Marconi and the Wireless Telegraph

by Rupert Holland

At first sight the wireless telegraph seems the most wonderful of all inventions and discoveries, the one that is least easy to understand, and that most nearly approaches that magic which is above all nature's laws. Even if we do come to understand it it loses nothing of its wonder, and the last impression is very like the first. We can understand how an electric current travels through a wire, even if we cannot understand electricity, but how that current can travel through limitless space and yet reach its destination strains the imagination. Yet wireless telegraphy is not a matter of the imagination, but of exact, demonstrable science.

On December 12, 1901, a quiet, dark-skinned young man sat, about noontime, in a room of the old barracks building on Signal Hill, near St. John's, Newfoundland. On the table in front of him was a mechanical apparatus, with an ordinary telephone receiver at its side. The window was partly open, and a wire led from the machine on the table through the window to a gigantic kite that a high wind kept flying fully 400 feet above the room. The young man picked up the receiver, and held it to his ear for a long time. His face showed no sign of excitement, though an assistant, standing near him, could barely keep still. Then, suddenly, came the sharp click of the "tapper" as it struck the "coherer." That meant that something was coming. The young man listened a few minutes, and then handed the receiver to his assistant. "See if you can hear anything, Mr. Kemp," said he. The other man took the receiver, and a moment later his ear caught the sound of three little clicks, faint, but distinct and unmistakable, the three dots of the letter S in the Morse Code. Those clicks had been sent from Poldhu, on the Cornish coast of England, and they had traveled through air across the Atlantic Ocean without any wire to guide them. That was one of the great moments of history. The young man at the table was Guglielmo Marconi, an Italian.

We know that it is no injustice to a great inventor to say that other men had imagined what he achieved, and had earlier tried to prove their theories. It takes nothing from the glory of that other great Italian, Columbus, to recall that other sailors had planned to cross the sea to the west of Europe and that some had tried it. So James Clerk-Maxwell had proved by mathematics the electro-magnetic theory of light in 1864, and Heinrich Hertz had demonstrated in 1888 by actual experiment that electric waves exist in the free ether, and Edison had for a time worked on the problem of a wireless telegraph. Marconi devised the last link that made the wonder possible, and caught the first click that came across the sea, and to him belong the palms. Judge Townsend, in deciding a suit in a United States court in 1905, declared, "It would seem, therefore, to be a sufficient answer to the attempts to belittle Marconi's great invention that, with the whole scientific world awakened by the disclosures of Hertz in 1887 to the new and undeveloped possibilities of electric waves, nine years elapsed without a single practical or commercially successful result, and Marconi was the first to describe and the first to achieve the transmission of definite intelligible signals by means of these Hertzian waves."

Marconi was born at Villa Griffone, near Bologna, in 1874, so that he was under thirty when he caught that first transatlantic message. He studied at Leghorn under Professor Rosa, and later at the University of Bologna with Professor Righi. He was always absorbed in science, and experimented, holiday after holiday, on his father's estate. He was precocious to an extraordinary degree, for in 1895, when only twenty-one, he had produced a wireless transmitting apparatus that he patented in Italy. Within a year he had taken out patents in England and in other European countries, and had proposed a wireless telegraph system to the English Post-Office Department. That Department, through Sir

William Henry Preece, Engineer-in-Chief of Telegraphs, took up the subject, and reported very favorably on the Marconi System. Marconi himself, at the House of Commons, telegraphed by wireless across the Thames, a distance of 250 yards. In June, 1897, he sent a message nine miles, in July twelve miles, and in 1898 he succeeded in sending one across the English Channel to France, thirty-two miles. In 1901 he covered a space of 3,000 miles.

Let us now see what it was that Marconi had actually done.

Wireless signals are in reality wave motions in the magnetic forces of the earth, or, in other words, disturbances of those forces. They are sent out through this magnetic field, and follow the earth's curvature, in the same way that tidal waves follow the ocean's surface. Everywhere about us there is a sea of what science calls the ether, and the ether is constantly in a state of turmoil, because it is the medium through which energy, radiating from the sun, is carried to the earth and other planets. This energy is transmitted through the free ether in waves, which are known as electromagnetic waves. It was this fact that Professor Hertz discovered, and the waves are sometimes called the Hertzian waves. Light is one variety of wave motion, and heat another. The ether must be distinguished from the air, for science means by it a medium which exists everywhere and is to be regarded as permeating all space and all matter. The ether exists in a vacuum, for, although all the air may have been withdrawn, an object placed in a vacuum can still be seen from outside, and hence the wave motions of light are traveling through a space devoid of air.

Professor Hertz proved in 1888 that a spark, or disruptive discharge of electricity, caused electro-magnetic waves to radiate away in all directions through the ether. The waves acted exactly like ripples that radiate from a stone when it strikes the water. These Hertzian waves were found to travel with the same velocity as light, and would circle the world eight times in a second. As soon as the existence of these waves was known many scientists began to consider whether they could not be used for telegraphy. But the problem was a very difficult one. The questions were how to transmit the energy to a distance, and how to make a receiver that should be sensitive enough to be affected by it.

Let us picture a body of still water with a twig floating upon its surface. If a stone is thrown into the water ripples radiate in all directions, these waves becoming weaker as the circles they form become larger, or in other words as they grow more distant from the point where the stone struck the water. When the waves reach the floating twig they will move it, and when they cease the twig will be motionless again. Should there be grasses or rocks protruding up from the water the motion given to the twig by the waves would be lessened, or distorted, or changed in many ways, depending on the intervening object. Whether the waves will actually impart motion to the twig will depend on the force by which these waves were started and upon the lightness of the twig, or its sensitiveness to the ripples as they radiate. If the water were disturbed by some other force than the stone the twig would be moved by that other force, and the observer could not tell from what direction the motion had come, or how it had been caused. Applying this to wireless telegraphy one may say that a device must be used that will send out waves of a certain length, and that the receiver must be constructed so that it will respond only to waves of the length sent by that transmitter.

There must therefore be accurate tuning of the two instruments. Let a weight be fastened at the end of a spiral spring and then be struck. The weight will oscillate at a uniform rate, or so many times a minute. If this be held so that it strikes the water the movement of the spring will create a certain number of waves a minute. If now a second weight, attached to a second spring, be hung down into the water, the waves caused by the first will reach the second, and if the springs be alike the movements or oscillations will correspond. But if the springs were not alike, or if, in other words, the two instruments were not in tune, the wave motions would not be received and copied accurately. Therefore in wireless telegraphy the instrument that is to impart the motion to the electro-magnetic waves that fill the ether must be tuned in accord with the instrument that is to receive the motion of those waves.

The sending of the wireless message requires a source of production of the electro-magnetic waves. This is obtained by what is known as capacity, or in other words, the power that is possessed by any metal surface to retain a charge of electricity, and by inductance, procured when a constantly changing current is sent through a coil of wire. This capacity and inductance must be adjusted to give exactly the same frequency of motion to the waves, or the same oscillations, if the receiver that is tuned to vibrate to those waves is to receive that message accurately. The receiving station must have the means to intercept the waves, and then transform them again into electrical oscillations that shall correspond to those sent out from the transmitting station.

As early as 1844 Samuel F. B. Morse had succeeded in telegraphing without wires under the Susquehanna River, and in 1854 James Bowman Lindsay, a Scotchman, had sent a message a distance of two miles through water without wires. Sir William Henry Preece, by using an induced current, had telegraphed several miles without a connecting wire. But the discoveries made in regard to the Hertzian waves placed the subject on a different footing, and the possibility of an actual usable wireless telegraph was now looked at from a new view-point.

Professor Hertz had used a simple form of apparatus to obtain his free ether waves. A loop of wire, with the ends almost touching each other, had been his receiver, or detector. When he set his generator, or instrument to create the oscillations, in operation, and held the detector near it, he could see very minute electric sparks passing between the ends of the loop of wire. This proved the existence of the electro-magnetic waves.

In 1890 Professor Eduard Branly found that loose metallic filings became good conductors of electricity when there were electric oscillations at hand. He demonstrated this by placing the filings between metal plugs in a glass tube, and connecting this in circuit with a battery and electric indicator. Professor Oliver Lodge named this device of Branly's a "coherer," and when he found that it was more sensitive than the Hertz detector he combined it with the Hertz oscillator. This was in 1894, and the combination of oscillator and coherer actually formed the first real wireless set.

Wireless stations on shore are marked by very tall masts, which support a single wire, or a set of wires, which are known as the antenna. The antenna has electrical capacity, and when it is connected with the other apparatus needful to produce the oscillations it disturbs the earth's magnetic field. For temporary service, as in the case of military operations, the antenna is frequently attached to captive balloons or kites, and so suspended high in air. On ships the antenna is fastened to the masts. The step that led to this addition was taken by Count Popoff in 1895, when he attached a vertical wire to one side of the coherer of the receiver of Professor Lodge, and connected the other side with the ground. He used this to learn the approach of thunder-storms.

With a knowledge of electro-magnetic waves, with a high-power oscillator, and a sensitive coherer, it remained for Marconi to connect an antenna to the transmitter, and thus secure a wide and practicable working field for the sending and receiving of his messages. This he did in 1896, and it was this addition that made the wireless telegraph of real use to men. Improvements in the transmitter and receiver have constantly increased the power of the invention, and have gradually allowed him to employ it over greater and greater distances.

With Marconi's successful demonstrations of wireless in England its use at once began. The Trinity House installed a station at the East Goodwin Lighthouse, which communicated with shore and proved of the greatest value in preventing shipwrecks. The Marconi Wireless Telegraph Company was organized in 1897, and made agreements to erect coast stations for the Italian, Canadian, and Newfoundland governments, and for Lloyd's. The great shipping lines established wireless stations on their vessels, and the antenna were soon to be seen on points of vantage along every coast. On December 12, 1901, Marconi in Newfoundland caught the message sent from Cornwall; on January 19, 1903, President Roosevelt sent the first "official" wireless message across the Atlantic to Edward VII, and in October, 1905, a message was sent from England across the mountains, valleys and cities of Europe to the battle-ship Renown, stationed at the entrance to the Suez Canal.

The system of operating wireless telegraphy is in some respects similar to that of the ordinary telegraph. The Morse Code is largely used in America, and a modification of it, called the Continental Code, in Europe. When the wireless operator wishes to send a message to another station he "listens in," as it is called, by connecting his receiving apparatus with the adjacent antenna and the ground. He has the telephone receiver attached to his ears. Next he adjusts his receiving circuits for a number of wave lengths. If he catches no signals in his telephone receiver he understands that no messages are being sent within his area. Then he "throws in" the transmitting apparatus, which automatically disconnects the receiving end. He gives the letters that stand for the station with which he wants to communicate, and adds the letters of his own station. He does this a number of times, to insure the other station picking up the call. Then he "listens in," and if he receives the clicks that show that the other station has heard him he is ready to establish regular telegraphic communication.

A number of distant stations may be sending messages simultaneously. In that case the operator tunes his instrument, or in other words adjusts his apparatus to suit the wave length of the station with which he wishes to communicate. In this way he "tunes out" the other messages, and receives only the one he wants. If, however, the stations that are sending simultaneously happen to be situated near together, as in the case of several vessels near a shore station, the operator is often unable to do this "tuning out," and must try to catch the message he wishes by the sound of the "spark" of the transmitting station, if he can in any way distinguish it from the "sparks" of the other messages.

There are several ways of determining when the two circuits are in tune. One is to insert a hot-wire current meter between the antenna and the inductance, which indicates the strength of the oscillatory current that has been established. A maximum reading can then be made by manipulating the flexible connections, and this will show whether the two circuits are in accord. The other method is by using a device that indicates the wave length. This measures the frequency of one circuit, and then the other circuit can be adjusted to give a corresponding wave length. The larger the antenna the longer will be the wave length and the greater the power of the apparatus. It is usual to employ a short wave length for low-power, short-distance equipments, and a long wave length for the high-power, long-distance stations.

Wireless telegraphy has already proved itself of the greatest value on the ocean. It has sent news of storms and wrecks across tossing seas and brought rescue to scores of voyagers. Ships may now keep in constant communication with their offices on shore. The great lines send Marconigrams to each other in mid-ocean, and publish daily papers giving the latest news of the whole world. Greater distances have so far been covered over water than over land, but this branch of the service is being rapidly developed, and it must prove in time of the greatest value across deserts and wild countries, where a regular telegraph service would be impracticable. In such a country as Alaska, where there are constant heavy sleet and snow storms, the wireless should prove invaluable.

The telegraph and cable companies did their best to ignore the claims of the wireless systems, but they have been compelled to acknowledge them at last. Rival companies have sprung up, using slightly different varieties of apparatus. Each of the big companies that were ready to compete with the Marconi Company by 1906, the German Telefunken Company, the American National Electric Signaling Company, the American De Forest Company, and the British Lodge-Muirhead Wireless Syndicate, had certain peculiar advantages over the others. The laws relating to the uses of wireless, and especially the rights of governments to the sole use of the systems in case of war, are in a confused condition, but eventually order must come from this chaos as it did in the history of the telephone and telegraph.

Wireless has brought the possibility of communication between any two individuals, no matter where they may be situated, within the realm of fact. A severing of communication with any part of the world will be impossible. Storms and earthquakes that destroy telegraph systems, enemies that cut submarine cables, cannot prevent the sending of Marconigrams. The African explorer and the Polar adventurer can each talk with his countrymen. The use of this agency is still in its earliest youth, but it has already done so much that it is impossible to say to what a stature it may grow. It should cut down the rates for using wire and cable systems, and ultimately place the means of communicating directly with any one on land or sea within the reach of every man. All the world's information will be at the instant disposal of whomsoever needs it, and all this is due to those electro-magnetic waves that permeate the ether, waiting to be put into service at the touch of man.

Source:

Holland, Rupert. "Marconi and the Wireless Telegraph." *Historic Inventions*. Philadelphia: George W. Jacobs & Company Publishers, 1911. 261 – 272. Electronic.