R. A. FESSENDEN.

APPARATUS FOR THE TRANSMISSION AND RECEIPT OF ELECTRICAL ENERGY.

APPLICATION FILED NOV. 22, 1907. RENEWED FEB. 19, 1915.

1,141,453. Patented June 1, 1915.

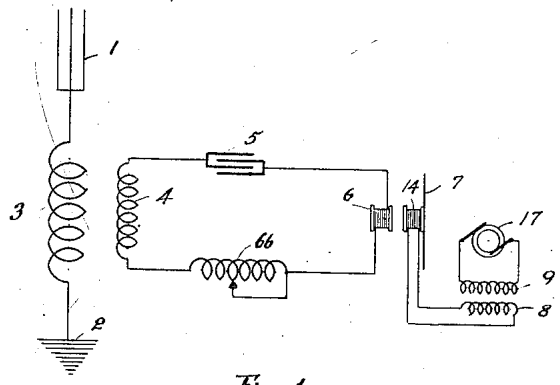

Fig. 1.

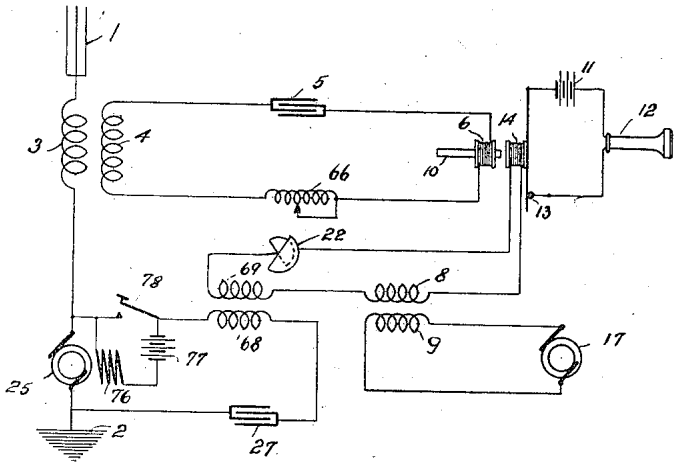

Fig. 2.

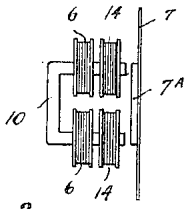

Fig. 3.

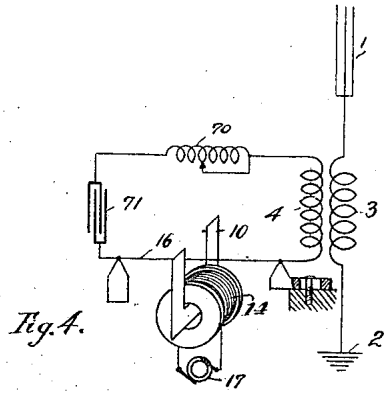

Fig. 4.

WITNESSES:
Jessie E. Bent.
Adeline Wolever

INVENTOR:
Reginald A. Fessenden
by F. W. K. Clay, atty.

UNITED STATES PATENT OFFICE.

REGINALD A. FESSENDEN, OF BRANT ROCK, MASSACHUSETTS, ASSIGNOR, BY MESNE ASSIGNMENTS, TO SAMUEL M. KINTNER, OF PITTSBURGH, PENNSYLVANIA, AND HALSEY M. BARRETT, OF BLOOMFIELD, NEW JERSEY, RECEIVERS.

APPARATUS FOR THE TRANSMISSION AND RECEIPT OF ELECTRICAL ENERGY.

1,141,453. Specification of Letters Patent. Patented June 1, 1915.

Original application filed August 26, 1904, Serial No. 222,301. Divided and this application filed November 22, 1907, Serial No. 403,286. Renewed February 19, 1915. Serial No. 9,417.

To all whom it may concern:

Be it known that I, REGINALD A. FESSENDEN, a citizen of the United States, residing at Brant Rock, in the county of Plymouth, State of Massachusetts, have invented certain new and useful Apparatus for the Transmission and Receipt of Electrical Energy, of which the following is a specification.

The invention herein described relates generally to the transmission and receipt of electrical energy and more particularly to telegraphy by means of oscillating currents and still more specifically to wireless telegraphy by means of electro-magnetic waves.

This application is a division of my copending application No. 222,301 filed August 26th, 1904, and the process here set forth is claimed in my other divisional application No. 403,285, of November 22d, 1907.

In the accompanying drawing Figure 1 is a diagram illustrating receiving apparatus, and Fig. 2 shows a modified form for mounting the coils therein. Figs. 3 and 4 illustrate modified arrangements as will hereinafter be described.

In the practice of this invention I employ for producing an indication, the interaction between currents or voltages produced by the received oscillations, (preferably the former) and currents or voltages produced by a local source which is practically continuous in operation and which generates oscillations of a frequency different from the oscillations received, such difference of frequency being preferably slight and of predetermined degree.

Thus in Fig. 1, 1 is an aerial grounded at 2, 3 the primary of a transformer whose secondary 4 forms part of a circuit comprising a condenser 5, a coil 6, and with or without the additional inductance 66. 14 is a coil placed in inductive relation to the coil 6. The coil 6 may, if desired, have a magnetic core 10, as shown in Fig. 2, preferably consisting of extremely fine iron wire or sheet. The coil 14 is preferably fastened to a diaphragm or spring 7 and may be used directly as a telephone, or otherwise as shown in Fig. 2, it may move the contact or microphone 13 attached to it and connected with a battery 11 and indicating instrument 12. In Fig. 1, 17 is a source adapted to continuously maintain oscillations preferably of a constant strength and of a frequency slightly different from that of the oscillations which it is desired to receive. This source is operatively connected in any convenient manner, as for example by means of a transformer 8, 9, with the coil 14.

In operation the wireless conductor is tuned either approximately or exactly to the oscillations which it is desired to receive, and also the circuit, 4, 5, 6, 66 is preferably tuned to the frequency of the oscillations which it is desired to receive. The currents generated in the coil 6 by the received oscillations interact with the magnetic field produced in 14 by the source 17. Obviously, as an alternative to the arrangement of Fig. 1, the coil 6 may be attached to the diaphragm 7, and 14 may be fixed. The described interaction between the two fields produced by the two coils causes the diaphragm 7 to move and produce an indication, preferably by the beats produced. A much stronger indication is produced by this interaction between the currents generated by the received electro-magnetic waves and the locally generated magnetic field than would be produced by the currents due to the received waves alone, because the locally generated magnetic field may be made to have any strength desired.

It is characteristic of this invention that the locally generated alternating magnetic field is excited continuously and not intermittently as by a spark discharge. The duration of a single oscillation produced by a spark is in the neighborhood of one four-millionth of a second. If we consider a train of twenty oscillations or twenty complete waves, such as is commonly used in this art, this train of waves will last for approximately one one-hundred-thousandths of a second. Even if the train of waves should be prolonged to one hundred complete periods, the total duration of the train of waves would only be one twenty-thousandths of a second. The apparatus commonly used in the art for producing electrical discharges gives from five to one hun-

dred and twenty sparks per second. Taking a figure near the higher number, say one hundred sparks per second, it will be seen that the duration of the train of waves is only one two-hundredths part of the interval between successive sparks even through the train of waves contains two hundred oscillations and there are one hundred sparks per second. From this it will be seen that the chance of a train of waves sent out from a sending station being received at a receiving station coincidentally with the production of a train of waves by a local source generating merely successive separate trains of waves rather than continuous oscillations, is only as one to two hundred, and any practical coincidence could not be expected more than once in several seconds. It is also characteristic of my method and of this apparatus that the frequency of the locally generated magnetic field should not be exactly the same as that of the oscillations which it is desired to receive, for in this case the chances are even that the phase difference should be such that no indication would be produced, since no slow beats are produced. It is furthermore preferred that the difference in frequency should be small, because if the difference in frequency be large, the beats will occur at such rapid intervals as to produce an inaudible indication, where a telephone diaphragm is used as in indicator, or else a weak indication, through the inability of the diaphragm or spring 7 to respond quickly.

It will be evident that the number of beats produced per second will depend upon the difference between the transmitted frequency and the local frequency, and as this may be varied, this affords a means of distinguishing between different stations, and where the receiving mechanism is made selective to the beat frequency, means of cutting out all stations except these with which it is desired to communicate.

Where the signals are produced by the interaction of voltages instead of currents a corresponding appropriate type of receiver is used, as for example an electro-static telephone receiver. This method may be used for simultaneously sending and receiving, as shown in Fig. 2, where a source of oscillating currents 25 is operatively connected to the wireless conductor 1, 2 and so arranged as to generate oscillations in the aerial 1. This source is also operatively connected, as by the transformer 68, 69 (with or without the use of the capacity 27,) with the coil 14, in such a way that when the key 78 is depressed so as to cause oscillations to be generated in the wireless conductor, (by thus closing the circuit containing the field coil 76 and local battery 77 as is well known,) oscillations of the same frequency and of the same duration are caused to occur in the coil 14, and the respective phases of the oscillations of this frequency thereby generated in the coils 6 and 14 are arranged as by adjusting the condenser 22 so as to be 90 degrees apart. The currents then produce no effect on microphone 13, or at most a continuous effect in one direction, so long as the oscillations persist. By this means the effect of the oscillations generated by 25 upon the receiver is neutralized and may be rendered entirely inappreciable, especially where the receiver is tuned to respond to a given mechanical frequency; thus allowing sending without disturbing the receiving apparatus. The condenser 27 also may be used for controlling the phase of the oscillations generated in the circuit 68, 27, 25.

Fig. 3 shows an alternative arrangement wherein the coils 6 and 14 are both mounted upon a single magnetic core 10, the diaphragm or spring 7 having a piece of finely laminated magnetic material 7^a fastened to it. By the interaction of the two coils the diaphragm is affected similarly as when making one of the coils 6 and 14 fixed and the other coil fastened to the diaphragm or spring 7.

Fig. 4 shows another modification, in which 1 is the aerial grounded at 2, 3 is the primary of a transformer, 4 is the secondary of a transformer, and 16 is a stretched wire in the circuit of the secondary of the transformer, which secondary is preferably tuned by the use of an inductance 70 and capacity 71. The wire 16 is preferably tuned to the desired mechanical frequency, *i. e.*, it swings to the frequency of the beats between the received and the locally produced oscillations. 10 is a magnetic core of a coil 14, made of finely laminated wire or sheet, embracing the wire 16; and the coil 14 is operatively connected with a local source 17 which may be a high frequency dynamo, designed to produce the oscillations. In operation the currents generated by the received electro-magnetic waves produce a field which interacts with the magnetic field generated in the magnet coil 14 and core by the local source, and this causes the wire to vibrate with the frequency of the beats, thereby producing an indication.

In the following claims the term alternating currents is intended to include oscillating currents, or all currents varying periodically in intensity, whether or not the sign of the oscillations be changed.

While I have described herein the operation by the received waves and locally produced waves of differing frequency in order to form beats, I have not claimed a specific mode of operation herein or the apparatus therefor, but the same is claimed in my copending but subsequently filed applications Nos. 271,539 and 275,165 being now Patents 1,050,441 and 1,050,728, respectively, the

claims herein being obviously not limited to beats or to a separate regulator at the receiving end or constant sending.

Having thus described my invention and illustrated its use, what I claim as new and desire to secure by Letters Patent, is the following:

1. An indicator for received alternating currents comprising a local oscillations producer and devices forming a field of force continuously excited thereby, a field excited by the received oscillations, and means operated by the coöperation of said two fields for producing signals, the whole being adapted to annul the influence of the locally generated field on the indicator when the field for excitation by the received oscillations is not excited.

2. An indicator for alternating currents comprising a coil excited by received currents, a second coil excited by locally produced continuously acting currents, and an indicator operated by the combined effects of the two coils, the indicator being adapted for normally annulling the signal-producing effect of the locally excited coil on the indicator when the other coil is not excited by received oscillations.

3. Receiving apparatus for wireless telegraphy comprising a practically continuously acting local source of oscillations and a receiver field excited thereby, a second local producing source, and means for annulling its effect on the receiver field, substantially as described.

4. In wireless telegraphy, the combination with a receiving device comprising a local source of continuous oscillations, of a sending source of oscillations, and means for annulling the effect of said sending source on the receiver whereby to send and receive simultaneously.

5. In wireless signaling the combination at a receiving station of devices forming a field of force excited by oscillations received, devices forming a supplementary field and local means for exciting it, an indicating instrument operated by interaction of said two fields, a sending source, and means in the locally excited field to counteract the effect of sending oscillations on the field excited by received oscillations whereby to prevent disturbance of the receiving instrument.

6. The combination with a generator and a connected antenna of devices forming a field inductively connected with the antenna and excited by oscillations received thereby, devices forming a supplementary field and local means for continuously exciting it, indicating means operated by said two fields, and connections between the generator and the locally excited field to counteract by effects in the latter the effects in the receiving field of oscillations sent, substantially as described.

In testimony whereof I have hereunder signed my name in the presence of the subscribed witnesses.

REGINALD A. FESSENDEN.

Witnesses:
JESSIE E. BENT,
ADELEINE W. HAER.