R. A. FESSENDEN.

METHOD OF SIGNALING.

APPLICATION FILED JAN. 24, 1908.

962,018. Patented June 21, 1910.

2 SHEETS—SHEET 1.

Fig. 1.

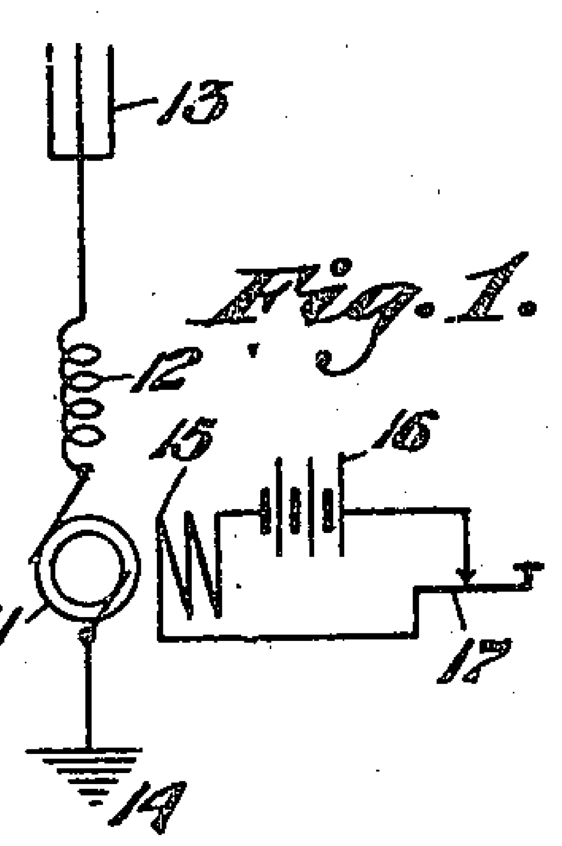


Fig. 2.

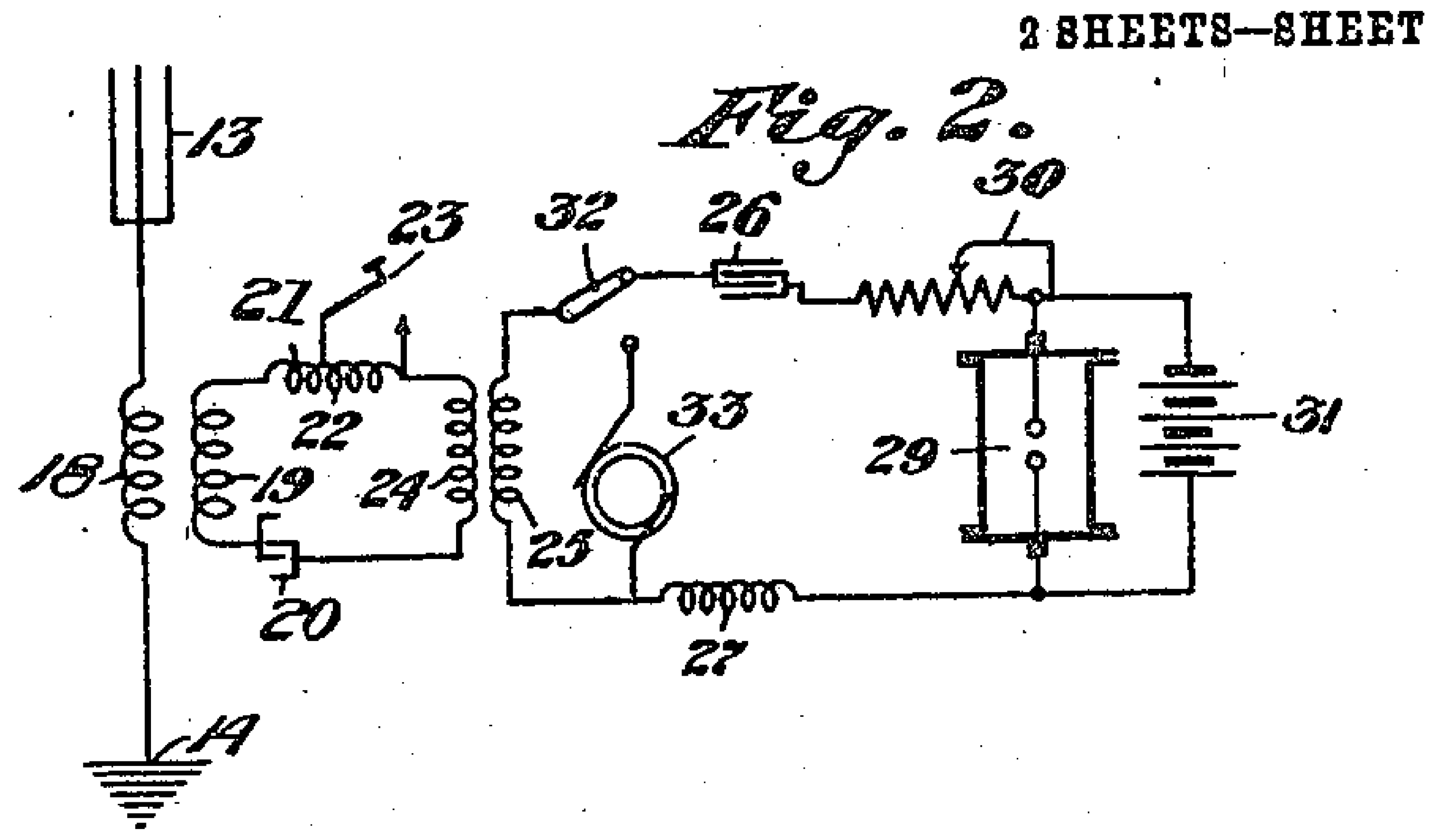


Fig. 3.

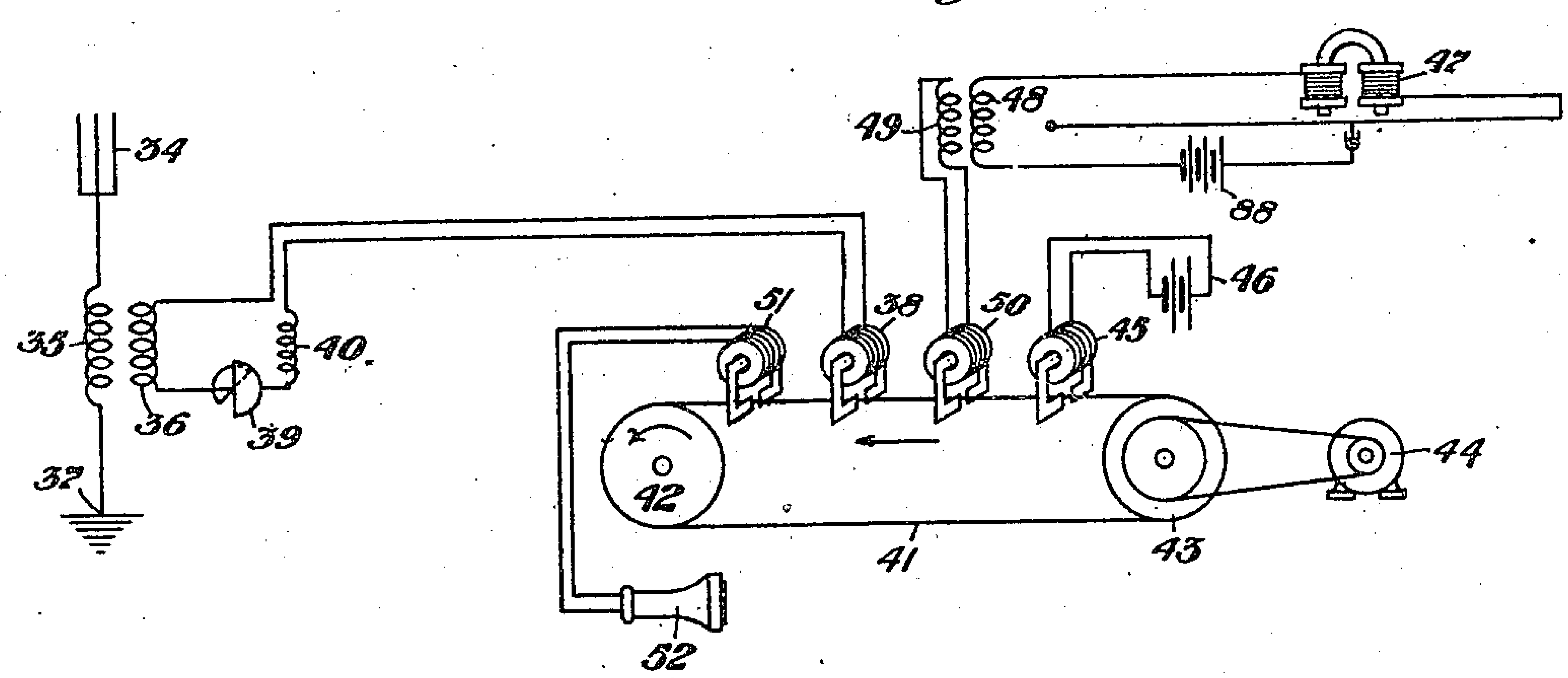
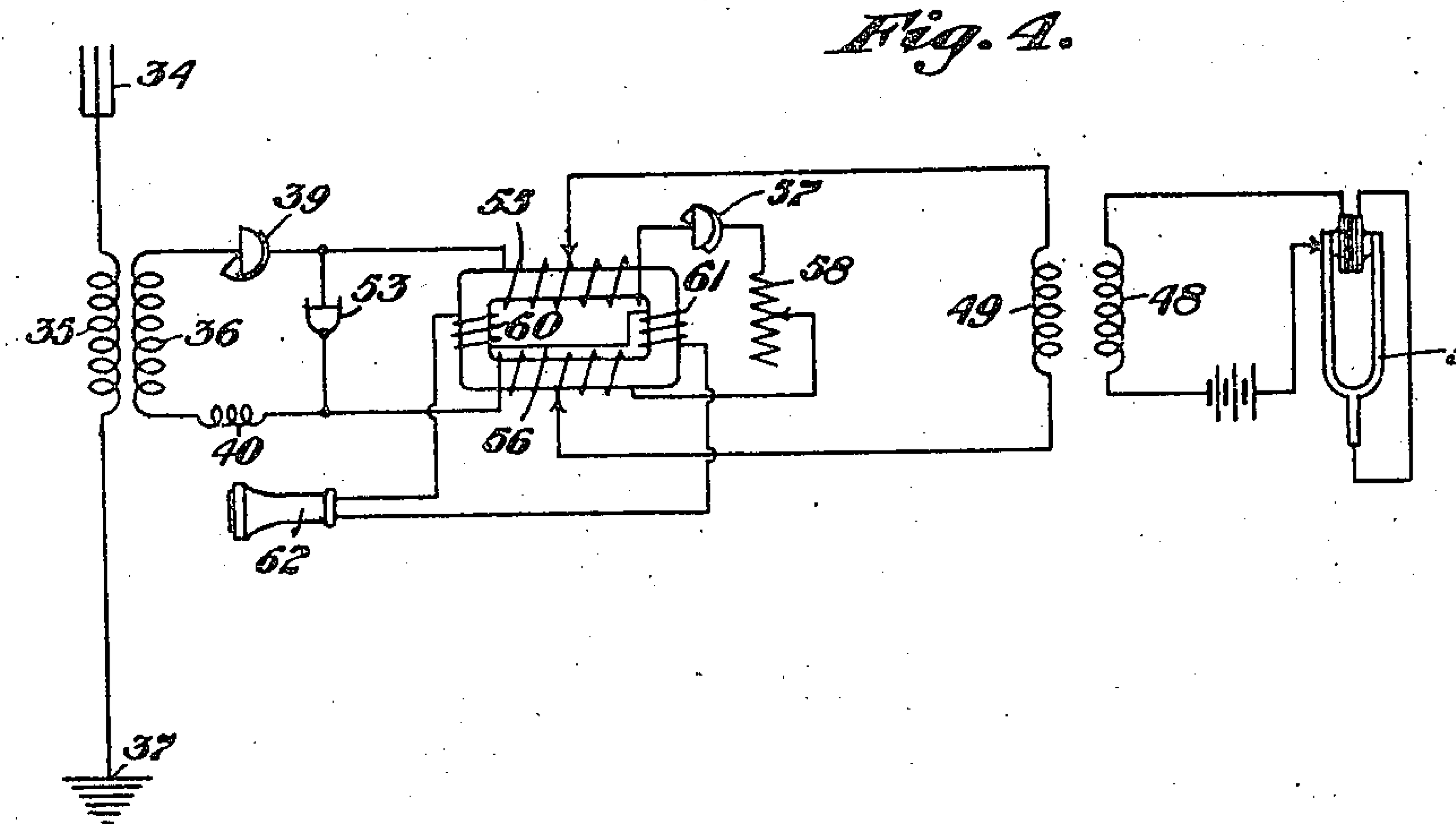


Fig. 4.



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2 SHEETS—SHEET 2.

Fig. 5.

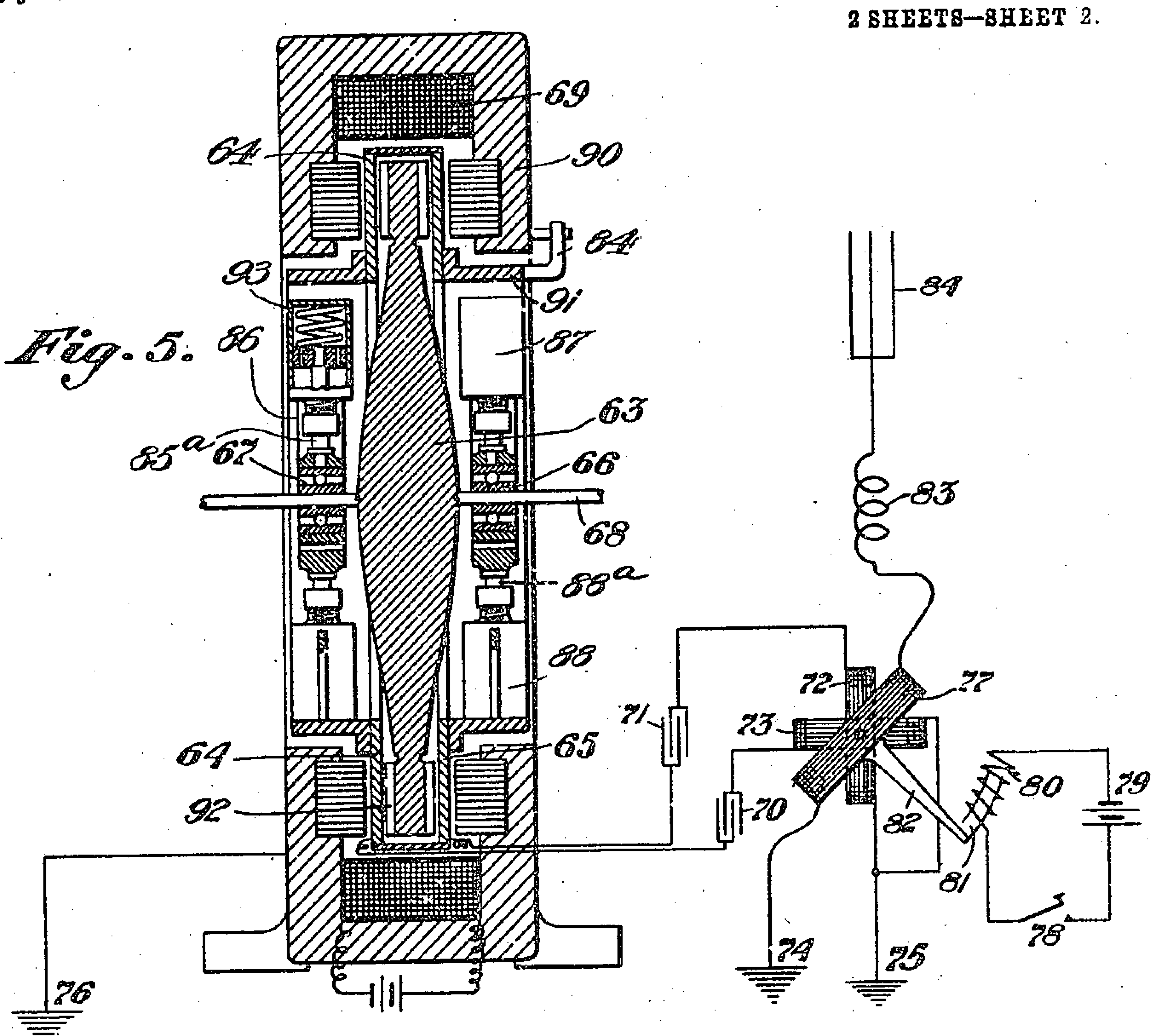
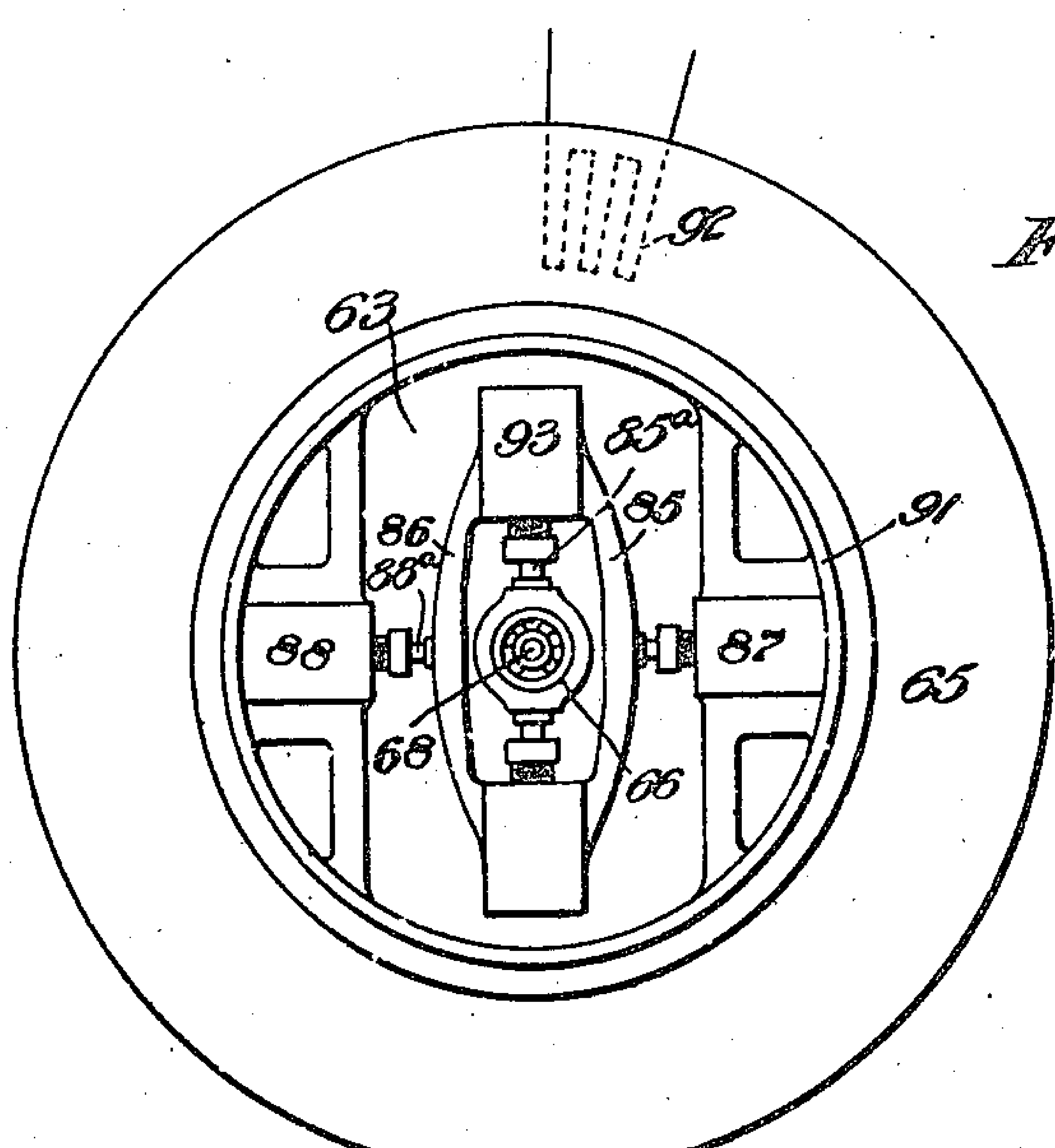


Fig. 6.



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UNITED STATES PATENT OFFICE.

REGINALD A. FESSENDEN, OF BRANT ROCK, MASSACHUSETTS.

METHOD OF SIGNALING.

962,018. Specification of Letters Patent. Patented June 21, 1910.

Original application filed October 10, 1907, Serial No. 396,817. Divided and this application filed June 24, 1908. Serial No. 412,417.

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 State of Massachusetts, have invented certain new and useful Methods of Signaling, of which the following is a specification.

My invention relates to the art of wireless signaling generally, and in some particulars especially to preventing interference in signaling. Its objects will appear hereinafter.

These objects, and other advantages which will hereinafter appear I attain by means of apparatus illustrated here and in my copending application No. 396,817 filed October 10th, 1907, of which this application is a division.

In the accompanying drawings which illustrate my methods in several forms, Figure 1 is a diagram of sending apparatus; Fig. 2 is a diagram showing modified arrangements of circuits for sending; Figs. 3 and 4 are diagrams of arrangements of receiving apparatus in two forms; Figs. 5 and 6 show respectively in section and side elevation a convenient means for generating electro-magnetic waves.

It has been customary to signal by sending at intervals certain trains of electromagnetic waves which vary in length or intensity or character to represent the dots and dashes of a Morse code and since all operators are familiar with the signals it is easy to read them. I avoid this and other objections, as well as gain certain psychological advantages by sending or modifying waves not for the dots and dashes but the spaces between dots and dashes, thus inverting the signals. It has also been customary to use receiving instruments which respond only to the signal, whereas in my method a continuous stream of impulses is kept up at the receiving station and this stream is intercepted or modified except upon receipt of the signals, which prevents any disturbance by other stations unless the frequency is of exactly the same tune. Other characteristics of my method will appear hereafter.

In the sending arrangement as illustrated in Fig. 1, a high frequency alternating dynamo 11 and a tuning inductance 12 are inserted in the sending conductor having the antenna 13 and grounded at 14. This antenna may otherwise be of the loop type, in which case it is preferred not to ground it. 15 represents the field of the dynamo 11, which is excited by a source 16 having in circuit a key 17, which is so arranged that when it is depressed it opens the field circuit and stops the emission of high frequency oscillations, which normally are sent out in a continuous stream. That is, when the key is in normal position electro-magnetic waves are being sent out, and when it is depressed this stream of waves is interrupted, thus signaling not the dots and dashes after the usual method, but the spaces between.

In Fig. 2 I have shown in the circuit of the antenna 13, the primary 18 of a transformer of which the secondary 19 is in circuit with an inductance 22 which has a key 23 arranged to short circuit it. Also in this circuit is the primary 24 of another transformer whose secondary 25 has in circuit a capacity 26, an inductance 27, a spark gap 29, which is preferably a compressed gas gap; also an adjustable resistance 30, and a source of continuous current 31. There is also a high frequency alternating current dynamo 33, which may be alternately used by throwing the switch 32 as will be evident. In the circuits as arranged the couplings of the transformers 18, 19, and 24, 25 respectively, are preferably different, though this is not necessary. It will be observed that waves are generated and emitted continuously but when the key 23 is depressed, the frequency of the waves is altered, which change will be detected at the receiving station.

The electrical constants of the circuits are preferably so arranged that the frequency will be less than 100,000 when it is desired to send over long distances; this because I have discovered by experiment that the absorption over long distances is very much less for frequencies of this value or less, than with higher frequencies. For example with a frequency of 50,000, there is comparatively little absorption up to a distance of 2,000 miles, in daylight, whereas with a frequency of 200,000 there is almost a total absorption.

In Fig. 3 I show a form of receiving apparatus. The antenna 34, grounded at 37 contains the primary 35 of a transformer whose secondary 36 is connected to a demagnetizing coil 38. The circuit also contains an adjustable capacity 39 and inductance 40, By means of pulleys 42, 43, driven as by motor 44 a soft iron wire 41 is continuously passed between the poles of magnet 38 and also between the poles of magnet 45 which is energized by battery 46 and magnetizes the iron wire as it passes in the direction toward coil 38. I provide a string vibrator shown at the top of the figure and actuated by coil 47 which is excited by battery 88 and by means of coils 48, 49, the coil 50 is given an undulating current which impresses on the wire an undulating or alternating magnetism, preferably of an audible frequency. The iron wire 41 thus having a succession of variations which if heard would produce a musical note, passes between the poles of magnet coil 51, after traversing the poles of coil 38. In circuit with this coil 51 is a telephone receiver 52, and it will thus be seen that without interference of the sending apparatus a continuous note would be heard. But when the sending key 17 or 23 as above described (in Figs. 1 and 2) is in normal condition (closed in Fig. 1 and open in Fig. 2), the waves emitted and received at 38 will eliminate or partly suppress the musical note in the telephone, by annulling the magnetism and orderly succession of variations in wire 41, thus wiping off the musical note and leaving a silent space until key 17 of Fig. 1 is depressed or opened; or in the case of the apparatus of Fig. 2 is closed, so that one frequency of the waves received at 38 will give a low intensity to the musical note which is altered by changing to another frequency by depressing the key 23. That is, the portions of the wire not having the magnetization representing a musical note wiped off from it, travel on between the poles of magnet 51 and keep up the musical note in the telephone. In this way the inverted sending is corrected in turn by an inverted receiving, and the dots and dashes come out as musical notes.

In the modification of Fig. 4 the circuit of the secondary 36, containing the capacity 39 and inductance 40, has a receiver 53 such as a liquid barretter or tellurium receiver, and includes also coils 55 and 56 of a transformer, and also a capacity 57 and adjustable resistance 58. 54 represents a tuning fork vibrator constantly producing a musical note, and by means of the primary 48 a secondary 49, the divided circuits 55, 53, 56, and 57, 58, 56 are effected with the frequency of this musical note. A telephone receiver 62 is connected in circuit with the secondaries 60, 61 of the transformer, and the resistance 58 and the capacity 57 are so adjusted that a continuous sound would be produced in the telephone 62, when in normal condition, but when waves of the strength produced by the proper sending station are received, the two divided circuits become balanced, and thus cut out the sound in the telephone. This accomplishes the same purpose of reinverting the signals as above described in Fig. 3.

By the method here described, no disturbance is produced by a sending station or other receiving stations unless they are exactly of the same tune to one-fifth of one per cent., as has been shown by experiment. It is practically impossible to interfere with a receiving station and very difficult to read messages even if they were received since they are sent in inverted form. It will be understood that the method may be used in connection with applicant's heterodyne receiver, in which the signal is produced by direct interaction of the received and locally produced currents, and with mechanical group tuning; but the particular kind of receiver and particular method of tuning, etc., are not material to the invention.

It is highly desirable in operating this method to have a particularly efficient generator, and in connection with the method illustrated in Fig. 2 I have shown a special form of generator (more fully described in my co-pending application No. 393,235 of September 16th, 1907), and means for operating with it, in Figs. 5 and 6. A revolving slotted disk 63 with teeth 92 wound as shown in dotted lines in Fig. 6, travels between the armatures 64 and 65, which are supported resiliently and indirectly by bearings 66 and 67 mounted on the shaft 68 carrying the disk 63 and held stationary in the frame by stop 84. The bearings are connected indirectly to the armatures by dash pots such as 88 and 87 in Fig. 6, and arms 85, 86 with similar devices 93. By this means the armature is supported flexibly and yet always concentrically with the revolving shaft 68 of the disk. A field coil 69, is provided, in the casing 90, and armature 65 is connected through capacity 71 with a fixed coil 72, while the armature 64 is connected through capacity 70 to fixed coil 73. These coils are grounded at 75 while the other terminals of the armatures are grounded through the frame 90 of the machine as at 76. The laminated rings 83 complete the magnetic circuit. Coils 72 and 73 are set at right angles to each other so that they exert no mutual inductive effect. Around them is a movable coil 77 having an arm 82 which is capable of being swung angularly by the action of the coil 80, excited by a battery 31. The core 81 and lever arms 82 are thus operated when the key 78 is depressed and turns the coil 77 from a position parallel to one of the coils 72, 73, to the other. Coil 77 is connected to antenna 84 through a tuning inductance 83, and to ground at 74. Shifting the key thus changes the frequency of the emitted waves while keeping their intensity constant.

The apparatus herein described is not here claimed, but is claimed in the co-pending parent application No. 396,817 above referred to.

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

1. The method of signaling by maintaining a continuous flow of impulses at a receiving station, normally annulling their effect by received impulses sent from another station, and signaling by modifying the sent impulses and thus interrupting said normal annulment.

2. The method of signaling by producing a continuous stream of impulses at a sending station, maintaining a continuous stream of impulses at a receiving station and normally annulling their effect by the agency of the sent impulses, and signaling by modifying the stream of impulses at the sending station.

3. The method of signaling by sending and receiving a continuous stream of electric impulses and normally annulling by their energy a continuous flow of impulses at a receiving station, and signaling by altering the sent impulses so as to allow the impulses at the receiving station to operate an indicating instrument.

4. The method of signaling by maintaining a continuous flow of impulses at each of two intercommunicating stations and modifying the character of impulses at one station by the energy of those from the other, and signaling by altering the character of the sent impulses to thereby omit said modification at the receiving station.

5. The inverted method of signaling which comprises transmitting electro-magnetic waves continuously except for interrupting them to represent the dots and dashes of a code, and reinverting the signals at the receiving station by causing the interruptions only to be sensible.

6. In the art of signaling, the method which comprises generating electro-magnetic waves with practical continuity, maintaining a continuous sensible indication at a receiving station independent of the waves received, and normally altering their character by the waves as received.

7. In wireless telegraphy, the method which consists in continuously generating and emitting waves and changing their character to represent dots and dashes of an alphabet, maintaining at a receiving station a continuous flow of impulses normally neutralized by the waves received and causing the abnormal received waves representing the dots and dashes to interrupt the neutralizing of said continuous local indication, to produce a signal.

8. In the art of wireless signaling, the method which comprises sending continuous waves representing spaces and interrupting them to represent dots and dashes.

9. In the art of wireless signaling, the method which comprises maintaining at a receiving station, a continuous sensible indication and normally modifying its effect by received waves except at intervals to form signals.

10. In wireless signaling, the method which comprises sending normally continuous electric waves, maintaining normally a continuous series of impulses for producing a sound indication at the receiving station, adapted to be normally silenced by the received waves, and changing the character of said sent waves, thus allowing the local sound to be heard.

11. In signaling by electro-magnetic waves, the process which comprises the continuous production at the receiving station of impulses for producing a musical sound, normally suppressing their effects and signaling by modifying the suppressing means to permit the sound to be produced.

12. The inverted method of signaling by sending and receiving a sustained flow of electric impulses of definite character to represent spaces, and signaling by altering their character to represent dots and dashes in a code and re-inverting and making only said dots and dashes sensible at the receiving station.

13. The method of signaling by sending a sustained normal flow of impulses of definite character, maintaining a continuous flow of local impulses at a receiving station, and modifying them by the received impulses and modifying the normal flow at the sending station to produce a signal by interrupting the normal modification of the local impulses.

14. The method of signaling by maintaining a continuous flow of impulses at each of two intercommunicating stations, normally modifying the character of the impulses at one station by the energy of those from the other, and signaling by altering the character of the sent impulses to thereby change said modification at the receiving station.

15. The method of signaling by maintaining a continuous flow of impulses for producing sound waves at a receiving station, normally annulling them by electro-magnetic waves emitted from a sending station, and signaling by altering the sent waves and thus interrupting the said annulment.

16. The method of electric signaling which comprises producing a continuous stream of impulses at a sending station, maintaining a continuous stream of impulses at a receiving station and normally suppressing their effect by means of the sent impulses, and signaling by interrupting the stream of sent impulses.

17. The method of electric signaling which

comprises transmitting electromagnetic waves normally continuously and modifying their character to represent dots and dashes of a code, and reinverting such signals at the receiving station by causing the normally continuous stream to be silenced, and causing the modifications only to be sensible.

18. The inverted method of signaling, which comprises sending a normally continuous stream of impulses, and interrupting it to represent dots and dashes, maintaining at the receiving station a continuous stream of impulses, and normally silencing them by the sent impulses, whereby the local impulses produce an effect when the silencing influence is removed by interrupting the transmitted impulses.

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

REGINALD A. FESSENDEN.

Witnesses:
JESSIE E. BENT,
J. W. LEE.