R. A. FESSENDEN.

METHOD OF TRANSMITTING AND RECEIVING ELECTRICAL ENERGY.

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1,141,386. Patented June 1, 1915

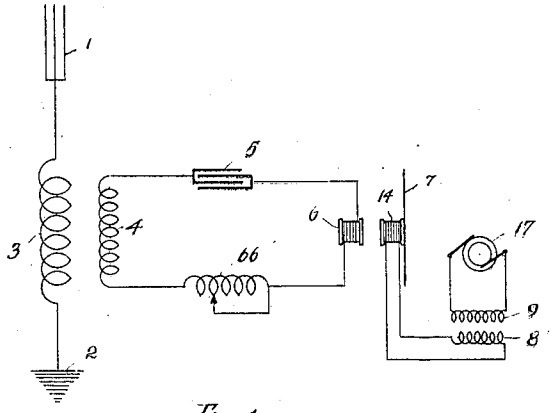

Fig. 1

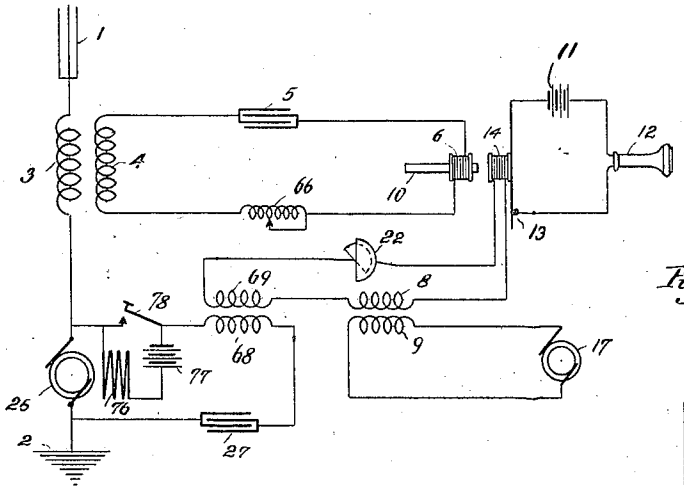

Fig. 2.

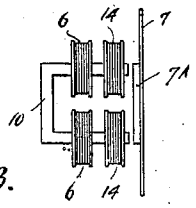

Fig. 3.

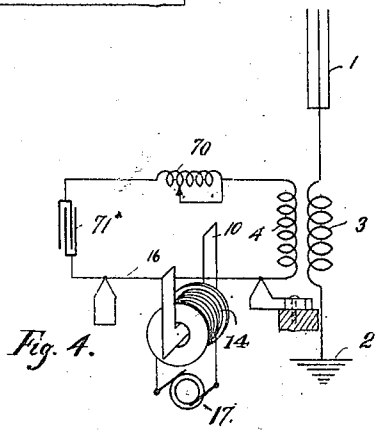

Fig. 4.

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UNITED STATES PATENT OFFICE.

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METHOD OF TRANSMITTING AND RECEIVING ELECTRICAL ENERGY.

1,141,386. 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. 403,285.

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 a certain new and useful Method of Transmitting and Receiving Electrical Energy, of which the following is a specification.

My invention relates generally to the transmission and receipt of electrical energy, more particularly to telegraphy by means of oscillating currents, and still more especially 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.

In the accompanying drawing Figure 1 is a diagram of receiving apparatus embodying my invention; Fig. 3 shows a modified mode of mounting coils, and Figs. 2 and 4 show modified arrangements for practising the method herein described.

In the practice of this invention I employ for producing an indication at the receiving station, the interaction between voltages, or preferably currents, produced by the received oscillations, 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 for use in this method I may employ the apparatus shown in Fig. 1, where 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 an 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, as shown at 10 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.

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 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. 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 by the received oscillations in the coil 6 interact with the magnetic field excited by the source 17 in the coil 14. Alternatively, it is obvious that the coil 6 may be attached to the diaphragm 7, and coil 14 may be fixed. The interaction between the two fields produced by the two coils causes the diaphragm 7 to move and produce an indication, preferably by the effects of the beats produced. A much stronger indication is produced by the interaction between the currents generated by the electro-magnetic waves and the locally generated magnetic field than would be produced by the currents due to the electro-magnetic 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 generated 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 the 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 hundred 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 inter-

val between successive sparks even though 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 source 17 generating trains of waves and not 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 that the frequency of the locally generated magnetic field should not be 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, there being no beats produced. It is also 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, or a weak indication, through the inability of the diaphragm or spring 7 to respond quickly.

It will be evident that the number of beats 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 those with which it is desired to communicate.

Where the signals are produced by the interaction of voltages instead of currents an appropriate corresponding type of receiver is used, for example an electro-static telephone receiver.

This method may be used for simultaneously sending and receiving, as shown in Fig. 2; for a source of oscillating currents 25 may be operatively connected to the wireless conductor 1, 2 and so arranged as to generate oscillations in the aerial 1. This source 25 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, as by closing the circuit containing the field coil 76 and local exciting battery 77, oscillations of the same frequency and of the same duration are caused to occur in the coil 14, and by adjusting condenser 22 the respective phases of the oscillations generated in the coils 6. 14, are arranged so as to be 90 degrees apart. Thus they produce no effect on diaphragm 7 or 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 or compensated and may be rendered entirely inappreciable especially where the receiver is tuned to respond to a given mechanical frequency. This allows sending without disturbing of the receiving apparatus. In Fig. 2 the condenser 27 may also be used for controlling the phase of the oscillations generated in the circuit 68, 27, 25.

As alternative to the construction in Fig. 1, Fig. 3 shows the coils 6 and 14 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.

Fig. 4 illustrates another form of suitable apparatus in which 1 is the antenna grounded at 2, 3 is the primary of a transformer, 4 is the secondary of the transformer, and 16 is a stretched wire in the circuit of the secondary. The secondary is preferably tuned by the use of an inductance 70 and capacity 71, the wire 16 being also preferably tuned to the desired mechanical frequency, *i. e.* the frequency of the beats between the received and local oscillations. 10 is a magnetic core of finely laminated wire or sheet embracing the wire 16, and 14 is a coil operatively connected with the local source 17, which may be a high frequency dynamo as shown. In operation currents generated by the electro-magnetic waves in wire 16 in the field of core 10 will interact with the magnetic field generated by the source 17 in the magnet coil 14 and its core 10 and cause the wire to vibrate by such interaction, thereby producing an indication.

By the term alternating currents I intend to include oscillating currents, *i. e.* all currents varying periodically in intensity whether the sign of the oscillations be changed or not.

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. The method of detecting the presence of alternating currents which comprises exciting a field at the station where such currents are received by said received currents, maintaining a supplementary field interacting with said first field, by means of a local source of energy, and meanwhile producing by said local source a compensating field which nullifies its signal producing effect at the receiving station, while signals are being sent from said station.

2. The method of simultaneously sending and receiving wireless signals which comprises exciting a field by the received oscillations, exciting a second field by oscillations locally produced and having a frequency definitely differing from those received,

causing the two fields to interact to produce a signal, and transmitting electric waves of a frequency definitely differing from those being received, substantially as described.

3. The method of signaling which comprises exciting a field of force by oscillations received at a station, exciting a supplementary field by a local high frequency source and operating a receiving indicating instrument by the combined effects of said two fields, generating oscillations for sending from the same station and neutralizing their effect on the receiving instrument by causing interaction in the field excited by received oscillations.

4. In wireless telegraphy the method of receiving at a sending station which comprises exciting a field of force by the received oscillations and also by the oscillations being sent, annulling the effects of the latter on a receiving instrument operated by the influence of said field excited by the received oscillations by oscillations in a local field.

5. In wireless telegraphy the method of receiving at a sending station which comprises exciting a local field of force both by the sent and received oscillations and annulling the effect of the former on a supplementary local field excited by a local source and operating an indicating instrument by the combined effects of said field and the field excited by received oscillations.

6. The method of simultaneous sending and receiving electric signals which comprises exciting a field of force by the received oscillations and also by oscillations being sent, maintaining a supplemental locally excited field, producing signals by interaction of said two fields, and annulling the effect of the oscillations being sent on the receiving field by oscillations of the same frequency simultaneously produced in said supplemental locally excited field.

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

REGINALD A. FESSENDEN.

Witnesses:
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