No. 749,372. PATENTED JAN. 12, 1904.

L. DE FOREST.

ART OF WIRELESS TELEGRAPHY.

APPLICATION FILED JUNE 4, 1903.

NO MODEL.

Fig. 1.

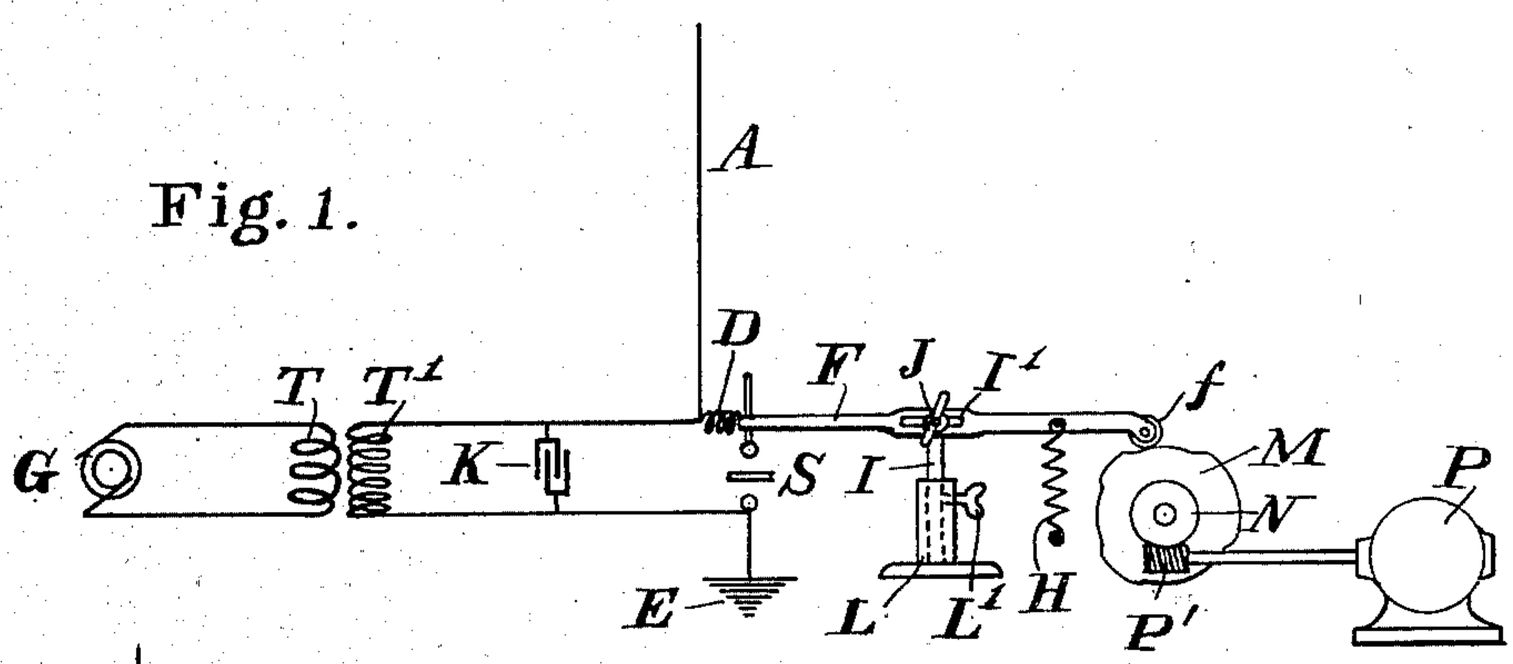


Fig. 2.

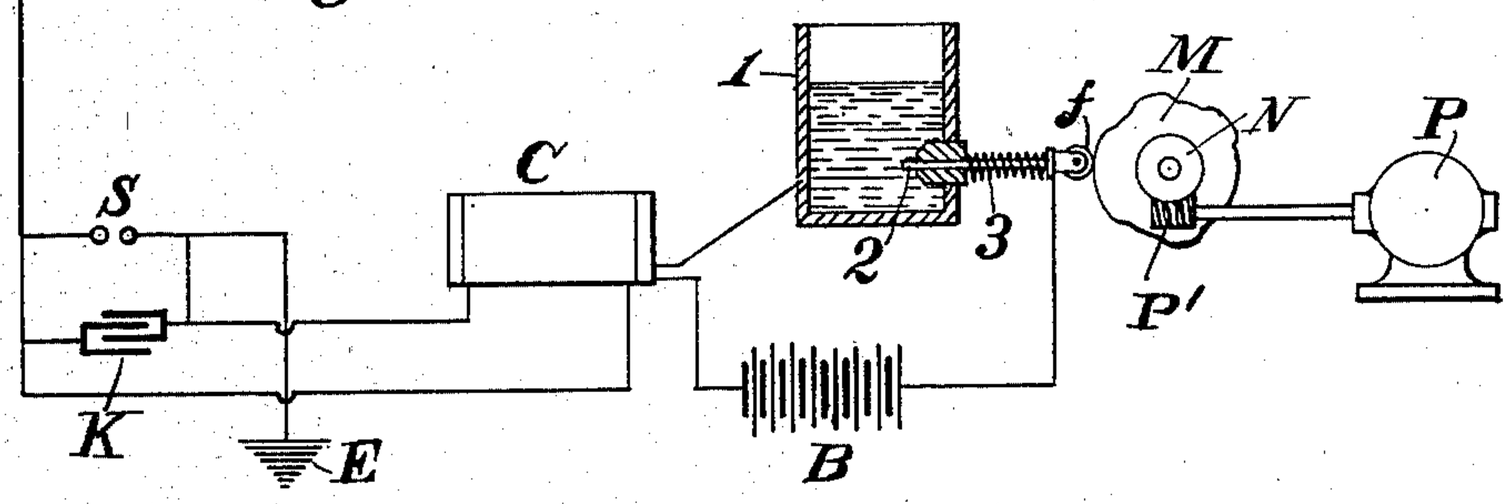


Fig. 3.

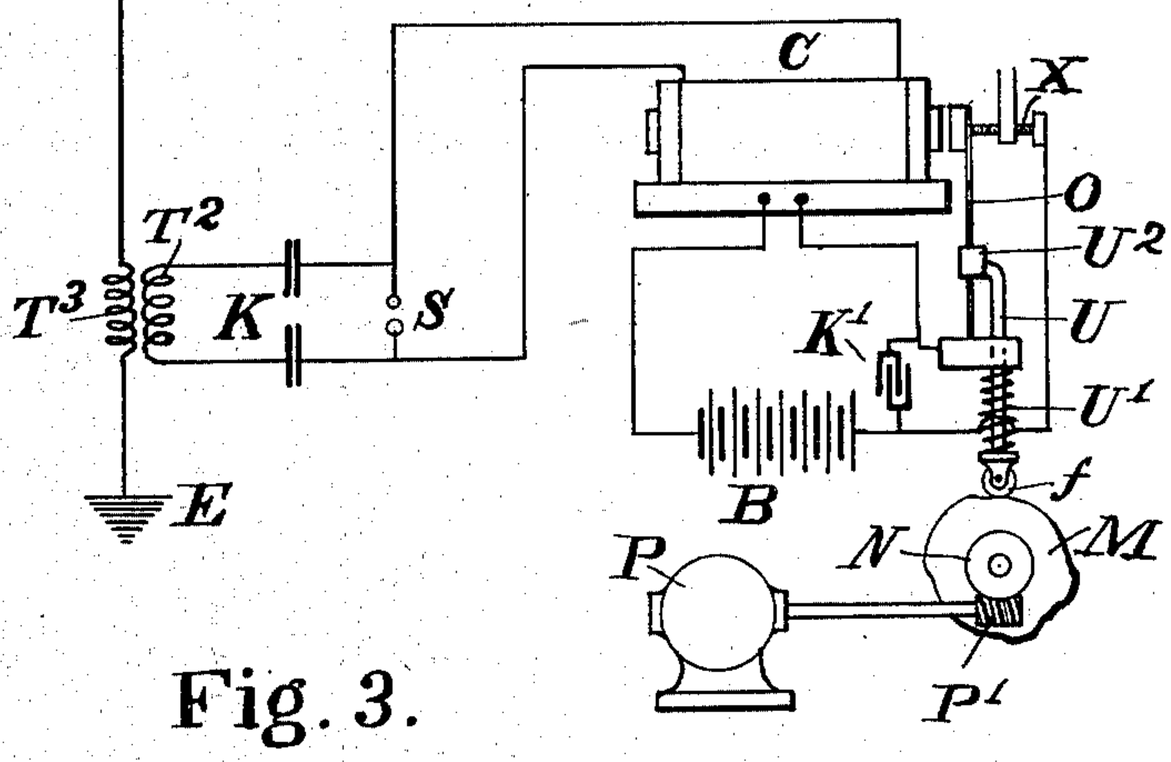
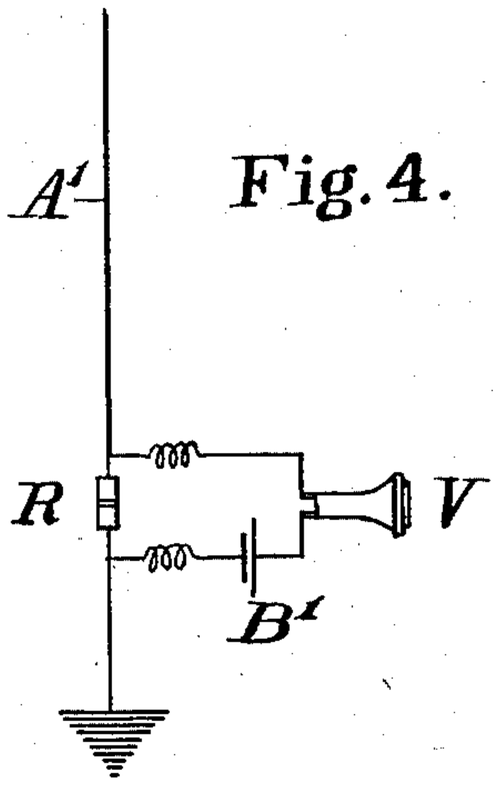


Fig. 4.



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No. 749,372. Patented January 12, 1904.

UNITED STATES PATENT OFFICE.

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ART OF WIRELESS TELEGRAPHY.

SPECIFICATION forming part of Letters Patent No. 749,372, dated January 12, 1904.

Application filed June 4, 1903. Serial No. 160,028. (No model.)

To all whom it may concern:

Be it known that I, LEE DE FOREST, a citizen of the United States, and a resident of the city, county, and State of New York, have invented certain new and useful Improvements in the Art of Wireless Signaling, of which the following is a specification.

My invention relates to an improvement in the method of transmitting and receiving signals by means of electric radiations which are transmitted aerially or without wires.

My invention is particularly designed for use in conveying warning-signals in such places and under such circumstances as a siren or foghorn is now used, although it will be evident that it may be employed for many other purposes than this.

One object of my invention is to provide a method of wireless signaling of such simplicity and reliability that it may be used by any one of ordinary intelligence without any special preliminary training.

The purpose and scope of my invention will appear from an inspection of the following specification and the claims terminating the same.

In the drawings accompanying herewith I have shown forms of apparatus which may be employed in carrying out my invention, the same being those now preferred by me.

Figure 1 diagrammatically shows an apparatus designed for radiating signals in accordance with my invention. Fig. 2 shows a sending apparatus employing an induction-coil and a Wehnelt interrupter. Fig. 3 shows a sending apparatus employing an induction-coil and an interrupter of the hammer type, and Fig. 4 is a diagrammatic illustration of apparatus for receiving such signals.

If an apparatus for receiving signals sent by aerial electric waves be provided with a wave-responsive device which is automatic or self-restoring and capable of sufficiently rapid changes in its condition and if with such a device a telephone-receiver or other audible translating or indicating device be employed, the emission of a continuous series of waves by the transmitter will produce a continuous sound in the receiver, the tone of such sound being determined by the frequency of the spark employed at the transmitter. Each spark produces its distinct and separate sound, and in accordance with the laws of sound the pitch or tone of the sound depends upon the rapidity with which the sound elements or waves follow each other. If, therefore, means are provided whereby the spark frequency may be arbitrarily varied in any predetermined manner and amount, the tone of the sound may be made to rise and fall, and this, together with the duration of any particular tone, as well as the order of succession of the changes and their intermittence, may be employed to transmit signals. Any other form of receiver which will indicate variations in spark frequencies may be employed as a substitute for the telephone-receiver. I prefer, however, to employ the telephone-receiver, as it is a reliable and simple instrument with which most persons are familiar.

The above-stated result will follow whatever the means by which the spark frequency is changed. I have, however, found that when an alternating-current source of electromotive force as a generator is employed the spark frequency may be sufficiently varied for this purpose by varying the distance between the sparking terminals. This, it is evident, may be carried out by a numerous variety of mechanisms.

In carrying out my present invention I employ a radiating conductor of any suitable type and means for impressing thereon oscillatory impulses of a high frequency and at the same time varying the frequency of recurrence of the sparks producing such oscillatory impulses in any desired manner, thereby creating in a suitable receiving instrument a tone which rises and falls in accordance with the variations produced in the frequency of the exciting-sparks. At the same time I may whenever desired break the continuity of the spark, thus further individualizing and differentiating the signals.

Referring to Fig. 1, which illustrates a sending apparatus employing an alternating generator, A represents the radiating antenna, to which is connected one of the terminals of the spark-gap S, the other terminal being connected with a ground E. The oscillatory im-

pulses are herein shown as produced by means of an alternating generator G, which is connected with the primary T of a transformer, the secondary T′ of said transformer being in the oscillating system, which is connected with the two terminals of the spark-gap, said system also preferably containing a condenser K, connected across the terminals of the spark-gap. This method of producing the desired oscillations is illustrated merely as a common and convenient method. Any method or apparatus for producing such oscillations may, however, be substituted therefor.

The terminals of the spark-gap S are so mounted that they may have relative movement toward and from each other. Any method of mounting which secures this result may be employed. I have shown this result as being secured by mounting one of the spark-terminals upon a lever F, which is pivoted upon an adjustable pivot J. This pivot-point may be and is herein shown as adjustable both in elevation and in distance from the spark-gap, so that the amount of movement of this terminal as well as the location of the path of its movement relative to the other terminal may be adjusted. The method herein shown for securing such adjustments consists in providing both the lever F and a standard I, upon which it is pivoted, with a horizontal slot I′, adapted to receive a clamping pivot-bolt J, and also by carrying the standard A in a base L, within which it may be vertically adjusted and held in position by a clamping-bolt L′. The lever F carries a roller *f* upon the end opposite the spark-terminal, said roller being held in engagement with a cam M by means of a spring H or other suitable device. The cam M is herein shown as being a disk having a series of projections thereon adapted to raise the roller *f* and hold it raised for a short time. These elevations may be varied in height, in extent, and in separation and also may be made to succeed each other in various orders, thereby enabling a further range of variations in the signals produced. The cam is designed to be continuously rotated at substantially uniform speed, which rotation may be secured by any suitable means—such, for instance, as the worm P′, the worm-wheel N, and the electric motor P. The mechanism employed for this purpose is, however, immaterial. A direct-current source of electromotive force may, however, be employed to carry out my invention. Devices designed to use such a source of electromotive force are shown in Figs. 2 and 3. The device shown in Fig. 2 employs an induction-coil C, a source of direct-current electromotive force, as the battery B, and a Wehnelt interrupter. This interrupter comprises a lead cell or jar 1, containing an acid electrolyte and a platinum point 2, which passes through a gland or stuffing-box in the side of the jar and projects a variable amount into the electrolyte. The spark frequency with this device depends upon the area of surface of this platinum point or rod which is exposed. This rod or an extension thereof extends outward of the jar and is held against the surface of cam M by a spring 3. As the cam revolves the rod 2 is forced inward and outward alternately under the action of the cam and the spring, thus varying the exposed surface of rod 2, and thereby changing the frequency of the sparks produced. In Fig. 3 an induction-coil device employing an interrupter of the hammer type is shown. This has an armature mounted upon a spring-arm O and attracted by the core of the induction-coil, one side of the battery B being connected through the coil C with the spring-arm O and the other with a contact-pin X, with which the spring-arm normally makes a contact, which is broken by the attraction of the coil when current passes therethrough. One element determining the period of such an interrupter is the free length of the arm O. I have shown a block U^2 embracing this arm and movable lengthwise thereof to vary its period. This block is carried by a rod U, which is mounted to slide in suitable guides and at one end bears upon a cam M, upon which it is held by a spring U′. This cam may be turned by any suitable means, those shown being such as have been hereinbefore described. Numerous other mechanisms may be employed to secure the same result. Those described have been given only as examples of simple and desirable forms of devices for use in carrying out my invention.

It is evident that with any of the forms shown the cam may be made to break the energizing-current to the spark-gap, if desired, so as to combine breaks in the sound with the variations in tone, thus enabling a greater variation in signals to be obtained. The receiving apparatus employed for such a message may be any form of wireless-telegraph receiver which is self-restoring or automatic in its action, combined with an indicating instrument which produces an audible sound or other manifestation which varies in accordance with the variations in the spark frequencies. In Fig. 4 I have illustrated a simple form of apparatus which may be employed. This consists of a collecting conductor or antenna A′, a wave-responsive device R, connected in series in said antenna and the earth E, and a local circuit which contains a battery B′ and a telephone V, the same being connected on opposite sides of the wave-responsive device, so as to include the same therein.

In using my method for conveying warning-signals it is designed that a sending apparatus shall be placed at the point from which it is desired to send the signals. This point may for purpose of illustration be assumed to be a location upon a shore from which it is de-

sired to warn approaching vessels of their proximity thereto. In such case when the shore is not visible, so that warning may be conveyed in that way, my method would be employed and the sending apparatus being put in action would emit a constant series of waves produced by sparks which vary in their frequency in accordance with a prearranged plan. In order that a vessel may avail itself of this warning, it is necessary that it should be equipped with a wireless receiving apparatus of the character herein indicated, in which case as soon as it came within the field of the waves radiating from the sending-antenna its receiver would emit a sound which would rise and fall in tone in correspondence with the character of the waves emitted. The variations characteristic of the various stations being known by means of a chart or table, the person receiving such signals aboard the vessel would know of his proximity to a particular station and would thus be warned of approach to shore in cases where other means would fail. The use of my method of signaling is, however, not confined to communicating signals from shore to vessel, but may be employed to give warning of the approach of two vessels toward each other. By use of a code previously arranged such signals may be made to indicate the course which each vessel is pursuing, and will thus tend to prevent collision. It is possible to quickly change from one signal to another, as by changing cams. In a similar way by using a code my methed may be employed for the transmission of numerous messages.

While I have heretofore described the emission of the waves as being continuous, it is evident that they may be emitted for a certain period of time and then intermitted for a certain period of time, thereby further increasing the means by which different stations may be indicated and also preventing the signal sent out by one vessel from interfering at all times with the signal sent out by another vessel. This method of operation may also be used to indicate the beginning and ending of a complete signal. When so operated, the action of the device would be still more analogous to the method of operation of a whistle or foghorn as a warning.

The receiving apparatus for use in carrying out my invention may be made very simple and reliable, so that any one of ordinary intelligence may keep it in good condition. No knowledge of a telegraphic code or special ability, such as is required for using such a code, is needed. Any one with a chart before him may identify the signal sent in the same way as mariners identify the various lights by their color and time of exposure.

Having thus described my invention, what I claim, and desire to secure by Letters Patent, is—

1. The method of wireless signaling which consists in radiating a continuous series of high-frequency, electrical waves having a spark frequency varied in a predetermined cycle and in therewith producing at the receiving-stations manifestations which vary in accordance with the variations in spark frequency.

2. The method of wireless signaling which consists in radiating a continuous series of high-frequency, electrical waves having a spark frequency varied in a predetermined cycle and in therewith producing sounds which vary in pitch or tone in accordance with the variations in spark frequency.

3. The method of wireless signaling which consists in radiating high-frequency, electrical waves varied in their mechanical frequency in a predetermined cycle and in therewith producing at the receiving-station manifestations which vary in a corresponding cycle.

4. The method of wireless signaling which consists in radiating high-frequency electrical waves varied in their mechanical frequency in a predetermined and recurring cycle and in therewith producing manifestations at the receiving-station varying in the same cycle.

5. The method of communicating a warning-signal which consists in emitting a recurring series of high-frequency electrical waves varying both in their spark frequencies and in their continuity in accordance with a predetermined cycle, and in translating said waves into audible sounds.

6. The method of communicating a warning-signal which consists in emitting a recurring series of high-frequency electrical waves varying both in their spark frequencies and in their continuity in accordance with a predetermined cycle, and in producing thereby manifestations which vary in accordance with the variations in said waves.

In testimony whereof I have hereunto affixed my signature, this 16th day of May, A. D. 1903, in the presence of two witnesses.

LEE DE FOREST.

Witnesses:
P. A. HALL,
H. L. REYNOLDS.