ELEVATOR SYSTEMS

Filed Sept. 27, 1956 9 Sheets-Sheet 1

Fig. I.

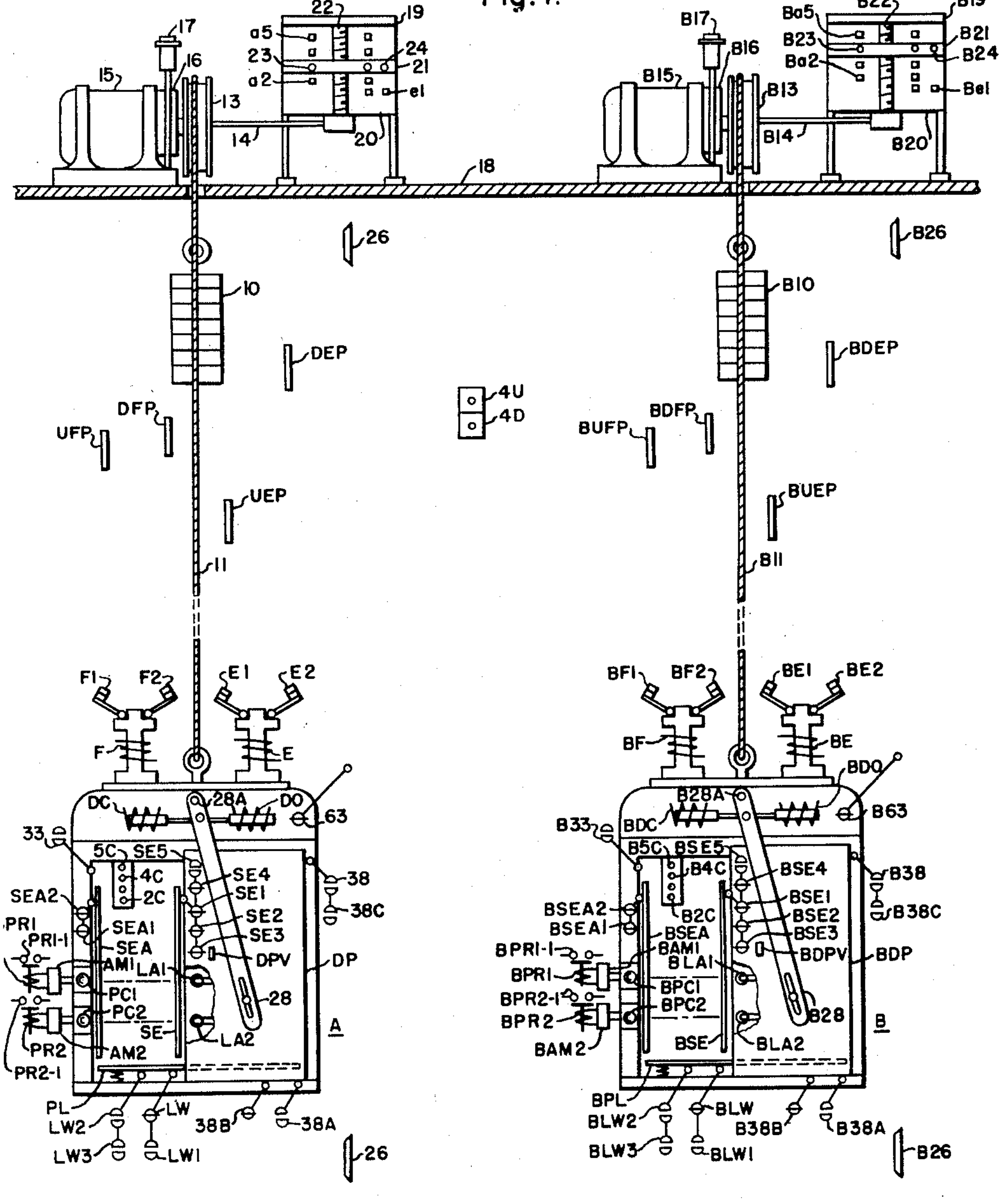
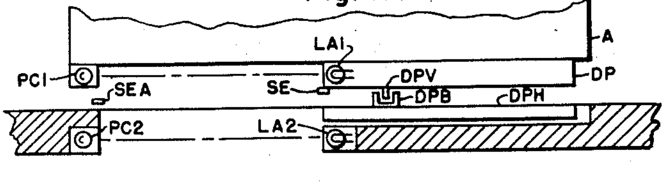


Fig. IA



ELEVATOR SYSTEMS

Filed Sept. 27, 1956 9 Sheets-Sheet 2

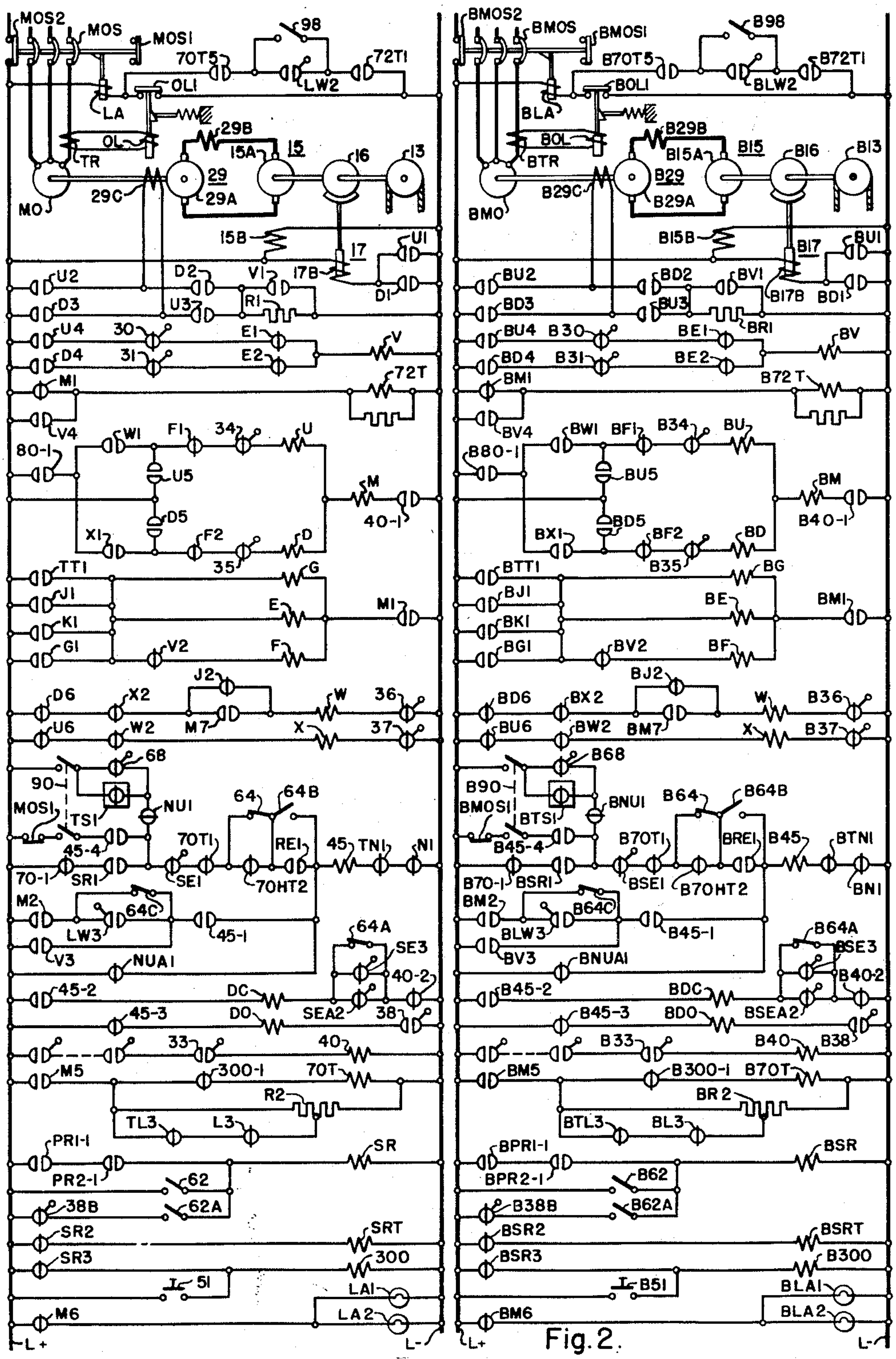


Fig. 2.

ELEVATOR SYSTEMS

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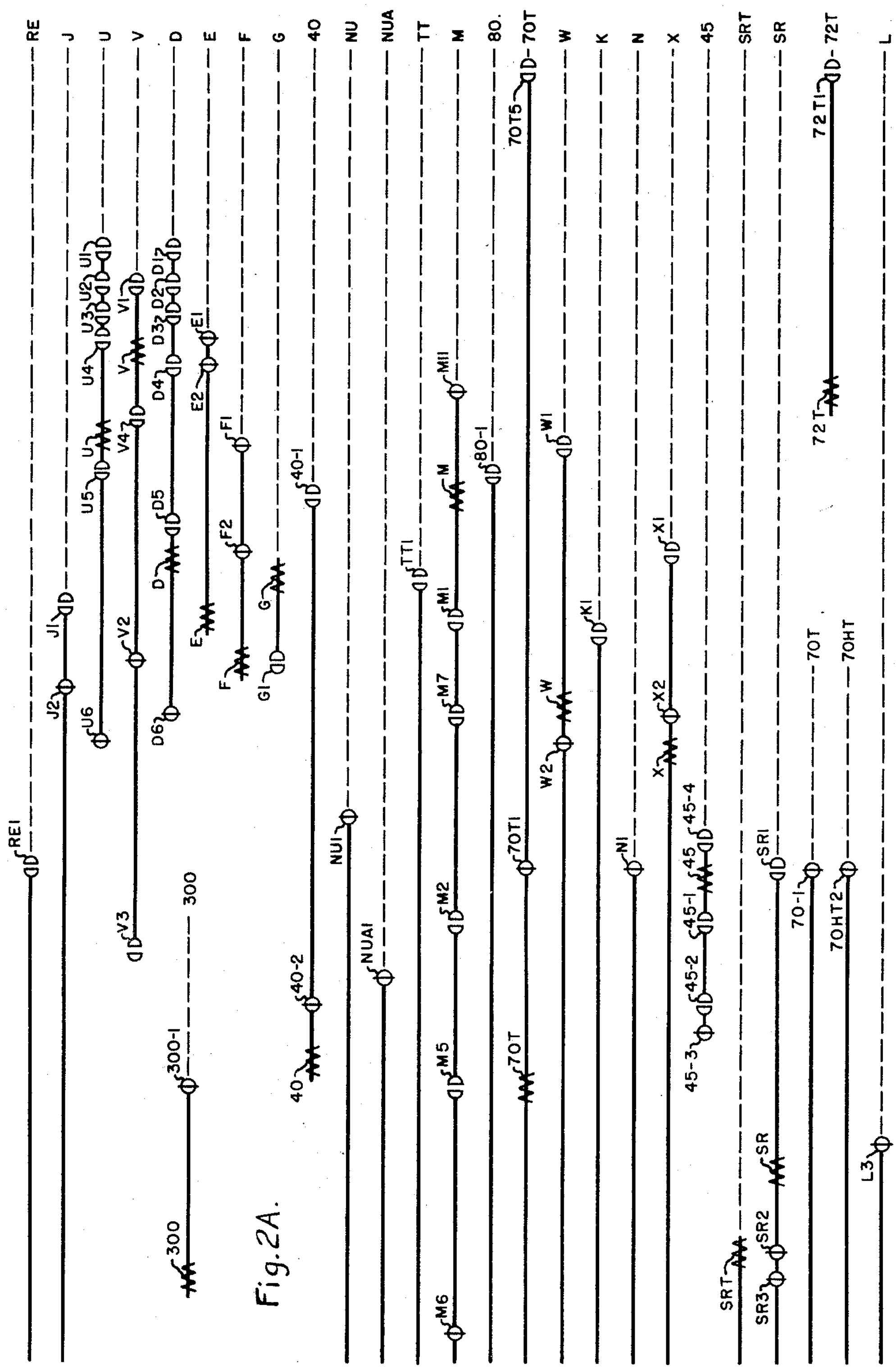
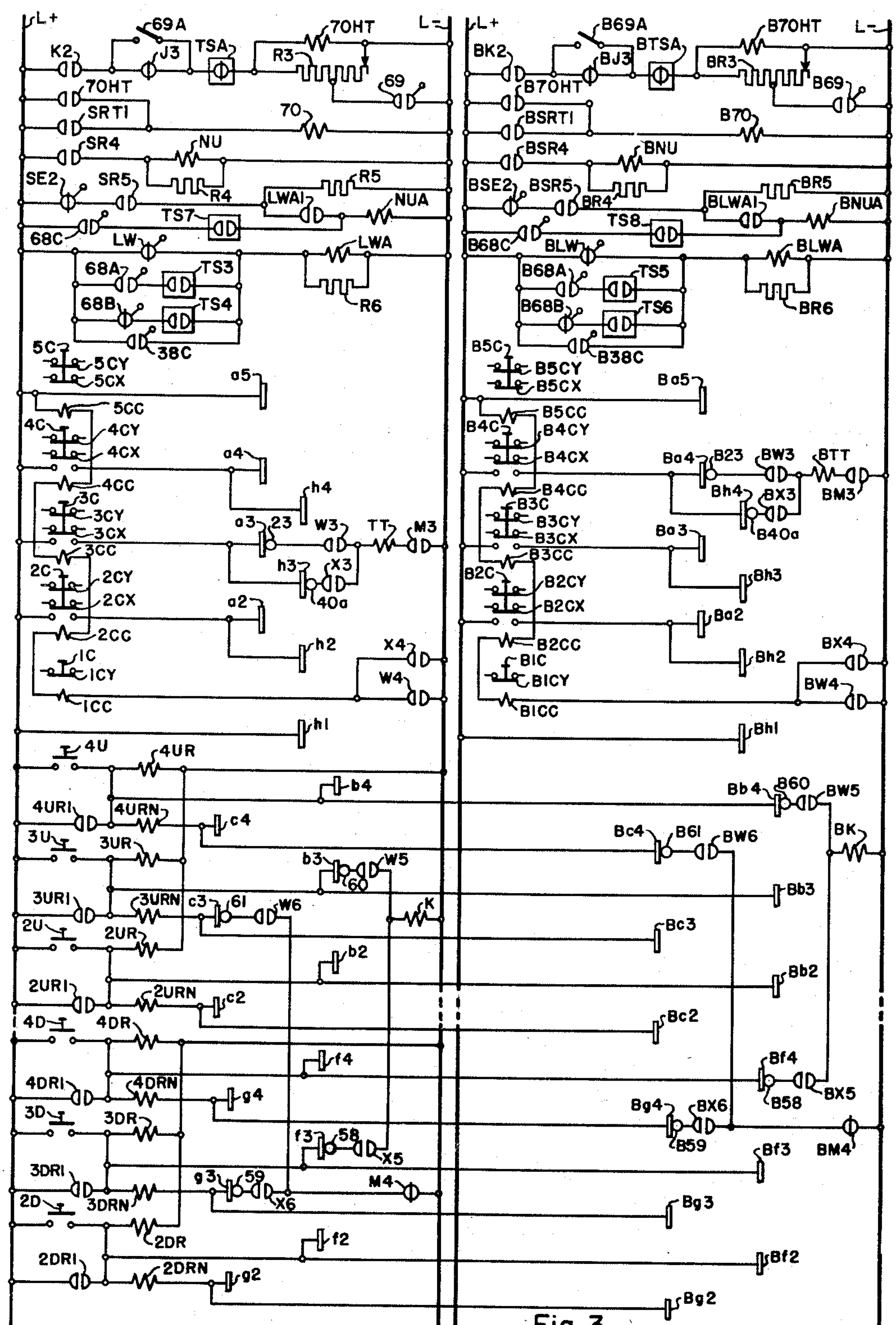


Fig. 2A.


L+
69A
70HT
L-
K2
J3
TSA
R3
69
70HT
SRT1
70
SR4
NU
SE2
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R4
R5
LWA1
NUA
TS7
68C
LW
LWA
68A
TS3
68B
TS4
R6
38C
5C
5CY
5CX
a5
5CC
4C
4CY
4CX
a4
4CC
h4
3C
3CY
3CX
a3
23
W3
TT
M3
3CC
h3
X3
40a
2C
2CY
2CX
a2
2CC
h2
X4
1C
1CY
W4
1CC
h1
4U
4UR
b4
4UR1
4URN
c4
3U
3UR
b3
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3UR1
3URN
c3
61
W6
K
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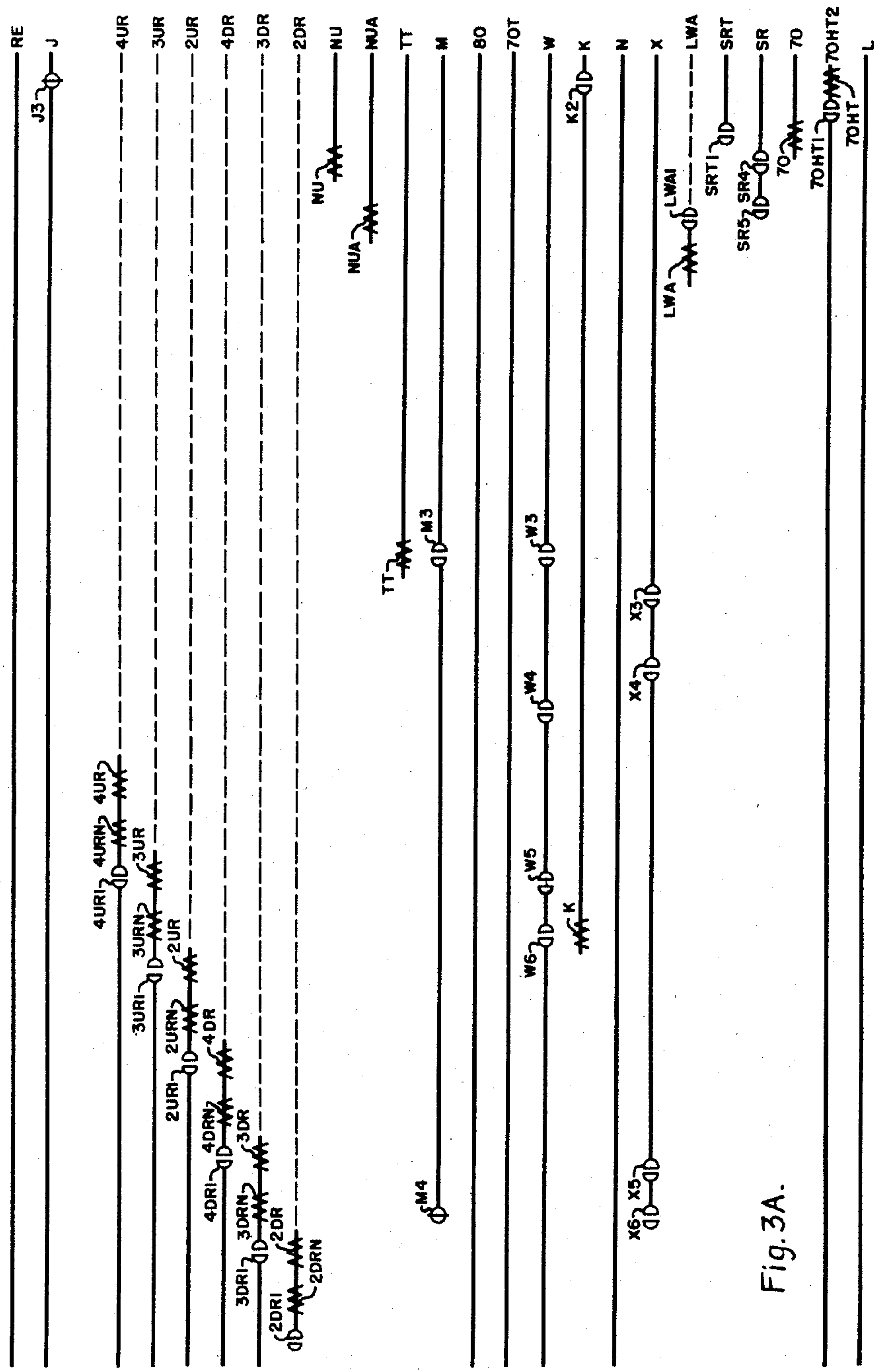
2UR
b2
2UR1
2URN
c2
4D
4DR
f4
4DR1
4DRN
g4
3D
3DR
f3
58
X5
3DR1
g3
59
X6
M4
2D
3DRN
2DR
f2
2DR1
2DRN
g2
B69A
B70HT
BK2
BJ3
BTSA
BR3
B69
B70HT
BSRT1
B70
BSR4
BNU
BSE2
BSR5
BR4
BLWA1
BR5
BNUA
TS8
B68C
BLW
BLWA
B68A
TS5
B68B
TS6
BR6
B38C
B5C
B5CY
B5CX
Ba5
B5CC
B4C
B4CY
B4CX
Ba4
B23
BW3
BTT
BM3
B4CC
Bh4
BX3
B40a
B3C
B3CY
B3CX
Ba3
B3CC
Bh3
B2C
B2CY
B2CX
Ba2
B2CC
Bh2
BX4
B1C
B1CY
BW4
B1CC
Bh1
Bb4
B60
BW5
Bc4
B61
BW6
BK
Bb3
Bc3
Bb2
Bc2
Bf4
B58
BX5
Bg4
BX6
B59
BM4
Bf3
Bg3
Bf2
Bg2
Fig. 3.



RE
J
J3
4UR
3UR
2UR
4DR
3DR
2DR
NU
NUA
TT
M
80
70T
W
K
N
X
LWA
SRT
SR
70
70HT2
L
K2
NU
NUA
LWA1
SRT1
SR4
SR5
70
70HT1
70HT
LWA
M3
TT
W3
X3
X4
W4
4UR
4URN
4UR1
3UR
3URN
3UR1
2UR
2URN
2UR1
4DR
4DRN
4DR1
3DR
3DRN
3DR1
2DR
2DRN
2DR1
W5
K
W6
M4
X5
X6

Fig. 3A.

ELEVATOR SYSTEMS

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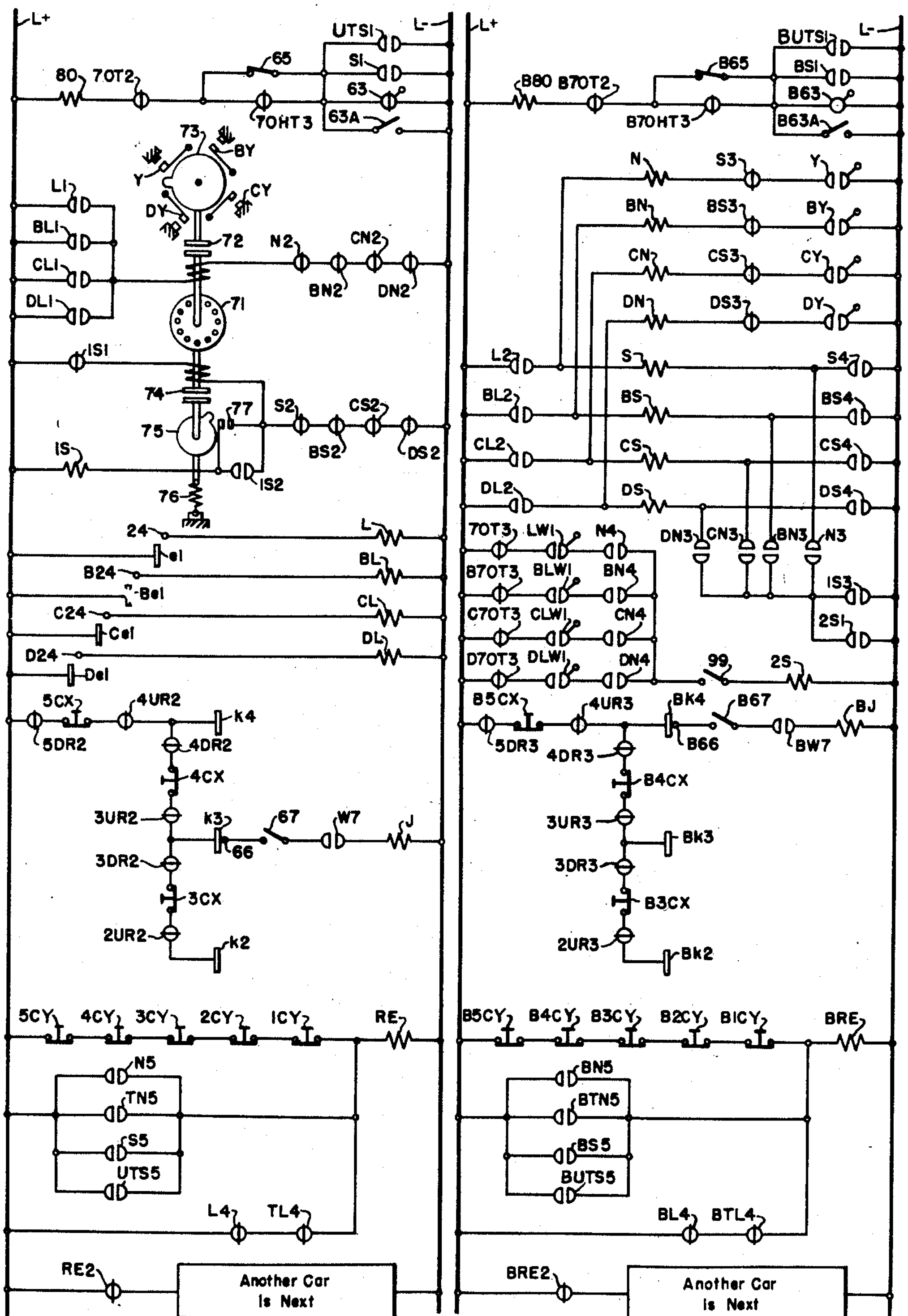

Fig. 4.

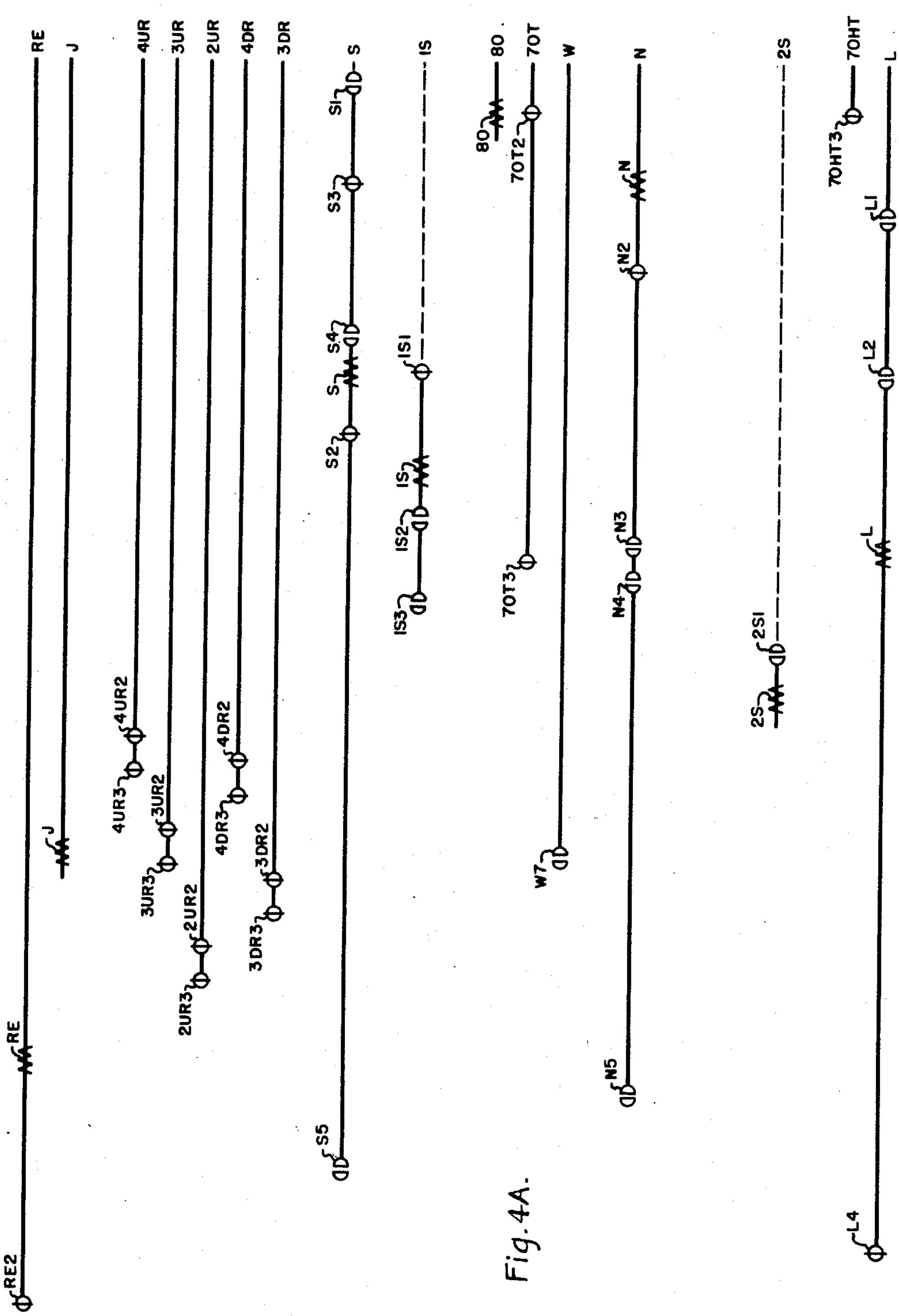
RE
J
4UR
3UR
2UR
4DR
3DR
S
IS
8O
7OT
W
N
2S
7OHT
L
S1
S3
S4
S
S2
S5
IS1
IS
IS2
IS3
8O
7OT2
7OT3
W7
N
N2
N3
N4
N5
2S1
2S
7OHT3
L1
L2
L
L4
4UR2
4UR3
3UR2
3UR3
2UR2
2UR3
4DR2
4DR3
3DR2
3DR3
J
RE
RE2

Fig. 4A.

ELEVATOR SYSTEMS

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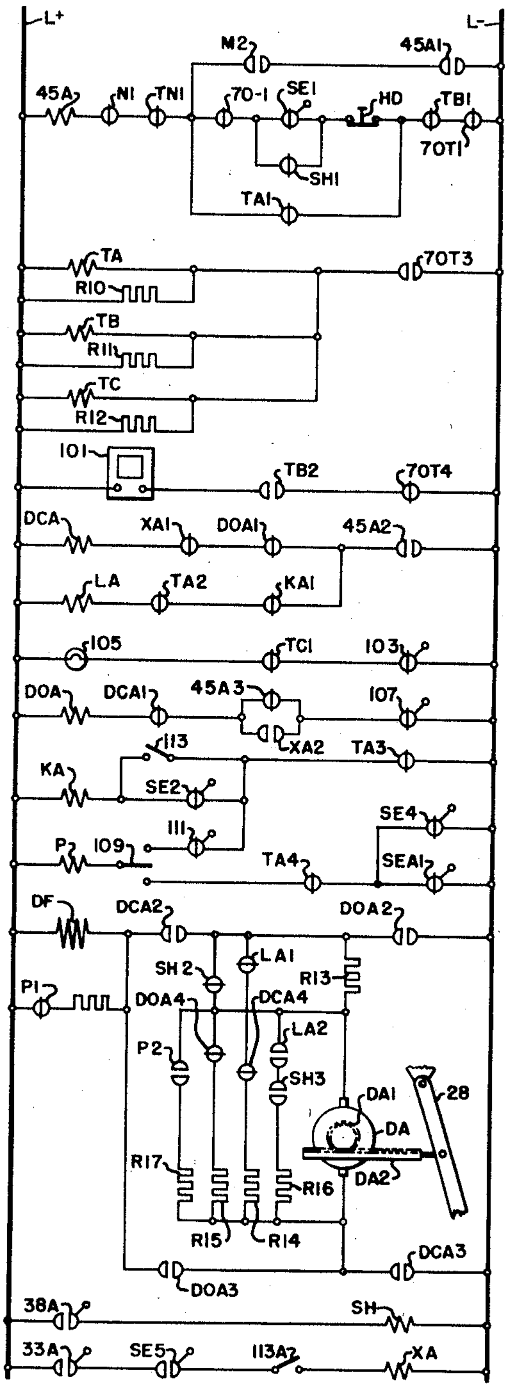


Fig. 5.

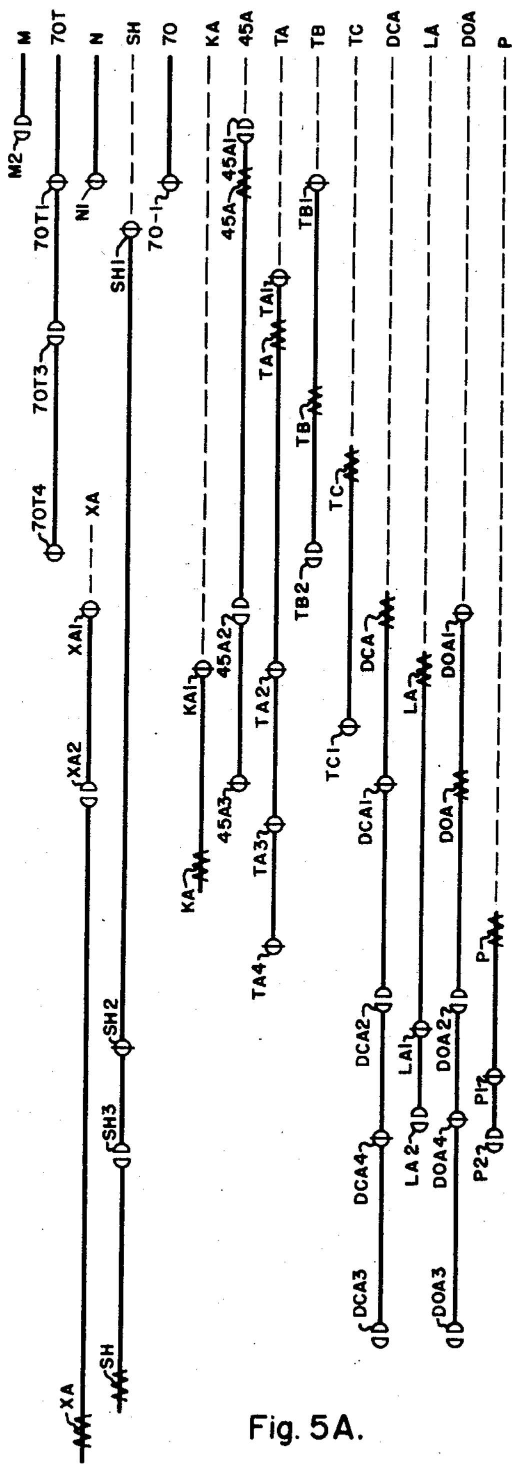


Fig. 5A.

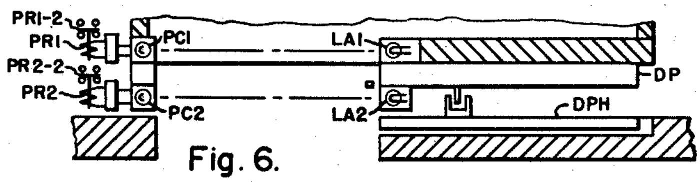


Fig. 6.

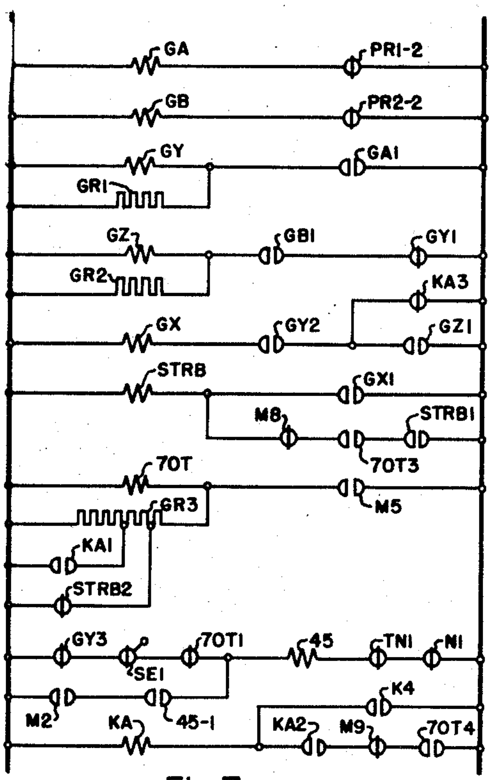


Fig. 7.

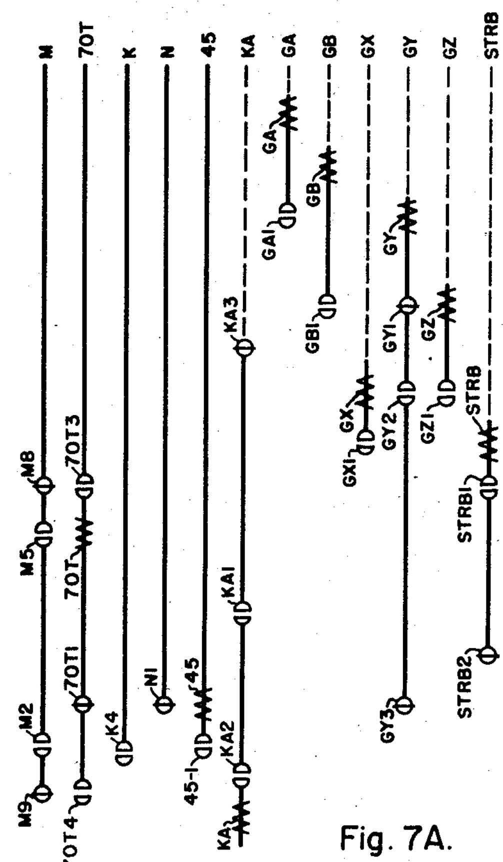
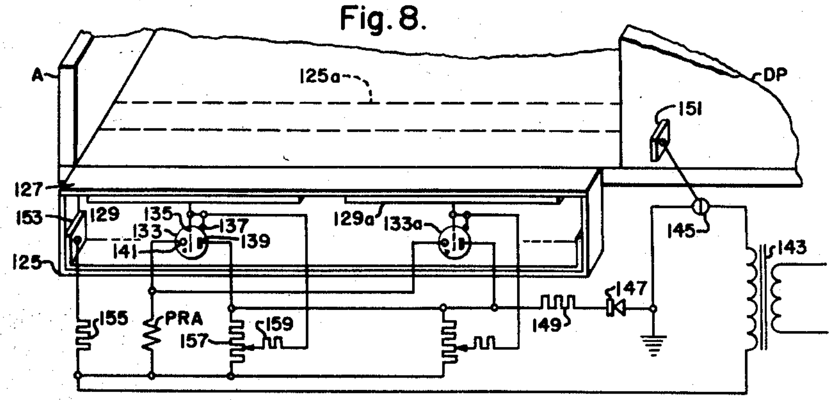


Fig. 7A.

Fig. 8.



United States Patent Office

2,847,089

Patented Aug. 12, 1958

2,847,089

ELEVATOR SYSTEMS

Danilo Santini, Tenafly, N. J., assignor to Westinghouse Electric Corporation, East Pittsburgh, Pa., a corporation of Pennsylvania

Application September 27, 1956, Serial No. 612,552

23 Claims. (Cl. 187—29)

This invention relates to elevator systems and it has particular relation to elevator systems which are designed for operation without car attendants.

Although aspects of the invention may be employed in elevator systems having car attendants, the invention is particularly desirable for elevator systems of the automatic type which do not have car attendants. For this reason, the invention will be discussed with particular reference to such operatorless systems.

When an elevator car in an operatorless system stops at a landing, such as a floor of a building or structure, it is the practice to hold the elevator car at the floor for a substantial time in order to permit loading and unloading of the elevator car. This time is referred to as a non-interference time. In the prior art systems, the non-interference time may be of the order of 5 or more seconds for each stop.

As shown in my copending patent application Serial No. 427,476, filed May 4, 1954, which issued as Patent 2,785,772 on March 19, 1957, of which this is a continuation-in-part, the non-interference time may be varied in accordance with the requirements for each of the floors at which a stop is made. To this end, the elevator system is designed to hold an elevator car at a floor at which the elevator stops for a non-interference substantial time, such as 5 seconds.

The non-interference time for a car call may differ from that employed for a floor call. Thus, if a passenger within the elevator car registers a call for a floor, the elevator car may be held at such floor for a non-interference time of the order of say three seconds. However, if the elevator car stops in response to a floor call registered by an intending passenger at one of the intermediate floors, a longer non-interference time, to allow a passenger to walk to the car that is stopping from the farthest point of the corridor, such as 5 to 7 seconds may be employed.

In one system to which the invention may be applied a substantial non-interference time is provided for each stop of the elevator car. However, upon movement of a passenger into or out of the elevator car, the non-interference time is reset to a smaller value which may be larger for a stop made in response to a floor call than for a stop made in response to a car call. For example, if the elevator car stops at a floor in response to a car call, the elevator car door opens and remains open for a non-interference time of the order of five seconds if no one leaves or enters the elevator car. However, as soon as a person leaves or enters the elevator car, the non-interference time is reset to a value of the order of one-half second. The non-interference time similarly is reset for a time of the order of one-half second each time a successive passenger leaves or enters the elevator car. If no passenger enters or leaves the elevator car after the predetermined time has elapsed for a period in excess of one-half second, the door starts to close. Once the door starts to close, it may continue to its completely closed position despite the attempt of additional passengers to enter the elevator car or leave the elevator car provided the elevator car is in condition to run. Alternatively, the elevator car door may be conditioned to open each time a passenger attempts to enter or leave the elevator car before the elevator car door completely closes. When this happens, the door does not start to close until a short time such as one-half second after the last passenger passes through the doorway.

If the elevator car stops in response to a registered floor call at an intermediate floor, the elevator car door again is opened and remains open for a substantial non-interference time, such as five seconds. However, if a person enters or leaves the elevator car, the non-interference time is reset for a smaller value, such as two seconds. If succeeding persons enter or leave the elevator car at close enough intervals, the non-interference time is reset for each of the persons for a time which may be of the order of one-half second in order to delay the reclosure of the door.

If the elevator car stops at an intermediate floor in response to a registered floor call and is assigned to reverse at such floor, the door may open for a non-interference time of the order of five seconds. In this case, entry of a person into the car or departure of a passenger from the car may reset the non-interference time to a smaller value of the order of one-half second. Each succeeding person entering or leaving the elevator car within suitable intervals may reset the non-interference time for an interval of the order of one-half second to delay reclosure of the door.

The movement of a passenger or an intending passenger into or out of the elevator car can be determined by transmitting energy into the passage traversed by such passenger. Interruption of such energy path by a passenger is ascertained by a suitable detector.

In some cases, a passenger may attempt to prevent the closure of the door for an unreasonably long time by standing in the path of the transmitted energy. If the energy is interrupted for an unduly long period, such as four seconds, a closing movement of the door is initiated promptly at the close of such period. Desirably the door may be provided with a protective edge which initiates the stopping or reopening of the door if the door reaches a person located in the closing path of the door. If as the door reopens the path for the energy is reestablished the door will remain open for the required one-half second and will not start to reclose as long as the path is interrupted at less than one-half second intervals.

After movement into or out of the elevator car starts, successive loads or passengers ordinarily follow the first load or passenger rapidly. Each load or passenger after the first one resets the non-interference time for an additional small time of the order of one-half second. Consequently, waste time is substantially eliminated and the efficiency of the elevator system is materially improved.

At terminal floors, it may be desirable to control the departure of elevator cars by a suitable dispatcher for the purpose of maintaining adequate spacing of the elevator cars. In such a case, the variable non-interference time is still desirable for the intermediate floors or landings served by each elevator car. If the car is loading or unloading after a closing operation of the elevator car door is initiated by the dispatcher, the closure of the door may be prevented by operation of the detector.

In a suitable system, an elevator car is provided with a passage through which load, such as a passenger, may enter and leave the elevator car. The passage may be exposed or closed by a door which is automatically opened as the elevator car reaches a predetermined load transfer position which ordinarily is a landing or floor of a building. Upon expiration of the non-interference time, the door may be closed for the purpose of permitting departure of the elevator car.

A signal or energy is established or transmitted across the passage. A detector is provided which is responsive to a function of the signal or energy. For example, the detector may be responsive to the presence or absence of radiant energy. If a load, such as a passenger, enters the area through which the radiant energy is projected, the detector senses the presence of such load. The detector, in turn, controls mechanism which, in response to the movement of the load through the passage, resets the non-interference time in the manner previously described. If the detector receives no radiant energy for more than a predetermined time the door may be promptly closed.

Other expedients may be employed for expediting closure of the elevator car door. Thus shortly before the elevator car door is assigned to close, a suitable signal may be operated to warn persons of the impending closure of the door. Such a signal may be in any suitable form such as a lamp or a voice message instructing persons to clear the doorway. A buzzer is quite suitable for such a signal.

If the elevator car door fails to close within a reasonable time, a second signal desirably is operated. This signal may be of the same general type as the first signal.

Door speed and door force may be controlled for the purpose of assuring door closure. If the elevator car door has remained open for more than a reasonable time, the closing force may be increased for the first part of the closing movement in order to force from the path of the door any obstruction impeding door closure. Desirably, the door under such circumstances may start its closing movement at a normal speed. However, if the door thereafter reaches an obstruction in the closing path of the door, the speed of the door may be reduced until the obstruction is removed.

If the closure of the door is prevented for more than a reasonable time, a closing force may be exerted on the door continuously until the door closes. The system may be so arranged that the closing force is exerted unless safety edges on both sides of the door opening are operated.

In the foregoing discussion, the operation resulting from an interruption of the beam of light is independent of the direction of movement of the load through the doorway. A system may be employed wherein a control is exercised which is dependent on the direction in which load moves.

Thus, first and second detectors may be provided which are responsive to different positions of a load. For example, if the load is represented by a passenger entering the elevator car, the movement of the passenger into the elevator car operates the first detector before operating the second detector. For a reverse movement of the load the detectors operate in the inverse order.

The detectors are employed for initiating control operations which are dependent on the direction of movement of the load. Thus, an elevator car may be provided with a non-interference time which may be of the order of 5 seconds. If the elevator car stops in response to a registered car call, movement of load through the doorway of the elevator car resets the non-interference time to a smaller value such as ½ second. If the elevator car stops in response to a registered floor call, movement of load into the elevator car resets the non-interference time to an intermediate value such as 2 seconds. If the elevator car stops at a floor for which both car and floor calls are registered, movement of load out of the elevator car does not reset the non-interference time. However, movement of load into the elevator car resets the non-interference time to an intermediate value such as 2 seconds.

It will be recalled that the starting of cars from a terminal floor may be controlled by a suitable dispatcher. Such a dispatcher may select elevator cars to leave a terminal floor successively. A substantial time is provided between the dispatch of successive elevator cars for the purpose of assuring proper spacing of the elevator cars.

If an empty elevator car reaches a terminal floor and is not selected as the next elevator car to leave the terminal floor, a problem arises because of the fact that the door of the elevator car remains open for its non-interference time. Prospective passengers at the terminal floor tend to enter any elevator car having an open door. The entry of such passengers into an elevator car which is not selected to leave the terminal floor interferes with efficient operation of the system.

In accordance with the invention, the non-interference time of an elevator car, which stops at a terminal floor, is substantially shorter than the non-interference time available at intermediate floors. For example, if a non-interference time of the order of 5 seconds is employed for intermediate floors, the interference time at a terminal floor may be of the order of 2 seconds. Such a decrease materially reduces the probability of the entry of prospective passengers into an elevator car which is not selected as the next elevator car to leave the terminal floor.

This aspect of the invention is particularly suitable for an elevator car which is provided with mechanism for maintaining the elevator car door open or for reopening an elevator car door in response to the presence of a passenger in the closing path of the door. Under such circumstances, passengers within the elevator car have ample time to leave the car following a stop at a terminal floor whereas prospective passengers at the terminal floor have comparatively little time within which to enter an elevator car which is not selected to leave the terminal floor.

Despite the foregoing reduction in non-interference time at a terminal floor, it is still possible that a prospective passenger at the terminal floor will succeed in entering an elevator car which is not selected to leave the terminal floor, and his entry may be followed by closure of the elevator car door. In accordance with an aspect of the invention, attempted registration of a car call by such passenger initiates a reopening of the door of the elevator car. In a preferred embodiment of the invention the attempt to register a car call additionally operates a signal which notifies the passenger that the elevator car is not selected to leave the terminal floor or that another elevator car will leave first.

If an elevator car door is equipped with a safety edge, a person sometimes will hold the door in its open position for an undue length of time by operating the safety edge with his hand. In order to discourage such operation the invention contemplates mechanism for applying a substantial force to the person's hand. This may be effected by rendering the safety edge ineffective for a brief interval following initiation of a door-closing movement or until the elevator car door has traveled a short distance from its fully-open condition. Thus, in a preferred embodiment of the invention the safety edge may be rendered ineffective until the elevator car door has moved a distance of the order of 1 or 2 inches from its fully-open position.

As the door completes a closing movement it is conceivable that a person's hand or a small object may be introduced into the closing path. Under these conditions the door may be reopened for a small distance sufficient to permit withdrawal of the hand or object. The door then may be reclosed.

Should the elevator car door be provided with mechanism maintaining the door open or reopening a closing door in response to the presence of a person at any position within the closing path of the door, door closure may be expedited by rendering such mechanism ineffective until the door has completed a substantial closing movement. Thus, in a preferred embodiment of the invention the mechanism is rendered ineffective to maintain the door open or to reopen a closing door until the door has traveled a substantial distance such as 10 inches from its fully-open position. Since a person often will clear the closed path of a door during this 10 inch movement of the door, a number of unnecessary door-opening operations are avoided.

Confusion and distress sometimes follow the opening of an elevator car door while the elevator car is stopped and displaced from a floor. This is particularly true if the elevator car is unduly loaded. In accordance with an aspect of the invention overload protective mechanism is effective for preventing movement of the elevator car only if the elevator car is at a floor. Preferably, the overload protective mechanism is effective only if the elevator car door is open. In the event that the elevator car stalls while it is displaced from a floor, the overload protective mechanism may be rendered effective despite such displacement of the elevator car and despite the fact that the elevator car door may be closed.

In order to conserve time it is the practice to start an opening operation of the elevator car door while the elevator car is still approaching a floor at which it is to stop. If the elevator car is heavily loaded, the car may stop at a substantial distance from the floor with its door open. Even though the elevator car is provided with automatic leveling equipment, the elevator car still may stop at a point substantially displaced from a floor before the leveling mechanism takes control of the elevator car. In order to prevent such operation the invention contemplates that the elevator car door will start to open in advance of a floor only if the elevator car load is below a predetermined value. If the elevator car is heavily loaded, the initiation of the opening operation of an elevator car door is delayed. This delay is preferably sufficient to assure that the car is stopped before such opening and preferably sufficient to permit prior deenergization of the motor driving the elevator car.

It is therefore an object of the invention to provide an elevator system having improved door operation.

It is a further object of the invention to provide an improved elevator system wherein an elevator car is held at certain of its stops for a substantial non-interference time and at other of its stops for a shorter non-interference time.

It is also an object of the invention to provide an elevator system wherein an elevator car has a shorter non-interference time at a dispatching floor than its non-interference time at an intermediate floor.

It is an additional object of the invention to provide an elevator system wherein an elevator car at a dispatching floor which is not selected to leave the dispatching floor and which has its door closed reopens its door in response to attempted registration of a car call.

Still another object of the invention is the provision of an elevator system wherein overload protective mechanism is effective only if an elevator car is stopped at a floor.

It is also an object of the invention to provide an elevator system wherein overload protective mechanism is effective only if an elevator car is stopped at a floor with its door open.

It is a further object of the invention to provide an elevator system wherein the door of a heavily loaded elevator car does not open in advance of a floor whereas a door of an elevator car not so loaded may open as the car approaches the floor at which it is to stop.

It is an additional object of the invention to provide an elevator car system wherein an elevator car door provided with protective edge mechanism can be reopened in response to operation of such mechanism only after the door has moved a substantial distance from its fully-open position.

It is another object of the invention to provide an elevator car system wherein door reopening mechanism responsive to the presence of an object in the closing path of the door is effective only after the elevator car door has moved a substantial distance from its fully-open position.

It is still another object of the invention to provide an elevator car system wherein an elevator car door which reaches an obstruction shortly before it arrives at fully-closed position is reopened for a short distance after which the door resumes its closing movement.

Other objects of the invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which:

Figure 1 is a schematic view with parts in elevation and parts broken away of an elevator system which may embody the invention;

Fig. 1A is a view in section with parts broken away showing an elevator car employed in Fig. 1 associated with a hoistway;

Figs. 2, 3 and 4 are schematic views including circuits in straight-line form of a control system embodying the invention;

Fig. 5 is a schematic view including circuits in straight-line form of a modified control system embodying the invention;

Fig. 6 is a view in section showing an elevator car associated with a hoistway and embodying a modified form of the invention;

Fig. 7 is a schematic view including circuits in straight-line form of a modified control system embodying the invention;

Fig. 8 is a view in section showing an elevator car associated with a hoistway and illustrating modified detectors which may be employed in the circuits illustrated in the preceding figures; and

Figs. 2A, 3A, 4A, 5A and 7A are key representations of electromagnetic relays and switches employed in the circuits of Figs. 2, 3, 4, 5 and 7. If Figs, 2, 3, 4, 5 and 7 are horizontally aligned respectively with Figs. 2A, 3A, 4A, 5A and 7A, it will be found that coils and contacts of the switches and relays appearing in the key representations are horizontally aligned with the corresponding coils and contacts shown in these circuits.

Although the invention may be incorporated in an elevator system employing various numbers of elevator cars serving buildings or structures having various numbers of floors, the invention can be described adequately with reference to an elevator system having four elevator cars serving a building having five floors. The elevator cars may be dispatched from any desired floors. The elevator cars will be assumed to be dispatched between the first floor and the upper terminal or fifth floor.

Because of the complexity of such systems, certain conventions have been adopted. The elevator cars will be identified by the reference characters A, B, C and D. Since the circuits for the cars are similar, substantially complete circuits are shown for the cars A and B. Components associated with the cars C and D are discussed only as required.

Components associated with the elevator cars B, C and D which correspond to a component of the elevator car A are identified by the same reference character employed for the component of the elevator car A preceded by the letters B, C and D, respectively. For example, the reference characters U, BU, CU and DU designate up switches, respectively, for the elevator cars A, B, C and D. The discussion will be directed primarily to the apparatus and circuits for the elevator car A.

The various relays and switches employed in the circuits may have break or back contacts which are closed when the relay is deenergized and dropped out. The break contacts are open when the relays or switches are energized and picked up.

The relays and switches also may have front or make contacts which are opened when the switches and relays are deenergized and dropped out. These contacts are closed when the switches and relays are energized and picked up. In the drawings the various switches and relays are shown in so far as possible in their deenergized and dropped-out conditions.

Each set of the contacts associated with a relay or switch is identified by the reference character associated with the relay or switch followed by a numeral identifying the specific set of contacts. Thus, the reference characters U1, U2 and U3 designate, respectively, the first, second and third sets of contacts of the up switch U.

In order to facilitate the presentation of the invention, the apparatus shown in the figures will be briefly set forth, and the operation of the complete system thereafter will be discussed. The system includes in part the following apparatus:

Apparatus specific to car A

V—Speed relay
U—Up switch
M—Car-running relay
D—Down switch
G—Holding relay
E—Slowdown inductor relay
F—Stopping inductor relay
W—Up-preference relay
X—Down-preference relay
70T—Timing relay
TT—Car-call stopping relay
K—Floor-call stopping relay
30—Main starting relay
L—Car-position relay
N—Loading relay
S—Auxiliary starting relay
OL—Overload relay
72T—Time-delay relay
RE—Reopen relay
40—Door relay
45—Door-control relay.
DC—Door-close solenoid
DO—Door-open solenoid
SR—Detector relay
LWA, NU, NUA, 70HT, SRT—Time delay relays
300—Expediter relay
J—Reversal relay

Apparatus common to all cars

2DR to 5DR—Down floor-call storing relays
2 UR to 4 UR—Up floor-call storing relays

FIGURE I

Fig. 1 illustrates the structural relationships of the elevator cars A, B and associated apparatus with reference to the building structure which the elevator cars are intended to serve.

The elevator car A and a counterweight 10 are secured to opposite ends of a rope or cable 11 which passes over a sheave 13. The sheave 13 is mounted on the shaft 14 of an elevator driving motor 15. The shaft 14 also carries a brake drum 16 with which a brake 17 of the conventional spring-applied electrically-released type is associated. The motor 15 is secured to the floor 18 of a penthouse located in the structure which the elevator car is intended to serve.

In order to simplify the association of control circuits with the elevator car A, a control device 19 is provided which is operated in accordance with a function of the movement of the elevator car A. In the specific embodiment of Fig. 1, the control device takes the form of a floor selector which includes an insulating panel 20 and a brush carriage 21. A screw 22 is mounted for rotation relative to the panel 20. This screw conveniently may be coupled through suitable gearing to the shaft 14 for rotation in accordance with movement of the elevator car A.

The brush carriage 21 is in threaded engagement with the screw 22. As the elevator car A moves upwardly, the brush carriage 21 is moved upwardly but at a rate much slower than the rate of movement of the elevator car. Similarly, when the elevator car A moves downwardly, the brush carriage 21 also moves downwardly at a slower rate.

The panel 20 carries a plurality of contact segments which are insulated from each other. Thus, the contact segments $a2$ to $a5$ are arranged in a row on the panel 20. As the elevator car proceeds upwardly from the basement, a brush 23 mounted on the carriage 21 successively engages the contact segments $a2$ to $a5$, as the elevator car approaches respectively the floors 2 to 5 of the structure. It will be understood that the contact segments $a2$ to $a5$ are spaced from each other in accordance with the spacings of the floors. As it will be pointed out below, these contact segments are employed with circuits controlling the stopping of the elevator car during up travel in response to car calls.

As a further example, the panel 20 has a single contact segment $e1$ which is engaged by a brush 24 mounted on the carriage 21 only when the elevator car A is adjacent the first or dispatching floor. As will be pointed out below, this contact segment is employed in controlling the operation of a dispatching device.

It will be understood that a number of rows of contact segments and a number of brushes may be employed in the floor selector. However, the foregoing discussion is believed sufficient to illustrate the mechanical relationships of these contact segments and brushes.

Certain apparatus is mounted on or in the elevator car A. Thus, car-call buttons 2c to 5c are provided for registering car calls for the second, third and fourth floors, respectively.

A slowdown-inductor relay E is provided for the purpose of initiating a slowdown of the elevator car A as it approaches a floor at which it is to stop. The inductor relay may be of conventional construction and includes two sets of break contacts E1 and E2. When the coil of the inductor relay E is energized, the contacts remain in the positions illustrated in Fig. 1 until the relay is adjacent an inductor plate located in the hoistway of the elevator car A. For example, when the coil of the inductor relay E is energized and the inductor relay is adjacent the magnetic plate UEP for the second floor, the magnetic circuit is completed, which results in opening of the break contacts E1. When open, the contacts remain open until the coil of the inductor relay E is deenergized. The inductor plate UEP is positioned to be reached by the inductor relay E as the elevator car approaches the second floor for the purpose of initiating slowdown of the elevator car. It will be understood that a similar inductor plate is similarly associated with each of the floors at which the elevator car is required to stop during up travel.

If the coil of the inductor relay E is energized during down travel of the elevator car, and if the relay reaches the inductor plate DEP for the second floor, a magnetic circuit is completed which results in opening of the break contacts E2. When open, the contacts remain open until the coil is deenergized. The inductor plate DEP is so positioned that it initiates slowdown of the elevator car A a suitable distance from the second floor. A similar inductor plate would be similarly associated with each of the floors at which the elevator car A is to stop during down travel.

The elevator car A also carries a stopping inductor relay F which is similar in construction to the inductor relay E. This relay is employed for initiating a stopping operation of the elevator car A. The stopping inductor relay F cooperates with inductor plates UFP and DFP in a manner which will be clear from the discussion of the cooperation of the slowdown inductor relay with the inductor plates UEP and DEP. If the coil of the relay F is energized and if the elevator car is to stop at the second floor while traveling up, when the inductor relay F reaches the inductor plate UFP a magnetic circuit is completed which results in opening of the break contacts F1. This initiates a stopping operation of the elevator car. An inductor plate similar to the plate UFP is similarly associated with each of the floors at which the elevator car A is to stop during up travel thereof. If the elevator car A during down travel is to stop at the second floor, the coil of the stopping inductor relay F is energized, and when the inductor relay reaches the inductor plate DFP for the second floor, a magnetic circuit is completed which results in opening of the contacts F2. This initiates a stopping operation of the elevator car A. It will be understood that an inductor plate similar to the inductor plate DFP is similarly associated with each of the floors at which the elevator A is to stop during down travel thereof.

The elevator car A also carries a mechanical switch **63** which is positioned to be operated by cams **26** located in the hoistway associated with the elevator car. The mechanical switch **63** normally is closed and is opened by a cam **26** when the elevator car A is adjacent the first or dispatching floor and by a similar cam when the car is at the upper terminal floor. It will be understood that other mechanical switches may be operated in a similar manner by the elevator car A.

An intending passenger on the fourth floor may register a floor call for elevator car service in the up direction by pressing a button of a push-button switch 4U. A similar push-button switch is located at each of the intermediate floors from which an intending passenger may desire to proceed in an up direction.

If the intending passenger at the fourth floor desires to proceed in a down direction, he may press the button of a push-button switch 4D located at the fourth floor. A similar push-button switch is located at each of the intermediate floors from which an intending passenger may desire to proceed in a down direction.

The elevator car A is provided with a door DP which is mounted to slide across the passage through which passengers enter and leave the elevator car. The door is moved by means of a lever **28** which is pivotally mounted on the car by means of a pivot 28A. The lever **28** is moved in a clockwise direction about a pivot by means of a door-close solenoid DC for the purpose of closing the passage and is moved in a counterclockwise movement about its passage to open the door by means of a door-open solenoid DO.

When the door is open an object-detecting device is effective. This device preferably includes, a signal or energy which is projected across the passage through which passengers enter and leave the elevator car. This signal may be of any type which can be modified by the movement of a passenger through the passage and in which the modification produced by such movement may be detected. For example, the signal may be in the form of infrared radiant energy or ultra-violet radiant energy. As a further example, supersonic energy may be projected across the passage. However, it will be assumed that the energy is in the form of visible light which is produced by a lamp **LA1** mounted on the edge of the door which is the leading edge during a closing movement of the door. The light is in the form of a beam which is focused in any suitable manner on a suitable detector such as a photocell **PC1**. The output of the photocell may be amplified by means of an amplifier AM1 which is supplied with electrical energy from a suitable source and the output of the amplifier is applied to a relay PR1. The relay PR1 may be designed to be picked up as long as the photocell PC1 receives the beam of radiant energy. Detectors of this type are well known in the art. Examples of such detectors may be found in the Kinnard et al. Patent 1,822,152 and in the Ellis, Jr., Patent 1,947,079.

Although a single beam may suffice, in some cases it is generally desirable to employ a plurality of beams. Such beams may be produced by interposing suitable reflectors between the lamp LA1 and the photocell PC1 to reflect a beam across the passage several times before it reaches the photocell. However, for present purposes, it will be assumed that separate lamps and photocells are employed for each of the beams. Thus, in Fig. 1A, a second lamp **LA2** is provided for projecting energy towards a photocell PC2 which is associated with an amplifier **AM2** and a relay **PR2**.

In the embodiment thus far described, the lamp LA1 is mounted on one edge of the door DP. If desired, a lamp and a photocell may be placed in any positions wherein the beam between the lamp and photocell is interrupted by the entry of load into the elevator car or the departure of load from the elevator car. Thus the beam may be located between the car and hoistway doors or it may be adjacent the hoistway door. A beam positioned about twelve inches above the floor has been found suitable.

In Fig. **1A**, a hoistway door DPH is provided which is coupled to the door DP for movement therewith when the elevator car is stopped at a floor. It will be understood that a separate hoistway door DPH is provided for each of the floors served by the elevator car. The coupling of the two doors may be effected in a conventional manner as by a vane DPV which is secured to the door DP for reception in the slot of a slotted block DPB which is mounted on the hoistway door DPH.

The hoistway door DPH is moved to close and expose a hoistway passage through which load enters and leaves the elevator car. As shown in Fig. 1A, the lamp LA2 is mounted on a hoistway wall or door jamb to protect radiant energy across the hoistway passage towards the photocell PC2 which also is mounted on a hoistway wall. By inspection of Fig. 1A, it will be observed that the radiant energy transmitted from the lamp LA2 to the photocell PC2 is interrupted each time a passenger enters or leaves the elevator car.

If desired one lamp, such as the lamp LA1, through suitable lenses may direct a first beam towards the photocell PC1 and a second beam towards the photocell PC2. This reduces the number of lamps required.

Movement of the door DP operates a number of switches. Thus, in its open position the door holds open switches 38, 38A and 38C which are biased towards closed conditions. In addition, the door holds closed a switch **38B** which is biased towards open condition. As the door starts to close switch 38 opens. After the door has traveled predetermined distances from open position (e.g. one inch for switch 38A and ten inches for switch **38B**) the switches 38A and 38B are permitted to operate to closed and open conditions respectively. As the door reaches fully-closed position, it operates a switch 33 from open to closed condition.

If desired, the edge of the door DP, which is the leading edge during a door-closing movement, may have an object-sensing device such as a safety-edge SE of conventional type. When such an edge reaches an obstruction, it opens switches SE1, SE2, SE3 and SE4 which may be employed in circuits to stop or reopen the door or for other purposes. If center-opening doors are employed, a separate safety edge may be provided for the edge of each door which is a leading edge during closing movement. In the present case, it will be assumed that the second safety edge SEA is located on the elevator car adjacent the photocells PC1, PC2. The safety edge SEA operates switches SEA1 and SEA2 for purposes hereinafter set forth.

The load in the elevator car is weighed in any suitable manner as by the deflection of a spring-mounted platform PL. Loads in excess of say 80 percent of rated capacity open the normally-closed load weighing switch LW, and close a normally-open load-weighing switch LW1. Loads in excess of say 110 percent of rated capacity close the normally-open switches LW2 and LW3.

FIGURE 2

Fig. 2 shows circuits for the driving motor, the brake, the speed relay V, the up switch U, the down switch D, the car-running relay M, the holding relay G, the slowdown inductor relay E, the stopping inductor relay F, the up-preference relay W, the down-preference relay X, the timing relay 70T, the door relay 40, the door-control relay 45, the door-close relay DC, the door-open relay DO, the detector relay SR, the time-delay relay SRT and the expediter relay 300. Energy for the various circuits is derived from direct-current buses L+ and L—.

Although various motor control circuits may be employed, it will be assumed that a control circuit of the variable-voltage type is employed. By inspection of Fig. 2, it will be noted that the armature 15A of the driving motor 15 and the armature 29A of a direct-current generator 29, together with a series field winding 29B for the generator, are connected in a series or loop circuit. The field winding 15B for the driving motor 15 is connected directly across the buses L+ and L—.

The magnitude and direction of energization of the driving motor 15 are controlled by the direction and magnitude of the energization of a separately-excited field winding 29C provided for the generator 29. It will be understood that the armature 29A of the generator is rotated at a substantially constant rate by a suitable motor MO which may be a polyphase induction motor energized from a suitable polyphase source of energy through a switch MOS. Contacts MOS1 are illustrated and are operated by the switch to closed position only when the motor MO is conditioned to run. For present purposes, it will be assumed that operation of the switch MOS to closed position also closes the contacts MOS1.

The switch MOS is biased towards open condition, and when closed is held in closed condition by a latch LA which is biased away from latching position and which is operated to latching position by energization of a solenoid. (The latch is shown in latching position.) The solenoid is energized through break contacts OL1 of an overload relay OL. For illustrative purposes it is assumed that the relay OL is energized from a phase conductor of the power source supplying the motor MO through a current transformer TR. When the current supplied to the motor increases to an excessive value indicating that the elevator car is overloaded or stalled, the relay OL picks up to interrupt the energization of the solenoid of the latch LA provided that a holding circuit including the make contacts 70T5, LW2 and 72T1 is open. As a result of such deenergization the switch MOS opens.

As shown in Fig. 2 the buses L+ and L— are energized from a suitable source of direct current through contacts MOS2 which are closed only when the switch MOS is closed.

When the elevator car A is conditioned for up travel, the generator field winding 29C is connected across the buses L+, L— through make contacts U2 and U3 of the up switch. When the elevator car A is conditioned for down travel, the generator field winding 29C is connected across the buses through the make contacts D2 and D3 of the down switch. The energizing circuit for the field winding may include a resistor R1 which is shunted by make contacts V1 of the speed relay V. By inspection of Fig. 2, it will be observed that the contacts U2, U3, D2 and D3 constitute in effect a reversing switch for controlling the direction of energization of the field winding. The resistors R1 and the contacts V1 are provided for controlling the magnitude of energization of the field winding.

The speed relay V may be energized through either of two circuits. One of the circuits includes make contacts U4 of the up switch U, a limit switch 30 which is normally closed and which is opened as the elevator car A nears the upper limit of its travel and the break contacts E1 of the slowdown inductor relay E. The other circuit is completed through make contacts D4 of the down switch D, mechanical limit switch 31 which is normally closed and which is opened as the elevator car nears the lower limit of its travel in the down direction, and break contacts E2 of the slowdown inductor relay.

A time-delay relay 72T is energized from the buses L+ and L— through make contacts V4 of the speed relay V, or break contacts M11 of the running relay M. When deenergized this relay 72T has a substantial delay in dropout. The time delay is represented by a resistor connected across the relay.

As previously pointed out, the brake 17 normally is spring-biased into engagement with the brake drum 16 and is released by energization of a brake coil 17B. The coil may be energized either through make contacts U1 of the up switch U or through make contacts D1 of the down switch D.

In order to energize the car-running relay M, certain safety devices 33 must be in their safe conditions. Such safety devices may include switches which are open when the doors of the elevator car and the associated hoistway doors are open, and which are closed when the doors are closed to control the door relay 40. Such safety devices are well known in the art. The car-running relay M may be energized through either of two circuits. One of the circuits includes the make contacts 80-1 of the starting relay 80, make contacts W1 of the up-preference relay W, break contacts F1 of the stopping-inductor relay, normally-closed contacts of a mechanical limit switch 34 which are opened when the car nears the upper limit of its travel, and the coil of the up switch U. When energized, the up switch U closes its make contacts U5 to complete a holding circuit around the contacts 80-1 and W1.

The second circuit for energizing the car-running relay M includes the contacts 80-1 of the starting relay, make contacts X1 of the down-preference relay X, break contacts F2 of the inductor stopping relay, normally-closed contacts of a mechanical limit switch 35 which are opened as the elevator car nears the lower limit of its travel in the down direction and the coil of the down switch D. When the down switch D is energized, make contacts D5 are closed to provide a holding circuit around the contacts 80-1 and X1.

Before the holding relay G and the inductor relays E and F can be energized, make contacts M1 of the car-running relay must be closed. In addition, any one set of make contacts J1 of the reversal relay, TT1 of the car-call stopping relay, and K1 of the floor-call stopping relay must be energized. A holding circuit around these contacts is established upon closure of the make contacts G1. Energization of the inductor stopping relay F further requires closure of the break contacts V2 of the speed relay.

If the break contacts J2 of the reversal relay are closed, the up-preference relay W is energized only if the elevator car is not operating in the down direction (break contacts D6 are closed); the elevator car is not conditioned for down travel (break contacts X2 are closed); and normally-closed contacts of a mechanical limit switch 36 are closed. The mechanical limit switch 36 is opened as the elevator car reaches its upper limit of travel. Make contacts M7 of the running relay shunt the contacts J2.

Energization of the down-preference relay X requires closure of the break contacts U6 of the up switch, closure of the break contacts W2 of the up-preference relay, and closure of the normally-closed contacts of a mechanical limit switch 37. The mechanical limit switch 37 is open when the elevator car A is adjacent the first or dispatching floor.

The doors for the elevator car A are controlled by a door-control relay 45. For this relay to be initially energized, and assuming that the manual switches 64, 64B and 90 are open, the break contacts N1 and TN1 must be closed to indicate that the elevator car is not being loaded at a terminal floor. Break contacts 70HT2 must be closed to indicate that non-interference time allowed for a corridor or floor call has elapsed or the switch 64 must be closed. In addition, the break contacts 70T1 must be closed to indicate that the general non-interference time has expired. The switch SE1 must be closed to indicate that the safety edge SE of the door is not deflected. The make contacts SR1 must be closed to indicate that no object is positioned in the closing path of the door. The break contacts 70-1 must be closed to indicate that an auxiliary or shortened non-interference time has expired. Finally, the make contacts RE1 must be closed to indicate that the door is not to reopen. When the relay 45 picks up, it closes make contacts 45-1 to partially complete a holding circuit for the relay.

If the switch 90 is closed, the energization of the relay 45 is further controlled by two circuits, one containing the switch MOSL and make contacts 45-4. The remaining circuit contains a cam-operated switch 68 which is open only when the elevator car is at the lower terminal floor, a switch TS1 which is open only when the elevator car is assigned for down peak operation and break contacts NU1 of a timing relay.

Should the safety-edge contacts SE1 be held open for an unreasonably long time (a door-hold button could be provided to control the relay 45 in a similar manner) or should the beams of light across the doorway be interrupted for an unreasonably long time, the break contacts NUA1 close to establish with the contacts TN1 and N1 an energizing circuit for the relay 45.

The door-control relay 45 controls the energization of the door-close solenoid DC and the door-open solenoid DO. If the contacts 45-2 of the door-control relay are closed, and the break contacts 40-2 are closed, the solenoid DC is energized. The contacts 40-2 are closed when the door of the elevator car A or an associated hoistway door is away from its closed condition. If a manual switch 64A is open the energization of the solenoid DC also is controlled by the contacts SE3 and SEA2 in parallel.

If the door-control relay 45 is dropped out, the make contacts 45-3 are closed to complete with the switch 38 an energizing circuit for the door-open solenoid DO. The switch 38 is a limit switch which is normally closed and which is opened as the door reaches its fully-open position.

The timing relay 70T is connected for energization by make contacts M5 of the car-running relay. The energizing circuit is completed through break contacts 300-1 of an expediter relay. It will be noted that a resistor R2 is connected across the timing relay 70T and the contacts 300-1. If the timing relay is energized and the contacts M5 thereafter open, the resistor R2 delays the dropout of the timing relay 70T for a suitable non-interference time, such as 5 seconds. If the contacts 300-1 open, the relay 70T drops out promptly. The effective resistance value of the resistor R2 is controlled by break contacts TL3 and L3 to decrease the time delay when the car is at a terminal floor to a value such as 2 seconds.

The retector relay SR is controlled by the make contacts PR1-1 and PR2-1. These contacts are closed respectively as long as the photocells PC1 and PC2 (Fig. 1) are illuminated by their respective radiant energy beams. The contacts may be bypassed by operation of a manual switch 62, or by operation of a manual switch 62A which is in series with the switch 38B which is closed as long as the door is within say ten inches of fully-open position.

Break contacts SR2 and SR3 of the relay SR respectively control the energization of the time delay relay SRT and the expediter relay 300. The time delay relay SRT may have a time delay in dropout of the order of one-half second.

The expediter relay 300 also may be energized by closure of contacts 51. These contacts may be arranged to close whenever a car call is registered in the elevator car A for the purpose of expediting departure of the elevator car from a floor at which it is stopped. For present purposes it will be assumed that the contacts 51 represent a push button which is located in the elevator car A and which is operated to expedite departure of the elevator car from a floor.

Although the lamps LA1 and LA2 of Fig. 1 may be continuously illuminated, they are illustrated in Fig. 2 as illuminated through break contacts M6 of the car-running relay M.

FIGURE 3

Fig. 3 illustrates additional circuits for controlling door operation and circuits for energizing the car-call stopping relay TT, and the floor-call stopping relay K.

If make contacts K2 of the floor-call stopping relay and the break contacts J3 of the reversal relay are both closed, the timing relay 70HT is energized and picked up. This relay has a time delay in dropout determined by a resistor R3 which may be of the order of two seconds to establish a shortened non-interference time under certain conditions. If a different time is desired at a certain floor a mechanical switch 69 may be operated at such floor to modify the dropout time. In the present case the switch closes to shunt a portion of the timing resistor R3 in order to increase the dropout time to say three seconds.

Make contacts 70HT1 and SRT1 in parallel control the energization of an auxiliary relay 70.

Make contacts SR4 control the energization of a timing relay NU. This relay has a time delay in dropout (determined by a resistor R4) which may be of the order of four seconds.

Make contacts SR5 of the detector relay SR and the contacts SE2 operated by the safety edge SE control in part the energization of a timing relay NUA which has a time delay in dropout of say twelve seconds as determined by a resistor R5. If the relay NUA is picked up, opening of make contacts LWA1 drops out the relay promptly.

The timing relay LWA is energized through any of four paths. One path contains the break contacts LW of the load weighing switch LW. A second path contains break contacts of a switch 68A which is closed only when the elevator car is at the bottom terminal floor and contacts TS3 which are closed only during down peak periods. The third path has contacts of a mechanical switch 68B which is closed only when the elevator car is away from the terminal floors and contacts TS4 which are closed only during up peak periods. The fourth path contains a limit switch 38C which is open only when the door is open.

The car-call push buttons 2*c* to 5*c* normally are biased into their open positions against back contacts 2*cx* to 5*cx*. The button 1*c* for the first landing does not have such back contacts. Each of the push buttons is provided with a holding coil 1*cc* to 5*cc*, which is effective for holding the associated pushbutton in its operated condition following a manual operation of such pushbutton. To this end, the pushbuttons may be made of magnetic material. Such construction of the pushbuttons is well known in the art.

Each of the pushbuttons 2*c* to 5*c* has front contacts controlling the connection of contact segments to the bus L+. When operated, the push button 2*c* connects the contact segments *a*2 and *h*2 to the bus L+. The push buttons 3*c* and 4*c* similarly connect contact segments for the third and fourth floors to the bus L+. Inasmuch as the elevator car is assumed to stop at the fifth floor or upper terminal floor at all times during up travel, the contact segment *a*5 is permanently connected to the bus L+. Similarly, during down travel, the elevator car A always stops when it reaches the first floor, and the contact segment $h1$ for the first floor is permanently connected to the bus L+.

It will be understood that the contact segments $a2$ to $a5$ are arranged in a row on the floor selector 19 of Fig. 1 and are successively engaged by a brush 23 as the elevator car moves from its lower limit to its upper limit of travel. In a similar manner, the contact segments $h4$ to $h1$ are arranged in a row in the order of the floors for successive engagement by a brush $40a$ as the elevator car moves from the upper terminal to its lower limit of travel.

During up travel of the elevator car A, the car-call stopping relay TT is connected between the brush **23** and the bus L− through make contacts W3 of the up-preference relay and make contacts M3 of the car-running relay. Consequently, when the brush 23 reaches one of the contact segments $a2$ to $a5$ which is connected to the bus L+, the car-call stopping relay TT is connected for energization across the buses L+ and L− for the purpose of stopping the elevator car at the next floor reached by the car. As the elevator car stops, the brush **23** preferably passes slightly beyond the associated contact segment.

When the elevator car A is conditioned for down travel, the car-call stopping relay TT is connected between the brush $40a$ and the bus L− through the make contacts X3 of the down-preference relay and the make contacts M3 of the car-running relay. Consequently, when the brush $40a$ reaches one of the contact segments $h4$ to $h1$ which is connected to the bus L+, the car-call stopping relay TT is energized to initiate a stopping operation of the elevator car at the next floor reached by the car. As the elevator car stops, the brush $40a$ preferably passes slightly beyond the associated contact segment.

The coils $1cc$ to $5cc$ are connected in series for energization either through make contacts W4 of the up-preference relay or make contacts X4 of the down-preference relay. When the elevator car reverses its direction of travel, the make contacts W4 and X4 both are momentarily opened to deenergize the associated holding coils for the purpose of resetting the car-call push buttons.

Each of the push buttons $1c$ to $5c$ when operated opens a set of contacts $1cy$ to $5cy$ respectively. These contacts control a reopening operation of the door which will be discussed below.

Each of the car-call buttons when operated also opens an auxiliary set of normally-closed contacts $2cx$, $3cx$ and $4cx$ respectively. These are employed in a high call circuit which will be discussed below. A set of contacts $5cx$ and a holding coil $5cc$ also are provided for the fifth floor.

When the down floor-call push button 2D is operated, the down floor-call storing relay 2DR is connected therethrough across the buses L+ and L− for energization. Upon energization, the relay closes its make contacts 2DR1 to establish a holding circuit around the push button. The contact segment $f2$ now is connected (and corresponding contact segments for the remaining elevator cars are connected) through the contacts 2DR1 to the bus L+. The contact segments $f4$ and $f3$ similarly are connected to the bus L+ by operation of the down floor-call push buttons 4D and 3D. The contact segments $f4$, $f3$ and $f2$ for the fourth, third, and second floors are positioned in a row on the floor selector 19 of Fig. 1 for successive engagement by a brush 58 as the elevator car A moves from the upper terminal in a down direction.

The floor-call stopping relay K is connected between the bus L+ and the brush 58 through make contacts X5 of the down-preference relay. Consequently, if the elevator car A approaches the second floor during a down trip while a down floor call is registered for such floor, the engagement of the contact segment $f2$ by the brush 58 completes an energizing circuit for the floor-call stopping relay K.

Each of the down floor-call storing relays **4DR**, **3DR** and **2DR** has an operating coil and a cancelling coil, respectively, **4DRN**, **3DRN** and **2DRN** which is energized in opposition to the energization of the operating coil. The cancelling coil **2DRN** is connected between a contact segment g**2** (and similar contact segments Bg2 etc. for the other elevator cars) and the bus L+ through the make contacts **2DR1**. As the elevator car A reaches the second floor, the following energizing circuit for the cancelling coil is established:

L+, **2DR1**, **2DRN**, g**2**, **59**, X6, M4, L−

Energization of the coil **2DRN** opposes energization of the relay by the operating coil and resets the relay. It will be understood that the contact segments g**4**, g3 and g**2** are arranged in a row for successive engagement by the brush **59** as the elevator car proceeds downwardly from the upper terminal floor to control the energization of the cancelling coils **4DRN**, **3DRN** and **2DRN**.

The down floor-call storing relays all cooperate with the brushes **58** and **59** in substantially the same manner to control the energization of the floor-call stopping relay during down travel of the elevator car.

When the up floor-call push button **2U** is operated, the up floor-call storing relay **2UR** is connected for energization therethrough across the buses L+ and L−. Upon operation, the relay closes its make contacts **2UR1** to establish a holding circuit around the push button **2U**. As a result, a contact segment b**2** is connected (and contact segments Bb**2** etc. for the other elevator cars are connected) to the bus L+ through such make contacts.

As the elevator car during up travel approaches the second floor, the brush **60** engages the contact segment b**2** to establish the following energizing circuit for the floor-call stopping relay:

L+, **2UR1**, b**2**, **60**, **W5**, K, L−

This conditions the elevator to stop at the second floor. As the elevator car stops at the second floor, a brush **61** engages the contact segment c**2** to establish the following circuit for the cancelling coil of the storing relay **2UR**:

L+, **2UR1**, **2URN**, c**2**, **61**, **W6**, **M4**, L−

Such energization of the cancelling coil results in resetting of the storing relay which has its main coil acting in opposition to the cancelling coil. The up floor-call push buttons **3U** and **4U** similarly control the associated storing relays and contact segments. It will be understood that the contact segments c**2**, c**3** and c**4**, and contact segments b**2**, b**3** and b**4** are arranged in rows on the floor selector for engagement successively by the brushes **61** and **60**, as the elevator car A proceeds upwardly.

FIGURE 4

In Fig. 4 a starting relay **80**, a dispatching device which normally controls the lower terminal dispatching of the elevator cars employed in the system, and a reversal relay J are illustrated.

The starting relay **80** can be energized only if the timing relay **70T** is deenergized and dropped out to close its break contacts **70T2**. If additional non-interference time is allowed for a corridor or floor call, the manual switch **65** is open and break contacts **70HT3** of the timing relay also must be closed to permit energization of the relay **80**. When the elevator car is positioned at the lower dispatching floor, the energizing circuit for the starting relay normally is completed through the make contacts **S1** of an auxiliary starting relay. At the upper terminal or dispatching floor, make contacts UTS1 may operate in a manner similar to the operation of the contacts S1 for the lower dispatching floor to start the elevator car from the upper terminal floor. Between the dispatching floors, the make contacts **S1** are shunted by the contacts of a mechanical switch **63**. This switch is cam operated to open when the elevator car is adjacent the upper terminal or dispatching floor and the lower dispatching floor. For all other positions of the elevator car A, the switch **63** is closed.

The selection and timing mechanism include as one component a motor **71** which operates substantially at constant speed. This motor may be of any suitable type, but for present purposes it will be assumed that the motor is a squirrel-cage alternating-current motor which is energized from a suitable source of alternating current. The motor **71** is connected through a spring-released electromagnetically-applied clutch **72** to a cam **73** having a protuberance for successively operating mechanical switches Y, BY, CY and DY which are associated with the respective elevator cars. The electromagnetic clutch can be energized only if one or more elevator cars are located at the dispatching floor which is assumed to be the first floor (one or more of the contacts L1, BL1, CL1, DL1 are closed), and if no elevator car has been selected as the next car to leave the dispatching floor (break contacts N2, BN2, CN2 and DN2 all are closed).

The motor **71** also may be coupled through a spring-released electromagnetically applied clutch **74** to a cam **75** which is biased towards a predetermined position by a spring **76**. The cam **75**, when coupled to the motor **71**, is rotated against the bias of the spring to close normally-open contacts **77** a predetermined time after the cam **75** is coupled to the motor **71**. The clutch **74** can be electrically energized only if no elevator car is being started (break contacts S2, BS2, CS2 and DS2 are closed), and if the break contacts 1S1 of the holding relay 1S are closed. The holding relay 1S is energized upon closure of the contacts **77** to close its make contacts 1S2 for the purpose of establishing a holding circuit around the contacts **77**.

The presence of an elevator car at the dispatching floor is determined by the energization of a car-position relay for each of the elevator cars. Thus, a car-position relay L for the elevator car A is energized when the brush **24** engages the contact segment *e*1.

The brush **24** is operated by the floor selector for the elevator car A to engage the contact segment *e*1 when the elevator car is at the dispatching floor.

If the elevator car A is at the dispatching floor (make contacts L2 are closed), if it has been selected as the next car to leave the dispatching floor (switch Y is closed), and if it is not being started (break contacts S3 are closed), the loading relay N for the elevator car A is energized. The loading relay may be employed in a conventional way to permit loading of the elevator car A. For example, the loading relay when energized may operate a loading signal, such as a lamp, which indicates that passengers may enter the elevator car. Conveniently, the loading relay N when energized opens the normally-closed doors of the elevator car A to permit entry of passengers into the elevator car.

After the expiration of a time sufficient for cam **75** to close the contacts **77** and energize the relay 1S, the make contacts 1S3 close to complete the following circuit:

L+, L2, S, N3, 1S3, L−

The relay S when energized closes its make contacts S4 to establish a holding circuit around the contacts N3 and 1S3, and starts the elevator car A from the dispatching floor.

If the elevator car is loaded before expiration of the interval measured by the relay 1S it may be advisable to expedite departure of the car. To this end a manual switch **99** may be closed to connect the relay 2S for energization through any of four parallel circuits, one for each of the elevator cars. The circuit for the elevator car A includes break contacts 70T3 of the non-interference relay, make contacts N4 of the loading relay and a switch LW1 which is closed only when the load in the elevator car exceeds say 80 percent of rated capacity. Thus if the elevator car A is selected as the next car to leave the terminal floor (contacts N4 are closed), if the non-interference time has expired (contacts 70T3 are closed) and if the elevator car is fully loaded (switch LW1 is closed) the relay 2S picks up and closes its contacts 2S1. Since the contacts 2S1 shunt the contacts 1S3, prior closure of the former contacts expedites dispatch of the elevator car.

Fig. 4 also discloses a reversal relay J which is connected between a brush **66** and the bus L+ through a manually-operated switch **67** and make contacts W7 of the up-preference relay. The brush **66** and an associated row of contact segments *k*2, *k*3 and *k*4 are included in the floor selector of Fig. 1. The contact segments are associated with a call circuit which includes break contacts of the call registering relays and the contacts 3CX, 4CX and 5CX associated with the car call push buttons. By tracing this circuit in Fig. 4 it will be noted that the bus L+ is connected to the contact segment *h*2 through the following circuit:

L+, 5DR2, 5CX, 4UR2, 4DR2, 4CX, 3UR2, 3DR2, 3CX, 2UR2, *k*2

(A down floor call registering relay is not illustrated in Fig. 3 for the fifth floor, but it will be understood that the break contacts 5DR2 of Fig. 4 are operated by a push button for the fifth floor in the same manner by which break contacts 4DR2 are operated by its push button for the fourth floor.) Consequently, contacts of all call registering relays or car call push buttons which when operated require car travel above the second floor are located between the contact circuit segments *k*2 for the second floor and the bus L+.

The contact segment *k*3 is connected to the call circuit between the contacts 3UR2 and 3DR2. Consequently, contacts of all call registering relays or car call push buttons requiring travel of the elevator car above the third floor are located between the contact segment *k*3 for the third floor and the bus L+. In an analogous manner, the contact segment *k*4 for the fourth floor is connected to the call circuit at a point between the contacts 4UR2 and 4DR2. Such call circuits are well known in the art.

The contacts 1*cy* to 5*cy* which are operated by the car-call push buttons are connected in series with the operating coil of the reopen relay RE across the buses L+ and L−. The relay also may be energized through any of the make contacts N5, TN5, S5 and UTS5 of the loading and auxiliary starting relays for the terminal landings. Finally, the relay RE may be energized through the break contacts L4 and TL4 of the car-position relays.

When the reopen relay operates, it opens break contacts RE2 to deenergize a suitable signal, such as a sign indicating that another car will be the next to leave the floor.

Operation

In order to explain the overall operation of the elevator system, it will be assumed first that the elevator cars are at the first or dispatching floor when the system initially is energized. The cars are conditioned for operation in the up direction. For example, the switches MOS and MOS1 are closed and the elevator car A has its up-preference relay W energized. Consequently, make contacts W1, W2, W3, W4, W5, W6, W7 of the relay are closed, whereas break contacts W2 of the relay are open. Time delay relay 72T is energized and picked up.

The switches **62A**, **90** (Fig. 2), **63A** and **67** (Fig. 4) are assumed to be open. Since the cars are at the first floor, the switch **63** also is open. The timing relay **70T** is assumed to have timed out. The relays SR, **45** and **40** are picked up and the elevator car doors are closed. Switches **64A**, **64B**, **64C**, **67S1** and **68A** are closed and switches **68B** and **67S2** are open.

The motor **71** (Fig. 4) is energized to rotate at a substantially constant rate.

Inasmuch as the elevator cars are assumed to be at the dispatching floor, the car-position relays L, etc. are energized.

As a result of its energization, the car-position relay L closes its make contacts L2 to prepare certain circuits for subsequent energization. In addition, the make contacts L1 close to complete the following circuit for the clutch **72**.

L+, L1, 72, N2, BN2, CN2, DN2, L−

The clutch now couples the motor **71** to the cam **73** for the purpose of successively closing and opening the associated mechanical switches. It will be assumed that the first switch reached by the cam is the switch Y for the elevator car A. Closure of this switch completes the following energizing circuit for the loading relay of the elevator car A:

L+, L2, N, S3, Y, L−

The loading relay N upon energization initiates opening of normally-closed doors of the elevator car A to permit intending passengers on the dispatching floor to enter the elevator car. Such opening is effected by opening of contacts N1 (Fig. 2) to deenergize the door-control relay **45**. This relay opens its contacts **45–1** and **45–2** without immediate effect on system operation. However, closure of contacts **45–3** energizes the solenoid DO to open the doors. In opening, the door opens its set of contacts **33** to deenergize the door relay **40** which opens its contacts **40–1** and closes its contacts **40–2** without immediate effect on system operation. When the door reaches a position say ten inches from fully-open position the switch **38B** closes. On reaching a position say one inch from fully-open position the door opens the switch **38A**. These switch operations have no immediate effect on the system. When it reaches open position, the door opens limit switch **38** to deenergize the solenoid DO.

Opening of the break contacts N2 (Fig. 4) deenergizes the clutch **72**. Consequently, the cam **73** is uncoupled from the motor **71**. The make contacts N3 close to prepare the starting relay S for subsequent energization. Closure of the make contacts does not affect the immediate operation of the system.

When the system was placed in operation, the clutch **74** was energized through the circuit:

L+, 1S1, 74, S2, BS2, CS2, DS2, L−

As a result of its coupling to the motor **71**, the cam **75** rotates against the bias of its spring **76** until at the expiration of the time interval allowed for loading elevator cars the contacts **77** close. Closure of these contacts completes the following circuit:

L+, 1S, 77, S2, BS2, CS2, DS2, L−

The energized relay 1S closes its make contacts 1S2 to establish a holding circuit around the contacts **77**. The break contacts 1S1 open to deenergize the clutch **74**, and the spring **76** now rotates the cam to its starting position. Also, the make contacts 1S3 close to energize the auxiliary starting relay S through the following circuit:

L+, L2, S, N3, 1S3, L−

Energization of the auxiliary starting relay S closes the make contacts S4 to establish a holding circuit around the contacts N3 and 1S3. Break contacts S3 open to deenergize the loading relay N. Break contacts S2 open, and this opening causes relay 1S to drop out. This has no immediate effect on the system operation. Closure of the make contacts S5 has no immediate effect on operation of the system.

The loading relay when deenergized opens its make contacts N3 and N5 without immediate effect on the operation of the system. In addition, break contacts N2 close to prepare the clutch **72** for subsequent energization.

The deenergization of the loading relay further closes break contacts N1 (Fig. 2) to complete with the contacts **70–1**, SR1, **70T1** and TN1 an energizing circuit for the door-control relay **45**. The latter relay closes its make contacts **45–1** and opens its break contacts **45–3** without immediate effect on system operation. However, closure of make contacts **45–2** completes with the contacts **40–2** an energizing circuit for the door-close solenoid DC, and the door now starts to close. If the switch **62** is open and a passenger is in the closing path of the door, he interrupts one of the beams of radiant energy and one of the sets of contacts PR1–1 or PR2–2 opens to deenergize the detector relay SR. This relay then opens its make contacts SR1 to deenergize the door-control relay **45**. The latter opens its contacts **45–2** to deenergize the door-close solenoid and closes its contacts **45–3** to energize the door-open solenoid for the purpose of reopening a partly-closed door. The detector relay also closes its break contacts SR2 and SR3 to energize the relays SRT and **300**. The energization of the relay **300** has no effect at this time on the operation of the system but the energization of the relay SRT closes make contacts SRT1 to pick up the timing relay **70** (Fig. 3). This relay opens its break contacts **70–1**. After the passenger clears the door closing path, the detector relay SR picks up to close its make contacts SR1, and open its break contacts SR2 and SR3. The resultant drop out of the relay **300** has no effect at this time on the system operation. However, the opening of contacts SR2 starts a timing out operation of the relay SRT. After the expiration of its time delay, such as one-half second the relay SRT drops out to open its contacts SRT1 and such opening drops out relay **70**. The relay **70** closes its break contacts **70–1** to complete a circuit for the relay **45**.

The operations of relays NU, NUA and LWA will be discussed below.

In some cases, it is desirable to prevent a reopening of the the door by the relay SR. In such a case, the manually-operated switch **90** may be closed to connect make contacts **45–4** of the door-control relay and the switch MOS1 around the contacts SR1 and **70–1**. When the door-control relay picks up, the resulting closure of its contacts **45–4** assures door closure despite subsequent drop out of the relay SR, provided that the switch MOS1 is closed to indicate that the motor generator set is running. For the following discussion, the switch **90** is considered to be open. Even with the switch **90** closed, if the door actually encounters a person, the safety edge would open the switch SE1 to deenergize the relay **45** and reopen the door.

It will be assumed however that no person is in the closing path and that the door closes. Upon closing, the door closes its switch **33** to complete an energizing circuit for the door relay **40** which closes its make contacts **40–1** and opens its break contacts **40–2** to denergize the door-close solenoid DC.

Turning now to Fig. 4, it will be noted that closure of the make contacts S1 results from energization of the auxiliary starting relay S. Inasmuch as the elevator car A is assumed to have remained at the dispatching floor for a time sufficient to permit closure of the break contacts **70T2**, an energizing circuit now is complete for the main starting relay **80**. Switch **65** is assumed to be closed.

The previously mentioned closure of contacts **40–1** of the door relay (Fig. 2) coupled with closure of the make contacts **80–1** of the starting relay completes the following circuit for the up switch and the car-running relay:

L+, **80–1**, W1, F1, 34, U, M, **40–1**, L−

The energized up switch U closes its make contact U1 to release the brake **17**, and contacts U2 and U3 close to energize the generator field winding **29C** with proper polarity for up travel of the elevator car. Make contacts U4 close to complete through the limit switch 30 and the contacts E1 an energizing circuit for the speed relay V. The speed relay closes its make contact V1 to shunt the resistor R1 and condition the elevator car A for full speed operation in the up direction. Also, the speed relay opens its break contacts V2 to prevent energization therethrough of the stopping inductor relay F. Closure of make contacts V3 establishes with contacts 45–1, TN1 and N1 a holding circuit for the relay 45. Closure of make contacts V4 maintains energization of the relay 72T following the opening of the contacts M11.

Returning to the up switch U, it will be noted that closure of the make contacts U5 establishes a holding circuit around the contacts 80–1 and W1. Opening of the break contacts U6 prevents energization therethrough of the down preference relay. The elevator car A now is in condition for full speed operation in the up direction and departs from the dispatching floor.

It will be recalled that the car-running relay M was energized with the up switch U. The car-running relay closed its make contacts M1, M3, M4 and M7 (Fig. 3) without immediate effect on the operation of the system. Closure of the make contacts M2 (Fig. 2) with the switch 64C shunts the contacts V3. (Opening of break contacts M6 deenergizes the lamps LA1 and LA2 if those are not continuously energized. However, continuous illumination of the lamps is assumed.) Closure of the make contacts M5 energizes the timing relay 70T. This relay opens its break contacts 70T2 (Fig. 4) which causes the starting relay 80 to become deenergized. Opening of break contacts 70T1 (Fig. 2) and closure of make contacts 70T5 do not immediately affect system operation.

It will be assumed now that the passenger in the elevator car operates the car-call push button 3*c* (Fig. 3) to register a car call for the third floor. Such operation opens the contacts 3*cx* and 3*cy* without immediate effect on the system and connects the contact segment *a*3 and *h*3 to the bus L+. As the elevator car nears the third floor, the brush 23 engages the contact segment *a*3 to complete the following circuit for the car-call stopping relay TT:

L+, 3*c*, *a*3, 23, W3, TT, M3, L−

The car-call stopping relay now closes its make contacts TT1 (Fig. 2) to energize the holding relay G and the slow down inductor relay E through the closed contacts M1. Energization of the holding relay G completes through the make contacts G1 a holding circuit around the contacts TT1.

When the elevator car A in its upward travel reaches the inductor plate UEP (Fig. 1) for the third floor, the break contacts E1 are opened to deenergize the speed relay V (Fig. 2). The speed relay opens its break contacts V1 to introduce the resistor R1 in series with the generator field winding 29C. The resultant reduction in field current slows the elevator car to a landing speed. In addition, the speed relay V closes its break contacts V2 to complete through the contacts G1 and M1 an energizing circuit for the stopping inductor relay F. Opening of the make contacts V3 has no immediate effect on system operation.

Opening of the make contacts V4 starts a timing out operation of the relay 72T. This relay may have a time delay in drop out of the order of six seconds. If the relay drops out such drop out indicates that the elevator car has failed to reach its stopping position within a reasonable time and is stalled.

Shortly before the elevator car A in its continued upward movement at the landing speed reaches the third floor, the inductor plate UFP for the third floor is adjacent the stopping inductor relay and completes a magnetic circuit which results in opening of the contacts F1.

Opening of the contacts F1 (Fig. 2) deenergizes the up switch U and the car-running relay M.

The up switch U opens its make contacts U1 to deenergize the brake 17, and the brake is promptly forced against the brake drum 16 by its associated spring. Contacts U2 and U3 open to deenergize the generator field winding 29C. Consequently, the elevator car A stops accurately at the third floor. Opening of the make contacts U4 and U5 and closure of the break contacts U6 have no immediate effect on the operation of the system. As the elevator car comes to a stop the brush 23 may pass the contact segment for a slight distance to deenergize the relay TT.

The previously-mentioned deenergization of the car-running relay resulted in opening of the make contacts M1 to deenergize the inductor relays E and F and the holding relay G. The holding relay G opened its make contacts G1 without immediately affecting the operation of the system.

The car-running relay also opened its make contacts M5 to start a timing-out operation of the timing relay 70T. Contacts M5 preferably open with a slight time delay to assure prior closure of contacts 300–1. This relay 70T has a time delay in drop out sufficient to permit discharge of passengers or entry of passengers into the elevator car A. For example, a time delay of five seconds may be employed. Opening of the make contacts M3 and closure of the break contacts M4 have no immediate effect on the operation of the system. (If continuous illumination of the lamps is not employed, closure of contacts M6 illuminates the lamps LA1 and LA2, and these illuminate their associated photocells to close contacts PR1–1 and PR2–1 which pick up relay SR. The pick up of relay SR and the resulting deenergization of relays SRT and 300 have no immediate effect on the operation except that closure of contact 300–1 facilitates the previously mentioned energization of the relay 70T.) However, the relay SRT starts to time out.

Closure of the break contacts M11 reenergizes the relay 72T. Normally this occurs before the relay can drop out.

Opening of make contacts M2 deenergizes the door control relay 45 and this relay opens its make contacts 45–1 and 45–2 without immediate effect on system operation. However, closure of break contacts 45–3 completes with the switch 38 a circuit for the door-open solenoid DO and the door now opens. In opening, the door opens its switch 33 to deenergize the door relay 40 without immediate effect on system operation.

Let it be assumed that instead of a car call, an up floor call was registered for the third floor by operation of the push button 3U (Fig. 3). Such operation energizes the up floor call storing relay 3UR which closes its make contacts 3UR1 to establish a holding circuit around the push button. The contacts 3UR1 also serve to connect the contact segment *b*3 and corresponding contact segments for the remaining elevator cars of the system to the bus L+. Opening of contacts 3UR2 and 3UR3 does not affect the operation of the system at this time.

As the elevator car approaches the third floor, the brush 60 engages the contact segment *b*3 to energize the floor-call stopping relay K through the following circuit:

L+, 3UR1, *b*3, 60, W5, K, L−

Upon energization, the floor call stopping relay closes its make contacts K1 (Fig. 2) to energize through the contacts M1 the holding relay G, the slowdown inductor relay E and the stopping inductor relay F. These relays operate in the same manner previously discussed to stop the elevator car accurately at the third floor. Contacts K2 of the floor call stopping relay also close to complete with the contacts J3 an energizing circuit for the relay 70HT. The latter relay 70HT closes its make contacts 70HT1 and opens break contacts 70HT2 and 70HT3 without immediately affecting the operation of the system.

As the elevator car A slows down to stop at the third floor, the brush **61** engages the contact segment $c3$ to complete the following cancelling circuit:

L+, 3UR1, 3URN, $c3$, **61**, W6, M4, L−

It will be recalled that the break contacts M4 close as the elevator car stops at the third floor. As a result of its energization, the cancelling coil 3URN resets the up floor-call storing relay for the third floor. Such reset is accompanied by deenergization of the floor-call stopping relay K which opens its make contacts K1 without affecting system operation. However, the opening of the make contacts K2 starts a timing out operation of the relay 70HT.

Referring to Fig. 4, it will be recalled that the mechanical switch **63** is open only at the dispatching-floor and the upper-terminal floor positions of the elevator car. Since the elevator car is now at the third floor, the switch **63** is closed. Consequently, as soon as the timing relay **70**T drops out, the break contacts **70**T**2** close to complete an energizing circuit for the starting relay **80**. This operates in the manner previously discussed to start the elevator car upwardly. In this way, the elevator car A continues to the upper terminal floor, answering all registered car calls and all registered up floor calls during its upward trip.

As previously pointed out, the drop out of the timing relay **70**T for intermediate landing stops (contacts TL3 and L3 are closed) provides a non-interference time which may be of the order of 5 seconds. If desired, a longer non-interference time may be provided for a stop made in response to a corridor or floor stop. For example, assume that the switches **64** (Fig. 2) and **65** (Fig. 4) are open and that the relay **70**HT has a delay in drop out of say six seconds. Under such circumstances, the relay **45** (Fig. 2) cannot be energized to close the door and the relay **80** (Fig. 3) cannot be energized to permit starting of the car until a non-interference time of six seconds has elapsed to permit closure of contacts **70**HT**2** and **70**HT**3**. It will be assumed, however, that the switches **64** and **65** are closed.

If a passenger leaves the elevator car at the third floor promptly, say, in 1 second, it follows that a substantial and unnecessary delay in the departure of the elevator car would be imposed if the relay **70**T is allowed to complete its normal timing interval before the car departs from the third floor.

In the present case, the departure of the elevator car is expedited to an extent dependent on whether the elevator car is answering a car call or a floor call. By reference to Fig. 1, it will be noted that when the car stops for a car call and the passenger leaves the elevator car at the third floor, he temporarily interrupts the beams of radiant energy directed towards the photocells PC**1** and PC**2**. Such temporary interruption temporarily interrupts and drops out the relays PR**1** and PR**2**.

Referring to Fig. 1 and Fig. 2, it will be noted that the drop out of the relays PR**1** and PR**2** opens make contacts PR**1**–**1** and PR**2**–**1** to deenergize the detector relay SR. The detector relay opens its make contacts SR**1** to prevent energization therethrough of the door-control relay **45** as long as the passenger stands in the closing path of the door. In addition, break contacts SR**2** and SR**3** close to energize the time delay relay SRT and the expediter relay **300**. Energization of the time delay relay SRT results in closing of the make contacts SRT**1** and pick up of the relay **70** without immediately affecting the operation of the system. The relay **70** opens its break contacts **70**–**1**. The expediter relay **300** opens its break contacts **300**–**1** to instantly drop out the timing relay **70**T. Since the timing relay is now dropped out, it closes its break contacts **70**T**1**. However, since the contacts SR**1** and **70**–**1** are open, the door-control relay **45** cannot be energized. In addition, break contacts **70**T**2** (Fig. 4) close to complete with the switch **63** an energizing circuit for the main starting relay **80**. The main starting relay **80** closes its make contacts **80**–**1** (Fig. 2) without immediate effect on the operation of the system. Contacts SR**4** and SR**5** (Fig. 3) open to start timing out operations of the relays NU and NUA.

It will be assumed that the passenger passes promptly through the doorway and that the beams of radiant energy are promptly reapplied to their associated photocells. As a result of such reapplication, the make contacts PR**1**–**1** and PR**2**–**1** reclose to energize the detector relay SR. This relay opens its break contacts SR**3** to deenergize the expediter relay **300**, but such deenergization has no immediate effect on the operation of the system. Opening of the break contacts SR**2** initiates a timing out operation of the time delay relay SRT. Closure of the make contacts SR**1** has no immediate effect on the energization of the door control relay **45** for the reason that the contacts **70**–**1** are still open. Closure of make contacts SR**4** and SR**5** (Fig. 3) reenergizes the relays NU and NUA.

Upon the expiration of the one-half second time delay in dropout of the relay SRT, this relay drops out to open its make contacts SHT**1**. The auxiliary relay **70** now closes its break contacts **70**–**1** to complete the energizing circuit for the door-control relay **45**. This relay **45** thereupon operates in the manner previously described to initiate a door-closing operation of the door of the elevator car A and the starting of the elevator car A from the third floor. It should be noted that this operation may save several seconds of time in starting the elevator car from the third floor.

Should another passenger immediately follow the first passenger to leave the elevator car at the third floor, the radiant energy beams again would be interrupted to deenergize the detector relay SR. This relay would reclose its break contacts SR**2** to reenergize the time delay relay SRT. Since the relay SRT has not yet dropped out, the reenergization thereof occurs before the elevator car door starts to close and delays reclosure of the door for the full time delay of the relay SRT. If a larger number of passengers follow each other out of the elevator car A, it follows that the relay SRT is reset in response to each departure of a passenger. A similar operation results from the successive entry of a plurality of passengers into the elevator car. Following the entry of the last passenger, the relay **45** is operated to close the door and start the elevator car.

The effect of movement of a passenger or an intending passenger out of or into the elevator car located at the third floor now will be considered for the case in which the elevator car has stopped at the third floor in response to the floor call registered by operation of the push button 3U. It will be recalled that if the elevator car A stopped at the third floor under these conditions, the make contacts K2 (Fig. 3) closed to energize the timing relay **70**HT and then reopened to start a timing out operation of the relay. For such operation, this relay may have a delay in drop out of the order of two seconds. When the relay **70**HT was energized, it closed its contacts **70**HT**1** to assist in maintaining energized the auxiliary relay **70**. It is assumed that the switch **64** is closed to shunt the break contacts **70**HT**2**.

If no passenger enters or leaves the elevator car for a period of two seconds, the timing relay **70**HT finally drops out to deenergize the auxiliary relay **70**. The relay **70** closes its break contacts **70**–**1** (Fig. 2) but the door control relay **45** cannot yet be energized for the reason that the break contacts **70**T**1** of the timing relay **70**T are still open.

If the elevator car remains at the third floor for a total of five seconds without the entry of an intending passenger or departure of a passenger from within the elevator car, the timing relay **70**T drops out to close its break contacts 70T1 and 70T2 (Fig. 4). This operation of the timing relay initiates the closing of the door and the starting of the elevator car from the third floor in the manner previously described.

Next let it be assumed that a passenger left the elevator car one second after the elevator car stopped at the third floor. It will be recalled that at this time the timing relays 70T and 70HT both had been picked up and both are timing out.

As the passenger passes through the doorway he temporarily interrupts the beams of radiant energy directed toward the photocells PC1 and PC2. Consequently, the relays PR1 and PR2 temporarily drop out to interrupt momentarily the energizing circuit for the detector relay SR. The detector relay SR momentarily opens its make contacts SR1 without immediate effect on the operation of the system. In addition, break contacts SR2 and SR3 close to energize the time delay relay SRT and the expediter relay 300. Opening of the make contacts SR4 and SR5 starts timing out operations of the relays NU and NUA.

As a result of its drop out, the expediter relay 300 opens its break contacts 300-1 to drop out instantly the timing relay 70T. The resulting closure of the break contacts 70T1 is ineffective for energizing door control relay 45 for the reason that the break contacts 70-1 of the auxiliary relay 70 are still open. The closure of the break contacts 70T2 (Fig. 4) completes an energizing circuit for the main starting relay 80. However, the main starting relay can not start the elevator car until the door is closed.

The temporary energization of the time delay relay SRT results in an energizing and timing out of this relay, inasmuch as this relay is assumed to have a delay in drop out of the order of one-half second. It finally drops out to open make contacts SRT1. Such opening has no effect on the system for the reason that the make contacts 70HT1 are still closed.

Upon the expiration of two seconds following the stopping of the elevator car at the third floor, the timing relay 70HT drops out to open its make contacts 70HT1. This deenergizes the auxiliary relay 70 and results in closure of the break contacts 70-1 to complete the following circuit:

L+, 70-1, SR1, SE1, 70T1, 64, 64B, 45, TN1, N1, L−

The door control relay 45 is now energized to initiate a closing operation of the door and the resultant starting of the elevator car by a sequence which will be clear from the foregoing discussion.

Let it be assumed next that just before the timing relay 70HT timed out a second passenger followed the first passenger out of the elevator car. This resulted in another temporary interruption of the beams of radiant energy directed towards the photocells PC1 and PC2 and a temporary drop out of the relays PR1 and PR2. Consequently, the detector relay SR again is temporarily dropped out to open its make contacts SR1 momentarily and close its break contacts SR3 momentarily to energize the relay 300. Such operations have no immediate effect on the performance of this system. The temporary opening of the make contacts SR4 and SR5 starts a timing out operation of the relays NU and NUA and then reenergizes the relays.

It will be noted that the relay SR also temporarily energizes the time delay relay SRT and this relay closes its make contacts SRT1 just before the make contacts 70HT1 open. Consequently, even though the time period for the timing relay 70HT has expired, the make contacts SRT1 maintain the energization of the auxiliary relay 70 for approximately a half second to permit movement of other passengers through the doorway as required. It will be recalled that the door cannot be reclosed until the auxiliary relay 70 drops out to close its break contacts 70-1. From the discussion, it should be clear that as long as successive passengers follow each other into or out of the elevator car within one-half second intervals, the door of the elevator car remains open to permit such movement of the passengers. One-half second after the departure of the last passenger, the contacts SRT1 open to drop out the auxiliary relay 70 and permit closure of the elevator car door.

In order to make the relay NU effective for controlling the operation of the system, the manual switch 90 may be closed. Such closure connects the break contacts NU1 of the timing relay NU and contacts of a switch TS1 across the contacts SR1 and 70-1.

If a passenger attempts to delay closure of the elevator car door by standing in the path of the beams of radiant energy directed towards photocells PC1 and PC2, he also maintains open the make contacts SR4 to permit a timing out operation of the timing relay NU. Upon the expiration of its time delay, which may be of the order of four seconds, this relay closes its break contacts to complete with the switch TS1 or the switch 68 an energizing circuit for the door controlled relay 45. Under these circumstances, the door promptly starts to close. If the door is provided with a safety edge and the safety edge encounters the passenger, the switch SE1 opens and initiates a reopening operation of door. Should the passenger move out of the path of the beams while the door is reopening, the detector relay SR again picks up and closes its make contacts SR4 to energize the timing relay NU. This relay opens its brake contacts NU1 to prevent energization therethrough of the door control relay. In addition, make contacts SR1 close and break contacts SR2 and SR3 open. Opening of the contacts SR2 initiates a timing out operation of the relay SRT. One-half second later this relay drops out to open its make contacts SRT1 and deenergize the auxiliary relay 70. The auxiliary relay then closes its break contacts 70-1 to complete an energizing circuit for the door control relay 45 and this initiates a closing operation of the door.

It may be desirable under certain conditions to prevent the timing relay NU from controlling the closure of the elevator car door. Thus, contacts may be included which render ineffective the contacts NU1 of the timing relay. For example, it may be undesirable to permit such control by the timing relay NU during a down-peak period at the lower terminal floor. The switch TS1 may be designed to open during the down-peak period. It will be understood that during a down-peak period the demand for elevator service is predominantly in the down direction.

For present purposes, it will be assumed that the switch TS1 is a time switch which opens its contacts during certain periods of the day when down-peak travel is expected. If the time switch is to be effective only at the lower terminal floor, it may be shunted by the mechanical switch 68 which is cam operated to open only at the lower terminal floor and which is closed for all other positions of the elevator car.

Let it be assumed next that the safety edge SE is operated to hold the contacts SE2 open for a period in excess of the dropout time delay of the relay NUA or that a person stands in the paths of the light beams to maintain the contacts SR5 open for such a period. Under such circumstances the relay NUA drops out and closes its contacts NUA1 to complete with the contacts TN1 and N1 an energizing circuit for the door control relay 45, to initiate a positive door-closing operation. If desired the dropout of the relay may operate contacts for controlling the door-closing motor or solenoid to close the doors at slower than normal speed and with increased force. Such operation of the door will be discussed below. If the safety edge SE is released or the person moves out of the paths of the light beams before the door closes, the relay NUA is reenergized and opens its contacts to restore the door control relay 45 to control by the safety edge SE and the light beams. However, if such restoration is not desired the relay NUA may be given sufficient delay in pickup to assure closure of the door.

Even though contacts NUA1 are closed, if the switch 64A is open the closure of the door is prevented if both safety edges SE and SEA are operated. Under such circumstances the parallel contacts SE3 and SEA2 are both opened to deenergize the door-close solenoid DC. If either of the safety edges thereafter is released the door resumes its closing movement.

Under some circumstances the efficiency of the elevator service may be improved by expediting the dropout of the relay NUA. Such dropout is expedited by opening of the make contacts LWA1 of the time-delay relay LWA.

The time delay relay LWA may have a time delay in dropout of the order of three seconds. If the elevator car is not fully loaded the relay LWA is energized through the load switch LW. If the elevator car is loaded in excess of say 80% of capacity, the load switch LW opens to permit deenergization of the relay LWA. If desired the relay LWA may have an instantaneous drop out when deenergized. Conveniently it may have a delay of the order of one and one-half seconds to two seconds to provide enough time for a passenger in a loaded car to interrupt the light beams.

Preferably the deenergization of the relay LWA is prevented while the elevator is at predetermined floors under predetermined traffic conditions. Thus if the elevator car is at the lower terminal floor the switch 68A is closed. If the elevator system at the same time is conditioned to provide down peak service the switch TS3 is closed. Since the relay LWA is maintained energized through the switches 68A and TS3 the relay is ineffective for shortening the dropout time delay of the relay NUA.

If the elevator car is away from both terminal floors the switch 68B is closed. If the elevator system is conditioned at the same time to provide up peak service the switch TS4 is closed. Under these conditions energization of the relay LWA is maintained through the switches 68B and TS4, and the relay is ineffective for shortening the dropout time delay of the relay NUA. During an up peak traffic is predominantly in the up direction. Systems for providing specialized elevator service during peak periods are known in the art. For present purposes it will be assumed that a time switch closes contacts TS4 during the periods of a day for which up peaks are expected to occur.

The relay LWA can be deenergized only while the door is open (switch 38C is open).

Thus if the elevator car is fully loaded at any floor during periods other than up and down peak periods, or if the elevator car is fully loaded at any floor other than the lower terminal floor during a down peak period or if the elevator car is fully loaded at a terminal floor during an up peak period the door will be closed positively three seconds after such full loading occurs or in the time determined by dropout of the relay LWA.

Positive closing of the door at the lower terminal floor during a down peak period usually is unnecessary. For this reason the relay NUA may be energized through an alternative circuit which includes a switch TS7 closed during down peak periods and a cam-operated switch 68C which is closed only when the elevator car is at the lower terminal floor.

Next let it be assumed that the switch 67 in Fig. 4 is closed to permit assignment of the elevator car A under certain conditions to reverse at an intermediate landing. The conditions may be such that no down floor call or no car call is registered for a floor above such landing and that no up floor call is registered for such landing or for any higher landing while the elevator car is set for up travel and is approaching such landing.

For illustrative purposes, let it be assumed that the elevator car A is approaching the fourth floor and that a down floor call for the fourth floor constitutes the only call registered in the system. Under such circumstances, the down floor call registering relay 4DR is picked up and the break contacts 4DR2 (Fig. 4) are open by a sequence clear from the foregoing discussion.

As the elevator car nears the fourth floor, the brush 66 engages the contact segment *k*4 to complete the following circuit:

L+, 5DR2, 5CX, 4UR2, *k*4, 66, 67, W7, J, L−

The relay J closes its make contacts J1 (Fig. 2) to complete with the make contacts M1, an energizing circuit for the relays E, F and G. These operate in the manner previously described to stop the elevator car at the fourth floor. In addition, break contacts J2 open. As the elevator car stops at the fourth floor, the make contacts M7 of the running relay also open to deenergize the up-preference relay W. Since the up-preference relay closes its break contacts W2 to energize the down-preference relay X, the elevator car now is assigned for down travel.

Finally, the reversal relay J opens its break contacts J3 to prevent energization therethrough of the timing relay 70HT. The floor call stopping relay resets and opens its make contacts K2 slightly before contacts J3 reclose. Consequently, the relay 70HT is ineffective for controlling the non-interference time.

The non-interference time of the elevator car now is controlled solely by the timing relays 70T and SRT. Consequently, the elevator car remains at the fourth floor for a maximum of five seconds. However, if a passenger leaves the elevator car or enters the elevator car within the five second period the non-interference time is reset to have a value of only one-half second. This operation of the relays 70T and SRT will be understood from the foregoing discussion.

If the additional time provided by the timing relay 70HT is desired for all floor calls the contacts J3 may be shunted by a manual switch 69A. The contacts M4 may then be given a slight time delay in closing. Under these circumstances the brush 58 is positioned to engage the contact segment *f*4 when the elevator car stops at the fourth floor. Closure of the contacts X5 when the elevator car is set for down travel energizes the relay K and the relay K is then deenergized by reset of the registering relay 4DR following closure of the contacts M4. The momentary closing of the contacts K2 operates in the manner previously described to provide a minimum non-interference time of two seconds. However, it will be assumed that the switch 69A is open and that a reversal of the car at an intermediate floor provides a minimum non interference time of one-half second.

If it is desired to make the relay 70HT effective for reversals at intermediate floors in response to corridor calls only for certain modes of operation, the switch TSA may be designed to close only during such modes. Thus the switch TSA may be a time switch which closes only during the period when the relay 70HT is to be effective for such reversals. For present purposes it is assumed that the switch TSA is permanently closed.

As the elevator car A on its up trip approaches the upper terminal or fifth floor, the brush 23 (Fig. 2) engages the contact segment *a*5 to complete the following energizing circuit for the car-call stopping relay:

L+, *a*5, 23, W3, TT, M3, L−

The car-call stopping relay operates in the manner previously discussed to stop the elevator car accurately at the upper-terminal floor.

As the elevator car A reaches the upper-terminal floor, the mechanical switch 63 (Fig. 4) opens. Consequently, the elevator car A cannot start from the upper-terminal floor until it is started by its upper-terminal dispatching device represented by the contacts TS1. It will be understood that the upper-terminal dispatching device may be similar to the dispatching device discussed for the first floor. For present purposes it will be assumed that the contacts TS1 operate for the upper-terminal dispatching floor in the same manner by which the contacts S1 operate for the lower dispatching floor.

As the elevator car reaches the fifth floor, the limit switch 36 (Fig. 2) opens to deenergize the up-preference relay W. This relay opens its make contacts W1, W3, W5, W6, without immediately affecting the operation of the system. However, opening of the make contacts W4 deenergizes the holding coils for the car-call push buttons, and these are reset. In addition, closing of the break contacts W2 completes the following energizing circuit for the down-preference relay:

L+, U6, W2, X, 37, 38, L−

The down-preference relay X closes its make contacts X1, X3, X4, X5 and X6 and opens its break contacts X2 to condition the elevator car for down travel.

It will be assumed next that the dispatching device for the upper terminal floor closes its contacts UTS1 (Fig. 4) and that the timing relay has closed its break contacts 70T2 to complete an energizing circuit for the starting relay 80. The loading relay of the dispatching device for the upper-terminal floor operates the contacts TN1 to control the door-control relay 45 in the same manner by which contacts N1 control the door-control relay at the lower terminal floor. The closing of the doors coupled with the closing of the make contacts 80–1 completes the following circuit for the down switch D and the car-running relay M:

L+, 80–1, X1, F2, 35, D, M, 40–1, L−

The car-running relay M operates in the manner previously described to prepare certain circuits for subsequent operation.

Upon energization, the down switch D closes its make contacts D1 to release the brake 17. In adition, make contacts D2 and D3 close to energize the generator field winding 29C in the proper direction for down travel of the elevator car. Closure of the make contacts D4 completes an energizing circuit for the speed relay V. This relay closes its make contacts V1 to shunt the resistor R1 and opens its break contacts V2. The elevator car now is conditioned for movement in the down direction at full speed and moves away from the upper terminal floor.

Closure of make contacts D5 establishes a holding circuit around the contacts 80–1 and X1. Opening of break contacts D6 has no immediate effect on the operation of the system.

It will be understood that as the elevator car leaves the upper terminal floor, the limit switch 34 (Fig. 2) and the switch 63 (Fig. 4) reclose.

It will be assumed next that a passenger in the elevator car operates the car-call push button 3*c* for the purpose of registering a car call for the third floor. This button connects the contact segments *a*3 and *h*3 to the bus L+. Also contacts 3*cx* and 3*cy* open.

When the brush 40*a* reaches the contact segment *h*3, an energizing circuit is established for the car-call stopping relay TT as follows:

L+, 3*c*, *h*3, 40*a*, X3, TT, M3, L−

Consequently, the relay closes its make contacts TT1 to energize through the contacts M1 the holding relay G and the inductor relay E. The holding relay G closes its make contacts G1 to establish a holding circuit around the contacts TT1.

When the slowdown inductor relay E reaches the inductor plate DEP for the third floor (Fig. 1), the contacts E2 open to deenergize the speed relay V (Fig. 2). The speed relay opens its make contacts V1 to introduce the resistor R1 in series with the generator field winding 29C. The elevator car now slows to a landing speed. In addition, the break contacts V2 close to complete an energizing circuit for the stopping inductor relay F. Contacts V3 open without immediate effect on the system and contacts V4 open to start a timing out of the relay 72T.

When the stopping inductor relay F reaches the inductor plate DFP for the third floor, the contacts F2 open to deenergize the down switch D and the car-running relay M. The down switch D opens its make contacts D1 to permit reapplication of the brake 17. Make contacts D2 and D3 open to deenergize the generator field winding, and the elevator car A stops accurately at the third floor. Opening of the make contacts D4 and D5 and closing of the break contacts D6 have no immediate effect on the operation of the system. As the elevator car comes to a stop the brush 40*a* may pass the contact segment *h*3 slightly to deenergize the relay TT.

The car-running relay M opens its make contacts M1 to deenergize the inductor relays and the holding relay G. The holding relay G in turn opens its make contacts G1 to prevent subsequent energization therethrough of the inductor relays.

The make contacts M2 open to initiate an opening operation of the doors. The opening and closing of the doors will be understood from the previous discussion thereof.

The car-running relay M also opens its make contacts M5 to start a timing-out operation of the timing relay 70T. Opening of make contacts M3 and M5 and closing of break contacts M4 have no immediate effect on the operation of the system. Break contacts M6 close to illuminate the lamps LA1 and LA2. When the timing relay 70T drops out, the break contacts 70T2 (Fig. 4) close to energize through the switch 63 the starting relay 80. The starting relay operates in the manner previously described to start the elevator car down from the third floor. It will be recalled that the drop out of the relay 70T may be expedited by entry or departure of a passenger relative to the car before the time delay of the relay expires.

Closure of the break contacts M11 reenergizes the relay 72T before this relay drops out.

Let it be assumed that instead of a car call a down floor call was registered for the third floor by operation of the push button 3D (Fig. 3). Such operation energizes the down floor-call storing relay 3DR which closes its make contact 3DR1 to establish a holding circuit around the push button 3D. The contact segment *f*3 and corresponding contact segments for the remaining elevator cars of the system are connected through the make contacts 3DR1 to the bus L+. Also contacts 3DR2 and 3DR3 (Fig. 4) open without affecting the operation of the system.

As the elevator car A approaches the third floor in the down direction, the brush 58 reaches the contact segment *f*3 to complete an energizing circuit for the floor call stopping relay K as follows:

L+, 3DR1, *f*3, 58, X5, K, L−

The relay K closes its make contacts K1 (Fig. 2) to energize the holding relay G and the slowdown inductor relay E through the contacts M1. These relays operate in the manner previously described to stop the down traveling elevator car at the third floor.

During the stopping operation, the following cancelling circuit (Fig. 3) is established:

L+, 3DR1, 3DRN, *g*3, 59, X6, M4, L−

As a result of energization of the cancelling coil 3DRN, the down floor call storing relay 3DR is reset.

When the elevator car in its down travel nears the first or dispatching floor, the brush 40*a* (Fig. 3) engages the contact segment *h*1 to complete the following circuit:

L+, *h*1, 40*a*, X3, TT, M3, L−

The energization of the car-call stopping relay TT stops the elevator car at the first floor in the same manner discussed with reference to the stopping of the elevator car at the third floor.

As the elevator car A stops at the first floor, the mechanical switch **37** opens to deenergize the down-preference relay X. This relay opens its make contacts X1, X3, X5 and X6 without immediately affecting the operation of the system. However, closure of the break contacts X2 completes an energizing circuit for the uppreference relay W. This operates in the manner previously discussed to condition the elevator car for up travel.

It will be noted that as the relay X is deenergized the make contacts X4 and W4 both are open until the up preference relay W is again energized. During this momentary opening of both sets of contacts, the holding coils for the car-call push button are deenergized to reset the buttons.

To illustrate the decreased non-interference time at a terminal floor, it will be assumed that the elevator car A while empty is approaching the lower terminal floor. As the elevator car reaches the lower terminal floor, the car position relay L (Fig. 4) picks up and opens its break contacts L3 (Fig. 2). The effect of such contact opening is to increase the effective value of resistance of the resistor R2 which is conducted across the timing relay **70T**.

As the elevator car stops the make contacts M5 of the car running relay M opens to deenergize the timing relay **70T**. The stopping of the elevator car will be understood from the preceding discussion.

Since the timing relay **70T** now is deenergized, it starts to time out. It will be recalled that the time delay **70T** has a time delay in drop out of the order of 5 seconds when the contacts **300–1**, TL3 and L3 are all closed. This is a non-interference time which is available at intermediate floors.

However, at the lower terminal floor the opening of the break contacts L3 increases the effective resistance of the resistor R2 and decreases the time delay in drop out of the timing relay **70T** to a value which may be of the order of 2 seconds. Upon drop out of the relay **70T** the elevator car door closes by a sequence which will be understood from the preceding discussion.

Because of the shortened non-interference time at the terminal floors, the probability of prospective passengers at the lower terminal floor entering the elevator car A when it is not selected as the next car to leave the lower terminal floor, is greatly reduced.

Despite the reduction in non-interference time at the lower terminal floor, ample time is provided for passengers within the elevator car to leave such car. It will be recalled that if a number of passengers leave, the door is maintained open for a brief time for each passenger passing through the doorway.

Next, the operation of the reopen relay RE will be considered. It will be assumed that the elevator car A has just stopped at the lower terminal floor, that it is not selected as the next elevator car to leave the lower terminal floor and that a prospective passenger at the lower terminal floor has succeeded in entering the elevator car before the non-interference time of 2 seconds expired. It will be assumed that following the entry of the prospective passenger into the elevator car the elevator car door recloses by the sequence previously discussed.

The natural reaction of a person entering an elevator car under these circumstances is to register a car call, and it will be assumed that the person within the elevator A operates the car-call push button **3***c* to register a car call for the third floor. The sequence for registering a car call previously has been described. It will be recalled that incident to the registration of the car call for the third floor, the contacts **3***cy* open. Turning to Fig. 4 it will be noted that opening of the contacts **3***cy* results in deenergization of the reopen relay RE. This is true for the reason that the elevator car has not been selected for the next car to leave a terminal floor, and the contacts N5 and TN5 consequently are open. In addition, the elevator car has not received a start signal and consequently the make contacts S5 and UTS5 of the auxiliary starting relays are open. Finally, since the elevator car is at the lower terminal floor, the car position relay L is energized and the break contacts L4 are open. Consequently, under these circumstances the contacts **3***cy* deenergize the reset relay RE and this relay opens its make contacts RE1 (Fig. 2).

If the manually operated switch **64B** is open it follows that the opening of the make contacts RE1 deenergizes the door control relay **45** and the elevator car door reopens by the sequence previously discussed. Consequently, the passenger within the elevator car A now is free to leave the elevator car.

As previously pointed out, it is desirable to provide a signal for the passenger under these circumstances. This signal may be a voice signal notifying him that another car will leave the floor or it may be a sound signal such as a buzzer. In a preferred embodiment of the invention, the signal may take the form of an illuminated sign ME bearing the legend "Another Car is Next." When the reset relay RE is deenergized, it closes its break contacts RE2 to illuminate this sign.

The effect of opening the manually-operable switch **64C** now will be considered.

Let it be assumed that the elevator car A is lightly loaded, and that it is to stop at the third floor which it is approaching. It will be recalled that the door control relay **45** under these circumstances is maintained in energized condition through the circuit L+, V3, **45–1**, **45**, **TN1**, **N1**, **L—**. Inasmuch as the elevator car is lightly loaded, the switch LW3 is open. Since the manually-operable switch **64C** also is assumed to be open, it follows that the make contacts M2 of the car running relay are ineffective for control purposes.

As the elevator car nears the third floor, the speed relay V drops out to slow down the elevator car to a landing speed by the sequence previously discussed. At the same time, the make contacts V3 of the speed relay open to deenergize the door-control relay **45**. The deenergized door-control relay initiates an opening operation of the elevator car door by the sequence previously discussed. Since the make contacts V3 open while the elevator car is displaced by a substantial distance of the third floor which may be of the order of 8 inches, it follows that the elevator car door starts to open while the car is still approaching the third floor. Such advance opening materially reduces the time lost at each stop of the elevator car.

Next, it will be assumed that the elevator car A is again conditioned to stop at the third floor. However, it is assumed that the car is heavily loaded and that the switch LW3 consequently is closed. Such closure of the switch renders the make contacts M2 of the car running relay effective for controlling the door-control relay **45**.

As the elevator car nears the third floor the make contacts V3 of the speed relay open in the manner previously discussed. However, since these contacts now are bypassed by the make contacts M2 of the car-running relay M and the switch LW3 it follows that opening of the make contacts V3 has no immediate effect on the system.

The elevator car continues its approach to the third floor with its door in closed position.

When the elevator car is in stopping position the car running relay M is deenergized by the sequence previously discussed and opens its make contacts M2 to deenergize the door control relay **45**. The deenergization of the door control relay results in opening of the elevator car door by the sequence previously discussed. However, it should be noted that because of the heavy loading of the elevator car A, the opening of the door has been delayed until the elevator car has stopped at the desired floor. This is desirable for the reason that the excessive loading of the elevator car may result in the stopping of the elevator car at a point displaced appreciably from the third floor. Advance opening of the doors under these circumstances is confusing for the passengers. If the elevator car A is provided with an automatic leveling system, such as that disclosed in the Santini et al. Patent 2,674,348, the heavily-loaded car may come to a pause before the leveling mechanism takes charge of the elevator car. Here again the delayed opening of the elevator car door is desirable.

The efficiency of the system may be improved somewhat by closure of the manually-operable switch **62A.** It will be understood that the manually-operable switch **62** remains open.

Let it be assumed that the door of the elevator car A is fully open and that a closing operation has been initiated. Since the elevator car door is open, the switch **38B** is closed, and the detector relay SR is connected across the buses through the switch **62A** and the switch **38B.**

If a person now enters the doorway of the elevator car, he interrupts the beam of light supplied to the photocells PC1 and PC2, and such interruption results in opening of the make contacts PR1–1 and PR2–1. However, these contacts are now bypassed by the switch **38B** and the switch **62A.** Consequently, the detector relay SR remains energized, and the door continues its closing movement.

After the closing door has traveled a predetermined distance, which may be for illustrative purposes of the order of 10 inches, the switch **38B** opens. If the person is still in the doorway, the detectors **PR1–1** and **PR2–1** are open and the detector relay SR operates to initiate a reopening of the door by the sequence previously described. However, in many cases, the person will have cleared the doorway by this time and the detectors **PR1–1** and PR2–1 consequently will be closed to maintain the energization of the detector relay SR. Under these circumstances an unnecessary opening operation of the door is avoided.

If the elevator car has a doorway of substantial width, which for illustrative purposes may be of the order of 40 inches, it follows that the closure of the elevator car to a distance such as 10 inches, will not inconvenience a person passing through the doorway. However, should the door actually reach such a person, the associated safety edge would initiate the opening operation by the sequence previously discussed.

It now will be assumed that the elevator car A is excessively loaded, and that the overload relay OL is energized sufficiently to open its break contacts **OL1.** It will be assumed that this overload relay is of a latching type which must be manually reset after it once operates. Since the elevator car is heavily loaded, the switch **LW2** is closed. If the elevator car is running between floors, the make contacts **70T5** of the timing relay **70T** and the make contacts **72T1** of the time-delay relay **72T** are closed. Consequently, the operation of the overload relay OL has no immediate effect on the operation of the system.

It will be assumed that the elevator car now stops at a floor. The elevator car door opens by the sequence previously discussed, and the load in the elevator car may decrease to a value sufficient to open the switch **LW2.** Since the contacts **OL1** remain open, as the switch **LW2** opens, the latch LA is deenergized. Inasmuch as the latch LA is biased toward tripping condition, it now trips the switch MOS.

If the elevator car, after it stops, remains excessively loaded, the switch LW2 remains closed. However, after expiration of a non-interference time, the make contacts **70T5** open. Such opening together with the open contacts **OL1** deenergizes the latch LA which trips the switch MOS. Because of the time delay introduced by the contacts **70T5**, the elevator car door is in open position when the switch MOS trips. Consequently, the passengers in the elevator car are not materially disturbed by the failure of the elevator car to run.

Should the elevator car stall between floors when the overload relay trips, the time-delay relay **72T** starts to time out. This is for the reason that the break contacts **M11** are open, and the contacts **V4** of the speed relay are open. Upon expiration of the time delay in drop out of the relay **72T** signifying a stalled car, the make contacts **72T1** open. The opening of these contacts, together with the open contacts **OL1,** deenergize the latch LA which trips the switch MOS. If the elevator car is equipped with the levelling mechanism of the aforesaid Santini et al. patent, the relay **72T** may be energized in the manner set forth in such patent for the relay similarly designated.

Consider next that the manual switch **98** is closed to shunt the switch **LW2.** Under such circumstances the desired operation is obtained even though the car is not loaded excessively. Thus if the overload relay trips and opens its contacts **OL1** while the elevator car is traveling with a light load (switch **LW2** is open) between floors, the presence of the open contacts **OL1** and **LW2** does not stop the car between floors for the reason that the switch **98** is now effective to maintain the latch LA energized until the contacts **70T5** or **72T1** open. Such operation of the overload relay for a light car loading may result from a dragging brake, for example. Thus in a preferred embodiment the switch **98** shunts the switch **LW2.**

FIGURE 5

Fig. 5 illustrates a modified door control system which may be employed for controlling the door for each of the elevator cars of Fig. 1. Except for the door control system the circuits employed for the elevator cars of Fig. 1 may be similar to those illustrated in Figs. 2, 3 and 4. In order to conserve space Fig. 5 illustrates a door control system for the elevator car A of Fig. 1. However, it is to be understood that a similar door control system may be provided for each of the elevator cars of the system.

The following relays are illustrated in Fig. 5:

45A—Door-control relay
TA, TB, TC—Timing relays
DCA—Door-close relay
LA—Slow-door relay
DOA—Door-open relay
KA—Door-speed relay
P—Door-force relay
SH—Stop-hold relay
XA—Release relay

In Fig. 5 the door-control relay **45A** is energized from the buses L+ and L− through contacts **N1, TN1, 70–1, SE1** and **70T1.** These contacts were disclosed in Fig. 2 and may operate in the same manner. In addition the energization of the door-control relay **45A** is controlled by a door-hold switch HD and break contacts **TB1** of a timing relay TB. The door hold switch HD is located in the elevator car A and is operated by any person desiring to prevent closure of the elevator car door. The break contacts **TB1** are designed to close a predetermined time such as one second after the elevator car door is assigned to close. Under certain conditions the contacts **SE1** are shunted by break contacts **SH1** during an initial portion of the door closing movement.

If the door fails to close within a suitable time such as 12 seconds, break contacts **TA1** of a timing relay TA close to shunt the break contacts **70–1** and **SE1** and the door-hold switch HD.

Make contacts **70T3** control the energization and pick up of the three timing relays TA, TB and TC. These relays have delays in dropout which may be provided in any suitable manner as by resistors **R10**, **R11** and **R12** respectively. Although the delay times of these relays may be selected in accordance with requirements, it will be assumed for present purposes that the relay TA has a dropout time of the order of 12 seconds, the relay TB has a dropout time of the order of one second and the relay TC has a dropout time of the order of 5 seconds.

Prior to closure of the elevator car door a suitable signal device **101** is operated to advice persons in the vicinity of the door that the door is about to close. For present purposes it will be assumed that the signal device is in the form of a buzzer which is connected across the buses L+ and L− through make contacts **TB2** of the timing relay TB and break contacts **70T4** of the timing relay **70T**.

If make contacts **45A2** of the door-control relay **45A**, break contacts **DOA1** of a door-open relay DOA and break contacts **XA1** of a release relay are all closed, an energizing circuit is completed for the door-close relay DCA. If the make contacts **45A2** are closed and in addition break contacts **KA1** of a door-speed relay KA and break contacts **TA2** of the timing relay TA are closed, the slow-door relay LA is energized. If the door of the elevator car is assigned to close but fails to close within a reasonable time, break contacts **TC1** of the timing relay TC close to complete with a limit switch **103** an energizing circuit for a signal device **105** for the purpose of advising persons in the closing path of the door to clear the doorway. For present purposes it will be assumed that the signal **105** is in the form of a lamp producing intense light directed into the doorway. The switch **103** is biased into closed position and is cam operated to open as the elevator car door reaches its fully-closed position.

The door-open relay DOA is energized through a circuit which includes break contacts **DCA1** of the door-close relay DCA, a mechanical switch **107** and the parallel combination of break contacts **45A3** of the door-control relay **45A** and make contacts **XA2** of the release relay XA. The switch **107** is biased to closed position and is cam-operated to open as the elevator car door reaches its fully-open position.

The door-speed relay KA is energized through break contacts **TA3** of the timing relay TA and the switch **SE2**. It will be recalled that this switch is operated by a safety edge associated with the elevator car door.

The door-force relay P is energized through a three-position switch **109**. This switch is illustrated in its fully-open position wherein the relay P cannot be energized. In a second position of the switch **109** the relay is energized through a circuit which includes the contacts **TA3** and a mechanical limit switch **111**. The mechanical limit switch **111** is biased to open position and is cam-operated to close as the elevator-car door reaches it fully-open position.

In the third position of the switch **109**, the door-force relay P is energized through the switches **SE4** and **SEA1** in parallel and break contacts **TA4** of the timing relay TA. The switch **SE4** is biased to closed position and is operated by the safety edge SE to open position when the safety edge reaches an obstruction in the closing path of the door. The switch **SEA1** is biased to closed position and is opened in response to operation of the safety edge **SEA1**. It will be recalled that if center-opening doors are provided, the safety edges SE and SEA during a closing operation of the doors may be located adjacent the leading edges respectively of the doors.

The door-opening and door-closing movements of the lever **28** of Fig. 1 is effected in the modification in Fig. 5 by a direct-current motor having an armature DA and a field winding DF. The armature DA has a shaft coupled to the lever **28** through a pinion **DA1** on the shaft and a rack **DA2** which is pivotally-connected to the lever **28**. Consequently rotation of the armature DA in one direction closes the door and rotation of the armature in the opposite direction opens the door.

The direction of rotation of the armature DA is determined by a reversing switch which is made up of contacts of the door-close relay DCA and the door-open relay DOA. Thus when the door close relay DCA is energized and picked up, the following energizing circuit is established:

L+, DF, **DCA2**, **LA1**, DA, **DCA3**, L−

The door motor now is energized with proper polarity to close the elevator car door.

If the door-open relay DOA is energized and picked up, the motor energizing circuit is as follows:

L+, DF, **DOA3**, DA, **LA1**, **DOA2**, L−

Under such circumstances the motor is energized to open the elevator car door.

Relays are provided for varying the energization of the motor. Thus if the slow-door relay LA is energized and picked up it opens its break contacts **LA1** and if the stop-hold relay SH is energized it opens its break contacts **SH2** to introduce a resistor **R13** in series with the armature DA of the motor. At the same time make contacts **LA2** and **SH3** close to connect a resistor **R16** in shunt with the armature DA. This results in a reduction in speed of the motor and consequently of the door.

If the door-face relay P is energized and picked up, the break contacts **P1** open to interrupt the shunting of the field winding DF by the resistor **R18**. At the same time the make contacts **P2** close to connect the resistor **R17** in shunt with the armature DA. This results in an increase in the force applied to the door by the motor DA and a reduction in the speed of the door.

The speed of the door during an opening operation is controlled by a resistor **R14** which is connected across the armature through break contacts **DCA4** of the door-close relay. During a closing operation the speed of the motor is controlled by a resistor **R15** which is connected across the armature DA through break contacts **DOA4** of the door-open relay. It will be understood that additional resistors would be connected across the armature of the motor DA during portions of the rotation of the motor to provide a checking of the speed of the door as it approaches its open and closed positions. However for the purpose of simplicity such checking resistors are not illustrated in Fig. 5.

The stop-hold relay SH is energized through the switch **38A** which is open only while the elevator car door is within a short distance, say one inch, of the fully-open position.

The release relay XA is energized through a cam-operated switch **33A** which is closed only while the door is within say two inches of fully-closed position, a normally-open switch **SE5** which is closed when the safety edge SE engages an obstruction in the closing path of the door and a manually-operable switch **113A**. For the present the switch **113A** is assumed to be open. Preferably the switch **33A** is closed only while the door is within a distance from its fully-closed position which is insufficient to permit passage of a person through the doorway while permitting movement of a hand. Thus the distance may be of the order of two to six inches, but for present purposes is assumed to be two inches.

The operation of the embodiment illustrated in Fig. 5 now will be considered. When the elevator car door is assigned to close, the break contacts **70T1** close. However, such closure cannot result in pickup of the door control relay for the reason that the break contacts **TB1** are still open. It is assumed that the break contacts **N1** and **TN1** are closed.

At the same time make contacts **70T3** of the relay **70T** open to deenergize the timing relays TA, TB and TC. Consequently these relays start to time out.

The relay 70T also closes its break contacts 70T4 to complete with the make contacts TB2 an energizing circuit for the signal 101. This warns persons within the vicinity of the elevator car that the door is about to close.

Following the expiration of a period of say one second, the timing relay TB drops out to close its break contacts TB1 and complete the following circuit:

L+, 45A, N1, TN1, 70-1, SE1 and SH1 in parallel, HD, TB1, 70T1, L−. In addition, make contacts TB2 open to interrupt the energization of the signal 101.

The energized door control relay 45A closes its make contacts 45A1 without immediate effect upon the operation of the system. Opening of break contacts 45A3 has no immediate effect upon the operation of the system. However, closure of the make contacts 45A2 completes with the break contacts DOA1 and XA1 an energizing circuit for the door close relay DCA.

The door close relay DCA opens its break contacts DCA1 without affecting the immediate operation of the system. However, make contacts DCA2 and DCA3 close and break contacts DCA4 open to energize the motor DA for a door-closing operation.

After the door has moved for a short time or for a short distance the break contacts SH1 open to render the switch SE1 effective to control the operation of the door. Thus, after the door has moved for about one inch from fully-open position, the switch 38A closes to energize the stop-hold relay SH which opens the contacts SH1.

If the door closes promptly, the elevator car starts in the manner discussed in connection with Figs. 2, 3 and 4 and the make contacts M2 of the running relay close to complete with the contacts 45A1 a holding circuit for the relay 45A.

After the expiration of 5 seconds, the timing relay TC drops out to close its contacts TC1. However, the closure of the door has resulted in opening of the switch 103 and the signal 105 consequently is not operated.

After a period of 12 seconds has elapsed, the timing relay TA drops out to close its break contacts TA1 without immediate effect on the operation of the system. Contacts TA2 close to permit energization therethrough of the slow-door relay LA and break contacts TA3 close to permit energization of the door-speed relay KA. Switch 109 is assumed to be in its open condition. Consequently, closure of contacts TA4 does not effect system operation. However, since the door is fully-closed these relays LA and KA cannot affect the operation of the system.

Passengers sometimes hold the door in its fully-open position by engaging the door safety edge. To discourage this practice the stop-hold relay SH is provided to render the safety edge ineffective for a short time after a door-closing operation is initiated. Conveniently, the safety edge is rendered ineffective until the door has traveled a short distance such as one or two inches from its fully-open position.

Thus, in its fully-open position the door holds open the switch 38A to deenergize the stop-hold relay SH. This relay closes its break contacts SH1 to render the safety edge switch SE1 ineffective. In a preferred embodiment the relay also closes its break contacts SH2 and opens its make contacts SH3 to render the resistors R13 and R16 ineffective. Consequently, a substantial door-closing force is applied to the hand of the person holding the door to discourage such holding. After the door has moved for say one inch the switch 38A closes to energize the stop-hold relay SH. Contacts SH1 thereupon open to restore the door to control by the safety edge for the remainder of the closing movement. Also contacts SH2 open and contacts SH3 close.

Let it be assumed next that as the elevator car door started its closing movement a passenger engaged the safety edge SE to open the break contacts SE1 or operated the door-hold switch HD to interrupt the energizing circuit for the door control relay 45A. Upon its deenergization the relay 45A opens its make contacts 45A1 without immediately affecting the operation of the system. Opening of make contacts 45A2 interrupts the energization of the door close relay DCA. The relay DCA now closes its break contacts DCA1 and DCA4 and opens its make contacts DCA2 and DCA3 to stop the closing movement of the elevator car door. Since the closing movement of the door results in closure of the switch 107, the closing of the break contacts DCA1 completes with the switch 107 and the contacts 45A3 an energizing circuit for the door open relay DOA. This relay opens its break contacts DOA1 without immediate effect on the operation of the system. In addition make contacts DOA2 and DOA3 close and break contacts DOA4 open to energize the door motor for a door-opening operation. As the elevator car door reaches its open position the switch 107 opens to deenergize the door-open relay DOA. Consequently, break contacts DOA1 reclose without immediate effect on the operation of the system. Opening of make contacts DOA2 and DOA3 deenergizes the door motor. Contacts DOA4 close without affecting the immediate operation of the system.

If the elevator car door is prevented from closing in this manner for a period of say 5 seconds, the timing relay TC finally times out to close its break contacts TC1. Such closure completes with the switch 103 an energizing circuit for the signal 105. This signal remains in operation until the door finally is fully closed to open the switch 103.

If the elevator car door is prevented from closing for a period of say 12 seconds, the timing relay TA finally times out to close its break contacts TA1. Since these contacts shunt the switch SE1, the contact 70-1 and the door hold switch HD, an energizing circuit for the relay 45A is positively completed and this relay operates in the manner previously described to initiate a door-closing movement.

In addition the break contacts TA3 close to complete with the switch SE2 an energizing circuit for the door-speed relay KA. This relay opens its break contacts KA1 to prevent energization of the slow-door relay even though the break contacts TA2 are now closed.

Let it be assumed that during the closing movement of the door the safety edge SE reaches a person standing in the closing path of the door. Under such circumstances the opening of the switch SE1 has no effect on the immediate operation of the system. This switch is still shunted through the break contacts TA1. However the switch SE2 opens to deenergize the door-speed relay KA. The door-speed relay KA closes its break contacts KA1 to complete with the contacts TA2 and 45A2 an energizing circuit for the slow-door relay LA.

As a result of its energization the slow-door relay LA opens its break contacts LA1 and closes its make contacts LA2 to condition the door motor for slow-speed operation. Consequently, the elevator car continues to close at a reduced speed in an effort to force the obstruction or person from its path.

If the obstruction is removed the switch SE2 recloses to reenergize the door-speed relay KA. The door-speed relay then opens its break contacts KA1 to interrupt the energization of the slow-door relay. Since the slow-door relay LA now is deenergized, break contacts LA1 close and make contacts LA2 open to return the door to its normal closing speed.

When the relay TA drops out it is possible that the door will close on a small obstruction such as a person's hand. To provide relief in such a case the switch 113A may be closed. Let it be assumed that the door is closing on a person's hand while the relay TA is dropped out. A short distance such as two inches from its fully-closed position the door closes the cam-operated switch 33A. As the safety edge engages the hand the switch SE5 is closed to complete an energizing circuit for the release relay XA. This relay opens its break contacts XA1 to deenergize the door-close relay DCA and the door closure ceases. In addition the make contacts XA2 close to complete with the switch **107** and the contacts DCA1 an energizing circuit for the door-open relay DOA. The door now starts to open, thus permitting withdrawal of the hand. As the door reaches a position about two inches from fully-closed position the switch 33A opens to deenergize the release relay XA. The resultant opening of the contacts XA2 deenergizes the door-open relay which closes its contacts DOA1 and interrupts door opening. Also contacts XA1 close to complete a reenergizing circuit for the door-close relay DCA and the door resumes its closing movement.

From the foregoing discussion of Fig. 5 it will be seen that a signal is operated in advance of door closure to notify persons that the door is about to close. If the door is prevented from closing a further signal is operated in an effort to clear the doorway. If the door still fails to close within a reasonable time, the door is positively moved towards its closed position at its normal speed. However, upon reaching an obstruction the speed of the door is reduced until the obstruction is cleared from the doorway.

In a preferred embodiment the operation of switch SE2 following dropout of the relay TA causes the door to stall without applying substantial force to the person responsible for operation of the switch SE2. Upon clearance of the closing path the door then resumes its full-speed closing movement. The desired stalling may be provided by proper selection of the resistance controlling the motor DA. Thus the resistor R16 may have a very low resistance to reduce the motor torque to a negligible value. Preferably the torque is sufficient to prevent the person from forcing the door open.

If the switch **109** is moved to its upper position, an additional control of the door movement is provided. This additional control is exercised only if the door has been prevented from closing for an unreasonable time such as 12 seconds to close the break contacts TA3. Under these circumstances if the door is in its fully-open position the switch **111** is closed and an energizing circuit is completed for the door-force relay P. The door-force relay opens its break contacts P1 for the purpose of increasing the energization of the field winding DF. In addition make contacts P2 close to connect the resistor R17 across the armature DA of the door motor. By proper selection of these resistors the force exerted on the door by the door motor may be substantially increased and if desired, the door-closing speed may be left substantially unchanged by operation of the relay P.

The increased force exerted by the door motor following the pickup of the door-force relay P assists in removing any object obstructing the movement of the door. However, the increased force preferably is applied only during the initial portion of the door closing movement. To this end as the door departs from its fully-open position, the switch **111** finally opens to deenergize the door-force relay P. The relay thereupon closes its break contacts P1 and opens its make contacts P2 to restore the door motor for normal energization. As an example the switch **111** may be cam-operated to remain in its closed position during movement of the door from its fully-open position to a 20% closed position.

By moving the switch **109** to its third postion a somewhat different modification of the door operation by the relay P is obtained. Under these circumstances the relay P is connected for energization through the break contacts TA4 and the switches SE4 and SEA1. Consequently, when the relay TA times out the relay P is energized to increase the closing force exerted on the door. This closing force continues to be exerted until the door is fully-closed or until both of the safety edges are operated to open the switches SE4 and SEA1. Under these circumstances the door starts to close with a substantial closing force applied to it for the purpose of forcing away from the doorway any objects positioned in the closing path of the door. However, if the object fails to clear the doorway, both of the safety edges ultimately will be engaged by the object and the closing force applied to the door will be reduced. When the door-force relay P is conditioned for such operation, the manual switch **113** may be closed for the purpose of shunting the switch SE2. If the switch **113** is closed energization of the relay KA is maintained for the purpose of preventing energization of the slow-door relay LA.

Subject matter above described is also described in the pending patent applications Serial Nos. 427,475 and 427,476, both filed on May 4, 1954, which have issued as Patents 2,785,771 and 2,785,772, and in the Keiper patent application Serial No. 406,706, filed January 28, 1954.

FIGURES 6, 7 AND 7A

In the embodiment of Figs. 1 and 1A, the detector relays are insensitive to the direction in which load moves between the elevator car and a floor at which the elevator car is stopped. An improved control may be provided which is dependent on such direction of movement of the load and such a control will be discussed with reference to Figs. 6, 7 and 7A. The following relays will be referred to in the discussion:

GA—Inner-beam relay
GB—Outer-beam relay
GY—Inner-beam auxiliary relay
GZ—Outer-beam-preference relay
GX—Selective relay
STRB—First-time-control relay
KA—Second-time-control relay

In order to simplify the presentation of this embodiment, Figs. 6, 7 and 7A illustrate apparatus and circuits only for the elevator car A. However, it will be understood that similar apparatus and circuits may be provided for each of the elevator cars.

Referring to Fig. 6 it will be noted that the elevator car A of Figs. 1 and 1A is illustrated. The only differences between the elevator car and its associated components reside in the location of the lamps LA1 and LA2 and the photocells PC1 and PC2 and in the provision of back or break contacts PR1–2 and PR2–2 for the relays PR1 and PR2 respectively.

By inspection of Fig. 6 it will be noted that the lamps LA1 and LA2 are positioned to project parallel beams of light which are displaced from each other in a horizontal direction and which extend across the doorway of the elevator car. Thus the lamp LA1 may be mounted on a wall or door buck of the elevator car to project a beam of light towards the photocell PC1. This will be referred to as an inner beam. The lamp LA2 is located in the space between the elevator car door DP and the hoistway door DPH but is mounted on the elevator car door DP. This lamp projects a beam of light towards the photocell PC2 which is carried by the elevator car.

By inspection of Fig. 6 it will be observed that a passenger entering the elevator car door must interrupt the beam of light from the lamp LA2 before he can interrupt the beam of light from the lamp LA1. Conversely if a passenger leaves the elevator car he must interrupt the beam of light from the lamp LA1 before he can interrupt the beam of light from the lamp LA2. A control system is provided which is responsive to the order in which these beams are interrupted and the system now will be described with particular reference to Fig. 7.

The break contacts PR1–2 and PR2–2 respectively control the energizations of an inner-beam relay GA and an outer beam relay GB. When the inner-beam relay GA is energized it closes its make contacts GA1 to energize the inner-beam auxiliary relay GY. The relay GY has a short time delay in dropout which may be provided in any desired manner as by a resistor GR1 connected thereacross and which may be for exemplary purposes of the order of one-half second.

The outer-beam-preference relay GZ is energized only if the outer beam of light is interrupted before the inner beam of light is interrupted. Thus if a passenger enters the elevator car he first interrupts the beam of light projected by the lamp LA2 to drop out the relay PR2. This relay closes its break contacts PR2–2 to energize the outer-beam relay GB. In response to such energization make contacts GB1 close to complete with the break contacts GY1 an energizing circuit for the outer-beam-preference relay. However, if a passenger initially leaves the elevator car A, he first interrupts the inner beam of light to drop out the relay PR1. This results in energization of the inner-beam relay GA which closes its make contacts GA1 to energize the inner beam auxiliary relay GY. The relay GY opens its break contacts GY1 to prevent energization of the relay GZ until the relay GY has timed out. The relay GZ has a slight time delay in dropout to assure energization of the selective relay GX under desired conditions.

If the elevator car stops in response to a car call, the make contacts K4 of the floor call stopping relay K remain open. The operation of the relay K was discussed in connection with Fig. 3. Under these circumstances the break contacts KA3 remain closed. Upon departure of a passenger from the elevator car the make contacts GY2 close to complete with the break contacts KA3 an energizing circuit for the selective relay GX.

If the elevator car stops at a floor in response to a corridor or floor call, the break contacts K4 are closed. Consequently, the break contacts KA3 are open and the selective relay GX can be energized only if the make contacts GZ1 of the outer-beam-preference relay are closed. It will be recalled that the contacts GZ1 do not close if a passenger initially leaves the elevator car. Consequently the relay GX remains deenergized until a passenger enters the elevator car to pick up the relay GZ for the purpose of closing the make contacts GZ1. The slight time delay in dropout of the relay GZ is for the purpose of assuring sufficient time for the make contacts GY2 to be closed while the make contacts GZ1 are closed even though the two beams are not interrupted simultaneously for a substantial time.

Make contacts GX1 of the selective relay control the energization of a first-time-control relay STRB. When it picks up, the first-time-control relay establishes a holding circuit through the break contacts M8 of the running relay, make contacts **70T3** and make contacts STRB1. Relay M was discussed in connection with Figs. 2, 3 and 4.

Relay **70T** together with the make contacts M5 of Fig. 2 are employed in Fig. 7. However, the time delay for the timing relay **70T** is provided somewhat differently in Fig. 7. The time delay is determined by a resistor GR3 which is connected across the relay. The effective value of the resistor is determined by two sets of contacts. If the break contacts STRB2 of the first-time-control relay are closed, a small value of resistance is connected across the timing relay and may suffice to provide a time delay in dropout of the order of 5 seconds. If the break contacts STRB2 open, the entire resistor GR3 is effective and may provide a time delay in dropout of the order of one-half second. If the break contacts STRB2 are open and the make contacts KA1 are closed, the effective value of the resistor GR3 may provide a time delay in dropout of the relay **70T** of the order of 2 seconds.

The door-control relay **45** together with the contacts N1, TN1, 70T1, 45–1 and M2 and the switch SE1 are similar to the corresponding components of Fig. 2 and the relay **45** operates in a similar manner to control the opening and closing of the elevator car door. In addition, the energization of the door-control relay may be controlled by break contacts GY3.

Finally, the second-time-control relay KA is energized through make contacts K4 of the floor-call stopping relay of Fig. 3. When it picks up, the relay KA establishes a holding circuit through the make contacts KA2, break contacts M9 and the make contacts **70T4**. It will be understood that the break contacts M9 are associated with the running relay M of Fig. 2.

The operation of the embodiment of Figs. 6, 7 and 7A now may be considered. Let it be assumed first that the elevator car stops at a floor in response to a registered car call. The sequence by which the elevator car stops will be understood from the preceding discussion. Since the elevator car stops in response to a car call, the floor call stopping relay K remains dropped out.

As the elevator car stops, the make contacts M2 open to deenergize the door-control relay **45** and this relay opens the elevator car door by the sequence discussed with reference to Fig. 2. When the elevator car door opens, the passenger who registered the car call leaves the elevator car. As he leaves the elevator car, the passenger first breaks the beam of light projected by the lamp LA1 to drop out the relay PR1. This relay closes its break contacts PR1–2 to energize the inner-beam relay GA. The inner-beam relay closes its make contacts GA1 to energize the inner-beam auxiliary relay GY.

As a result of its energization the relay GY opens its break contacts GY1 to prevent energization therethrough of the outer-beam preference relay GZ. Make contacts GY2 close to complete with the break contacts KA3 an energizing circuit for the selective relay GX. This relay in turn closes its make contacts GX1 to energize the first-time-control relay STRB.

As a result of its energization the relay STRB closes its make contacts STRB1 to complete with the make contacts **70T3** and the break contacts M8 a self-holding circuit.

It will be understood that as the elevator car stopped at the floor the make contacts M5 opened to start a timing out operation of the timing relay **70T**. With the break contacts STRB2 closed, this relay has a time delay in dropout of the order of 5 seconds to provide a non-interference time.

Since the passenger is leaving the elevator car, a shortened non-interference time is desirable. Such a shortened time is provided by the opening of the break contacts STRB2, which reduces the dropout time of the relay **70T** to one-half second. Consequently, at the end of one-half second the relay **70T** drops out to close its break contacts **70T1**. Inasmuch as the relay GY also has had time to drop out, the break contacts GY3 are closed to complete an energizing circuit for the door control relay **45**. This relay initiates a closing operation of the door by a sequence which will be clear from the discussion of Fig. 2. The dropout of the relay GY also resets the relay GX as a result of opening of the contacts GY2. Contacts GX1 consequently open.

If a second passenger follows a first passenger out of the car promptly, the beam projected by the lamp LA1 again is interrupted and the relays GA and GY again are energized. The energization of the relay GY occurs before the expiration of its one-half second dropout time. Under these circumstances the break contacts GY3 remain open to prevent a closing operation of the door until at least one-half second has elapsed after the departure of the last passenger from the elevator car. To prevent undue holding of the elevator car door the contacts GY3 may be bypassed in the same manner by which the break contacts **70–1** of Fig. 2 are bypassed. For present purposes it will be assumed that such bypassing circuits are not provided for the embodiment of Fig. 7.

The dropout of the timing relay **70T** also is accompanied by opening of the make contacts **70T3** to interrupt the energization of the relay STRB which consequently resets. Opening of the make contacts 70T4 does not have any effect on the immediate operation of the system.

As the elevator car leaves the floor, the running relay picks up in the manner discussed with reference to Fig. 2 to open its break contacts M8 and M9 and close its make contacts M5. Closure of the make contacts M5 reenergizes the time relay 70T.

Returning to the movement of the initial passenger from the elevator car, it will be understood that the passenger passes through the outer beam. As the passenger leaves the inner beam, the relay PR1 again picks up to open its break contacts PR1–2. Such opening deenergizes the relay GA which opens its make contacts GA1 to deenergize the inner-beam auxiliary relay GY. Upon the expiration of the delay period for this relay, the relay drops out to close its break contacts GY1 and open its make contacts GY2. The opening of the contacts GY2 deenergizes the selective relay GX which opens its make contact GX1 without immediate effect on the operation of the system. The effect of closure of the break contacts GY3 previously was discussed.

The continued movement of the passenger also interrupted the outer beam. Consequently the relay PR2 drops out to close its break contacts PR2–2 and energize the relay GB. The relay GB closes its make contacts GB1. However, since the break contacts GY1 are now open, the closure of the make contacts GB1 has no effect on the operation of the system. The continued movement of the passenger permits the beam to be reestablished and the relay PR2 picks up to open its break contacts PR2–2. As a result of the energization of the outer beam relay GB, the make contacts GB1 open but such opening has no effect on the operation of the system at this time.

Let it be assumed next that the elevator car stops at a floor in response to a registered floor call. As a result of such registration, the floor call relay K picks up as the elevator car approaches the floor at which it is to stop by a sequence which will be understood from the discussion of Fig. 3. Consequently the make contacts K4 are closed to energize the second time control relay KA. This relay opens its break contacts KA3 and closes its make contacts KA2 to complete with the break contacts M9 (when they close) and the make contacts 70T4 a self-holding circuit. In addition, make contacts KA1 close but have no immediate effect on the operation of the system.

The elevator car now stops at the floor and the door opens by a sequence which will be understood from the preceding discussion. When the passenger who ordered the elevator car enters the elevator car, he initially interrupts the beam projected by the lamp LA2. Such interruption results in dropout of the relay PR2 which closes its break contacts PR2–2 to energize the outer-beam relay GB. Make contacts GB1 now close to complete with the break contacts GY1 an energizing circuit for the relay GZ. The relay GZ closes its make contacts GZ1 to prepare the selective relay GX for subsequent energization.

The continued movement of the passenger into the elevator car results in interruption of the beam projected by the lamp LA1. This results in dropout of the relay PR1 which closes its break contacts PR1–2 to energize the inner-beam relay GA. The inner-beam relay closes its make contacts GA1 to energize the auxiliary relay GY. The auxiliary relay opens its break contacts GY1 and the relay GZ starts to time out. However, before the relay times out the closure of the make contacts GY2 completes with the closed make contacts GZ1 an energizing circuit for the selective relay GX. The selective relay GX closes its make contacts to energize the first-time-control relay STRB which establishes a holding circuit through the contacts STRB1, 70T3 and M8.

In addition, the break contacts STRB2 open to modify the effective value of the resistance across the timing relay 70T. However, it will be recalled that the make contacts KA1 are now closed. Consequently, the effective value reduces the non-interference time to a value of the order of 2 seconds which is desirable for floor calls.

As the passenger leaves the path of the beam projected by the lamp LA2, the relay PR2 picks up to open its break contacts PR2–2 and deenergize the relay GB. The opening of the make contacts GB1 has no immediate effect on the operation of the system. Finally the passenger clears the path of the beam projected by the lamp LA1 and the relay PR1 picks up to open its break contacts PR1–2. The resultant dropout of the relay GA opens make contacts GA1 to deenergize the inner-beam auxiliary relay and this relay now starts to time out.

Upon expiration of the dropout time of the relay GY, break contacts GY1 and GY3 close without immediately effectiing the operation of the system. Opening of make contacts GY2 also has no effect on the immediate operation of the system.

Upon the expiration of its 2-second time delay the timing relay 70T drops out to close its break contacts 70T1. This completes an energizing circuit for the door control relay 45 which operates in the manner previously discussed to close the door of the elevator car and permit the starting of the elevator car from the floor. Opening of the make contacts 70T3 resets the first-time-control relay STRB which opens its make contacts STRB1 and closes its break contacts STRB2 without immediate effect on the operation of the system. Opening of the make contacts 70T4 deenergizes the second-time-control relay KA and this relay opens its make contacts KA1 and KA2 without immediately effecting the operation of the system. It will be recalled that as the elevator car completed its stopping operation the floor call stopping relay K dropped out to close its break contacts and open its make contacts K4 without immediate effect on the operation of the system, the relay KA remaining energized through its holding circuit. The starting of the elevator car from the floor will be understood from the preceding discussion.

Next let it be assumed that the elevator car stops at a floor for which both a car call and a floor call are registered. Under such circumstances a passenger may leave the elevator car before the passenger who registered the floor call is in a position to enter the elevator car.

Since a floor call is registered the floor call stopping relay K picks up as the elevator car approaches the floor at which it is to stop and closes its make contacts K4. Consequently the second-time-control relay KA is energized to close its make contacts KA1 without immediately effecting the operation of the system. In addition, make contacts KA2 close to complete with the contacts M9 and 70T4 a self-holding circuit. Break contacts KA3 open without immediately affecting system operation.

The elevator car now stops at the floor by a sequence which will be understood from the preceding discussion and the elevator car door opens.

When the passenger within the elevator car leaves the elevator car he first interrupts the beam from the lamp LA1 to deenergize the relay PR1. This closes its break contacts PR1–2 to energize the innerbeam relay GA. As a result of closure of the make contacts GA1, the auxiliary relay GY picks up to open its break contacts GY1. In addition, make contacts GY2 close but since the contacts KA3 and GZ1 both are now open, the relay GX remains deenergized. As the passenger continues his movement he interrupts the beam from the lamp LA2 and relay PR2 drops out to close its contacts PR2–2. The resultant energization of the outer-beam relay GB closes make contacts GB1. However, the break contacts GY1 are now open and the relay GZ cannot be energized. Consequently, despite the movement of the passenger from the elevator car the break contacts STRB2 remain closed and the entire time delay of 5 seconds is available from the relay 70T.

As the passenger completes his movement from the elevator car the beams are reestablished and the break contacts PR1–2 and PR2–2 reclose to energize the relays GA and GB. The relay GA opens its make contacts GA1 to deenergize the auxiliary relay GY which starts to time out. Make contacts GB1 open without affecting the operation of the system at this time. Relay GY times out and resets.

Let it be assumed next that the passenger who registered the floor call now enters the elevator car. During this entrance he first interrupts the beam from the lamp LA2. Consequently, the relay PR2 drops out to close its break contacts PR2–2 and energize the relay GB. The resultant closure of the contacts GB1 now completes with the contacts GY1 an energizing circuit for the preference relay GZ. This relay closes its make contacts GZ1.

The continued movement of the passenger results in interruption of the beam projected by the lamp LA1 and the relay PR1 drops out to close its break contacts PR1–2 and energize the inner-beam relay GA. Closure of the make contacts GA1 picks up the relay GY to open the break contacts GY1. The relay GZ now starts to time out. However, before it can time out the make contacts GY2 close to complete with the contacts GZ1 an energizing circuit for the selective relay GX. The relay GX closes its make contacts GX1 to energize the first-time-control relay STRB. This relay closes its make contacts STRB1 to complete with the contacts M8 and 70T3 a self-holding circuit. The subsequent dropout of the relay GZ and opening of the make contacts GZ1 does not affect the immediate system operation.

The first-time-control relay also opens its break contacts STRB2. Since the make contacts KA1 are closed, however, the timing relay 70T is now adjusted to have a time delay in dropout of 2 seconds. Consequently, the timing relay 70T drops out after a time delay which does not exceed 2 seconds measured from the opening of the break contacts STRB2 to permit closure of the elevator car door.

As the passenger continues his movement into the elevator car, the beams are reestablished and the contacts PR1-2 and PR2-2 open to deenergize the relays GA and GB. Opening of the make contacts GA1 starts a timing operation of the relay GY, and this relay resets in one-half second to close its break contacts GY1, open its make contacts GY2 and close its break contacts GY3. Such operation of the relay GY does not affect the operation of the system at this time. Also the opening of the make contacts GB1 does not affect the immediate operation of the system.

From the foregoing discussion it is clear that if an elevator car stops at a floor in response to a car call, the maximum non-interference time of 5 seconds is reset to a smaller value of the order of one-half second by movement of a passenger out of the elevator car. If the elevator car stops in response to a registered floor call, the maximum non-interference time of 5 seconds is reset to a smaller value of the order of 2 seconds in response to movement of a passenger into the elevator car. If the elevator car stops at a floor for which a floor call and a car call are both registered, the maximum non-interference time of 5 seconds is not affected by the initial movement of a passenger out of the elevator car, but is reduced to a value of the order of 2 seconds in response to movement of the first passenger into the elevator car.

FIGURE 8

A preferred embodiment of a detector system wherein radiation such as light is projected across a doorway is described above. However, other detector systems may be employed. In Fig. 8, a detector system is illustrated wherein a change in capacity to ground produced by movement of a load through a doorway of an elevator car actuates the detector system.

In Fig. 8 the elevator car A including the door DP is illustrated. This elevator car is provided with a detector system which includes a rectangular box 125 located in the space between the elevator car and the hoistway, the box being secured to the elevator car. The front of the box has been removed for the purpose of exposing the contents thereof.

The upper face of the box is defined by a sheet of insulation 127 which is flush with the floor of the elevator car. Beneath the sheet of insulation one or more antennas may be located. In the specific embodiment of Fig. 8 two antennas 129 and 129*a* are located adjacent the lower face of the sheet 127.

Each of the antennas has associated therewith an electronic tube which conveniently may be a cold-cathode-thyratron tube. Thus the antenna 129 has a tube 133 associated therewith whereas the antenna 129*a* has a tube 133*a* associated therewith. Since the tubes are similar and are similarly associated with their antennas, a description of the tube 133 will suffice. Components of the tube 133*a* will be identified by the same reference characters applied to the corresponding components of tube 133, with the suffix "*a*" added thereto.

The tube 133 has a control electrode 135 and a conductive spot 137 located on the outside of the glass envelope enclosing the tube, both of which are conductively connected to the antenna 129. The tube 133 also includes an anode electrode 139 and a cathode electrode 141.

The cathode electrodes 141 and 141*a* are connected through a relay PRA to one terminal of the secondary winding of a transformer 143 which is energized from a suitable source of alternating current. This source may represent the usual power source having a frequency of the order of 60 cycles per second. The remaining terminal of the secondary winding is connected through a switch 145, a rectifier 147 and a resistor 149 to the anode electrodes of both tubes. It will be noted that this connection is grounded intermediate the switch 145 and the rectifier 147. The rectifier 147 may include suitable filters for reducing the ripple in the direct-current output thereof if so desired.

The switch 145 is normally open and is closed by a lug 151 secured to the door DP as the door reaches its fully-open position.

A shield 153 may surround a substantial portion of the sides and base of the rectangular box 125. This shield is conductively connected through a resistor 155 to the ungrounded terminal of the secondary winding of the transformer 143. Consequently when the system is in operating condition an alternating voltage is applied between the shield and ground.

The control electrode 135 of the tube 133 has both an alternating bias and a direct bias applied thereto. The direct bias may be derived from a resistor 157 which is connected between the ungrounded terminal of the secondary winding of the transformer 143 and the anode 139. An adjustable tap on this resistor is connected through a resistor 159 to the control electrode 135 and the conductive spot 137.

It will be noted that the antenna 129 has a first capacitance relative to the shield 153 and a second capacitance relative to ground. By suitable shaping of the antenna and of the shield and by suitable adjustment of the bias of the tube 133 the tube may be designed to break down when an object alters the capacitance between the antenna and ground, and the effective zone may be confined substantially to the vertical space above the antenna. In the present case the object which alters the capacitance to ground represents a foot of a passenger as a passenger enters or leaves an elevator car. Inasmuch as the foot of a passenger rarely leaves the ground by a substantial distance, an effective zone above the antenna 129 of the order of 4 to 8 inches ordinarily suffices for detection of the movement of the passenger.

When a passenger enters or leaves the elevator car the tube **133** (or the tube **133*a***) breaks down to energize and pick up the relay PRA. Consequently break contacts of the relay PRA may replace the contacts **PR1-1** and **PR2-1** in Fig. 2 for the purpose of controlling the relay SR.

The operation of the system may be described briefly as follows. When the elevator car A stops at a floor the door DP opens. As the door DP reaches its fully open position the lug **151** operates the switch **145** to its closed position for the purpose of connecting the transformer **143** operatively to the tubes and the shields. If a passenger moves his foot over the antenna **129** the capacitance to ground of the antenna is altered. The resultant change in the bias applied to the control electrode of the tube **133** is sufficient to cause this tube to break down. The resulting flow of current in the anode-cathode circuit of the tube **133** picks up the relay PRA. If break contacts of this relay are included in the circuit of Fig. 2, in place of the contacts **PR1-1** and **PR2-1**, the pickup of the relay PRA deenergizes the relay SR and the relay SR operates in the manner previously described to control closure of the elevator car door.

As the elevator car door DP starts its closing movement the lug **151** releases the switch **145** which opens to disconnect the secondary winding of the transformer **143** from the remainder of the associated circuit. This interrupts the discharge through the tube **133** and the relay PRA resets.

If it is desired to provide two detector systems which are successively actuated by a passenger entering or leaving the elevator car, a second box **125*a*** may be located just inside the doorway of the elevator car. It will be understood that the box **125*a*** includes a detector system similar to that associated with the box **125** and the operation thereof will be understood from the foregoing discussion. Make contacts of the relay PRA and of the corresponding relay associated with the box **125*a*** then may replace the contacts **PR1–2** and **PR2–2** of Fig. 7.

Although the invention has been described with reference to certain particular embodiments thereof, numerous modifications falling within the spirit and scope thereof are possible.

I claim as my invention:

1. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a door, door-operating means for opening and closing the door, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means operable for stopping the elevator car at a preselected intermediate landing and initiating a door-opening operation of the door operating means, initiating means responsive to the expiration of a substantial time following the stopping of the elevator car at said preselected intermediate landing for initiating a door-closing operation of the door-operating means, start control means responsive to closure of the door for initiating a starting operation of the elevator car, said control means being effective for stopping the elevator car at one of the terminal floors and initiating a door-opening operation of the door-operating means, and means responsive to the expiration of a time less than said substantial time following the stopping of the elevator car at the terminal floor for initiating a door-closing operation of the door operating means.

2. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a door, door-operating means for opening and closing the door, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising down landing call means for each of the intermediate landings for registering calls for elevator service in the down direction, up landing call means for each of the intermediate landings for registering calls for elevator service in the up direction, car call means for registering calls for landings desired by passengers in the elevator car, means for stopping the elevator car at a landing and initiating a door-opening operation of said door-operating means, initiating means responsive to the the expiration of a substantial time following the stopping of the elevator car at an intermediate one of said landings for initiating a door-closing operation of the door-operating means, load-responsive detector means disposed for operation by load moving through the doorway of the elevator car, expediting means responsive to prompt operation of the detector means following a stopping of the elevator car at a landing for reducing said substantial time to a smaller value of time, and means responsive to the stopping of the elevator car at a predetermined one of said landings for decreasing the value of said substantial time to a smaller value of time.

3. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means for stopping the elevator car at a preselected landing, initiating means responsive to the expiration of a substantial time following the stopping of the elevator car at said preselected landing for initiating a starting operation of the elevator car, load-responsive means for preventing operation of the elevator car, and means rendering said load-responsive means effective only while the elevator car is at one of the landings.

4. A system as claimed in claim 3 in combination with means responsive to failure of the elevator car to start within a predetermined time while it is in starting condition for rendering said load-responsive means effective despite displacement of the elevator car from any of the landings.

5. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a doorway, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means for stopping the elevator car at a preselected landing, initiating means responsive to the expiration of a substantial time following the stopping of the elevator car at said preselected landing for initiating a starting operation of the elevator car, protective means responsive to a predetermined condition for preventing operation of the elevator car, means responsive to substantial displacement of the elevator car from any of said landings for rendering the protective means ineffective, and means responsive to a loading of the elevator car above a predetermined value for rendering the protective means ineffective.

6. A system as claimed in claim 5 in combination with means responsive to failure of the elevator car to start for a substantial time during which the car is conditioned to start for rendering the protective means effective despite presence of said displacement and despite presence of a loading in excess of said predetermined value.

7. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a door, door-operating means

for opening and closing the door, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means for stopping the elevator car at a preselected landing and initiating a door-opening operation of said door-operating means, initiating means responsive to the expiration of a substantial time following the stopping of the elevator car at said preselected landing for initiating a door-closing operation of the door-operating means, start control means responsive to closure of the door for initiating a starting operation of the elevator car, protective means responsive to a predetermined condition for preventing normal operation of the elevator car, means responsive to substantial displacement of the elevator car from any of said landings for rendering the protective means ineffective, and means responsive to a closed condition of the door for rendering the protective means ineffective.

8. A system as claimed in claim 7 in combination with means responsive to failure of the elevator car to start for a substantial time during which the elevator car is conditioned to start for rendering the protective means effective despite presence of said displacement and despite said closed condition of the door.

9. A system as claimed in claim 7 in combination with means responsive to a load in the elevator car below a predetermined value for rendering the protective means ineffective.

10. A system as claimed in claim 9 in combination with means responsive to failure of the elevator car to start for a substantial time during which the elevator car is conditioned to start for rendering the protective means effective despite presence of said displacement and despite said closed condition of the door.

11. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a door, door-operating means for opening and closing the door, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means for stopping the elevator car at a preselected intermediate landing and initiating a door-opening operation of said door-operating means while the motor of the stopping elevator car is energized, initiating means responsive to the expiration of a substantial time following the stopping of the elevator car at said preselected landing for initiating a door-closing operation of the door-operating means, start control means responsive to closure of the door for initiating a starting operation of the elevator car, and load-responsive means responsive to presence in the elevator car of a load in excess of a predetermined value for delaying the door-opening operation of the door-operating means.

12. A system as claimed in claim 11 wherein said delay is until the motor of the stopping elevator car is deenergized.

13. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a door, door-operating means for opening and closing the door, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means for stopping the elevator car at a preselected intermediate landing and initiating a door-opening operation of said door-operating means, initiating means responsive to the expiration of a substantial time following the stopping of the elevator car at said preselected landing for initiating a door-closing operation of the door-operating means, start control means responsive to closure of the door for initiating a starting operation of the elevator car, and load responsive means responsive to presence in the elevator car of a load in excess of a predetermined value for altering the condition for which the door-opening operation of the door-operating means is initiated.

14. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a door, door-operating means for opening and closing the door, said door having a first edge which is the leading edge during a closing movement of the door, a second edge member disposed adjacent the door opening opposite to the first edge, said edges during a closing movement of the door moving towards each other with the effective door opening being located there-between, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means for stopping the elevator car at a preselected landing and initiating a door-opening operation of said door-operating means, initiating means for initiating a door-closing operation of the door-operating means, and means responsive to the proximity to said first edge of an object in the doorway for modifying a closing movement of the door, said last-named means being ineffective to produce said modification until said door has traveled a substantial distance from fully-open position, said distance being less than the closing movement of the door.

15. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a door, door-operating means for opening and closing the door, said door having a first edge which is the leading edge during a closing movement of the door, a second edge member disposed adjacent the door opening opposite to the first edge, said edges during a closing movement of the door moving towards each other with the effective door opening being located therebetween, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means for stopping the elevator car at a preselected landing and initiating a door-opening operation of said door-operating means, initiating means for initiating a door-closing operation of the door-operating means, and means responsive to the proximity to one of said edges of an object in the doorway during a closing movement of the door for initiating a door-reopening operation of the door-operating means, said last-named means being effective only after the door has moved substantially from its fully-open position.

16. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a door, door-operating means for opening and closing the door, said door having a first edge which is the leading edge during a closing movement of the door, a second edge member disposed adjacent the door opening opposite to the first edge, said edges during a closing movement of the door moving towards each other with the effective door opening being located therebetween, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means for stopping the elevator car at a preselected landing and initiating a door-opening operation of said door-operating means, initiating means for initiating a door-closing operation of the door-operating means, and means responsive to the presence of an object in the doorway during a closing move-

ment of the door for modifying the movement of the door, said last-named means being effective only after the door has had time to move substantially from its fully-open position following initiation of a door-closing operation.

17. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a door, door-operating means for opening and closing the door, said door having a first edge which is the leading edge during a closing movement of the door, a second edge member disposed adjacent the door opening opposite to the first edge, said edges during a closing movement of the door moving towards each other with the effective door opening being located therebetween, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means for stopping the elevator car at a preselected intermediate landing and initiating a door-opening operation of said door-operating means, initiating means responsive to the expiration of a substantial time following the stopping of the elevator car at said preselected landing for initiating a door-closing operation of the door-operating means, scanning means for projecting a quantity substantially into said doorway through a predetermined air path, and reopening means responsive to interference with transmission of the quantity through the air path for initiating an opening movement of the closing door provided that the door has moved substantially from its fully-open position, said reopening means being ineffective until the door has moved substantially from its fully-open position.

18. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, a plurality of elevator cars, each of said elevator cars having a door, door-operating means for opening and closing the door, means mounting the elevator car for movement relative to the structure to serve said landings, and motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator cars, said control means comprising first call means for each of the intermediate landings operable for registering calls for elevator service desired by intending passengers, second call means for each of the elevator cars operable for registering calls for landings desired by passengers in the associated elevator car, dispatching means for successively selecting elevator cars to leave one of said terminal landings, and for starting each selected car from such terminal landing, and means responsive to operation of the second call means in a nonselected one of the elevator cars standing at the last-named terminal landing with its door closed for initiating a door-opening operation of the door-operating means for the last-named elevator car.

19. A system claimed in claim 18 in combination with a signal for each of the elevator cars, and means responsive to said initiation of a door-opening operation of the non-selected car for operating the associated signal.

20. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, a plurality of elevator cars, each of the elevator cars having a door, door-operating means for opening and closing the door, means mounting the elevator car for movment relative to the structure to serve said landings, and motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator cars, said control means comprising first call means for each of the intermediate landings operable for registering calls for elevator service desired by intending passengers, second call means for each of the elevator cars operable for registering calls for landings desired by passengers in the associated elevator car, means for stopping each of the elevator cars at any intermediate landing approach by the elevator car for which a call is registered by the call means for the direction of approach of the elevator car which may be answered by such stopping and initiating a door-opening operation of said door-operating means, initiating means responsive to the expiration of a first substantial time following the stopping of the elevator car at an intermediate landing in response to a call registered by the call means for initiating a door-closing operation of the door-operating means, start-control means responsive to closure of the door for initiating a starting operation of the stopping elevator car, said control means being effective for stopping each of the elevator cars at one of the terminal landings and initiating a door-opening operation of the door-operating means for each such stopping elevator car, means responsive to the expiration of a second time materially shorter than said first substantial time following the stopping of any of the elevator cars at a terminal landing and following the opening of the door of the last-named elevator car for initiating a door-closing operation of the last-named door, dispatching means for successively selecting elevator cars to leave one of the terminal landings, and for starting each selected elevator car from such terminal landing, and means responsive to operation of the second call means in a non-selected one of the elevator cars at the last-named terminal landing with its door closed for initiating an opening operation of such door.

21. A system as claimed in claim 20 in combination with a signal for each of the elevator cars, and means responsive to said initiation of a door-opening operation of the non-selected car for operating the associated signal.

22. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a door, door-operating means for opening and closing the door, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means for stopping the elevator car at a preselected landing and initiating a door-opening operation of said door-operating means, initiating means responsive to the expiration of a substantial time following the stopping of the elevator car at said preselected landing for initiating a door-closing operation of the door-operating means, start control means responsive to closure of the door for initiating a starting operation of the elevator car, and means responsive to presence of an obstruction in the closing path of the door when the door is adjacent its fully-closed position for initiating a releasing door-opening operation of the door-operating means, said last-named means being responsive to an opening movement of the door which is insufficient to permit passage of a person therethrough for interrupting the releasing door-opening operation and initiating a door-closing operation of the door-operating means.

23. In an elevator system, a structure having a pair of terminal landings and a plurality of intermediate landings, an elevator car having a door, door-operating means for opening and closing the door, means mounting the elevator car for movement relative to the structure to serve said landings, motive means for moving the elevator car, and control means cooperating with the motive means for controlling operation of the elevator car, said control means comprising means for stopping the elevator car at a preselected landing and initiating a door-opening operation of said door-operating means, initiating means responsive to the expiration of a substantial time following the stopping of the elevator car at said preselected landing for initiating a door-closing operation of the door-operating means, start control means responsive to closure of the door for initiating a starting operation of the elevator car, switch means having a first condition

when the door occupies a position spaced from fully-closed position of the door by an amount less than a predetermined distance which is insufficient to permit passage of a person through the remaining door opening, said switch means having a second condition when the door is spaced from fully-closed position by a distance greater than said predetermined distance, and initiating means responsive to the conjoint presence of an object in the closing path of the door and the first condition of said switch for initiating a releasing door-opening operation of the door-operating means, said initiating means being responsive during said releasing door-opening operation to operation of the switch means to the second condition for controlling the door-operating means to initiate a door-closing operation of the door.

No references cited.