No. 706,747. Patented Aug. 12, 1902.

R. A. FESSENDEN.

APPARATUS FOR SIGNALING BY ELECTROMAGNETIC WAVES.

(Application filed July 22, 1902.)

(No Model.)

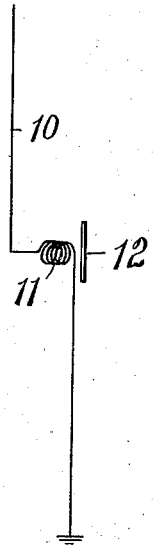
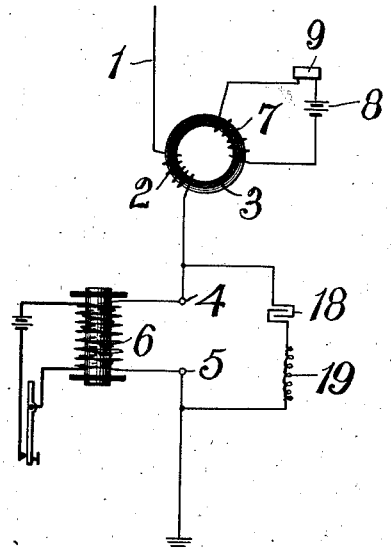


FIG. 1.



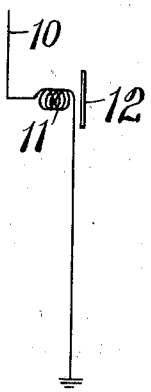
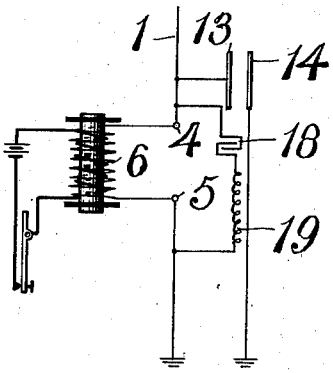


FIG. 2.



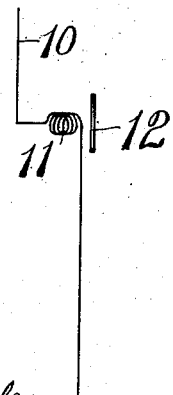
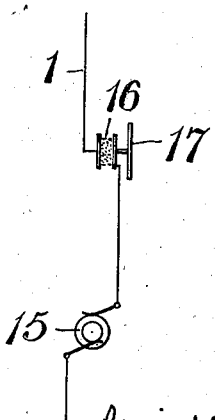


FIG. 3.



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UNITED STATES PATENT OFFICE.

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APPARATUS FOR SIGNALING BY ELECTROMAGNETIC WAVES.

SPECIFICATION forming part of Letters Patent No. 706,747, dated August 12, 1902.

Original application filed September 28, 1901, Serial No. 76,837. Divided and this application filed July 22, 1902. Serial No. 116,483. (No model.)

To all whom it may concern:

Be it known that I, REGINALD A. FESSENDEN, a citizen of the United States, residing at Manteo, in the county of Dare and State of North Carolina, have invented or discovered certain new and useful Improvements in Apparatus for Signaling by Electromagnetic Waves, of which improvements the following is a specification.

The invention described herein relates to certain improvements in apparatus for the wireless transmission of signals by electromagnetic waves, said improvements relating more especially to the transmission and reproduction of words or other audible signals.

In general terms the invention consists in mechanism or apparatus at the sending-station for the generation of electromagnetic waves or impulses and the modification of the character of the waves by sound-waves or other desired means and of suitable mechanism or apparatus at the receiving-station operative by the waves or impulses from the sending-station to give a signal or indication.

By the term "electromagnetic waves" as used herein is meant waves of a wave length long in comparison with the wave length of what are commonly called "heat-waves" or "radiant heat." By "grounded conductor" is meant a conductor grounded either directly or through a capacity, an inductance, or a resistance, so that the current in the conductor flows from the conductor to ground, and vice versa, when the electromagnetic waves are generated.

The invention is hereinafter more fully described and claimed.

In the accompanying drawings, forming a part of this specification, Figure 1 is a diagrammatic view illustrating forms of apparatus for the sending and receiving stations. Fig. 2 is a similar view illustrating a modification of the sending apparatus, and Fig. 3 illustrates a further modification of the sending apparatus.

In the practice of my invention I provide at the sending-station a conductor 1, of suitable construction and arrangement, and connect the same to one terminal of a coil 2, surrounding a core 3, preferably annular in shape and preferably formed of fine iron wire. The other terminal of the coil is connected to one of the knobs or terminals 4 of an induction-coil or other suitable generator 6, capable of producing practically continuous and rapid oscillations in the conductor. The other terminal 5 of the generator is connected to ground. A second coil 7, forming a part of the circuit for the battery 8, is placed on the core 3, and a transmitter 9, preferably microphonic in construction, or other mechanism capable of modifying the current in the circuit is included in the circuit of the battery and coil 7. A capacity 18 and inductance 19 are connected in shunt to the spark-gap for the purpose of maintaining sustained oscillations of practically constant frequency.

The capacity 18 and inductance 19 should be arranged to have the same period of oscillation as the receiving-conductor 10 and the sending-conductor 1. It will be seen that the circuit containing capacity 18 and inductance 19 being connected across the spark-gap forms a parallel circuit in the sending-conductor 1, whose aerial and grounded sections are also connected across the spark-gap. On account of the fact that the circuit 18 19 and the sending-conductor 1 are in parallel and not in series the difference of potential across these two circuits is the same, while the currents in the two circuits are different, this construction being thus differentiated from a series connection in which the circuit 18 19 would be connected electrically between the aerial portion of the sending-conductor 1 and the ground.

At the receiving-station I employ a conductor 10, connected to one terminal of a mechanism capable of responding to oscillations in the conductor 10. A form of mechanism adapted to the purpose consists of a coil 11, having one terminal connected to the conductor and the other terminal grounded. A telephone-diaphragm 12, formed of metal or consisting of insulating material having a metal plate or coil of wire secured thereto or any other suitable construction adapted to vibrate in unison with changes of current produced by the waves radiated from the sending-station, is suitably supported in operative relation to the coil 11. The apparatus at the receiving-station is tuned or made resonant by

any suitable means known in the art to the sending-conductor 1. The terms "tuned" and "resonant" are used herein one to include the other. When an alternating current is set up in the conductor 10, as by waves or impulses from the sending-station, such current acts to repel or attract the diaphragm, according to the time constant of the metal part of the diaphragm, through induced currents set up in the diaphragm.

When the generator is operated, the diaphragm 12 will take up a mean position relative to coil 11, the distance of such position from the coil varying with the intensity of the oscillations in the sending-conductor; but when the current in the circuit of the coil 7 is modified or changed, as by speaking into the transmitter, the permeability of the core 3 is correspondingly changed or modified, thereby producing a corresponding change or modification in the self-inductance and a change in the frequency or the natural period of vibration of the sending-conductor 1, which is thereby thrown out of resonance with a resonating circuit 18 19, connected in parallel to said sending-conductor 1, and due to this failure in resonance, producing a corresponding change or modification in the intensity of the waves or impulses given off by the conductor 1 and in the intensity of the oscillations produced in the receiving-conductor. The changes in the intensity of the oscillations will produce corresponding changes in the mean position of the diaphragm 12, such changes corresponding to the vibrations of the diaphragm of the transmitter, exactly reproducing any of the waves or impulses which affected the transmitter. The same result may be effected by changing the capacity of the conductor 1, as shown in Fig. 2. To this end the conductor 1 is connected to a fixed plate 13 of a condenser, while the other plate 14 is formed by or connected to a diaphragm capable of responding to waves or impulses. As the plate 14 in vibrating moves toward or from the other plate the capacity of the conductor 1 is changed, correspondingly altering the intensity of the waves or impulses generated by the conductor.

Instead of using an induction-coil and spark-gap an alternating-current generator of high periodicity—as, for example, of fifty thousand per second—may be used, as shown in Fig. 3. It is preferred that the generator should be of the character described in application Serial No. 62,301, filed March 29, 1901. One terminal of the generator 15 is connected to the sending-conductor and the other terminal to ground. A microphonic contact 16 may be interposed, as shown, in the circuit of the sending generator and conductor, the microphonic contact forming part of a carbon transmitter, the diaphragm of which is indicated at 17. The microphonic contact should be of the kind used in what are known as "speaking" arc-lights and capable of working with currents of ten to one hundred amperes or more if the waves generated are very intense. Its operation is as follows: The sending-conductor has its natural period in resonance with the period of the dynamo, and the amount of the resonant voltage depends upon the resistance of the microphonic contact. Hence speaking against the diaphragm the amount of the voltage is changed to correspond with the sound-waves. This microphonic contact may also be used in place of the variable inductance shown in Fig. 1 or the variable capacity shown in Fig. 2 in connection with the induction-coil and the auxiliary circuit 18 19.

It is characteristic of my improvement that waves or impulses are generated at the sending-station and received at the other station and that the signaling is effected not by interruption of the flow of waves or impulses, but by a modification or change in the character of the waves or impulses. Many ways of modifying or changing the waves will readily suggest themselves to those skilled in the art, and hence as regards the broader features of my invention I do not limit myself to any particular mechanism for modifying the waves or impulses. The term "signaling" is used herein in a broad sense, and especially as including the transmission and receipt of words, sounds, characters, &c.

No claim is made herein to my improved method of signaling by electromagnetic waves or impulses as the same forms the subject-matter of application Serial No. 76,837, filed September 28, 1901.

I claim herein as my invention—

1. In a system of signaling by electromagnetic waves, the combination of means for the practically continuous generation of electromagnetic waves or impulses, means for modifying or changing the character of such waves or impulses without interruption of their continuity, and an indicating means or mechanism at the receiving-station operative by the electromagnetic waves or impulses, substantially as set forth.

2. In a system of signaling by electromagnetic waves, the combination of means for the practically continuous generation of electromagnetic waves or impulses, means for continuously modifying or changing the character of such waves or impulses without interruption of their continuity, and an indicating mechanism at the receiving-station operative by the electromagnetic waves or impulses, substantially as set forth.

3. In a system of signaling by electromagnetic waves, the combination of means for generating electromagnetic waves or impulses, means for modifying or varying the character of a portion of such waves or impulses without interruption of their continuity, and an indicating mechanism at the receiving-station operative by the electromagnetic waves or impulses, substantially as set forth.

4. In a system of signaling by electromag-

netic waves, the combination of means for the generation of electromagnetic waves or impulses of uniform character, means for continuously modifying or varying the character of a portion of such waves or impulses without interruption of their continuity and an indicating mechanism at the receiving-station operative by the electromagnetic waves or impulses, substantially as set forth.

5. In a system for transmitting sounds by electromagnetic waves, the combination of means for the generation of electromagnetic waves or impulses, means operative by sound waves or impulses for modifying or varying the character of the electromagnetic waves or impulses without interruption of their continuity, and mechanism at the receiving-station operative by the electromagnetic waves or impulses, substantially as set forth.

6. In a system of signaling by electromagnetic waves, the combination of means for the practically continuous generation of electromagnetic waves or impulses normally of a predetermined character, means for changing the electrical constants of the sending-conductor so as to change the degree of resonance between the generator and the sending-conductor and thereby modify or change the character of such waves or impulses without interrupting their continuity, and mechanism at the receiving-station operative by the electromagnetic waves or impulses, substantially as set forth.

7. In a system of signaling by electromagnetic waves, the combination of means for the practically continuous generation of electromagnetic waves or impulses, means for modifying or changing the intensity of said waves or impulses without interrupting their continuity and a receiving-conductor tuned to correspond with the sending-conductor, whereby the receiving-conductor will be effected by the electromagnetic waves or impulses during only a portion of the time, substantially as set forth.

8. In a system of signaling by electromagnetic waves, the combination of means for the practically continuous generation of electromagnetic waves or impulses, and means for changing the resistance in the sending-conductor, thereby modifying or changing the intensity of the electromagnetic waves or impulses without interrupting their continuity, substantially as set forth.

9. In a system of signaling by electromagnetic waves, the combination of means for the practically continuous generation of electromagnetic waves or impulses normally of a predetermined character, means for modifying or changing the character of such waves or impulses without interruption of their continuity, and mechanism at the receiving-station operative by the electromagnetic waves or impulses, substantially as set forth.

10. In a system of signaling by electromagnetic waves, the combination of means for the practically continuous generation of electromagnetic waves or impulses normally of a predetermined character, means for continuously modifying or changing the character of such waves or impulses without interruption of their continuity and indicating mechanism at the receiving-station operative by the electromagnetic waves or impulses, substantially as set forth.

11. In a system for the transmission of sounds by electromagnetic waves, the combination of means for the generation of electromagnetic waves or impulses normally of uniform character and means operative by sound waves or impulses for modifying or changing the character of the electromagnetic waves or impulses without interruption of their continuity, substantially as set forth.

12. In a system of signaling by electromagnetic waves, the combination of means for the practically continuous generation of electromagnetic waves or impulses of uniform character, means for modifying the character of said waves or impulses without interruption of their continuity and indicating mechanism at the receiving-station operative by the electromagnetic waves or impulses, substantially as set forth.

13. In a system of signaling by electromagnetic waves or impulses, the combination of means for the practically continuous generation of electromagnetic waves or impulses of constant periodicity, means for modifying or changing the intensity of such waves without interruption of their continuity and an indicating mechanism at the receiving-station operative by the electromagnetic waves or impulses, substantially as set forth.

14. In a system for transmission of speech by electromagnetic waves the combination at the sending-station of means for the practically continuous generation of electromagnetic waves a telephone-transmitter for modifying the character of the waves or impulses, and a telephone-receiver at the receiving-station responsive to currents generated by the electromagnetic waves, substantially as set forth.

15. In a system of signaling by electromagnetic waves, the combination of means for the practically continuous generation of electromagnetic waves or impulses of constant periodicity, means for changing the resistance of the sending-conductor, thereby modifying or changing the intensity of such waves or impulses without interruption of their continuity, and an indicating mechanism at the receiving-station operative by the electromagnetic waves or impulses, substantially as set forth.

In testimony whereof I have hereunto set my hand.

REGINALD A. FESSENDEN.

Witnesses:
LOUIS DORMAN,
OVID ST. MARIE.