Jan. 2, 1934. H. W. MATTINGLY ET AL 1,942,253

ELEVATOR DOOR OPERATING APPARATUS

Filed March 6, 1929

Fig. 1.

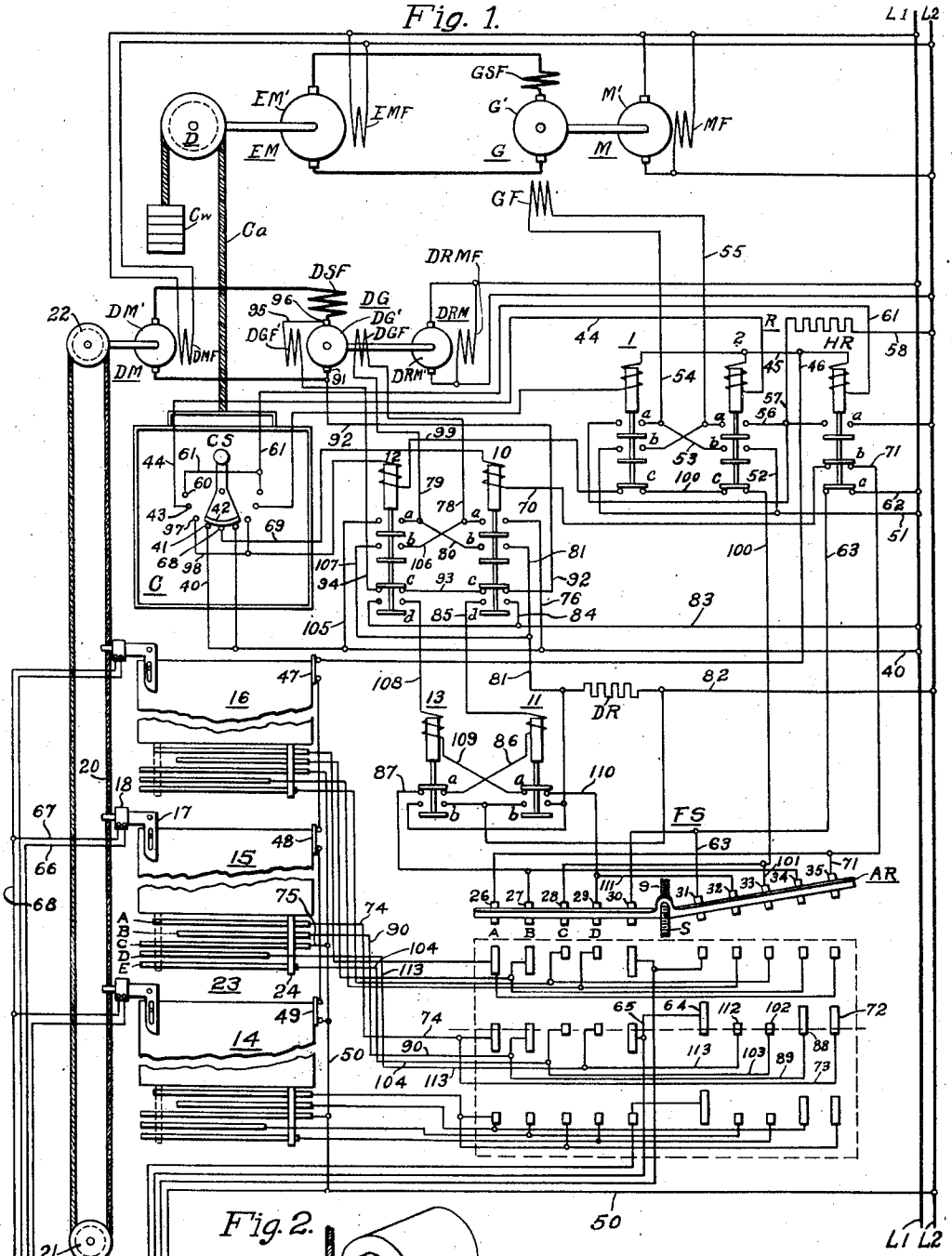
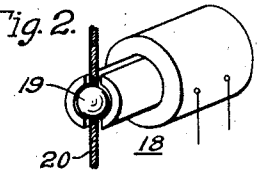


Fig. 2.



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ATTORNEY

Patented Jan. 2, 1934 1,942,253

UNITED STATES PATENT OFFICE

1,942,253

ELEVATOR DOOR OPERATING APPARATUS

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Application March 6, 1929. Serial No. 344,735

2 Claims. (Cl. 187—52)

Our invention relates to elevator-door-operating systems and more particularly to operating systems for rapidly opening and closing elevator doors at the landings at which the elevator cars make stops.

In the present day installations of elevator systems in tall buildings, the cars are usually arranged to operate at a high speed of 700 feet or more per minute for the purpose of handling a large number of passengers with a minimum numbers of cars.

While the speed of the cars is a factor of considerable importance in the rapid and economical operation of elevator systems, there is another factor having a decided bearing upon the number of passengers the elevators may be able to transport within a given period that has not yet been satisfactorily taken care of and that is the time consumed in opening and closing the doors at the landings where stops are made for passengers to enter and leave the cars.

It is evident that any decrease in the time required in opening and closing the doors will lower the time required by the cars in collecting and discharging passengers at the landings and thereby speed up the operation of the elevator system as a whole.

Therefore, it is an object of our invention to provide for opening and closing the doors of an elevator within a minimum amount of time.

Another object of our invention is to provide for rapidly opening an elevator door at a landing as a car approaches a stop at that landing for the purpose of saving the time that would otherwise be consumed in opening the door after the car actually stops.

A further object of our invention is to provide for overcoming the difficulty of operating elevator doors when the door tracks become clogged with dirt, snow or ice tracked in by the users of the elevator.

It is also an object of our invention to provide an elevator-door-operating system that shall be simple and efficient in operation and capable of being economically constructed, installed and maintained.

Other objects of our invention will, in part, be obvious and will, in part, appear hereinafter.

For an illustration of one of the many forms our invention may take, reference may be had to the accompanying drawing in which:

Fig. 1 is a diagrammatic view representing an elevator installation that is provided with a door-operating system constructed and arranged in accordance with our invention; and

Fig. 2 is a detailed view, in perspective, of one of the door-operating clutches embodied in the system shown in Fig. 1.

The drawing illustrates a car C as suitably suspended in a hatchway by a hoisting cable Ca that passes over a hoisting drum D to a suitable counterweight Cw. The hoisting drum D is directly coupled to, and operated by, the armature EM' of an elevator hoisting motor EM.

A variable-voltage system of control may be provided for the elevator motor EM, wherein the armature EM' of the elevator motor is connected in loop circuit with the armature G' of the generator G. The generator G is provided with a separately excited field winding GF and an accumulative series field winding GSF. The armature G' of the generator G is suitably driven by means of a driving motor M illustrated as being of the shunt-wound type having its armature M' and its field winding MF connected in shunt relation to a source of power designated as the supply conductors L1 and L2. The elevator motor EM has its field winding EMF connected for constant-voltage energization to the supply conductors L1 and L2.

The direction and speed of the operation of the hoisting motor EM may be suitably controlled by controlling the direction and value of the excitation current that is supplied to the separately excited field winding GF of the generator G.

The direction of the excitation current for the field winding GF may be suitably controlled by means of an up-direction switch 1 and a down-direction switch 2, while the value of the current supplied to the field winding may be controlled by means of a high-speed relay HR.

The operation of the up-direction and the down-direction switches 1 and 2 may be controlled by means of a car switch CS that is mounted upon the elevator car C in position to be actuated by an attendant on the car.

As shown, the hatchway for the car C is provided with a plurality of corridor doors 14, 15 and 16. Associated with each of the doors is a door-operating lever 17 on the outer end of which is mounted a mechanically operated clutch 18 which may be energized to grip a button or other gripping device 19 (see Fig. 2) on a door-operating member or cable 20, when the door is to be moved to an open or to a closed position. The cable 20 passes around an idler sheave 21 near the bottom of the hatchway and then up the hatchway past the doors 14, 15 and 16 and over a driving sheave 22 that is coupled to a door-operating motor DM.

In the operation of elevators, the door tracks often become clogged with dirt, snow or ice tracked in by the users of the elevators to such an extent that the doors stick and become difficult to move. Again, while the doors are originally adjusted to work smoothly and easily, the door tracks become warped or moved out of line after considerable service and thus cause the doors to bind at certain points in their travel.

Heretofore, when the doors have been provided with power-operated motors, the sticking or binding of the doors has slowed the operation of the elevator considerably by stalling or slowing the door-operating motors because the motors have been supplied with a predetermined limited amount of power.

Therefore, in order to overcome the difficulties caused by the sticking or binding of the doors, we have provided a variable-voltage system of control for operating the door motor DM in such manner that any sticking or binding of the doors will cause sufficient additional power to be applied to the door-moving apparatus to overcome the sticking and binding and prevent the stalling of the door-operating motor.

In providing the variable-voltage system of control for the door-operating motor DM, its field winding DMF is connected, for constant-voltage energization, to the supply conductors L1 and L2, while its armature DM' is connected in loop circuit with the armature DG' of a generator DG.

The generator DG is provided with a suitable exciting field winding DGF, a demagnetizing winding DGF' and a suitable cumulative series field winding DSF. The series field winding DSF is so proportioned that cumulative compounding of the generator DG is achieved to increase the voltage supply to the door-operating motor DM under an increase in load, and to decrease the voltage supply to the motor under a light load in such proportions as to counteract the otherwise normal characteristic of the motor to decrease its speed or to stall when its load is increased by the sticking or the binding of the door.

The armature DG' of the generator DG is suitably driven by means of a driving motor DRM, illustrated as being of the shunt-wound type having its armature DRM' and its field winding DRMF connected in shunt relation to the supply conductors L1 and L2.

The direction and speed of operation of the door-operating motor DM may be suitably controlled by controlling the direction and value of the excitation current that is supplied to the separately excited field winding DGF of the generator DG.

The direction of the excitation current for the winding DGF may be suitably controlled by means of a door-opening relay 10 and a door-closing relay 12, while the value of the current supplied to the field winding may be controlled by a high-speed door relay 11 when the doors are being opened and by a high-speed door relay 13 when the doors are being closed.

The coils of the door-opening relay 10 and the door-closing relay 12 are connected to suitable contact members of the car switch CS in order that the operation of the relays to open or to close the doors may be effected by movements of the car switch to start and stop the car.

Associated with each of the doors is a controlling device 23 for controlling the speed of operation of the doors. Each of the controlling devices 23 comprises a plurality of contact strips A, B, C, D and E that are secured to the door frame and a cooperating brush 24 mounted on the door in such position that it will slidingly engage the contact strips A, B, C, D and E as the door is moved to a closed or to an open position.

The contact strip C is connected directly to the supply conductor L2, while the contact strips A and B are connected to the supply conductor L1 through circuits for opening the door, and the contact strips D and E are connected to the supply conductor L1 through circuits for closing the door.

The contact strips A and B are extended and arranged to be engaged by the brush 24 in such manner that, while full power will be supplied to the door-operating motor as the door starts to open, the power will be reduced to decelerate the motor as the door nears the end of its travel and will be completely cut off to stop the motor as the door reaches its full-open position. Similarly, the contact members D and E are arranged to cooperate with the brush 24 to supply full power to the door as it starts to close and then to reduce the power and finally to cut it off as the door reaches its closed position.

Included in the system is a floor selector FS for connecting the circuits for the door-operating relays 10 and 12, the door high-speed relays 11 and 13, the electromagnetic clutches 19 and the controlling devices 23 of the doors in such manner that none of the doors can be opened or closed by manipulation of the car switch CS unless the car is adjacent to the door that is to be opened or closed.

The floor selector FS may be similar to those usually employed in the elevator control and signal art and may be located at any suitable point, for example, in the pent house or in the elevator shaft.

As shown, the floor selector FS is provided with a plurality of "up" contact segments and a plurality of "down" contact segments that are disposed to be engaged by a plurality of cooperating brushes 26 to 35, inclusive, which are disposed upon and insulated from a movable arm AR.

The movable arm AR is mounted upon the floor selector and is operated in synchronism with the movements of the car past the floors, by a screw S that is driven by some part of the operating mechanism of the car C.

The contact segments under the brushes 26, 27, 28, 29, 32, 33, 34 and 35 are connected to the contact strips of the controlling devices 23 of the doors, while the contact segments under the brushes 30 and 31 are connected to the magnetically operated clutches 19 for connecting the door levers 17 to the door-operating rope 20.

The invention may be understood best from an assumed operation of the apparatus illustrated in the drawing.

Assuming that the car C is standing at the top floor, that the doors are closed and that the attendant, desiring to start the car downward, moves the car switch CS in a clockwise direction, then the direction switch 2 will be energized for moving the car downward by way of a circuit that extends from supply conductor L1, through conductor 40, the contact members 41, 42 and 43 of the car switch CS, conductor 44, the coil of down-direction switch 2, conductors 45 and 46 and thence, in series, through door contact members 47, 48 and 49 and in conductor 50, to supply conductor L2.

The closing of the contact members *a* and *b* on the down-direction switch 2, energizes the field winding GF of the generator G with current in one direction by way of a circuit that extends

from supply conductor L1, through conductors 51 and 52, the contact members *b* of down-direction switch 2, conductors 53 and 54, the field winding GF, conductor 55, the contact members *a* of down-direction switch 2, conductors 56 and 57, a resistor R and conductor 58, to supply conductor L2. The energization of the field winding GF causes the generator G to supply current in one direction to the hoisting motor EM, and the car starts downwardly.

As the attendant continues the movement of the car switch CS in a clockwise direction, a circuit is completed for operating the car at high speed, which circuit extends from supply conductor L1, through conductor 40, the contact members 41, 42 and 60, conductor 61, the coil of high-speed relay HR, conductor 46, elevator-door contact members 47, 48 and 49 and conductor 50, to supply conductor L2.

The closing of the contact members *a* on the high-speed relay HR shunts the resistor R from the circuit previously traced for the field winding GF to thereby cause the car to travel down at high speed.

Assuming now that the attendant on the car desires to stop the car at the second floor landing and moves the car switch CS in a counter-clockwise direction as the car nears the second floor, thereby opening the contact members 60 and 42 on the car switch CS, then the high-speed relay HR will be deenergized to reinsert the resistor R in the circuit for the field winding GF, thereby causing the car to decelerate to a lower speed.

As the car approaches the second-floor landing, the brush 31 on the arm AR of the floor selector FS engages the "down" contact segment 64 for the second floor and, the closing of the contact members *c* on the high-speed relay HR completes a circuit for energizing the electromagnetic clutch 18 to grip the ball 19 on the rope 20 so that the door 15 will be opened when the rope 20 is moved, which circuit extends from supply conductor L1, through conductor 62, the contact members *c* of high speed relay HR, conductor 63, brush 31 and contact segment 64 on the floor selector, conductors 65 and 66, the magnet 18 and conductors 67, 68 and 50 to supply conductor L2.

As the car continues toward the second floor, the brush 35 on the arm AR engages the contact segment 72 on the floor selector and completes a circuit for energizing the door-opening relay 10 to cause the rope 20 to be moved to open the door 15, which circuit extends from supply conductor L1, through conductor 40, the contact members 41, 42 and 68 of the car switch CS, conductor 69, the coil of door-opening relay 10, conductor 70, the normally closed contact members *b* of high-speed relay HR, conductors 71, brush 35 and contact segment 72 on the floor selector, conductors 73 and 74 the contact strip A, the brush 24 and the contact strip C on the controlling device 23, and conductors 75 and 50, to supply conductor L2.

The closing of the contact members *a* and *b* on the door-opening relay 10 completes a circuit for the field winding DGF of the generator DG for actuating the door-operating motor DM, by way of a circuit from supply conductor L1, through conductors 40 and 76, the contact members *a* of relay 10, conductor 78, the generator field winding DGF, conductors 79 and 80, the contact members *b*, conductor 81, resistor DR and conductor 82, to the supply conductor L2.

The opening of the contact member *c* on the door-opening relay 10 opens the circuit for the demagnetizing winding DGF' on the generator DG' and prevents a flow of current through that winding while the door motor DM is operating.

The closing of the contact members *d* on the door-opening relay 10 completes a circuit for energizing the high-speed door relay 11 by way of a circuit that extends from supply conductor L1, through conductors 83 and 84, the contact members *d* of relay 10, conductor 85, the coil of relay 11, conductor 86, the normally closed contact members *a* of relay 13, conductor 87, brush 34, contact segment 88, conductors 89 and 90, the contactc strip B, brush 24 and contact strip C on control device 23, and conductors 75 and 50, to supply conductor L2.

The closing of the contact member *b* on the relay 11 serves to shunt the resistor section DR from the circuit previously traced for the field winding DGF, thereby allowing full line voltage to be supplied to the generator field winding DGF to cause generator DG to operate the door motor DM at high speed.

The door motor DM, being operated in a counterclockwise direction at high speed, rotates the driving sheave 22 in a counter-clockwise direction and thereby causes the rope 20 to move in a counter-clockwise direction. Inasmuch as the rope 20 has been gripped by the energized clutch 18 on the outer end of the lever 17, the movement of the rope will operate the lever to open the door at high speed.

As the door 15 moves toward its open position, the brush 24 attached to the door and forming part of the controlling device 23 will be moved along over the contact strips A, B and C. As shown, the contact strip B extends throughout the movement of the door except for the last few inches of movement toward open position. Therefore, inasmuch as the contact strip B is connected in the circuit for the coil of the high-speed door relay 11, when the brush 24 moves off the end of the contact strip B, the high-speed door relay 11 is deenergized to open its contact members *b* for reinserting the resistor DR in circuit with the field winding DGF of the generator DG, thereby decelerating the door-operating motor DM and slowing down the movement of the door 15.

It will be observed that reinsertion of resistor DR in the circuit for field winding DGF lowers the voltage output of generator DG and causes a regenerative-braking effect to be applied to the door-operating motor DM. We propose to utilize this regenerative braking to check the movements of the door at the ends of travel and we are thus enabled to dispense with dash pots or other retarding devices to bring the doors to rest when fully opened or closed.

It will also be noted that the contact strip A on the controlling device 23 extends substantially through the full distance of the door movement but ends at such point that the door will be completely open before the brush 24 carried thereby moves off the contact strip A. Inasmuch as the contact strip A is connected in the circuit for the coil of the door-opening relay 10, when the door arrives at its full-open position, and the brush 24 moves beyond the cutoff end of the contact strip A, the relay 10 will be deenergized to open its contact members *a* and *b*, thereby deenergizing the field winding DGF of the generator DG and stopping the door-operating motor DM.

At the same time, the closing of the contact members *c* on the relay 10 will energize the demagnetizing winding DGF' to prevent the generator DG from overrunning by way of a circuit that extends from the brush 91 of the generator DG through conductor 92, the contact members *c* of door-opening relay 10, conductor 93, the contact members *c* of door-closing relay 12, conductor 94, the winding DGF' and conductor 95 to the brush 96 of the generator DG.

During the operation of the door-opening apparatus, the car C is slowly approaching the second floor and finally comes to a stop as the door reaches its full-open position. The length and position of the contact strips (64 and 72 for instance) on the floor selector FS may be selected to start the opening of the door at any point desired as the car approaches a stop at a floor. However, it should be kept in mind that the clutch contact segment 64 should be slightly longer than the door-opening contact 72 to cause the rope to be gripped by the clutch before it is moved.

It will be noted that the door contact strip 72 ends at the dotted line representing the second floor and, therefore, that the door-opening relay 10 cannot be reenergized to open the door after the car leaves the second floor while descending until it approaches the first floor.

It should also be noted that the clutch 18 will remain energized while the car is standing at the second floor by reason of the closed position of the contact members *c* on the high-speed relay HR and further, that the car cannot be started from the second floor until the door 15 and its interlocking contact members 48 are closed.

Assuming now that the stop at the second floor is completed and that the attendant, desiring to restart the car again, moves the car switch CS in a clockwise direction, then, inasmuch as the brush 24 is off the contact strips A and B but is in engagement with the contact strips C and D on the controlling device 23, a circuit will be completed for energizing the door-closing relay 12 to cause the door 15 to close, which circuit extends from supply conductor L1, through conductor 40, the contact members 41, 42 and 97 of the car switch CS, conductor 98, the coil of door-closing relay 12 and conductor 99, and thence, in series, through the normally closed contact members *c* of the "up"-direction switch 1 and the normally closed contact members *c* of the "down"-direction switch 2, conductors 100 and 101, floor selector brush 33, contact segment 102, conductor 103 and 104, the contact strip E, the contact brush 24 and contact strip C on controlling device 23, and conductors 75 and 50, to supply conductor L2.

The closing of the contact members *a* and *b* on the door-closing relay 12 energizes field winding DGF of the generator with current in a reverse direction by way of a circuit that extends from supply conductor L1, through conductors 40 and 105, the contact members *a* of relay 12, conductor 79, the field winding DGF, conductors 78 and 106, the contact members *b* of relay 12, conductors 107 and 81, resistor DR and conductor 82, to supply conductor L2. The energization of the field winding DGF causes the generator DG to supply current in a reverse direction to the door-operating motor DM for running that motor in a clockwise direction.

The closing of the contact members *d* on the relay 12 completes a circuit for energizing the coil of the high-speed door relay 13 for closing the door at high speed by way of a circuit that extends from the supply conductor L1, through conductor 83, contact member *d* of relay 12, conductor 108, the coil of relay 13, conductor 109, the contact members *a* of relay 11, conductors 110 and 111, the brush 32 and contact strip 112 of the floor selector, conductor 113, contact strip D, brush 24 and contact strip C of the controlling device 23, and conductors 75 and 50, to supply conductor L2.

The closing of the contact members *b* on the high speed door relay 13 serves to shunt the resistor DR from the circuit previously traced for the field winding DGF, thereby allowing full line voltage to be supplied to the winding DGF to cause the door 15 to close at high speed.

As the door nears its completely closed position, the contact brush 24 runs off the contact strip D which is connected in circuit with the coil of the high-speed relay 13 and thereby deenergizes the relay 13 to open its contact members *b* for reinserting the resistor DR in the circuit previously traced for the field winding DGF of the generator DG for slowing the door as it approaches its closed position.

As the door continues to, and reaches, its fully-closed position, the contact brush 24 runs off the contact strip E which is connected in circuit with the coil of the door-closing relay 12 and thereby deenergizes relay 12 to open its contact members *a* and *b* for deenergizing the field winding DGF of the generator DG to effect the stopping of the door motor DM.

The closing of the contact members *c* of the relay 12 completes a circuit, as previously traced, for energizing the demagnetizing winding DGF' for deenergizing the generator DG and preventing it from overrunning.

When the door 15 reaches its closed position, the door-interlocking contact members 48 close, and the "down"-direction switch 2 is energized through the circuit previously traced in starting the car, and the car starts downwardly. Further operation of the car will not be given as it may be stopped at the bottom floor and at other floors in the manner already described.

Thus, it will be seen that we have provided an elevator in which the doors may be opened at high speed as the car approaches its stops and will be closed at high speed when the car is conditioned to leave its stops, regardless of sticking or binding of the doors in their tracks. It will also be seen that, by reason of the speed of the door-operating motor being controlled by the movement of the door, no dash pots will be required to decelerate the door and bring it gently to a stop.

While we have illustrated and described only one specific embodiment of our invention, we realize that it is susceptible of wide application and we do not desire to be limited to the precise system illustrated and described.

We claim as our invention:

1. In an elevator system, a car operable in a hatchway; a motor for driving said car; means for controlling said motor; a plurality of doors in said hatchway; a door motor having an armature and a field winding; mechanism for controlling said door motor to move any one of said doors between predetermined limit positions, including means for applying a voltage to said armature; means responsive to the position of said car for initiating operation of said mechanism to move any selected one of said doors when said car is in a predetermined position with reference to said selected door; and means respon-

sive to the position of said selected door for controlling said mechanism to establish connections of said door motor such that said field winding is energized, said voltage is zero and said armature is included in a local circuit, when said selected door is in a limit position, whereby said selected door is brought to rest by dynamic braking.

2. In an elevator system, the combination of a car for serving a plurality of hatchway doors, a single door motor, a dynamic braking means for the motor, means operably responsive to operation of the car for effecting the selection of a particular door to be operated, and means operable in accordance with the position of the particular door operated to effect operation of the dynamic brake means.

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