MARCONI TALKS ABOUT HIS FIRST WIRELESS TELEGRAPHY SYSTEM, AND HIS TRANSATLANTIC TRIUMPH AT SIGNAL HILL, NFLD, DECEMBER 1901, *and more*…

A transcription for the California Historical Radio Society,
By Bart Lee, K6VK, Archivist

NB: related Index and 1902 Coda by Nevil Maskelyne, and Archivist's Comments, and Graphics, follow the main text

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THE PROGRESS OF ELECTRIC SPACE TELEGRAPHY. *

* An address by William Marconi before the Royal Institution, [London] June 13, 1902.

Wireless telegraphy, or telegraphy through space without connecting wires, is a subject which at present is probably attracting more world-wide attention than any other practical development of modern electrical engineering.

That it should be possible to actuate an instrument from a distance of hundreds or thousands of miles and oblige it at will to reproduce audible or visible signals through the effects of electrical oscillations transmitted to it without the aid of any continuous artificial conductor strikes the minds of most people as being an achievement both wonderful and mysterious.

If we examine the subject closely we may, however, come to the conclusion that although telegraphy through space is certainly wonderful, as are likewise all natural and physical phenomena, yet it is certainly in no way more wonderful than the transmission of telegrams along an ordinary telegraph wire. The heat and light waves of the sun and stars travel to us through millions of miles of space, and sound also reaches our ears without requiring any artificial conductor. Is it not, therefore, wonderful that man should have devised means by which he is enabled to confine electricity conveying messages or power to a wire and cause the effect, which we call an electric current, to follow all the turns and convolutions which may exist in the wire?

We find that the first systems of telegraphy used by mankind were truly wire-less. A bonfire built on a hill by a band of aboriginal Indians conveyed a signal wirelessly by etheric waves - in this case light waves - to Indians on another hill, perhaps miles distant. Even today there are innumerable systems of what may truly be called wireless telegraphy in practical use. A red light at a railway crossing conveys a signal by waves through the ether to the eye of the engine-driver. The red light is the transmitter, the eye the receiver.

The method of space telegraphy of which I intend speaking to-night is founded on a comparatively new way of controlling and detecting certain kinds of etheric waves, much slower in rate of vibration than light waves, called Hertzian waves, after the scientist who first demonstrated their existence.

The mathematical and experimental proof by Clerk Maxwell and Heinrich Hertz of the identity of light and electricity and the knowledge of how to produce and detect certain previously unknown ether waves made possible this new method of communication.

I think I am right in saying that the importance of the discoveries of Maxwell and Hertz was realized by very few, and even, perhaps, so recently as a year ago a great number of scientific men would have hardly foreseen the advances which have been made in so brief a time in the art of space telegraphy.

The time allowed for this discourse does not permit me to describe all the various steps which have made possible the results recently obtained, nor to describe the work of the numerous workers who have contributed to the advance of the subject, but I hope it may be of interest if I describe the various problems which have lately been solved and the very interesting developments which have taken place in my own work during the last few months.

I shall first briefly describe my system as used in my early experiments, six years ago, and afterward endeavor to explain the various improvements and modifications which have since been introduced into it.

The transmitter consists of a modified form of Hertzian oscillator, the main feature of which is in having one sphere of the spark discharger earthed and the other connected to an elevated capacity area or to a comparatively vertical wire. The two spheres are also connected to the ends of the secondary winding of an induction coil or transformer. When the key is pressed the current of the battery is allowed to actuate the spark coil, which charges the spheres and the vertical wire, which when discharging causes a rapid succession of sparks to pass across the spark gap. The sudden release caused by the spark discharge of the electrical strain or displacement created along certain lines of electric force, though space by the charged wire causes some of the electrical energy to be thrown off in the form of a displacement wave in the ether, and as a consequence the vertical wire becomes a radiator of electric waves.

In this connection it is interesting to remember that Lord Kelvin showed mathematically more than forty years ago the precise conditions under which such a discharge as we are considering would be oscillatory.

It is easy to understand how, by pressing the key for longer or shorter intervals, it is possible to emit a long or short succession of impulses or waves which when they influence a suitable receiver reproduce on it a long or short effect according to their duration, in this way reproducing the Morse or other signals transmitted from the sending station.

The receiver consists of a coherer placed in a circuit containing a local cell and a sensitive telegraph relay actuating another circuit which works a trembler or decoherer and a recording instrument. In its normal condition the resistance of the coherer is infinite or at least very great and the current of the battery can not pass through it to actuate the instruments, but when influenced by electric waves the coherer becomes a comparatively good conductor, its resistance falling to between 100 and 500 ohms. This allows the current from the local cell to actuate the relay which in turn causes another stronger current to work the recording instrument and also the tapper or decoherer which is so arranged as to tap or shake the coherer and in this way re store its sensitiveness. The practical result is that the circuit of the recording instrument is closed for a time equal to that during which the key is pressed at the transmitting station, and in this way it is possible to obtain a graphic, acoustic or optical reproduction of the movements of the key at the sending station. One end of the tube or coherer is connected to earth and the other to an insulated conductor, preferably terminating in a capacity area similar in every respect to the one employed at the transmitting station.

I noticed that by employing similar vertical rods at both stations it was possible to detect the effects of electric waves, and in that way convey the intelligible alphabetical signals over distances far greater than had previously been believed possible, and by means of similar arrangements distances of transmission up to about 100 miles were obtained.

It was soon, however, realized that so long as it was possible to work only two installations within what I may call their sphere of influence, a very important limit to the practical utilization of the system was imposed.

Without some practical method of tuning the stations it would have been impossible to work a number in the vicinity of each other at the same time without interference caused by the mixing of messages.

The new methods of connection which I adopted in 1898, i.e., connecting the receiving vertical wire or aerial directly to earth instead of to the coherer, and by the introduction of a proper form of oscillation transformer in conjunction with a condenser so as to form a [38] resonator tuned to respond best to waves given out by a given length of aerial wire, were important steps in the right direction.

I had, however, realized at the time, that one great difficulty in the way of achieving the desired effects was caused by the action of the transmitting wire. A straight rod in which electrical oscillations are set up forms, as is well known, a very good radiator of electrical waves.

In all what we call good radiators, electrical oscillations set up by the ordinary spark discharge method cease or are damped out very rapidly, not necessarily by resistance, but by electrical radiation, removing the energy in the form of electric waves.

It is a well-known fact that when one of two tuning forks having the same period of vibration is set in motion, waves will form in the air, and the other tuning fork, if in suitable proximity, will immediately begin to vibrate in unison with the first. In the same way a violin player, sounding a note on his instrument will find a response from a certain wire in a piano near-by, that particular wire out of all the wires of the piano happening to be the only one which has a period of vibration identical with that of the musical note sounded by the violinist. Tuning forks and violins, of course, have to do with air waves, and wireless telegraphy with ether waves, but the action in both cases is similar.

It is very important to take into consideration the one essential condition which must be obtained in order that a well marked tuning or electrical resonance may take place. Electrical resonance like mechanical resonance essentially depends upon the accumulated effect of a large number of small impulses properly timed. Tuning can only be obtained if a sufficient number of these timed electrical impulses reach the receiver. As Professor Fleming so graphically puts it in one of his lectures on electrical oscillations, to "set a pendulum in vibration by puffs of air we must not only time the puffs properly but keep on puffing for a considerable period."

It is therefore clear that a dead heat radiator, i.e., one that does not give a train or succession of electrical oscillations, is not suitable for tuned or syntonic space telegraphy.

As I pointed out before, a transmitter consisting of a vertical wire discharging through a spark gap is not a persistent oscillator. Its electrical capacity is comparatively so small and its capability of radiating waves so great that the oscillations which take place in it must be considerably damped. In this case receivers or resonators of a considerably different period or pitch will respond and be affected by it.

Early in 1900 I obtained very good results with another arrangement in which the radiating and resonating conductors each take the form of two concentric cylinders, the internal cylinder being earthed. By using zinc cylinders only seven metres high and 1.5 metres in diameter good signals could easily be obtained between St. Catherine's Point, Isle of Wight, and Poole, over a distance of thirty miles, these signals not being interfered with or read by other wireless telegraph installations worked by my assistants or by the Admiralty in the immediate vicinity.

The capacity of the transmitter, due to the internal conductor, is so large that the energy set in motion by the spark discharge can not all radiate in one or two oscillations, but forms a train of slowly damped oscillations, which is just what is required.

A simple vertical wire may be compared with an empty teapot, which after being heated would cool very rapidly, and the concentric cylinder system with the same teapot filled with hot water which would take a very much longer time to cool.

In the receiver the closely adjacent cylinders which give it large electrical capacity cause it to be a resonator possessing a very decided period of its own, and it becomes no longer apt to respond to frequencies which differ from its own particular period of electrical oscillation, nor to be interfered with by stray ether waves which are sometimes caused by atmospheric disturbances, and which occasionally prove troublesome during the summer.

Another successful system of tuning or syntonizing the apparatus was the outcome of a series of experiments carried out with the discharge of condenser or Leyden jar circuits. I tried by means of associating with the radiating wire or capacity, a condenser circuit, which is known to be a persistent oscillator, to set up the required number of oscillations in the radiator. An arrangement consisting of a circuit containing a condenser and a spark-gap constitutes a very persistent oscillator. Professor Lodge has shown us how, by placing it near another similar circuit, it is possible to demonstrate interesting effects of resonance by the experiment usually referred to as that of Lodge's syntonic jars. But, as Lodge points out, "a closed circuit such as this is a feeble radiator and a feeble absorber, so that it is not adapted for action at a distance." I very much doubt if it would be possible to affect an ordinary receiver at even a few hundred yards.

It is, however, interesting to notice how easy it is to cause the energy contained in the circuits of this arrangement to radiate into space.

It is sufficient to place near one of its sides a straight metal rod or good electrical radiator, the only other condition necessary for long-distance transmission being that the period of oscillation of the wire or rod should be equal to that of the nearly closed circuit. Stronger effects of radiation are obtained if the radiating conductor is partly bent round the circuit [39] containing the condenser (so as to resemble the circuits of a transformer).

My first trials with this system were not successful, in consequence of the fact that I had not recognized the necessity of attempting to tune to the same period of electrical oscillation (or octaves) the two electrical circuits of the transmitting arrangement, these circuits being the circuit consisting of the condenser and primary of the transformer and the aerial or radiating conductor and secondary of the transformer. Unless this condition is fulfilled, the different periods of the two conductors create oscillations of a different frequency and phase in each circuit, with the result that the effects obtained are feeble and unsatisfactory on a tuned receiver.

FIG. 1 - SYNTONIZED TRANSMITTER, MARCONI SPACE TELEGRAPHY

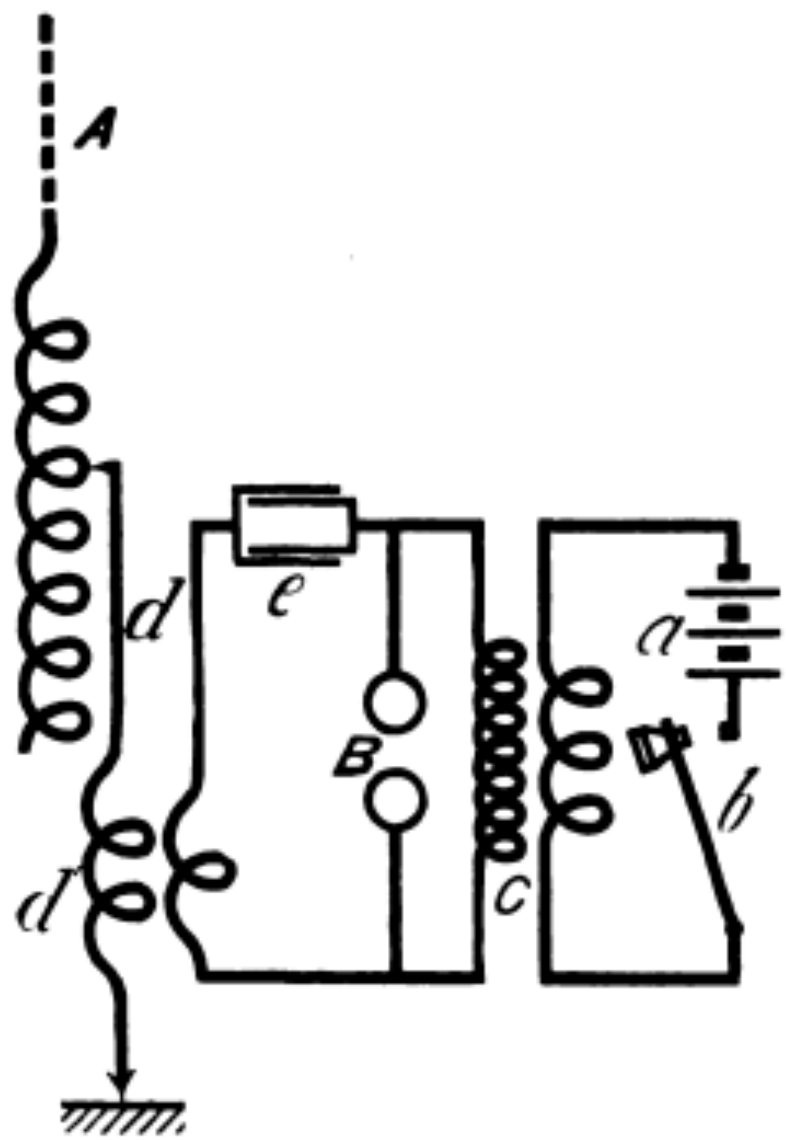

FIG. 1.—SYNTONIZED TRANSMITTER, MARCONI SPACE TELEGRAPHY.

The syntonized transmitter is shown in Fig. 1. The period of oscillation of the vertical conductor ***A*** can be increased by introducing turns of wire, or decreased by diminishing their number, or by introducing a condenser in series with it. The condenser in the primary circuit is constructed in such a manner as to render it possible to vary its electrical capacity.

FIG. 2 - RECEIVING STATION ARRANGEMENTS, MARCONI SPACE TELEGRAPHY

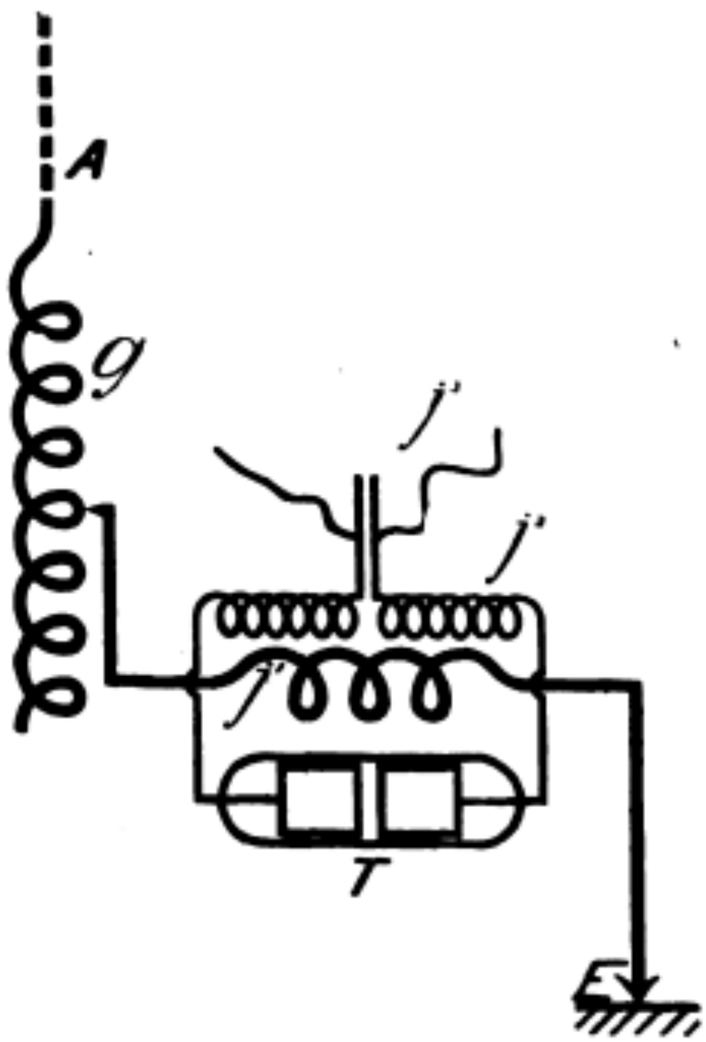

FIG. 2.—RECEIVING STATION ARRANGEMENTS, MARCONI SPACE TELEGRAPHY.

The receiving station arrangements are shown in Fig. 2. Here we have a vertical conductor connected to earth through the primary of a transformer, the secondary circuit of which is joined to the coherer or detector. In order to make the tuning more marked, I place an adjustable condenser [*h*] across the coherer in Fig. 3.

FIG. 3 - ADJUSTABLE CONDENSER ACROSS COHERER, MARCONI SPACE TELEGRAPHY

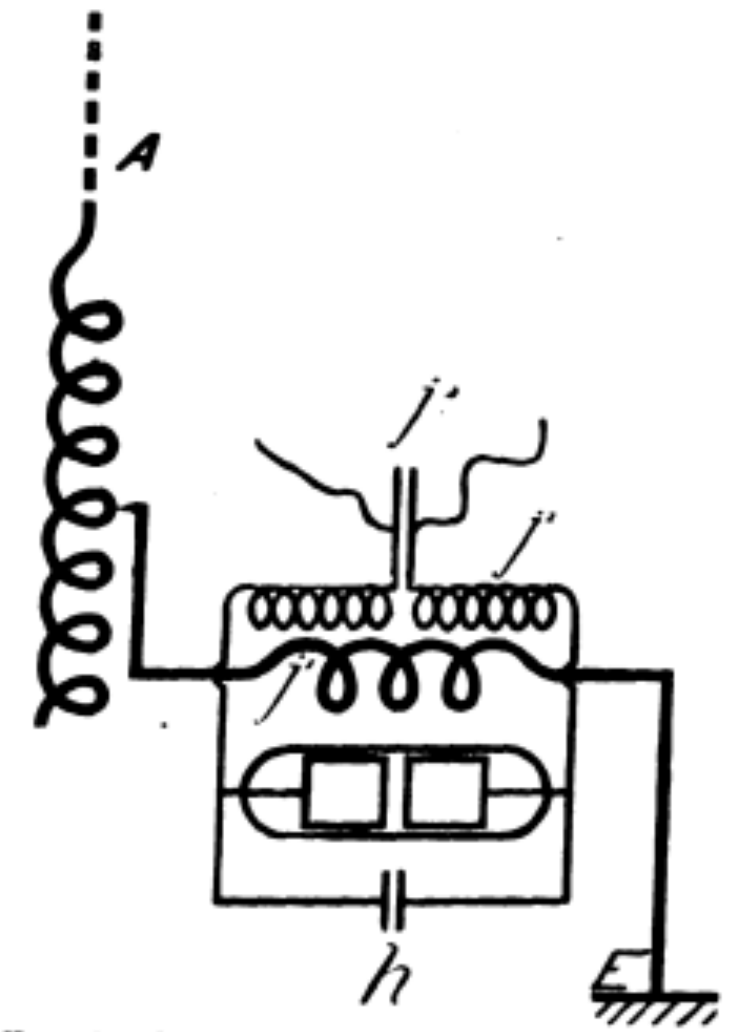

FIG. 3.—ADJUSTABLE CONDENSER ACROSS COHERER, MARCONI SPACE TELEGRAPHY.

Now in order to obtain best results it is necessary that the free period of electrical oscillation of the vertical wire primary of transformer and earth connection should be in electrical resonance with the second circuit of the transformer, which includes the condenser. I stated that in order to make the tuning more marked a condenser is placed across the coherer. This condenser increases the capacity of the secondary resonating circuit of the transformer, and in the case of a large series of comparatively feeble but properly timed electrical oscillations being received the effect of the same is summed up until the electro-motive force at the terminal of the coherer is sufficient to break down its insulation and cause a signal to be recorded.

In order that the two systems, transmitter and receiver, should be in tune it is necessary (if we assume the resistance to be very small or negligible) that the product of the capacity and inductance in all four circuits should be equal.

It is easy to understand that if we have several stations, each tuned to a different period of electrical vibration, and of which the corresponding inductance and capacity at the transmitting station are known, it will not be difficult to transmit to any one of them, without danger of the message being picked up by the other stations for which it is not intended. But better than this we can connect to the same vertical sending wire, through connections of different inductance, several differently tuned transmitters, and to the receiving vertical wire a number of corresponding receivers.

Different messages can be sent by each transmitter connected to the same radiating wire simultaneously and received equally simultaneously by the vertical wire connected to differently tuned receivers. This result, which I believe was quite novel at the time, I showed to several friends of mine including Dr. J. A. Fleming, F.R.S., nearly two years ago. Dr. Fleming made mention of the results he had seen in a letter to the London Times, dated October 4, 1900.

I have further noticed that the tuning can be further improved by the combination of the two systems described. In this case the cylinders are connected to the secondary of the transmitting transformer, and the receiver to a properly tuned induction coil, and all circuits must be tuned to the same period as already described. This arrangement is going to be further tested in long-distance experiments shortly to be undertaken between England and Canada.

The syntonic systems have not been applied generally to ships, as it has always been considered an advantage that each ship should be able, especially in case of distress, to call up any other ship or ships which may happen to be at the time within the range of its transmitter, but in the case of land stations the syntonic method has been applied in several instances where necessity demanded it. Thus at the testing stations which maintain communication between St. Catherine's, Isle of Wight, and Poole, in Dorset, when electric waves of a certain frequency are used no interference whatever can be caused by the working of the Admiralty installations in the vicinity. The long-distance station at Poldhu, Cornwall, is able to transmit signals decipherable on a tuned receiver on a ship at over 1,000 miles distance, while the Lloyds wireless station at the Lizard, only seven miles away, is not affected by the powerful waves radiated from Poldhu if tuned to a different frequency.

I am not at all prepared to say that under no possible circumstances could a wireless message transmitted between syntonic instruments be tapped or interfered with, but I wish to point out that it is now possible to work a considerable number of wireless telegraph stations simultaneously in the vicinity of each other with out the messages suffering from any interference. Of course if a powerful transmitter, giving off waves of different frequencies, is actuated near one of the receiving stations it may prevent the reception of messages, but the ordinary systems of communication through wires may be likewise affected.

I shall now say a few words on the subject of the detector of the electric waves, called sometimes "the electric eye," which consists of that essential part of the receiving apparatus especially affected by the electrical oscillations.

In all wireless telegraph apparatus used up to quite a recent date, a detector now called a coherer has been employed. This detector is based on discoveries and observations made by S. A. Varley, Professors Hughes, Colzecchi-Onesti and especially Professor Branly. Professor O. Lodge has made large use of this apparatus which he first named "coherer" in the very numerous experiments and studies he has carried out on the effects produced by Hertzian waves.

The form of coherer I have found most trustworthy and reliable for long-distance work consists of a small glass tube about four centimetres long into which two metal pole pieces are tightly fitted. They are separated from each other by a small gap which is partly filled with a mixture of nickel and silver filings.

Provided such a coherer is properly constructed and the tapper and relay in [40] good adjustment it proves to be quite reliable when within the range of the transmitting station.

Experiments with syntonic systems have, however, shown that certain kinds of coherers can be far more advantageously employed than others. One apparently all-important condition is that the resistance of the coherer in its sensitive state or after being tapped should appear to be infinite when measured with an electromotive force of about one volt.

If the tapping does not entirely do away with the conductivity of the filings very poor results are obtained, which can be explained as follows: According to the systems I have described electrical syntony between the transmitter and receiver is dependent on the proper electrical resonance of the various circuits of the transformers used in the receivers. The condenser and secondary of the transformer must not be partially short-circuited by the coherer, otherwise the oscillations can not mount up or sum up their effects as is essential in order to produce the difference of potential at the ends of the coherer necessary for breaking down its resistance, but the electrical oscillations will leak across the conductive coherer without causing it to record any signal. Of course the condenser is short-circuited when the filings cohere under the influence of the received oscillations, but in this case the signal is already recorded and the tapper at once restores the coherer to its non-conducting condition and in this way restores its sensitiveness.

By using coherers containing very fine filings the necessary condition of non-conductivity when in a sensitive state is obtained.

Coherers have lately been tried which will work to a certain extent satisfactorily without the necessity of employing any tapper or decoherer in connection with them. Nearly all are dependent on the use of a carbon microphonic contact or contacts which possess the curious quality of partially reacquiring spontaneously their high resistance condition after the effect of the electrical oscillations has ceased. This enables one to obtain a far greater speed of reception than is possible by means of a mechanically tapped coherer, the inertia of the relay and tapper which are used in connection with it being necessarily sluggish in their action.

In all these self-decohering coherers a telephone which is affected by the variations of the electric current, caused by the changes in conductivity of the coherer, is used in place of the recording instrument.

It has not yet been found possible, so far as I am aware, to actuate a recording instrument or relay by means of a self-restoring coherer.

The late Professor Hughes was the first, I believe, to experiment with and receive signals on one of these coherers associated with a telephone. His experiments were carried out as early as 1879 and I regret that this pioneer work of his is not more generally known.

Other self-restoring coherers were proposed by Professors Tommasina, Popoff and others, but one which has given good results when syntonic effects were not aimed at was (according to official information communicated to me) designed by the technical personnel of the Italian Navy. This coherer at the request of the Italian Government I tested during numerous experiments. It consists of a glass tube containing plugs of carbon or iron with between them a globule of mercury.

These non-tapped coherers have not been found to be sufficiently reliable for regular or commercial work. They have a way of cohering permanently when subjected to the action of strong electrical waves of atmospheric electrical disturbances and have also an unpleasant tendency toward suspending action in the middle of a message. The fact that their electrical resistance is low and always varying, when in a sensitive state, causes them to be unsatisfactory for the reasons I have already enumerated when worked in connection with my system of syntonic wireless telegraphy.

These coherers are, however, useful if employed for temporary tests in which the complete accuracy of messages is not all-important and when the attainment of syntonic effects is not aimed at. They are especially useful when using receiving vertical wires supported by kites or balloons, the variations of the height of the wires (and therefore of their capacity) caused by the wind making it extremely difficult to obtain good results on a syntonic receiver.

Coherers have long been considered as constituting almost the essential basis of electric space telegraphy, and although many detectors of electric waves existed, none of them possessed a sensitiveness which even approached that of a coherer and most of them were also unsuitable for the reception of telegraphic messages.

With a view to producing a receiver which could be worked at a much higher speed than a coherer, I was fortunate enough to succeed in constructing a magnetic detector of electric waves, based on a principle essentially different from that of the coherer and which I think leaves all coherers far behind in speed, facility of adjustment and efficiency when worked in tuned circuits.

The magnetization and demagnetization of steel needles by the effect of electrical oscillations has long been known and was noted especially by Professor T. Henry, Aloria, Lord Rayleigh and others. Mr. E. Rutherford also has described a magnetic detector of electric waves based on the partial demagnetization of a small core composed of fine steel needles previously magnetized to saturation. By means of a magnetometer Mr. Rutherford succeeded in 1895 in tracing the effects of his electrical radiator up to a distance of three-quarters of a mile across Cambridge.

But Mr. Rutherford's arrangement is not suitable for the reception of telegraphic messages in consequence of the fact that a careful process of remagnetization, which requires some time to effect, is necessary in order to restore its sensitiveness after the receipt of each impulse. Mr. Rutherford's arrangement is also considerably less sensitive than a coherer.

The detector which I am about to de scribe is, in my opinion, based upon the decrease of magnetic hysteresis which takes place in iron when under certain conditions it is exposed to the effect of high frequency oscillations or Hertzian waves.

As employed by me, it has been constructed in the following manner: On a core of thin iron or steel, but preferably hard drawn iron, are wound one or two layers of thin insulated copper wire. Over this winding, insulated material is placed, and over this again another longer winding of thin copper wire contained in a narrow bobbin. The ends of the winding nearest the iron core are connected one to earth and the other to an elevated conductor, or they may be connected to the secondary of a suitable receiving transformer or intensifying coil, such as are employed for syntonic wireless telegraphy. The ends of the other winding are connected to the terminals of a telephone or other suitable receiving instrument. Near the ends of the core or in close proximity to it is placed a horseshoe magnet, which by a clockwork arrangement is so moved or revolved as to cause a slow and constant change or successive reversals in the magnetization of the piece of iron. (To be continued.)

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THE PROGRESS OF ELECTRIC SPACE TELEGRAPHY- II. * (Concluded.) * An address by William Marconi before the Royal Institution, [London] June 13, 1902.

I have noticed that if electrical oscillations of suitable period be sent from a transmitter, rapid changes necessarily cause induced currents in the windings, which in their turn reproduce on the telephone with great clearness and distinctness the telegraphic signals which may be sent from the transmitting station. Should the magnet be removed or its movement stopped the receiver ceases to be perceptibly affected by the electric waves even when these are generated at very short distances from the radiator.

I have had occasion to notice that the signals audible in the telephone are weakest when the poles of the rotating magnet have just passed the core and are increasing their distance from it while they are strongest when the magnet's poles are approaching the core.

Good results have also been obtained by keeping the magnet fixed and using an endless iron rope or core of thin wires revolving on pulleys (worked by clock work) which cause the iron to travel through the copper wire windings, in proximity to preferably two horseshoe magnets with their poles close to the windings, care being taken that their poles of the same sign are adjacent.

This detector has been successfully employed for some time in the reception of wireless telegraphic messages between St. Catherine's Point, Isle of Wight, and the North Haven, Poole, over a distance of thirty miles, also between Poldhu in Cornwall and Poole in Dorset over a distance of 12 [sic: ~ 150] miles, of which 109 are over sea and forty-three overland.

It would no doubt be possible to obtain signals by causing the iron core to act directly on a telephone diaphragm and in this case the secondary winding could be omitted.

This detector, as I have already stated, appears to be more sensitive and reliable than a coherer, nor does it require any of the adjustments or precautions which are necessarily for the good working of the latter. It possesses a uniform and constant resistance, and as it will work with a much lower electro-motive force the secondaries of the tuning transformers can be made to possess much less inductance, their period of oscillation being regulated by a condenser in circuit with them, which condenser may be much larger (in consequence of the smaller inductance of the circuit) than those used for the same period of oscillation in a coherer circuit, with the result that the receiving circuits can be tuned much more accurately to a particular radiator of fairly persistent electric waves.

As a call a coherer in circuit with a relay working a bell can always be used and if it is found possible to make the magnetic detector record on a registering instrument (as to the possibility of which the results of recent tests have left little doubt in my mind), it may be found possible to receive wireless telegraph messages at a speed of several hundred words a minute.

At present by means of this detector it is possible to read about thirty words per minute.

The considerations which led me to the construction of the above-described detector are the following:

It is a well-known fact that after any change has taken place in the magnetic force acting on a piece of iron some time elapses before the corresponding change in the magnetic state of the iron is complete. If the applied magnetic force be caused to effect a cyclic variation the corresponding induced magnetic variation in the iron will lag behind the changes in the applied force. To this tendency to lag behind Professor Ewing has given the name of magnetic hysteresis.

It has been shown also by Professors Gerosa, Finzi and others, that the effect of alternating currents or high-frequency electrical oscillations acting upon iron is to reduce considerably the effects of magnetic hysteresis causing the metal to respond readily to any influence which may tend to alter its magnetic condition.

The effect of electrical oscillations probably is to bring about a momentary release of the molecules of iron from the constraint in which they are ordinarily held, diminishing their retentiveness and consequently decreasing the lag in the magnetic variation taking place in the iron.

I therefore anticipated that the group of electrical waves emitted by each spark of a Hertzian radiator would, if caused to act upon a piece of iron which is being subjected at the same time to a slowly varying magnetic force, produce sudden variations in its magnetic hysteresis, which would cause others of a sudden or jerky nature in its magnetic condition. In other words the magnetization of the iron instead of slowly following the variations of the magnetic force applied gives a sort of jump each time it is affected by the electric waves emitted by each spark of the radiator.

These jerks in the magnetic condition of the iron would, I thought, cause induced currents in a coil of wire, of strength sufficient to allow the signals transmitted to be detected intelligibly on a telephone, or perhaps even read on a mirror galvanometer. The results obtained go to confirm my belief that this detector can be advantageously substituted for the coherer for the purposes of long-distance space telegraphy.

During the last few years the developments in the practical applications of my system have been exceedingly rapid.

Time does not allow me to give you an account of the many cases in which it has proved its usefulness, but it may be sufficient if I mention that Lloyds have adopted the system exclusively for use at their stations at home and abroad for a period of fourteen years, and that no less than seventeen liners plying across the Atlantic carry permanent installations. In more than one case recorded in the daily papers the system has been of service to vessels in distress, especially in the English Channel.

No less than forty land stations are being equipped with the system in Great Britain and Europe, and over forty vessels in His Majesty's navy are carrying installations.

The adoption of my system in the Royal Navy has brought about a certain slight change of appearance in the rig of the ships. Some naval officers believe that this change improves the ship's appearance; others think the contrary.

The Italian Admiralty after experimenting for some time with the self de-cohering coherers to which I have referred before, have informed me officially by a letter dated May 24 last, of its decision to equip their war vessels with the same apparatus as has been successfully employed on the transatlantic liners. On these liners commercial use is made of the system for the convenience of passengers and as an illustration of its commercial workableness I might mention that lately the Campania and Lucania of the Cunard Line have been collecting as much as £60 each trip in receipts de rived from passengers' wireless messages.

Nearly two years ago the facility with which communication was possible over distances of nearly 200 miles and the improvements in syntonic methods introduced, together with the ascertained fact, that of the non-interference of the curvature of the earth, led me to decide to recommend the construction of a large power station in Cornwall and another [76] one at Cape Cod, Mass., in order to test whether by the employment of much greater power it might not be possible to transmit messages across the Atlantic, and establish a transoceanic commercial communication which the monopoly of the Postmaster-General will not apparently permit between the stations if both are situated in Great Britain.

An unfortunate accident to the masts at Cape Cod seemed likely to postpone the experiments for several months, when I came to the conclusion that whilst the necessary repairs there were being carried out, I would use a purely temporary installation in Newfoundland for the purpose of a transatlantic experiment, from which I might at any rate be able to judge how far the arrangements in Cornwall had been conducted on right lines. Before describing the results it may be useful if I give a brief description of the nature of the apparatus used at the transmitting and receiving stations.

The transmitter at Poldhu was similar in principle to the syntonic one I have already described, but the elevated conductor at the transmitting station was much larger and the potential to which it was charged very much in excess of any that had previously been employed, the amount of energy to be used in this transmitting station having been approximately determined by me prior to its erection.

The transmitting elevated conductor consisted of fifty almost vertical naked copper wires, suspended at the top by a horizontal wire stretched between two poles each forty-eight metres high and placed sixty metres apart. These wires were separated from each other by a space of about one metre at the top, and, after converging together were all connected to the transmitting instruments at the bottom. The potential to which these conductors were charged during transmission was sufficient to cause sparking between the top of these wires and an earthed conductor across a space of thirty centimeters of air.

The general engineering arrangements of the electric power station, erected at Poldhu for the execution of these plans and for creating the electric waves of the frequency which I desired to use were made by Dr. J. A. Fleming, F.R.S., who also devised many of the details of the appliances for producing and controlling the electric oscillations.

These, together with devices introduced by me and my special system of syntonization of inductive circuits, have provided an electric wave generating plant more powerful than any hitherto constructed.

Mr. R. N. Vyvyan and Mr. W. S. Entwistle have also greatly assisted me in the experiments carried out with the very high tension electrical apparatus employed.

The first experiments were carried out in Newfoundland last December and every assistance and encouragement was given me by the Newfoundland Government.

As it was impossible at that time of the year to set up a permanent installation with poles, I carried out experiments with receivers joined to a vertical wire about 400 feet long, elevated by a kite. This gave a very great deal of trouble, as, in consequence of the variations of the wind, constant variations in the electrical capacity of the wire were caused.

My assistants in Cornwall had received instructions to send a succession of “S’s” followed by a short message, at a certain prearranged speed every ten minutes, alternating with five minutes’ rest, during certain hours every day.

Owing to the constant variations in the capacity of the aerial wire it was soon found out that an ordinary syntonic receiver was not suitable, although a number of doubtful signals were at one time recorded.

I therefore tried various microphonic self-restoring coherers placed in the secondary circuit of a transformer, the signals being read on a telephone. With several of these coherers, signals were distinctly and accurately received and only at the prearranged times, in many cases a succession of “S’s” being heard distinctly, although-probably in consequence of the weakness of the signals and the unreliability of the detector, no actual message could be deciphered.

The coherers which gave the signals were one containing loose carbon filings; another, designed by myself, containing a mixture of carbon dust and cobalt filings, and, thirdly, the “Italian Navy coherer,” containing a globule of mercury between two plugs.

For the good results obtained I was very much indebted to two of my assistants, Mr. G. S. Kemp and Mr. P. W. Paget, who gave me very efficient aid during the tests, which the extremely severe weather prevailing in December in Newfoundland made exceedingly difficult to carry out.

The result of these tests was sufficient to convince myself and my assistants that with permanent stations at both sides of the Atlantic and by the employment of a little more power messages could be sent across the ocean with the same facility as across much shorter distances.

The experiments could not be continued or extended in consequence of the action which the cable company, which claims all telegraphic rights in Newfoundland, saw fit to make at the time. Having received a most generous invitation from the government of the Dominion of Canada to continue my operations in the

Dominion, it was thought undesirable to continue the experiments in Newfoundland, where I should have probably been brought into litigation with the telegraph company.

I am glad to say that the Canadian Government, on the initiative of Sir Wilfrid Laurier and Mr. Fielding, has shown itself most enterprising in the matter and not only encouraged the erection of a large station in Nova Scotia, but actually granted a subsidy of £16,000 toward the erection of this transatlantic station, the object of which is to communicate with England from the coast of Nova Scotia.

It is anticipated that the Canadian station will be ready for further tests very shortly.

Another station for the same purpose is being erected on the United States coast.

Toward the end of February of this year I thought it desirable to test how far the messages transmitted by the powerful station at Poldhu could be detected on board a ship.

The ship selected was the Philadelphia, of the American Line. The receiving aerial conductor was fixed to the mast, the top of which was about sixty metres above sea level. As the elevated conductor was fixed and not floating about with a kite as in the case of the Newfoundland experiments, very good results were obtained on an ordinary syntonic receiver similar to those I have already de scribed and the signals were all recorded on tape by the ordinary Morse recorder.

Readable messages on tape were received up to a distance of 1,551 miles from Cornwall, and indications were received as far as 2,099 miles. Most of the messages were received in the presence of the captain or the chief officer of the ship who were good enough to sign the tapes. It is curious to observe that signals could not be received at over 900 miles by any of the self-restoring coherers. The reason for this lies probably in the fact that the tuned receiver when connected to a fixed aerial is more efficient. Another result of considerable scientific interest was that at distances [77] of over 700 miles the signals transmitted during the day failed entirely, while those sent at night remained, as I have stated, quite strong up to 1,551 miles and were even decipherable up to a distance of 2,099 miles. This result may be due to the diselectrification of the very highly charged transmitting elevated conductor operated by the influence of daylight.

I regret that time does not permit me to give you the views which have been expressed with reference to this phenomenon. I do not think, however, that the effect of daylight will be to confine the working of transatlantic wireless telegraphy to the hours of darkness as sufficient sending energy can be used during daytime at the transmitting station to make up for the loss of range of the signals and therefore this business of communicating across the Atlantic will not be one of those works of darkness with which some people connected with cable companies would seem disposed to class it. It is, however, probable that had I known of this effect of light at the time of the Newfoundland experiments, and had tried receiving at night-time, the results would have been much better than those that were obtained.

The day is rapidly approaching when ships will be able to be in touch and communication with the shore across all oceans and the quiet and isolation from the outside world which it is still possible to enjoy on board ship will, I fear, soon be things of the past.

However great may be the importance of wireless telegraphy to ships and shipping, I believe it will be of even greater importance to the world if found workable and applicable over such great distances as those which divide Great Britain from her colonies and from America.

Any of those who have lived in the colonies will easily appreciate what a hardship it is to have to wait perhaps four or five weeks before receiving an answer to a letter sent home. The cable rates are at present prohibitive to a vast majority of people. May it not perhaps be for wireless telegraphy to supply the want?
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[CODA]

ELECTRICAL REVIEW, December 6, 1902 [at page] 779

A Supplement to Lieutenant Solari's Report on "the Radio-Telegraphic Expedition of H. I. M. S. Carlo Alberto."

In this article Mr. Nevil Maskelyne gives an account of the effect of the messages sent out from Poldhu on his station. This station was located at Porthcurno, Cornwall, for the purpose of signaling to vessels now being fitted for wireless installations, and the author personally superintended the erection of this station and, last August, pending the erection of the mast, set up a scaffold pole carrying a diminutive collecting circuit in order to make preliminary tests and adjustments.

At once he began to receive signals and messages in the Morse code. These signals did not continue all day, but at certain regular times. At each quarter of an hour they began, and continued for about ten minutes. There was a definite plan of working, the signals commencing with a certain call. This was followed by about 200 repetitions of the letter S, next a small item of news, and finally a signature. Copies of the original slips are reproduced in this article.

As Poldhu was about eighteen miles away, the supposition was that these signals came from that point, and the call and signature lent weight to this opinion. As the apparatus installed in this station was not fitted with Marconi's syntonic apparatus, the supposition was that no attempt at syntony was being made at the Poldhu station. A question was raised why this was not done. After erecting the mast and a full-sized collecting circuit, the problem presented was not how to intercept messages from Poldhu, but how to deal with their enormous excess of energy. This was done by relaying the receiving instrument through land lines to the station in the valley below, and all of the Poldhu signals were sent to his house throughout the night and day.

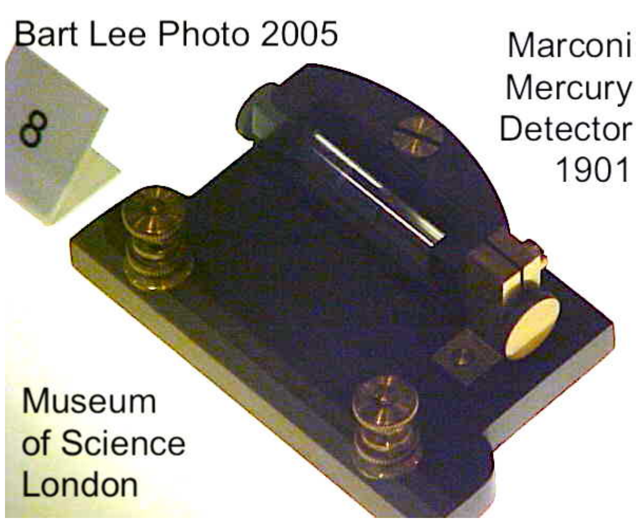
At one time, when the receiving instruments were behaving in a most peculiar manner, examination showed that two messages were being sent simultaneously, and a careful study of the record revealed the fact that this was due to the superimposing of a series of dots upon a regular message. By a suitable choice of capacity and inductance the two sets of signals were separated, and are reproduced in this article. The inference drawn from this is that the signal is in tended to prevent any station nearer than the vessel intercepting the message.

It is stated that a number of signals which were received by the Carlo Alberto so successfully were repeated again and again before the vessel succeeded in recording them. It is further stated that the records at the Porthcurno station show that the speed of transmission was about five words per minute. It is held that a station such as that now operating at Poldhu will upset every other station on land and sea within a radius of 100 miles, and in this way interfere with the chief utility of wireless telegraphy - that of signaling between ship and shore. - *Electrician* (London), November 7 [1902]. ##

Archivist's comment:

This text is very lightly edited, from its Internet source: Google Books, title: New York Review of the Telegraph and Telephone and Electrical Journal, Volume 41, 1902. Marconi's address was widely published at the time; however, technical limitations of reproduction at this late date make reading it a matter of some difficulty.

There follows a photograph of the Mercury Detector that Marconi used to capture, in Newfoundland, the signals from Poldhu, Cornwall in 1901:



And an image of the Marconi Magnetic Detector:

Marconi Magnetic Detector

From the Spark Museum of Electrical Invention (Bellingham, WA), with the permission of John Jenkins.

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Replica coherers, patterned on Marconi's, can be had from time to time. The one that follows participated in sophisticated testing by John Staples (Ph.D.), W6BM, CHRS. CHRS published his remarkable results.

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Marconi mentions two amounts of money in British pounds,

(1) Revenue from wireless massages at sea "as much as £60 each trip" at *Journal* page 75, and

(2) "[A] subsidy of £16,000" from Canada for a wireless station, at *Journal* page 76.

A British pound in 1902 would be the equivalent of about 156 present day (2023) British pounds. So each of those numbers would be:

(1) £9,360 and

(2) £2,496,000.

At the current exchange rate to US Dollars (1.2), those numbers are

(1) $11,232 and

(2) $2,995,200 or, roughly $3,000,000.

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Re Marconi's transatlantic tests in 1901, see:

MARCONI'S TRANSOCEANIC TRIUMPH – A skip into History, By Bartholomew Lee, 13 Antique Wireless Review 81 (2000)

https://www.antiquewireless.org/wp-content/uploads/2000-AWA-Review-Vol-13-1.pdf

https://californiahistoricalradio.com/wp-content/uploads//2011/11/CHRSMarconiTransatlanticLeap.pdf

Re Maskelyne at Porthcurno, Cornwall in 1902 see:

WIRELESS — ITS EVOLUTION FROM MYSTERIOUS WONDER TO WEAPON OF WAR, 1902 TO 1905, By Bartholomew Lee, 25 Antique Wireless Review 147 (2012)

"ABSTRACT, AWA Review *** The following four events are covered 1) Wireless Spying on Marconi at Porthcurno, Cornwall, UK – A First ***"

https://www.antiquewireless.org/wp-content/uploads/Vol.-25.pdf

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Robert Lozier, KD4HSH, AWA Fellow, comments:

"It was delightful to read this lecture transcript.... For decades casual readers of history as disclosed in the popular press have questioned whether Marconi's work in late 1901 was real or not. But here is a lecture delivered only about 7 months after that date giving a clear description of the chain of events leading up to the date of the tests. I have enjoyed the recent writings and recreations of equipment and testing conducted by the likes of Eric Wenaas, [AWA] etc. that reinforce the Marconi claims.

"Some ten years ago I built my own Marconi style magnetic detector. Recreating the iron wire belt was the most difficult part of the project. The joy of hearing the first signals from the local AM broadcast station via my detector was one of the high points of my retirement. ***"

(28 I 2023 v2.3 de K6VK) ##