ships at sea and the ports on land, with a view to enabling the shore stations to maintain constant communication with vessels all the way across the Atlantic. If he succeeds in doing this, there will at last be no escape for the weary from the daily news of the world, so long one of the advantages of an ocean voyage. For every morning each ship though in mid-ocean, will get its bulletin of news, the ship's printing-press will strike it off, and it will be served hot with the coffee. Yet think what such a system will mean to ships in distress, and how often it will relieve the anxiety of friends awaiting the delayed voyager.

Mr. Marconi's faith in his invention is boundless. He told me that one of the projects which he hoped soon to attempt was to communicate between England and New Zealand. If the electric waves follow the curvature of the earth, as the Newfoundland experiments indicate, he sees no reason why he should not send signals 6,000 or 10,000 miles as easily as 2,000.

Then there is the whole question of the use of wireless telegraphy on land, a subject hardly studied, though messages have already been sent upward of sixty miles overland. The new system will certainly prove an important adjunct on land in war-time, for it will enable generals to signal, as they have done in South Africa, over comparatively long distances in fog and storm, and over stretches where it might be impossible for the telegraph corps to string wires or for couriers to pass on account of the presence of the enemy.

Annual Dinner of the Institute at the Waldorf-Astoria, January 13, 1902, in honor of Guglielmo Marconi, *1902 Transactions of the American Institute of Electrical Engineers*, pages 93-121:

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

The annual dinner of the INSTITUTE was held this evening at the Waldorf-Astoria, the guest of honor being Mr. Guglielmo Marconi, the distinguished Italian space telegraphy expert. The brilliant assemblage of guests, numbering nearly 300 members and ladies, among them some of the foremost men in the various professions, made the occasion one of the most successful ever arranged by the INSTITUTE. The Astor Gallery, where the dinner was held, was decorated with novel and beautiful effects. Along one side of the room under a huge American flag, was a big table upon a dais; at the table were seated President Steinmetz, Past Presidents Elihu Thomson, Alexander Graham Bell, Francis Bacon Crocker, Frank J. Sprague and Carl Hering; Sir Percy Sanderson, C.B., the British Consul General; Cav. Branchi, the Italian Consul General; Dr. M. I. Pupin, William Stanley, Charles W. Price, Arthur Williams and the toast-master, Past President T. Commerford Martin. The menus were made interesting by clever sketches of Marconi staffs on the coast lighthouses, signalling "ss" in three dots, all the way across the ocean. By means of flexible conductors and tablets, the room was decorated with hundreds of electric lamps, while very small green lamps were inserted in great coils of the conductors upon the tables. On large tablets at either end of the dining hail were the names "Poldhu;" and "St. Johns," in letters formed of electric lamps, and opposite the speakers' table was another tablet bearing the name "Marconi." In strands of the conductor which was strung so as to connect the three signs, were inserted clusters of three lamps at frequent intervals, designed to represent the three dots or "s;" flashed by Mr. Marconi's assistant across the Atlantic from the coast of Cornwall to Newfoundland. These were flashed now and then or allowed to remain lighted, forming an appropriate and novel feature of the dinner festivities. In keeping also with the spirit of the evening was the procession of waiters carrying assorted ices, which were formed in semblance of electric lamps and automobiles grouped at the bases of telegraph poles. From these poles dangled broken wires, and between the poles were carried ships and other symbolic designs. All of these features were loudly applauded by the guests at the tables and in the galleries.

After dinner was over, President Steinmetz greeted the guests and cordially welcomed Mr. Marconi.

PRESIDENT STEINMETZ :--Ladies and Gentlemen: It is extremely gratifying to me that I am enabled to greet you at this, the annual dinner of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. I believe I voice the sentiments of all when I say that we are extremely sorry not to have with us the grand master of our industry, Mr. Edison, who from the early days of our profession has been working with us, and is still actively engaged in pioneer work of highest importance; he who has, I may say, founded our industry and has been principally instrumental in developing it and thereby enabling us, who constitute the profession, to be what we are at present.

I am glad, however, to introduce to you to-night another genius; an engineer who has been distinguished on both sides of the Atlantic by his work; who, taking up where Mr. Edison left off in the beginning of his career, has advanced beyond what others have done. While telegraphers have sent their messages through wires over the country or through cables across the Atlantic, and telephony has made talk possible over great distance, Mr. Marconi, our distinguished and honored guest, has done more. Instead of sending messages across the seas by cables, he has succeeded in sending them across empty space through the luminiferous ether.

I am glad and very thankful that we have with us this distinguished guest from abroad. I do not need to dwell any further upon this because we will have the pleasure of listening to him after a very short while, and I understand that Mr. Marconi will give us an explanation of what he has done and of what he hopes to do in the near future.

I now will turn the chairmanship of this meeting over to Mr. Martin as toastmaster. I hardly need to introduce Mr. Martin to you, because you have known him for years and years as a toastmaster. While presidents come and go and other officers of the INSTITUTE, Mr. Martin's efficiency as a toastmaster, as we all remember from many enjoyable social gatherings, has been so prominent that nobody has ever been found who could anywhere nearly equal his mastery; and, if you do not believe this, you will see for yourselves how true it is. (Laughter and applause.)

TOASTMASTER MARTIN:--On such an eventful, memorable and delightful evening as this in the history of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, there is fortunately very little left for the toastmaster to do. In company with the rest of the committee, he has simply been loafing and idling during the last forty-eight hours. (Laughter.) We were not quite sure when Mr. Marconi would get through in Canada, or whether he was going to Vancouver, or was about to try experiments on the Pacific Ocean. When we succeeded at last in locating him, we had barely forty-eight hours left us in which to organize this banquet. On behalf of the committee, and particularly of Mr. Calvin W. Rice, our Chairman, I beg you to accept our most profound and humble apologies. We have done our best. (Applause.)

The first duty which devolves upon me this evening is to read to you various communications which have been received by our committee. One, which is in autograph, and a fac simile copy of which I think everyone here would like to have, is as follows:

> I am sorry that I am prevented from attending your annual dinner to-night, especially as I should like to pay my respects to Marconi, the young man who had the monumental audacity to attempt and succeed in, jumping an electrical wave clear across the Atlantic Ocean.
>
> Yours,
>
> EDISON.

It was absolutely impossible for Mr. Edison to be with us to-night, but he said he would be thoroughly well represented when he sent his better half, (Applause). I may add that within the last ten days I had the pleasure of speaking to Mr. Edison himself with regard to Mr. Marconi, and he said that he had thought that sometime or other there might be signals flashed either way across the Atlantic without wires, but that he did not know when, and being pre-occupied, he did not think he would have time to do it himself, and he said to me: "Martin, I'm glad he did it. That fellow's work puts him in my class. He is a worker. It is a good thing we got him young."

Gen. Miles, the Commander-in-Chief of the United States Army, was to have been with us this evening, indeed, he accepted our invitation; but later he found it impossible for him to leave Washington, and he sent this evening a personal message to Mr. Marconi, and also to the INSTITUTE through Col. Samuel Reber, one of our officers, in which he desired him to express his great regret at his inability to be present, and his pleasure in knowing that we were extending this honor to Mr. Marconi as our guest.

I now have the pleasure of reading the following which is headed "City of New York," and is from the office of our wireless Mayor. (Laughter and prolonged applause).

> I am sorry that it is not in my power to attend the dinner of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS to be given this evening, at which Mr. Marconi is to be the guest of honor. The results already obtained by Mr. Marconi mark him as a man who has been a benefactor of the race, and his latest achievements seem to give promise of still greater services to mankind. I wish it were possible for me to be present to say to him in person, on behalf of the City of New York, how highly his scientific labors are appreciated. Asking you to convey to him my regards and best wishes, I am, respectfully,

SETH LOW,
*Mayor*.

I hold before you, fellow-members of the INSTITUTE, the record of the dinner given to Cyrus W. Field in this city thirty-five years ago, when, after labors that were superhuman and devotion and courage that were almost immortal, the Atlantic cable had at last been finally and successfully laid. Mayor Low's father presided at that dinner, and this is Prof. Morse's own copy of the record. I thought it would be interesting to bring it out of my little collection this evening and put it on the table.

The following letter has been received from the President of Columbia University:

> I regret deeply that a previous engagement for the evening of Monday will debar me of the pleasure of accepting the invitation that I have received from Prof. Sever to be present at the dinner tendered by the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS to Signor Marconi. I greatly regret my enforced absence for I should enjoy being able to join in your tribute of respect to the distinguished inventor, and in felicitating him upon having placed his name on the roll of the great discoverers and the great benefactors of the human race, for there appears to be every reason to believe that the most important practical results will follow in due time from Signor Marconi's successful experiments. Pray tender to your distinguished guest an expression of my sincerest congratulations and high regard, and believe me,

Very truly yours,

NICHOLAS MURRAY BUTLER.

From Capt. Chadwick of the United States Navy, whose name is remembered whenever we celebrate American victory and American valor, the following was received:

> I greatly regret my inability to attend the dinner in honor of Mr. Marconi. It would afford me great pleasure to be present to give in evidence my esteem and regard for him. I know him well enough to know that his genius is equalled by a modesty and reticence of statement, for which I have an equal admiration with the best. When he told me last Spring of his hopes, I knew he would do more than he mentioned. The result has more than justified expectancy.

F. E. CHADWICK.

I will also read the following letter to Mr. Rice as Chairman of the committee:

> Replying to your kind invitation which was delivered during my absence from the city, I beg you to transmit to the INSTITUTE my thanks for the honor proffered. I feel that I could not rise to the occasion, and regret not being able to contribute to the pleasure of the evening; but I wish to join the members in heartily congratulating Mr. Marconi on his brilliant results. He is a splendid worker, full of rare and subtle energies. May he prove to be one of those whose powers increase and whose mind feelers reach out further with advancing years for the good of the world and the honor of his country.

Yours very truly,

NIKOLA TESLA.

Permit me to say, gentlemen, even if it be a personal allusion, that from my beloved friend Tesla these ten years gone, I learned to believe that it would be possible to do what Mr. Marconi has now done.

As you are doubtless aware, our esteemed friend, Mr. George G. Ward, Vice-President of the Commercial Cable Company, is the representative in this country of the Institution of Electrical Engineers of Great Britain, of which our guest this evening, Mr. Marconi, is a member. I have received the accompanying letter from Mr. Ward, from which you will gather that he still believes in the laying of submarine cables.

> Your letter of January 10th, conveying the kind invitation of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS to join with them on this Monday evening, was delivered while I was away from the city, in Washington. I regret to say that I am unable to accept the invitation. I am compelled to return to Washington this afternoon to attend to matters in connection with the laying of the Commercial Pacific Cable. I congratulate the society upon its distinguished guest. I am very sorry I cannot be there to meet him.

Yours very truly,

GEORGE G. WARD.

I wish to say that Mr. Ward called me up on the telephone and asked me to take Mr. Marconi by the hand and shake it, and say that everything that would further the cause of communication between the hemispheres he was with and for.

Mr. Marconi had the distinguished honor of being born an Italian. I have had handed to me this evening by the Italian Consul in this City, a message which he has received from the Italian Ambassador to this country, which it will afford me great pleasure to read to you.

> Absent because of previous engagements of importance from the dinner which the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS gives in honor of Signor Marconi, I beg you to offer my assurance that I am present in spirit and rejoice in the sympathy shown for our illustrious countryman who adds his own to the other great Italian names of Volta, Galvani, Pacinotti and Ferraris in the history of electrical science. The new invention of Signor Marconi whose development will unite more and more firmly the new and old world in all their relations, is really an inestimable victory of human genius over the forces of nature; a noble conquest of civilization and mankind. I salute my glorious compatriot, and thank the worthy and high honorable Association which so fraternally welcomes and lauds him and his achievement.

THE ITALIAN AMBASSADOR TO THE UNITED STATES.

If you will look at your menus, gentlemen, on the second page you will find enumerated one or two of the European societies to which our guest of honor belongs. We have deemed it fit and appropriate that with them this evening we should exchange fraternal greetings, and one of the officers of the INSTITUTE, in conference with President Steinmetz, has prepared, with the permission of Mr. Marconi, cable messages, which, with your approval and consent, we shall take pleasure in forwarding. I have pleasure in calling upon one of our members, not less well-known in Italy than in this, his own country, Mr. John W. Lieb, who was associated with the Edison Company in Milan for years, to read you the despatches which it is proposed to forward.

Mr. Lieb then read a series of cablegrams to be sent to the various foreign organizations with which Signor Marconi is associated, and, on motion, the Secretary of the INSTITUTE was authorized to forward the same on behalf of the Society.

THE TOASTMASTER.--A distinguished English architect, when asked what his monument might be, and, in fact, it was afterwards inscribed as his epitaph in St. Paul's Cathedral, London, said, "Look around you." In introducing the guest of honor this evening all that I will say, gentlemen, is, look at these illuminations around you and three cheers for Signor Guglielmo Marconi. (Loud applause.)

SIGNOR MARCONI:--Mr. President, Ladies and Gentlemen: I can hardly find words to express my gratitude and thanks for the reception I have had here to-night. I thank you very much for the appreciation of the work which I have been fortunate enough to carry out. I feel myself highly honored to be entertained by such a great body as the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS. I think it is well-known all over the world that Americans stand first in applied electrical engineering. I feel myself greatly honored to be among so many eminent men, whose names are household words in the whole civilized world.

With your permission I will give you a brief description of what my system has at present accomplished, especially in reference to use on ships, and what I hope it will accomplish in the future. Wireless telegraphy is now attracting very great attention all over the world, and its progress is not slow. Five years ago, the system with which my name is identified was working over a distance of about two miles, but its range has been rapidly increased until a few months ago it was quite possible to communicate by means of an improved and attuned system over a distance of 200 miles. The commercial application of the system has been given serious consideration, and improvements of importance have been made.

It may interest you to know that the commercial application of the system has been tried in Great Britain, its chief base being in England. It may interest you, also, to know that there are over seventy ships carrying permanent installations for wireless telegraphy. Of these thirty-seven are in the British Navy, twelve in the Italian Navy and the remainder are on the large liners, such as the vessels of the Cunard Line, the North German Lloyd and the Beaver Line.

There are over twenty land stations equipped in Great Britain and on the Continent of Europe, which work in connection with the ships, and several on this side of the water, and a certain number of Lloyd's signal stations are now being equipped.

I regret very much that it is impossible for me in a brief address to go into the scientific details or into the historic development of my system, but I would like very much to reply in some way to the questions that are constantly asked as to the practical working of this system. I think I am right in saying that it is the general belief that when a message has been transmitted, or, as we might say, has once been entrusted to space, anyone with an appropriate receiver will be able to take it up and thereby find out what the message is and other people's business. This, in a commercial enterprise, would be very awkward, because nobody would like to send messages, and certainly commercial messages, such as stock quotations or private messages, if they thought that other people would get hold of them. By experiments and improvements which have been made, messages can only be read when the receiver and the transmitter are attuned. This perfected system is not at present in use on the ships. It has been deemed necessary that each ship should be equipped with apparatus which will permit of its reading a message sent from any other ship, because of the possibility of aid being required in distress. Therefore, the apparatus on all ships is attuned so that one ship may call up any other ship; but it is practicable to have the apparatus so attuned that the messages transmitted can in no way be received by any other apparatus except that attuned to receive the message.

In the case of transmissions from land to land, or across land, what we call the attuned system must be used. I will refer the technical gentlemen, who are here present, for details as to my work on that subject to a paper published by the Society of Arts in May of last year. With reference to what has already been accomplished at short distances--what I call short distances is up to two hundred miles--I refer you to some remarks which I will read, made by Prof. A. Fleming, who is professor of electrical engineering in London University, and who is well acquainted with the workings of my system. In a paper that he read on "Electrical Oscillations and Waves" before the Society of Arts in December, 1900, he said: "Communication was established by the Marconi system for the Admiralty between Portsmouth and Portland, two places about sixty-five miles apart, in a straight line, having hills eight hundred feet high in the line of sight. Across this line of communication, and included in it, there is another thirty-mile Marconi circuit between stations. These two lines cross each other at not a very great angle. By the employment of properly attuned receiving and transmitting circuits, it has been found possible to render these circuits quite independent of each other, so that no messages which go on between either two of the stations can interfere with messages being sent between the other two stations. What has been done here can be carried out indefinitely, and the objections as to interference of stations which uninformed persons are in the habit of raising, with regard to the system of wireless telegraphy, as a matter of fact no longer exist."

I have mentioned that I found it possible by means of the attuned system to transmit messages a distance of two hundred miles. Transmission was obtained between stations in England and Ireland, even in cases when a very small amount of energy was used--perhaps only as much as a very small incandescent lamp. That was found sufficient to telegraph two hundred miles. But it was at once thought that by the rational application of large amounts of energy, which electrical engineering has taught us how to produce with ease and to utilize, it would be possible to transmit messages to a much greater distance than had heretofore been dreamed of, or found possible. With the intention of demonstrating that trans-Atlantic transmission was possible, two comparatively very powerful installations were set up, one in Cornwall, Eng., and the other at Cape Cod, Mass. Prof. Fleming, of the University College in London, assisted me greatly in the installation of the powerful machines required. An unfortunate accident, which was caused by a hurricane at Cape Cod, partly demolished that station and for a few months at least, caused the postponement of the tests which I intended to carry out between England and the United States.

As I did not want to wait until repairs were effected at Cape Cod, I thought it might be useful in some way to get the English station to transmit with its full power, and the messages to be received on this side by means of a temporary installation; and as I did not think it prudent to try such a distance as three thousand miles at once, I thought that this temporary installation, this first shot of getting messages across the Atlantic, should be tried on the Island of Newfoundland, at St. Johns, which is about two thousand land miles from England. Instead of poles, as are generally used for permanent work, kites and balloons were employed to elevate the aerial wires, the necessity of which I think you are pretty well acquainted with. These kites or balloons gave a great deal of trouble, as, owing to the tempestuous weather which prevailed in Newfoundland last December, it was found almost impossible to raise the kites or balloons to the required height. However, I am glad to say that at certain intervals, on the 12th and 13th of December, the kites were for a short time got into satisfactory position, and my assistants and I had the great satisfaction of receiving a number of the prearranged signals from Cornwall, at the right time and at the prearranged speed. (Applause and cheers.)

Experiments would have been continued in Newfoundland with a more permanent installation, as I at once recognized the unsatisfactory results which were obtained by an installation which depended on the wind and weather, which in those northern regions are very unreliable in winter; and this permanent installation would have been set up, had I not discovered the fact that the Anglo-American Telegraph Company has, or claims to have, a monopoly of all telegraph communication in that colony (Laughter); not only has it got the cable and ordinary communication, but it claims to have the monopoly of preventing anyone from trying experiments which are connected with telegraphy in that colony, and in a certain way claims to have a monopoly of the air and the sea. (Laughter.)

It is rather strange, I may mention, that in England the British Government has the monopoly of the telegraph, and I am glad to say that it has encouraged my experiments rather more than prevented them. Certainly, when it comes to commercial work between stations in England--not between stations in England and ships, but between stations in England--we have come to a suggested arrangement; and I do not think the British Government would have thought of interfering with experiments, the object of which was the advancement of science. In Newfoundland, although we were not interfering with the revenue, but rather increasing it, due to the cabled results of my experiments and of what was going on (Applause), I was told by the manager of the cable station at St. Johns that he was pleased that I had provided a revenue for the company, because during the three days I was there they sent fifty thousand words over the wire. Still, we had to stop, and I do not think it wise to put up a permanent installation there.

My colleagues in the electrical profession well know, and in other professions too, that it is difficult enough to push a new thing when it is practically unimpeded, and that it becomes almost an impossibility when you have got to face injunctions and threatened injunctions.

Well, under the circumstances, I thought I would cross over to a country that is not very far from Newfoundland, about ninety miles away, Nova Scotia, part of the Dominion of Canada; and I think that a permanent station will be erected there, and that the one at Cape Cod will be repaired, and I am confident--perhaps inventors sometimes, or what are called inventors are over-confident--that it will be possible to transmit messages, and perhaps several messages across the ocean at the same time, and in a commercial and sure manner.

I wish to state here before you all that I am very greatly indebted to the governments of Newfoundland and Canada for the encouragement, sympathy and assistance they have given me in my work, and I trust that the future results will bear out our hopes and expectations.

I think it is generally admitted that modern history has proved beyond a doubt that one of the greatest factors of civilization in all the progress of the world is the facility with which people living long distances apart can readily and quickly communicate with each other. If my system can be commercially established, which has yet to be proved on long distances, between the different parts of the earth, it will not fail to bring about a further great cheapening of the methods of communication. An installation that will work across the Atlantic, however elaborate, costs only a very small fraction of what a cable costs. At present the great cost of the cables themselves and their heavy working expenses, causes the existing method to be beyond the reach of the majority of people inhabiting the various countries, but I believe that should my dream be realized and this new method be applied, the cost of cabling to distant countries will be very greatly and substantially reduced. A cheap telegraphic service between united families, however scattered, would keep the dispersed members in close and constant touch with the old home, and would cement friendships between the people of this great nation and the other nations of the globe--forging another link in the ties which bind this country to Great Britain. (Applause).

Time has not permitted me--I have said this before--to make any reference to the history of wireless telegraphy. I wish you to know how much the success of my work has depended upon the work of my predecessors and my present assistants I have built very greatly on the work of others; and before concluding, I would like to mention only a few of the names; I may omit some, but these occur to me at present. They are Clerk Maxwell, Lord Kelvin, Prof. Henry and Prof. Hertz. (Applause.) I do not know if you are all aware of it; I think it has been well published in the daily press, with more or less accuracy, that these messages were received on the telephone which was actuated by the impulses translated through it from a coherer which was influenced by the electric rays coming from England, and I wish to mention the name of Prof. Alexander Graham Bell in that connection. (Applause.) If it had not been for the invention of the telephone, I do not know whether at this day we would have received signals across the Atlantic. They might have been received later, with a great deal more power. An ordinary recording instrument was not sufficiently sensitive to work at that distance, but, by the aid of the telephone, it did work.

Gentlemen, I can hardly express how grateful I am for your hospitality and the kind references which have been made to my work. I hope that I can bring this work to a successful completion. As a stranger here, I thank you very much for your hospitality, and now I have the honor to drink the health of the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

Mr. Marconi took a glass from the table, holding it high above his head, then lowered it to his lips, and the diners doing the same, drank the toast in silence.

THE TOASTMASTER:--When on Sunday last your committee had the honor and pleasure of meeting Signor Marconi and telling him that it was "up to him," they had a very quick appreciation of the fact that when he came before you this evening he would justify the expectation which we entertained when we desired his presence among us to-night as our guest of honor. And when, during that long and laggard leisure which was at the disposal of your committee in making the arrangements for this banquet to-night, we cast around in a desire to rally the best spirits in the INSTITUTE about us, needless to say, our first thoughts turned to New England and to Prof. Elihu Thomson. While Prof. Thomson lives in New England, in these days of rapid transit that is no impediment to New York citizenship. We have understood that either to him, or to Mr. Lockwood, is attributable that remark of a Bostonian, living somewhere within the periphery of the Hub, that one of the best things about Boston was the 5:30 express for New York. Prof. Thomson knows that whatever train he takes for New York, he is equally welcome--with due respect to the New York *Sun*--in our midst.

Prof. Thomson and myself, and one or two others, around this board to-night, have somewhat of a reluctance in uttering the phrase "Anglo-American"; but, gentlemen, as you know, this country, in the cordiality which it extends to talent and genius of every kind, has not drawn the line at the little island that sits within the seas, but has welcomed the old and great continent of Europe. When Signor Marconi came to this country he also had a whole continent, presumably, at his disposal; but he went to Newfoundland, seeking a bluff. (Laughter.) He found it. Then, turning his eyes eastward and southward, the next Anglo-American promontory upon which his eager and anxious gaze fixed was in the vicinity of Boston, but, to his intense disappointment, he found that it was occupied and pre-occupied and that the golfers of Boston were teeing off from Bunker Hill. (Laughter.)

During this evening he has received word from Cape Cod that the Government is willing that he should use that as a coaling station. (Renewed laughter.) He had already had extended to him the genuine and fervent hospitality of our distinguished past President, Alexander Graham Bell, who said "Here is my property at Cape Breton, come and own it for yourself." But southward still was his cry, until he reached New York City, having heard that within this bailiwick and enjoying the freedom of the city, which has been extended to him by our Mayor, he could find a place, not far from us, where perhaps exist the steepest bluffs to be found along the Atlantic coast, to which he may now have the reversion, and which in his honor we will name *Mar*coni Island. (Laughter and Applause.) Now, fellow members, had this been an American addressing an English audience, I should have said you were rather slow.

Prof. Elihu Thomson is not only one of our most distinguished Past Presidents, but, you will agree with me, one of the most distinguished electrical engineers this country has ever produced (Applause), and when at our brief bidding he comes as others have come, hundreds of miles to join with us in our greetings and acclamation to the guest of honor this evening, we can all feel deeply pleased and gratified at the earnestness he has shown in joining with us in this celebration. I have now the greatest pleasure in calling upon Prof. Thomson.

PROF. ELIHU THOMSON:--Mr. President, Ladies and Gentlemen: I am sure your toastmaster has done more than justice to myself; in fact, he has so treated me that my modesty almost compels me to sit down and say nothing. Inasmuch as I have made this long journey from the hub of the universe to one of the outlying stations, I surely shall try to do my best on an occasion of this kind.

We are present here this evening to do honor to a gentleman who does us honor in coming here and presenting to us in the simple, straightforward manner in which he has spoken, the results of his great work. I think I can speak for you all in saying that we are intensely gratified that he has been able to do this for us. Our feeling of gratitude is almost beyond our powers of expression. We realize perfectly the many difficulties which he has had to contend with. We know that pioneer work in any field is not by any means easy. It is always hard work. It is not easy to set going these forces and get valuable results. His last achievement reminds me of a school boy companion whom I lost sight of for a very short time. He was one of the smallest fellows in the class. When I next saw him he was about six feet tall. Such was my idea of wireless telegraphy a short time since. It was a small thing but had possibilities of growth. But all of a sudden it jumps to a height that we did not dream possible. In other words, it jumps across the Atlantic ocean. Marconi went quietly to work and laid his plans, and, without saving a word to anybody, got ready to make this supreme test, and when he made it, succeeded in doing what he might be expected to succeed in doing, provided, of course, he had everything at his command conductive to the result--in other words, command of enough electrical energy and a confidence in the working of his apparatus, which comes only from entire familiarity, and as one may say, from living with it.

There was really no need of the trans-Atlantic feat of Signor Marconi to convince us that he was doing a great work, but when we heard of that, we certainly felt that he had done far more than we ever expected he would do in so short a time. I well remember when a few weeks ago the announcement was made in the newspapers. I first heard of it through a reporter's call over the telephone, which was, "What do you think of Marconi?" I replied, "Why, what has he done? I haven't read the papers to-day." "Why, he claims that he has sent messages across the Atlantic." I answered, "If he says he has done that, he probably has done it." (Applause.) Signor Marconi's method of work has been such as to command the admiration of all engineers, and of all scientific men, because it has been scientific from the first, and at the same time he has never lost sight of the commercial aspect of the subject. The whole field of wireless telegraphy is one full of most interesting scientific problems, and were there not the slightest probability of a commercial outcome there would be a grand edifice of scientific work remaining. But, on the other hand, there is indeed the greatest promise of commercial results, and Marconi has even taken you into his confidence to only a certain degree here to-night. I have no doubt he would be able to say a great deal more of what he can promise in times to come if he wished to do so. He is not yet sure of some things that he knows pretty well will come to pass, but he is modest enough to stand back and say "I won't say anything about those now." He has given us in private a few suggestions of what he has been doing, and what he expects to do.

The man who succeeds in this world is one whose ardor is not damped by obstacles, one who makes obstacles stepping stones. In my philosophy of life, I find that there are two classes of people: Some meet an obstacle and say "I cannot get over that"; others say "I must get over that," and, having got over it, they open up a wide field of useful art or something of the kind; they make an advance; their ardor is not damped by obstacles in the way. The successful men are those who, instead of being set back by an obstacle, say "This is a stimulus to do better, to go farther, to progress to a degree which I at first did not think was possible."

The modern age, the age in which we live, is distinguished from the ages preceding by the quickness with which scientific work and discovery, however recondite they may be, however theoretical they may seem at the start, are soon put to practical use whenever they can be used. Instance, for example, the Roentgen ray, which was no sooner known as a scientific discovery than surgeons began using it. We also find that it is being used in the diagnosis of disease, such as tuberculosis of the lungs and in pneumonia. Further than that, these rays have another quality; they are used in actually killing bacteria, curing skin diseases, and even, to a certain extent, cancerous growths upon the skin. All these uses of the Roentgen rays have been discovered and developed within a very short time.

Hertz waves were discovered about fifteen years ago. They were simply a confirmation of the electro-magnetic theory of light as enunciated by Maxwell, oscillations taking place in a discharging circuit, or oscillations produced in any way in a circuit, and a radiation of energy from that circuit taking place in all directions in the form of Hertz waves in the ether. These were found and recognized, at varying distances away, by suitably attuned receivers. And upon this basis it is that Marconi has built. It was long ago pointed out by Henry that condensers, Leyden jars, in discharging produced oscillations. Clerk Maxwell dealt mathematically with the same problem. Hertz however, by experimental investigation proved the reality of these things which had been mathematically treated of before. Wireless telegraphy of to-day is built upon the foundation laid by Hertz.

We have in the electrical gamut all sorts and kinds of oscillations. The Roentgen ray may be said to top the scale with its thousands of millions of millions of oscillations per second. The ordinary luminous rays come further down in the scale; the violet topping the rate in the ordinary spectrum, down to the red, where we find the pitch much lower. Below that we find the invisible heat rays, and further down still the very wide range of pitch covered by the Hertz waves or oscillations, as they are termed, the same in their nature as light waves, but invisible, carrying energy and capable of being produced over a very wide range of what is called frequency. Marconi tells us that he has used a frequency of something like 800,000, or close to a million per second, which is, of course, many millions of times below the rate which would give us anything in the nature of light. In our ordinary alternating currents, however, we have only a very few waves per second. We have, then, the whole gamut from a few per second up to the most extreme possible rate which, perhaps, is capable of being generated by the atonic charges of matter in vibration.

I did not mean to take any great time to dwell upon these matters. It is certainly a surprise to me that the Anglo-American Company should attempt to hold back Marconi's experiments and to claim a monopoly not, as Signor Marconi says, of the earth and the air, but of the ether. What is this ether of which we talk so glibly? We do not know. It is apparently the sub-stratum of everything. It is the thing of all things about which we probably know least, but which we know most certainly exists. It is something which we know must exist in space, but we know very little about its actual properties. And still the whole art of electrical engineering, the whole science of electricity, is built upon the interaction between the ether and ordinary matter, as we call it. In other words, we have in electrical work the science of the ether as affected by ordinary matter--the matter in ether. We cannot get along without matter. We cannot get along without ether. But whether matter itself is a form of ether--some modification which has been brought about in ether--is a question which the science of the future has to answer.

Wireless telegraphy will do away with many things which we have hitherto counted as necessities. We will have no dead cables or wires. The ether is always alive, communication always open. We will never need to think of open circuits in that medium. We will never need to think of a new investment in cables. When a man sends to you, at the end of a telegram wanting you to do something which you probably do not want to do particularly, "Wire answer," it may in the future take the form of "Please answer coherently." (Laughter and applause.)

THE TOASTMASTER.--Surely, ladies and gentlemen, this evening, if never before, the fact has been demonstrated that electricity has no nationality. Ralph Waldo Emerson, when visiting England a great many years ago, being impressed with the energy which he found on every hand in that little island, said that he regarded steam as half an Englishman. As we Americans look around us and contemplate the work which has been done in this country during the last forty or fifty years bearing the illustrious names of Joseph Henry, of Morse, of Alexander Graham Bell, of Brush, of Edison, of Sprague, and many another of our fellow-members, why, we are half inclined to exclaim that electricity is altogether a Yankee. But even as that thought rises in our minds, there loom up the great classic shades of Faraday, the Englishman; Ampère, the Frenchman; Ohm, the German; and Jacobi, the Russian, to say nothing of great Italians--and we come back to the proposition which I have just enunciated, that electricity knows no nationality in its scope and in its achievement, as we have seen demonstrated and illustrated this evening.

And in calling upon the next and closing speaker of the evening, this fact is brought once more forcibly to our attention. It was once said by a great Slav, one of the finest metaphysicians and mathematicians the world has ever known, that, as for his countrymen, they had never been able to invent even a mousetrap that anybody could sell.

It has fallen to the lot of one member of the Slavic race to be most successful in harnessing the great energies and forces of Niagara, and I would like to put it to the great

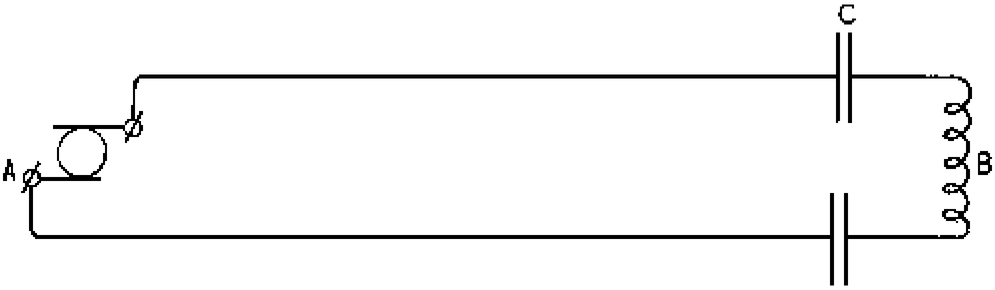


FIG. 1.

telephone company in this country what it thinks of that mouse-trap theorem as applied to Dr. Michael I. Pupin. (Applause.) It is at least a singular and happy coincidence that on my right and on my left--both from the far eastern corner of Europe--are the two men who within the last year have most concentrated the scientific and electrical engineering attention of the world in the work which they have done in facilitating the communication of intelligence. I refer to Marconi and Pupin. (Applause.) Surely, they are assisting in that assimilation and blending of the nations which is now going on at a faster rate than ever before, and which perhaps was unhappily illustrated in a more barbaric fashion in the experience of the Chinese consul before he came to our city, being then stationed in Samoa with one clerk. It happened that a cannibalistic banquet intervened in which two chiefs participated, as the result of which the consul alone left the island. His next post of duty was in New York City, and in establishing his telephonic connection he requested Mr. Bethell to make his number "Two ate one John." (Prolonged laughter.)

Aside from the fact that Dr. Pupin is a distinguished member of the Slavic race, he has another call upon our gratitude, and that is as being a representative here to-night, with his fellow professor, F. B. Crocker, of Columbia University, which upon its high hill in this city stands a bright beacon and center of illumination and culture and civilization and purity in political and social administration. More than that, we are indebted to one of its graduates and one of our fellow-members, who I am sorry not to see here to-night, Dr. Schuyler S. Wheeler, for one of the most munificent donations that a scientific body has ever received in this country from one of its members, in the purchase of the Latimer Clark Library and its gift to this INSTITUTE. (Applause). That gift was immediately seconded by another gift from Mr. Andrew Carnegie, who, finding that somebody else besides himself had the library habit, immediately equalled Dr. Wheeler's gift, so that the library could be carried on and sustained.

And now, gentlemen, with that library, the equal of which does not exist in this world, we are looking around for a building, and when Signor Marconi has signalled across the Pacific ocean, we hope to entertain him in the tallest building the world has ever seen, because, gentlemen, you know that in a library building there is no limit to the number of stories. We have understood that possibly from the wealth which has been accumulated in telephonic circles, and even by our friend, Dr. Pupin, we may eventually hope to attain our fondest ambitions in that direction. I have now the greatest pleasure in introducing to you our distinguished fellow-member, Dr. Pupin.

DR. MICHAEL I. PUPIN:--Members of the INSTITUTE and guests. A few days ago our Committee on Papers was so kind as to invite me to be present here this evening as a guest and to make a few remarks on a subject with which the work of our distinguished guest of honor, Signor Marconi, has been identified. I have followed Signor Marconi's work with much respectful attention during the last six years. His experiments aroused my scientific interest and curiosity; his struggles excited my sympathy, and his success was always a source of the greatest gratification to me, as it is to all of you who are delighted in seeing true merit rewarded. (Applause.)

I shall, therefore, be very happy indeed if, by the few remarks which I have to offer this evening, I may in any way contribute to a clear understanding of the aims of our distinguished guest and of the means by which he hopes to accomplish his task.

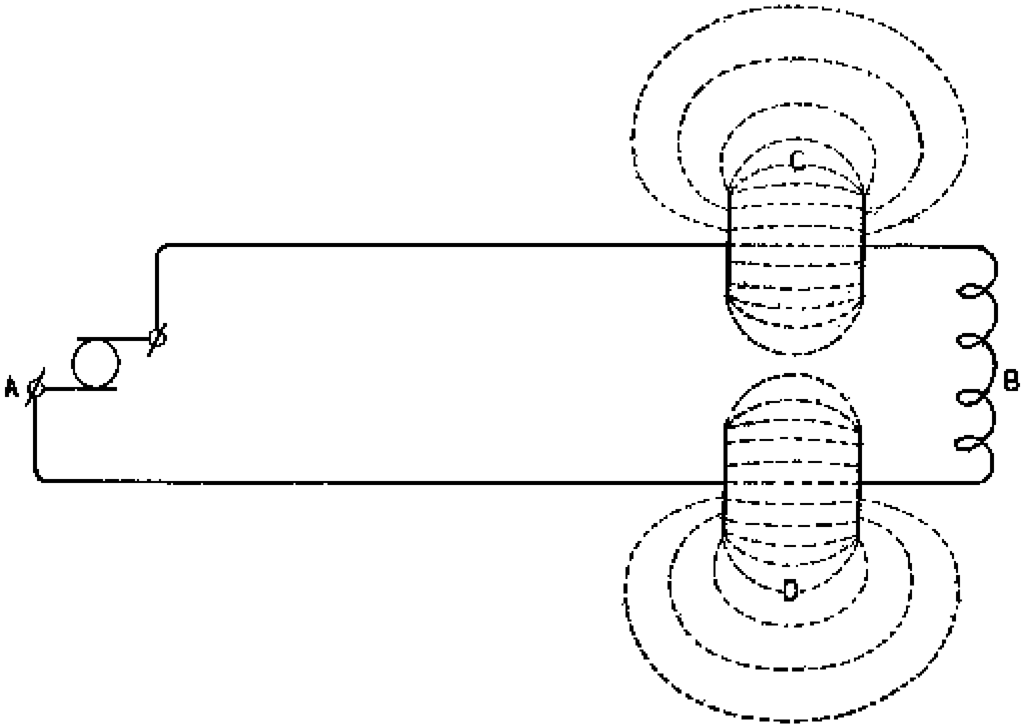
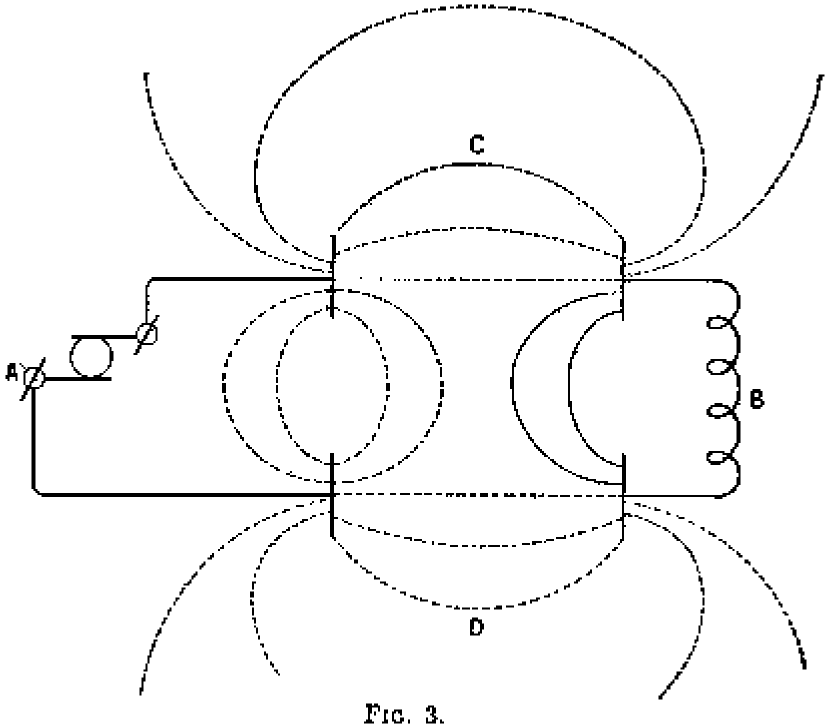



FIG. 2.

One cannot very well discuss any topic connected with Signor Marconi's work without plunging headlong into the bottomless sea of electrical waves, and then he has to struggle hard to keep his head above the etheral fluid. He has, indeed, to be a very expert swimmer. He must be a physicist of ingenuity and rare skill; he must be a mathematician of exceptional training, and above all, he must be an engineer of sound judgment.

Now, I must say that I cannot lay a just claim to any one of these most exceptional qualities. You can see, therefore, that my position this evening is rather a difficult one. It is true that I do teach future electrical engineers in electro-mechanics, a subject which implies a fair knowledge of physics, electrical engineering and mathematics. I say, a fair knowledge only, and I mean that the amount of knowledge required is really a great deal less than people suppose. It would not be a wise policy for me to say this within hearing distance of our University, of course, because a professor's salary, small as it is, often depends on how easily he and his subject can be replaced (Laughter); but here in this distinguished assemblage, where I see the faces of some of the most distinguished engineers in the country, I must be frank if I am to expect leniency. It is true, also, that electro-mechanics has a great deal to do with electrical waves. Perhaps on that account I happened to take a particular interest in this field of work.

Now this subject of electrical waves has three sides: the purely mathematical side; the physical side; and, finally, the engineering side. It is on that account, perhaps, that those men who engage in the research of this particular subject are more or less pioneers because the subject belongs to three different departments of general physics, without belonging to any one in particular. It is in the borderland, and that offers some advantages. If one working in the field of electrical waves happened to find something which after much argument his intimate friends admit to possess some novelty, then he goes to the American Mathematical Society and reads a paper on the mathematical side of his investigation; they say "Why, for a physicist he is a pretty good mathematician." Then he goes to the American Physical Society and gives an account of the physical side of his work, and they will generously admit that for an electrical engineer he is a pretty good physicist. Finally, he goes to the AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS and gives them an account of the engineering side of his work and they will tell him that for a pure mathematician his engineering judgment is not at all bad. (Laughter.) In that way one gets on. It reminds me of a story which I heard Sir Robert Ball, the English astronomer, relate the other day in a lecture. He said that many years ago there was a famous professor at the University of Cambridge. He was famous, not because the people at Cambridge thought he was, but because the people of Continental Europe made him



Fɪɢ. 3.

famous, and it happened in this way. He was a professor of astronomy and of geology. Whenever he called on his distinguished friends on the Continent he took with him two sets of visiting cards. On one set he was Professor of Geology and on the other set he was Professor of Astronomy. Whenever he called on a geologist he sent up the card on which his title was Professor of Astronomy and when he called on an astronomer he sent up his card with the title of Professor of Geology. In that way he became very famous as a man of broad learning. So it is with a man who works in electrical waves. He gains some fame, and he does not himself know how. As I said, because the subject of electrical waves is on the borderland, every man who works on the borderland is a pioneer, and the world, of course, admires the pioneer. It is, perhaps, on that account, also, that there is no particular class of men making the study of electrical waves a particular work of their own; that the subject of electrical waves is perhaps less understood than any other study in physics and electrical engineering. You have heard people say that Mr. Marconi's system is nothing more or less than Hertz's system; that there are Hertzian waves, and that they are transmitted through the ether. Another man will say that they are transmitted through the earth. Another will say they are transmitted through the water. One man said to me the other day, "Why, anybody can do what Marconi did. One end of the Anglo-American cable was near Cornwall, and the other near Newfoundland, and Marconi sent his signal through the cable, and it is no wonder that the Anglo-American Company is kicking. He is using the cable for transmitting his signals. He is going to Cape Cod next. Another cable lands near there. He always goes wherever there is a cable terminal." (Laughter.)

Anybody who understands anything about the theory of electrical waves knows that to transmit oscillations of this enormous frequency through a cable would be a much more wonderful achievement than to transmit them through the ether. Now, I shall devote a few minutes, only, to some explanations--you see, teaching is my business and I must always explain, so if I am somewhat didactic you will understand that it has become a habit of mine; I cannot help it. I shall explain the difference, in as few words as I can, between the Hertzian waves, the telephonic or the Bell waves, and the Marconi waves. Several years ago I read an article written by that most distinguished mathematician, Oliver Heaviside. It was a criticism of another article written by another most distinguished physicist--the late Prof. Von Helmholtz, of the University of Berlin--and it dealt with the subject of the electromagnetic theory of light. Heaviside found fault with it, saying that it did not satisfy the conditions of a telegraphic circuit. Now, many of you will say: What in the name of common sense has a telegraphic circuit to do with the electro-magnetic theory of light? That is exactly what I said at that time. I did not understand it. Very often we do not understand Heaviside for the time being, but in about ten years or so his meaning suddenly dawns upon us. So one day last summer when it rained all day long, and it was impossible to go out and play golf or call upon one's idle friends, I was forced to stay home

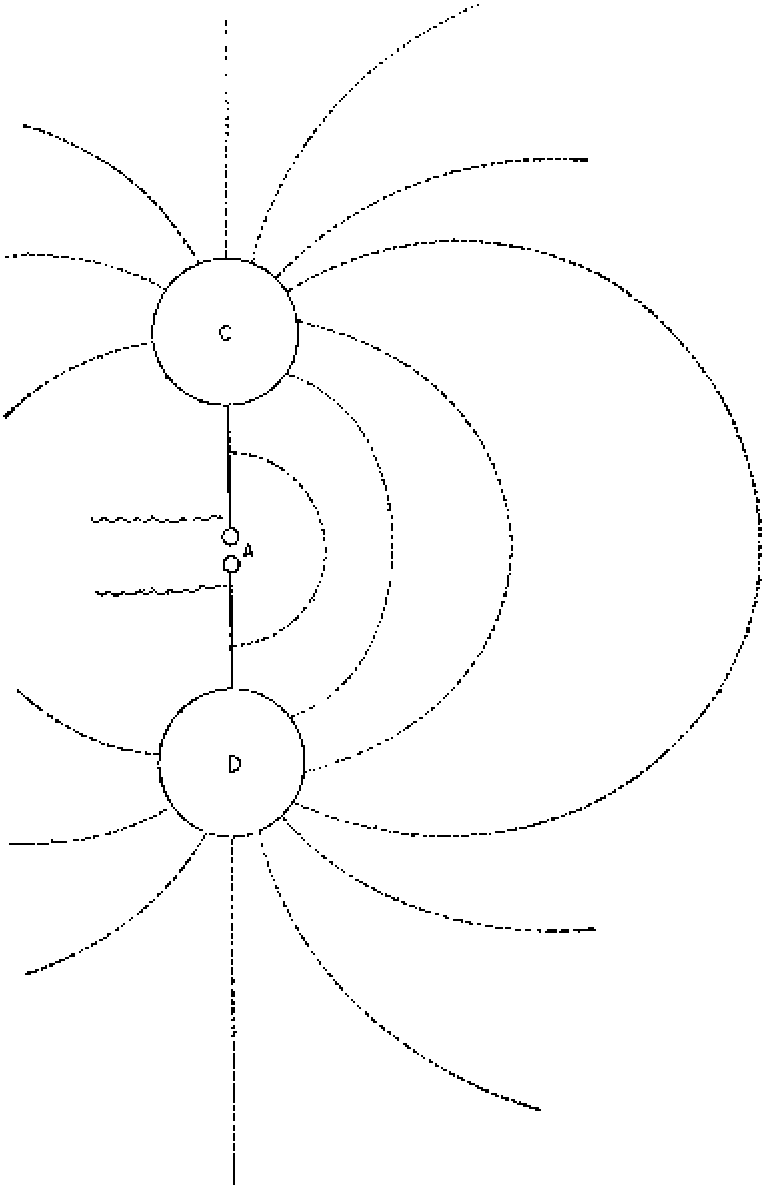


FIG. 4.

and pass my time in idle speculation; and, naturally enough, I speculated about electrical waves. It happened that a short time before that I spent a very pleasant evening with Signor Marconi under this very roof, and our conversation somehow or other drifted in the direction of electrical waves; some bits of this conversation still stuck in my brain, and the principal subject of my speculation on that day was concerning the conversation I had with our distinguished guest. I said to myself, now, here are Hertzian waves and Marconi waves and Prof. Bell's waves, and all other kinds of waves. What is the use of calling these waves by so many different names? I am perfectly sure, I said to myself, that Prof. Hertz, if he were alive would not care to hear people call any particular set of waves by his name, nor am I aware that Signor Marconi is anxious to label another set of waves as Marconi waves, nor that Prof. Bell claims all telephonic waves, nor that every telegraph or power transmission station working with alternating currents would care to label every one of its waves. It would not be just and it would not be practicable. I said to myself, there are no different breeds of waves; they are all one and the same thing. Well, said I to myself, if they are all one and the same thing, is there possibly any convenient method of classifying them? Well, there is. The difference between waves consists in the manner, in the combination of an apparatus, by which you produce them, and the purpose for which you wish to employ them.

Now, I said a little while ago, that the subject of electrical waves has a mathematical, a physical and an engineering side. Speaking from a purely mathematical and physical standpoint, there is no difference between electrical waves, absolutely none. But speaking from an engineering point of view, there is every difference between them. How absurd it is, then, to hear every now and then people say, "Why, years ago I stuck a wire here and I stuck a wire there and I actually transmitted signals across my back yard, using an open circuit; my work is just as good as Marconi's; there is no difference between us." Why, you might just as well say that there is no difference between the Brooklyn Bridge and the bridge which Julius Cæsar describes in his book "De Bello Gallico." There is every difference, the difference consisting chiefly in the construction of the apparatus which you employ. I also heard a man say, "Years ago I thought of transmitting wireless signals by the wobbling of the charge of the earth." Well, any one of us can think of schemes like that; any one of us who has had any experience in inventing can think of schemes like that as fast as you can write them down, for anybody knows you can transmit electrical waves to any distance, that is, mathematically and physically perhaps. But how about the engineering side of it? I said to this man, "Give me an engineering specification of your apparatus by means of which you intend to wobble the charge of the earth, and then I will believe you; not before."

Now this is what Signor Marconi has done: He has written out a specification for setting up apparatus and wobbling the charge of the earth and transmitting the signals between wires. (Applause). We have here, then, the idea and the engineering fact. The idea is all right as far as it goes, but without the engineering specification it amounts to nothing as far as the possibility of obtaining desirable results is concerned.

Well, now, what are the Marconi waves and the Marconi apparatus? In fact, I will take the first question back. I ask what is the Marconi apparatus, because if you know what the telephone waves are and the telegraph waves and the Hertzian waves, you know what the Marconi waves are. They are exactly the same thing. What we want to know is, what is the Marconi apparatus, and does it differ or does it not differ, from other apparatus, employed before, for the production of electrical waves? Now, on that rainy summer day when I sat speculating, I came to this conclusion: All apparatus for the production of electrical waves, and the reception of electrical waves by the law of evolution or the law of continuity, may be deduced from two sets of telegraphic circuits. That is what Heaviside meant when he said that Helmholtz's theory did not satisfy the conditions of a telegraph circuit.

I shall now show you how we may take a telegraph circuit and by a continuous change evolve from it the Hertzian apparatus for the production of electrical waves. I do not think that any subject dealing with engineering can be properly presented unless you have either a blackboard or a few diagrams, and so I venture to offer you a real novelty, an after-dinner speech illustrated by diagrams. If, in spite of this effort on my part, you fail to understand my jokes, it will not be my fault. Here is diagram Fig. 1:

This may be called a typical telegraph circuit. A is the sending generator and B is the receiving apparatus; for a specific reason I have introduced two condensers, C and D. If the circuit is long, say a mile and the condensers are large, we can use a transmitting generator of low frequency. In the next place, let us increase the frequency by giving the generator a higher speed. Now we may diminish the size of our condensers. The size of the condensers may be diminished by putting the plates further apart as shown in Fig. 2. Here I want to call your attention to the fact that the electro-static lines of force begin to bulge out. In the first case shown in Fig. 1, the lines of electro-static force were practically all straight from plate to plate, because there was no stray external field. But in the second case there is, that is to say, the condenser begins to be more sympathetic and to communicate with the rest of the world, throwing out its feelers in the shape of electro-static lines of force. Now, increase the frequency of the alternator still further and, of course, as everybody knows, we may still further diminish the capacity of our condensers, which we do by separating the plates C and D and placing them at a considerably longer distance apart, as shown in Fig. 3. The fact to which I wish to call your particular attention is that the electro-static field of force is bulging out still more; it throws out its feelers more and more and can affect bodies on the outside. We say that the condensers and therefore the total arrangement begins to have more and more radiating power. Radiation is simply the capacity of a system to communicate energy to other bodies outside of the system. You see, then, that as the frequency increases, the condenser plates may be taken further apart and the system begins to have larger and larger capacity for radiating power, and to

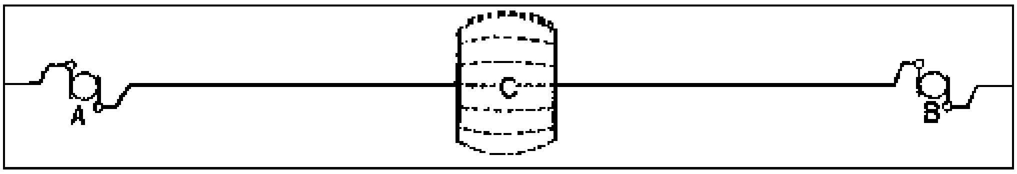



FIG. 6.

affect bodies outside of the electrical circuit under consideration.

Suppose, now, that we want to work at a still higher frequency, having in the last case reached a frequency of ten thousand periods per second. From this point on, sound engineering judgment tells us--and, mind you, I said that in dealing with electrical waves in their practical applications you have to be not only a mathematician and a physicist, but you must be also an engineer, that is to say, you must have sound practical judgment--from that point on, sound engineering judgment tells us: You have reached the limit of speed of the machine. The periphical speed is 6,000 feet per minute. Stop. You must use, now, something else. Our knowledge of physics tells us to use an artifice which Joseph Henry employed in 1842 and Feddersen again in 1858, and finally Hertz in 1887, with the brilliant success of which you all know. We use a spark gap. The condensers are now replaced by two balls, C and D, as indicated in Fig. 4. In place of the generator is the spark gap A. This is all that is left of our circuit. The receiving end of our circuit may be put anywhere. After every spark discharge at A. we have rapid oscillations of any frequency that we choose to select It is just like striking a bell; after each stroke we have a sonorous sounding of the bell. The bell becomes silent again after it has sent forth into all directions the energy communicated to it by the stroke. Observe here, now, the radiation of the lines of electric force Here is a perfect type of a sympathetic circuit--a circuit which throws its feelers of electric force in every direction, ready to communicate energy to any other circuit or body at its own expense. This is a circuit of large radiating power. But for that very reason it gives off its energy at a rapid rate; it is not sonorous, but so lavish in its radiating power as to be almost aperiodic. It does not continue to vibrate, but during its very first vibration its entire energy is thrown upon the outside world.

Now this is the Hertzian oscillator. You can transmit wireless messages with that. But how far? If you transmit them a mile you are a fine manipulator. A gentleman told me the other day "At our University one of our young men years ago transmitted wireless messages over a mile, the same as Mr. Marconi." I said. "That is very nice for the young man, but how did he do it?" "He used a Hertzian oscillator," he replied. I said "That is a very different story. If he has transmitted a mile he has probably done a very good thing; but he could not do it any farther than that to-day, even if he had kept on trying from that day to this, whereas Mr. Marconi gets easily over a hundred miles." You see, this was an educated man and he understood the subject fairly well; nevertheless, he actually believed that his young man had done the same thing that Mr. Marconi is doing to-day, only his young man was too modest to announce his great feat to the world, and too unselfish to form a stock company.

This, then, is the apparatus, by means of which Hertz produced electrical waves. There was nothing very novel in that apparatus at the time when Hertz first employed it, and Hertz never claimed that there was anything novel in it, and if he had, there is no doubt that Prof. Lodge for one would have called him to order.

What, then, did he claim? All these oscillations can be and were predicted by Prof. Thomson, now Lord Kelvin, on the basis of the old theory, a theory of a hundred years ago, the theory which was completely worked out in the days of Ampère and Faraday. But there was one thing that could not be predicted by the old theory, and that is, that if you proceed from the oscillator in a certain direction you will get to a point where you get no induction, and then to a point where there is strong induction, and then again to another

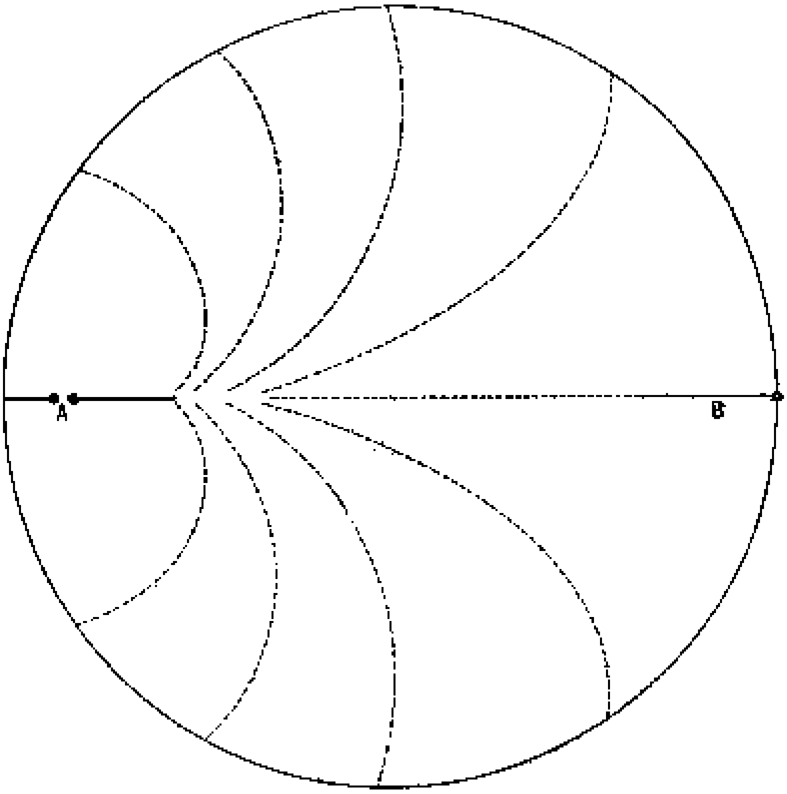
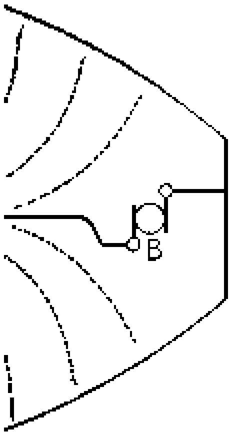


Fig. 8.




point where there is no induction, and thus he proved the existence of electrical waves in the ether. Hertz proved that electrical energy traveled from the oscillator with a finite velocity equal to the

s nor the waves. He claimed nothing except
nergy radiated from this apparatus with the
f he were living to-day he would object that
es They are simply electrical waves.
that from a mathematical and physical point
ny distance, but he will also tell you that
practically you cannot transmit them over more than a mile, if you employ the arrangement which Hertz employed.

This Hertzian arrangement was entirely different from the system known as the Marconi arrangement, and to prove it I shall now perform another transformation trick. I shall now evolve the Marconi system from the telegraph circuit of the second type. I told you that all apparatus for generating electric waves may be evolved from one of two types of telegraph circuit. The first type that I have just shown you is the land circuit; the second is the submarine type, the so-called cable. For this purpose I have borrowed a cable, not from the Anglo-American Company, but from the Commercial Cable Company. Here in Fig. 5 is a diagram of what may be called the second type of telegraph circuit, that is, a cable. Say this end at A is the transmitting apparatus at Cornwall, and this end at B is the receiving apparatus in Newfoundland. The line in the middle connecting A to B is the conducting core of the cable or the copper conductor. The terminal squares are the stations, and the tubular arrangement between them is the sheathing which protects the copper conductor. I have also put a condenser, C, in the middle. (Laughter.) I understand that is not the usual practice, but still it could be done. I violate no scientific principle in doing that, and I have introduced it for a definite purpose, which will be apparent presently. Now, to transmit signals over this cable we all know, and Mr. Marconi will not contradict us, that we have to transmit very slowly on account of certain limitations. Therefore, our alternator at A has to work at very low speed. Suppose, now, that we wanted to increase the speed of the transmitting alternator, thereby increasing the frequency of the alternating current which we employ, we would have to increase the cross-section of this sheathing so as to diminish the capacity; and we can also then diminish the capacity of the condenser C, without any loss or inconvenience, because the higher the frequency the smaller can be the capacity of condenser C.

Now, the second cable (Fig. 6), is a cable which has a higher speed. It is a cable of a larger cross-section of sheathing. I do not pretend that this is a practicable cable, but for the sake of the scientific demonstration it will do. The point to which I wish to call your attention is that, as the size of this condenser C is diminished, the lines of electro-static force, indicated by the dotted lines between the plates, begin to bulge out as if they were anxious to communicate their energy to the surrounding bodies.

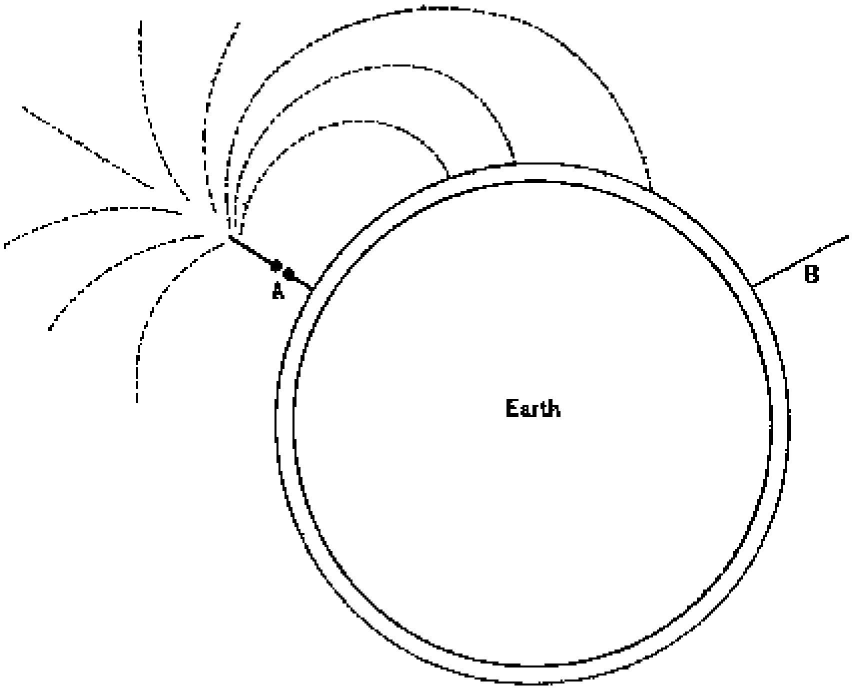



Fig. 9.

transmitting apparatus, we would then
 again, and we can then still further
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bodies or to the ether.
uency. But suppose we wanted to use
se the sheathing very much, using the
airs shown in Fig. 8. Mind you, the
afford to have it as thin as we please
tted through a very thin layer near the
n or a thick conductor does not make any difference. The original sheathing will suffice to enclose as much space as we please.

There is nothing to prevent us from making this sphere as large as the earth.

Here is a system of wireless telegraphy that would be even better than Marconi's system. It would communicate most of its energy here from the transmitting apparatus A to the receiving apparatus at B. You see, the condenser and cable core have almost entirely disappeared; the capacity of the condenser C is replaced by the capacity between the terminal wires at A and B and the surrounding sheathing. But of course an arrangement like that, as big as the earth, would not do. So, although the scheme is a very nice one, mathematically, mind you, and physically, it would not do from a purely engineering point of view. But it serves a very good purpose. It enables a mathematician to calculate in an exact and complete manner how the waves proceeding from A are going to be transmitted to B. You get a most beautiful result. It is a pity that the arrangement is not satisfactory from an engineering point of view.

But I said that a man dealing with electrical waves has to be not only a mathematician and engineer, but also a physicist. Now a physicist would say this: Why not make a cut here along a meridian of the spherical shell and then turn it inside out, and drop the earth into it. Then we would get this arrangement in Fig. 9. Here is now the sheathing all around the earth. Here is one wire at A, here is the other at B, and that is the Marconi system. (Applause.) It is more than that, because if he had this thin conductor all over the earth it would stop business and interfere with people. This thin conducting covering is a relic of barbarism, Sig. Marconi will undoubtedly say, reminding people of the cable from which we have just evolved his system. The physicist will tell you that it is unnecessary; the earth is a conductor, and therefore there is no necessity for the conducting sheathing; cut it out; run your transmitting wire, A, right into the earth and also the receiving wire, and you have the Marconi system. Here, then, in a didactic way, is, a complete representation of the Marconi system, and we have evolved it by gradual steps from the second type of the telegraph circuit. The Marconi system, therefore, satisfies Heaviside's condition, namely, that every electrical arrangement should satisfy the conditions of a telegraph circuit. The Marconi system must satisfy it because it has been evolved from it by gradual steps by the law of continuity. In fact, the form of transmission is the same as in the case of a telephone conductor, by conduction currents along the surface of the great conductor, which connects the transmitting wire to the receiving wire.

Now, it follows also that the Marconi system of wireless telegraphy, looked at from this view-point, is just as definite a problem, mathematically and physically, as the cable problem was in 1854, when Sir William Thomson, now Lord Kelvin, took it up, to calculate what can be done with it. I think that this system may be worked out mathematically with just as great accuracy as Lord Kelvin worked out the cable problem nearly 50 years ago. I am perfectly sure we can tell with close approximation what can be done with this system from a purely mathematical and physical point of view. What can be done with it, from a purely engineering and commercial point of view, is another question. The first objection which people will raise will be this: Here you have a common conductor. Anybody can stick a transmitting wire there and a receiving wire here and interfere with you. If you could put signs all over the earth and tell people to keep off the earth, then it would be all right, but you cannot do that. We are not all like the Anglo-American Company, claiming the earth and the sea and the ether. We have to let other people enjoy some rights and privileges. Now Sig. Marconi tells us that by the system of electric resonance and syntony he can overcome this difficulty. If he says so, I am inclined to believe him, if for no other reason. But in scientific work we never believe anything until we see a demonstration of it. I believe that Sig. Marconi has transmitted the famous three dots across the Atlantic, but I must say that I believe him because I know him personally. If I did not know him personally, I would not believe him, because the proof which Signor Marconi has furnished is not sufficiently strong from a purely scientific point of view; but knowing him personally as I do, I believe his statement. Well, what of it? Suppose he has transmitted trans-Atlantic signals. Suppose that the wireless system of telegraphy enables us to transmit signals across the Atlantic in a satisfactory way, what of it? Is that going to affect the condition of the present cable companies? It may at first, perhaps, if the Marconi system proves to be just as good a system and even a better one than the present cable systems. But it will affect them in the same way that electric lighting affected the gas companies. Gas stock went down at first. To-day it is way up. How did the telephone affect telegraphy? Why, telegraphy stands higher to-day than it did in 1876. Do you suppose the perfection of bicycles and automobiles has affected the price of horses? Why, last spring the prices of horses were higher than at any other time in the history of this country. I myself sold a horse last spring to a dealer for more than I paid for it several years ago. (Laughter.) So that I, for my part, if I had a lot of stock in a cable company, which unfortunately I have not, I would stick to it. I think that every success that Marconi may accomplish will help the cable business, instead of doing the contrary. I think that whatever may happen, whether Signor Marconi succeeds in giving us a better system of transmitting intelligence across the Atlantic or not, of one thing we may be certain, and that is, that we must judge him to-night by what he has done. He has done great things. He has supplied us with a method of communicating between moving ships between ships and lighthouses and between places between which there was no communication before. That is a grand thing, and if Signor Marconi does not accomplish another thing, he has done enough for any man to be satisfied with. But I think it will be a grand thing if he should succeed in perfecting a system of transmitting intelligence across the Atlantic and the Pacific with the same exactness, facility and promptitude with which the present cable companies transmit messages. It would be a great thing because we would then have a competitor, and there is nothing so powerful in stimulating progress as competition. The trouble with the cable companies, if there is any, is that they have had no serious competitor. There was no progress in a certain sense, but

I should rather say that there was progress, only I think there might have been a great deal more progress, if there had been more competition; if two or three or four different systems had been competing against each other. Let Sig. Marconi perfect his trans-Atlantic system. I wish him success from the bottom of my heart, because I am sure that if he does succeed there will be a cable transmission system in less than ten years that will astonish the world. I am sure, therefore, that every one of us, the cable engineers included, wish Signor Marconi a signal success. (Applause.)

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At the conclusion of Dr. Pupin's remarks the toastmaster invited the guests and members to remain for a few moments after the banquet, if they desired, so they might have the opportunity of being presented to Signor Marconi. The privilege was generally accepted and the guest of the evening was the recipient of hearty congratulations from the members present.

Scientific American, June 4, 1921, page 449:

*A New Era In Wireless.*

What Is Being Done With the Radio Telephone By Way of Broadcasting News, Music and *Sermons*

By L. H. Rosenberg

For years commercial stations have been using the wireless telegraph successfully and amateurs, experimenting with the art, have spent hour after hour on this interesting subject. The mystery of the dots and dashes received from the ether after having traveled hundreds of miles, has interested thousands, and many boys and even grown men have painstakingly spent hours in order to master the wonders of radio and to learn perfectly how to send and receive code messages.

But now there is a new era, and we have radio in a new rôle. No longer is this fascinating subject confined to the expert, for today all may enjoy its many benefits. Radio telephony has developed to such an extent that one does not need to be an expert to receive the messages of the air.

From many plants all over the United States music and actual talking can be picked up as broadcast from efficient broadcasting radio telephone stations. One of the most successful of these stations is the experimental broadcasting station of the Westinghouse Electric and Manufacturing Company at East Pittsburgh, Pa. Concerts are given nightly from this station and they are heard over an area of three million square miles. In this territory there are hundreds of thousands of persons who hear these concerts. The programs for the evenings usually consist, in the main, of phonograph music and national and international news. The great success of this scheme which is attracting wide attention, is the care taken in the selection of the program. For instance, a careful study has been made of phonograph music. Records which sound exceedingly well when played on the ordinary talking machine may be entirely unsuited for this character of music. The best records are tenor and contralto solos and it has been found that instrumental music such as the xylophone, saxophone, the accordion and the cornet are very clear. The program for each night is carefully considered and a selection is made of instrumental and vocal, classical and popular.

Not only is phonograph music transmitted from this station, but the sending out of a complete church service is the feature of each Sunday night. In the church and pulpit of the Calvary Episcopal Church of Pittsburgh are installed several transmitters. These transmitters are connected to a private telephone line which runs to the radio station seven miles from the church. When the choir sings, or the rector preaches, these transmitters respond to the sound waves and the music or sermon, as it may be, is transmitted to East Pittsburgh via the telephone line. There it is broadcast by means of the radio apparatus, thus allowing thousands of people to hear the service in their own homes. Think what this means to many people: the invalid, unable to go to church can enjoy its benefits without leaving his bed or wheel chair; the farmer, too far from town to go to church has the service brought to him; and the sick in the hospital are encouraged to get well by the wonderful words of the preacher. It is marvelous, this transmitting of church services by radio. One can almost imagine being in church. The blending music of the sixty men and boys lifted in song and the ring of the deep-set voice of the preacher all make the service seem realistic.

So many of the innovations with radio have proved successful that the possibilities of the radio broadcasting plan seem unlimited. When Herbert Hoover visited Pittsburgh to tell his story about the starving children in Europe, arrangements were made for sending this appeal broadcast by radio. A special speech was not necessary. Immediately in front of Mr. Hoover at the dinner, held at the Duquesne Club, was a transmitter. It was arranged in such a manner that it was unseen by both Mr. Hoover and the audience but this did not prevent it from working perfectly. Instead of making his plea to one or two hundred men gathered at dinner, Mr. Hoover was able to reach thousands of people who stayed at home listening to their wireless receiving sets.

A short time ago Prof. Vladmir Karapetoff, professor of Electrical Engineering at Cornell University, who is also a noted musician, gave a lecture piano recital at the Westinghouse Club. Although this event was held in a large hall, the attendance was limited. Here was wonderful music and a discussion of the great composers, which were limited to hundreds--that is it would have been limited to hundreds if it had not been for the wonder of radio broadcasting.

Besides the transmission of the concert music, the church service, the speech of prominent men, broadcasting of a more material nature is forthcoming. The farmer can receive the crop report at the present time; this is sent from Washington, D. C., and the tired business man can get the high points of the latest news. When he gets his morning paper, if he lives in the city he reads more about the happenings given in brief the previous night by radio.

And let us predict further. When the radio broadcasting has reached a higher stage of development and is more fully utilized, the benefits will be enormous. It will be like a three-ring circus. If you look in one direction, you see clowns performing antics, or you may see acrobats, chariot races and what-not.

Soon in radio you will be able to get popular music if you desire, or classical music, or church service, or speeches, or crop reports or news. These will all be sent out at the same time and it will merely be a question of "looking in the proper direction" for the reception of your choice. This will be accomplished by transmitting in what is known as "wave lengths."

One wave length will convey one kind of entertainment, and another wave length will convey another kind. By a simple adjustment of the receiving apparatus, any wave length reception may be selected.

The apparatus necessary to receive this radio broadcasting is exceedingly simple and can be purchased from a few dollars up, depending on the quality of reception desired and the distance from the broadcasting station.

The original idea of the necessity of the telephone headset has been bettered and now by the addition of a loud-speaking horn to a good set of apparatus, many can hear the broadcasting from the same outfit.

Although much has been done with respect to these radio telephone experiments, in a few years we will wonder that we were ever able to exist without enjoying its many benefits.

<u>BROADCAST TO THE CHICAGO TRIBUNE FORUM</u>

<u>11th March, 1937 - G.M.T. 10.00-10.10 p.m.</u>

*By Guglielmo Marconi*

THE SIGNIFICANCE OF MODERN COMMUNICATION

In addressing so imposing a gathering as “THE FORUM” held by the Chicago Tribune at Chicago, the vision comes back before my mind’s eye of the crowds with whom I came in touch in October 1933, when my wife and I were privileged to visit the World Fair as its highly honoured guests. “Hectic days” those were indeed; but how pleasing it is to remember them now, and how gladly would I live them again! I remember distinctly how the strong norwesterly breeze sweeping over the vast expanse of Lake “Mich” braced us all for the exertion ahead of us, and how delightful it was to enjoy the rolling and pitching of Capt. Macdonald’s “MIZPAH” after the sultry air of New York, enveloped in a belated heat-wave. That sudden climatic change gave me, in a way, the explanation of the astounding development reached in a few decades by your great City. I was at once impressed by the driving power and the spirit of enetrprise of its inhabitants, and it is under this impression, still vivid in my eyes, that I address you from Rome today, at a distance of some 4000 miles, as the crow flies. Let me, first of all, convey my thanks to the “Chicago Tribune” for doing me the honour of inviting me to take part in your gathering, and giving me another opportunity of coming into touch over the air with the American people, among whom I have many of my dearest and most esteemed friends, and whose contact is always a source of genuine joy to me.

Needless to say, I am rather satisfied at the idea that if, inspite of the great distance bodily separating us, you hear my voice as clearly and distinctly as you <u>should</u> hear it, I am personally responsible, to a certain extent, for this rather remarkable feat. Those of you who were present at the Chicago World Fair on October second, 1933, the so-called

"Marconi-day", might remember that one of the features of that day was my sending round the world by radio the three dots making up the letter "S" of the Morse alphabet.

This feature was to commemorate the first spanning of the Atlantic Ocean by Radio which occurred on December 12th, 1901, when in a hap-hazard receiving station rigged up by myself at St. John, Newfoundland, I was able to receive in succession three clicks corresponding to the three dots of the letter "S", launched by a Morse key into space at Poldhu in Cornwall, on the other side of the Atlantic.

In October 1933, the signal travelled from Chicago, in relays, to New York, London, Rome, Warsaw, Shanghai, Manila, Honolulu, San Francisco and again to Chicago, in exactly three minutes and five seconds, out of which fully two minutes were lost in expectation of further signals.

To our up-to-date mind, this may appear a matter-of-course event; but its significance is none the smaller for that. Now, as you know, it is possible to cause a signal to go round the world without relays and the time taken for this somewhat lengthy trip is only the seventh part of a second.

We have now reached a stage in the science and art of radio communications, when the expression of our thoughts can almost instantaneously and simultaneously be transmitted to and received by our fellowmen practically in every spot of the globe where a simple receiving apparatus is available. Yet, it is less than a score of years ago that the first indication was given to the public of the possibilities of broadcasting as it might affect their everyday lives. When in June 1920 a concert by Nellie Melba was broadcast from Chelmsford, England, only a few hundred wireless amateurs, the only people, at that time, who possessed wireless receiving apparatus - with the exception, of course, of wireless professionals - could listen in. To the general body of people, that broadcast probably meant nothing more that an incident, which did not appear to have very much significance so far as they themselves were concerned. May I ask how many of us would not consider today a receiving set a necessary implement in our daily life? If this stage has been reached in barely a score of years, may I again ask what are we not to expect for the future?

Broadcasting, however, with all the importance it has attained, and the wide, unexplored fields still lying open to it, is not - in my opinion - the most significant part of modern communications, in so far as it is a “one way” communication. A far greater importance attaches, in my opinion, to the possibility afforded by radio of exchanging communications wherever the correspondents may be situated: whether in mid-ocean, or on the ice pack of the pole, or in the waste of a desert, or above the clouds in a airplane! It is only through radio, in fact, that we are capable - so far - of talking to each other, with our own voice, across the oceans as well as between the antipodes. The crowning reward of my work and effort lies exactly in this bare statement. More than by any praise for the lives rescued through radio, and the marvels of television, my heart is touched by the simple letters of appreciation and gratitude which I often receive from people who have been talking to each other, say from Australia to New York, or from Brasil to Japan!

The peculiarity of man, the characteristic marking his difference from, and superiority to, other living beings, apart from the divinity of his origin and of his ultimate goal, lies, I think, in his capacity of exchanging in detail with his fellow creatures his thoughts, his feelings, his yearnings, his ideals, his troubles, and, alas, also his complaints! Everything designed to facilitate and extend the development of this really superior capacity is to be hailed - I venture to submit - as the very medium for real human progress, the way of enhancing the typical peculiarity of man. With all our friction, jealousy and antagonism, (the inevitable chronic ailment of mankind), and inspite of the bloody eruptions which from time to time rend it asunder, the ideal of peace and fraternity remains unabated in us: we all yearn for a better life, based on a better understanding of one another on that every nation should have its chance. In radio we have a fitting tool for bringing the people of the world together, for letting their voices be heard, their needs and aspirations be manifested. The significance of this modern means of communication is thus fully revealed: a wide channel for the improvement of our mutual relations is available to us; we have only to follow its course in a spirit of tolerance and sympathy, solicitous of exploiting the achievements of science and human ingenuity for the common well. I am firmly convinced of the possibility of realising this ideal, and in this belief I take leave of you today, wishing you all, who are convened in Chicago, and to all other listeners in America and elsewhere, the best of luck.