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ELECTRICAL SIGNALING SYSTEM.

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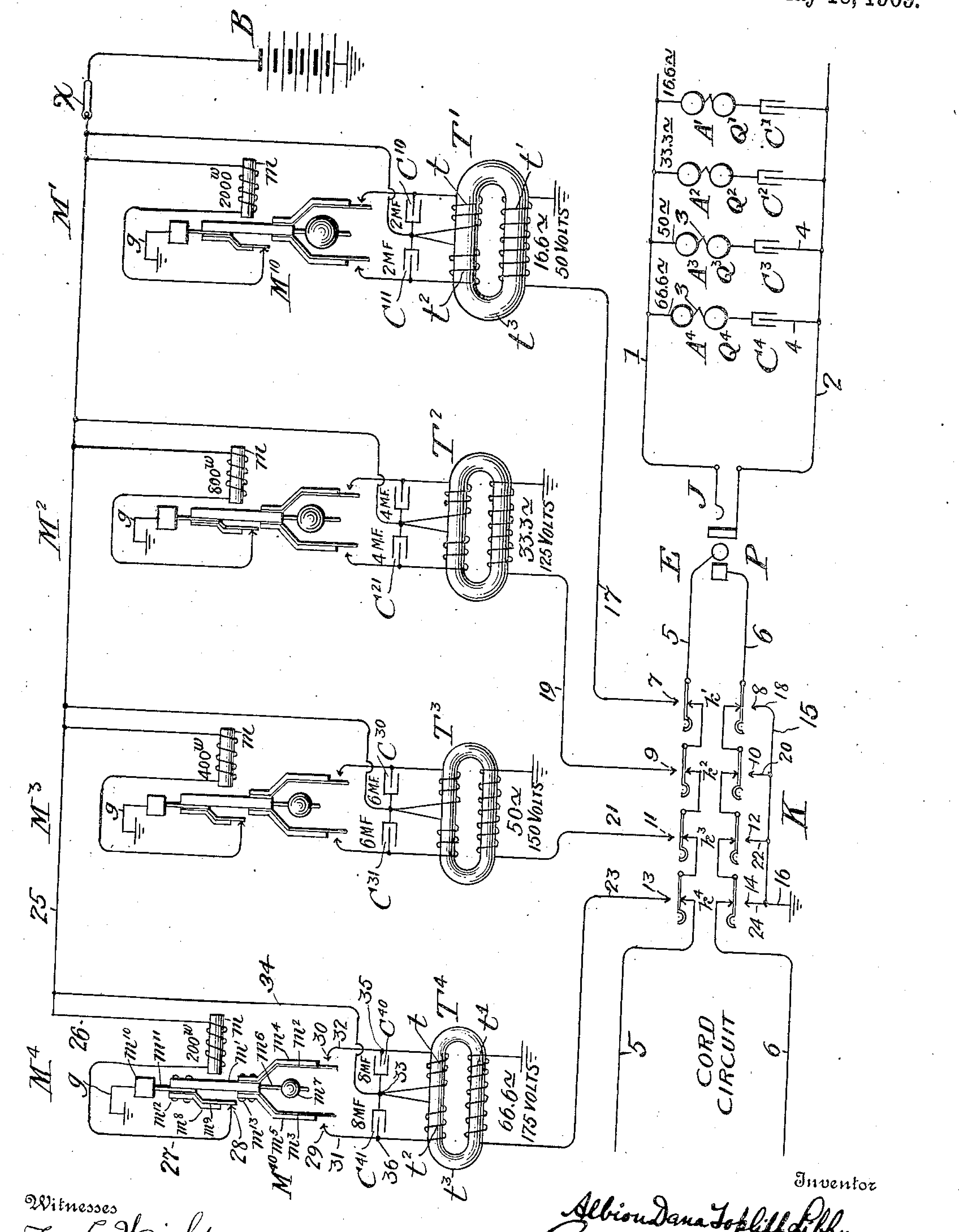

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ELECTRICAL SIGNALING SYSTEM.

No. 922,006. Specification of Letters Patent. Patented May 18, 1909.

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To all whom it may concern:

Be it known that I, ALBION DANA TOPLIFF LIBBY, a citizen of the United States, residing at Elyria, in the county of Lorain and State of Ohio, have invented certain new and useful Improvements in Electrical Signaling Systems, of which the following is a specification, reference being had therein to the accompanying drawing.

My invention relates to electric signaling systems, and particularly to those in which selection is to be accomplished by means of differences in the character or conditions of the signaling current or its application.

The invention contemplates the use of transformers and of circuit-changers or interrupters therefor, and the objects of the invention are to simplify the apparatus employed, while increasing the efficiency of the same and of the system in which it is employed.

More specifically stated, my invention relates to what are known as "harmonic" or poly-frequency systems of signaling, in which the current supplied to the line-circuits is produced in the secondary windings of transformers, the primaries of which are controlled by interrupters or pole-changers. In the embodiment of the invention which I shall hereinafter describe, a single main battery or other source of direct current supplies all the energy for both signaling and signal control through the motors. In accordance with established usage in so-called harmonic systems, an assemblage of four units is employed, each comprising a tuned vibrating pole-changer having a motor magnet and controlling the primary energy of a suitable transformer, the secondary of which supplies the line-signaling current.

The principal characteristic features of my invention are nine in number, as follows:—

First:—The use of a transformer with a double primary, each half of which has the same number of turns, or in other words, a parallel winding so as to have the same quantitative effect on the secondary winding when the same amount of current flows in either coil.

Second:—A vibrating mechanism for alternately connecting the primaries of these transformers so that current will first flow through one coil, and then on the return of the vibrator this coil will be cut off and the second primary coil so connetced that current will flow therein in an opposite direction from that in the first, thereby producing an alternating magnetizing effect in the transformer core.

Third:—The use of condensers placed across the primaries of these coils to assist in the action thereof as well as to cut down the sparking at the contacts.

Fourth:—The use of a simplified vibrator or weighted armature connected to ground side of battery and a contact on the same for alternately making connection with two stationary contacts. This obviates the necessity of having insulated parts attached to the armature and using flexible leading-in conductors for the same.

Fifth:—The mechanical tuning of the armatures by mounting them on different sized springs and by the use of different sized weights. For example, the lowest frequency vibrator is mounted on a thin spring of very light tension and has a large weight. The other vibrators have thicker springs and smaller weights.

Sixth:—The adjustment of the motor winding, which controls a vibrator armature, to the frequency for which the armature is tuned. A low frequency winding is preferably made of high resistance, while the higher frequency vibrators have windings of the lowest resistance. By this means it is possible to give a uniform strength of movement to the armatures for the various vibrators.

Seventh:—The adjustment of the transformers to the different frequencies by regulating the amount of iron in the cores, as well as the design of the windings. The low frequency transformer has a large amount of iron and the others a lesser amount, the highest frequency having the smallest amount of iron.

Eighth:—The adjustment of the capacity of each condenser to suit the frequency as well as the characteristics of its transformer. For example, a low frequency transformer has low capacity condensers across its primaries, while the others have large capacities.

Ninth:—The adjustment of the voltage of the secondaries of the transformers to conform to the requirements of the harmonic party-line signal receivers, the low frequency secondary tension being about fifty (50) volts, for example, and the others in proportion thereto, the highest frequency reaches about one hundred and seventy-five (175) volts.

This invention is particularly useful in connection with party-lines selective ringing in exchange systems of telephones. For convenience, therefore, I shall illustrate and describe the apparatus and circuits as they are applied to such a system.

The invention is illustrated in the accompanying drawing, in which the diagram shows a line-circuit extending to four stations, the operator's circuit-terminal whereby connection is effected with said line-circuit, the central office equipment of generating units, and finally the switches by means of which the same are connected through the terminal to the line.

Referring to the drawing, the numerals 1—2 represent a line-circuit extending from the central station E to the four sub-stations A′, A^2, A^3 and A^4. The telephone sets at these substations are not shown, being immaterial to the signaling circuits, but they are of any usual or suitable type, their circuits being disconnected or opened when not in use. At each station is a ringer Q′, Q^2, Q^3 or Q^4 bridged across the line-wires 1—2 in series with the condenser C′, C^2, C^3 or C^4; the bridge wires being indicated at 3—4. The ringers, and if desired the condensers, at the several stations are adjusted for particular frequencies. As indicated in the diagram, the ringer Q′ at station A′ is tuned so that it will vibrate with a free natural period of 16.6 cycles per second; the ringer Q^2 at station A^2 vibrates with a period of 33.3 cycles per second; the ringer Q^3 at station A^3 has a natural period of fifty cycles per second; and finally the ringer Q^4 at station A^4 has a natural period of 66.6 cycles per second.

The line-wires terminate at the exchange or central station E upon contacts of a spring-jack J, with which the plug P coöperates to connect the cord-conductors 5—6 to the line-wires 1—2. These cord-conductors may lead to any desired talking and subsidiary apparatus, all of which is omitted, for the simplicity in the drawing. I have limited my showing to the apparatus particularly needed for the practice of this invention, which is the selective ringing key K. This key consists as shown of four sets of springs k', k^2, k^3 and k^4, all normally closed upon anvil contacts by which the cord-circuit is completed through them in series. It will be understood, of course, that this type of key, and other specific apparatus herein illustrated, are used for convenience, and are not to be taken as limiting the invention in any way. Any suitable key may be employed, and any suitable design of circuits not incompatible with the essential portions of the generating units and their circuits. Each of the spring keys k', k^2, etc., is assumed to have a button or cam by which the springs may be spread so as to break connection with their normal anvil or resting contacts and make connection with the outside contacts shown arranged in pairs at 7—8; 9—10; 11—12; 13—14. This arrangement of spring contacts is well understood by all those skilled in the art, and the operating cams need no illustration.

The contacts 8, 10, 12 and 14 are joined together by the bus-wire 15, and connected to earth through the wire 16. Their individual branches 18—20—22—24 may however be carried back to their respective transformer secondaries, if desired, instead of being tied together. The contact 7 is connected by wire 17 to the secondary winding t' of the transformer T′, designed as will presently appear to produce alternating current at a frequency of 16.6 cycles and fifty volts. The contact 9 is similarly connected by wire 19 to the secondary of transformer T^2 designed to furnish current at 33.3 cycles and 125 volts; contact 11 is connected by wire 21 to the secondary of the transformer T^3 adapted to furnish current at fifty cycles and 150 volts; while contact 13 is connected to the secondary of a transformer T^4 adapted to furnish current at 66.6 cycles and 175 volts. Each of these transformers forms a part of a complete unit, these units being respectively designated as M′, M^2, M^3 and M^4. Since the corresponding parts of all the units are similar in their shape, arrangement and connection, a description of one will suffice for all. I will therefore describe the unit M^4 which alone bears detailed reference letters, and afterward I will point out the adjustments and variations in size, etc., by which these units are tuned. Referring then to the unit M^4, this comprises as its essential elements a pole-changer M^{40}, with a suitable motor to drive the same, and a transformer T^4. Current is supplied to all of the units from the main battery B through the bus-wire 25. This battery may conveniently be designed to give a voltage of 24, in accordance with usual practice.

The pole-changer M^{40} has a rigid abutment or post m^{10}, carrying a supporting spring m^{11}, upon which is secured the vibrating arm m' carrying spring-contacts and tuned as to the period of its vibration, partly by the regulation of the spring m^{11} and partly by the pendulum bob or weight m^7. The arm or vibrator m' is controlled by the motor magnet m, whose winding is adjusted as to its resistance and self-induction in accordance with the periodicity for which the particular unit is designed. The principle upon which this magnet works the vibrator is that which has become quite familiar in ordinary vibrating bells. The winding of the magnet is connected on one side to the bus-wire 25 through the branch wire 26, and from its other side a wire 27 passes to the fixed contact 28, which coöperates with a spring m^9 secured upon and to the vibrator by means of rivets m^{12} which conveniently pass through the vibrator arm and the spring m^{11}, and also through a stiffening strip m^8, thereby securing all the parts together in a simple but highly efficient manner.

Secured at the lower end of the vibrator are two contact springs m^2 and m^3, each with a stiffening strip or arm, m^4 and m^5, and both springs with their stiffening strips secured rigidly upon the vibrator arm by means of rivets m^{13}. The vibrator and the three springs m^2, m^3, and m^9 are all in metallic contact and electrically connected, being grounded through the spring m^{11} and the abutment m^{10}, which is provided with a suitable ground wire g. As the magnet m attracts the vibrator arm, the contacts m^9 and 28 remain together during the first part of the movement, but separate at a predetermined point where the spring snaps against the stiffener m^8. The magnet thus loses its ground, and becoming deënergized permits the vibrator to swing back until the contacts m^9 and 28 again come together when the former operation is repeated, and so on indefinitely. It goes without saying that any suitable switching means may be employed to control the circuits of the magnets m, but for the sake of simplicity in the diagram I have omitted all controlling switches, indicating these magnets in constantly closed circuits. In practice at least one switch is interposed as at X in the figure.

As the vibrator moves back and forth it brings first the one and then the other of the springs m^2 and m^3 against their contacts 30 and 29, respectively. The contact 30 is connected by wire 32 to one end of the primary winding t, and the contact 29 is connected by wire 31 to one end of the winding t^2. The other ends of both windings are connected together at 33, and thence through the common wire 34 to the battery bus-wire 25. As the vibrator swings back and forth, therefore, current will flow alternately through one and the other of these windings, by reason of the outer ends being alternately grounded. The two windings are proportioned and laid on the core of the transformer so as to produce equal but opposite magnetic effects therein; hence their alternating supply of current, by reversing magnetic conditions in the core, produces alternating electromotive forces and alternating current in the secondary t' and the wire 23.

Across the terminals 33 and 35 of the primary winding t I connect a condenser C^{40}, and across the terminals 33 and 36 of the other primary t^2 I connect a condenser C^{41}. The corresponding condensers in the other units are marked with different coefficients to the indicating letter C, but their connection is the same in each case.

Having thus described the essential features of each unit, I will now point out the distinguishing differences between the units. These are stated as points Nos. 5, 6, 7, 8 and 9, in the preamble to this specification.

Point 5th is the mechanical tuning of the armatures by the springs and weights. Each armature or vibrator m' has its period determined by the gage and tension of the spring m^{11} and the mass of the bob m^7. The high-speed vibrator M^{40} has a very light bob and a thick spring; while the lowest speed vibrator M^{10} has a thin spring and a heavy bob, as shown in the diagram. I should here point out that instead of varying the springs m^{11}, I may attain the same result by varying the thickness and tension of the springs m^9, by grading from a suitable thickness in the vibrator M^{40} down to comparative thinness in the vibrator M^{10}. I may also combine both of these gradations.

The 6th point is the motor winding. The motor magnet m in the unit M^4 is wound to 200 ohms; in the unit M^3 it is wound to 400 ohms; in the unit M^2 it is wound to 800 ohms and in the unit M' it is wound to 2000 ohms. Thus, it will be noted that speaking approximately the resistance of the motor windings is inversely proportional to the frequencies desired. The amount of energy supplied to the several vibrators is thus maintained approximately constant. Assuming that one complete cycle of movement of the vibrator requires a unit of energy, then for a 16 cycle frequency, 16 units of energy are required; for a 33 cycle frequency, 33 units are required, and so on. By regulating the resistance and number of turns in the different motor magnet windings, the amount of current at constant voltage that will pass through each magnet, and the number of ampere turns with the consequent amount of energy magnetically transmitted to the armature, can be regulated to a nicety.

The 7th point is the adjustment of the transformers. This also is roughly indicated in the diagram, the core t^3 of the transformer T^4 being shown as relatively small, while those of the succeeding units increase progressively in the amount of iron they contain until the low frequency transformer T' is reached in which the amount of iron is the maximum. The principles of transformer design being well understood, it is unnecessary to explain the reasons for this, my invention consisting particularly in the combination set forth, and not in the design of a particular transformer.

The 8th point is the adjustment of the capacity of each condenser C^{40} or C^{41}, etc. In the unit M' the condensers have a capacity of 2 m. f. each; in the unit M^2 each condenser has 4 m. f.; in the unit M^3 each has 6 m. f., and finally in the unit M^4 each condenser has a capacity of 8 m. f. The reason for these variations is easily apparent. These condensers have a two-fold function. They tend to sharpen the action of the transformers, by furnishing a leading electromotive force to neutralize the lag due to inductance, while at the same time they take up the discharges from the coils and so cut down the sparking at the contacts 29—m^3 and 30—m^2.

The 9th point is the adjustment of the voltage of the secondaries t', whereby for any given frequency an amount of energy will be imparted to the signal actuating magnet or ringer proportional to the work it has to do, and the danger of interference between high and low frequency magnets will be largely obviated.

I find in my system that it is desirable to use secondary voltages of 50, 125, 150 and 175 for the transformers adapted to operate on 16.6, 33.3, 50 and 66.6 cycles per second respectively, and hence such secondary voltages may be said to be approximately proportional to such frequencies.

Without going into any elaborate mathematical statement, or formulating equations, I believe I have sufficiently shown that there is for each frequency in this system a condition of resonance both mechanical and electrical for the particular signal receiver intended to be reached, and this condition is maintained without the necessity for any delicate adjustments, all parts being interchangeable and easily manufactured. It will be observed that there are only two contacts in the pole-changer, which is less than in any similar device of which I have knowledge. A third contact is provided for the motor magnet, and all three of these contacts are of the simplest possible design, solidly supported, mechanically and electrically good, without any interposed insulation, and free from battery connections which might produce a short-circuit by accident.

I am aware that the invention thus described may be incorporated in a great many different forms of apparatus, but I do not wish to limit myself to any specific form, beyond what is necessary to embody the features I point out as being of the essence of the invention. All minor or non-essential changes I regard as in the scope of the following claims.

I shall use the term "generating unit" in my claims hereinafter to mean the combination of elements which I have shown for producing a given frequency. The battery, while it is the primary source of energy for this system, serves the same purpose as an exciter in any system of generation. The currents which go to line and do the work of signaling are actually generated in the secondary windings of the transformers, but the primary winding and circuit of each transformer with its vibrator, and its exciting source of constant current, form obvious parts of the complete unit.

Having thus described my invention, what I claim and desire to secure by Letters Patent of the United States is:

1. In an electrical signaling system, a source of current, a signal-receiving device, and a transformer having a secondary winding connected therewith and two primary windings adapted to produce opposite effects on the transformer core and means for alternately connecting such primary windings to such source of current.

2. In an electrical signaling system, a source of current, a signal-receiving device, transforming means in circuit with such device and adapted to be operated from such source of current and a vibrating member for changing the circuit connections of such transforming means to such source of energy, contacts carried by such member for effecting its own operation and also such circuit changes, such contacts being in electrical connection with each other and with such vibrating member.

3. In an electrical signaling system, a plurality of means adapted to produce alternating currents of different frequencies, each means comprising a transformer having primary and secondary windings and a circuit controller in such primary circuit, a signaling device in such secondary circuit, the volume of the cores of such transformers being inversely proportional to such frequencies and the secondary windings of such transformers adapted to deliver currents at pressures approximately proportional to such frequencies.

4. In an electrical signaling system, a plurality of means adapted to produce alternating currents of different frequencies, each means comprising a transformer having primary and secondary windings and a circuit controller in such primary circuit, a signaling device in such secondary circuit, the volume of the cores of such transformers being inversely proportional to such frequencies, the secondary windings of such transformers adapted to deliver currents at pressures approximately proportional to such frequencies and condensers bridged across the terminals of such primary windings, the capacities of such condensers being proportional to such frequencies.

5. In an electrical signaling system, a plurality of means adapted to produce alternating currents of different frequencies, each means comprising a transformer having primary and secondary windings and a circuit controller in such primary circuit, a signal device in such secondary circuit, the volume of the cores of such transformers being inversely proportional to such frequencies, the secondary windings of such transformers

adapted to deliver currents at pressures approximately proportional to such frequencies, condensers bridged across the terminals of such primary windings, the capacities of such condensers being proportional to such frequencies and motor windings for such circuit controllers of resistances approximately inversely proportional to such frequencies.

6. In an electrical signaling system, a plurality of means adapted to produce periodic currents of different frequencies, each means comprising a transformer having primary and secondary windings and a circuit controller in such primary circuit, a signaling device in such secondary circuit, the volume of the cores of such transformers being inversely proportional to such frequencies.

7. In an electrical signaling system, a plurality of means adapted to produce periodic currents of different frequencies, each means comprising a transformer having primary and secondary windings and a circuit controller in such primary circuit, a signaling device in such secondary circuit, the secondary windings of such transformers adapted to deliver currents at pressures approximately proportional to such frequencies.

8. In an electrical signaling system, a plurality of means adapted to produce periodic currents of different frequencies, each means comprising a transformer having primary and secondary windings and a circuit controller in such primary circuit, a signaling device in such secondary circuit and motor windings for such circuit controllers of resistances approximately inversely proportional to such frequencies.

9. In an electrical signaling system, a plurality of means adapted to produce signaling current comprising circuit changers adapted to vibrate at different frequencies and motor magnets for such circuit changers inversely proportional to such frequencies in their magnetic effect.

10. In an electrical signaling system, a plurality of means adapted to produce signaling current of different frequencies comprising circuit changers connected in circuit with a source of current and the primary windings of corresponding transformers and signal devices in circuit with the secondary windings of such transformers and means for delivering currents from such secondary windings at pressures approximately proportional to the frequencies of the currents supplied to the corresponding transformers.

11. In an electrical signaling system, a source of current, a signal receiving device, a transformer having a secondary winding connected therewith and two primary windings adapted to produce opposite effects on the transformer core, and a pole changer for alternately connecting such primary winding to such source of current.

12. In an electrical signaling system, a source of current, a signal receiving device, a transformer having a secondary winding connected therewith and two primary windings adapted to produce opposite effects on the transformer core, one terminal of each of such windings permanently connected to one terminal of such source, and a pole changer for alternately connecting the other terminals of such primary windings to the other terminal of such source.

13. In an electrical signaling system, a source of current, a signal receiving device, a transformer having a secondary winding connected therewith and two primary windings adapted to produce opposite effects on the transformer core, one terminal of each of such windings permanently connected to one terminal of such source, and a pole changer consisting in a vibratory member connected to the other terminal of such source, such member adapted as it vibrates to engage contacts connected to the other terminals of the primary windings.

14. In an electrical signaling system, a source of current, a signal receiving device, a transformer having a secondary winding connected therewith and two primary windings adapted to produce opposite effects on the transformer core, one terminal of each of such windings permanently connected to one terminal of such source, a pole changer, a motor magnet for such pole changer, one terminal of which is connected to one terminal of such source, and a vibratory member in such pole changer, such member adapted as it vibrates to engage contacts connected to the other terminals of the primary windings and of the motor magnet.

15. In an electrical signaling system, a source of current, a signal receiving device, a transformer having a secondary winding connected therewith and two primary windings adapted to produce opposite effects on the transformer core, a pole changer for alternately connecting such windings to such source, such pole changer consisting in a vibratory member mounted upon a base and connected to one terminal of such source, a motor magnet for such members, contacts carried by such member in electrical connection therewith, and contacts insulated from the base to coöperate with the vibratory contacts, such insulated contacts being connected to one terminal of the motor magnet and to one terminal of each of the primary windings, the other terminals of the motor magnet and primary windings being connected together and to the other terminal of the source.

In testimony whereof I affix my signature in presence of two witnesses.

ALBION D. T. LIBBY.

Witnesses:

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