G. MARCONI.

WIRELESS SIGNALING SYSTEM.

APPLICATION FILED NOV. 27, 1905.

924,168. Patented June 8, 1909.

2 SHEETS—SHEET 1.

Fig. 1

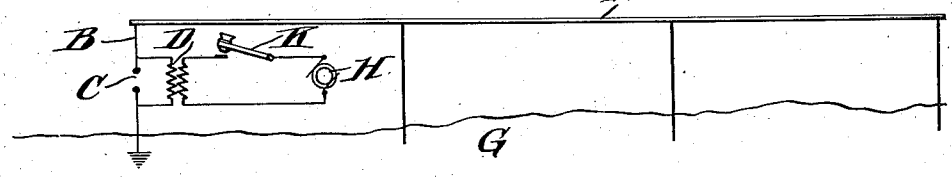


Fig. 2.

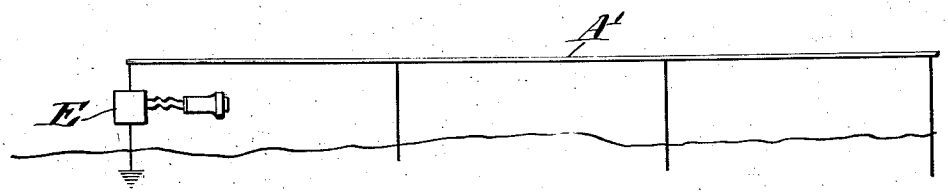
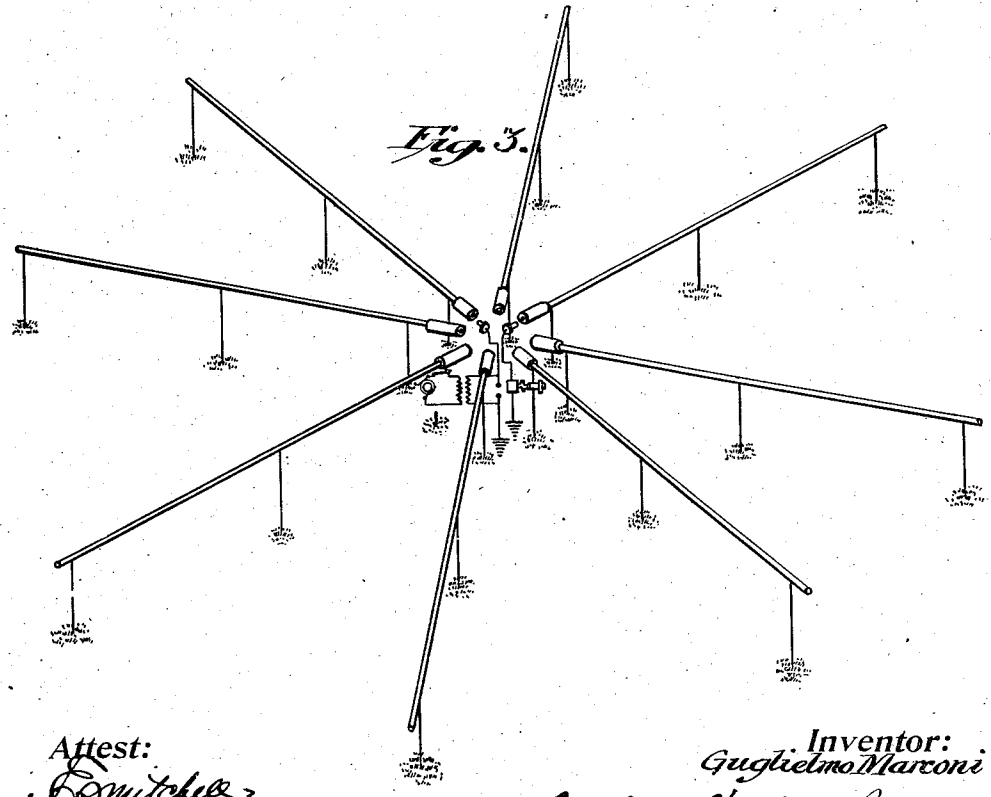


Fig. 3.



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2 SHEETS—SHEET 2.

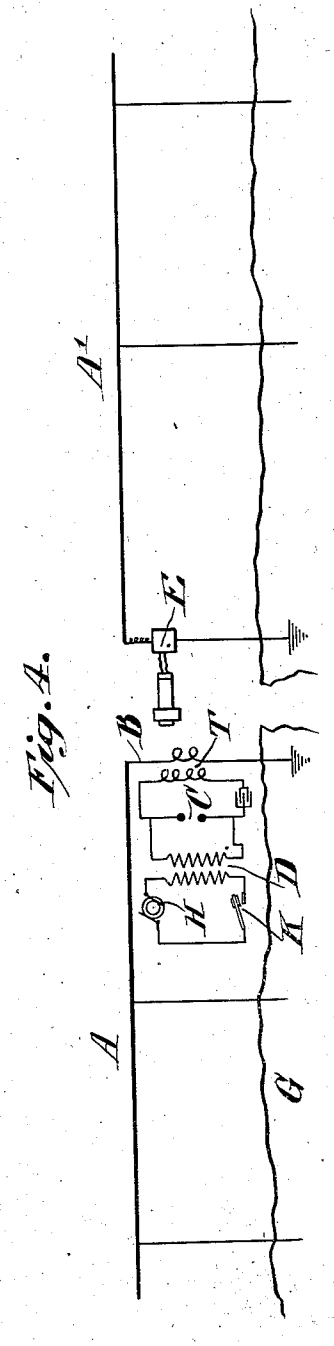


Fig. 4.

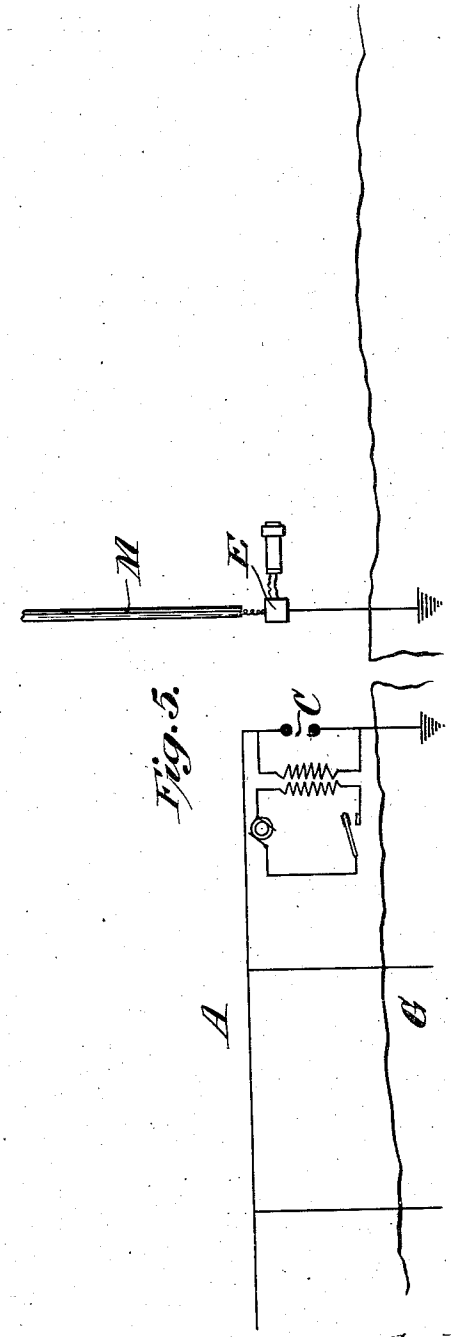


Fig. 5.

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UNITED STATES PATENT OFFICE.

GUGLIELMO MARCONI, OF LONDON, ENGLAND, ASSIGNOR TO MARCONI WIRELESS TELEGRAPH COMPANY OF AMERICA, OF NEW YORK, N. Y., A CORPORATION OF NEW JERSEY.

WIRELESS SIGNALING SYSTEM.

No. 924,168. Specification of Letters Patent. Patented June 8, 1909.

Application filed November 27, 1905. Serial No. 289,327.

To all whom it may concern:

Be it known that I, GUGLIELMO MARCONI, a subject of the King of Italy, residing in London, England, have invented certain new and useful Improvements in Wireless Signaling Systems, of which the following is a specification.

The object of this invention is to provide improved apparatus and systems for communicating electrical signals without wires and by means of Hertz waves or electrical oscillations of high frequency, whereby the efficiency of the apparatus can be greatly increased, and whereby direction can be given to the emitted waves so enabling one station to signal to another without interfering with neighboring stations; and also whereby a receiving station can accurately and definitely ascertain from what sending station the signals are coming.

The object of the invention is accomplished by the apparatus diagrammatically illustrated in the accompanying drawings, in which—

Figure 1 is a diagrammatic illustration of a transmitting station, and Fig. 2 is a similar illustration of a receiving station, showing my improved apparatus in its simplest form; and Fig. 3 is an illustration of an arrangement of my improved antennæ, which may be employed at either a transmitting station, at a receiving station or both. Fig. 4 is a diagrammatic illustration of a sending station and a receiving station, both employing my improved antenna, and Fig. 5 is a diagrammatic illustration of a sending station employing my improved antenna in connection with a receiving station employing the ordinary elevated conductor.

The so-called Hertz waves or etheric disturbances produced by an electric discharge across a spark-gap in the absence of modifying conductors, spread radially outward in ever widening circles from the spark-gap or generating center. When one side of the spark-gap is connected to a vertical radiating conductor, or antenna, and the other side of the spark-gap is connected to earth as in systems now in common use the etheric disturbances radiate from the vertical antenna as a center. In the systems of wireless telegraphy now most commonly used these etheric disturbances or Hertz waves fall upon the vertical antenna at the receiving station and produce therein currents which are led through the detector or receiving instrument to earth. Such waves, in the absence of modifying conductors, affect in equal degree a receiving station located anywhere on a given circumference drawn around the generating center.

I have discovered that if the vertical antenna at the transmitting station is discarded and if there is substituted therefor one or a plurality of parallel or substantially parallel conductors or antennæ disposed in a horizontal or substantially horizontal straight line upon, or at a suitable distance above, the surface of the earth (ground or water) and insulated therefrom (as shown in Fig. 1), then this horizontal antenna serves to direct the Hertz waves or etheric disturbances in a definite direction, which direction is a prolongation of the straight line of the horizontal antenna itself. I have found that if one end of such a horizontal antenna is connected to one side of a spark-gap, the other side of which is earthed, then the Hertz waves or etheric disturbances are principally confined to a straight path which is a prolongation of the line of the antenna from the end to which the spark-gap is connected, and that a receiver at a distance will be operated only if it is substantially within this straight path. Waves are also emitted from the other or "free" end of the antenna, but only to a small extent. The nearer to the ground that the antenna is disposed, the more confined is the path of the radiations, but the antenna may be supported above the ground at a distance small compared to its horizontal length, in which case the radiations are somewhat more powerful, but are not so restricted in direction, and the more the antenna is raised the more do the radiations tend to spread out. By turning the antenna in a horizontal plane about the end to which the spark-gap is connected, signals may be emitted in any desired direction; in other words, to signal to any desired station it is only necessary to turn the antenna so that its "free" end is pointing directly away from that station.

When the horizontal antenna which I have described is used at the transmitting station, any receiving device and arrangement of receiving circuits may be used at the receiving station so long as it is located substantially within the path above described. Thus the vertical antenna now in ordinary use may be employed at the receiving station. (As shown in Fig. 5). I have also found

that a horizontal antenna of the character above described may advantageously be employed at a receiving station. In such case the end of the horizontal receiving antenna nearer to the transmitting station is earthed through a magnetic or other detector. With such an arrangement (as shown in Fig. 2) the receiver is operated principally by waves emitted from a generating center with respect to which the horizontal receiving antenna is radially disposed, or, in other words, the receiver is operated only when the transmitting station is located substantially in a line constituting a prolongation of the horizontal antenna from its end to which the detector is connected, and at a much smaller distance by stations located in a continuation of the same straight line through the "free" end of the horizontal antenna. If, therefore, signals be best received with the antenna in a certain position, the operator will know that the transmitting station is in the line of the antenna; in other words, that its "free" end is pointing directly away from the transmitting station. This receiving antenna may be used with great advantage to determine the direction of a transmitter, say for instance of a ship at sea, whether the transmitting antenna be of the kind above described or any ordinary antenna, such as a vertical antenna now in common use. By bisecting the angle between the limiting positions of the antenna in which signals can be detected, the direction of the transmitter can be ascertained with great accuracy.

I have described above the arrangement of my improved antennæ at a transmitting station and at a receiving station, but it will be understood that I may utilize my improved antennæ at both the transmitting station and the receiving station in the same signaling system. In such case, the two horizontal antennæ should, of course, be arranged in substantial coincidence with the same straight line, as indicated in Fig. 4. In all cases above described, the horizontal antennæ should be insulated from the earth, except for their respective connections through the spark-gap and detector; and it will be understood that when here I say "insulated from the earth" I mean so effectively insulated from the earth that the currents generated by or generating the Hertz waves or etheric disturbances, shall be forced to pass to earth through the detector or wave generator, as the case may be.

Referring to Fig. 1 of the drawings, which shows a transmitting station, A is an antenna supported in substantial parallelism with the surface of the ground, or water G. The end of the antenna A nearer the receiving station is connected, through wire B, to one side of the spark-gap C, the other side of the spark-gap being connected to ground, as illustrated. The terminals of the spark-gap are illustrated as connected into the secondary circuit of a high tension transformer, D, in a way which will be readily understood by those skilled in the art. The primary circuit of this transformer contains a generator, H, of alternating current, and a key, K, for closing the primary circuit.

In Fig. 2 is shown a receiving station in which the antenna A' is supported in substantial parallelism with the surface of the ground, in the manner described. The end of this antenna nearer the transmitting station is connected to one coil of a magnetic detector E, the other end of the coil being grounded. This magnetic detector is of a character which is now well-known, and which is described in a paper entitled "Note on a magnetic detector of electric waves which can be employed as a receiver for space telegraphy," which was presented by me to the Royal Society and published in Volume 70, No. 463, of the Proceedings of the Royal Society.

Fig. 3 is a top plan view of a plurality of horizontal conductors disposed substantially parallel with the surface of the earth, but in which all of them are disconnected from the spark producer, if such conductor is used at the transmitting station, and from the receiving apparatus, if such conductor is used at the receiving station. When now it is desired to transmit a signal or message from the sending station to any particular receiving station, it will be obvious, from what I have described, that all that it is necessary to do is to connect to the transmitting apparatus that particular horizontal wire conductor which is in a substantially coincident line with the receiving station to which it is desired to transmit a message. Similarly, if it is desired to receive a message from any one of a number of transmitting stations located in different localities, all that it is necessary to do is to connect to the receiving station that particular horizontal receiving antenna which is in a coincident line to such sending station.

Fig. 4 illustrates a receiving station and a transmitting station, both employing my improved antenna. At the sending station A is the horizontal antenna connected through a wire B to the secondary coil of the oscillation transformer T. The primary coil of this transformer is connected in a closed resonant circuit with the spark-gap C and the secondary coil of the transformer D and capacity, in the manner which is now well known. The primary coil of the transformer D is connected in circuit with the generator H and the circuit-closing key K. At the receiving station A' is the horizontal receiving antenna and E is a magnetic detector.

In Fig. 5 is illustrated a transmitting horizontal antenna A, grounded through the

spark-gap, C, in the same manner as illustrated in Fig. 1, and at the receiving station I have indicated an elevated conductor M grounded through the magnetic detector E.

When my improved horizontal antenna is used the length of the horizontal conductor should preferably equal one quarter wave length of the waves transmitted or received, or the antennæ should be properly tuned by the addition of suitable inductance and capacity.

Although I have illustrated diagrammatically two arrangements of spark-gap and related circuits at the sending station, and a magnetic detector at the receiving station, I wish it to be clearly understood that the invention is in no way limited to any particular form or arrangement of spark gap circuit connections, or to any particular form of detector and circuit connections, but it may be employed with any arrangement of transmitting apparatus and receiving apparatus, as a substitute for the vertical antennæ and grounded connections which are now in use.

What I claim as my invention, and desire to secure by Letters Patent is:

1. In a wireless signaling system, a terminal station, an antenna situated at said station and disposed substantially parallel with the surface of the earth, the position of the antenna being substantially coincident with the line of direction in which it is desired to transmit or receive signals, said antenna having a connection with earth at its end nearer the distant station, and suitable signaling apparatus in said connection.

2. In a wireless signaling system, a transmitting station, an antenna situated at said station and disposed substantially parallel with the surface of the earth, the horizontal position of the antenna being substantially coincident with the line of direction to a receiving station, and means, having its terminals connected with earth and with an end of said antenna nearer the distant station, for impressing upon said antenna electrical oscillations of high frequency.

3. In a wireless signaling system employing electrical oscillations of high frequency, a receiving antenna comprising a conductor disposed substantially parallel with the surface of the earth and connected with earth at one end and having its free end extended radially but in the opposite direction with respect to the generating center and suitable receiving apparatus interposed in said earth connection.

4. In a wireless signaling system, a plurality of electrically independent antennæ, situated at said station and disposed substantially parallel with the surface of the earth but radiating from a common center, a set of wireless telegraph apparatus at said station, and means for independently connecting any one of the antennæ to said apparatus.

5. In a wireless signaling system employing electrical oscillations of high frequency, a plurality of receiving antennæ situated at one station and comprising electrically independent conductors disposed substantially parallel with the surface of the earth, each of said conductors extending radially in the opposite direction, in relation to its respective generating center, and means for detecting electric signals adapted to be independently connected with any one of said conductors.

In testimony whereof, I have signed my name to this specification in the presence of two subscribing witnesses.

GUGLIELMO MARCONI.

Witnesses:
JAMES J. COSGROVE,
WILLIAM H. DAVIS.