Nov. 7, 1933. C. E. ELLIS, JR., ET AL 1,934,590

AUTOMATIC DOOR OPENING APPARATUS

Filed Jan. 11, 1930 2 Sheets-Sheet 1

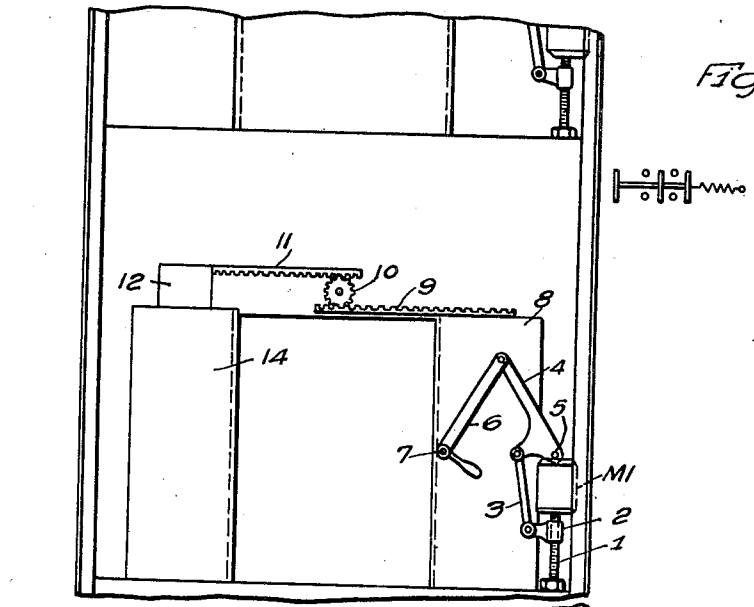

Fig. 1.

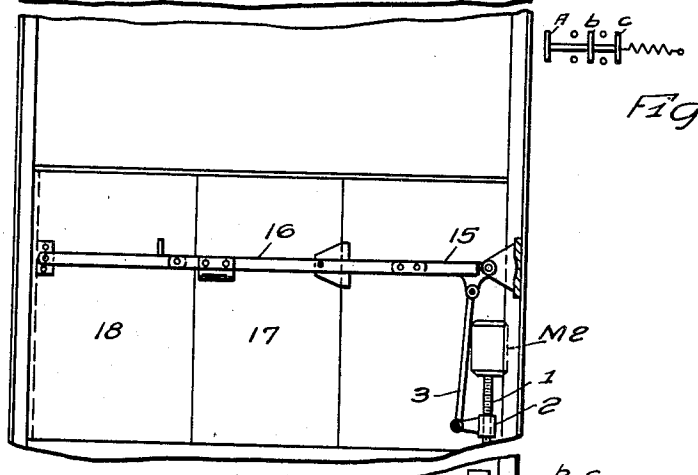

Fig. 2.

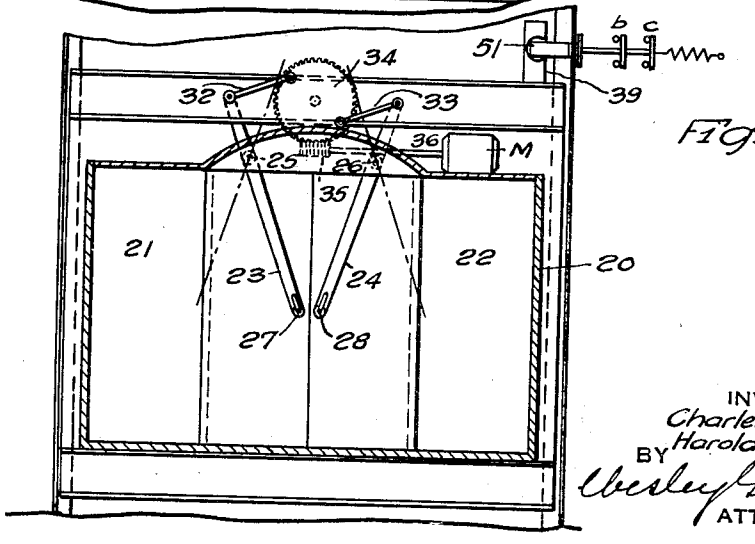

Fig. 3.

INVENTORS
Charles E. Ellis Jr. &
Harold V. McCormick.
BY
Oberlin & Clark
ATTORNEY

Nov. 7, 1933. C. E. ELLIS, JR., ET AL 1,934,590

AUTOMATIC DOOR OPENING APPARATUS

Filed Jan. 11, 1930 2 Sheets-Sheet 2

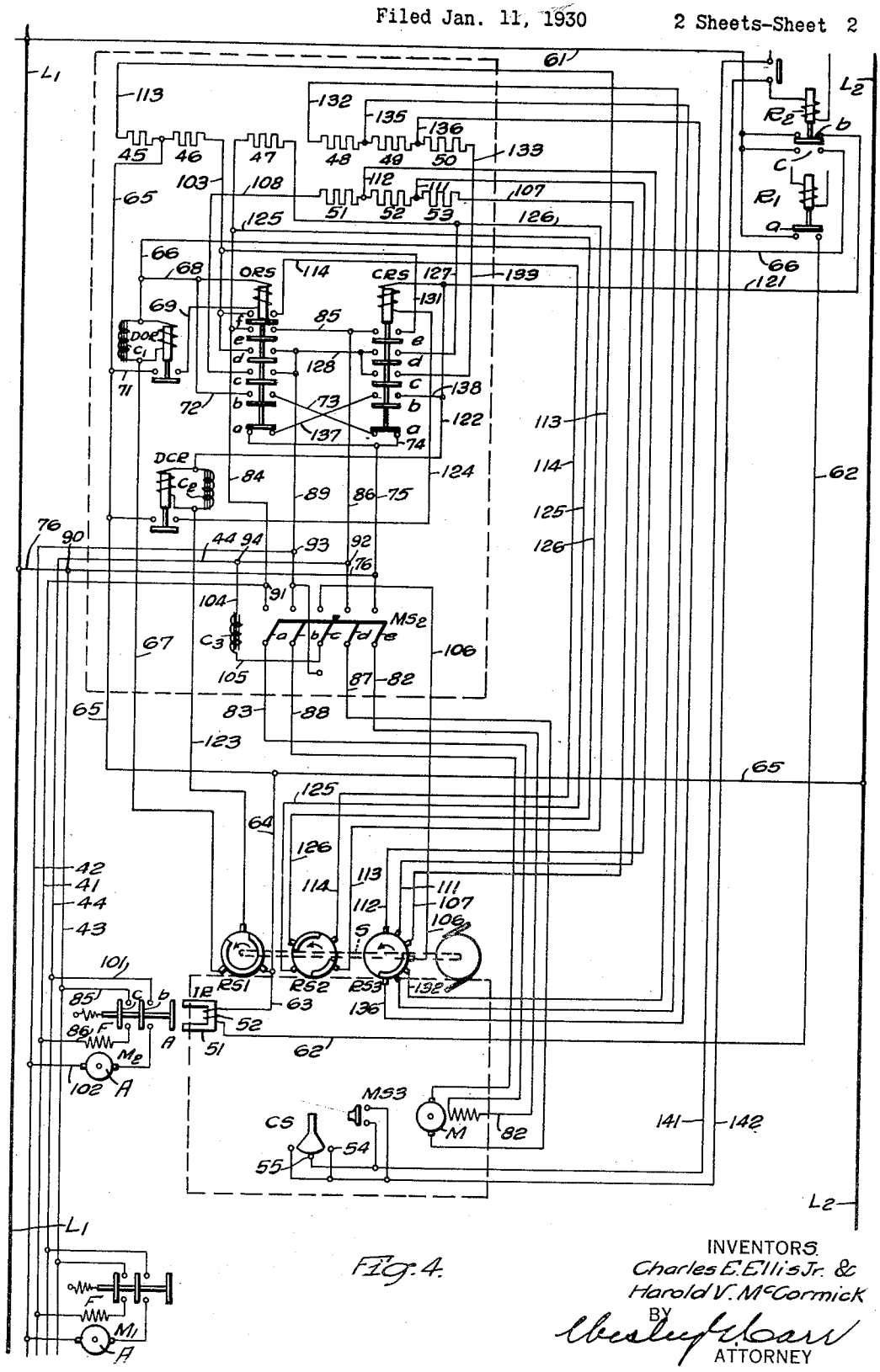

Fig. 4.

INVENTORS
Charles E. Ellis Jr. &
Harold V. McCormick
BY
ATTORNEY

Patented Nov. 7, 1933 1,934,590

UNITED STATES PATENT OFFICE

1,934,590

AUTOMATIC DOOR OPENING APPARATUS

Charles E. Ellis, Jr., Mahwah, N. J., and Harold V. McCormick, Long Beach, N. Y., assignors, by mesne assignments, to Westinghouse Electric Elevator Company, Chicago, Ill., a corporation of Illinois

Application January 11, 1930. Serial No. 420,092

27 Claims. (Cl. 187—54)

Our invention relates to automatic door-opening apparatus and has particular relation to apparatus for automatically opening a door in response to the performance of some separate act, preliminary to the stopping of an elevator car opposite a shaft door which is to be opened for the purpose of discharging or taking aboard passengers.

The principal object of our invention is to provide apparatus which automatically opens a door in an elevator shaft when the corresponding car comes to rest, is about to come to rest or has initiated some movement to come to rest at the particular floor individual to the said shaft door.

Another object of this invention is to provide apparatus of the character described in which the shaft door and the gate of the car are automatically operated in unison during both opening and closing operations, whether or not either of these operations is immediately under manual or automatic control.

A further object of our invention is to provide an operating motor for the car gate, a separate motor for operating each hatch door, and selecting means whereby the gate-operating motor and any selected one of the hatch-door motors may be simultaneously operated without mechanical connection therebetween.

Another object is to provide a system such that a single set of control apparatus may be used for controlling the operation of the car motor and any one of the hatch-door motors which has been selected for simultaneous operation therewith, whereby it is unnecessary to provide an independent set of control apparatus for each hatch-door motor.

It is also an object of our invention to provide a system of the above character wherein the selecting means operates automatically to select the hatch-door motor at the floor where the car is preparing to stop.

A further object of our invention is the provision of such control system that suitable resistance and inductance will be connected into the motor circuits to cause simultaneous dynamic braking of both motors as the doors near the extreme positions, to prevent slamming.

Another object of our invention is to provide a separate door-opening-and-closing motor for each shaft door at each floor of the building served by the elevator, whereby the failure or breakage of one motor does not affect the operativeness of the other shaft doors and allows the door having the inoperative motor to be opened manually by the operator of the car in the usual way.

Another object of our invention is to provide an elevator-door-operating system which will open the car gate and one of the hatchway doors automatically upon the juxtaposition of the car adjacent thereto, preparatory to stopping, in which there will be no mechanical connection between the car and the hatchway, which will operate quietly and smoothly, and in which a single set of control apparatus will be used, irrespective of which hatch door is opened.

Another object of our invention is to provide a motorized door-opening device which may be applied as a unit to any existing door-actuating mechanism.

Other objects of the invention will become apparent upon examination of the preferred embodiment thereof which is described in connection with the accompanying drawings, in which

Figure 1 is a view, in elevation, of a portion of an elevator shaft having a door which is shown in the open position.

Fig. 2 is a view, in elevation, of a portion of an elevator shaft having a door which is shown in the closed position.

Fig. 3 is a view, in elevation, of a portion of an elevator car having the car gate in closed position.

Fig. 4 is a diagrammatic view which illustrates the wiring of an elevator-door-operating system in accordance with our invention.

In the preferred embodiment of our hatch-door operating mechanism, as shown in Fig. 1, we provide a motor door-operating unit in conjunction with each hatch-door. This door-operating unit comprises a vertically mounted motor M_1 or the motor M_2 driving a screw threaded shaft 1 having mounted thereon a co-operating threaded nut member 2 which will be carried toward or away from the motor, depending upon the direction of rotation of the motor as is more fully disclosed in the application of Harold V. McCormick, Serial No. 473,850, filed August 8, 1930, resulting in Patent 1,909,063, issued May 16, 1933 and assigned by mesne assignments to Westinghouse Electric Elevator Company. Pivotally connected to the nut 2 is a link member 3 the other end of which is pivotally connected to the usual toggle door-opening device. In mechanism of the type shown in connection with motor M_1, the link member 3 is connected to the lever 4 mounted on a stationary pivot 5 at the other side of the motor. Movement of the nut 2 along the screw threaded shaft 1 is transmitted to the lever 4 through the link 3, causing the free end of the lever to swing

through an arc. The free end of lever 4 is pivotally connected to one end of a link 6 the other end of which, in the first modification, is pivotally jointed to one panel 8 of the two-panel door which is slidably mounted in guides in the usual manner. As the free end of lever 4 swings through an arc, in response to movement of the nut 2 along the shaft 1, the door panel 8 will be pulled to open position by the link 6. A rack gear 9 is joined to the door panel 8 and is extended to engage pinion 10 mounted on a stationary bearing. A rack gear 11 is carried on a bracket 12 by the other door panel 14 (which constitutes the other half of the door) and is extended to engage the side of the stationary pinion 10 opposite that engaged by 9, whereby motion will be imparted to panel 14 in a direction opposite to that of panel 4. As shown in Fig. 1, the hatch door is in its fully open position, the panels 8 and 14 having been moved to their extreme outward positions. In the door of the type shown in Fig. 2, in connection with motor M2 the link 3 is connected to the pivoted end of a lever 15 the free end of which is connected to lever 16 which causes the telescoping of panels 17 and 18 and moves them away from the passageway to be exposed.

In Fig. 3, an elevator car 20 is shown carrying a motor M for operating the gate thereof. The car gate consists also of two slidably mounted panels 21 and 22 movable in opposite directions in a manner similar to the hatch doors, although the actuating mechanism differs somewhat. Two levers 23 and 24 are mounted on pivots 25 and 26 stationary on the car. One end of each pivoted lever is slidably connected to a panel of the gate, as at 27 and 28, and the opposite ends are connected, through link members 32 and 33, to diametrically opposite points on a worm wheel 34 mounted on the car. The motor M drives the worm wheel 34 through a worm 35 in engagement therewith and mounted on the motor shaft. As shown, the panels of the car gate are in closed position. However, as the wheel 34 is rotated in a clockwise direction by its driving motor M, the levers 23 and 24 will be rocked about their pivot points 25 and 26, thereby pushing the gate panels apart to the open position which, with the corresponding position of the other elements, is represented by dotted lines. Rotation of the motor in the opposite direction will move the gate panels together to the closed position.

The coil structure 51 of an inductor relay is also carried by the car on a suitable supporting member 39 in such position that it may cooperate with various armature members A arranged along the hatchway. The armature A will be attracted by the coil and will close contacts *b* and *c*, when adjacent thereto, as shown in Fig. 3. The armatures A and the contacts *b* and *c* are normally biased toward the open position by a spring, as shown, or in any other suitable manner. Rotary switches RS1, RS2 and RS3 are also carried by the car, as shown in Fig. 4, but no attempt is made to show them in Fig. 3, since the drawing would be unnecessarily complicated thereby.

In Fig. 4, the complete door-motor-controlling system is shown diagrammatically. At the lower left-hand corner of this diagram we have shown the hatchway motors designated as M_1, M_2, etc. An independent motor-actuating unit being provided for each hatchway door, there are as many motors as there are floors. The specific mechanism through which these motors actuate the doors is disclosed in Figs. 1, 2 and 3.

As shown in Fig. 4, one end of each field winding F and one side of each armature A are permanently connected to conductors 41 and 42, respectively. The other connections from each motor are controlled through an inductor relay IR, one part of which is mounted in the hatchway and the other part of which is carried by the elevator car in such position that it will be brought into adjacent cooperating relation with the portion mounted in the hatchway at any particular floor, as the car approaches that floor. The portion of relay IR mounted in the hatchway at each floor includes the fixed contacts, the movable contacts, and the armature A for moving the latter into engagement with the former. The portion carried by the car includes the magnetizable coil or field structure 51 of the relay and the winding 52 for energizing the same. As shown, the connections from this side of the motor are normally open circuited at the contacts of inductor relays, but, when a car approaches any particular floor, with its coil 51 energized, the armature A of the inductor relay at that floor will be moved over, thereby closing the contacts *b* and *c* and connecting the open ends of the motor field and armature windings to conductors 43 and 44, respectively.

At the upper left-hand portion of Fig. 4, the various apparatus essential to the door-controlling system is shown assembled for convenience upon a board which is outlined by broken lines. Mounted on this board is a manually actuated switch MS_2 which, when up, connects the system for normal automatic operation. The switches ORS and CRS are the reversing switches which control the energization of the motors in the proper direction for opening and closing, respectively. The one or the other of these reversing switches ORS or CRS is energized in response to the actuation of relay DOR and relay DCR, respectively. It will be observed that a choke coil C_1 is connected in parallel with the winding of relay DOR and another choke coil C_2 is similarly associated with relay DCR. The decay of flux in the choke coil will keep its associated relay winding energized for an interval of time after the relay circuit has been opened, whereby the energization of the motor is likewise maintained, thereby ensuring the complete opening or closing of the doors. Choke coils of about 29 henrys inductance have been found satisfactory for this purpose.

At the top of the board are shown various sections of resistance 45 through 53, which are connected into the motor circuits, at various stages of the operation, to check the speed of the motors, increase the torque, permit operation without acceleration, etc. at various stages of opening and closing the door. At the lower central portion of Fig. 4, a choke coil C_3 of about 14 henrys is also used in conjunction with the resistance for checking the motors.

In Fig. 4, on the lower portion of the drawings, we have shown, by broken lines, the outline of the elevator car. This may be a conventional elevator car supported in the usual manner (not shown) and controlled either manually or automatically by a conventional elevator-control system (not shown). Carried by the car, is a motor M which actuates the car gate through mechanism disclosed in Fig. 3. Also mounted on the elevator car are rotary switches RS1, RS2 and RS3 which are all mounted on a common shaft S connected to the car-gate-actuating mechanism whereby they are rotated in unison as the gate is opened or closed and whereby the position of the switches, at any instant, corresponds to the posi-

tion of the car gate at that time. These switches are shown in the drawings in the position they will assume when the gate is in its closed position. When the gate opens, the switches will turn in the direction indicated by the arrows. The switches RS1, RS2 and RS3 control the connection of the resistance elements 45 through 53 and the choke coil C_3 in the motor circuits for controlling the operation of the motors. Inasmuch as the switches are operated by the car gate mechanism connected to the motor M, that motor acts as a controlling motor as well as a car gate motor. A manually actuable switch MS3 is provided on the car, and contacts 54 and 55 are also located on the car adjacent to the car switch CS for controlling the closing of the doors, either manually or automatically, as desired. A portion of the inductor relay IR, as previously described, is carried by the car and mounted in such position that it will be brought into and out of cooperating relation with the armature A mounted in the hatchway.

In the upper right-hand corner of the drawings are shown two relays R_1 and R_2 which control the initiation of the door-opening-and-closing operation. The windings of both these relays are so connected to the control apparatus for the elevator car that they are normally energized when the car is in motion, whereby the contact members "*a*" of relay R_1 are open, the contact members *b* of relay R_2 are closed, and contact members *c* of R_2 are open, as shown in the drawings. The winding of relay R_1 is so interconnected with the elevator-control system that it will be deenergized as the car reduces its speed and approaches a floor for landing. This energizes the inductor relay coil to select the particular hatch-door motor which is to be operated and will preferably occur when the car is about 3 feet from the floor. The winding of the other relay R_2 is so interconnected that it will be deenergized as the car approaches the floor slowly for leveling and, preferably, about 7 inches from the floor. This simultaneously energizes the selected hatch-door motor and the car motor.

Our invention, however, is more readily understood when considered in connection with an assumed operation thereof. Assuming that the car is traveling at full speed, the various elements of the system will occupy the positions shown in drawings. The car reduces its speed as it approaches a floor to discharge or take on passengers. As it does so, certain relays on the elevator control board (not shown) drop out and, as a result, the winding of relay R_1 is deenergized, as previously described, thereby closing contacts *a*. The closing of contacts *a* completes a circuit through the coil 52 of the inductor relay IR. This circuit, starting from the main line at conductor L_1, is as follows: from conductor L_1, through conductor 61, contacts *a*, and conductor 62, to the winding 52 of the inductor relay, from the other side of winding 52, through conductors 63, 64 and 65, to the other line conductor L_2. The inductor relay winding 52, having been energized, will attract the armature A at the adjacent floor as soon as it is carried into attractive relation therewith. The movement of armature A will actuate the contacts in connection therewith to prepare the circuit of the hatch-door motor at that floor. As the car approaches within a few inches of the floor and slows up to leveling speed, the winding of relay R_2 will be deenergized, thereby closing its contacts *c* and energizing the motors through circuits which extend from conductors L_1 and 61, contacts *c*, conductor 66, winding of door-opening relay DOR and choke coil C_1 in parallel therewith and conductor 67, to the finger of the rotary switch RS1, through the ring conductor, to the other finger in engagement therewith, then, by way of conductors 64 and 65, to L_2. The winding of relay DOR, having been energized, its armature will be pulled up to close the contacts in conjunction therewith. This will energize the winding of the opening reversing switch ORS by the following circuit: from conductor 66 (which, as previously traced, is now energized from L_1 through contacts C of R_2) by way of conductor 68, through the winding of ORS, to conductor 69, through the contacts of DOR, and, by way of conductors 71 and 65, to line L_2.

As a result of the energization of the winding of the relay ORS, its armature will pull up to open its normally closed contacts *a* and to close all its normally open contacts *b*, *c*, *d* and *e*. The closing of contacts *b* completes a holding circuit for relays DOR and ORS from line L_1, by way of conductors 76, 75 and 74, contacts *a* of CRS, conductor 73, contacts "*b*" of ORS and conductor 72, to conductor 63 and thence through the coils of relays DOR and ORS as previously described. The holding circuit just traced is in shunt to the circuit from L_1, through contacts *c* of relay R_2, whereby the operation of the door-opening system will continue, once it is started, irrespective of the condition of contacts *c* thereafter. The closing of contacts "*e*" of relay ORS completes a circuit for energizing the car motor and the selected hatch door motor simultaneously, which may be traced as follows: from conductor L_1, through conductors 76, 75, blade *e* of manually actuable switch MS_2, conductor 82, the field winding of the car motor M, conductor 83 and blade *a* of switch MS_2, to conductor 84. The field winding of the hatch motor is simultaneously connected in parallel therewith through a circuit which extends from junction point 90 on conductor 76, through conductors 43 and 85, closed contact members *c* of IR, the field winding F and conductors 86 and 41, to junction point 91 on conductor 84. Since these circuits may both be traced from junction point 90, through the field winding, to junction point 91, they are in parallel. From conductor 84, we may continue to trace the motor circuit, through contact member "*e*" of relay ORS, conductors 85 and 86, switch MS_2, conductor 87, armature of car motor M, conductor 88 and switch MS_2, to conductor 89. Returning to conductor 86, a parallel circuit for the armature of the hatch motor may be traced from junction point 92 on conductor 86, through conductors 44 and 101 and contact members *b*, to the armature of motor M_2 and, from the other side of the armature, by way of conductors 102 and 42, to junction point 93 on conductor 89. From conductor 89, the circuit continues, through contact members *d*, conductor 103, 40 ohm resistance 46 and conductor 65, to line L_2.

From the circuits traced, it will be understood that the two motors are energized simultaneously, with their field windings in parallel or shunt to each other and their armatures in parallel but in series relation to the field windings. An effect of this interconnected parallel relation of the motors is that they will tend to operate at the same speed, whereby the hatch door and car gate will be opened or closed at the same speed.

The motors will now operate simultaneously, moving the hatch door and the car gate toward

the open position. As the doors move, the rotary switches RS1, RS2, and RS3 will be rotated in the direction indicated by the arrows. As soon as the doors are about half opened, the rotary switch RS3 will have been rotated far enough to bring the conducting ring into engagement with the nearest disengaged finger. A circuit will then be completed to connect the choke coil C_3 and three 10-ohm resistance elements 51, 52 and 53 in shunt to the motor armatures for checking the motors to prevent slamming of the doors. As the motion of the doors continues, the resistance elements 52 and 53 are shunted out until, as the doors approach the extreme open position, the coil C_3 is in shunt to the armature having only one 10-ohm resistance 51 in series therewith, and the doors will be moved smoothly to the extreme position without slamming. As the doors near the extreme position, the 40-ohm resistance 46, which has been in series with the motors, is bypassed by connecting the 10-ohm resistance 45 in shunt thereto for the purpose of increasing the torque of the motors. The purpose of so increasing the torque of the motors is to compensate for the increasing mechanical disadvantage at which the motors work because of the characteristics of the door-actuating mechanism.

The circuit by which the checking resistance elements are connected in parallel with the motor armature will now be traced. Starting from one side of the armature of the hatch-door motor M_2, the circuit extends through the closed contact members *b* of the inductor relay IR, conductors 101 and 44 to junction point 94 thereon, through conductor 104, choke coil C_3, conductor 105, blade *c* of the manually actuable switch MS_2, through conductor 106, to the center finger of the rotary switch RS3, through the conducting ring thereof to the next finger above, which will now be engaged by the ring because of the rotation of the switch RS3. The circuit continues up through conductor 107, through the three 10-ohm resistance elements 53, 52 and 51 in series, through conductor 108, to contact members *c* of relay ORS, through conductor 89 to junction point 93 and, by way of conductors 42 and 102, to the other side of the armature. As the switch RS3 continues to rotate, the conducting ring will be brought into conductive relation to conductors 111 and 112 which successively shunt out resistance elements 52 and 53, whereby, in the extreme position the choke coil C_3, in series with resistance 51, alone will be shunted across the armature. These checking resistances will also be connected in shunt to the armature of the car motor M, since, as previously explained, the armatures are in parallel with each other. The circuit for shunting the 40-ohm series resistance element 46, through the 10-ohm resistor element 45 may be traced as follows: from the end of 40-ohm resistor 46, through the 10-ohm resistor 45 to conductor 113, through the conducting ring of rotary switch RS2 and return by conductor 114 and the contact members *f* of relay ORS to the other side of the 40-ohm resistance 46.

When the door has approximately reached the fully open position, rotary switch RS1 will have been turned to such position that the circuit from relay DOR, through conductors 67 and 64, will be opened at the fingers of the switch for deenergizing the motors. It is important, however, that the motors remain energized for a brief interval of time after this relay circuit is opened in order to insure that both doors shall be forced into the extreme positions. This is accomplished by means of the choke coil C_1, connected in parallel with the winding of the relay, as previously explained in describing the apparatus used. It is readily possible to provide a magnetic decay relay instead of relay DOR and the choke coil in parallel therewith, if desired.

Assuming now that the operator wishes to close the door, he may accomplish this by depressing push button MS3 on the car or by turning his car switch from the center position which will bridge the conductors 141 and 142 thereby closing the break in the circuit to the winding of relay R_2. The relay R_2 will then open its contact members *c* and close its contact members *b*. The closing operation for the doors is almost exactly like the opening operation except that, after the motors are started and the doors are about 40% closed, an additional resistance of about 25 ohms, termed the "safety resistance", is cut in series into the motor circuit which only permits the motors to keep moving without accelerating. The control of the excitation of the motors is now through the reversing switch CRS controlled by relay DCR and will be in such direction that the motor will be reversed. The circuits for the door-closing operation will now be completely traced.

Assuming that the contact members *b* of relay R_2 has been closed, a circuit will be completed from L_1, 61, contact member *b*, 121, 122, door-closing relay DCR and its associated choke coil C_2, conductor 123, conducting ring of switch RS1, conductors 64, 65 and L_2. Relay DCR will then pull up to complete a circuit for the winding of switch CRS from conductor 121, by way of conductor 124, through its contacts to conductors 65 and L_2, whereby the winding of closing reversing switch CRS is now energized. Switch CRS now pulls up to separate its contact members *a* and to close contact members *b*, *c*, *d* and *e*. The motors are now energized through circuits extending from line conductor L_1, through conductor 76, to junction point 90 from which two circuits branch off through the motor field windings in parallel and join again at junction point 91, as previously traced in connection with the opening circuit of the doors. From point 91, the circuit extends along conductors 84 and 125 to the fingers and conducting ring RS2 (which is now in door-open position and serves to shunt out the 25-ohm resistance 47), returning by conductor 126 to conductor 127, then, through contact members *d*, conductor 128 and conductor 89, to junction point 93. From junction point 93, two circuits branch off in parallel relation through the motor armatures to join again at junction point 92, as previously traced in the door-opening operation. However, the circuit previously traced for the opening operation went from point 92 to point 93, whereas it is now traced from point 93 to point 92, hence the armatures are energized in the opposite direction, and the motors will rotate in the proper direction to close the door. From point 92, the motor circuit is completed through conductors 86 and 85, through contact members *e* of relay CRS by way of conductors 131, 114, 103, resistance 46 and conductor 65, to line L_2. The relay CRS closes a self-holding circuit for itself from conductor L_1, through conductors 76, 75 and 74, contact members *a* of relay ORS, conductor 137, contact members *b* of relay CRS, conductors 138, 122 and 121 to the winding of relay CRS. This circuit, being

in shunt to contact members b of relay R_2, will maintain the circuit for relay CRS, irrespective of the position of the contacts of relay R_2. When the doors have been moved a certain distance toward the closed position, the rotary switch RS2 will be turned in a direction, opposite to that shown by the arrows, to such position that the shunt around the safety resistance 47, through conductors 125 and 126, will be broken and its resistance will be inserted into the motor circuit. This resistance is such that it will merely permit the doors to keep moving without accelerating.

As the doors move toward the closed position, the conducting ring of switch RS3 will be turned, in a direction opposite to the arrow, to such position that a connection will be established from the center brush to the one next below it which will cut in the first step of checking resistance in series with the choke coil C_3 across the motor armatures. This circuit may be traced from junction point 93, which is at one side of both armatures, through conductors 39 and 128, contacts c of relay CRS, conductor 133, resistances 50, 49 and 48, conductor 132, the brush ending conductor 132 on switch RS3, the conducting ring, the center brush, conductor 106, blade c, conductor 105, choke coil C_3, conductor 104, junction point 94 and conductor 44 to junction 92. As switch RS3 continues to rotate, its conducting ring will make conductive connection with conductors successively, thereby shunting out resistance elements 48 and 49 and, as the doors near the extreme closed position, only one resistance element 50, in series with the choke coil C_3, will be in shunt to the armatures, thereby bringing the doors smoothly into the closed position.

As the doors come to the full closed position, the rotary switch RS1 will have been turned in a direction opposite to the arrow to such position that the circuit for the relay DCR, by way of conductor 123, will be broken at its brushes. However, the relay will not release immediately but will be held up for a certain interval of time by the decay of flux in choke coil C_2, in the same manner as previously set forth in connection with relay DOR and coil C_1. This will ensure that the doors are positively closed. When DCR releases, the winding of relay CRS will be deenergized and will release, thereby opening the motor circuits. The rotary switch RS1 has now prepared a circuit from conductor 67 to conductor 64, whereby relay DOR may next be energized when it is desired to open the doors.

We have now considered an operation of the door-opening system beginning with the approach of a car to a floor and have seen that, as some act is initiated to bring the car to a stop, a selecting means is rendered operative to prepare the circuit of the hatch-door motor at that particular floor, and that, later, the car-door motor and the selected hatchdoor motor are energized simultaneously to open the car gate and the hatch door at the same time. As the doors approach the open position, dynamic braking means become effective to check the speed of both motors simultaneously, and a booster resistance is cut into to increase the torque of the motors. When the doors reach the open position, the motors are automatically deenergized, but not until a certain predetermined time afterward.

The doors, when opened, remained so until some act is initiated to start the car from the floor or as the result of a separate manual act by the operator when the motors were again energized but in the reverse direction and the doors are moved toward the closed position. As the doors approach the closed position, dynamic braking again becomes effective to reduce the speed of the motors. On the closing operation, however, the booster resistance is not connected in for increasing the torque of the motors but, instead, a safety resistance is connected in series to merely permit the motors to continue moving without accelerating. In the extreme closed position, the motors are automatically deenergized, as in opening.

Furthermore, if an obstruction slows down the closing of either door, the other door and its motor will also slow down and the checking resistance elements will not be inserted or the power will not be cut off until the doors have moved to the positions where such operations should occur. This is true because the field winding of the car gate or controlling motor M is connected in shunt with the series field winding of the selected hatchway door motor. Since the hatchway door motor has series characteristics, any obstruction to the hatchway door will cause its motor to slow down and develop an increased torque to overcome the obstruction. This, of course, increases the time for closing of the door, and the car gate motor should be slowed down so as to allow more time before checking occurs and before power is finally cut off. This is accomplished with the connections employed, because, as the hatchway door motor slows down, it draws more current, which, passing through its series field, increases the voltage drop in this field, which, in turn, increases the voltage on the field of the car gate motor, causing it to slow down also, thereby allowing the increased time required.

The specific circuit connections, the specific resistances and inductances and the arrangement of contacts and location of parts herein set forth are merely to be taken as a disclosure of one embodiment of our invention, and we do not wish to be restricted thereby. It may be desirable, in adapting our system to various classes of service, to make some alterations in accordance therewith. We desire, therefore, that only such limitations shall be imposed as are set forth in the appended claims.

We claim as our invention:

1. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising an electric motor-operated unit for each hatchway door, an electric motor operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for connecting simultaneously the car motor and the selected one of the hatch-door motors in parallel interconnected relation to a source of electrical energy, whereby the hatch-door and the car gate will be actuated simultaneously.

2. In combination with an elevator car operable in a hatch-way having a door for each landing, an elevator-door-operating system comprising an electric motor-operated unit for each hatchway door, an electric motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, means for simultaneously connecting the car motor and the selected hatch-door motor to a source of electrical energy, whereby the hatch door and the car gate will be actuated simultaneously, means whereby said selecting means is rendered operative by the approach of the car to a stop at a floor, means whereby said connecting means is rendered operative in response to

deceleration of the car to the stop at the floor, and circuits for the simultaneously operated motors to interconnect them in parallel relation.

3. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising an electric motor-operated unit for each hatchway door, an electric motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for simultaneously connecting the car motor and the selected one of the hatch-door motors to a source of electrical energy whereby the hatch-door and the car gate will be actuated simultaneously, and means operably responsive to the operation of one of the motors for checking the speed of both motors as the doors approach the extreme position.

4. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising an electric-motor-operated unit for each hatchway door, an electric motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for simultaneously connecting the car motor and the selected one of the hatch-door motors in parallel interconnected relation to a source of electrical energy, whereby the hatch-door and the car gate will be actuated simultaneously, and means operably responsive to operation of one of the motors for checking the speed of both motors as the doors approach the extreme position.

5. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for energizing simultaneously the car motor and the selected one of the hatch-door motors in parallel interconnected relation, whereby the hatch-door and the car gate will be actuated simultaneously, means for checking the speed of the motors as the doors approach the extreme position comprising inductance and resistance elements and means for connecting various of said elements in parallel with the motor armatures.

6. In combination with an elevator car operable in a hatchway having a door for each landing, a motor carried by the elevator car to open or close the gate thereof, a motor mounted in the hatchway in connection with each hatch-door to open or close the same, selecting means for selecting the motor of a hatch-door being approached by the car for landing, means for energizing simultaneously the selected hatch-door motor and the car-gate motor whereby the door and the gate are opened simultaneously, means for checking the speed of the motors as the doors approach the open position, including resistors, and means for connecting various ones of the resistors in parallel to the motor armatures as the doors approach the open position, whereby the speed is checked progressively.

7. In combination with an elevator car movable in a hatchway having a door for each landing, a motor carried by the elevator car to open or close the gate thereof, a motor mounted in the hatchway in connection with each hatch-door to open or close the same, selecting means for selecting the motor of a hatch-door being approached by the car for landing, means for energizing simultaneously the selected hatch-door motor and the car-gate motor as the car slows at the floor, whereby the door and the gate are opened simultaneously, means for checking the speed of the motors as the doors approach the open position, including resistors and an inductance element, means for connecting various of the resistors in series with the inductance element and in parallel with the motor armatures as the doors approach the open position.

8. In combination with an elevator car operable in a hatch-way having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatch-way door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, means for energizing simultaneously the car motor and the selected hatch-door motor, whereby the hatch door and the car gate will be actuated simultaneously, means whereby said selecting means is rendered operative by some act or condition related or preliminary to the approach of the car to a floor for leveling, means whereby said energizing means is rendered operative in response to some act or condition related or preliminary to leveling at the floor, and such circuits for the simultaneously operated motors that they are in interconnected parallel relation, means for checking the speed of the motors as the doors approach the extreme position comprising an inductance element and resistance elements and means for connecting various of these elements in shunt to the motor armatures.

9. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising an electric motor-operated unit for each hatchway door, an electric motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for simultaneously connecting the car motor and the selected one of the hatch-door motors to a source of electrical energy, whereby the hatch-door and the car gate will be actuated simultaneously, and means operably responsive to operation of one of said motors for deenergizing both motors when the doors have been moved to the extreme position.

10. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising an electric motor-operated unit for each hatchway door, an electric motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for simultaneously connecting the car motor and the selected one of the hatch-door motors to a source of electrical energy, whereby the hatch door and the car gate will be actuated simultaneously, and means operably responsive to operation of one of the motors for checking the speed of both motors as the doors approach the extreme position and for deenergizing both motors when the doors have been moved to the extreme position.

11. In combination with an elevator car movable in a hatchway having a door for each landing, a motor carried by the elevator car to open or close the gate thereof, a motor mounted in the hatchway in connection with each hatch-door to open or close the same, selecting means for selecting the motor of a hatch-door being approached by the car for landing, means for energizing simultaneously the selected hatch-door

motor and the car-gate motor as the car slows at the floor, whereby the door and the gate are opened simultaneously, means for opening the control circuit of the motor-energizing means when the doors approach the open position, and means for holding the motor-energizing means in its operative position for a certain time interval after said circuit has been opened.

12. In combination with an elevator car operable in a hatch-way having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, means for energizing simultaneously the car motor and the selected hatch-door motor, whereby the hatch door and the car gate will be actuated simultaneously, means whereby said selecting means is rendered operative by some act or condition related to or preliminary to the approach of the car to a floor for leveling, means whereby said energizing means is rendered operative in response to some act or condition related or preliminary to leveling at the floor, means for opening the circuit of the motor-energizing means as the doors approach the extreme position, and additional means for maintaining the energization of the motor-energizing means for a short interval thereafter, whereby the movement of the doors to the extreme position is assured.

13. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for energizing simultaneously the car motor and the selected one of the hatch-door motors whereby the hatch door and the car gate will be actuated simultaneously, means for checking the speed of the motors as the doors approach the extreme position, means for opening the circuit of the motor-energizing means as the doors approach the extreme position, and additional means for holding the motor-energizing means in its operative position for a short interval thereafter, whereby the movement of the doors to the extreme position is assured.

14. In combination with an elevator car operable in a hatch-way having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatch-way door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, means for energizing simultaneously the car motor and the selected hatch-door motor, whereby the hatch door and the car gate will be actuated simultaneously, means whereby said selecting means is rendered operative by the approach of the car to a stop at a floor, means whereby said energizing means is rendered operative in response to deceleration of the car to the stop at the floor, means for checking the speed of the motors as the doors approach the open position, means for opening the control circuit of the motor-energizing means when the doors approach the open position, and means for holding the motor-energizing means in its operative position for a certain time interval after said circuit has been opened, whereby the movement of the doors to the extreme position is assured.

15. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatch-way door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, means for energizing simultaneously the car motor and the selected hatch-door motor, whereby the hatch door and the car gate will be actuated simultaneously, means whereby said selecting means is rendered operative by the approach of the car to a stop at a floor, means whereby said energizing means is rendered operative in response to deceleration of the car to the stop at the floor, means for checking the speed of the motors as the doors approach the open position, means for opening the control circuit of the motor-energizing means when the doors approach the open position, and means for holding the motor-energizing means in its operative position for a certain time interval after said circuit has been opened, whereby the movement of the doors to the extreme position is assured, and such circuits for the simultaneously energized motors that they are in interconnected parallel relation while operating.

16. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for energizing simultaneously the car motor and the selected one of the hatch-door motors, whereby the hatch-door and the car gate will be actuated simultaneously, means for increasing the potential impressed on the motors as the doors move toward the open position to increase the torque thereof.

17. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for energizing simultaneously the car motor and the selected one of the hatch-door motors whereby the hatch-door and the car gate will be actuated simultaneously, means for checking the speed of the motors as the doors approach the open position comprising elements adapted to be connected in shunt to the motor armatures and means for increasing the potential impressed upon the motors as they approach the open position for increasing the torque thereof.

18. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for energizing simultaneously the car motor and the selected one of the hatch-door motors, whereby the hatch-door and the car gate will be actuated simultaneously, means for checking the speed of the motors as the doors approach the open position comprising elements adapted to be connected in shunt to the motor armatures and means for increasing the potential impressed upon the motors as they approach the open position for increasing the torque thereof and means for opening the circuit of the motor-energizing means as the doors approach the open position.

19. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for energizing simultaneously the car motor and the selected one of the hatch-door motors, whereby the hatch-door and the car gate will be actuated simultaneously, means for checking the speed of the motors as the doors approach the open position comprising elements adapted to be connected in shunt to the motor armatures, and means for increasing the potential impressed upon the motors as they approach the open position for increasing the torque thereof, and means for opening the circuit of the motor-energizing means as the doors approach the open position, additional means for holding the motor-energizing means in its operative position for an interval of time after said circuit has been opened, whereby the movement of the doors to their extreme positions is assured.

20. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for energizing simultaneously the car motor and the selected one of the hatch door motors, whereby the hatch-door and the car gate will be actuated simultaneously, means for checking the speed of the motors as the doors approach the open position comprising elements adapted to be connected in shunt to the motor armatures, and means for increasing the potential impressed upon the motors as they approach the open position for increasing the torque thereof, and means for opening the circuit of the motor-energizing means as the doors approach the open position, additional means for holding the motor-energizing means in its operative position for an interval of time after said circuit has been opened, whereby the movement of the doors to their extreme positions is assured, and such circuits for the simultaneously operated motors that they are in interconnected parallel relation.

21. In combination with an elevator car operable in a hatchway having a door for each landing, an elevator-door-operating system comprising a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, and means for energizing simultaneously the car motor and the selected one of the hatch-door motors, whereby the hatch-door and the car gate will be opened simultaneously, means for deenergizing the motors when the doors approach the open position, additional energizing means for energizing the motors simultaneously for motion in the reverse direction, whereby the hatch-door and the car gate will be closed, and means actuated by the closing motion of the mechanism for reducing the potential applied to the motors, whereby the motors will continue to operate without accelerating.

22. In combination with an elevator car operable in a hatch-way having a door for each landing, a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for energizing the car motor and an adjacent hatch-way motor simultaneously in interconnected parallel circuits, whereby the car gate and the adjacent hatch door may be closed simultaneously, and means actuated in conjunction with the doors to insert such additional resistance in series with the motors that the motors will continue to operate without accelerating.

23. In combination with an elevator car operable in a hatchway having a door for each landing, a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for energizing the car motor and an adjacent hatchway motor simultaneously in interconnected parallel circuits, whereby the car gate and the adjacent hatch door may be closed simultaneously, means actuated in conjunction with the doors to insert such additional resistance in series with the motors that the motors will continue to operate without accelerating, additional means actuated in conjunction with the doors to check the speed of the motors as the doors approach the closed position.

24. In combination with an elevator car operable in a hatchway having a door for each landing, a motor-operated unit for each hatchway door, a motor-operated unit for the car gate, means for energizing the car motor and an adjacent hatchway motor simultaneously in interconnected parallel circuits, whereby the car gate and the adjacent hatch door may be closed simultaneously, means actuated in conjunction with the doors to insert such additional resistance in series with the motors that the motors will continue to operate without accelerating, additional means actuated in conjunction with the doors to check the speed of the motors as the doors approach the closed position, means for opening the circuit of the motor-energizing means when the doors have been moved to the extreme position, and means for holding said energizing means in its operative position for a certain interval of time after the circuit is opened.

25. In combination with an elevator car operable in a hatch-way having a door for each landing, an elevator-door-operating system comprising, a motor-operated unit for each hatch-way door, a motor-operated unit for the car gate, means for selecting and preparing a circuit for one of the hatch-door motors, means for energizing simultaneously the car motor and the selected hatch-door motor, whereby the hatch door and the car gate will be actuated simultaneously, means whereby said selecting means is rendered operative by the approach of the car to a stop at a floor, means whereby said energizing means is rendered operative in response to deceleration of the car to the stop at the floor, and such circuits for the simultaneously operated motors that they are in interconnected parallel relation, means for checking the speed and means for increasing the torque of the motor as the doors approach the open position, means for opening the circuit of the motor-energizing means when the doors have been moved to the open position and means for holding said energizing means in operative position for a certain interval of time after said circuit is opened, means for energizing said motors in interconnected parallel relation for motion in the reverse direction to close the doors, means actuated by the doors when moving toward the closed position to insert such additional resistance in series with the motors that they will continue to operate without accelerating, means actuated as the doors approach the closed position for pro-

gressively checking the speed of the motors, means for opening the circuit of the motor-energizing means when the doors are moved to the closed position, and means for holding the energizing means in the operative position for a certain interval of time after the circuit has been opened.

26. In an elevator door-operating system, a series motor operated unit for a hatchway door, a series motor for controlling the operation of the hatchway door motor, and circuits for said motors, said circuits including the connection of the series field of the controlling motor in shunt with the series field of the hatchway door motor to cause the motors to operate in unison.

27. In an elevator door-operating system, a series motor operated unit for a hatchway door, a series motor for controlling the operation of the hatchway door motor, circuits for said motors, said circuits including connection of the series field of the controlling motor in shunt with the series field of the hatchway door motor to cause the motors to operate in unison, a resistance element, and means operably responsive to operation of the controlling motor for including the resistance element in the said motor circuits to control the speed of said motors in accordance with the position of the hatchway door.

CHARLES E. ELLIS, JR.
HAROLD V. McCORMICK.