(No Model.) 3 Sheets—Sheet 1.

J. F. OTT & A. E. KENNELLY.

MEANS FOR CONTROLLING ELECTRIC MOTORS.

No. 489,687. Patented Jan. 10, 1893.

Fig. 1.

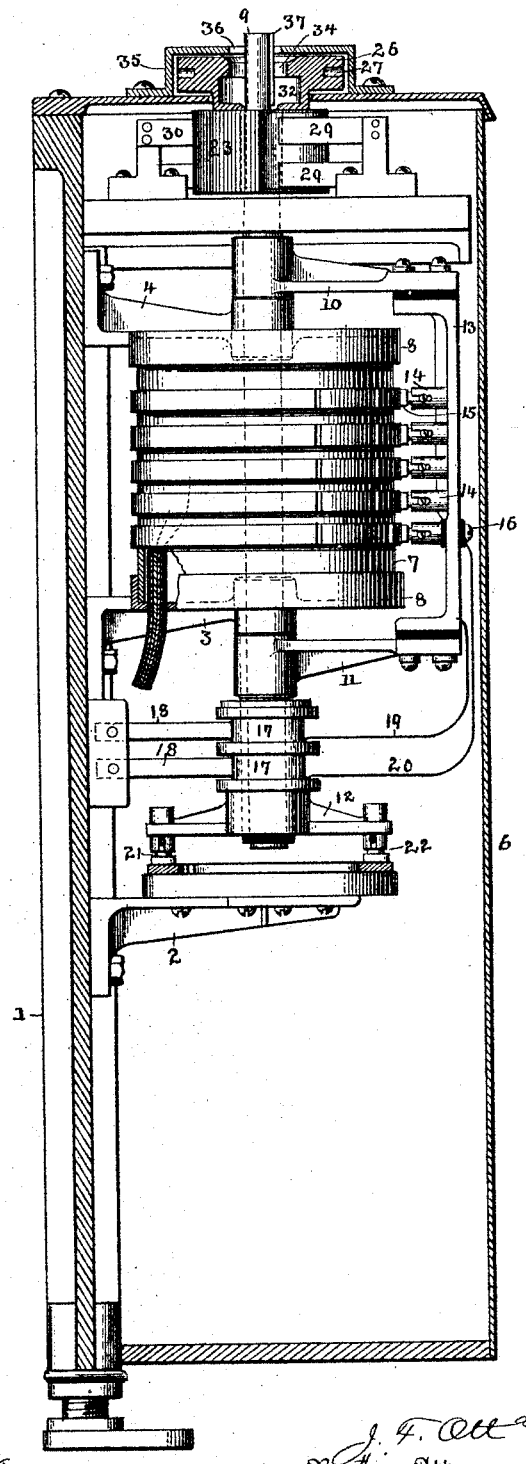


Fig. 2.

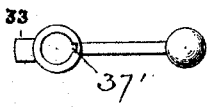
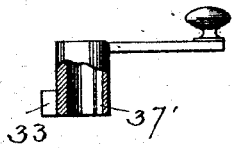


Fig. 2a.



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(No Model.) 3 Sheets—Sheet 2.

J. F. OTT & A. E. KENNELLY.

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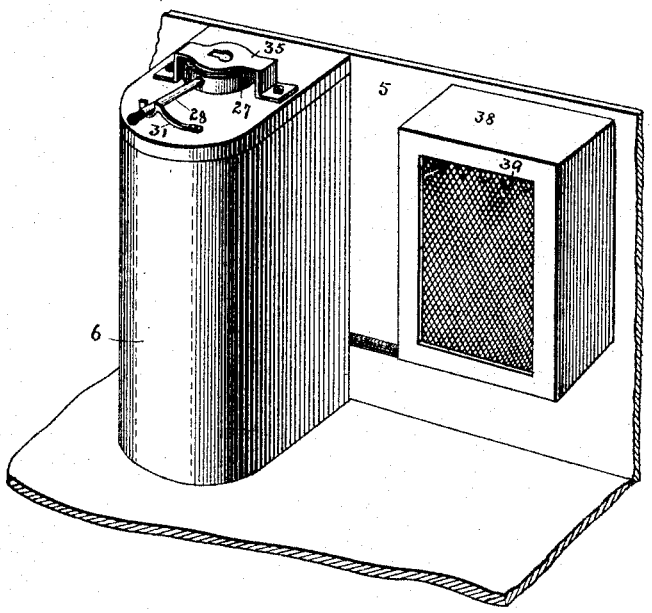


Fig. 3.

Fig. 4.

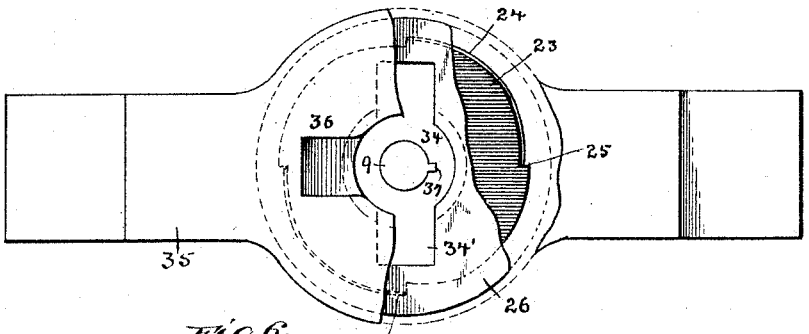
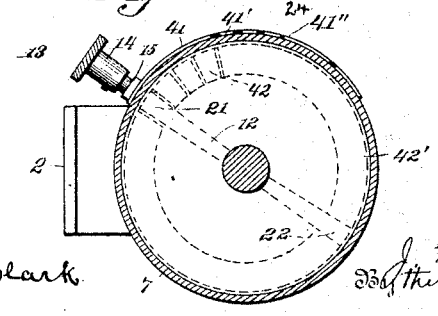


Fig. 6.



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(No Model.) 3 Sheets—Sheet 3.

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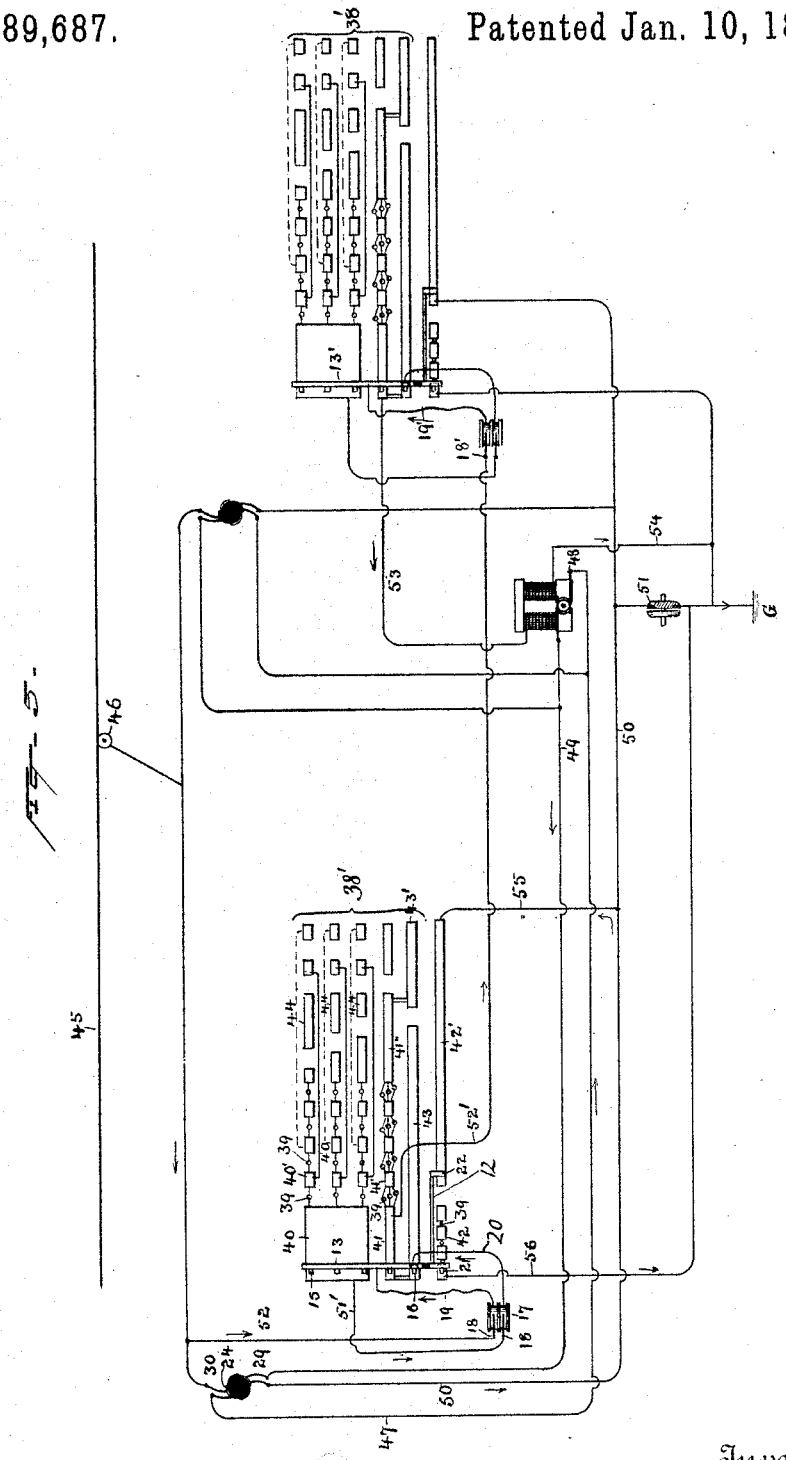

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UNITED STATES PATENT OFFICE.

JOHN F. OTT AND ARTHUR E. KENNELLY, OF ORANGE, NEW JERSEY, ASSIGNORS TO THE EDISON GENERAL ELECTRIC COMPANY, OF NEW YORK, N. Y.

MEANS FOR CONTROLLING ELECTRIC MOTORS.

SPECIFICATION forming part of Letters Patent No. 489,687, dated January 10, 1893.

Application filed May 7, 1891. Serial No. 391,861. (No model.)

To all whom it may concern:

Be it known that we, JOHN F. OTT, a citizen of the United States, and ARTHUR E. KENNELLY, a subject of the Queen of Great Britain, residing at Orange, county of Essex, State of New Jersey, have invented certain new and useful Improvements in Means for Controlling Electric Motors, of which the following is a specification.

The present invention relates to switch and resistance apparatus designed especially for controlling electric motors employed to propel vehicles, and the main object is to provide improved devices by which the motor can be controlled in a safe and efficient manner from either end of the vehicle.

The apparatus to be described is designed especially for use on a vehicle having circuits and apparatus such as invented and used by Mr. Edison, comprising a motor, a switch at each end of the car for controlling the same, one switch closing the circuit of the motor in one direction, and the other switch closing the circuit of the motor in the opposite direction only, and both switches serving to throw resistance into or out of the field magnet circuit; and also to control the resistance in a shunt around a magnetic clutch which serves to transmit power from the motor to the car-axle. It will be clear, however, that several features of the present improvement are applicable to other circuits and locations.

In the accompanying drawings, Figure 1 is a view of the switch, the inclosing case being in section; Fig. 2 is a plan view of a handle for operating the switch; Fig. 2^a is a side view of the handle, partly in section and on a larger scale than Fig. 1; Fig. 3 is a view of a car platform showing the switch apparatus and resistance box in place thereon; Fig. 4 is a plan view, with parts broken away, of a part of the apparatus; Fig. 5 is a diagram illustrating the switch as applied to the circuits of a vehicle; and Fig. 6 is a cross-section of the drum 7 taken above the second row of contacts and looking downward.

In Fig. 1, 1 is the back plate supporting the several parts of the switch by means of brackets 2, 3, 4, and is adapted to be secured to the dash-board 5, of Fig. 3. 6 is a sheet metal case inclosing the switching apparatus. Within the case is a stationary cylinder 7 of insulating material, such as wood. This cylinder is held between the caps 8 secured to the two brackets 3, 4. Through the center of the cylinder extends a spindle 9, to which is secured, so as to turn therewith, arms 10, 11 and 12. To the first two arms, but insulated therefrom, is connected a cross-arm 13, and this arm carries several brushes or current collecting devices 15, and an additional brush or device 16 which is insulated from the arm 13. All of these brushes bear on the circular rows of contact plates or strips on the cylinder, as shown, and from the several plates wires extend to the resistance box. No attempt is made to indicate in Fig. 1 the manner in which these contact strips are divided, that being shown in the diagram. The contacts are so arranged on the cylinder that the switch brushes do not have to travel entirely around to pass over all of the contacts. Below the arm 11 are two conducting rings 17 on which bear brushes 18. The upper ring is connected by wire 19 with the arm 13, while the lower one is connected by wire 20 with the insulated brush 16. The arm 12 carries a contact brush 21, 22 at each end. The former co-operates with a series of short contacts and the latter rides on a long contact, for a purpose hereinafter described. The arrangement of contacts is such that before brush 22 reaches the first resistance contact, the main brushes will have passed over all of their contacts. Near the upper end of the spindle is a circuit maker and breaker consisting of a block or disk 23, having several cam faces, as shown in Fig. 4. Alternating faces are provided with the conducting strips or plates 24, while the other faces are of insulating material, and terminate in shoulder 25. This block or disk is free to turn on the spindle, and is turned by means of the block 26 which is connected with it. This block is provided with several holes 27 adapted to receive a handle 28 by which the block may be turned. When the handle is in position to hold the block turned to close the circuit by bringing the springs 29, 30, onto the conducting strips or plates 24, the handle will rest in a locking device 31. The block 26 is provided with a central cavity 32 in which the

lug 33 of the switch handle can move when said handle is turned to operate the switch. Communicating with this cavity is a passage 34 of the shape shown in Fig. 4, that is, extending in two directions as indicated at 34′ to admit the projection 33 of the switch-handle. Over the block 26 is a plate or bracket 35 which is provided with an opening for the reception of the handle, said opening being extended in one direction only to admit the lug 33, as indicated at 36. 37 is a spline or rib on the spindle adapted to fit the corresponding groove 37′ in the sleeve of the handle. 38 is a box which contains resistance lamps or devices 39, said resistance being thrown into or out of circuit by the switch apparatus.

Referring now to Fig. 5, we will describe the application of the apparatus to the circuits of a vehicle motor: The contacts of the drum 7 are shown developed at 38′. The first contact plates 40, 41 of the upper rows are as long as the several contacts 42 of the lower row. Between each contact of the latter row is included a resistance lamp or device 39. The strip 43 extends half way or more around the switch cylinder, and is connected to contact 41. Between the contact 40 and the succeeding contact 40′ are connected resistance lamps or devices 39, as shown. Between contact 41 and the succeeding contact 41′ are connected several of such resistance devices, for example three, and so on for the succeeding contacts. The last contact plate 41″ is connected with 43′. The three strips 44 are not connected with the circuits. The contacts 40′ of the first vertical row are connected with corresponding contacts at the right of the strips 44, as shown. The contacts of the succeeding vertical rows are similarly connected, although to avoid confusion this is not shown in the drawings. 45 is a trolley wire against which trolley 46 bears. From the trolley wires extend to the two switches arranged at opposite ends of the vehicle. The circuit is shown closed at the left of the diagram, the springs 30 resting on one plate 24 and the springs 29 resting on the opposite plate. From one of the springs 30 a wire 47 extends to the lower commutator brush 48 of the vehicle motor, and from the upper brush a wire 49 extends to first spring 29, and from the opposite spring a wire 50 extends through the coil 51 of magnetic clutch, and thence to ground G. From the trolley wire branches a wire 52 which extends to the upper brush 18; thence by wire 19 to the switch-arm 13. From contact 40 a wire 51′ extends to the lower brush 18, and thence by wire 20 to the insulated brush 16. From the contact 41 a wire 52′ extends to a brush 18′ at the opposite switch and by wire 19′ to the switch-arm 13′, and thence by wire 53 through the field magnet of the motor and by wire 54 to ground G. The long contact plate or strip 42′ is connected by wire 55 to wire 50. The first contact 42 is connected by wire 56 to the ground wire between the ground and the magnetic clutch. It is thought unnecessary to describe the connections of the switch at the right in detail, they being the same as already set forth. The contact plates may be arranged on the periphery of the drum as indicated in Fig. 6, where the contacts 41, 41′ &c. only occupy a portion of the circumference, and all the changes necessary can be made by moving the switch brushes 15, 21 &c. through an arc of ninety degrees or a little more. The contacts 42 on which the brush 21 bears are dotted in, being below the bottom of the drum 7. These contacts occupy the same arc as the long contact 41.

When it is desired to start the motor, the handle is put in place, which can only be done when the block 26 is in position to hold the circuit open at springs 29, 30, since in that position one of the extensions 34′ of the opening 34 will be in line with the opening 36. When the handle has thus been put in place, the block 26 is turned by placing the handle 28 in one of the holes 27 and moving it through forty-five degrees, thereby allowing the springs 29, 30 to snap from the shoulder 25 of the insulating block onto the conducting plates 24, suddenly closing the motor circuit at several points. This movement of the block 26 brings the shoulder at the upper side of the cavity 32 under the extension 36 of the opening in the bracket 35 and forms a trap or lock so that the handle cannot be withdrawn, since the lug 33 when in line with the opening in the bracket would be directly under said shoulder. To remove the handle, therefore, it is necessary to turn the block through a quarter revolution. With this arrangement, it is impossible for the operator to remove the handle without breaking the armature circuit, and he must break said circuit before he can close the circuit of the motor in the opposite direction at the other end of the car, since the other switch is operated by means of the same handle. It will be evident that when the second quarter turn is given to the block the circuit will be broken instantaneously at several points.

The armature circuit may be traced as follows: From the trolley to wire 47 through the armature to wire 49, to wire 50 and to ground. By tracing the circuit through the opposite switch, it will be clear that when that switch is used, the circuit through the motor armature is from the upper brush to the lower brush, hence when this switch is used the motor will be driven in the opposite direction.

The field magnet circuit may be traced as follows: From the trolley wire 52, wire 19, switch-arm 13, to wire 52′, to the switch-arm 13′ at the opposite switch to wire 53, through the field magnet to ground. This circuit contains no artificial resistance. With the circuits in this condition, the motor will be running at a speed to drive the car about four miles an hour, but the car will not be moved because the clutch is short-circuited by wires 50, 55 and 56 and switch-arm 12.

To start the car the switch-arm 13 is moved toward the right bringing the brush 21 onto succeeding contacts 42, thereby throwing more and more resistance into the short-circuit and increasing the amount of current through the clutch coil 51, until finally spring 21 passes from the last contact 42 and breaks the short circuit or shunt to the clutch. This movement of the switch has not affected the circuit of the field magnet, because of the length of the plates 40, 41, but just after clutch short-circuit is broken the switch-arm comes in line with the first vertical row of contacts 40′. This throws six resistance lamps or devices into the field magnet circuit in multiple arc, thereby increasing the speed of the motor. When the switch-arm is moved onto the second vertical row of contacts 40′ six more lamps are thrown into the field magnet circuit in multiple arc, but in series with the first six lamps, and so on for the four vertical rows of lamps. The next movement of the switch will throw out of circuit the upper line of lamps, leaving four groups of five lamps each in circuit; while the next movement will cut out the second line of lamps and leave four groups of four lamps each in circuit; the following movement will cut out the third row leaving four groups of three lamps each in circuit; the next movement, which brings the switch-arm onto the first vertical row of contacts at the right of strips 44, will give five groups of three lamps each, the circuit being over the switch-arm to the first vertical row of contacts 40′ by means of the connecting wires through three lamps in multiple arc to plate 40, by wires 51 and 20 to the contact 16, to contact 43′ to 41″, through four groups of lamps, and thence to the field magnet. When the arm is again moved three more lamps will be thrown into circuit, as will be clear without further description. From this it will be seen that the operation of the switch described first varies resistance clutch short-circuit, then breaks said short circuit, and then throws resistance devices into the field magnet circuit in large multiple arc groups, the number of groups gradually increasing and then, while maintaining the number of groups in said circuit, gradually decrease the number in each group until the number in each group is reduced to three (or any suitable number), and then gradually increases the number of these small groups, whereby by a simple movement of the switch-handle, and by the use of only twenty-four resistance devices, ten different resistance units may be thrown into the field magnet circuit, for the purpose of regulating its speed from its minimum speed, say, four miles an hour up to its maximum speed, say, twelve miles an hour.

We are aware of the invention set forth in Mr. Edison's application Serial No. 378,258. The circuits of our diagram (Fig. 5) differ from the circuits set forth in said application only in certain connections due to the form of our switching apparatus, and in having two sets of resistance devices, one at each end of the car, instead of having one set of resistances arranged beneath the car and having wires extending therefrom to the two switches.

What we claim is,

1. The combination in a switching apparatus of a stationary cylinder on the surface of which are a series of contact strips or plates, a spindle passing through said cylinder, means for turning said spindle, and an arm having contact devices co-operating with said contact strips and moved by the spindle, means for preventing more than one successive rotation of the spindle in the same direction whereby the switch-arm is moved over the cylinder contacts, first in one direction and then in the other substantially as described.

2. The combination in a switching apparatus, of a stationary cylinder or drum, a spindle passing loosely through it, means for turning the spindle, a switch-arm carried by the spindle and having several connected contact devices co-operating with corresponding rows of contacts on the drum, and an insulated contact brush carried by said arm and co-operating with a corresponding row of contacts on the drum, substantially as described.

3. The combination, in a switching apparatus, of a stationary cylinder or drum on the surface of which are a series of contact strips connected through resistance lamps or devices, a spindle passing loosely through said drum, means for turning the spindle, and an arm having contact devices co-operating with said contact strips and moved by said spindle, means for preventing more than one successive rotation of the spindle in the same direction whereby the switch-arm is moved over the spindle contacts, and the resistance in circuit is varied, substantially as described.

4. The combination, in a switch, of a cylinder or drum having contacts and a switch-arm co-operating therewith, of a circuit maker and breaker loosely mounted on a spindle passing through the drum, substantially as described.

5. The combination, in a switch, of a cylinder or drum having contacts and a switch-arm co-operating therewith, of a circuit maker and breaker loosely mounted on a spindle passing through the drum, said circuit maker and breaker consisting of a block having alternating, conducting and non-conducting cam faces, and co-operating contact springs, substantially as described.

6. The combination, in a switch, of a cylinder or drum having contacts and a switch-arm co-operating therewith, of a circuit maker and breaker loosely mounted on a spindle passing through the drum, said circuit maker and breaker consisting of a block having alternating, conducting and non-conducting cam faces and co-operating springs, means for moving the spindle, and independent means for moving the circuit maker and breaker, substantially as described.

7. The combination of a switch, a removable handle for moving it, a trap or lock for holding the handle in place when the circuit is closed, and means independent of the handle for operating said trap or lock to release the handle, substantially as described.

8. The combination of a switch mechanism having a spindle by means of which the switch may be operated, a handle adapted to fit said spindle in a certain definite position, a plate adjacent to the spindle having an opening adapted to receive the handle, a block adjacent to the first plate and having an opening also adapted to receive the handle, whereby when said openings are in line the handle may be put in place or removed, substantially as described.

9. The combination of a cylinder or drum on the surface of which are contacts, a switch-arm having contact devices co-operating therewith, a spindle passing through the drum and serving to move the movable member of the switch, a second switch-arm with contact devices also moved by said spindle, and contacts connected by resistances with which said devices co-operate said second switch-arm and its contacts being arranged to effect their operation before the first mentioned switch-arm and contacts, substantially as described.

10. The combination of a motor, a series of resistances a switch for throwing said resistances into circuit in groups and means for closing the armature circuit in one direction, only a separate switch and a separate set of resistances, and means for closing the armature in the opposite direction, only substantially as described.

11. The combination of an electric motor and means at two different points for controlling it, each of said means consisting of a series of resistance lamps or devices, a switch for throwing said resistances into the field magnet circuit in large multiple arc groups, the number of the groups gradually increasing, then in multiple arc groups with decreasing numbers in each group, and finally in small groups gradually increasing in number, substantially as described.

12. The combination of an electric motor and means for controlling it consisting of a series of resistance devices and a switch having contacts for throwing said devices into the motor circuit by a simple movement of the switch-arm in large multiple arc groups, increasing the number of groups and then decreasing the number of devices in each group, substantially as described.

13. The combination of an electric motor and means for controlling it consisting of a series of resistance devices, and a switch having contacts for throwing said devices into the motor circuit by a simple movement of the switch-arm in large multiple arc groups, increasing the number of groups and then decreasing the number of devices in each group, and finally for throwing in small multiple arc groups, substantially as described.

Signed this 25th day of April, 1891.

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ARTHUR E. KENNELLY.

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