April 5, 1960 H. L. HEART 2,931,462

CONTROL FOR AN ELEVATOR CLOSURE

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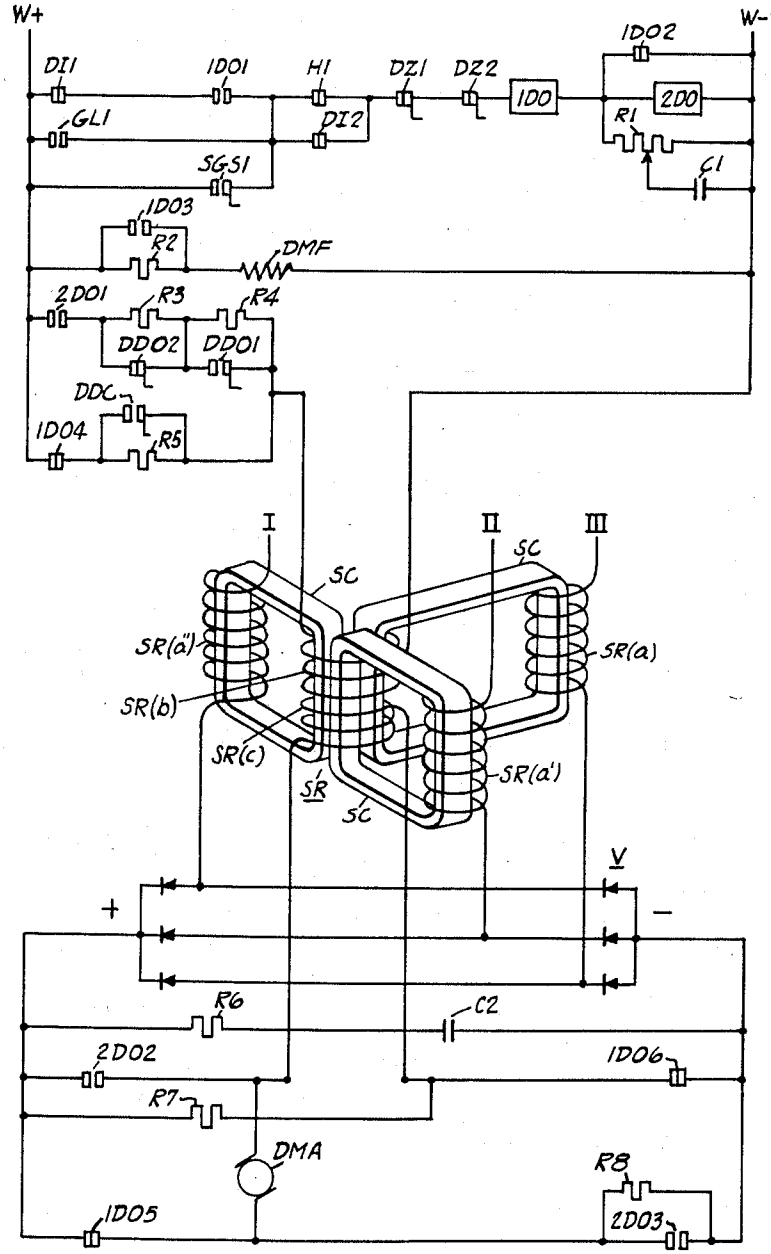

FIG. 1

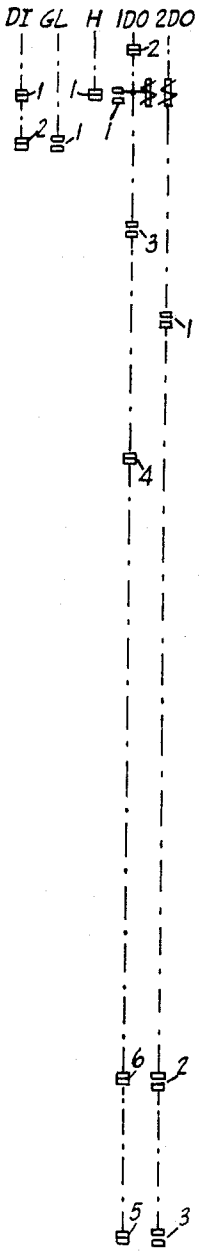

FIG. 1a

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CONTROL FOR AN ELEVATOR CLOSURE

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6 Claims. (Cl. 187—29)

This invention is directed to the control of elevator doors and relates to subject matter akin to that disclosed and claimed in my co-pending application No. 666,187, filed on June 17, 1957, now Patent No. 2,858,904, dated November 4, 1958, for Control For an Elevator Closure.

In equipping buidings there frequently is a conflict between the desire to provide adequate and satisfactory elevator service and the desire to secure the greatest amount of usable or income producing floor space by maintaining at a minimum the space utilized for elevator hoistways.

One way of resolving this conflict is so to operate the elevators that they remain stationary at a floor landing transferring passengers the least practicable amount of time, and are moving to carry passengers the greatest practicable time. Inasmuch as a considerable portion of the time required for an elevator to make a round trip is consumed in the opening and closing movements of its door, one of the most fruitful ways of obtaining that objective is so to manage the door movements that they are at all times under the complete control of and respond quickly and smoothly to the force applied by the mechanism that actuates them.

Regardless whether the elevators and their doors are controlled by attendants or whether they are under the control of automatic mechanisms, the apparatus that controls the movement of the door is required to start, accelerate, stop and reverse the door movement many times each day. Wear and tear on the mechanism inevitably accompanies such usage. Also, as a general proposition, the degree of this wear and tear is somewhat proportional to the speed with which these operations are accomplished. Therefore, the desire to handle elevator door movements in the least practicable time imposes a heavy burden on the mechanism that controls their movements. This desire can be realized and the wear and tear on the equipment can best be minimized, all else being equal, by performing these door movement operations smoothly and with a minimum of abrupt changes in the forces that are applied to them.

Although it is desirable to accomplish the door movements in the least practicable time, it is also desirable to limit the maximum closing force of the door to a predetermined value without unduly reducing the speed of the door in closing. Stated in another manner, while it is desirable to close the door in the least practicable time in order to reduce to a minimum the time that the elevator remains stationary at a floor landing transferring passengers, the external force necessary to stop the closing movement of the door upon its encountering a substantial obstruction in its path, such as a person attempting to restrain its closing movement, should be kept within predetermined safe limits. However, should the door in closing encounter a relatively slight obstruction, such as increased friction due to dirt in the door track, it is desirable to maintain the closing speed of the door constant. One way of realizing this objective is to include in the door control mechanism, means which inherently limit the maximum closing force of the driving

mechanism to a predetermined safe value, upon the application of a substantial external force opposing the door closing movement, but upon the application of a relatively slight opposing force, increase the closing force of the driving mechanism to maintain a constant door closing speed, thereby acting as a driving motor torque regulator.

It is also desirable to minimize manufacturing and installation effort by using the same type of door control mechanism for a variety of door operating mechanisms, each of which, due to differences in construction and operating conditions, often differ in their mass and in the internal and external frictional forces which the driving mechanism must overcome during door movements. This objective is best attained, without sacrificing speed and smoothness of door operation, by manufacturing a door control mechanism which is easily adaptable by a simple adjustment to a variety of door operating mechanisms.

It is an object of the invention to improve the quality of operation of the elevator door.

Another object of the invention is to provide a door control which is simple yet reliable in operation, which effects acceleration and deceleration quickly and smoothly and which is easily adaptable to a variety of door operating mechanism and operating conditions.

Still another object of the invention is to provide a door control which effects acceleration and deceleration quickly and smoothly and yet is effective to limit the closing force of the door upon it encountering a substantial obstruction in its path.

A further object of the invention is to provide a door control which increases the magnitude of the closing force applied to the door upon the door encountering a relatively slight obstruction to its closing movement to maintain constant the closing speed of the door, yet limits the magnitude of the closing force applied to the door when the door encounters a relatively substantial obstruction to its closing movement.

In carrying out the invention, according to the preferred embodiment, a saturable reactor is utilized for controlling the energization of a direct current operating motor. The door motor is connected through a direction-of-rotation reversal switch to the power output windings of the saturable reactor, the impedance of which windings is a function of the permeability of their cores as influenced by the excitation of two control windings on these same cores. Direct current is selectively supplied to one of these two control windings, which winding is designated the shunt winding, so that it produces a flux in the cores. The other control winding designated the series winding is connected in series with the motor armature during the door closing operation so that it produces a flux in the cores in opposing relation to the flux generated by the shunt winding. The flux concentration in the cores or the net excitation of the saturable reactor is determined by the algebraic summation of the flux produced by both control windings and determines the permeability of the cores. An increase in the net flux concentration decreases the permeability of the cores with a resulting decrease in impedance of the power output windings on these cores. The opposite is true of a decrease in the net flux concentration. This net excitation of the saturable reactor is preadjusted to obtain a certain closing speed of the door.

It is desirable to start energizing the door operating motor with a relatively small application of power and to increase the applied power as smoothly and rapidly as desired. This is accomplished on each reversal of the door operating motor from a door closing direction of rotation to a door opening direction of rotation by first interrupting the connection of the shunt control winding to the direct current source and at the same time reversing the direction of current flow through the motor armature

and the series control winding. As this occurs, the flux due to the series control winding reverses polarity, passing through zero value and increasing exponentially in a direction tending to maintain the decaying flux due to the previously energized shunt control winding. As a result, the net flux concentration in the reactor cores ultimately will decrease to a steady state value equal to the flux produced by the series control winding alone. As the direction of current flow through the armature is reversed and the net excitation of the saturable reactor is thus reduced, stopping torque is instantaneously applied to the door operating motor to stop the door, which is then smoothly accelerated in the oppsite direction. However, at a predetermined point during the foregoing flux variation, direct current is reapplied to the shunt control winding, producing a flux of the same polarity as the series control winding, and the series control winding is short circuited. The net flux concentration in the reactor cores is thus rapidly and smoothly increased to a maximum peak value, increasing the armature current to accelerate the door quickly to full speed. As the flux due to the now short circuited series control winding decays, the net excitation of the saturable reactor smoothly decreases to a value equal to the magnitude of the flux produced by the shunt control winding alone, thereby decreasing the armature current to a predetermined value to maintain the speed of the door. This arrangement yields a very flexible motor control, which is capable, by proper selection of the optimum point at which to reenergize the shunt control winding and short circuit the series control winding, of providing extremely fast and smooth door motor reversal and of adaptation to various types of closure mechanisms.

An added advantage of the subject door motor control is that because the saturable reactor to be described herein is a substantially constant current source for relatively large changes in its applied load, it tends to maintain the door at a constant speed should it encounter relatively slight obstructions, such as increased friction due to dirt in the door track, and yet should it encounter a relatively large obstruction in its closing movement, such as a person restraining the closing movement of the door, the maximum motor torque is inherently limited to a certain magnitude, enabling that person to stop the door. This is accomplished by means of the series control winding in the armature circuit and a pair of shunting resistors connected in parallel across the armature and series control winding during door closing. As the door meets a relatively slight obstruction, the current flow through these shunting resistors decreases while the current flow through the armature increases, increasing the motor torque to maintain the closing speed constant. The shunt control winding and the series control winding are so selected relative to each other that a slight increase in current through the series control winding is ineffective to influence appreciably the net excitation of the saturable reactor. However, a relatively large increase in armature current, as the door meets a substantial obstruction, decreases the net flux concentration in the cores, since the series control winding and shunt control winding are in opposing relation during door closing, increasing the permeability of the cores, with a resulting increase in impedance of the power output windings on these cores. The armature current is thus reduced, thereby maintaining the motor torque within a predetermined maximum value. In this manner, the subject door control acts as a motor torque regulator.

This reactor control yields exceptional smoothness of operation in opening, closing and reversing the direction of door movement, permits the door movements to be made at maximum practical speeds, while limiting the closing torque of the door to a predetermined maximum value.

Features and advantages of the invention will be seen from the above and from the following description of operation when considered in conjunction with the drawings in which:

Figure 1 is an "across-the-line" wiring diagram of a simplified elevator door control system embodying the invention and including a diagrammatic representation of a saturable reactor utilized in the control of a direct current door operating motor; and

Figure 1*s* is a spindle sheet for use in side-by-side alignment with Figure 1 for locating the coils and contacts in Figure 1.

Elevator control systems are varied and complex and may contain many varied circuits which affect door operation. It is to be understood that, in applying the invention to such systems, various alterations in the circuits illustrated may be in order, depending on the particular elevator control system. For convenience, the invention will be described as being applied to an elevator in which protective mechanism is provided for sensing the presence of a person in the elevator entranceway, with protective mechanism may be any one of the types described in connection with Figures 4, 5, 6 and 7 of the patent to W. H. Bruns et al., No. 2,634,828, granted April 14, 1953. However, for simplicity, only protective mechanism of the mechanical safety shoe type, mounted on the leading edge of the car door and shown in Figure 5 of that patent, will be shown in the wiring diagram; it being understood that the invention is just as applicable to other forms of protective mechanism.

With reference to the drawings, for convenience, only the contacts of the following electromagnetic switches are shown in the wiring diagram, these switches being operated in the usual manner by any one of various elevator controls incident to the car starting and stopping at a floor landing and only their contacts, as shown in the circuits of Figure 1, being involved in the operation of the subject invention.

DI—Door initiating switch
GL—Elevator running switch
H—Field and brake switch

Door initiating switch DI is operated to initiate closing of the door incident to the starting operation, and is released incident to the car approaching a floor landing at which a stop is to be made. Elevator running switch GL is operated a short time after starting the car and remains operated until a short time after the car is brought to a stop. Field and brake switch H operates when the car starts and releases when the car is brought to a stop. 1DO and 2DO designate first door open-close and second door open-close switches, respectively. The foregoing designating letters are applied to the coils of the switches (where shown) and, with reference numerals appended thereto, are applied to the contacts of the switches to differentiate between different sets of contacts on the same switch, all contacts being shown for the unoperated condition of their switches.

DZ1 and DZ2 designate door zone switches actuated by car movement to define the zone of car movement in which the door opening operation may take place and are shown in the position corresponding to the car standing at a floor landing. SGS designates a mechanical safety shoe switch which is actuatable to closed position as the leading edge of the car door encounters a person in its path in closing and which returns to open position as the leading edge of the car door loses contact with that person. Door accelerating switch DDO1 and door decelerating switches DDO2 and DDC are actuated by door movement and are illustrated for the closed position of the door.

DMA designates the direct current door motor armature and DMF designates the door motor field. Resistors and capacitors are designated generally as R and C, respectively. Saturable reactor SR has 3-phase windings SR(*a*), SR(*a'*) and SR(*a''*) to which alternating voltages are supplied from 3-phase supply lines I, II and III. A

different one of each of the 3-phase windings SR(*a*) etc. is wound on a different core SC, and two direct current control windings, designated shunt winding SR(*b*) and series winding SR(*c*), are wound on and interlock the three cores SC. The output of each alternating current winding of reactor SR is connected to one leg of a 3-phase full wave rectifier V. Across the output of rectifier V are parallel circuits comprising, a shunting circuit consisting of resistor R6 and capacitor C2, door motor armature DMA in series with the saturable reactor series control winding SR(*c*) together with circuit reversing connections 2DO2, 2DO3 and 1DO5, 1DO6. The shunting circuit R6, C2 acts to reduce hum of the door motor armature DMA during periods of low excitation. Supply lines W+ and W— apply unidirectional power to door motor field DMF and the control circuit portion of Figure 1, including the saturable reactor shunt control winding SR(*b*).

An understanding of the invention can best be gained from a description of the sequences of operations beginning with a door opening operation. Assume that the car is traveling between floor landings so that door zone switches DZ1, DZ2 are in open condition. Under such conditions, shunt control winding SR(*b*) of the saturable reactor SR remains energized through closed contacts 1DO4 of the first door open-close switch, maintaining a current flow through door motor armature DMA in a direction to keep the door closed, the latter circuit extending from the positive side of rectifier V through contacts 1DO5 of the first door open-close switch, armature DMA, series control winding SR(*c*) and contacts 1DO6 of the first door open-close switch to the negative side of rectifier V. Under these conditions, the net flux concentration in cores SC is the algebraic summation of the fluxes generated by shunt control winding SR(*b*) and series control winding SR(*c*), which control windings are in opposing relation to each other. Series control winding SR(*c*) is so selected relative to shunt control winding SR(*b*) as to generate a flux of relatively small magnitude in relation to the flux generated by shunt control winding SR(*b*) during periods of normal excitation.

As the car approaches the floor landing at which a stop is to be made, contacts DI1 and DI2 of the door initiating switch (not shown) engage and, as the car arrives at a predetermined distance from the floor landing, door zone switches DZ1, DZ2 are closed by car movement. Inasmuch as contacts GL1 of the elevator running switch (not shown) are in engagement while the car is running, the closing of the door zone switches DZ1, DZ2 completes a circuit for the coil 1DO of the first door open-close switch, but not for the coil 2DO of the second door open-close switch, since coil 2DO is short circuited by normally engaged contacts 1DO2. The circuit thus completed extends from supply line W+ through GL1, DI2, DZ1, DZ2, 1DO and 1DO2 to supply line W—.

Switch 1DO, upon operation, engages its self holding contacts 1DO1. This switch also separates contacts 1DO2, removing the short circuit from coil 2DO of the second door open-close switch. Switch 2DO is delayed in operating for a time interval determined by the position of the adjustable tap on resistor R1, shunting its coil 2DO, and the charging rate of capacitor C1, which capacitor begins charging. First door open-close switch 1DO separates its contacts 1DO4, interrupting the circuit to shunt control winding SR(*b*) which starts to deenergize, increasing the effective permeability of cores SC to reduce the armature current. First door open-close switch 1DO also separates its contacts 1DO5 and 1DO6 in the door motor armature circuits, interrupting the current flow through armature DMA in a door closing direction and through series control winding SR(*c*). However, due to the provision of shunting resistors R7 and R8, now in series with armature DMA and series control winding SR(*c*), current is immediately reversed through series control winding SR(*c*) and door motor armature DMA, applying an opening torque to the door motor to move the door in an opening direction, the circuit extending from the positive side of rectifier V through shunting resistor R7, series control winding SR(*c*), armature DMA and shunting resistor R8 to the negative side of rectifier V. As the current flow through series control winding SR(*c*) is thus reversed at substantially the same time that the flux due to shunt control winding SR(*b*) is decaying, the net excitation of the saturable reactor is decreased exponentially to obtain a fast but smooth initial acceleration of the door. Switch 1DO also engages its contacts 1DO3, removing resistor R2 in series with door motor field DMF to increase the torque of the motor.

After a predetermined time interval when capacitor C1 has charged sufficiently, the second door open-close switch 2DO operates, engaging its contacts 2DO1 to complete the circuit for shunt control winding SR(*b*), the circuit extending from supply line W+ through contacts 2DO1, decelerating switch DDO2, resistor R4 and shunt control winding SR(*b*) to supply line W—. Shunt control winding SR(*b*) is thus reenergized, the flux generated, aiding the flux due to series control winding SR(*c*) to decrease the permeability of reactor cores SC thereby reducing the impedance of the saturable reactor output windings to increase the armature current, and further accelerate the door in the opening direction. At the same time switch 2DO closes its contacts 2DO2 and 2DO3 in the armature circuit, short circuiting resistors R7, R8 and series control winding SR(*c*), causing an immediate increase in armature current, accelerating the door to a higher speed, the circuit extending from the positive side of rectifier V through 2DO2, DMA and 2DO3 to the negative side of rectifier V. As the flux previously generated by now short circuited series control winding SR(*c*) decays, the net excitation of saturable reactor SR and in turn the armature current decrease to their normal value for the door opening operation.

Shortly after door movement starts, accelerating switch DDO1 is closed by door movement, short circuiting resistor R4 to attain full speed door opening. At the same time, decelerating switch DDC is opened by door movement in preparation for a subsequent door closing operation, as will be described later. As the car stops at the floor landing, contacts H1 of the field and brake switch engage and contacts GL1 of the elevator running switch separate, without effect at this time. As the door approaches its fully opened position, deceleration switch DDO2 is opened by door movement inserting resistor R3 in the shunt control winding circuit to reduce the speed of the door.

A door closing operation including a door reversal initiated by the mechanical safety shoe being actuated by an obstruction in the path of the closing door will now be described. At the end of a predetermined door open interval, door initiating switch DI (not shown) operates to separate contacts DI1, interrupting the circuit of coils 1DO and 2DO. Switch 1DO, upon releasing, separates contacts 1DO3, inserting resistance R2 in series with door motor field DMF thereby lowering the torque of the motor in closing. Switch 1DO also engages contacts 1DO2, short circuiting the coil 2DO of the second door open-close switch to discharge capacitor C1 quickly, causing switch 2DO to release. Switch 2DO, in conjunction with switch 1DO separates contacts 2DO2 and 2DO3 and engages contacts 1DO5, 1DO6, respectively, in the armature circuit, thereby reversing the direction of current flow through armature DMA and reinserting series control winding SR(*c*) in series with armature DMA. At the same time switches 2DO and 1DO separate contacts 2DO1 and engage contacts 1DO4, respectively, momentarily interrupting the circuit of shunt control winding SR(*b*). The armature current quickly and smoothly increases to a maximum value, overcoming the inertia of the door operating mechanism

to accelerate the door in a closing direction. As the armature current thus increases, the flux due to series control winding SR(*c*) attains its maximum value in opposition to the flux due to shunt control winding SR(*b*), reducing the net excitation of saturable reactor SR to cause the armature current to decrease to a predetermined value for the door closing operation. Since the series control winding SR(*c*) is only effective during the door closing movement and upon reversal of the door movement from closing to opening, the desired net excitation of the saturable reactor SR during closing movement of the door may be predetermined by proper selection of the value of resistor R5 in series with shunt control winding SR(*b*).

As the door starts to move in the closing direction, door decelerating switch DDO2 is closed by door movement in preparation for a subsequent door opening operation.

Assume that while the door is closing, mechanical safety shoe switch SGS is actuated to closed position by an obstruction in the closing path of the door. Door reversal takes place as follows: a circuit is completed by means of switch SGS for the coil of switch 1DO, which switch operates, separating its contacts 1DO2 to remove the short circuit around coil 2DO. As has been previously explained, switch 2DO is delayed in operating by the action of resistor R1 and capacitor C1, which capacitor begins charging. Switch 1DO also engages contacts 1DO3 short circuiting resistor R2 to increase the door motor field and in turn the motor torque. This switch also separates contacts 1DO4 interrupting the circuit of the shunt control winding SR(*b*), the flux of which starts to decay. At the same time, contacts 1DO5 and 1DO6 separate, reversing the direction of current flow through the armature DMA and series control winding SR(*c*). The flux due to the series control winding SR(*c*) reverses polarity, passing through zero value and increasing exponentially in a direction tending to maintain the decaying flux due to the previously energized shunt control winding SR(*b*), causing the net flux concentration in the reactor cores to start to decrease to a value equal to the flux produced by the series control winding SR(*c*) alone. As the direction of current flow through the armature is reversed and the net excitation of the saturable reactor is thus reduced, a stopping torque is instantly applied to the door operating motor to stop the door, which is then smoothly accelerated in the opening direction.

After capacitor C1 has charged sufficiently, switch 2DO operates, engaging contacts 2DO2 and 2DO3 to short circuit series control winding SR(*c*) and the shunting resistors R7, R8 in the armature circuit, increasing the armature current further. Switch 2DO also engages its contacts 2DO1, completing the circuit of shunt control winding SR(*b*), causing the net flux concentration in the saturable reactor to increase exponentially to a maximum peak value, thereby smoothly increasing the armature current and accelerating the door in the opening direction. As the flux due to the now short circuit series control winding SR(*c*) decays, the net excitation of the saturable reactor smoothly decreases to a value equal to the magnitude of the flux produced by the shunt control winding SR(*b*) alone, thereby decreasing the armature current to a predetermined value.

It may be noted that the reversal of current flow through series control winding SR(*c*) quickly "bucks out" the residual flux of that winding and then increases exponentially to its maximum value at the same time that the flux generated by shunt control winding SR(*b*) is in the process of decaying to its zero value. By proper selection of shunt control winding SR(*b*) relative to series control winding SR(*c*) and by selecting, by means of the adjustable tap on resistor R1, the optimum point during the foregoing flux variation at which to reenergize shunt control winding SR(*b*) and short circuit series control winding SR(*c*), the door opening and reversal operations may be accomplished extremely quickly and smoothly. It may also be noted that by varying the position of the adjustable tap on resistor R1, a wide variety of magnitudes and rates of change of the flux concentration in the cores SC may be obtained, making the subject door control easily adaptable to a variety of door operating mechanisms.

As the door moves in the opening direction, mechanical safety shoe switch SGS moves out of contact with the obstruction and is actuated to open position, interrupting the circuit to the coils 1DO and 2DO. Switches 1DO and 2DO, upon releasing, separate contacts 1DO3 reinserting resistor R2 in series with door motor field DMF, separate contacts 2DO1 and engage contacts 1DO4, momentarily interrupting the circuit to shunt control winding SR(*b*). Switches 1DO and 2DO also actuate the circuit reversing connections 2DO2, 2DO3 and 1DO5, 1DO6 in the armature circuit, causing a reversal of the armature current and inserting series control winding SR(*c*) in series with the armature, thereby stopping the opening movement of the door and smoothly accelerating the door in the closing direction, as has been previously described.

It may be noted that a decrease in excitation of armature DMA or an increase in the external forces opposing door movement decreases the door speed and the counter-electromotive force of the armature. These external forces may be increased frictional forces, such as dirt in a door track or the usual mechanical dampening applied during final door movement. During the door closing operation, as contacts 2DO2 and 2DO3 separate and contacts 1DO5 and 1DO6 engage, resistors R7 and R8, each of which may have a value from two to three times the resistance of armature DMA, are inserted across the output of rectifier V and in parallel with armature DMA and series control winding SR(*c*). Inasmuch as saturable reactor SR is a substantively constant current device for relatively large values of load variation, as the counter-electromotive force of the armature DMA decreases, the current through resistors R7 and R8 decreases while the current flow through the armature and the closing torque increase. As has been previously stated, the series control winding SR(*c*) is so selected relative to the shunt control winding SR(*b*) that a slight variation in the current flowing through series control winding SR(*c*) does not materially affect the saturable reactor excitation. The door thus tends to maintain substantively constant speed during the closing operation regardless of an increase in the frictional forces opposing the door closing.

However, should the door in closing encounter a substantial obstruction in its path, such as a person attempting to stop its closing movement, while the mechanical safety shoe device is inoperative, the closing torque of the driving motor is limited to a maximum safe value as follows: as the armature current flowing through series control winding SR(*c*) increases substantially, the flux generated by that control winding increases in opposition to the flux generated by shunt control winding SR(*b*), decreasing the net excitation of saturable reactor SR to increase the impedance to current flow in the saturable reactor output windings, thereby limiting the maximum motor torque to a safe value.

As the door approaches its fully closed position, decelerating switch DDC is actuated by door movement to open position in preparation for a subsequent door opening operation.

Incident to the starting operation, contacts H1 separate to prevent reopening of the door. As the car moves away from the floor landing, door zone switches DZ1 and DZ2 are actuated by car movement to open position.

The subject door control is easily adaptable to a variety of door operating mechanisms by merely selecting the proper values of resistor R1, capacitor C1 and of series control winding SR(*c*) relative to shunt control

winding SR(b) for each particular door operating mechanism. When these components are properly selected, the subject door control effects quick and smooth door operation while acting as a motor torque regulator during door closing operation.

As changes can be made in the above described construction and many apparently different embodiments of this invention can be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown on the accompanying drawing be interpreted as illustrative only and not in a limiting sense.

What is claimed is:

1. A control for an elevator closure wherein a reversible direct current motor having an armature is operatively connected to said closure for movement thereof, said control comprising, a source of alternating power, a source of unidirectional power, a saturable reactor having at least one power output winding including an input terminal and an output terminal, said input terminal being electrically connected to said source of alternating power, said saturable reactor having two control windings, one of said control windings being connected in series with said armature, unidirectional current conducting means electrically connected to said output terminal of said power output winding, and electric switching mechanism operatively connected between said unidirectional power source and the other of said control windings and between said unidirectional current conducting means and said door motor armature in series with said one control winding, said switching mechanism being controllably operative to interrupt momentarily the current flow in said other control winding substantially simultaneously with reversal of direction of current flow to said armature and said one control winding from said power output winding.

2. In combination, a reversible direct current motor having an armature, switching means including a reversing switch in series with said armature to control the direction of rotation of said armature, said switching means being operable from a first condition to a second condition and after a predetermined time delay to a third condition, unidirectional current conducting means, an alternating current source, a saturable reactor having an output winding supplied with current from said alternating current source and supplying current to said armature through said unidirectional current conducting means and said reversing switch, said saturable reactor also having two control windings, one of said control windings being operatively connected in series with said armature, and a direct current source for energizing said other control winding, said switching means when in said first condition causing said two control windings to be energized in opposing relation to each other and when in said second condition interrupting said current flow through said other control winding while reversing the direction of current flow through said one control winding and said armature, and when in said third condition reenergizing said other control winding while short circuiting said one control winding to increase the current flow through said armature.

3. In combination, a reversible direct current motor having an armature, unidirectional current conducting means, an alternating current source, a saturable reactor having an output winding supplied with current from said alternating current source and for supplying current to said armature through said unidirectional current conducting means, said saturable reactor also having two control windings, one of said control windings being connected in circuit with said armature, a unidirectional power source for energizing the other of said control windings, circuit control means operable from a first condition to a second condition and then to a third condition for controlling said motor, and time delaying means for causing actuation of said circuit control means from said second condition to said third condition after a predetermined time interval measured from the actuation of said circuit control means to said second condition from said first condition, said circuit control means when in said first condition causing energization of said other control winding by said unidirectional power source and electrical connection of said armature and said one control winding to said unidirectional current conducting means for rotation of said armature in a first direction and energization of said one control winding in opposing relationship to said other control winding, said circuit control means when in said second condition disconnecting said other control winding from said undirectional power source while reversing the electrical connection of said armature and said other control winding to said unidirectional current conducting means for reversing the polarity of said other control winding and the direction of rotation of said armature, said circuit control means when actuated to said third condition after said predetermined time interval short circuiting said other control winding while reconnecting said one control winding to said unidirectional power source.

4. A control for a direct current motor having an armature for operating an elevator door at a landing served by the elevator car, said control comprising, a source of alternating current, a saturable reactor having output winding means and two control windings, said output winding means being supplied with current from said alternating current source, unidirectional current conducting means electrically connected to said output winding means, a direct current supply for one of said control windings, switching means operable from a first condition to a second condition and then to a third condition for controlling the excitation of said motor and said control windings, delay means for actuating said switching means from said second condition to said third condition after a predetermined time delay measured from the actuation of said switching means to said second condition from said first condition, said switching means when in said first condition connecting said other control winding in series with said armature and connecting said unidirectional current conducting means to said armature and said other control winding for a first polarity of excitation of said armature and said other control winding, and for connecting said one control winding to said direct current source for a polarity of excitation in opposing relation of said first polarity of said other control winding, means operable upon arrival of the car at a predetermined distance from said landing in stopping thereat for actuating said switching means to said second condition, said switching means when so actuated causing immediate reversal of current flow through said armature and said other control winding, and disconnecting said one control winding from said direct current source substantially simultaneously with said current reversal to open the door, and after a time delay, determined by said delay means, said switching means being actuated to said third condition for reconnecting said one control winding to said direct current source for said opposing polarity of excitation while short circuiting said other control winding to increase armature current flow to accelerate the door in the opening direction, and means operable incident to the restarting of the car to actuate said switching means from said third condition to said first condition to reinsert said other control winding in series with said armature while immediately reversing the direction of current flow through said armature and said other control winding for exciting said armature and said control winding in said first polarity of excitation in opposing relation to said polarity of said one control winding to close the door and for momentarily disconnecting said one control winding from said direct current source substantially simultaneously with said last mentioned reversal of current flow.

5. In combination, a reversible direct current motor having an armature, switching means including a reversing switch in series with said armature to control the direction of rotation of said armature, said switching means being operable from a first condition to a second condition and after a predetermined time delay to a third condition, unidirectional current conducting means, an alternating current source, a saturable reactor having an output winding supplied with current from said alternating current source and supplying current to said armature through said unidirectional current conducting means and said reversing switch, said saturable reactor also having two control windings, one of said control windings being operatively connected in series with said armature, two shunting resistors connected in parallel with said armature and said one control winding, and a direct current source for energizing said other control winding, said switching means when in said first condition causing said two control windings to be energized in opposing relation to each other and when in said second condition interrupting said current flow through said other control winding while reversing the direction of current flow through said one control winding and said armature and inserting said shunting resistors in series therewith, and when in said third condition reenergizing said other control winding while short circuiting said one control winding and said shunting resistors to increase the current flow through said armature.

6. In combination, a reversible direct current motor having an armature, switching means including a reversing switch in series with said armature to control the direction of rotation of said armature, said switching means being operable from a first condition to a second condition and after a predetermined time delay to a third condition, unidirectional current conducting means, an alternating current source, a saturable reactor having an output winding supplied with current from said alternating current source and supplying current to said armature through said unidirectional current conducting means and said reversing switch, said saturable reactor also having two control windings, one of said control windings being operatively connected in series with said armature, a direct current source for energizing said other control winding, said switching means when in said first condition causing said two control windings to be energized in opposing relation to each other and when in said second condition interrupting said current flow through said other control winding while reversing the direction of current flow through said one control winding and said armature, and when in said third condition reenergizing said other control winding while short circuiting said one control winding to increase the current flow through said armature, door open means operable upon arrival of the car within a certain distance from the landing in stopping thereat for actuating said switching means from said first condition to said second condition and after said predetermined time delay to said third condition for causing said motor to propel said door in an opening direction smoothly and quickly, door close means operable incident to the starting of the car for actuating said switching means back to said first condition from said third condition for causing said motor to propel said door in a closing direction smoothly and quickly, and door reversal means operable during closing of the door for actuating said switching means from said first condition to said second condition and after the expiration of said predetermined time delay to said third condition for causing said motor to stop and reverse the direction of movement of said door from closing to opening quickly and smoothly.

No references cited.