No. 676,332. Patented June 11, 1901.

G. MARCONI.

APPARATUS FOR WIRELESS TELEGRAPHY.

(No Model.) (Application filed Feb. 23, 1901.) 2 Sheets—Sheet 1.

Fig. 1.

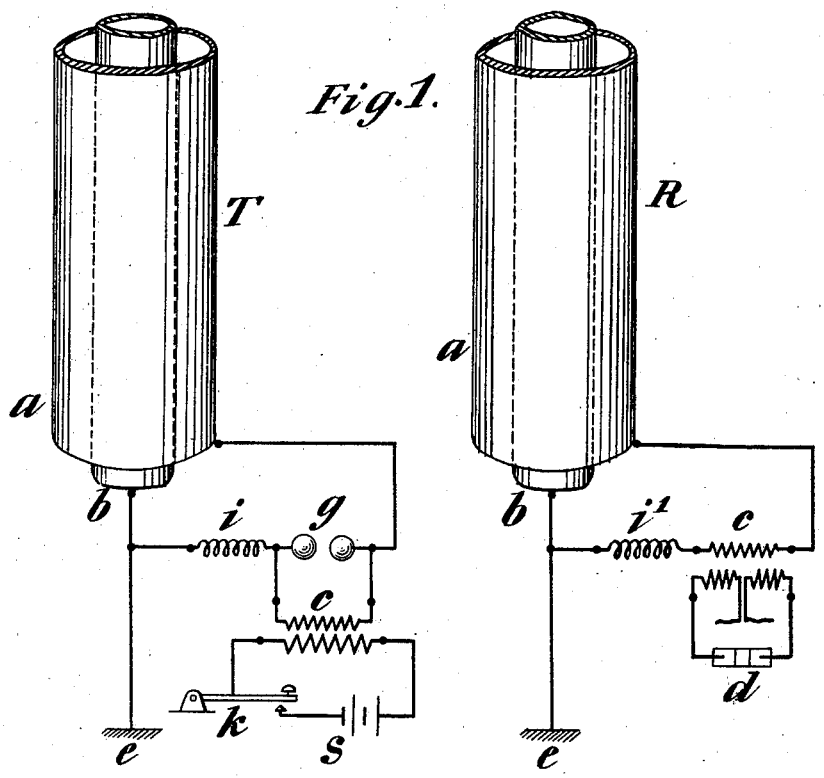

Fig. 2.

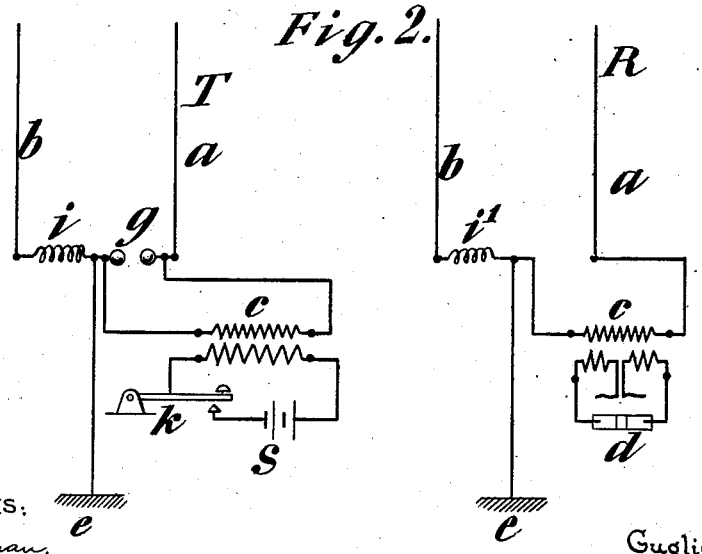

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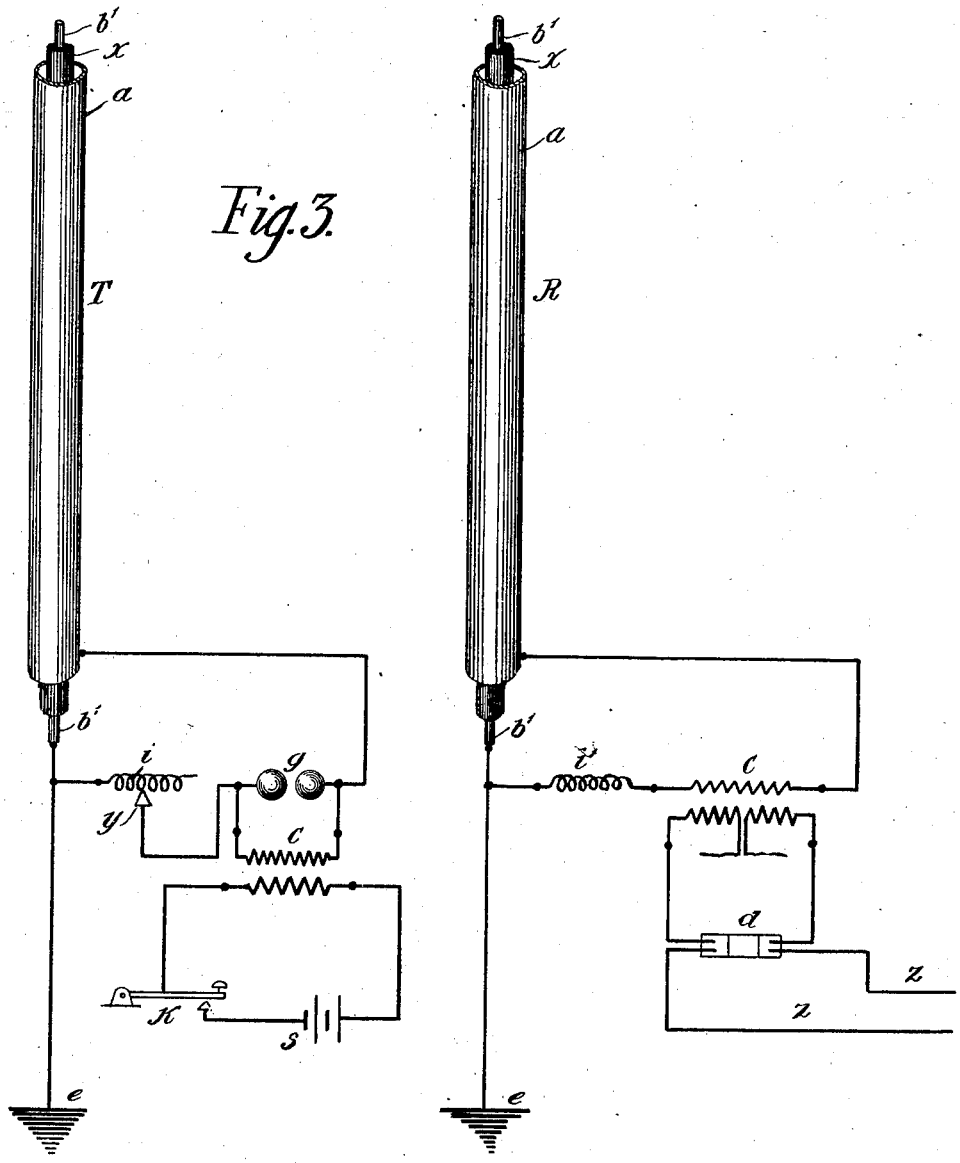
Fig. 3.



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UNITED STATES PATENT OFFICE.

GUGLIELMO MARCONI, OF LONDON, ENGLAND, ASSIGNOR TO MARCONI'S WIRELESS TELEGRAPH COMPANY, LIMITED, OF SAME PLACE.

APPARATUS FOR WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 676,332, dated June 11, 1901.

Application filed February 23, 1901. Serial No. 48,447. (No model.)

To all whom it may concern:

Be it known that I, GUGLIELMO MARCONI, a citizen of the Kingdom of Italy, residing at 18 Finch Lane, Threadneedle street, in the city of London, England, (and having a post-office address at 18 Finch Lane aforesaid,) have invented certain new and useful Improvements in Apparatus for Wireless Telegraphy, (for which I have applied for a patent in Great Britain, dated March 21, 1900, No. 5,387,) of which the following is a specification.

My invention relates to improvements in apparatus for communicating signals and telegraphing electrically without wires, employing at a transmitting-station, a producer of Hertz oscillations controlled by a signaling instrument, and, at a receiving-station, a coherer or other imperfect contact for controlling a sounder, relay, or other device; and the objects of my invention are to increase the efficiency of the system and to provide a means whereby oscillations from a transmitting-station may be localized when desired at any selected receiving station or stations.

In my former patents, especially Nos. 586,193, 624,516, 650,109, and 650,110, I have described means for communicating between two stations situated at a great distance and between which obstacles may intervene.

Referring to the accompanying drawings, which show diagrammatically three embodiments of my new improvements, Figure 1 shows one embodiment of the system wherein the two conductors at each station are arranged concentrically and fixed inductance-coils are employed at each station. Fig. 2 shows a modification having the conductors arranged side by side, and Fig. 3 shows a system having a variable inductance at the transmitting-station and a fixed inductance at a receiving-station.

I have discovered means for greatly increasing the efficiency of the apparatus at the receiving and transmitting stations of the system.

Heretofore, so far as I am aware, each station has been provided with a single aerial conductor for receiving or transmitting electrical oscillations. I have, however, discovered that the communication of signals may be greatly facilitated by the employment at each station of two aerial conductors insulated from each other and to which may be connected conductors leading directly or through a transformer-circuit to a spark-producer or other source of electrical oscillations or to a coherer or other instrument influenced by said oscillations.

I have further discovered that advantageous results are attained by the inclusion in the aerial circuits at both the transmitting and receiving stations of inductances preferably employing (especially at the transmitting-station) inductance-coils capable of wide variations of self-induction, whereby the resonance of the inductances at the transmitting and receiving stations can be harmonized and the receiving apparatus caused to readily respond to the oscillations sent from the transmitting-station.

The aerial conductors at both stations may be disposed in any suitable way, care being taken, however, to thoroughly insulate them from each other. As shown in Figs. 1 and 3, they may consist of inner and outer conductors, (insulated from each other,) and they may be of any desired shape. The inner conductor may be simple or compound—such as a metallic tube *b*, Fig. 1, or a cable or rod *b'*, Fig. 3—and the second conductor *a* may be disposed concentrically around the first named, being preferably insulated therefrom—for instance, by an applied coating X, Fig. 3, of india-rubber, gutta-percha, or other insulent—and the conductors being separated by a surrounding air-space. The conductor *a* may be a metallic tube, as shown in Figs. 1 and 3, or a concentric cable, spiral band, or wire, or even a metal-foil covering. Instead, however, of being arranged concentrically the two conductors *a* and *b* (or *b'*) may be separated in any suitable way. As shown in Fig. 2, they are two parallel vertically-extending rods, wires, or strips insulated from one another by the air alone or by an applied coating. At the transmitting-station I erect one of these double conductors and at the receiving-station a similar one or several of these. At the transmitting-station I preferably connect one of the conductors—for instance, *b*—to one terminal of an induc-

tion-coil capable of giving electric sparks and also connect that terminal to earth. The other terminal of the induction-coil is preferably connected to the other conductor. In series either with the one or the other of the two conductors, at both stations, I place an inductance-coil, preferably of variable inductance. When the two conductors are in concentric form, I prefer to connect the inner one to earth. At the receiving end I provide an inductance-coil in series with either of the two conductors, and preferably with a similar earth connection to one of them, and I connect a suitable form of sensitive tube, coherer, or other Hertz wave-receiving device between the two conductors and the associated inductance-coil. I may also add to the receiving device a telegraphic relay or other receiving device, as a sounder or printing instrument, for receiving or recording messages or otherwise making the received oscillations manifest, in accordance with arrangements described by me in my earlier patents. I usually also insert between the coherer or other receiving device and the termination of the pair of conductors an induction-coil or transformer of a kind suitable for the transformation of very-rapidly-alternating currents, such as are described in patents heretofore issued to me.

In employing my invention to localize the transmission of intelligence to one of several receiving-stations I proceed as follows: At the transmitting end the inductance-coil which I preferably employ is one that may have its self-induction varied over wide limits. At each of the receiving-stations I employ an inductance-coil of fixed inductance, suitably selected. I find that if the inductance-coil at the transmitting-station has its inductance varied until the electrical system composed of the aerial conductor or conductors and the associated inductance-coil is in resonance with that of one of the receiving systems, that one alone of all the receiving systems responds, provided that the distance between the transmitter and receiver is not too small. In this manner by systematic trials I can adjust each receiving instrument to respond to the transmitter when the inductance of that transmitter has a value corresponding to the particular receiving instrument which is to be affected.

Figs. 1 and 2 are diagrams of transmitting and receiving apparatus arranged as above described. T indicates the transmitting system, and R the receiving.

In Fig. 1, *a b* indicate concentric metal cylinders. I have used with success outer cylinders three feet in diameter and inner cylinders one foot six inches in diameter, both twenty feet high. For higher cylinders it is desirable to increase the annular space between the outer and inner cylinders. *g* indicates the spark-gap of an induction-coil or transformer *c*, which is connected to the cylinders *b* and *a*, an inductance-coil *i* being interposed. *s* is the battery, and *k* the key. A Tesla coil may be used to produce the oscillation. At R an induction-coil or transformer *c*, similar to those described in my previous patents and applications, is used and is inserted between the two concentric cylinders *b a* along with an inductance-coil *i'*. The induction-coil or transformer *c* is connected to a coherer or detector *d* of electric waves and a suitable receiver—such, for example, as is described in United States Letters Patent No. 586,193, granted to me—the connection and other details being, for clearness, omitted. The internal cylinders *b* are connected to earth *e* or to a large capacity which may be used in place of earth.

Fig. 2 shows a modification in which two adjacent conductors *a* and *b* are used instead of the concentric cylinders.

Referring especially to Fig. 3, the inductance-coil *i* at T is shown as being capable of variation in power. For this purpose the switch Y or other electrical device adapted to increase or decrease the number of turns of the inductance-coil in circuit may be employed. I do not wish to be understood, however, as confining my invention to a system employing a variable-inductance coil at the transmitting-station and fixed inductance-coils at the receiving-stations. If desired, the inductance at the transmitter may be fixed and the inductance at the receiving-station may be variable. In said figure I have also shown wires Z Z, connected to the coherer *d* and leading to a device which may control the operation of a sounder, printing device, or a decohering mechanism.

I am aware of United States Letters Patent No. 609,154, dated August 16, 1898, to Lodge, of British Letters Patent No. 14,449, of 1899, to Brown, and of German Letters Patent No. 11,578, dated October 14, 1898, to Braun; but none of these contain the distinctive features of my invention. While Lodge shows two large oscillation-producing conductors and an inductance device connected between them, yet in none of these patents is it proposed to use a plurality of aerial oscillation-producing conductors insulated from each other by the air or some other insulating substance and in combination therewith to arrange inductances in what I call the "oscillation-circuits" at the transmitting apparatus—that is, the circuit which extends from one oscillation-producing conductor to the other—by connecting it in series with the conductors and with the oscillation-producer; nor is it therein proposed at the receiving apparatus to include an inductance in what I call a "receiving-circuit" by inserting it in series with two aerial conductors and so locating the coherer or detector as to be influenced by the oscillations in the circuit so formed. In practice I have found that the best result will be secured by dissymmetrically including the inductance in the oscillation and receiving circuits. To obtain the best results in long-

distance wireless telegraphy, it is essential to give to the electrical oscillations a difference in phase, and this is secured by the dissymmetrical inclusion of the inductance in series with the oscillation-producer and with the oscillation-producing conductors at the transmitting apparatus and by the dissymmetrical inclusion of the inductance in the receiving-circuit, with the coherer or detector so arranged as to be readily influenced thereby. Where the inductance is not used in the receiving-circuit, the result will be that both terminals of the coherer will be electrified positively or negatively simultaneously and current will not flow therein. By my preferred arrangement the including of the inductance in the receiving-circuit in such position that the received oscillations will readily pass through the coherer and affect the relay will secure the desired result. Moreover, none of the said patents show the combination at a station of two aerial conductors with an inductance connected in series between them and with a connection from one of said conductors to the earth, which arrangement I have found to be highly advantageous in operation.

While I have herein shown and described embodiments of my invention which I have found to be practical, yet I do not desire to be understood as limiting my claims thereto. Obviously modifications thereof will readily suggest themselves to electricians and to persons skilled in wireless telegraphy.

What I claim is—

1. In apparatus for communicating electrical signals, the combination, at a transmitting-station, of two aerial oscillation-producing conductors insulated from each other; an inductance connected in series with said conductors; a producer of electrical oscillations and a signaling instrument controlling the oscillation-producer.

2. In apparatus for communicating electrical signals, the combination, at a transmitting-station, of two aerial oscillation-producing conductors; an inductance connected in series with said conductors; a producer of electrical oscillations; a signaling instrument controlling the oscillation-producer, and a connection from one of the oscillation-producing conductors to earth.

3. In apparatus for communicating electrical signals, the combination, at a transmitting-station, of two aerial oscillation-producing conductors insulated from each other; an inductance connected in series with said conductors; a producer of electrical oscillations; a signaling instrument controlling the oscillation-producer, and a connection from one of the oscillation-producing conductors to earth.

4. In apparatus for communicating electrical signals, the combination, at a receiving-station, of two aerial oscillation-receiving conductors insulated from each other; an inductance connected in series with said conductors; and an imperfect electrical contact or detector influenced by the received oscillations.

5. In apparatus for communicating electrical signals, the combination, at a receiving-station, of two aerial oscillation-receiving conductors insulated from each other; an inductance connected in series with said conductors; an imperfect electrical contact or detector influenced by the received oscillations; and a connection from one of the oscillation-receiving conductors to earth.

In testimony whereof I have hereunto set my hand in presence of two subscribing witnesses.

GUGLIELMO MARCONI.

Witnesses:
WILLIS UTLEY,
HARRY WARD.