Nov. 4, 1958 H. L. HEART 2,858,904

CONTROL FOR AN ELEVATOR CLOSURE

Filed June 17, 1957 2 Sheets-Sheet 1

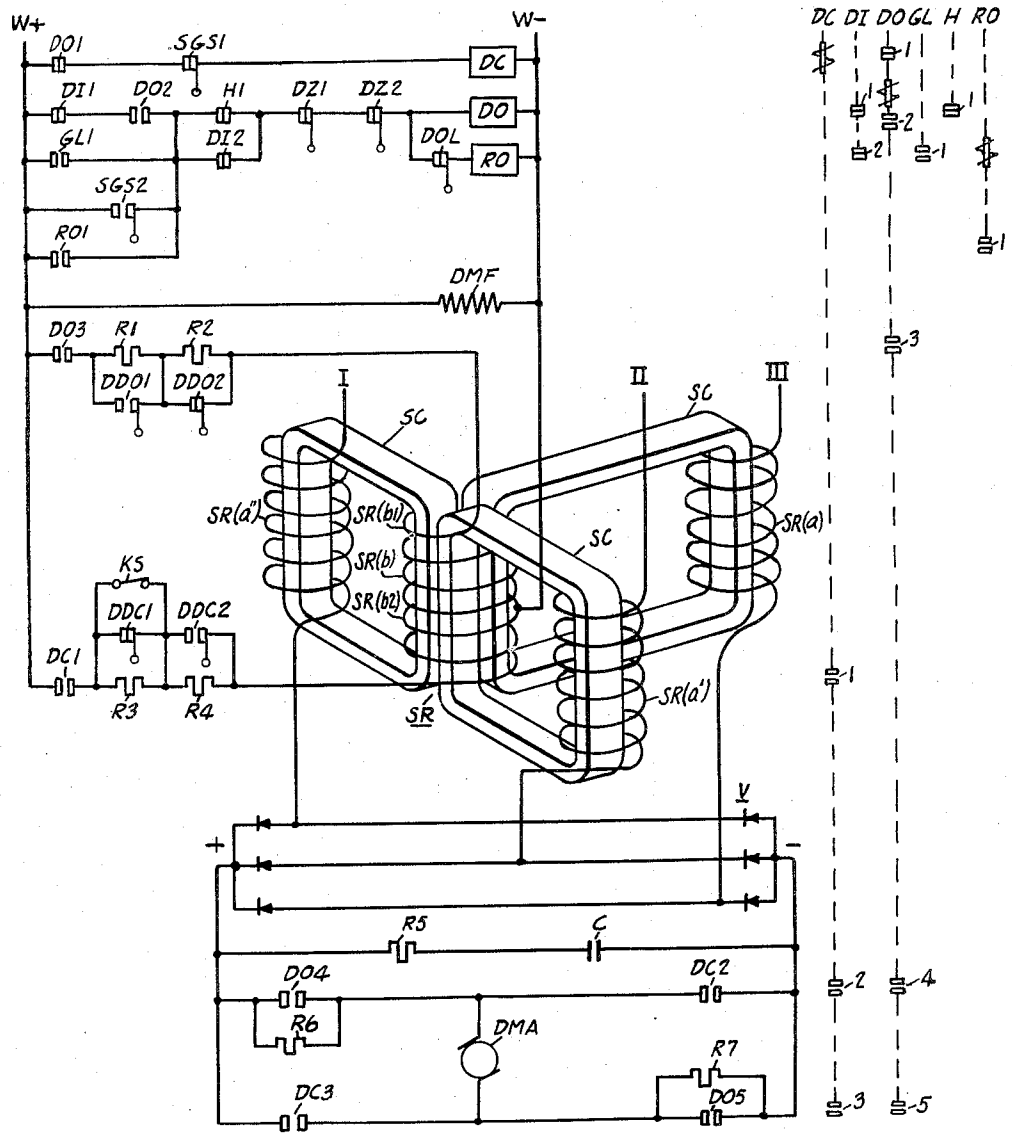


FIG 1

FIG 1S

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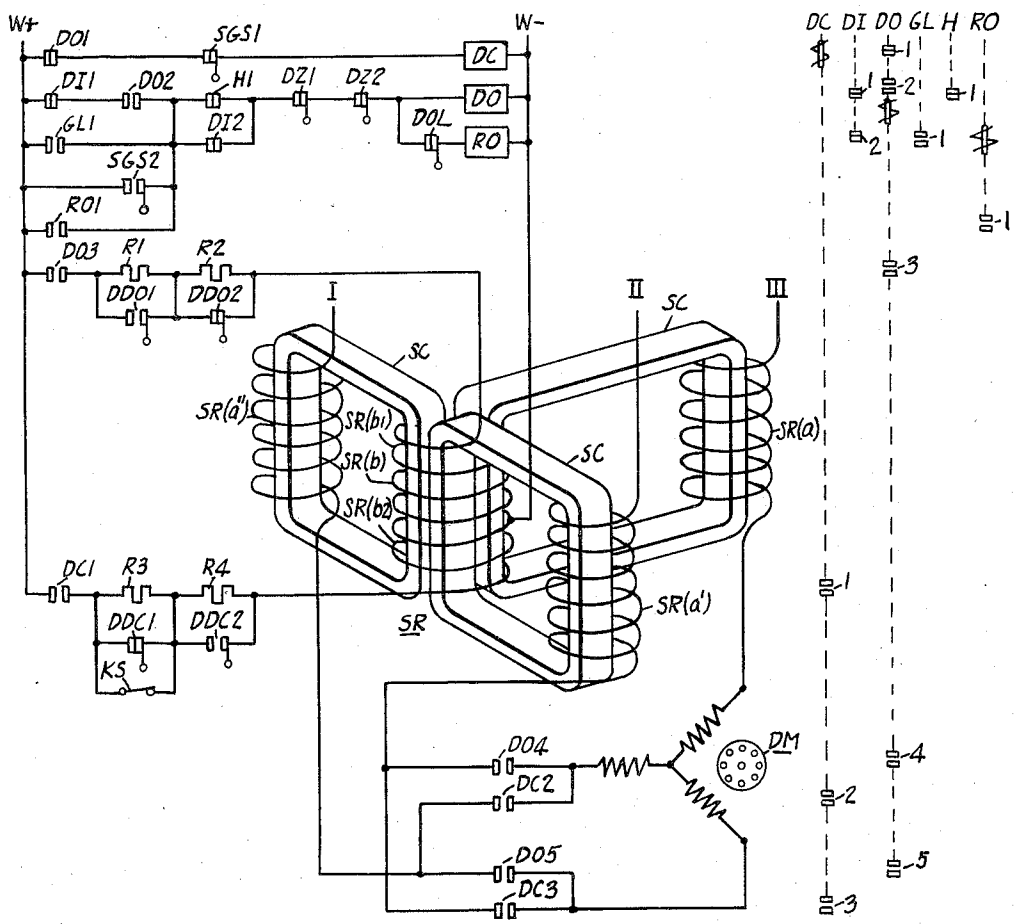


FIG. 2

FIG. 2s

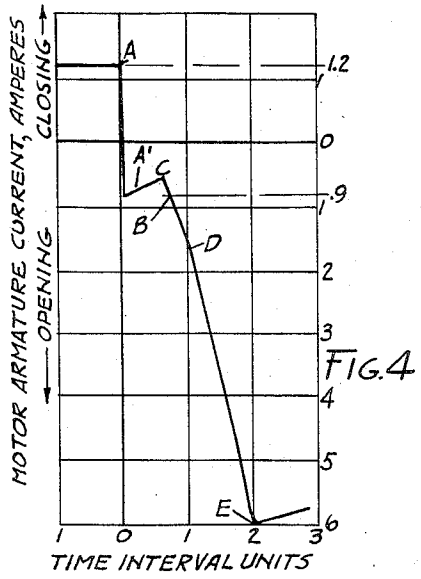


FIG. 4

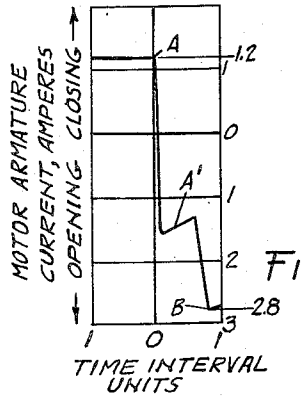


FIG. 3

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United States Patent Office

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CONTROL FOR AN ELEVATOR CLOSURE

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Application June 17, 1957, Serial No. 666,187

12 Claims. (Cl. 187—29)

This invention relates to the control of doors and especially to a reversible drive or control for elevator doors.

In equipping buildings 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 to so operate the elevators that they remain stationary at a floor 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 movement of its door, one of the most fruitful ways of obtaining that objective is to so 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.

In the prior art this result has been sought through the use of control arrangements which supply power to the motor armature either directly or through one or more accelerating resistors, which are progressively removed from the armature circuit in accordance with door movement. These arrangements are fairly effective but have several disadvantages. The accelerating resistors must be large enough to accommodate the armature currents. Because they are in the armature circuit they are usually located in the motor machine room which requires there be connections in the car traveling cable between them and the accelerating switches that are operated by door movement. Further, in order to adjust the door movement, it is necessary to correlate changes in the values of these resistors with the operation of the door, which adjustments, because of the physical separation involved, presents an intercommunication problem.

Even accepting the foregoing considerations, it is still somewhat undesirable to apply the power to the operating motor in discrete steps; the undesirability increasing as the size of the power increments increase.

It is accordingly 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 and which effects acceleration and deceleration quickly and smoothly.

Yet another object of the invention is the provision of a door control embodying a relatively few small circuit components in the control circuit portions instead of large circuit components in the power sections of the apparatus.

In carrying out the invention, according to one preferred embodiment, a saturable reactor is utilized for controlling the energization of the door 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 a control winding on these same cores and to which direct current is selectively supplied. As the direct current in the control winding is increased to increase the flux concentration in the cores, their permeability is decreased with a resulting decrease in impedance of the power output windings on these cores. 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 by first reducing the residual flux in the reactor to zero value and then causing it to increase exponentially to its maximum value by application of direct current to the control winding. This can be accomplished either by reversal of current in the control winding or by the use of a split control winding as will be explained herein in connection with one tested embodiment of the invention.

Because the saturable reactor to be described herein is a substantially constant current source for relatively large changes in its applied load, it is not necessary when using it to correlate the switching of the motor armature circuit to secure "break before make" connections, as is the case with the prior art resistance control arrangements.

This reactor control yields exceptional smoothness of operation in opening, closing and reversing the direction of door movement while at the same time permitting the door movements to be made at speeds equal to or greater than for comparable operations with previously known control arrangements.

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 as applied to a direct current door operating motor;

Figure 2 is an "across-the-line" wiring diagram of a modification of the invention applicable to a simplified door control system using an alternating current door operating motor;

Figures 1*s* and 2*s* are spindle sheets for use in side-by-side alignment with Figures 1 and 2 respectively, for locating the coils and contacts of those circuits.

Figure 3 is a graph which shows the waveshape of door motor armature current, as portrayed by an oscilloscope, as the door is reversed in its movements when a conventional resistance control system without accelerating steps is used; and

Figure 4 is a graph, which shows the waveshape of door motor armature current, as portrayed by an oscilloscope, as the door is reversed in its movement by the subject door control.

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 a device is provided for sensing the presence of a person in the elevator entranceway.

Referring first to Figure 1, the electro-magnetic switches are illustrated in their deenergized position and are designated as follows:

DC—door close switch
DO—door open switch
RO—re-open switch

Numbers are appended to the contacts of each of the switches to differentiate between them. GL1 are contacts of a switch (not shown) which is energized incident to starting the car and which remains energized until a short time after the car is brought to a stop. DI1 and DI2 are contacts of a switch (not shown) which is operated to initiate closing of the door incident to the starting operation, and which is released when a call is picked up for a floor at which a stop is to be made. H1 are contacts of a switch (not shown) which operates when the car starts.

SGS1 and SGS2 designate contacts of a protective mechanism which are actuatable to prevent a person or object in the path of a closing door from being hit by the door. The protective mechanism may be anyone of the types described in connection with Figures 4, 5, 6, and 7 of the patent to W. H. Bruns et al., Number 2,634,828, granted April 14, 1953. DZ1 and DZ2 designate door zone contacts which 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. DMA designates the direct current door motor armature. DMF designates the door motor field. The door-open and door-close accelerating and decelerating switches DDO1, DDO2 and DDC1, DDC2, respectively, and door-open limit switch DOL are actuated by door movement and are illustrated for the closed position of the door.

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 an individual core SC, and a direct current control winding SR(b) is wound on and interlocks the three cores. This winding SR(b) is divided into a door-open excitation portion SR($b1$) and door-close excitation portion SR($b2$). Excitation of the direct current control winding SR(b) is subject to action of door-open relay DO and door-close relay DC through their contacts DO3 and DC1, respectively. In series with these contacts are current limiting resistors R1, R2, R3 and R4. R1 and R3 are shunted by accelerating contacts DDO1 and DDC1, respectively, while R2 and R4 are shunted by decelerating contacts DDO2 and DDC2, respectively. Supply lines W+ and W— supply power to the two portions of control windings SR(b).

In the case of the direct current door operating motor (Figure 1) 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 the armature DMA of the door motor, together with its circuit reversing connections DO4, DO5 and DC2, DC3 and a shunting circuit comprising resistor R5 and capacitor C. This shunting circuit acts to reduce hum of the door motor armature DMA during periods of low excitation. Across contacts DO4 and DO5 are resistors R6 and R7, respectively.

In the case of the alternating current door operating motor (Figure 2) the output of each alternating current winding of reactor SR is connected to a different leg of the star-connected field winding of a polyphase alternating current motor designated DM. Reversing contacts DO4, DO5 and DC2, DC3 are connected in series with two field windings.

An understanding of the invention can best be gained from a description of the sequences of operations, considered in conjunction with Figure 1. Assume that the car has been started and contacts GL1 are closed. While running, the door-close switch DC remains energized through closed contacts DO1 and SGS1 of the door-open switch and the protective device, respectively. The door motor armature remains energized through rectifier V and closed contacts DC2 and DC3. The closing portion of SR($b2$) of the saturable reactor control winding SR(b) remains energized through closed contacts DC1, DDC1 and resistor R4.

As the car approaches the floor at which a stop is to be made, contacts DI1 and DI2 close, and as the car arrives a predetermined distance from the floor, contacts DZ1 and DZ2 are closed by car movement. Inasmuch as contacts GL1, DI2 and door-open limit switch DOL are closed under this condition, the closing of the door zone contacts DZ1 and DZ2 completes the circuits for the coil of switch DO and the coil of re-open switch RO. The closing of contacts RO1 has no effect at this time. Contacts DO2 in closing, bypass contacts GL1, to maintain switch DO energized after the car is brought to a stop and contacts GL1 open. Contacts DO1 in opening de-energize door-close switch DC, opening contacts DC1 in the control circuit of reactor SR and contacts DC2 and DC3 in the circuit of armature DMA. This results in an immediate reversal of current flow through armature DMA through resistors R6 and R7, now in series with the armature. As contacts DO4 and DO5 close the current through the armature DMA increases further as resistors R6 and R7 are removed from the circuit. Contacts DO3 close to energize the door-open portion SR($b1$) of control winding SR(b) through resistor R1 and switch DDO2 to the control winding tap connected to supply line W—. The resulting flux first counteracts the decaying flux remaining from the previous excitation of winding SR($b2$) and then increases exponentially in the cores SC to control the effective permeability of these cores, decreasing this permeability as the flux increases. Therefore, as the control flux increases the impedances of the alternating current windings SR(a), etc., decrease to supply increasing direct current to motor armature DMA through rectifier V.

Shortly after door movement starts, switch DDO1 is closed by door movement to short circuit resistor R1 and to attain full speed door opening. As the door approaches its fully opened position, switch DDO2 is opened, inserting resistor R2 in the circuit to reduce the speed of the door. As the door reaches its fully opened position, limit switch DOL is opened by door movement, de-energizing switch RO and leaving switch DO energized.

At the end of the door-open interval, door initiating switch DI (not shown) is energized to open contacts DI1 and interrupt the circuit of switch DO. Switch DO in releasing closes contacts DO1 to energize switch DC and also opens contacts DO4 and DO5 in the circuit of armature DMA. Contacts DO3 open to de-energize the door-open control winding portion SR($b1$) of the reactor and increase the effective impedance of this reactor, thereby reducing the current flowing through the armature.

Switch DC closes contacts DC1 to energize the door-close control winding portion SR($b2$) of the reactor by completing the circuit from line W+ through knife switch KS, contacts DDC2 (now closed), and coil SR($b2$) to line W—, thereby bucking the residual flux from the

door opening operation and reversing the flux in reactor SR where it builds up exponentially in the opposite direction to again decrease the effective impedance of this reactor. Switch DC also closes contacts DC2 and DC3, completing the circuit from the + side of rectifier V through DC3, DMA, and DC2 to the — side of rectifier V to move the door toward its closed position. A decrease in excitation of the armature DMA or an increase in the external forces opposing door movement decrease the door speed and the counter-electromotive force of the armature. These external forces may be increased frictional forces, such as, dirt in the door track or the usual mechanical dampening applied during final door movement. When contacts DO4 and DO5 opened and contacts DC2 and DC3 closed, resistors R6 and R7, each of which may have a value from two to three times the resistance of armature DMA, where inserted in parallel across the output of rectifier V and in parallel with armature DMA. Saturable reactor SR is a substantively constant current device for relatively large values of load variation. As the C. E. M. F. of the armature DMA decreases, the current through resistors R6 and R7 decreases while the current flow through the armature and the closing torque increase. 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.

If, perchance, it is desired to control the door closing speed in discrete steps, knife switch KS may be opened to insert resistor R3 in the circuit, subject to switch DDC1. Under these conditions, shortly after the door starts its closing motion, switch DDC1 closes to short circuit resistor R3 to attain full door closing speed. As the door approaches its closed position, switch DDC2 opens, inserting resistor R4 in the control circuit, to reduce the door speed. When the elevator car starts away from the floor landing, contacts H1 in the circuit of door-open switch DO open to prevent reopening of the door.

Assume that while the door is closing, door protective mechanism contacts SGS1 and SGS2 are actuated. Door reversal takes place as follows: Switch DC is de-energized by the opening of contacts SGS1. Switch DO is energized by the closing of SGS2, the circuit extending from W+ through SGS2, H1, DZ1, DZ2, DO to W—. Switch RO is also energized through DOL. Contacts RO1 close, thereby maintaining switch DO energized and contacts DO1 opn, to maintain switch DC de-energized, even though the door protective mechanism contacts SGS1 and SGS2 return to unactuated condition. They remain this way until the door reaches fully open position and until switch RO is de-energized by the opening of contacts DOL, as previously set forth.

As switch DC is de-energized and contacts DC2 and DC3 open, the circuit including resistors R6 and R7 and armature DMA becomes effective to reverse the direction of rotation of the motor to open the door. As contacts DO4 and DO5 close to short circuit resistors R6 and R7, the flow of current through the armature is increased further. In conjunction with the above, contacts DC1 open and contacts DO3 close in the control winding circuits to cause first a decrease, reversal and then increase of flux in reactor SR, as previously described, thereby causing a correspondingly smooth change in the power output and the direct current flowing through armature DMA. The immediate reversal of current through the armature through resistors R6 and R7 in a direction to cause door opening, the bucking-out of existing flux and the relatively smooth building-up of flux in the opposite direction in the reactor combine to yield extremely fast and very smooth door reversal at a fast door opening speed.

Refer now to Figures 3 and 4, where are shown graphs of actual motor armature current plotted against time, as the door was reversed in its closing movement. Figure 3 represents the current in the previously known resistance type door control from which steps of accelerating resistance have been omitted. Figure 4 represents the current in a door control utilizing the subject invention. Each control arrangement was tested using the same door and operating motor and was adjusted to bring about the reversal of the closing movement of the door with the same "slide distance." The "slide distance" is defined as that distance which the door travels in its closing movement before reversing direction, after protective mechanism contacts SGS1 and SGS2 are actuated. Since the same door motor and door mechanism was used with both door controls, a comparison of the graphs of their armature current waveshapes when taken under the same conditions is equivalent to comparing the torque developed by the door motor under the same conditions. This comparison indicates the greatly improved performance obtained with the subject invention.

By experimentation, it was found necessary to adjust the maximum motor armature current at 2.8 amperes to secure door reversal within the predetermined "slide distance" when using the resistance type control arrangement (see point B of Figure 3). When so adjusted this maximum current was attained in approximately three-fourths of a time interval unit. As will be seen from Figure 3 this increase in current presents a very steeply sloped curve and indicates nearly an instantaneous application of full motor torque to the door. This abrupt application of full power causes the door reversal movement to be accompanied by an undesirable jerk and considerable vibration of the door and operating equipment. In this tested control the closing door was reversed and fully reopened from approximately its three-quarters closed position in an average of 2.5 seconds.

For comparative purposes the door control using the subject invention was adjusted to produce door reversals at the three-quarters closed position in the same "slide distance" as has been described above while using the same speed of door closing. The maximum motor armature current during the reversal operation was measured at approximately six amperes (see point E, Figure 4). When so adjusted, this armature current reached approximately .9 ampere at three-fourths of a time interval unit (point B, Figure 4—corresponding to point B, Figure 3). As will be seen from Figure 4 the armature current continued to increase to reach its maximum value at slightly more than two time interval units (point E), with a minor change in slope at point D where the saturable reactor SR reached its saturated condition. In this tested embodiment of the invention the closing door was reversed and fully reopened from its three-quarters closed position in an average of 1.62 seconds, which represents a decrease of 1.23 seconds or 43% over the door reopening of the comparable resistance type control described above.

Not only did this embodiment of the invention save an average of 1.23 seconds on each door reversal but accomplished this reversal with no jerking movement and with very much less vibration of the equipment. The reasons for this are portrayed in the waveform of Figure 4, wherein it will be noted, the initial torque (armature current) is small and is increased rapidly but smoothly to a much larger peak value than in the case of the comparable tested resistance type control.

Because the armature current of the subject invention has only a relatively small portion of rapid increase and this at low value, the current need not be limited to prevent jolting the door and accelerating resistance steps need not be used to obtain smoothness of reversal of door movement at high speed.

This ability of the subject door control to reverse the movement of the door at high speed results in the elevator car remaining stationary at the floors a shorter time and keeps the overall round trip time of the car at a minimum; resulting in the use of the smallest number of cars to perform the required service. In marginal

cases this savings may result in a reduction in the number of elevators required and additional building space be made available for income production while, all other things being equal, better service is obtained with less maintenance of the door equipment.

The small amount of control current required with the saturable reactor control permits the use of small, inexpensive rheostats mounted on top of the elevator car instead of large units mounted in the machine room. This arrangement also reduces the number of traveling hoistway cable conductors required, and makes for easy adjustment of the control since the adjustment can be made while physically observing operation of the door.

Although the merits of this invention have been described in terms of reopening a closing door, it should be appreciated that it also presents an improvement in operation of the door from its fully closed position as the car reaches the floor where a stop is to be made. Where a common door operating motor is mounted on the elevator car it is customary to interlock the car door and the landing doors through the use of a vane on the car door which engages a pivot or stop on the landing door. Since movement of the landing door is imparted by movement of the car door, it is necessary to first move the car door to engage the vane with the landing door stop. Customarily, in the resistance type control where nearly full torque is applied initially this engagement is rather "rough" and is generally accompanied by a jerk and vibration of the equipment. The use of a number of steps of accelerating resistance, therefore, is frequently employed in order to apply the torque more gradually.

In the described embodiment of the invention this necessity for steps of accelerating resistance in the motor armature circuit is obviated because as the car approaches the floor at which a stop is to be made the door-close switch is in energized condition, energizing the door-close portion SR(*b*2) of the control winding of reactor SR. When the car arrives within the door opening zone as defined by mechanically operated contacts DZ1 and DZ2 the door-open switch is also energized. This now gives us a build-up of flux. The closing of contacts DO3 in the control winding circuit causes flux to be generated in a directional sense opposite to that generated by the door-close portion of that circuit and as contacts DC1 open cause a complete reversal and build-up in the opposite direction of this control flux to first reduce the power supplied to the motor armature DMA to a minimum and then gradually increase it to its maximum value. This gradual application of power to the door opening motor together with its smooth, rapid build-up permits the opening of the car door in such manner that the engagement of the mechanical coupling to the landing door is effected smoothly and noiselessly, while the door movement is being accelerated toward its maximum value.

In the foregoing, the invention has been described as being incorporated in a structure having a tapped control winding such that flux caused by energization of one portion is opposite in direction to flux caused by energization of the conjugate portion. This arrangement has the characteristic that both portions may, if desired, be energized simultaneously. A large portion of the advantages of the invention may, however, be realized through use of a single unitary control winding arranged in a switching circuit similar to that connecting armature DMA. In this latter arrangement only one polarity of unidirectional current may be supplied to the winding at any instant and this polarity may be reversed simultaneously with the reversal of connections to armature DMA, thereby reducing the residual flux to zero value before again increasing it to its maximum or running value.

Although the invention has been described as being applied to a control using a direct current door motor and a polyphase power source, it is equally applicable to a control using single phase power or one using an alternating current motor. The latter system is illustrated in Figure 2. The operation of the door control system, illustrated in Figure 2, is similar to that of the foregoing described system, except that it is unnecessary to convert the power output of reactor SR through the use of rectifier V and resistors R6 and R7 have been omitted.

Also, in the foregoing description, the invention has been described as being used with an elevator operating with a protective mechanism for sensing the presence of an object in the path of the closing door. However, it is obvious that it is equally applicable to a system in which the opening or closing of the door is under the control of an attendant.

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

What is claimed is:

1. A control for an elevator closure wherein a reversible electric motor is operatively connected to said closure for movement thereof comprising, a source of alternating power, a source of unidirectional power, a saturable reactor having at least a power output winding which is electrically connected to said source of alternating power and a control winding, electric switching mechanism operatively connected between said unidirectional power source and said control winding and between said power output winding and said reversible motor, said switching mechanism being controllably operative to reverse the direction of current flow in said control winding simultaneously with reversal of direction of current flow to said motor from said power output winding.

2. A control for an elevator closure wherein a reversible electric motor is operatively connected to said closure for movement thereof comprising, a source of alternating power, a source of unidirectional power, a saturable reactor having at least a power output winding connected to said source of alternating power and a control winding having a tap intermediate its two terminals, electric switching mechanism in circuit connection and controlling the conductive circuit between each of said terminals and one polarity of said unidirectional power source and in circuit connection and reversibly controlling the conductive circuit between said output winding and said electric motor, a conductive connection between said control winding tap and the other polarity of unidirectional power, said switching mechanism being controllably operative to control the interconnection between said unidirectional source and each of said control winding terminals substantially simultaneously with its control of the circuit connection between said electric motor and said output winding.

3. A control for an elevator closure as set forth in claim 2, wherein one of said control winding terminals is connected to said unidirectional source slightly in advance of the disconnecting of its conjugate terminal from said source.

4. A reversible drive comprising, an electric motor, a source of alternating current for said motor, reversing switching mechanism connecting said motor to said source for selective directional operation thereof, a saturable reactor having output winding means and control winding means, said output winding means being connected between said motor and said source, and said control winding means having two control portions, a direct current power supply for said control winding means, and means connecting one portion of said control winding means to said direct current power supply to provide control flux of one polarity in said reactor for operation of

said motor in one direction and operable, upon operation of said reversing switching mechanism to cause operation of said motor in the opposite direction, to disconnect said one portion and connect the other portion of said control winding means to said direct current power supply for opposite polarity of excitation of said reactor first to reduce the flux in said reactor and then increase it in the opposite direction to control the rate of change of current flowing in said motor.

5. In combination, a direct current motor having an armature, a reversing switch in series with said armature to control the direction of rotation of said armature, unidirectional current conducting means, an alternating current source, a saturable reactor having an output winding supplied with a 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 a control winding, said control winding being split into a first portion and a second portion, a direct current source for energizing said control winding, and means to cause said first portion and said second portion of said control winding to be alternatively energized in opposing relation to each other to limit armature current surge as the direction of current flowing through said armature is reversed as said reversing switch is actuated.

6. A reversible drive comprising, a direct current motor having an armature, a reversing switch in series with said armature to control the direction of rotation of said armature, three core members of a saturable reactor, a reactance winding on each of said members, an alternating current source connected to said reactance windings, unidirectional current conducting means connecting said reactance windings to said reversing switch to provide energizing voltage for said armature, a saturating control winding interlocking said core members, said control winding being split into a first and second portion, a direct current power supply for energizing said control winding, and means to cause current from said direct current power supply to flow through said first portion in one direction and then through said second portion in the opposite direction in conjunction with operation of said reversing switch to minimize surge current through said armature upon reversal of armature current flow.

7. A control system for a direct current motor for operating an elevator door at a landing served by the elevator car comprising, a source of alternating current for said motor, a saturable reactor having output winding means and control winding means, said output winding means being supplied with current from said source, said control winding means having two portions, unidirectional current conducting means connected to said output winding means, a direct current power supply for said control winding means, means operable incident to the starting of the car for connecting said motor to said unidirectional current conducting means for a polarity of excitation to close said door and for connecting one portion of said control winding means to said power supply for one polarity of excitation of said reactor for controlling the door closing operation, and means operable during closing of said door for connecting said motor to said unidirectional current conducting means for a polarity of excitation to open the door for reversing the direction of movement of said door and for disconnecting said one portion from said power supply and thereafter connecting the other portion of said control winding means to said power supply for opposite polarity of excitation of said reactor to enable a quick reversal of said door to be smoothly effected.

8. A control system for a direct current motor for operating an elevator door at a landing served by the elevator car comprising, a source of alternating current for said motor, a saturable reactor having output winding means and control winding means, said output winding means being supplied with current from said source, and said control winding means having two portions, unidirectional current conducting means connected to said output winding means, first switching means operable as the car arrives a predetermined distance from the landing in stopping thereat for connecting said motor to said unidirectional current conducting means for a first polarity of excitation for operation in a direction to open said door and maintaining said motor connected to said conducting means, second switching means operable incident to the starting of the car from the landing for disconnecting said motor from said conducting means and for connecting said motor to said unidirectional current conducting means for a second polarity of excitation for operation in a direction to close said door and for maintaining said motor connected to said conducting means until the door open operation is initiated, safety mechanism operable during closing of said door for disconnecting said motor from said unidirectional current conducting means for said second polarity of excitation, and thereafter re-establishing the connection of said motor to said unidirectional current conducting means for said first polarity of excitation for reversing the operation of said door, a direct current power supply, and third switching means to connect one portion of said control winding to said power supply for controlling the generating of flux in said reactor for the door opening operation, to connect the other portion of said control winding to said power supply for controlling the generating of flux in said reactor for the door closing operation and to disconnect said other portion from said power supply, and thereafter establish the connection of said one portion to said power supply for door reversal operation to cause cancellation of existing flux in said reactor and then reversal of the flux in said reactor to minimize the flow of surge current in said motor.

9. A control system for a direct current motor for operating an elevator door at a landing served by the elevator car comprising, a source of alternating current for said motor, a saturable reactor having output winding means and control winding means, said output winding means being supplied with current from said source and said control winding means having two portions, unidirectional current conducting means connected to said output winding means, a direct current power supply for said control winding means, means operable incident to the starting of the car for connecting said motor to said unidirectional current conducting means for a polarity of excitation to close said door and for connecting one portion of said control winding means to said power supply for one polarity of excitation of said reactor for controlling the door closing operation, means operable upon arrival of the car a predetermined distance from the landing in stopping thereat for connecting said motor to said unidirectional current conducting means for a polarity of excitation to open said door and for connecting the other portion of said control winding means to said power supply for opposite polarity of excitation of said reactor to control the door opening operation, and means operable during closing of said door incident to the restarting of the car to disconnect said motor from said unidirectional current conducting means for said polarity of excitation to close the door, and thereafter connect said motor to said unidirectional current conducting means for said polarity of excitation to open the door to reverse movement of the door and to re-establish the connection of said other portion to said power supply after disconnecting said one portion from said power supply to control reversal of said motor.

10. A control system for a direct current motor for operating an elevator door at a landing served by the elevator car comprising, a source of alternating current for said motor, a saturable reactor having output winding means and control winding means, said output winding means being supplied with current from said source

and said control winding means having two portions, unidirectional current conducting means connected to said output winding means, a direct current power supply for said control winding means, door close means operable incident to the starting of the car for connecting said motor to said unidirectional current conducting means for a polarity of excitation to close said door and for connecting one portion of said control winding means to said power supply for one polarity of excitation of said reactor for controlling the build-up of flux in said reactor for the door closing operation and for thereafter maintaining said one portion thus connected to said power supply, door-open means operable upon arrival of the car a certain distance from the landing in stopping thereat for connecting said motor to said unidirectional current conducting means for a polarity of excitation to open said door and for connecting the other portion of said control winding means to said power supply for opposite polarity of excitation of said reactor and thereafter disconnecting said one portion from said power supply to utilize the reversal of control flux in the reactor and build-up thereof in the opposite direction for the door opening operation, and door reversal means operable during closing of said door incident to the restarting of the car for controlling said door-open means and said door-close means to connect said motor to said unidirectional current conducting means for said first-mentioned polarity of excitation to reverse the direction of rotation of said motor to return the door to open position and to disconnect said one portion from said power supply and thereafter, to re-establish the connection of said other portion to said power supply to utilize the reversal of the control flux in said reactor and build-up thereof in the opposite direction to control said reversal of said motor so as to minimize the flow of surge current in said motor and to obtain a smooth, quick stopping and reversal operation.

11. In an elevator door control, a door-close door operating motor having an armature, a three-phase alternating current supply, unidirectional current conducting means, a saturable reactor having three core members, and three reactance windings, one wound on each member, said reactance windings being series connected between said alternating current supply and the input of said unidirectional current conducting means, a door-open switch and a door-close switch, said switches having contacts reversibly connected between the output of said unidirectional current conducting means and said armature to control the direction of direct current flow through said armature to open and close the door, a saturating control winding interlocking said core members, said control winding having a door-open portion and a door-close portion, a direct current supply, said door-open switch and said door-close switch having circuit controlling means to connect selectively said control winding portions to said direct current supply to cause current flow through said door-open portion in one direction and through said door-close portion in the opposite direction in conjunction with operation of said reversibly connected contacts, safety mechanism to initiate the stopping of the door while the door is closing by causing said door-close contacts to open and said door-open contacts to close, and shunting resistors connected across said door-open contacts to cause immediate flow of current through said armature in a direction to open the door as said door-close contacts open.

12. In combination, an alternating current source, an alternating current door motor, reversing switching mechanism in series with said door motor, a saturable reactor having an output winding supplied with current from said alternating source and supplying current to said motor through said reversing switching mechanism, a saturable reactor control winding, said winding having a closing portion and an opening portion, a direct current source for energizing said control winding, a door-open switch, a door-close switch, first circuit controlling means responsive to the operation of said door-close switch to connect said direct current source to said closing portion of said control winding, and second circuit controlling means responsive to the operation of said door-open switch to connect said direct current source to said opening portion of said control winding in opposing relation to the door-close excitation to cause flux reversal in the reactor, said reversing switching mechanism also being responsive to operation of said door-close switch and said door-open switch to control the direction of rotation of said door motor.

No references cited.