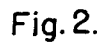


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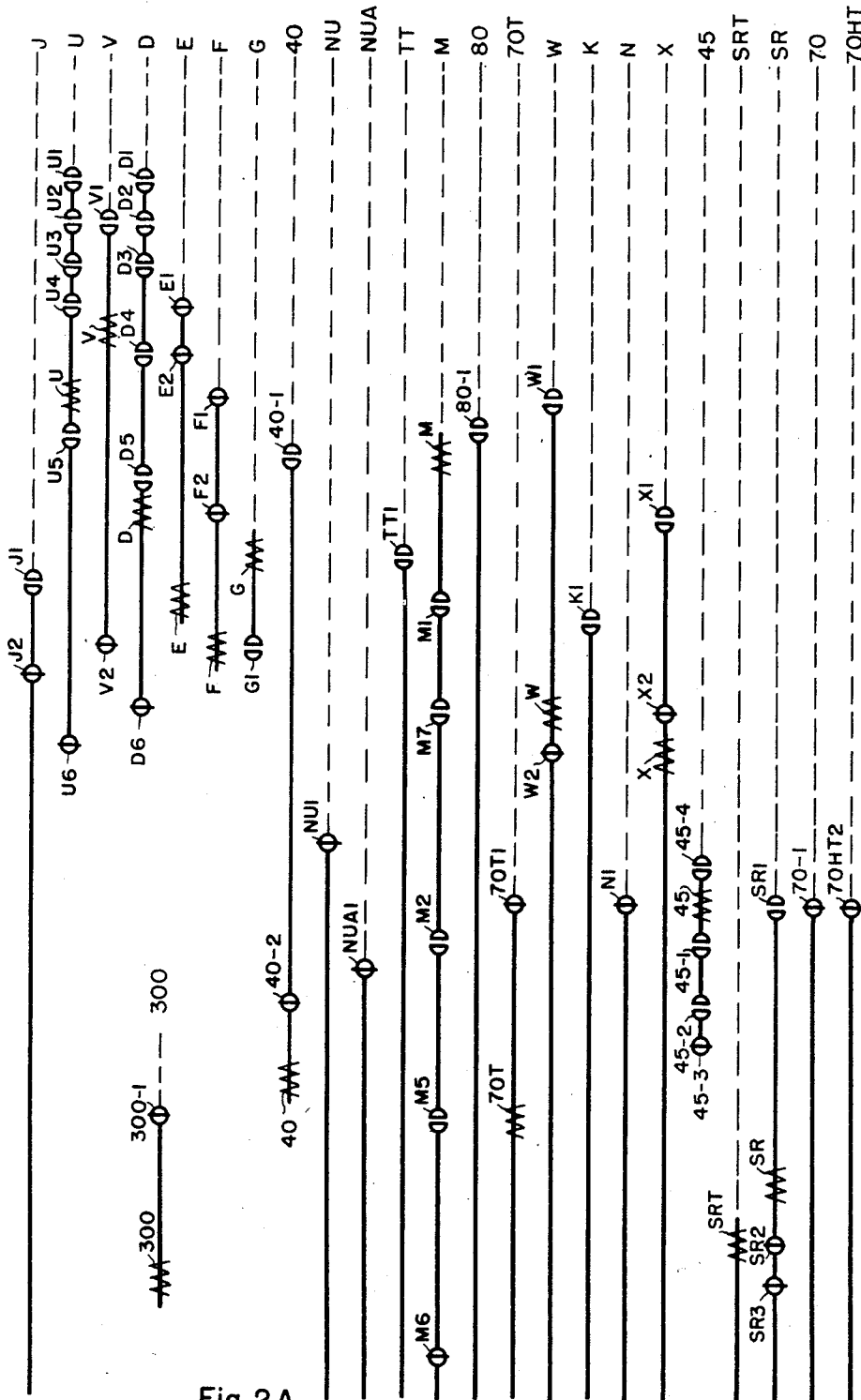
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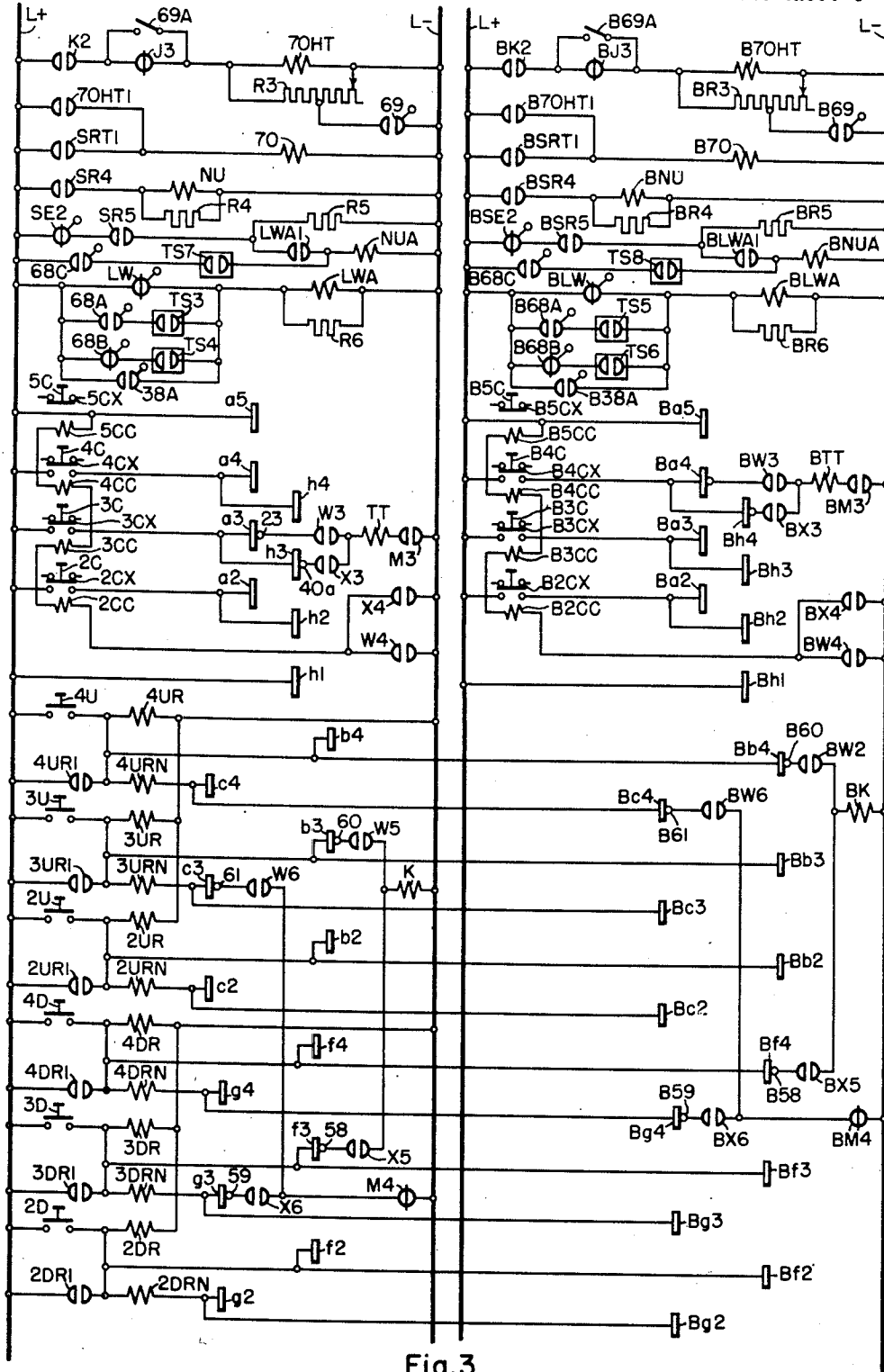


Fig. 3.

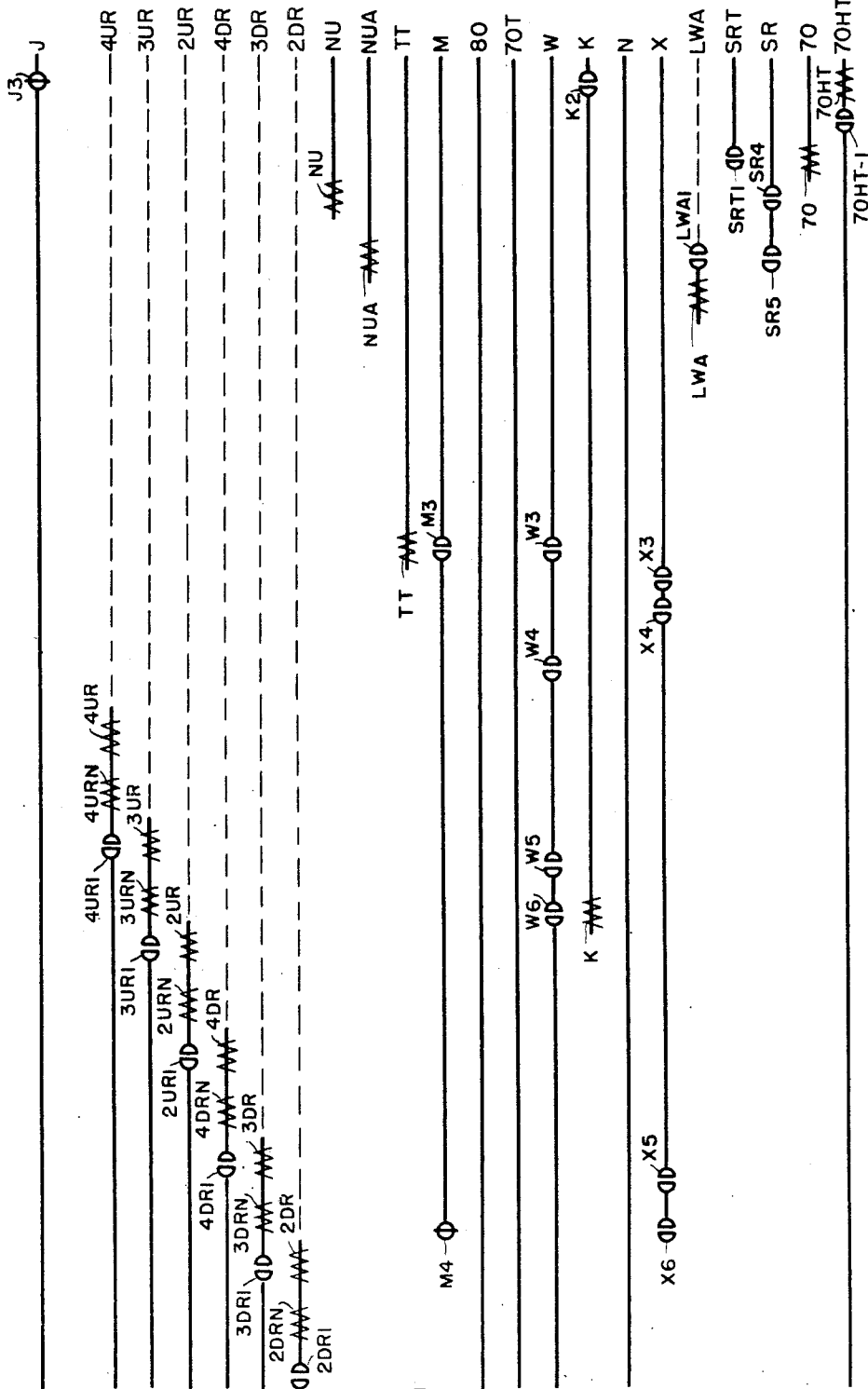
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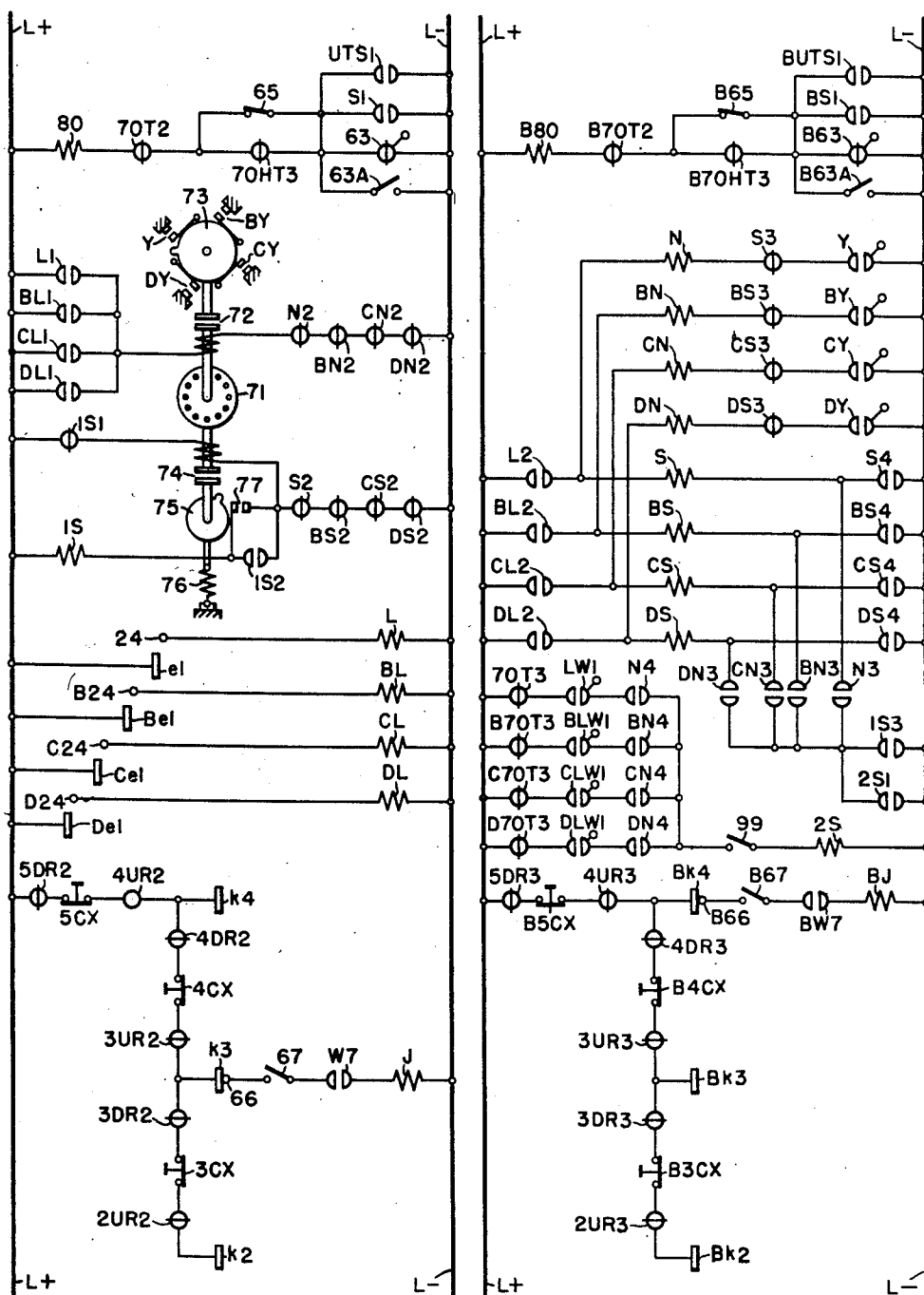


Fig.4.

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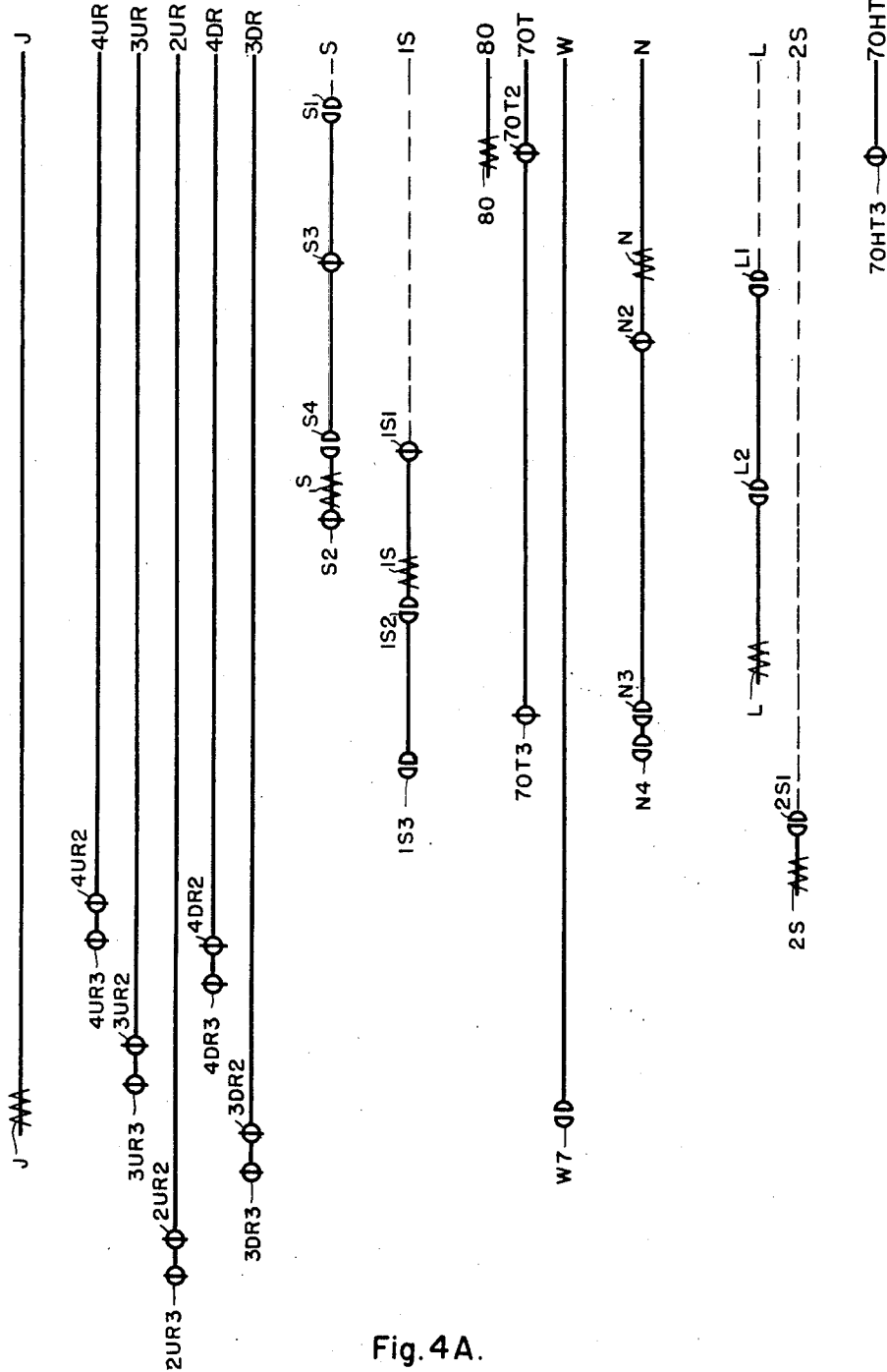


Fig. 4A.

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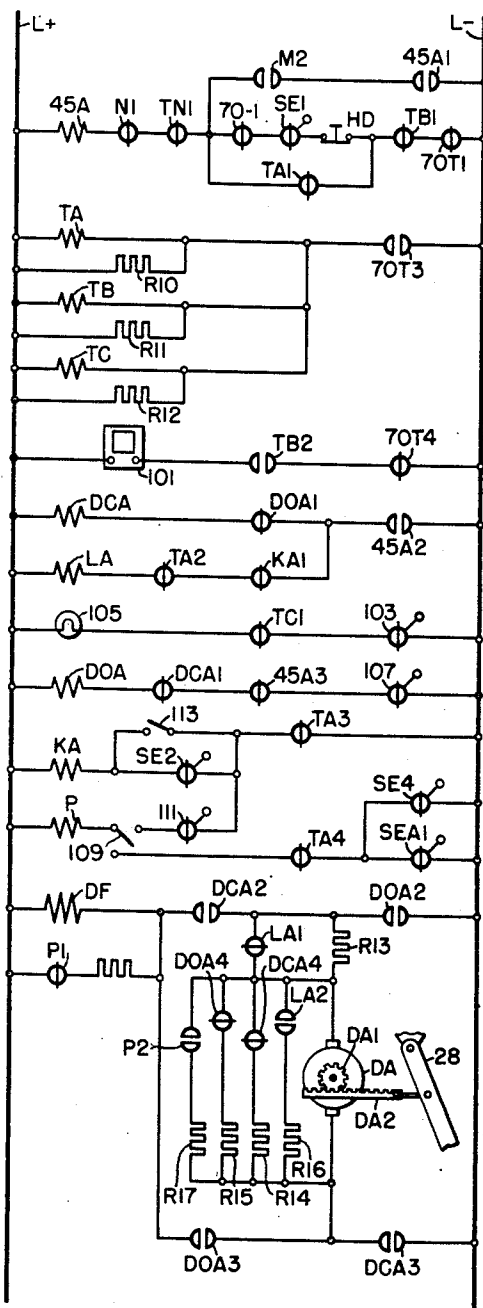


Fig. 5.

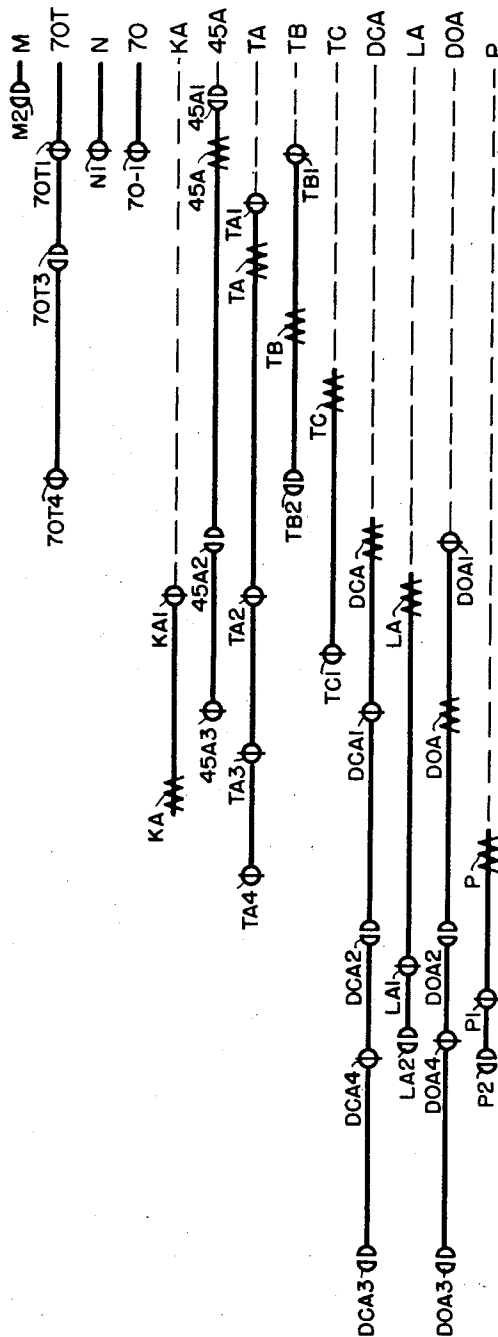


Fig. 5A.

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ELEVATOR SYSTEMS

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Application May 4, 1954, Serial No. 427,475

9 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.

In accordance with the invention, the non-interference time is 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

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close until one-half second after the beam has been reestablished.

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. Preferably, once the door starts to close, an attempt of a passenger to enter or leave the elevator car will not cause the door to reopen.

In a preferred embodiment of the invention the movement of a passenger or an intending passenger into or out of the elevator car is 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. In accordance with an aspect of the invention, 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 the 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 preferred embodiment of the invention, 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.

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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. In a preferred embodiment of the invention the closing force is exerted unless safety edges on both sides of the door opening are operated.

It is, therefore, an object of the invention to provide an improved elevator system having a minimum of lost time at each elevator car stop.

It is a still further object of the invention to provide a non-interference time for an elevator car which varies in accordance with the nature of the call answered by the elevator car.

It is another object of the invention to provide an elevator system employing protective radiant energy for controlling door closure wherein failure of the radiant energy for a predetermined time terminates the control of door closure by said radiant energy.

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 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; and

Figs. 2A, 3A, 4A and 5A are key representations of electromagnetic relays and switches employed in the circuits of Figs. 2, 3, 4 and 5. If Figs. 2, 3, 4 and 5 are horizontally aligned respectively with Figs. 2A, 3A, 4A and 5A 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.

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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
- 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

2UR to 4UR—up floor-call storing relays

Figure 1

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 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 4c 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 opened, 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 DEP 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, 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 and SE3 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 three 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.

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 expeditor 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 source 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.

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.

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, 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. Finally, the break contacts 70-1 must be closed to indicate that an auxiliary or shortened non-interference time has expired. 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 MOS1 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 expeditor 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 detector 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.

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

The expeditor 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 79HT1 and SRT1 in parallel control the energization of an auxiliary relay 79.

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 63B 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 38A which is open only when the door is open.

The car-call push buttons 2c to 4c normally are biased into their open positions against back contacts 2cx to 4cx. Each of the pushbuttons is provided with a holding coil 2cc to 4cc, 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 2c to 4c has front contacts controlling the connection of contact segments to the bus L+. When operated, the push button 2c connects the contact segments a2 and h2 to the bus L+. The push buttons 3c and 4c 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 a5 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 2cc to 4cc 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 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 there-through 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 g2 (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, g2, 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 g4, g3 and g2 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 b2 is connected (and contact segments Bb2 etc. for the other elevator cars are connected) to the bus L+ through such make contacts.

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As the elevator car during up travel approaches the second floor, the brush 60 engages the contact segment b2 to establish the following energizing circuit for the floor-call stopping relay:

L+, 2UR1, b2, 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 c2 to establish the following circuit for the cancelling coil of the storing relay 2UR:

L+, 2UR1, 2URN, c2, 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 c2, c3 and c4, and contact segments b2, b3 and b4 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 opened 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

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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 e1.

The brush 24 is operated by the floor selector for the elevator car A to engage the contact segment e1 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 k2, k3 and k4 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 h2 through the following circuit:

L+, 5DR2, 5CX, 4UR2, 4DR2,
4CX, 3UR2, 3DR2, 3CX, 2UR2, k2

(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 k2 for the second floor and the bus L+.

The contact segment *k3* 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 *k3* for the third floor and the bus L+. In an analogous manner, the contact segment *k4* 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.

Operation

In order to explain the over-all 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, W3, W4, W5, W6, W7 of the relay are closed, whereas break contacts W2 of the relay are open.

The switches 90 (Fig. 2), 63A (Fig. 3) 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 and 68A are closed and switch 68B is 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 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. Finally, the make contacts N3 close to prepare the starting relay S for subsequent energization.

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 71T, 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—

- 5 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.

- The loading relay when deenergized opens its make contacts N3 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 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 deenergize 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.

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. However, closure of the make contacts M2 (Fig. 2) completes with the contacts 45-1 and N1 a holding circuit for the door-control relay 45. Opening of break contacts M6 deenergizes the lamps LA1 and LA2. 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) does not immediately affect system operation.

It will be assumed now that the passenger in the elevator car operates the car-call push button 3c (Fig. 3) to register a car call for the third floor. Such operation opens the contacts 3cx without immediate effect on the system and connects the contact segments a3 and b3 to the bus L+. As the elevator car nears the third floor, the brush 23 engages the contact segment a3 to complete the following circuit for the car-call stopping relay TT:

L+, 3c, a3, 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 slowdown 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.

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. 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. However, the relay SRT starts to time 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 operations. 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 contacts segment b3 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 b3 to energize the floor-call stopping relay K through the following circuit:

L+, 3UR1, b3, 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+, SUR1, 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 70T drops out, the break contacts 70T2 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 70T 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 70HT 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 70HT2 and 70HT3. 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 70T 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 PC1 and PC2. Such temporary interruption temporarily interrupts and drops out the relays PR1 and PR2.

Referring to Fig. 1 and Fig. 2, it will be noted that the drop out of the relays PR1 and PR2 opens make contacts PR1-1 and PR2-1 to deenergize the detector relay SR. The detector relay opens its make contacts SR1 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 SR2 and SR3 close to energize the time delay relay SRT and the expeditor relay 300. Energization of the time delay relay SRT results in closing of the make contacts SRT1 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 expeditor relay 300 opens its break contacts 300-1 to instantly drop out the timing relay 70T. Since the timing relay is now dropped out, it closes its break contacts 70T1. However, since the contacts SR1 and 70-1 are open, the door-control relay 45 cannot be energized. In addition, break contacts 70T2 (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 SR4 and SR5 (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 PR1-1 and PR2-1 reclose to energize the detector relay SR. This relay opens its break contacts SR3 to deenergize the expeditor relay 300, but such deenergization has no immediate effect on the operation of the system. Opening of the break contacts SR2 initiates a timing out operation of the time delay relay SRT. Closure of the make contacts SR1 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 SR4 and SR5 (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 SRT1, 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 SR2 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 70HT and then reopened to start a timing out operation of the relay. For this sequence, this relay may have a delay in drop out of the order of two seconds. When the relay 70HT was energized, it closed its contacts 70HT1 to assist in maintaining energized the auxiliary relay 70. It is assumed that the switch 64 is closed to shunt the break contacts 70HT2.

If no passenger enters or leaves the elevator car for a period of two seconds, the timing relay 70HT 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 70T1 of the timing relay 70T 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 70T 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 are 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, 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 re-energizes 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 break 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 dropout when deenergized.

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.

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.

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 75

66 engages the contact segment k4 to complete the following circuit:

L+, 5DR2, 5CX, 4UR2, k4, 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 f4 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.

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 a5 to complete the following energizing circuit for the car-call stopping relay:

L+, a5, 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 UTS1. 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 UTS1 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 addition, 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 3c for the purpose of registering a car call for the third floor. This button connects the contact segments a3 and h3 to the bus L+. Also contacts 3cx open.

When the brush 40a reaches the contact segment h3, an energizing circuit is established for the car-call stopping relay TT as follows:

L+, 3c, h3, 40a, 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.

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 40a may pass the contact segment h3 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.

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 f3 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 f3 to complete an energizing circuit for the floor call stopping relay K as follows:

L+, 3DR1, f3, 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, g3, 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 40a (Fig. 3) engages the contact segment h1 to complete the following circuit:

L+, h1, 40a, 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 up preference 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.

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 sys-

tem 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

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-holding 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.

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.

When the elevator car door is assigned to close the make contacts 70T3 close to energize and pick up 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 advise 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 and break contacts DOA1 of a door-open relay DOA are both 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 break contacts 45A3 of the door-control relay 45A. 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 its 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 to introduce a resistor R13 in series with the armature DA of the motor. At the same time make contacts LA2 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-force 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 arma-

ture 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 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, 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 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.

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 affect system operation. However, since the door is fully-closed these relays LA and KA cannot affect the operation of the system.

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.

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.

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 de-energize 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 position 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 SE41. 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 SE41. 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 copending patent application Serial No. 427,476, filed concurrently herewith and in the Keiper patent application Serial No. 406,706, filed January 28, 1954.

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

We claim as our 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 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 first call means for each of the intermediate landings, each of the call means being operable for registering a call for elevator service desired by an intending passenger at the associated landing, second call means for each of the intermediate landings, each of the second call means being operable for registering a call for a landing at which the elevator car is to stop, stopping means responsive to an approach of the elevator car to a preselected landing for which a call is registered by the call means which the elevator car is available to serve for stopping the elevator car at the last-named 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, and means for providing a different value of said time for a stop

of the elevator car resulting from a call registered by the first call means than for a stop resulting from a call for a landing registered only by the second call means, and object-detecting means comprising means for directing energy across said doorway and delay means responsive to interruption of said energy by an object in the doorway for delaying the starting of the elevator car from a landing at which the elevator car is stopped.

2. 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 selectively responsive to either of two conditions for stopping the elevator car at a preselected intermediate 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, means for providing a different value of said time for a stop of the elevator car resulting from one of said conditions than for a stop resulting from the other of said conditions, and object-detecting means comprising means for directing energy across said doorway and delay means responsive to interruption of said energy for a first time by an object in the doorway for delaying the starting of the elevator car from a landing at which the elevator car is stopped, and means responsive to interruption of the energy by an object in the doorway for a time substantially longer than the first time for rendering the delay means ineffective for delaying the starting of the elevator car from a landing at which the elevator car is stopped.

3. 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, 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, object detecting means responsive to presence of an object for a first time in the closing path of the door at substantially any distance from the door for delaying closure of the door by the door operating means, object sensing means responsive to presence of an object adjacent the edge of the door which is the leading edge during a door-closing movement for delaying closure of the door, and means responsive to presence of an object in the closing path of the door for a second time substantially longer than the first time for rendering the object-detecting means ineffective for delaying closure of the door while said object sensing means remains effective.

4. An elevator system as claimed in claim 3 wherein the object-detecting means comprises a transmitter for transmitting a beam of radiant energy across the doorway of the elevator car and a radiant energy sensitive detector positioned in the path of radiant energy which has traversed the doorway, and means responsive to interruption in the reception of the detector of said radiant energy for delaying closure of the door.

5. 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 ele-

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vator 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 preselected landing in response to a call registered by said call means for such 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 comprising means for directing detectable energy through air substantially through the passage closed by said door, presence of a person in the path of the energy serving to block the energy, means responsive to a temporary interruption in the energy transmitted through said passage for resetting the substantial time to a smaller first value for delaying operation of the initiating means, and means responsive to an interruption of energy transmitted substantially through said passage for more than a predetermined time for initiating a closing of the door.

6. 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 preselected landing in response to a call registered by said call means for such 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 in response to a call registered by the landing call means for initiating a door-closing operation of the door-operating means, said initiating means being responsive to the expiration of a time less than said substantial time following the stopping of the elevator car at said preselected landing in response to a call registered by the car call means for initiating a door-closing operation of the door-operating means, object-detecting means responsive to presence of an object in the closing path of the door for delaying a door-closing operation of the door-operating means, and start control means responsive to closure of the door for initiating a starting operation of the elevator car.

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 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

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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 preselected landing in response to a call registered by said call means for such 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 in response to a call registered by the landing call means for initiating a door-closing operation of the door-operating means, said initiating means being responsive to the expiration of a time less than said substantial time following the stopping of the elevator car at said preselected landing in response to a call registered by the car call means for initiating a door-closing operation of the door-operating means, object-detecting means responsive to presence of an object in the closing path of the door for less than a predetermined time for delaying a door-closing operation of the door-operating means, means responsive to the presence of an object in the closing path of the door for more than a predetermined time for rendering the object-detecting means ineffective to delay a door-closing operation, and start control means responsive to closure of the door for initiating a starting operation of the elevator car.

8. 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 preselected landing in response to a call registered by said call means for such 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 in response to a call registered by the landing call means for initiating a door-closing operation of the door-operating means, said initiating means being responsive to the expiration of a time less than said substantial time following the stopping of the elevator car at said preselected landing in response to a call registered by the car call means for initiating a door-closing operation of the door-operating means, object-detecting means comprising a transmitter for transmitting detectable energy through air across the doorway of the elevator car, said energy being blocked by a person in the path of such energy, a detector positioned to detect presence of the energy after such energy has crossed the doorway of the elevator car, delay means responsive to interruption in the reception by the detector of said energy for preventing for a time closure of the door, and start control means responsive to closure of the door for initiating a starting operation of the elevator car.

9. 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

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ing 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 preselected landing in response to a call registered by said call means for such 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 in response to a call registered by the landing call means for initiating a door-closing operation of the door-operating means, said initiating means being responsive to the expiration of a time less than said substantial time following the stopping of the elevator car at said preselected landing in response to a call registered by the car call means for initiating a door-closing operation of the door-operating means, object-detecting means comprising a transmitter for transmitting detectable energy through air across the doorway

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of the elevator car, said energy being blocked by a person in the path of such energy, a detector positioned to detect presence of the energy after such energy has crossed the doorway of the elevator car, delay means responsive to a temporary interruption in the reception by the detector of said energy for preventing for a time closure of the door, means responsive to interruption in reception by the detector of said energy only for a time substantially longer than said temporary interruption for initiating a closing operation of the door-operating means, and start control means responsive to closure of the door for initiating a starting operation of the elevator car.

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