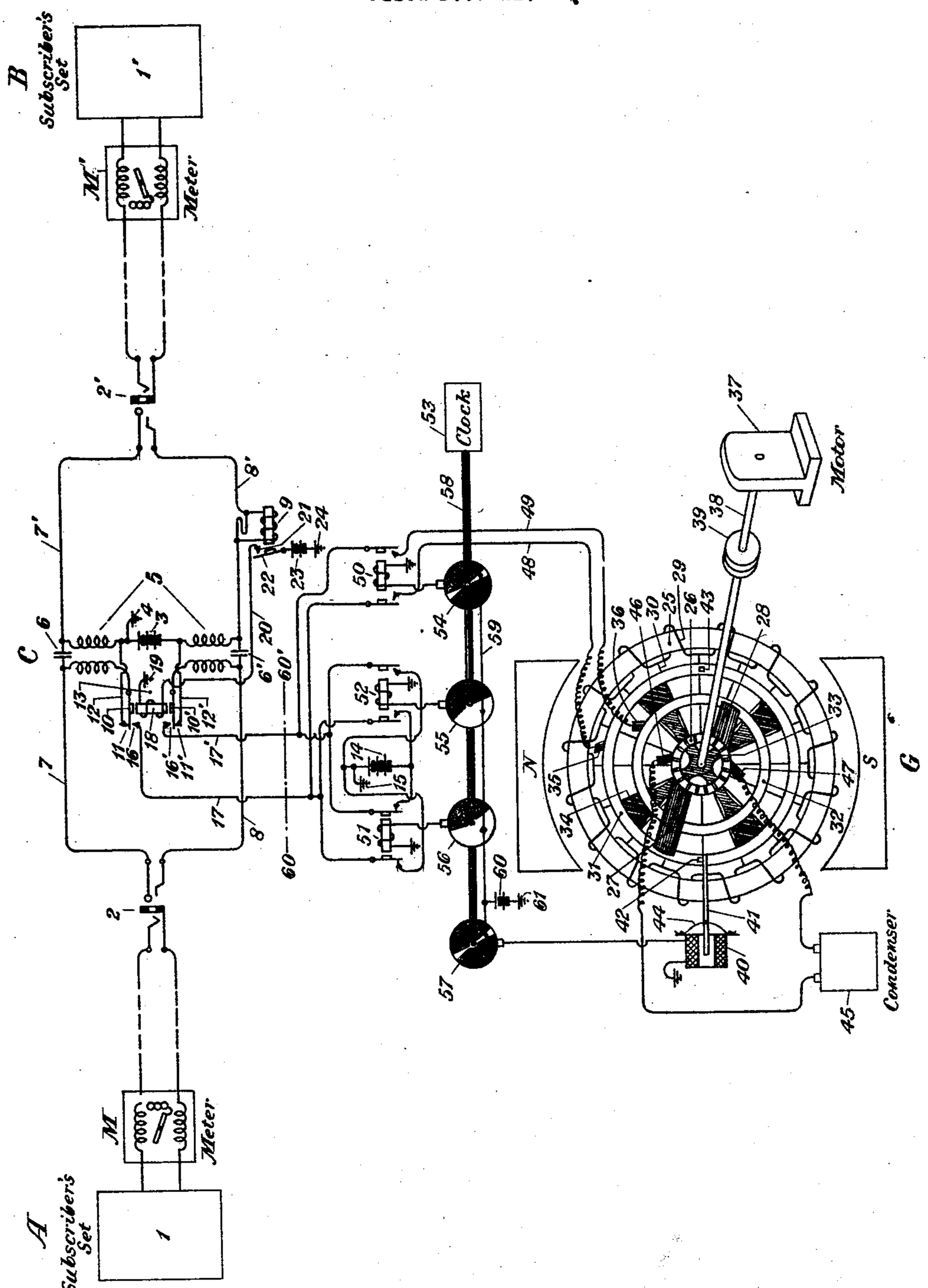
Feb. 24, 1931. W. H. EDWARDS 1,793,598

TELEPHONE SYSTEM

Filed Dec. 21, 1928



INVENTOR
W. H. Edwards
BY
ATTORNEY

Patented Feb. 24, 1931

1,793,598

UNITED STATES PATENT OFFICE

WILLIAM H. EDWARDS, OF BAYSIDE, NEW YORK, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

TELEPHONE SYSTEM

Application filed December 21, 1928. Serial No. 327,502.

This invention relates to telephone metering systems and more particularly to methods and apparatus for gradually reversing the direction of current flow in a telephone system at predetermined intervals of time to operate a meter which records the length of time the telephone is in use.

It is an object of this invention to provide a novel and efficient method of and means for periodically varying or reversing the direction of current flow in a telephone subscriber's line to operate a timing meter located at his substation without interrupting the conversation or creating disturbances in the talking circuit.

The apparatus constituting a part of the invention comprises in combination a meter located at the subscriber's station adapted to be operated by current reversals in the line to which the battery is connected, a direct current generator equipped with brushes which may be periodically shifted to reduce the current produced by the generator gradually to zero and build it up again gradually in the opposite direction, and means for periodically and successively connecting said generator in the circuit in parallel with the line battery, disconnecting said line battery, reversing the output current of said generator by shifting its brushes, reconnecting the line battery in the circuit in the reverse direction and disconnecting said generator.

The drawing illustrates diagrammatically a telephone system embodying the invention. In the drawing, two subscribers' stations A and B with subscribers' sets 1 and 1′ are shown with subscribers' loops extending to the central office and terminating in the jacks 2 and 2′. As shown, A represents the station of the calling subscriber and B that of the called subscriber. There are located at the stations meters M and M′ which are adapted to respond to current reversals in the subscribers' loops.

The cord circuit C of the central office is here illustrated as the impedance coil feed type. Obviously, a cord circuit of the repeating coil feed type may be used, if desired. The cord circuit shown comprises the usual current source 3 grounded at 4, a current supply bridge comprising impedance coils 5, the capacities 6 and 6′ the cord conductors 7, 7′, 8 and 8′ and the supervisory relay 9. Normally, the current supply bridge of the calling subscriber is connected to the source 3 through the armatures 10 and 10′, the contacts 11 and 11′ and the leads 12 and 12′. A switching means 13 is provided to disconnect the current supply bridge of the calling subscriber from the source 3 and to connect it to the auxiliary source 14, grounded at 15, through the armatures 10 and 10′, the contacts 16 and 16′ and the leads 17 and 17′. This switching means which is under the control of relay 9 comprises a relay 18 grounded at 19, the conductor 20, the contact 21, the armature 22 and the source 23 grounded at 24.

In addition there is located at the central office a direct current generator G of substantially the same voltage as the source 14 which comprises a magnet with north pole N and south pole S, the armature 25, the commutator 26 and the brushes 27 and 28. The armature 25 is shown as the closed coil ring type and includes a plurality of coils 29 forming a closed circuit with leads 30 connecting said coils to the bars of the commutator 26. Other types of armatures may be used, if desired. Brushes 27 and 28 are positioned so as to be in contact with opposite sides of the commutator 26 and are fastened preferably by rocking brush rigging to the collector rings 31 and 32, respectively. The collector ring 32 is supported by the spider 33 and the collector ring 31 is rigidly fastened to the collector ring 32 by the insulated joints 34. Stationary brushes 35 and 36 are positioned so as to be in contact with collector rings 31 and 32, respectively. The collector rings 31 and 32 with the brushes 27 and 28, respectively, are adapted to be rotated periodically through a predetermined arc, for example, one-half revolution. As shown, the armature rotates in a clock-wise direction and the collector rings and brushes in a counter-clockwise direction. An armature of the stationary type with a rotating magnet may be used, if desired.

Any suitable driving means may be used to cause the rotation of the collector rings and

brushes and any suitable means may be provided to regulate the arc and time of rotation. As diagrammatically shown, the driving means comprises a continuously revolving motor 37 connected by shaft 38 through a friction clutch 39 to the spider 33 and the regulating means comprises a solenoid 40 which is momentarily energized at predetermined intervals of time by the closure of its circuit which is controlled by the clock mechanism 53. The solenoid has an armature 41 which, in its normal position, engages one of the stop lugs 42 or 43 which are fastened at opposite points on the surface of the collector ring 31. The momentary energization of the solenoid 40 attracts its armature 41 and releases its engagement with the stop lug 42. Immediately thereafter and before the collector ring has completed its one-half revolution, for example, the solenoid is deenergized and its armature is restored to its normal position by means of the ribbon spring 44 to engage the other stop lug 43. As soon as the stop lug is released from engagement with the armature 41, the collector ring which is under constant tension, due to its connection with the continuously revolving motor 37 through the shaft 38 and the friction clutch 39, rotates, for example, one-half revolution at substantially constant speed until its other stop lug 43 engages the armature 41. Obviously, the brushes 27 and 28 are rotated at the same time as the collector rings 31 and 32. It is to be understood that this invention is not limited to the particular forms of driving means and regulating means shown nor to a magnet having only two poles. A condenser element 45, preferably of the electrolytic type, is connected in parallel with the generator circuit through the stationary brushes 46 and 47 to absorb the ripples in the commutator current and to prevent any noise that might be caused by generator operation from getting into the talking circuit.

The generator G is associated with the supply bridge of the calling subscriber in parallel with the auxiliary source 14 through the leads 48 and 49, the contacts and armatures of the relay 50 and the leads 17 and 17′. The auxiliary source 14 is likewise associated with said supply bridge through the contacts and armatures of relays 51 and 52 and the leads 17 and 17′. These relays, as well as the solenoid 40, are under the control of the clock mechanism 53 which includes the interrupters 54, 55, 56 and 57 supported and operated by the shaft 58. The circuit of each relay includes an individual ground connection, winding, lead and brush which is in contact with its corresponding interrupter and a common lead 59 and a source 60 grounded at 61. The clock mechanism is designed to rotate the interrupters at a constant speed, for example, one revolution every thirty seconds during which time two reversals of the line current take place. The interrupters are designed so that during one revolution the relay 50 is operated twice, the solenoid 40 twice, the relay 51 once and the relay 52 once in predetermined sequence and at predetermined intervals of time as will be hereinafter more fully explained.

As a safeguard against sparking, the brushes 27 and 28 are preferably made of carbon of high contact resistance and being made large enough to be in contact with at least two commutator bars at all times are normally located in an advanced position with respect to the neutral area of the magnetic field and the direction of rotation. Also, the self-induction of each coil on the armature is reduced to a minimum. This is obtained with the given voltage and current output by employing a maximum number of coils, commensurate with practical design with a minimum number of turn in each coil. Likewise, the provision of comparatively wide pole pieces, as shown, distributes the magnetic field uniformly over a large area and avoids concentration at any one point.

The operation of the system is as follows: When the calling subscriber at station A removes his receiver from the hook to initiate a call, the operator in response to the signal establishes a connection to the central office in the well known manner. At this time, the current flows from the positive terminal of the source 3 through the lead 12, the contact 11, the armature 10, the upper left impedance coil 5, the cord conductor 7, the jack 2, out over the subscriber's loop, through the meter and the subscriber's set, back through the jack 2, the cord conductor 8, the lower left impedance coil 5, the armature 10′, the contact 11′ and the lead 12′ to the negative terminal of the source 3. After the connection has been completed through the cord circuit C to the station B of the called subscriber and when the called subscriber removes his receiver from the hook, the circuit including the relay 9 will be closed. The closure of this circuit and the resulting energization of the relay 9 causes the latter to attract its armature 22 which establishes a connection with contact 21. The establishment of this connection closes the circuit of the relay 18 and causes its energization. When energized, this relay attracts its armatures 10 and 10′ to break their connection with contacts 11 and 11′, respectively, and to establish their connection with contacts 16 and 16′, respectively. This breaks the connection of the impedance coils of the supply bridge of the calling subscriber with the source 3 and connects them to the auxiliary source 14 through the contacts 16 and 16′, the leads 17 and 17′ and the armatures and contacts of relay 51. At this time, the auxiliary source 14 is supplying current to the calling subscriber's line in the same direction as before. At predetermined intervals of time, for example,

every fifteen seconds, the clock mechanism 53 through the interrupter 54 closes the circuit of relay 50 which connects the generator in the circuit of the calling subscriber's line in parallel with the source 14, the polarity of the generator at this time being the same as that of the source 14. At the end of a predetermined interval of time, for example, one second, the further rotation of the shaft 58 through the interrupters 56 and 57 simultaneously closes the circuits of the relay 51 and the solenoid 40. The operation of relay 51 disconnects the source 14 from the circuit and the operation of solenoid 40 causes the engagement between the armature 40 and the stop lug 42 to be momentarily released. The brushes 27 and 28 are rotated through a predetermined arc, for example, one-half revolution, as hitherto described, which rotation causes the generator current and hence the current of the calling subscriber's line to be reversed. This reversal which takes place very rapidly, for example, in .01 seconds, operates the meter M of the calling subscriber. As soon as the reversal is completed, the circuit of the relay 52 is closed through the interrupter 55. The operation of this relay causes the source 14 to be reconnected in the circuit in the reverse direction. At the end of a predetermined interval of time, for example, one second, the interrupter 54 breaks the circuit of the relay 50 and causes the generator to be disconnected from the circuit. The current now flows from the positive terminal of the source 14 through the right-hand contact and armature of the relay 52, the lead 17′, the contact 16′, the armature 10′, the lower left impedance coil 5, the cord conductor 8, the jack 2, out over the calling subscriber's line, through the meter and the subscriber's set, back through the jack 2, the cord conductor 7, the upper left impedance coil 5, the armature 10, the contact 16, the lead 17, the left armature and contact of the relay 52 to the negative terminal of the source 14. The meter located in the called subscriber's loop is not operated due to the fact that the current therein is not reversed.

Although the invention has been described specifically as a current reversing system, it should be understood that a system in which the current is varied from a maximum to zero and back again to a maximum of the same direction is within the scope of this invention.

As shown and described, the generator is connected on one side of the cord circuit only, since, in general, it is desirable to charge the call to the calling subscriber only. It is obvious, however, that the same mechanism could be applied on the other side of the cord circuit or on both sides of the cord circuit, if desired. The mechanism shown in the drawing below the dotted line 60—60′ may be common to all of the cords of a given exchange or to a group of cords or to each cord separately. Likewise, the association of the generator with the cord circuit may be under the control of other means than the relay 9 in such a manner that the operation of the meter will begin at any desired time during the connection.

While this invention has been illustrated in connection with a typical cord circuit used in manual operation, it is apparent that it is equally applicable to dial systems.

What is claimed is:

1. In combination, a load circuit having a source of current adapted to be connected therein, measuring apparatus in said circuit adapted to be operated by current variations therein, and a voltage producing means adapted to be connected in said circuit in parallel with said source, and having a plurality of brushes adapted to be shifted periodically through a predetermined arc to vary the current in said circuit when said source is disconnected therefrom.

2. In combination, a load circuit having a source of current connected therein, measuring apparatus in said circuit responsive to current variations therein, a dynamo-electric machine adapted to be connected in said circuit in parallel with said source, and having a plurality of brushes adapted to be rotated periodically through a predetermined arc to vary the current in said circuit when said source is disconnected therefrom, and means for reconnecting said source in said circuit after said brushes have been rotated.

3. In combination, a load circuit having a source of current connected therein, metering apparatus responsive to current reversals in said circuit for measuring the length of time said circuit is in use, a generator connected in said circuit in parallel with said source and having a plurality of brushes adapted to be rotated periodically through a predetermined arc to reverse the direction of current flow in said circuit when said source is disconnected therefrom, and means for reconnecting said source in said circuit in its reverse direction and disconnecting said generator therefrom after said brushes have been rotated.

4. In a telephone system, subscribers' lines, metering apparatus located in said lines and responsive to current variations therein, connecting circuits for establishing talking connections between said lines, a source of potential connected to said circuits, a dynamo-electric machine adapted to be connected in said connecting circuits in parallel with said source and having a plurality of rotatable brushes, and means for periodically and successively disconnecting said source from said circuits and rotating said brushes through a predetermined arc to vary the current in said lines.

5. In a telephone system, a calling line and

a called line, metering apparatus located in said calling line and adapted to be operated by polarity reversals of the voltage therein, connecting circuits for establishing talking connections between said lines, a battery of substantially constant voltage associated with said connecting circuits, a direct current generator of substantially the same voltage as said battery and having a plurality of commutator brushes adapted to be shifted through a predetermined arc to reverse the polarity of the voltage of said generator, and means for periodically and successively impressing said generator voltage on the circuit of said calling line in parallel with said battery voltage and in the same direction therewith, removing said battery voltage from the circuit of said calling line, shifting said commutator brushes through a predetermined arc to reverse the polarity of said generator voltage, reimpressing said battery voltage on the circuit of said calling line in the same direction as said generator voltage after its reversal, and removing said generator voltage therefrom.

6. In a telephone system, a calling line and a called line, a meter located in the circuit of said calling line and responsive to polarity reversals of the voltage therein, connecting circuits for establishing talking connections between said lines, a battery connected in the circuit of said calling line, a generator of substantially the same voltage as said battery and having a plurality of brushes adapted to be rotated through a predetermined arc to reverse the polarity of said generator voltage, and means operative periodically and successively for impressing said generator voltage in the circuit of the calling line in parallel with said battery and in the same direction therewith and removing said battery voltage therefrom, for rotating said brushes through a predetermined arc to reverse the polarity of said generator voltage, and for reimpressing said battery voltage on the circuit of said calling line in the same direction as said generator voltage after its reversal and removing said generator voltage therefrom.

7. In a telephone system, a calling line and a called line, a meter located in said calling line and adapted to be operated by polarity reversals of the voltage therein, connecting circuits for establishing talking connections between said lines, a battery adapted to supply current to said lines, a second battery adapted to supply current to said calling line, switching means controlled by the closure of the circuit of said called line for disconnecting said calling line from said first battery and connecting it to said second battery, a dynamo-electric machine adapted to be connected in the circuit of said calling line in parallel with said second battery, a condenser element in parallel relationship with said dynamo-electric machine, said dynamo-electric machine including a field magnet having a plurality of poles, an armature, a commutator, and a plurality of brushes in electrical contact with opposite sides of said commutator and adapted to be shifted through a predetermined arc to reverse the polarity of the voltage of said dynamo-electric machine, and means for periodically and successively impressing the voltage of said dynamo-electric machine on the circuit of said calling line in parallel with said second battery, removing the voltage of said second battery therefrom, shifting the brushes of said dynamo-electric machine through a predetermined arc to reverse the polarity of the voltage impressed on the circuit of said calling line, reimpressing the voltage of said second battery on the circuit of said calling line in the same direction as that of said dynamo-electric machine after its brushes have been shifted, and removing the voltage of said dynamo-electric machine therefrom.

8. In a measuring system including a load circuit having measuring apparatus responsive to voltage variations therein, a source of electrical energy of substantially constant voltage, and a second source of electrical energy of variable voltage, the method of operating said measuring apparatus which consists in impressing the voltage of both of said sources in parallel simultaneously on said load circuit, removing the voltage of said first source therefrom, and gradually varying the voltage of said second source to operate said measuring apparatus.

9. In a measuring system including a load circuit having a source of electrical energy of substantially constant voltage, measuring apparatus responsive to polarity reversals of the voltage therein, and a second source of electrical energy the polarity of the voltage of which is variable, the method of operating said measuring apparatus which consists in gradually reversing the polarity of the voltage of said second source after the voltage of said first source has been removed from said circuit and that of said second source impressed thereon.

10. The method of reversing the polarity of the applied voltage in a work circuit having normally therein a source of substantially constant voltage, which consists in periodically and successively impressing a variable voltage on said work circuit in parallel with said source of constant voltage and in the same direction therewith, removing said constant voltage from said circuit, gradually reversing the polarity of said variable voltage, reimpressing said constant voltage on said circuit in parallel with said variable voltage and in the same direction as said variable voltage after its reversal, and removing said variable voltage from said work circuit.

11. The method of reversing the polarity of the applied voltage in a work circuit having normally therein a source of substantially constant voltage, which consists in impressing on said circuit a variable voltage of the same polarity as that of said constant voltage and removing said constant voltage therefrom, gradually reversing the polarity of said variable voltage, and reimpressing said constant voltage on said circuit in its opposite polarity and removing said variable voltage therefrom.

12. A method of varying the applied voltage in a work circuit having normally therein a source of substantially constant voltage, which consists in removing said constant voltage from said circuit and simultaneously impressing thereon a variable voltage of the same polarity as that of said constant voltage, varying said variable voltage, and reimpressing said constant voltage on said circuit and simultaneously removing said variable voltage therefrom.

In testimony whereof, I have signed my name to this specification this 19th day of December 1928.

WILLIAM H. EDWARDS.