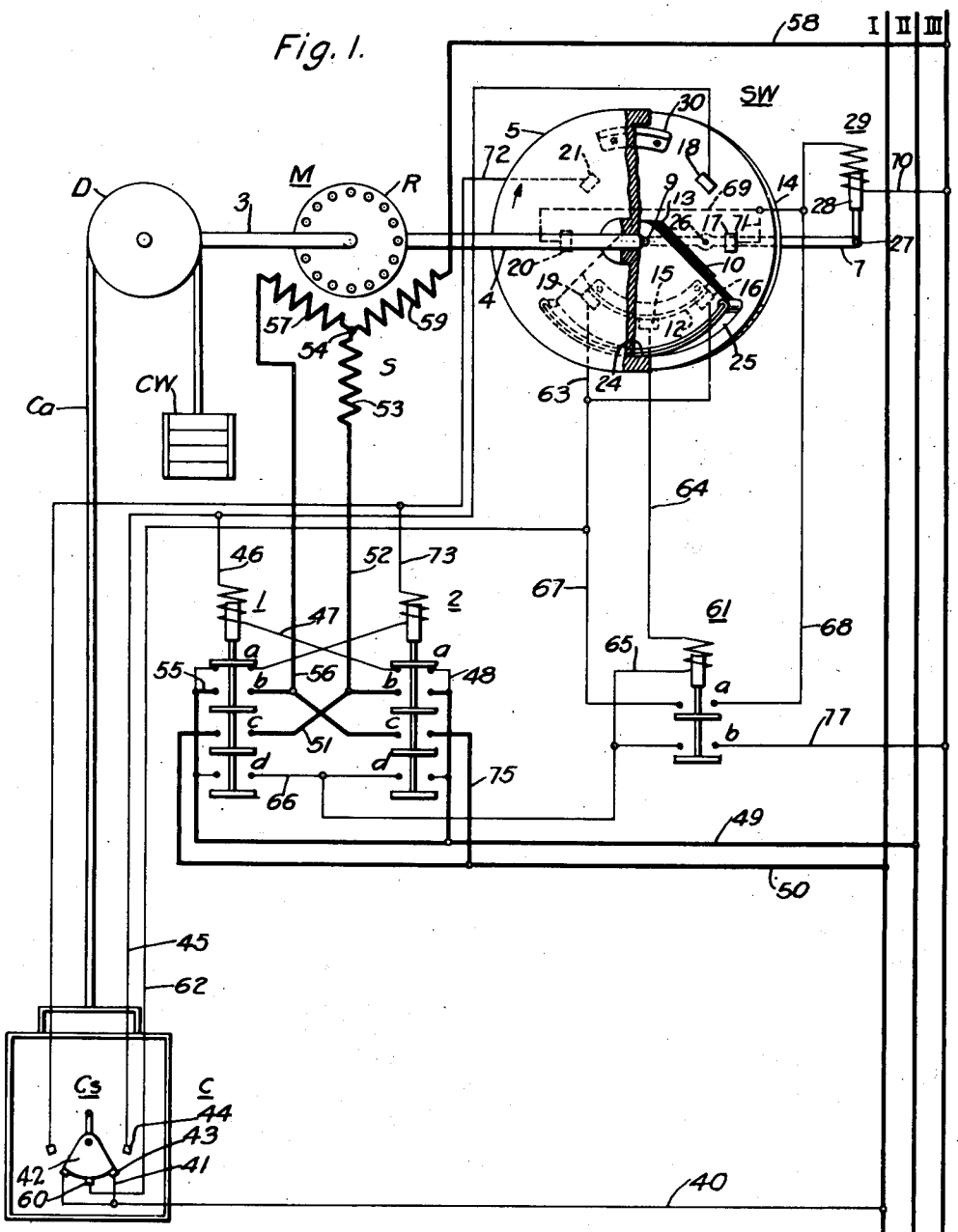
Jan. 19, 1932. R. P. HIGBEE 1,841,601

MOTOR CONTROL SYSTEM

Filed Feb. 17, 1928 2 Sheets-Sheet 1

Fig. 1.



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MOTOR CONTROL SYSTEM

Filed Feb. 17, 1928 2 Sheets-Sheet 2

Fig. 2.

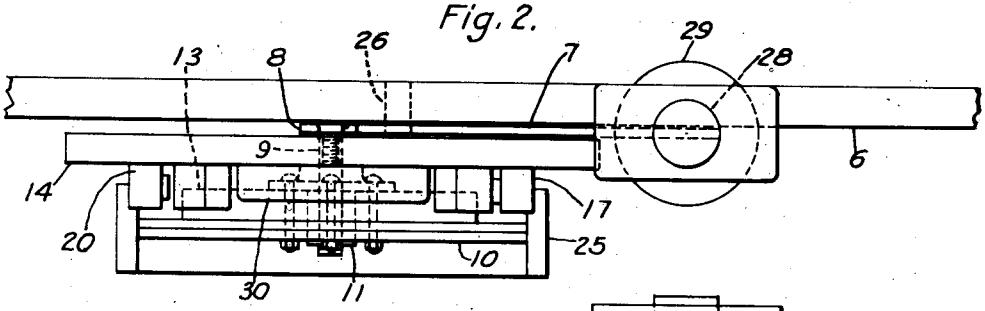


Fig. 3.

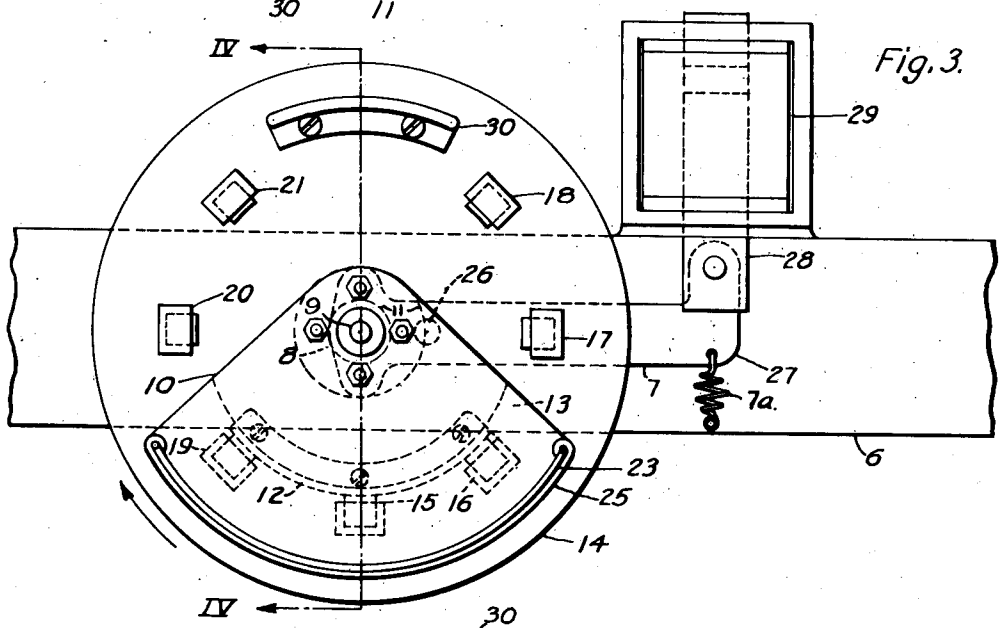
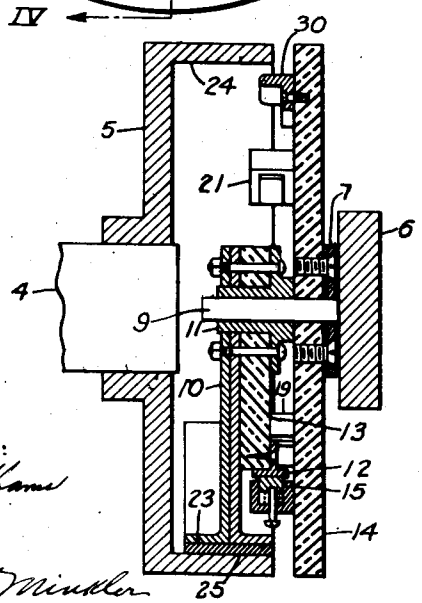


Fig. 4.



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UNITED STATES PATENT OFFICE

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MOTOR CONTROL SYSTEM

Application filed February 17, 1928. Serial No. 254,968.

My invention relates to motor-control systems, and has special relation to control systems for elevators, hoists and similar machinery.

An object of my invention is to provide a control system for machines, operable in either of two directions, to achieve a dynamic-braking condition when the machine is to be stopped after travelling in either of the directions.

Another object of my invention is to provide a control system for an alternating-current motor, wherein a dynamic-braking effect will be achieved when the motor is to be stopped.

Another object of my invention is to provide a control system for an alternating-current motor-driven machine, wherein, when it is desired to stop the motor, circuits will be automatically set up for producing a dynamic-braking effect which will continue until the motor has reached a zero speed.

Another object of my invention is to provide a control system for an elevator driven by an alternating-current motor, wherein the elevator will be brought to a stop entirely through the effect of a dynamic-braking condition automatically set up by the elevator when the motor is to be stopped.

Other objects of my invention will be set forth in the accompanying description.

One form of my invention is illustrated in the accompanying drawings, wherein;

Figure 1 is a diagrammatic view of an elevator system provided with my dynamic-braking devices.

Fig. 2 is a plan view of one of two relatively movable elements of a switching device embodying my invention,

Fig. 3 is a view in front elevation of the switch device shown in Fig. 2, and,

Fig. 4 is a view in section taken on the line IV—IV of Fig. 3, and including the other of the two relatively movable elements of my switching device.

It is a characteristic of an alternating-current motor that, when it is to be decelerated from a high speed, a dynamic-braking effect may be achieved by reversing the current supplied to it. It is my intention to utilize this characteristic, in order to produce an efficient dynamic-braking condition whenever it is desired to reduce the speed of an elevator in making a stop.

Referring to Fig. 1 of the drawings, I have illustrated an elevator car C suspended upon the usual cable C*a* and extending over a drum D to a suitable counter-weight C*w*. Suitably coupled to the hoisting drum D, as by a shaft 3, is the rotor R of a squirrel-cage motor M, the stator S of which is wound for connection to a three-phase source of alternating-current energy. The direction of operation of the motor M is suitably controlled through the operation of the up-direction and down-direction switches designated by the reference characters 1 and 2, respectively, which switches are, in turn, controlled through the operation of a suitable car switch C*s* mounted upon the elevator car C.

Referring now to Figures 2, 3 and 4, the shaft, which couples the motor M to the hoisting drum D, is provided with an extension 4, carrying a cup shaped member 5 which is thus made rotatable with the motor M. Suitably mounted upon a supporting arm 6, is a lever 7, one end 8 of which acts as a bearing for a stub shaft 9 upon which a friction segment 10 is rotatably mounted, to lie within the cup 5 and engage therewith to constitute a friction clutch. To provide a suitable bearing surface for the segment 10, I have provided a sleeve 11 upon which a contact segment 12 is also suitably insulatingly mounted through the interposition of a segmental member 13 constructed of insulating material.

A disc 14 of insulating material, upon which are mounted a plurality of contact brushes 15, 16, 17, 18, 19, 20 and 21, is suit-

ably and non-rotatably mounted on the outer end 8 of lever 7. By reason of this construction, any rotation of the friction segment 10 causes a similar movement of the contact segment 12 over the cooperating contact brushes 15, 16, etc.

As will be observed from an inspection of Fig. 4, the friction segment 10 is so mounted adjacent to the cup-like member 5 as to lie wholly within it, with the friction face 23 adjacent to the inner face of the flange 24. The frictional engagement between the cup member 5 and the friction segment will cause rotation of the former to be transmitted to the contact segment 12.

In order to increase the coefficient of friction between the cup member 5 and the friction segment 10, I have illustrated a lining 25 of suitable material secured to the face 23.

The lever 7, carrying the friction member and the contact brushes, is pivoted upon member 6 closely adjacent to the end 8 by means of a suitable pivotal bearing 26, and the lever 7 has its opposite end 27 suitably coupled to a core 28 of a solenoid 29. By suitably selecting the length of the lever 7 on the opposite sides of the pivot 26, the friction segment 10 may be caused to engage the cup member 5 only when the solenoid 29 is energized. For purposes of clarity, the parts have been illustrated in the position assumed thereby when the solenoid 29 is energized. It will be understood that when the solenoid 29 is deenergized, the lever 7 rotates in a clockwise direction under the influence of a spring 7*a* to disengage the frictional surfaces.

Assuming that the motor shaft 4 is operating in the direction of the arrow (Fig. 3), the energization of the solenoid 29 will cause engagement of the faces 24 and 25, and the member 10 will be rotated in the same direction. The contact segment 12 will be carried from the position illustrated in Fig. 3 to a position in which the member 10 will engage a stop member 30 suitably mounted upon the stationary disc 14. Upon deenergization of the solenoid 29, the friction member 10 and the segment 12 will be returned to the illustrated position by gravity, in which position it will remain until the solenoid 29 is again energized.

The operation of my system will be best described with reference to an assumed elevator operation. Assuming that it is desired to move the elevator car upwardly, the attendant on the car C may move the car switch C*s* to the left, causing energization of the up-direction switch 1 by way of a circuit which extends from line conductor I, through conductors 40 and 41, contact member 43, contact segment 42, and contact member 44 of the car switch C*s*, conductors 45 and 46, the coil of up-direction switch 1, conductor 47, normally closed contact members *a* of down-direction switch 2 and conductors 48 and 49, to line conductor II.

The actuation of up-direction switch 1 completes a circuit for energizing the stator windings S of the motor M, the circuits for which extend from line conductor I, through conductor 50, contact members *c* of up-direction switch 1, conductors 51 and 52 and phase winding 53 of the stator S, to the star point 54; from line conductor II, through conductors 49 and 55, contact members *b* of up-direction switch 1, conductor 56, the second phase winding 57, to the star point 54 and from line conductor III, through conductor 58, to the third phase winding 59 of the stator S and to the star point 54. The elevator car will be started upwardly and will continue travelling in this direction until the car switch C*s* is returned to the neutral or "off" position.

When it is desired to stop the elevator car, I propose to reverse the connections of the stator winding S to cause the motor M to act as a dynamic brake to effect deceleration of the elevator. To accomplish this, I have illustrated a contact member 60 engageable by the segment 42 when the car switch C*s* is in the illustrated neutral position for completing circuits to the contact members of switching device SW.

Upon centering the car switch C*s*, a circuit will be completed for energizing the coil of a relay 61, which circuit extends from line conductor I, through conductors 40 and 41, contact member 43, contact segment 42, and contact member 60 of car switch C*s*, conductors 62, 63, contact members 19, 12 and 15 on the switching device SW, conductor 64, the coil of relay 61, conductors 65 and 66, contact members *d* of up-direction switch 1 and conductor 49, to line conductor II. Energization of relay 61 completes a circuit for energizing the coil of solenoid 29, which circuit extends from line conductor I, through conductors 40 and 41, contact member 43, contact segment 42, and contact member 60 of car switch C*s*, conductors 62 and 67, contact members *a* of relay 61, conductors 68 and 69, the coil of solenoid 29 and conductor 70, to line conductor III.

Energization of solenoid 29 will, as previously described, move the friction segment 10 into engagement with rotatable member 5 mounted upon the motor shaft 4, thus transmitting the rotation of the motor to the contact segment 12. The contact segment 12 will be operated in the direction of the arrow to simultaneously engage and connect contact brushes 19, 20 and 21, and to disengage contact member 15. The engagement with contact member 20 will complete an auxiliary circuit for the solenoid 29 to maintain this solenoid energized during the entire time the motor M is moving, this circuit extending, through conductors 40 and 41, contact member

43, contact segment 42 and contact member 60 of car switch Cs, conductors 62 and 63, members 19, 12 and 20, to conductor 69 and thence, as previously described, for solenoid 29.

The engagement with contact member 21 by contact segment 12 will complete a circuit for the down-direction switch 2, which circuit extends from line conductor I, through conductors 40 and 41, contact member 43, contact segment 42, and contact member 60 of car switch Cs, conductors 62 and 63, contact members 19, 12 and 21 of the switch SW and conductors 72 and 73, the coil of down-direction switch 2, contact members *a* of up-direction switch 1, and conductor 49, to line conductor II.

The operation of down-direction switch 2, will cause current to be supplied to phase winding 53, (previously supplied from phase conductor I) from phase conductor II by way of conductors 49 and 48, contact members *b* of down-direction switch 2, and conductor 52. The operation of switch 2 will also cause phase winding 57 (previously supplied with current from phase conductor II) to be supplied with current from phase conductor I, through conductors 50 and 75, contact members *c* of down-direction switch 2, and conductor 56. The effect of this connection of the phase windings of the stator will be to tend to rotate the armature in the direction opposite to the direction in which it is now rotating, and the resultant effect will be that of a dynamic braking.

It will be observed that the length of the contact segment 12 is such that, when it is moved into full engaging position with contact member 21, it is disengaged from its contact member 15, thereby opening the circuit for relay 61, thus, when the movement of the contact segment 12 is reversed, the only circuit for solenoid 29 is through contact member 20. Reenergization of relay 61 is prevented at this time since both direction switches 1 and 2 are deenergized, and the circuit for relay 61 is broken at contact members *d* of these switches.

It will also be observed that the length of contact segment 42 on the car switch Cs is such that contact will be made with contact member 60 just prior to the time at which contact segment 42 is disengaged from contact member 44, controlling up-direction switch 1, thus relay 61 will be energized through the contact member *d* of the up-direction switch 1 prior to the deenergization of up-direction switch 1. However, after the initial energization of relay 61, this relay completes a self-holding circuit for itself from phase conductor III through conductor 77 and contact members *b* of relay 61, and remains energized until the holding circuit is broken at contact member 15.

Hence, the dynamic-braking effect will be continued until the speed of motor M is reduced to zero, since, as long as the motor is rotating, the contact segment 12 will be maintained in engagement with contact member 21. However, when the motor M is brought to a stop, the reversed current in the phase windings 53 and 57 will cause the motor to reverse, thereby disengaging contact segment 12 from contact member 21 to cause the direction switch 2 to be deenergized. The reverse motion of the contact segment 12 will be continued until it is disengaged from contact member 20, thereby deenergizing solenoid 29. This reverse movement, however, represents a reverse car travel of only a fraction of an inch and is negligible, as effecting the operation of the elevator.

Thus, it will be observed that only a very slight reverse rotation of the motor M is required to deenergize the solenoid 29 to permit the contact segment 12 to assume its normal position. It has been observed that this slight reverse motion is not unpleasant or detrimental in the operation of the elevator and it follows that the motor will be brought to a complete stop entirely through the effect of a dynamic-braking condition. It is assumed that the usual mechanical brake is provided for holding the elevator in its stopped position.

While I have illustrated the preferred embodiment of my invention, it is understood that this description is illustrative only and I do not desire to be limited to any of the details shown, except as defined in the appended claims.

I claim as my invention:

1. In a device for stopping an alternating-current motor operable from a source of power, control means operable to connect said motor to said source for movement in either of two directions and means operable upon actuation of said control means to stop said motor from movement in either direction, for automatically reversing the connections to said motor and for maintaining said reversed connections until said motor starts in the new direction, said means including switching means, means for engaging said switching means with said motor for movement therewith and operable upon reverse movement of said motor for disengaging said switching means and said motor.

2. In a device for stopping an alternating-current motor operable from a source of power, control means operable to connect said motor to said source for movement in either of two directions and means operable upon actuation of said control means to stop said motor from movement in either direction, for automatically reversing the connections to said motor and for maintaining said reversed connections until said motor starts in the new direction, said means including switching means disposed for actuation by

movement of said motor in either direction for operating the controlling means for the opposite direction, means for engaging said switching means with said motor for movement therewith, and means for selectively actuating said engaging means.

3. In an elevator-control system, an elevator, an alternating-current motor therefor, a source of energy for said motor, control means for selectively connecting said motor to said source for movement in either of two directions, a car switch for selectively actuating said controlling means, and means operable, when said car switch is actuated to stop said motor, for automatically reversing the connection of said motor to said source and for maintaining said reversed connection until said motor starts in the reverse direction, including switching means disposed for actuation by movement of said motor in either direction for operating the control means for the opposite direction, means for engaging said switching means with said motor for movement therewith and means controlled by movement of said car switch to stop said motor for actuating said engaging means.

4. In an elevator-control system, an elevator, an alternating-current motor therefor, a source of energy for said motor, control means for connecting said motor to said source for movement in either of two directions, a car switch for selectively actuating said control means, and means operable upon movement of said car switch to stop said motor, for reversing the connections of said motor and for maintaining said reversed connections until said motor starts in the new direction, including a first friction member rotatable in synchronism with said motor, a second friction member normally disengaged from said first member, switch means for completing said reversing connections mounted for actuation by movement of said second member, a magnet operable upon movement of said car switch to stop said elevator for moving said second member into frictional engagement with said first member for movement therewith, and means operable upon reversal of movement of said second member for deenergizing said magnet.

5. In a control system for an alternating current motor; a motor; a source of power for said motor; control means operable to connect said motor to said source for operation in a selected direction; and means for retarding the speed of said motor, including a switching device effective to complete reversed connections between said motor and said source; said switching device comprising two normally disengaged relatively movable elements, one of said elements being movable in accordance with the movements of said motor, and means, responsive to the actuation of said control means to disconnect said motor from said source, for moving said two elements into engagement to complete and maintain said reversed connections while the original direction of rotation of said motor persists.

6. In a control system for an alternating current motor; a motor; a source of power for said motor; control means operable to connect said motor to said source for operation in a selected direction; and means for retarding the speed of said motor, including a switching device effective to complete reversed connections between said motor and said source; said switching device comprising two normally disengaged relatively movable elements, one of said elements being movable in accordance with the movements of said motor, means, responsive to the actuation of said control means to disconnect said motor from said source, for moving said two elements into engagement to complete said reversed connections, and means controlled by the relative position of said two elements when in engagement for maintaining said engaging means effective while the original direction of rotation of said motor persists.

7. In a control system for an alternating current motor; a motor; a source of power for said motor; control means operable to connect said motor to said source for operation in a selected direction; and means for retarding the speed of said motor, including a switching device effective to complete reversed connections between said motor and said source; said switching device comprising two normally disengaged relatively movable elements, one of said elements being movable in accordance with the movements of said motor, and means, responsive to the actuation of said control means to disconnect said motor from said source, for moving said other element into engagement with said first named element for actuation thereby to complete and maintain said reversed connections while the original direction of rotation of said motor persists.

8. In a control system for an alternating current motor, a motor, a source of power for said motor, control means operable to connect said motor to said source for operation in a selected direction, means for retarding the speed of said motor, including a switching device operable to complete reverse connections between said motor and said source, two normally disengaged relatively movable elements, one of said elements being movable in accordance with the movement of said motor, the other of said elements being disposed to engage said movable element and be moved thereby to operate said switching device, and means, responsive to the operation of said control means to disconnect said motor from said source, for effecting the engagement of said two elements.

9. In combination, a motor, a source of power for said motor, control means operable to reversibly start and stop said motor, switching means actuable in response to the operation of said control means for connecting said motor to said source, means for effecting the retardation of the speed of said motor, including a switching device normally inoperative when said motor is rotating, and means, responsive to the operation of said control means to stop said motor, for effecting the operation of said switching device, the operation of said switching device effecting the actuation of said switching means to connect said motor to said source as for rotation in a direction opposite to the direction in which the motor is rotated, whereby the said motor is retarded.

10. In combination, a motor, a source of power for said motor, control means operable to reversibly start and stop said motor, switching means actuable in response to the operation of said control means, for connecting said motor to said source, means for effecting the retardation of the speed of said motor upon the operation of said control means to stop said motor, said means including a switching device which is normally in an inoperative condition while said motor is moving but which is selectively operable when the said control means is operated to stop said motor, for effecting the actuation of said switching means as for a direction of movement of said motor opposite to that in which the motor is moving, whereby said motor is retarded, and means, including means operably responsive to the operation of said control means to stop said motor, for selectively operating said switching device.

11. In combination, a motor, a source of power for said motor, control means operable to reversibly start and stop said motor, switching means actuable in response to the operation of said control means, for connecting said motor to said source, means for effecting the retardation of the speed of said motor from the time said control means is operated to stop said motor until said motor is stopped, said means including a switching device, which is in an inoperative condition when said motor is moving under normal operation but which is selectively operable when said control means is operated to stop said motor, for effecting the actuation of said switching means as for the operation of said motor in a direction opposite to that in which the motor is moving, means, including means responsive to the operation of said control means to stop said motor, for selectively operating said switching device when said control means is operated to stop said motor, and for continuing to operate said switching device until said motor starts to reverse its direction of movement, the said operating means for said switching device being responsive to a change in direction of movement of the motor for causing said switching device to return to its inoperative condition, the return of said switching device to its inoperative condition effecting the actuation of said switching means to disconnect said motor from said source and thereby stop said motor.

12. In combination, a motor, a source of power for said motor, control means operable to reversibly start and stop said motor, switching means actuable in response to the operation of said control means, for connecting said motor to said source, means for effecting a retardation of the speed of said motor, including a switching device which is normally in an operative condition while said motor is moving but which is selectively operable when said control means is operated to stop said motor, for effecting the actuation of said switching means as for a direction of movement of said motor opposite to that in which the motor is moving, whereby said motor is retarded, and means for selectively operating said switching device in response to the operation of said control means to stop said motor, said last mentioned means comprising two relatively movable elements normally disengaged from each other, one of said elements being movable in accordance with the movement of said motor, the other of said elements disposed to engage said movable element and be moved thereby to effect the selective operation of said switching device, and means operably responsive to the operation of said control means to stop said motor, for effecting the engagement of said two elements.

13. In combination, a motor, a source of power for said motor, control means operable to reversibly start and stop said motor, switching means actuable in response to the operation of said control means, for connecting said motor to said source, means for effecting a continuous retardation in the speed of said motor from the time said control means is operated to stop said motor until said motor is stopped, said means including a switching device, which is in an inoperative condition while said motor is moving under normal operation but which is selectively operable when said control means is operated to stop said motor, for effecting the actuation of said switching means as for the operation of said motor in a direction opposite to that in which the motor is moving, means for selectively operating said switching device, including two relatively movable elements normally disengaged from each other, one of said elements being movable in accordance with the movement of said motor, the other of said elements being disposed to engage said movable element and be moved thereby to effect the selective operation of said switching device, means operably re-

sponsive to the operation of said control means to stop said motor, for effecting the engagement of said two elements, and means controlled by the position of the other of said two elements for maintaining said last mentioned means effective as long as the said motor moves in its original direction.

In testimony whereof, I have hereunto subscribed my name this 11th day of February, 1928.

RAY P. HIGBEE.