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TELEPHONE SYSTEM

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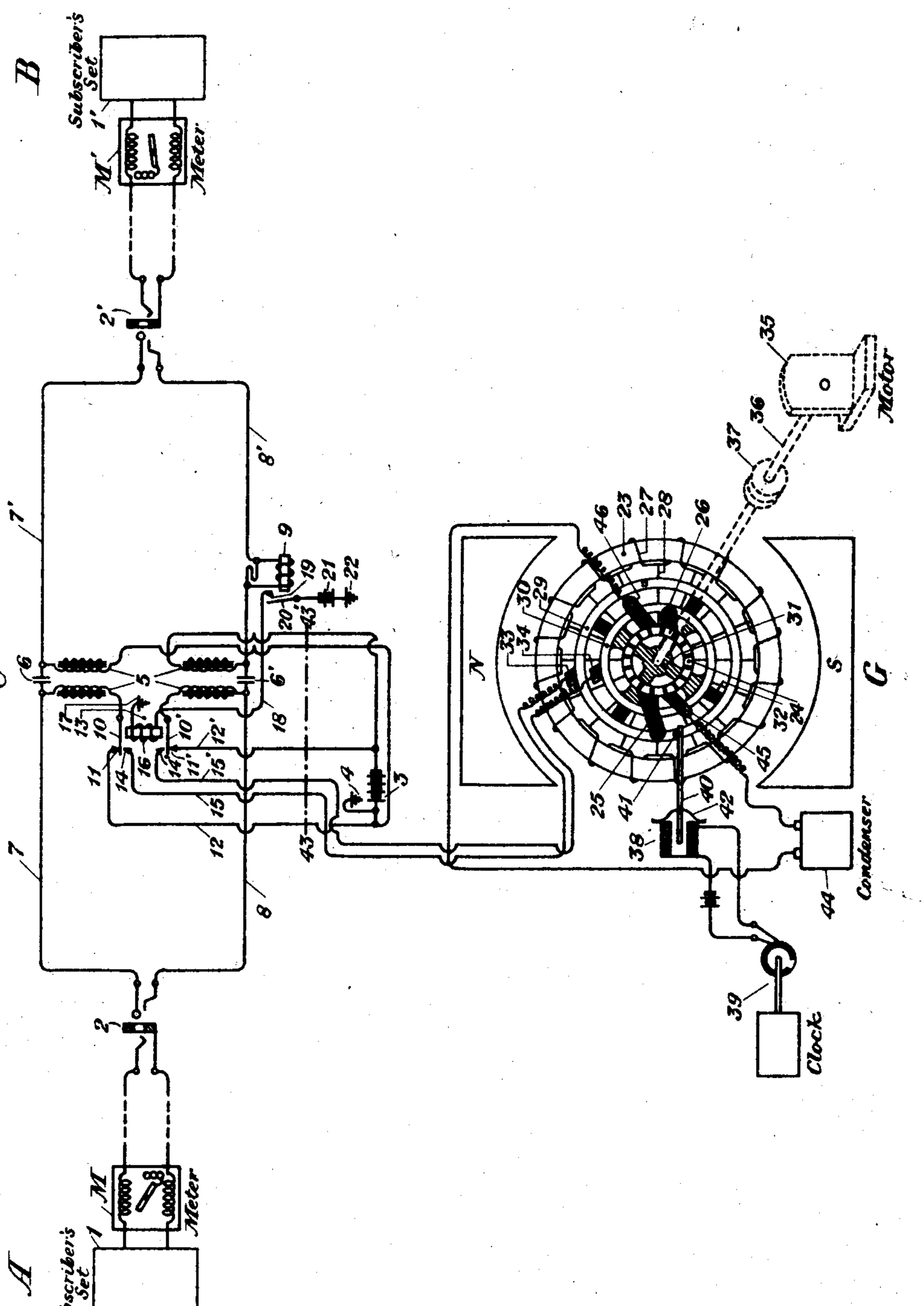

INVENTOR
I. W. Green

BY

ATTORNEY

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IRVING W. GREEN, OF CRANFORD, NEW JERSEY, ASSIGNOR TO AMERICAN TELEPHONE AND TELEGRAPH COMPANY, A CORPORATION OF NEW YORK

TELEPHONE SYSTEM

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This invention relates to telephone metering systems, and more particularly to means for periodically reversing the direction of current flow in a telephone circuit 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, efficient and inexpensive means which is adapted to supply talking current and meter operating current for such systems and which eliminates the necessity of using expensive auxiliary apparatus for reversing the direction of current flow therein to operate the recording device.

The invention comprises, in combination with a telephone metering system, 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 gradually in the opposite direction and a means for periodically shifting said brushes.

The drawing illustrates diagrammatically a telephone system embodying the invention. In the drawing, two subscribers' stations A and B with subscriber 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 variations in the subscribers' loops.

The cord circuit C of a 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 the 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 direct current generator G through the armatures 10 and 10′, the contacts 14 and 14′ and the leads 15 and 15′. This switching means which is under the control of relay 9 comprises the relay 16 grounded at 17, the armatures 10 and 10′, the conductor 18, the contact 19, the armature 20 and the source 21 grounded at 22.

The direct current generator G comprises a magnet with north pole N and south pole S, the armature 23, the commutator 24 and the brushes 25 and 26. The armature 23 is shown as the closed coil ring type and includes a plurality of coils 27 forming a closed circuit with leads 28 connecting said coils to the bars of the commutator 24. Other types of armatures may be used if desired. Brushes 25 and 26 are positioned so as to be in contact with the opposite sides of the commutator 24 and are fastened preferably by rocking brush rigging to the collector rings 29 and 30, respectively. The collector ring 30 is supported by the spider 31 and the collector ring 29 is rigidly fastened to the collector ring 30 by the insulated joints 32. Stationary brushes 33 and 34 which are connected to leads 15 and 15′ are positioned so as to be in contact with collector rings 29 and 30, respectively. The collector rings 29 and 30 with the brushes 25 and 26, respectively, are adapted to be rotated periodically through a predetermined arc, for example, one-half revolution. As shown, the armature rotates in a clockwise direction and the collector rings and brushes in a counterclockwise direction. An armature of the stationary type with a rotating magnet may be used without departing from the scope of the invention. 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 35 connected by shaft 36 through a friction clutch 37 to the spider 31 and the regulating means comprises a solenoid 38 which is momentarily energized at predetermined intervals of time by the closure of its circuit which is controlled by the

clock mechanism 39. The solenoid has an armature 40 which, in its normal position, engages one of the stop lugs 41 which are fastened at opposite points on the surface of the collector ring 29. The momentary energization of the solenoid 38 attracts its armature 40 and releases its engagement with the stop lug 41. 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 ribbin spring 42 to engage the other stop lug. As soon as the stop lug is released from engagement with the armature 40, the collector ring which is under constant tension, due to its connection with the continuously revolving motor 35 through the shaft 36 and the friction clutch 37, rotates, for example, on-half revolution at substantially constant speed until its other stop lug engages the armature 40. Obviously, the brushes 25 and 26 are rotated at the same time as the collector rings 29 and 30. 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 44, preferably of the electrolytic type, is connected in parallel with the generator circuit through the stationary brushes 45 and 46 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.

Although the question of sparking between the brushes and the commutator bars is largely a problem of design, several features have been embodied in the generator constituting a part of the present invention to prevent sparking. In an ordinary generator, the coils which are directly under the brushes are momentarily short-circuited. If the brushes are positioned in the neutral area of the magnetic field—namely, the area in which the coils are not cutting any lines of force but are moving parallel thereto—there is no induced current acting in the short-circuited coils. At this time, the current in the circuit of the active coils is flowing through the leads of the short-circuited coils, the corresponding commutator bars and brushes. When these commutator bars pass out from under the brushes, said coils are thrown as perfectly idle coils into the circuit of the active coils and the current flowing in this circuit will, for an instant, continue to flow through said leads and said commutator bars and spark across the intervening space to the brushes, due to the self-induction of said idle coils. On the other hand, if the brushes are placed in a retarded position with respect to the neutral area of the magnetic field and the direction of rotation, there will be an induced electromotive force acting in the short-circuited coils, which electromotive force will produce a large current therein due to the low short-circuit resistance. This current will tend to flow in a direction opposite to that of the current in the active circuit. When the commutator bars corresponding to said coils pass out from under the brushes, both the large short-circuited current and the current of the active circuit will, for an instant, continue to flow from the commutator bars to the brushes, due again to the self-induction of the short-circuited coils, and thus cause sparking. In the generator disclosed in the drawing, the brushes are placed in an advanced position with respect to the neutral area of the magnetic field and the direction of rotation. Because of this, as the coils pass the brushes, they, having already passed the neutral area, are beginning to enter the forward magnetic field and to cut the magnetic lines in such a way as to tend to set up in them a current in the reverse direction—namely, in the same direction as the current in the circuit of the active coils. Hence self-induction will not be present in the coil at this time and no sparking will result. In order to prevent sparking when the brushes are being rotated, carbon brushes having adequate contact resistance and being large enough to cover at least two commutator bars are employed. Due to the contact resistance of the carbon brushes, the resistance of the brushes to the current flowing from the commutator bars increases as the area of contact between the brushes and the bars decreases. Obviously, this tends to prevent sparking. By making each brush large enough to cover several commutator bars at the same time, part of the current produced by the active coils passes through the short-circuited coils while it is still under the brush. Hence, when it passes out from under the brush, self-induction, as regards this current, will not be present and there will be no tendency for this current to spark across the space between the commutator bar and the brush.

As a further safeguard against sparking, the self-induction of each coil is reduced to a minimum. This is obtained with a given voltage and current output by employing a maximum number of coils, commensurate with practical design, and a corresponding minimum number of turns 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. Other means may be employed to prevent sparking, for example, artificially increasing the resistance of that part of the brush that last touches the commutator bars and increasing the resistance of the leads 28.

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 conductors 8, the lower left impedance coil 5, the armature 10′, the contact 11′ and 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 20 which establishes a connection with the contact 19. The establishment of this connection closes the circuit of the relay 16 and causes its energization. When energized, this relay attracts its armatures 10 and 10′ to break their connection with the contacts 11 and 11′, respectively, and to establish their connection with the contacts 14 and 14′, 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 generator G through the contacts 14 and 14′ and the leads 15 and 15′. During this period, the generator G is supplying current to the calling subscriber's loop and the source 3 to the called subscriber's loop. At predetermined intervals of time, for example, every fifteen seconds, the clock mechanism 39 causes the engagement between the armature 40 and the stop lug 41 to be momentarily released and the brushes 25 and 26 are rotated for example, one-half revolution as hitherto described. As they rotate from their normal position to the midpoints of their arcs of rotation, the current in the calling subscriber's loop is gradually decreased, due to the bucking of the electromotive force induced in the coils on the opposite sides of the armature. At the instant the brushes reach the midpoints of their arcs of rotation, there is no difference in potential between the brushes and hence the current in the calling subscriber's loop is zero. When the brushes pass these midpoints, the current is reversed, flowing from the brush 26 through the collector ring 30, the brush 34, the lead 15′, the contact 14′, the armature 10′, the lower left impedance coil 5, the cord conductor 8, the jack 2, out over the subscriber's loop, 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 14, the lead 15, the brush 33 and the collector ring 29 to the brush 25. As the brushes 25 and 26 continue to rotate until the one-half revolution, for example, its completed, the reversed current is gradually increased to its maximum. These reversals which occur during the conversation at predetermined intervals of time take place very rapidly, for example, in .01 seconds and each revolution causes the operation of the meter located in the calling subscriber's loop. 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 polarity 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, or may be used in place of the source 3 to supply talking current to both subscribers' lines. The mechanism shown in the drawing below the dotted lines 43—43′ may be common to all the cords of a given exchange or to a group of cords or, if desired, may be supplied to each of the cords separately. Likewise, the connection of the generator with the cord circuits may be unde the control of other means than the relay 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, using manual operation, it is apparent that it is equally applicable to machine switching apparatus.

What is claimed is:

1. In combination, a magnet having a plurality of poles, an armature including a core and a plurality of coils around said core adapted to have electromotive force induced therein by relative rotation between said magnet and said armature, a commutator including a plurality of bars, said bars and said coils being electrically connected to one another, a pair of collector rings insulated from each other, a pair of brushes fastened to said collector rings and adapted to be in electrical contact with opposite sides of said commutator, and means for periodically rotating said collector rings through a predetermined arc to vary the current therethrough.

2. In combination, a magnet having a plurality of poles, an armature including a plurality of coils adapted to have electromotive force induced therein by relative rotation between said magnet and said armature, the number of said coils having a high ratio to the number of turns in each coil in the production of a predetermined electromotive

force therein, a commutator including a plurality of bars electrically connected to said coils, a pair of collector rings insulated from each other, a pair of brushes of high contact resistance fastened to said collector rings and positioned so as to be in electrical contact with opposite sides of said commutator along that edge of the magnetic field which is beyond the neutral area thereof in the direction of rotation, said brushes being adapted to be simultaneously in contact with a plurality of said commutator bars, a pair of conductors in electrical connection with said collector rings, and means for periodically rotating said brushes through a predetermined arc.

3. In a dynamo electric machine, a field magnet, an armature adapted to have electromotive force induced therein by relative rotation between said magnet and said armature, a commutator, and a pair of brushes in electrical contact with opposite sides of said commutator and adapted to be rotated periodically through a predetermined arm to vary the current therethrough.

4. In a dynamo electric machine having a field magnet and an armature adapted to have electromotive force induced therein by relative rotation between said magnet and said armature, a commutator, a pair of brushes in electrical contact with opposite sides of said commutator, a pair of collector rings fastened to said brushes, and means for periodically rotating said collector rings through a predetermined arm to vary the current therethrough.

5. In a dynamo electric machine having a field magnet and an armature adapted to have electromotive force induced therein by relative rotation between said magnet and said armature, a commutator including a plurality of bars, a pair of collector rings insulated from each other, a pair of brushes of high contact resistance fastened to said collector rings and located so as to be in electrical contact with opposite sides of said commutator and in an advanced position with respect to the neutral area of the magnetic field and the direction of rotation, said brushes being adapted to be simultaneously in contact with a plurality of said commutator bars, and means for periodically rotating said collector rings through a predetermined arc to vary the current therethrough.

In testimony whereof I have signed my name to this specification this 18th day of December, 1928.

IRVING W. GREEN.