No. 724,611. PATENTED APR. 7, 1903.

W. B. POTTER.

CONTROLLING DEVICE FOR ELECTRIC MOTORS.

APPLICATION FILED AUG. 13, 1898.

NO MODEL. 3 SHEETS—SHEET 1.

FIG. 1.

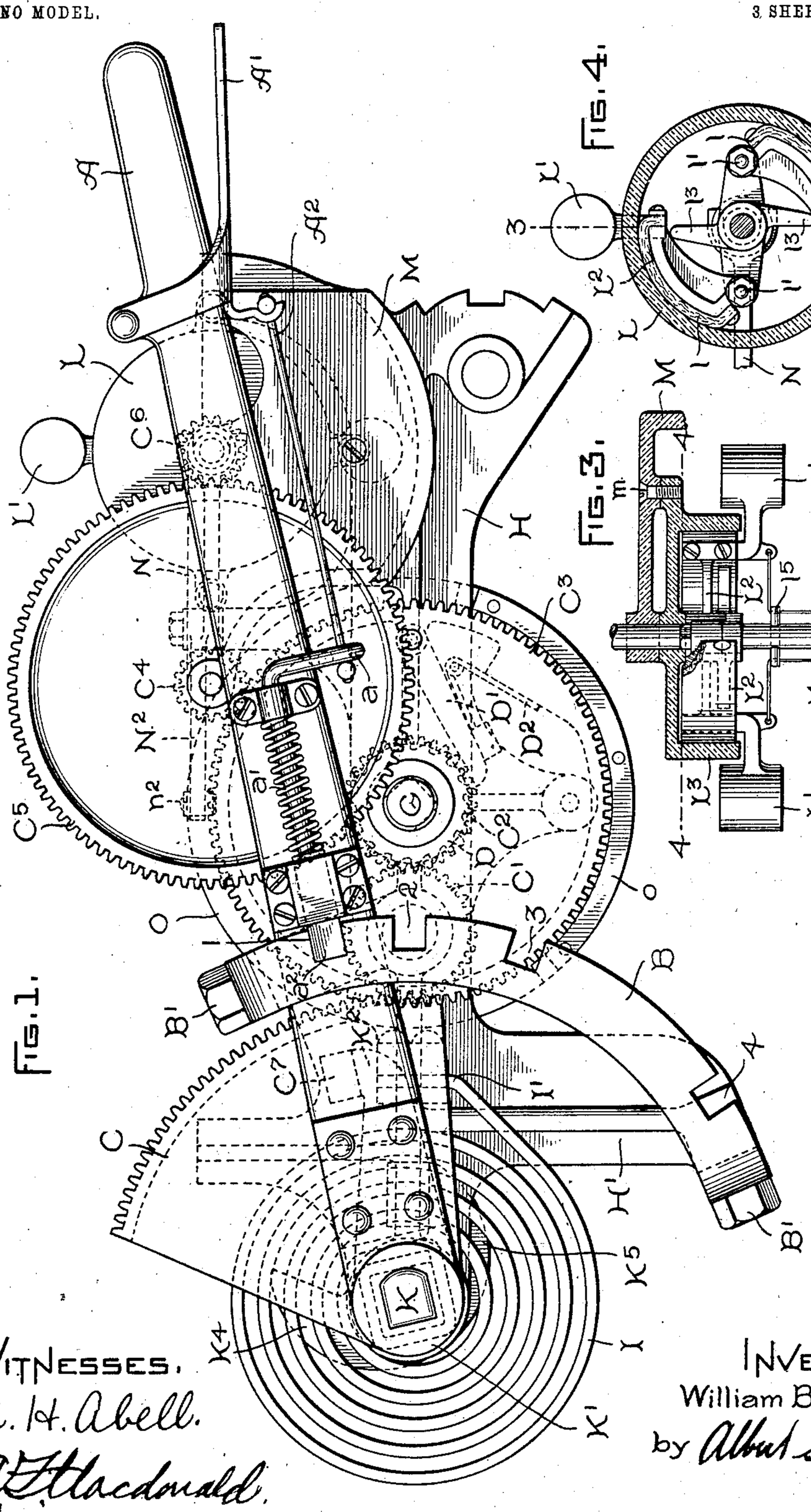

FIG. 4.

FIG. 3.

WITNESSES.
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A. E. Macdonald.

INVENTOR.
William B. Potter
by Albert G. Davis
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NO MODEL. 3 SHEETS—SHEET 2.

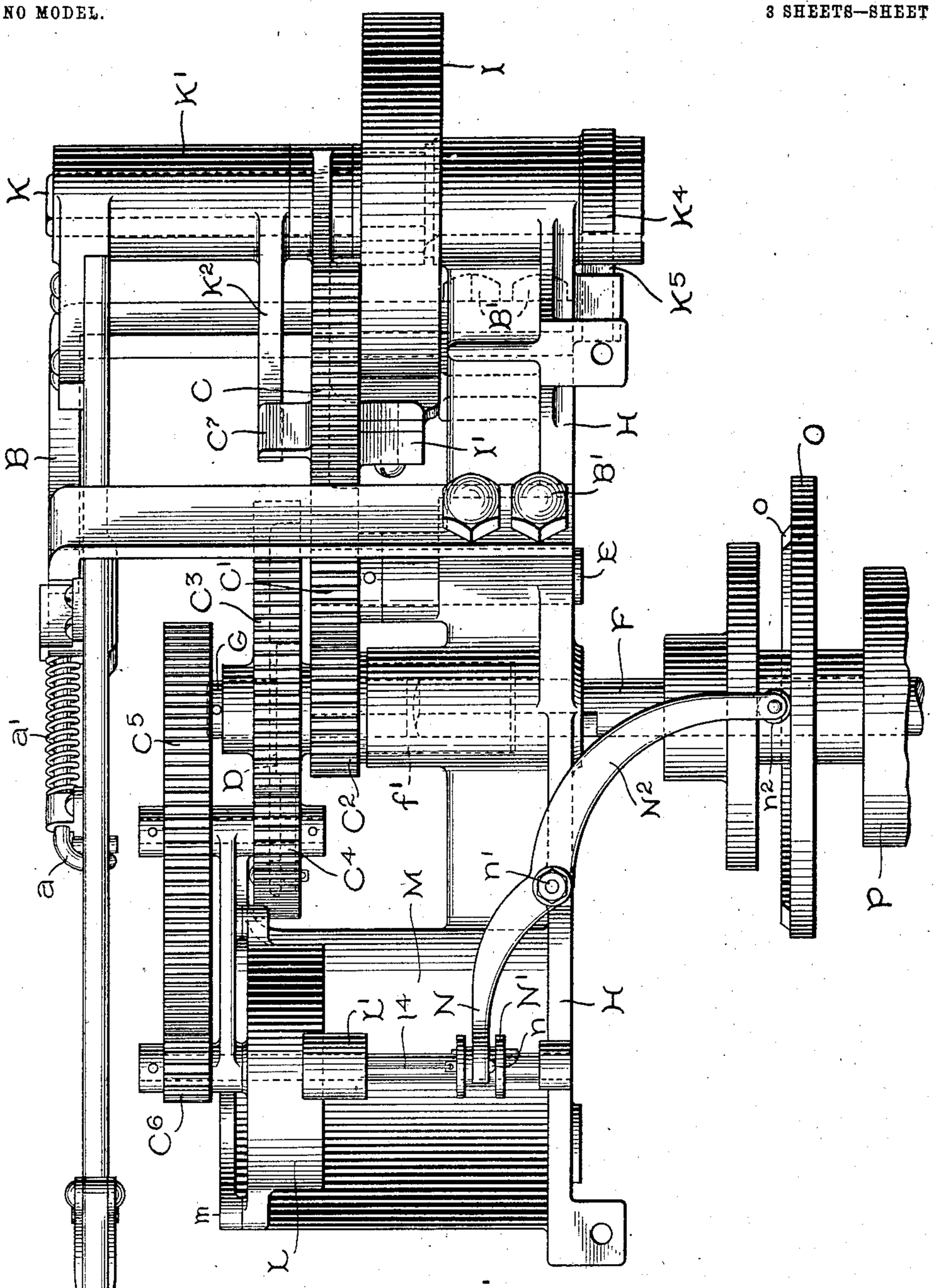

FIG. 2.

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NO MODEL. 3 SHEETS—SHEET 3.

FIG. 5.

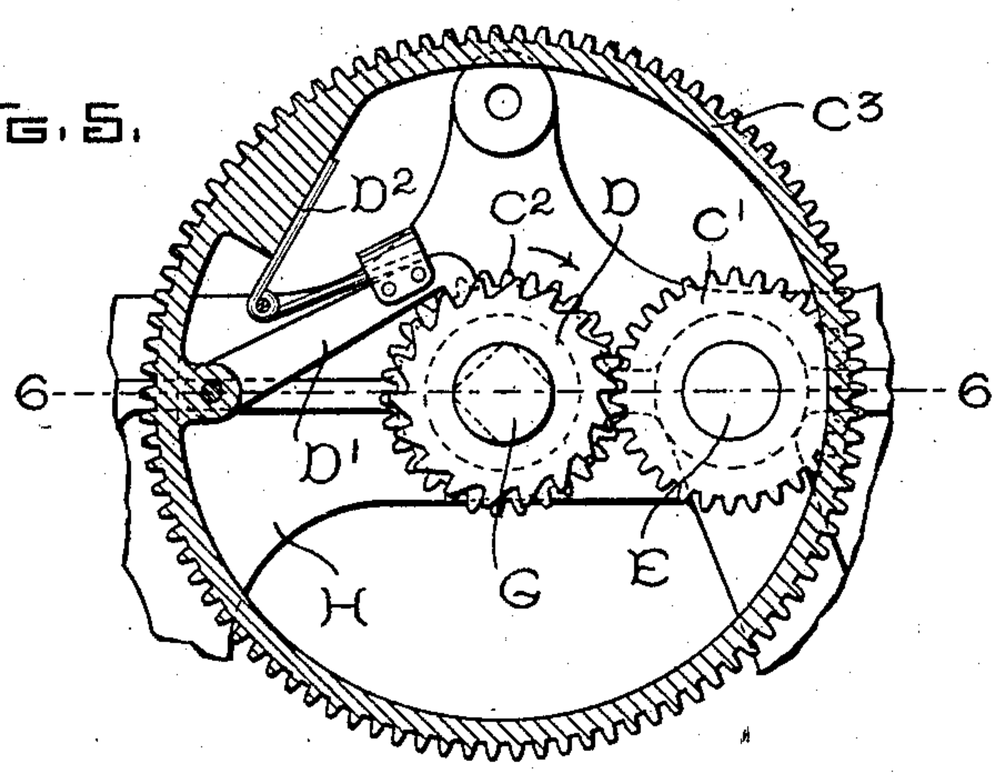
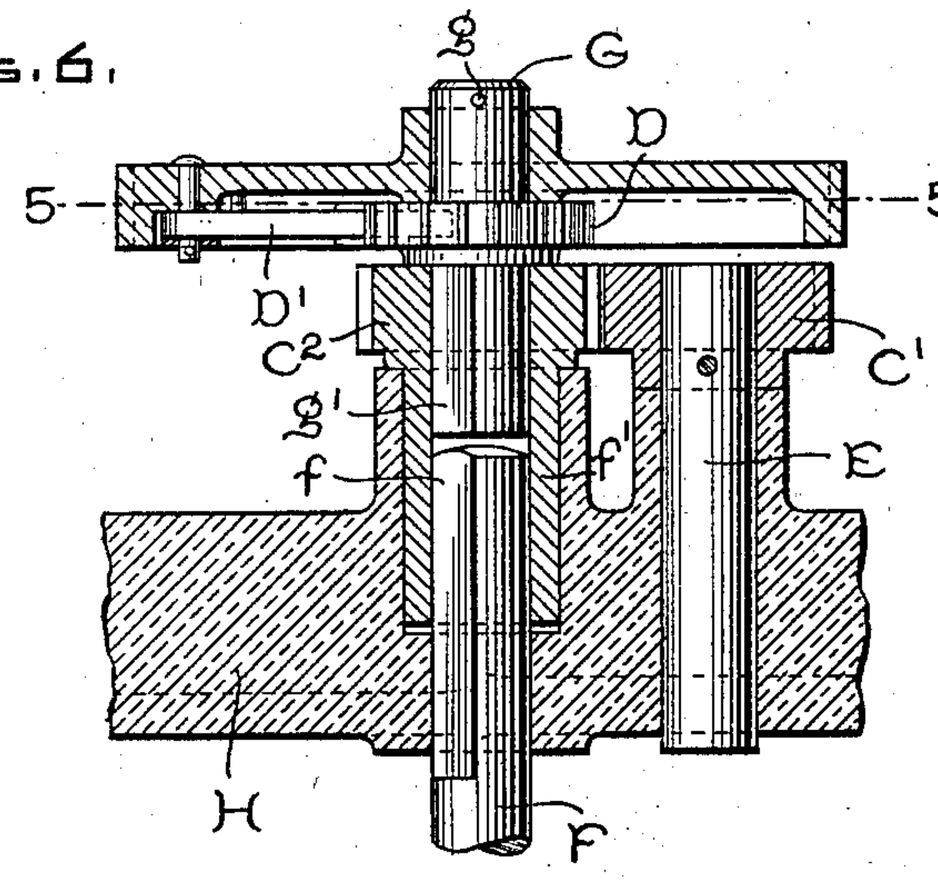


FIG. 6.



WITNESSES.

A. H. Abell.

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INVENTOR,

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by Albert G. Davis

Atty.

UNITED STATES PATENT OFFICE.

WILLIAM B. POTTER, OF SCHENECTADY, NEW YORK, ASSIGNOR TO THE GENERAL ELECTRIC COMPANY, A CORPORATION OF NEW YORK.

CONTROLLING DEVICE FOR ELECTRIC MOTORS.

SPECIFICATION forming part of Letters Patent No. 724,611, dated April 7, 1903.

Application filed August 13, 1898. Serial No. 688,535. (No model.)

To all whom it may concern:

Be it known that I, WILLIAM B. POTTER, a citizen of the United States, residing at Schenectady, in the county of Schenectady, State of New York, have invented certain new and useful Improvements in Controlling Devices for Electric Motors, of which the following is a specification.

My present invention relates to controllers for electric motors, and has for its object to obviate a difficulty which arises either from inexperience or carelessness of the motorman. In many cases the acceleration of the car is more rapid than it should be, because the motorman does not stop long enough on the different positions of the controller to allow the motors to come to the full speed corresponding to each position before turning to the next. Resistance is cut out too rapidly or the change from series to parallel is made too fast. This not only makes the car jerk, which is very unpleasant to passengers, but it is injurious to the apparatus. In installations where a number of motors are employed on each car and the currents are necessarily greater than those in ordinary tramways the difficulty is particularly apparent and the danger of accident to the apparatus correspondingly increased. To obviate it, I have devised the apparatus of the present invention, which consists, in its essence, of a lost-motion connection between the handle or other actuator and the switch controlling the motors, together with means for causing the switch to follow the motion of the handle at a uniform rate irrespective of the speed with which the motorman may operate the latter. The particular device which I have here shown for this purpose is a spring constituting a resilient or elastic energy-storing connection, with suitable speed-governing apparatus by which the progress of the switch is regulated. Of course other mechanisms might be adopted and still be within my invention.

Although my invention in its preferred form employs a lost-motion energy-storing connection between the handle and the switch and in addition thereto a speed-governing device for the controller, it is evident that these mechanisms are capable of use singly, in combination with other elements of a controller mechanism, as well as in combination with each other, and in the claims appended to this specification I aim to cover these mechanisms in all their novel combinations.

With the apparatus which I have employed for the purposes of my invention I place stops for the handle only at the actual "running" positions of the switch, as they are commonly called—that is to say, when the handle is moved from one position to another it is always from a position in which the motors may be operated for any convenient length of time to another similar position. In most controllers, as is well understood, there are a number of positions in which the motors are not to be allowed to run for any length of time. These are commonly called "transition-points." Some of these are resistance-points and others are the points at which the transition from series to parallel is made in this particular type of controller. The advantage of my invention in this regard consists in the fact that however careless or inattentive the motorman may be his controlling apparatus will still be in one of its proper running positions and no injury will come to any of the apparatus.

To effect the purposes of the invention, I employ an ordinary cylindrical switch or drum and a handle for its rotation, connecting the handle and the switch by a spiral spring. To the switch I connect a retarding device consisting of a governor of the centrifugal type, with gearing interposed between the governor and the switch, so as to render the rotation of the former more rapid and the regulation more minute and accurate. The arrangement is such that the handle is moved freely toward the running positions of the controller and is followed by the movable member of the controller at a slower speed unless the handle be moved very slowly, the particular speed of the handle at which the movable member of the controller will have a corresponding speed depending upon the character of the retarding device and the inertia of the parts of the mechanism. When the handle is brought to rest at any one of the running positions, the controller-cylinder will at predetermined speed follow it up, making the successive transitions at a rate preadjusted to the best and most regular acceleration. The spring connection between the handle and the switch is so constructed and arranged that the initial move-

ment of the handle will cause the switch to move simultaneously therewith. If therefore the handle is moved forward to any point and there stopped, the switch will be moved by means of the spring connection into a position corresponding to the point at which the handle is stopped and will then come to rest. The acceleration of the car thus becomes uniform either from rest to a desired speed or from one speed to another. It is thus also impossible to hold the controller in a position in which it should not remain for any length of time. It is unnecessary, however, to regulate the turning off of the current in the way just named. Emergencies are apt to occur in which the motor-current should be at once shut off. This I provide for by so arranging the connection between the controller-cylinder and its operating-handle that in the reverse direction it is positive, while in turning on the power there is the lost motion already referred to.

The invention will be better understood from the accompanying drawings, showing one particular form, in which—

Figure 1 is a plan of the apparatus. Fig. 2 is a rear elevation of the parts shown in Fig. 1. Fig. 3 is a side elevation of the governor, partly in section, on the line 3 3 of Fig. 4. Fig. 4 is a sectional plan of the parts shown in Fig. 3 upon the line 4 4 of the latter figure. Figs. 5 and 6 are details of the connection between the handle and the controller-cylinder by which the motion of the latter is positive in turning off.

In Figs. 1 and 2, A is the operating-handle, having the latch a^2, controlled by a spring a' and lifted out of the notches 1, 2, 3, or 4 of the sector B by the rod a, the link A^2, and the handle A'. So much of the device resembles in general the lever of an ordinary locomotive. The sector B is held in place by the bolts B' B', being secured to the base-plate H of the apparatus, the latter being provided with a bracket H', to one end of which the sector B is secured. The base H is so constructed that it may take the place of the cap-plate of the ordinary controller. The lever A rotates the shaft K. To the shaft K is secured one end of the spring I, the other end being secured at I' to the segment C. The latter meshes with a train of gears driving controller-shaft and the governor L. The segment C drives the pinion C', and this latter drives a second pinion C^2, which rotates the shaft F of the controller. (See Figs. 2, 5, and 6.) The gear C^3 is driven from this shaft by means of a ratchet D, being connected to the ratchet by the pawl D', held in place by the spring D^2. The purpose of this will presently appear, and the construction is best seen in Figs. 5 and 6, to be more fully described hereinafter. The gear C^3 meshes with the pinion C^4, driving the gear C^5, the latter driving the governor L through the pinion C^6. The rotation of the governor causes the balls or weights L' (see Figs. 3 and 4) to fly outward, and thus force the friction-pawls L^2 L^2 against the inner face of the cylinder L^3, the latter being stationary and held in place by the screw m, which connects it to the guard M, fixed to any part of the apparatus. Stops l^3 prevent the friction-pawls from being so far drawn in that the weights L' will rub on the outer surface of the cylinder. The pawls are pivoted at l', and a packing l, of leather or other suitable material, serves to increase their adhesion.

Referring now to Fig. 2, which should be read in connection with Fig. 1, it will be seen that to the hub K', to which the lever A is secured, is fixed an arm K^2, which may be made integral with the hub. Against this arm bears a stop C^7, fixed to the segment-gear C. As the lever A is moved the arm K^2 is brought away from the stop C^7, the motion of the lever putting the spring I under tension. The spring being fixed at I' to the gear C tends to draw this gear around until the stop C^7 rests against the arm K^2. This communicates motion to the entire train of gears and through the shaft F to the controller, the governor L controlling the rate at which the controller shall be rotated. As soon as the stop C^7 strikes the arm K^2 the movement of the controller ceases. The lever A may be moved into any of the notches 1, 2, 3, or 4 of the segment B, and the controller will then start and follow it up at the desired rate of speed.

In order to provide for the positive return of the controller mechanism and the turning off of current, the arrangement shown in detail in Figs. 5 and 6 and indicated in dotted lines in Fig. 1 is employed. The gear C^3 rotates upon the stud G, the upper part of which is made round, the gear being held in place by the pin g. The lower part of the stud G, as shown at g', is shaped like the upper part f of the controller-shaft F. The gear C^2 is mounted upon or formed integral with a collar f', which fits over the upper part of the shaft F and rotates the controller, and in this collar the part g' of the stud G also fits. The ratchet D is formed to fit the lower part g' of the stud. Thus as the gear C^2 turns it turns the ratchet D by means of the stud G and also the shaft F of the controller. The gear-wheel C^3, however, being connected with the ratchet through the pawl D', will rotate when the ratchet turns in one direction, but is stationary when it is turned in the other. When, therefore, by the motion of the handle the gear C', mounted on the shaft E, rotates the gear C^2, so that the ratchet turns in the direction of the arrow, as shown in Fig. 5, the gear C^3 rotates and the governor is brought into play; but when the mechanism is reversed the pawl D' slips over the ratchet and the motion of the handle is independent of the governor. The backward motion of the handle thus forces back the arm K^2 and through the stop C^7 moves the segment C backward, thus rotating the gears C'

and C^2 (and through them the shaft F of the controller P) positively backward. By removing or fastening back the pawl D′ the controller evidently becomes one of ordinary type, the governor L being thrown entirely out of action.

In the particular type of controller which I have selected for embodying my invention the change from series to parallel is made by shunting one of the motors. A good form of controller is that shown in my prior patent, No. 524,396, in which a full description of the circuits may also be found. I have not thought it necessary to describe and illustrate the device in this application. Any other controller in which a regular and moderate movement will give a substantially uniform acceleration of the motors may be employed, as is well understood. It is desirable for several reasons, unnecessary to recite, that the change from series to parallel should be made with reasonable rapidity, and I have therefore so arranged the device illustrated that the governor will be thrown out of action during this part of its rotation. Due to the influence of the retarding device the movement of the switch will be maintained substantially uniform; but when the governor is thrown out of action the speed of movement of said switch will be increased.

Referring to Figs. 1 to 4, O is a disk on the top of the controller-cylinder. (Seen best in Fig. 2.) Upon this disk is mounted a cam *o*. Pivoted at *n′* is a lever having a fork N, provided with friction-rollers *n*, rotating in the collar N′, fixed to the shaft of the governor by a feather-key, so that the collar is free to slide up and down within certain limits. Cords or wires l^4 pass through holes in the pin l^5 and are connected to the friction-pawls L^2 and the weights L′. The lower part N^2 of the lever is provided with a friction-roller n^2, traveling on the disk O and the cam *o*. The position of the cam *o* is such that as the transition-point from series to parallel is reached in the revolution of the controller the cam *o* passes under the roller n^2, the fork N is slightly depressed, thus depressing the collar N′ and pulling on the cords or wires l^4 and drawing in the weights L′, releasing the friction-pawls, so that the governor is thrown out of action. This part of the movement of the controller is therefore accomplished more quickly than the rest.

In order to prevent too great a rotation of the controller, I employ stops K^4 K^5, (see Figs. 1 and 2,) which strike a projection from the base H, and thus limit the movement of the handle A.

In the ordinary operation of the device the motorman will bring the lever A at starting to the notch 3, which corresponds to the full-series position of the controller, and after the train or car has acquired full speed in this position the lever will be brought over to the notch 4 and the change of motor connections from series to parallel will be effected. This change can be made with safety, as already pointed out, much more rapidly than the change from rest to the full-series position. In high-speed service the handle may be brought at once to the last running position, and thus the maximum even acceleration will be attained without further attention from the engineer.

In practical operation I have found that the acceleration of the train could not be made greater than the desired rate for which the device was designed whether the force applied to the handle be much or little, although where it is desirable to diminish this rate it could readily be done by moving the handle so slowly that the switch would follow it up closely. This is not ordinarily the desired method of operation, but may be useful on occasion.

What I claim as new, and desire to secure by Letters Patent of the United States, is—

1. In a controller, the combination with the switch, of an actuator therefor, and a resilient connection between the actuator and the switch so constructed and arranged that the initial movement of the actuator will cause the switch to move simultaneously at a different rate of speed.

2. In a controller, the combination with the switch, of an actuator therefor, and a resilient connection between the actuator and the switch so constructed and arranged that the initial movement of the actuator will cause the switch to start to move simultaneously at a different but uniform rate.

3. In a controller, in combination, a switch having "running positions" and "transition positions," an operating-handle therefor provided with stops corresponding to the running positions only, and a lost-motion, energy-storing connection between said handle and said switch.

4. In a controller, in combination, a switch having "running positions" and "transition positions," an operating-handle therefor provided with stops corresponding to the running positions only, a lost-motion, energy-storing connection between said handle and said switch, and means whereby the switch is caused to pass through certain positions at a speed greater than the speed at which it passes through the other positions.

5. A controlling device for electric motors, comprising a handle free to move, a switch with a lost-motion connection between the switch and the handle, a governor for controlling the motion of the switch, means for causing the switch to follow the handle, and means for throwing the governor out of action during part of the following movement of the switch.

6. A controlling device for electric motors, comprising a switch, a handle operatively connected thereto, means whereby the switch is started in motion simultaneously with the initial movement of said handle, a retarding

means operating to retard the movement of the switch in turning on current and a positive connection between the handle and the switch operative only in turning the current off.

7. The combination of a freely-movable switch for controlling a motor or motors, a handle having lost-motion energy-storing connection with the switch in one direction of movement, means for maintaining uniform the speed of the switch, and a positive engaging means between the handle and the switch, operative in the reverse direction.

8. In a controlling device, the combination of a handle free to move in one direction without immediately effecting a corresponding movement of the switch, means for causing the switch to follow the handle, a governor for the switch, and means for throwing the retarding means out of action during a certain part of the forward motion of the switch; with a positive engaging means between the handle and switch and a slip connection between the governor and switch, operative as the movement of the latter is reversed.

9. In a controlling device, means retarding the motion of the switch in turning on current, a device for throwing the retarding means out of action when the motion of the switch is reversed, and means for throwing the retarding means out of action during a part of the movement of the switch to the on position.

10. In combination, a switch, a governor for the switch, a ratchet between the governor and the switch, whereby the governor controls the motion of the switch in one direction, but not in the other, and means independent of the ratchet for throwing the governor out of action during the motion of the switch in the former direction.

11. A controlling device for electric motors having a freely-movable handle, stops for said handle at the running positions of the controlling device, and a lost-motion, energy-storing connection between said handle and said controlling device.

12. A controlling device for electric motors comprising a switch, a handle, for operating said switch, having a plurality of operative positions, a lost-motion, energy-storing connection between said handle and said switch, and means for arresting the motion of the switch when it reaches a position corresponding to the position of the operating-handle.

13. A controlling device having a handle free to move relatively to the switch, with means for causing the switch to automatically follow the handle, and stops for the handle corresponding to the running-points only of the controller.

14. A controlling device having a handle free to move in one direction relatively to the switch, with a governor limiting the speed, a spring for driving the switch, and stops for the handle, corresponding to the running-points only; whereby the transition-points may be passed at a predetermined speed.

15. A controlling device for electric motors, comprising a freely-movable switch, a handle, for operating said switch, having a plurality of operative positions, a spring connection interposed between said switch and said handle, and means for arresting said switch when it has reached a position corresponding to the position of said operating-handle.

16. A controlling device for electric motors, comprising a switch, a handle having a plurality of operative positions and connected to said switch by means of a device constructed and arranged to cause the switch to start in motion simultaneously with the initial movements of said handle, a stop connected to said switch, and a lug on said handle arranged to be engaged by said stop whenever the switch occupies a position corresponding to that of the operating-handle.

17. The combination with a controlling device, comprising a movable part, of a retarding device adapted to prevent the too rapid movement of said controlling device, whereby the retarding device is responsive to the movement of the controlling device, and a limiting device associated with said retarding device adapted to limit the duration of its effective action.

18. The combination with a controlling device having a movable part, of a retarding device therefor consisting of a train of gears operating a friction-producing device, said friction-producing device comprising a fixed part, and a moving part adapted to be moved by centrifugal action into engagement with said fixed part.

19. The combination with a controlling device having a movable part, of a retarding device therefor consisting of a train of gears operating a centrifugal governor, said governor comprising a fixed part, and a moving part adapted to be moved by centrifugal action into engagement with said fixed part, and means for rendering said governor temporarily inoperative.

20. The combination with a controlling device having a movable part of a retarding device therefor having a governor and means for rendering said governor inoperative during a part of the movement of said controlling device.

21. In a controller, the combination with a freely-movable switch, of an actuator therefor, resilient means constructed and arranged to transfer energy from the actuator to the switch simultaneously with the initial movement of the actuator, and means for regulating the rate of movement of said switch.

22. In a controller, the combination with the switch, of an actuator elastically connected thereto, a governing device for controlling the rate of movement of the switch, and means controlled by the switch itself for rendering said governing device temporarily inoperative.

23. In a controller, the combination with the switch, of an actuator elastically connect-

ed thereto, a centrifugal friction-governor for controlling the rate of movement of the switch, and means for rendering said governor temporarily inoperative.

24. In a controller, the combination with the switch having a plurality of running-points, of actuating means adapted to move said switch at a rate of speed independent of that of the actuator, and means for stopping the switch at any running-point to which the actuator is brought.

25. In a controller, the combination with the switch, of an actuator therefor, a spring connection arranged to start said switch in motion simultaneously with the initial movement of the actuator in one direction, and means for positively transferring energy from the actuator to the switch upon movement in an opposite direction.

26. In a controller, the combination with the switch, of actuating means therefor adapted to move said switch from any running-point to any other at a rate of speed independent of that of the actuator.

27. In a controller, the combination with the switch, of an actuator therefor, and means whereby the switch is started by the first movement of the actuator to be moved to the next running-point only or to the full-on position at a predetermined rate of speed.

28. In a controller, the combination with the switch, of an actuator therefor and means for causing said switch to move at a rate of speed independent of that of the actuator when the latter is moved above a determined rate, but causing the movement of said switch to be dependent upon that of the actuator when the latter is moved at a less rate.

29. In a controller, the combination with the switch, of an actuator therefor, an elastic connection between said switch and said actuator, stops for said switch at the running-points, and means separate from said stops for hindering the operation of the switch.

30. In a controller, the combination with the switch, of means for actuating said switch at a desired speed, and means for insuring a different rate of speed during a predetermined part of the movement of said switch.

31. In a series-parallel controller, the combination with the switch, of means for actuating said switch at a desired speed, and means for insuring a different rate of speed during the change from series to parallel relation.

32. In a controller, the combination with the switch, of means for insuring a uniform rate of movement of said switch, and means for insuring a different rate of speed during a part of said movement.

33. In a controller, the combination with the switch, of the actuator therefor, means for insuring a rate of movement of said switch independent of the movement of the handle, and means for insuring a different rate of speed during a part of said movement.

34. In a controller, the combination with the switch, of the actuator therefor, means for regulating the speed of movement of said switch during its movement in one direction, and means for making said means inoperative during a part of said movement.

35. In a controller, the combination with the switch, of the actuator therefor, means for regulating the speed of movement of said switch, during its movement in one direction, and means whereby said switch causes said regulating means to become inoperative during a part of said movement.

36. In a controller, the combination with the switch, of means for actuating said switch, means for controlling the operation of the switch, and means for changing the effect of said controlling means during a part of the movement of the switch.

37. In a controller, the combination with the switch, of means for actuating said switch, means normally operating to maintain a uniform rate of movement of said switch, and means for causing an increased speed during a part of the movement of the switch.

38. In a controller, the combination with the switch, of an actuator therefor, means for decreasing the effect of said actuator during a part of the movement of said switch, and means for increasing the speed during another part of the movement of the switch.

39. In a controller, the combination with the switch, of actuating means therefor, a friction-governor for said actuating means, and means for rendering said governor inoperative at a certain part of the movement of the switch.

40. In a controller, the combination with the switch, of an actuator therefor, a governor for said actuator, a cam on said switch, and means operated by said cam for rendering the governor inoperative.

41. In a controller, the combination with the switch, of actuating means therefor, a governor for said actuating means, and means whereby the governor is itself controlled by the movement of said switch.

42. A controlling device for electric motors, comprising a switch, an actuator for said switch, a lost-motion, energy-storing connection between said switch and said actuator, means independent of the actuator for controlling the movement of said switch, and means for rendering the said controlling means inoperative during a part of the forward movement of said switch.

43. In a controlling device for electric motors, a movable member, means for moving said member at a predetermined speed, and means controlled by the said movable member for increasing the speed during a portion of the movement thereof.

In witness whereof I have hereunto set my hand this 2d day of August, 1898.

WILLIAM B. POTTER.

Witnesses:
EDWARD P. MACLEAN,
JOHN S. ABERCROMBIE.