Nov. 13, 1962 R. B. DUNCAN ET AL 3,063,516

ELEVATOR CLOSURES

Filed June 15, 1959 2 Sheets-Sheet 1

Fig. 1

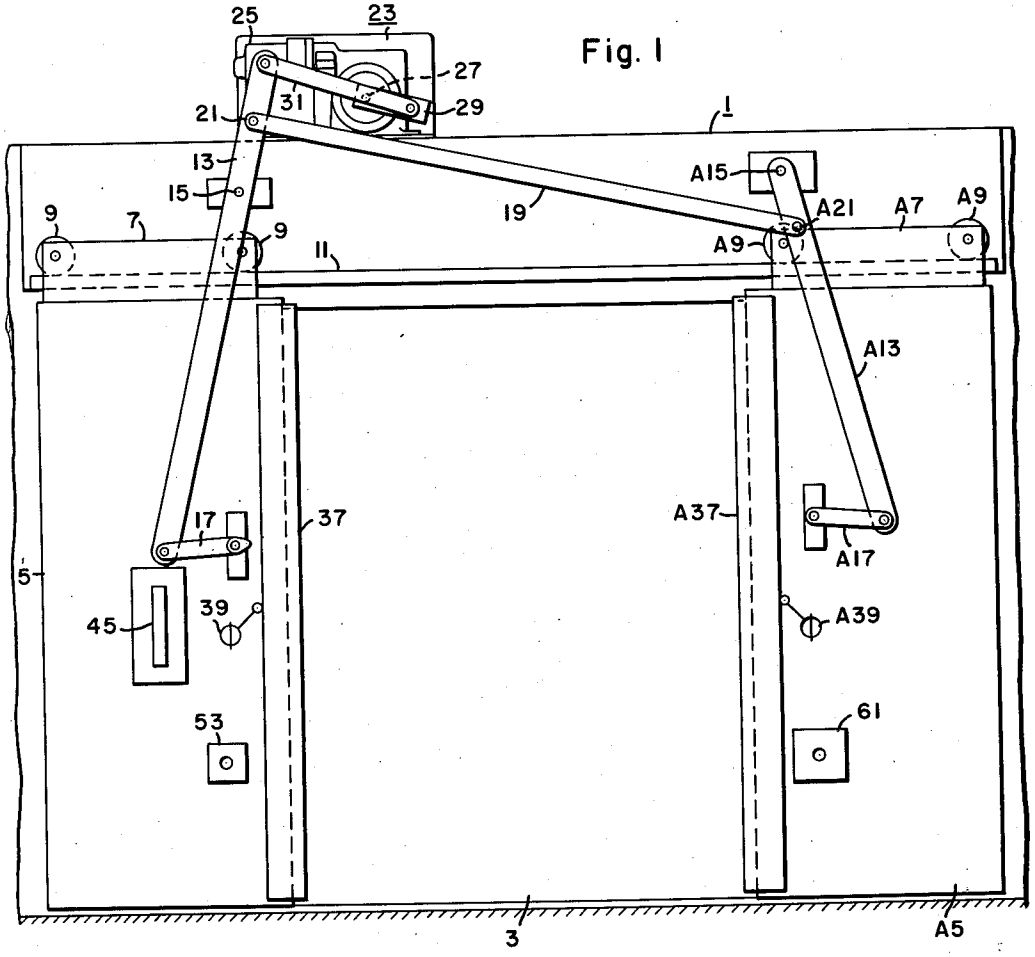


Fig. 7

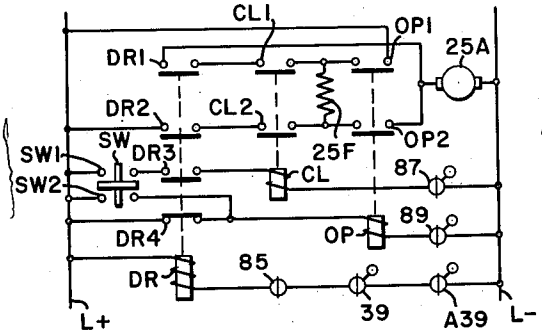
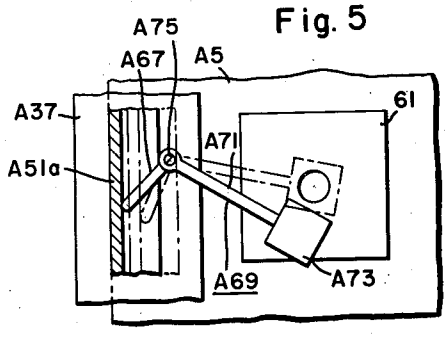


Fig. 5



WITNESSES

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ELEVATOR CLOSURES

Filed June 15, 1959 2 Sheets-Sheet 2

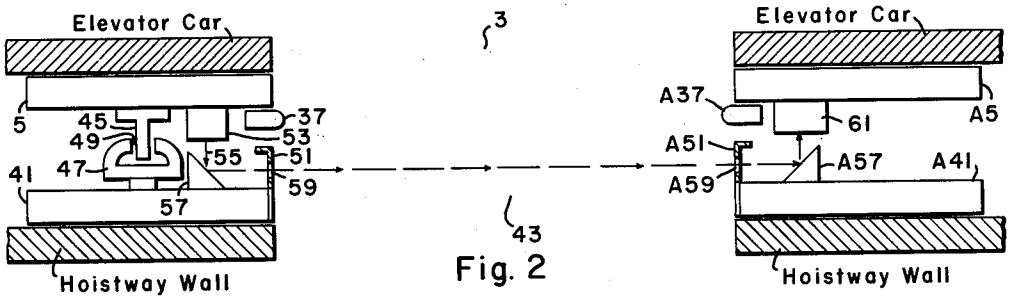


Fig. 2

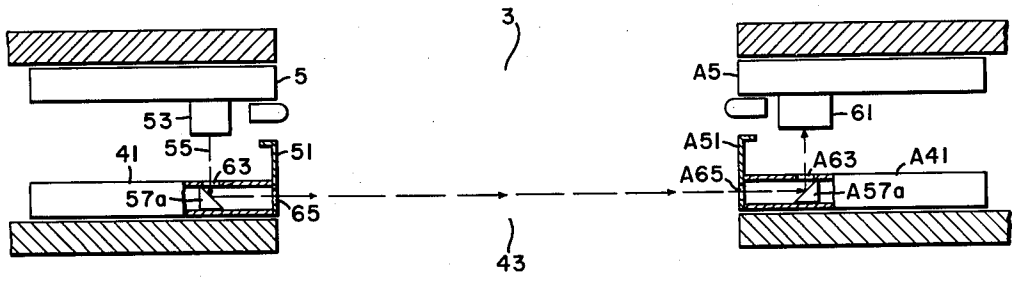


Fig. 3

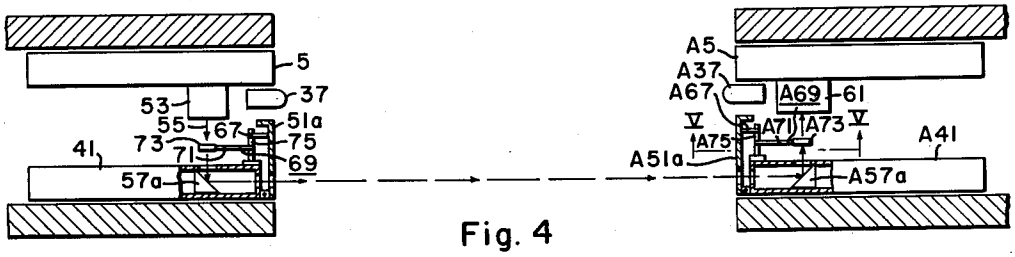


Fig. 4

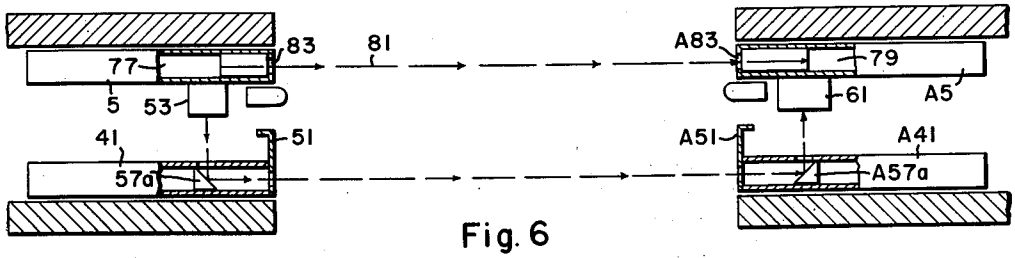


Fig. 6

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3,063,516

ELEVATOR CLOSURES

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Filed June 15, 1959, Ser. No. 820,350
8 Claims. (Cl. 187—52)

This invention relates to closure control mechanism and it has particular relation to controls for the doors of elevator systems.

Although aspects of the invention are applicable to closures designed for various applications, the invention is particularly suitable for closures or doors employed in elevator systems. Consequently, the invention will be described with particular reference to elevator closures or doors. Furthermore, aspects of the invention are applicable to doors of various types such as center-opening, side-opening, single-speed and two-speed door assemblies. In addition, the invention may be applied to manually-operated doors but it is especially suitable for power-operated doors such as those encountered in elevator systems. For the purpose of discussion, reference will be made to door assemblies of the center-opening power-operated type as employed in elevator systems.

In addition to the elevator car door, a separate hoistway door generally is provided for each of the landings or floors served by an elevator car. In an elevator system, the elevator car and hoistway doors may be under the supervision of a car attendant or they may be operated automatically, no car attendant being provided. Devices for preventing a door from striking an object in the closing path of the door may be employed for elevator systems wherein an elevator car is provided with a car attendant, but they are even more desirable for an elevator system wherein no car attendant is provided for an elevator car.

One well-known type of door protective device employs a beam of radiant energy which is projected across an elevator car opening. Means are provided which are responsive to interruption of the beam by a car-entering or -exiting passenger for controlling operation of both the elevator car door and an associated hoistway door.

In accordance with the invention transmitting and detecting devices for radiant energy are carried by the elevator car. Means mounted on adjacent hoistway parts are provided in the path of the transmitted radiant energy for directing the radiant energy substantially across an associated hoistway opening. Preferably, the radiant energy is capable of being concentrated or focussed into a beam and preferably it is not in the portion of the spectrum visible to the eye. Infrared radiant energy is particularly suitable. When the beam of radiant energy is interrupted by an object disposed substantially in the closing path of movement of the hoistway door, movement of both the elevator car and the hoistway doors may be modified in any suitable manner, such as by stopping or reversing.

The beam may be of fixed length dimension for all conditions of door operation. Preferably the beam is arranged to shorten as the doors close. To this end, a transmitting device may be mounted on the elevator car door for movement in accordance with movement of the door relative to the car opening. The transmitting device projects radiant energy into the hoistway toward the associated hoistway door. Reflecting means mounted on the oppositely disposed hoistway door which may be made to move in unison with the car door projects the beam substantially across the hoistway opening. Additional reflecting means, which may be movable relative to the hoistway opening and which also is mounted on suitable

hoistway parts, intercepts the beam after is crosses the hoistway opening and redirects it across the hoistway toward a beam detecting device which is mounted on elevator car parts.

In a further aspect of the invention, protection is provided for the full height of the hoistway door. Thus an edge of the hoistway door which is a leading edge during a door closing movement conveniently is movable. If this movable edge should strike an object in the closing path of the hoistway door, a beam of radiant energy which is substantially projected across the hoistway opening is interrupted by means responsive to movement of the edge by the obstructing object. Here again, the interruption of the beam may be utilized for stopping or reversing the hoistway and the elevator car doors.

It is, therefore, an object of the invention to provide improved means for detecting objects in the path of movement of hoistway doors employed in elevator systems.

It is an additional object of the invention to provide protection for an object disposed substantially in the closing path of movement of a hoistway door of an elevator system by means of equipment carried by an elevator car which serves the floor with which the hoistway door is associated.

It is a further object of the invention to provide protection as set forth in the previous object wherein the equipment carried by the elevator car comprises radiant energy transmitting means and detecting means and wherein means mounted on hoistway parts in the path of the radiant energy between the transmitting means and the detecting means direct such radiant energy substantially across the associated hoistway opening in a direction parallel to the closing path of movement of the hoistway door.

It is another object of the invention to provide protection for an object disposed in the closing path of movement of an elevator system hoistway door as set forth in the preceding object, wherein means are provided for interrupting detection of the radiant energy by the detecting means in the event that a leading edge of the hoistway door during a closing movement thereof engages the object.

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

FIG. 1 is a view in front elevation with portions broken away and parts not shown of an elevator car having a closure system embodying the invention;

FIG. 2 is a top view with parts in sections, parts not shown, and parts broken away of the closure system of FIG. 1 with the addition of an associated hoistway door;

FIGS. 3 and 4 are top views illustrating modifications of the invention shown in FIG. 2;

FIG. 5 is a fragmentary view taken along the line V—V of FIG. 4;

FIG. 6 illustrates the embodiment of the invention shown in FIG. 3 with the addition of radiant energy protecting means for the elevator car door; and

FIG. 7 is a schematic view of an electrical system suitable for operating the closures of FIGS. 1 through 6.

Referring to the drawings, FIG. 1 illustrates an elevator car 1 having a door for opening and closing a elevator car entranceway 3 through which load may enter and leave the car. This elevator car may serve any desired number of floors or landings. Since suitable control mechanisms for elevator cars are understood in the art, further discussion thereof is unnecessary for an understanding of the invention.

As heretofore noted, the elevator car door may be of any desired conventional construction, such as a center opening or a side-opening door, or a double or a single

door. For purpose of illustration, it will be assumed that the door is a center-opening door mounted for horizontal sliding movement.

The center-opening car door comprises two sections 5 and A5. In FIG. 1 the door is shown in its fully open position. A number of similar components is employed for the door sections 5 and A5. Insofar as is practicable, a component for the door section A5 which is similar to a component for the door section 5 will be identified by the same reference numeral as is employed for the corresponding component associated with the door section 5 prefixed by the letter A.

The door section 5 is provided with a door hanger 7, on which door hanger wheels 9 are mounted for rotation. The door hanger wheels for the door sections 5 and A5 are positioned for movement along a horizontally-mounted track 11 in a conventional manner. The track 11 is secured to the elevator car by any suitable means.

Movement of the door section 5 is effected by a lever 13 pivotally mounted on the elevator car by means of a pin 15. The lower end of the lever 13 is pivotally connected to one end of a link 17, the other end of the link being pivotally connected to the door section 5. By inspection of FIG. 1, it will be observed that the lever 13 is coupled to the lever A13 by a link 19, the ends of which are pivotally attached to the levers 13 and A13 by pivots 21 and A21, respectively. It will further be observed that the pivot 21 is positioned above the pin 15, whereas the pivot A21 is located below the pin A15. Consequently, rotation of the lever 13 to open the door section 5 moves the link 19 in the proper direction to open the door section A5.

The lever 13 preferably is operated by a suitable door operator 23 which may include a reversible rotation electric motor 25 coupled through suitable gearing to a shaft 27. The shaft 27 carries an arm 29 which is pivotally connected to one end of a link 31, the remaining end of the link 31 being pivotally connected to the lever 13. Consequently, the motor 25 may be energized in a conventional manner for the purpose of opening and closing the door sections 5 and A5. When the door is to be opened, the motor 25 is operated to rotate the arm 29 in a clockwise direction as viewed in FIG. 1. In order to reclose the door, the electric motor is reversed and returns the arm 29 to the position illustrated in FIG. 1.

Conveniently, the car door sections 5 and A5 may have associated therewith mechanical safety edges 37 and A37 respectively. The edges 37 and A37 are movable by an obstructing object in the closing path of movement of their associated door sections to actuate limit switches 39 and A39, respectively, for controlling movement of the door sections. Since mechanical safety edges are well known in the art, it appears unnecessary to describe them further.

Referring now to FIG. 2, the elevator car door sections 5 and A5 are shown in association with hoistway door sections 41 and A41, respectively. The hoistway door is operable for opening and closing a hoistway entranceway 43.

Although the hoistway door sections may be operated by any conventional door operator, preferably the hoistway door sections also are operated by the door operator 23 mounted on the elevator car through cooperating vane and drive block members 45 and 47, respectively. The vane 45 is secured to the car door section 5 and is adapted for reception in a slot 49 of the drive block 47, which is secured to the hoistway door section 41. A suitable linkage (not shown) similar to that between the car door sections 5 and A5 is provided between the hoistway door sections 41 and A41. Thus, operation of the door operator mounted on the elevator car effects movement of both the car and the hoistway door sections in unison.

Mounted on the edge of the hoistway door section 41 which is a leading edge during a door closing movement and running from the top to the bottom thereof is a sight guard 51.

During a closing operation of the hoistway door sections 41 and A41, it is highly desirable that the door sections be prevented from striking an object located in the closing paths thereof. For this purpose, the hoistway door of FIG. 2 and each of the remaining hoistway doors associated with the elevator car may be provided with means for detecting such an object. It will be apparent, however, that the cost of such means will be directly proportional to the number of hoistway doors in the elevator system. Furthermore, the maintenance problems associated with such means also will be directly proportional to the number of hoistway doors in the elevator system. The invention described herein reduces the amount of detecting equipment required per hoistway entrance and in addition eliminates any need for electrical connections to the hoistway doors. The invention also provides for ready accessibility of the hoistway door detecting equipment for maintenance purposes, as hereinafter will be apparent.

Returning to FIG. 2, mounted on the car door section 5 is a transmitting device 53. This transmitting device projects a beam of radiant energy 55 across the hoistway toward the hoistway door section 41. Disposed in the path of the beam 55 and mounted on the hoistway door section 41 is reflecting means 57. The reflecting means 57 may take the form of a mirror or a total reflecting prism. The reflecting means 57 is disposed to reflect the beam of radiant energy substantially across the hoistway opening 43 through apertures 59 and A59 in the hoistway door section sight guards 51 and A51, respectively. After the beam passes through the aperture A59, it strikes reflecting means A57 which is mounted on the hoistway door section A41. The reflecting means A57 is similar to the reflecting means 57 described above and is disposed to redirect the beam of radiant energy into the hoistway toward the car door section A5. Mounted on the car door section A5 in the path of the beam reflected from the reflecting means A57 is a radiant energy detecting device 61.

The radiant energy projected by the transmitting device 53 may have a frequency selected from a wide range. For example, the transmitting device may be designed to project visible light into the hoistway. However, since numerous sources of light are present both within the elevator car and in the corridors served by the elevator car, the possibility of false operation of the apparatus due to these external sources is present; and if an attempt is made to shield the detecting device 61 from other light sources, it becomes difficult to clean and to maintain the detecting device. For these and other reasons, non-visible radiant energy is desirable.

Preferably, the transmitting device 53 is designed to transmit a beam of infrared radiant energy. Such devices are well known in the art. The detecting device 61 may be of any type responsive to the radiant energy received from the transmitting device 53. Thus, for infrared radiant energy the detecting device 61 may be of the photoemissive type, the photoconductive type or the photovoltaic type as desired. Such detecting devices also are well known. Reference may be made to the Eames Patent 2,900,521 for details of construction of suitable radiant energy transmitting and detecting devices.

From the embodiment of the invention illustrated in FIG. 2, it will be appreciated that an object disposed in the path of the beam of radiant energy 55, and thus substantially in the closing paths of the hoistway door sections 41 and A41, will block detection of the beam by the detecting device 61. This interruption of the beam may be utilized for controlling movement of the hoistway and elevator car door sections in any suitable manner, as hereinafter will be described.

In FIG. 3 a modified arrangement of the hoistway door protective means illustrated in FIG. 2 is shown.

Here, reflecting means 57*a* and A57*a* are mounted inside the hoistway door sections 41 and A41, respectively. The beam of radiant energy 55 transmitted by the transmitting device 53 in FIG. 3 passes through an aperture 63 in the hoistway door section 41 and is intercepted by the reflecting mirror or prism 57*a*, which directs the beam across the hoistway door opening 43 through an aperture 65 in the edge of the hoistway door section 41. At the opposite side of the hoistway opening in the hoistway door section A41 is an aperture A65, through which the beam passes thence to be intercepted by the reflecting means A57*a*, which redirects the beam into the hoistway toward the detecting device 61. With the arrangement of FIG. 3, it is possible to obtain maximum protection at the leading edges of the hoistway door sections during closing movement thereof.

It will be apparent that the radiant energy protective device thus far described provides limited sensing due to the restricted width of the beam. Conveniently, the transmitting device 53 and its associated detecting device 61 may be mounted near the bottom of the elevator car approximately 15 inches above floor level, as is clearly illustrated in FIG. 1. Thus, if an object such as the hand of a passenger is located above or below the beam of radiant energy, it is liable to be struck by one or both of the hoistway door sections, since it is not in position to interrupt the beam. To this end, FIGS. 4 and 5 illustrate a typical arrangement which may be used to provide protection for the full height of the hoistway door sections.

The radiant energy beam transmitting and detecting system of FIG. 4 is basically the same as that illustrated in FIG. 3. In FIG. 4, however, the hoistway door sections 41 and A41 are provided with edges 51*a* and A51*a*, respectively, which are movable relative to the door sections in directions opposite to the closing directions thereof. These movable edges also embody hoistway door sight guards similar to those illustrated in FIG. 3.

Engaging the movable edge A51*a* is one arm A67 of a bell crank A69. Connected to an end of another arm A71 of the bell crank is a plate or flag A73. The arms of the bell crank A69 are mounted on an axle A75, which is mounted for rotation about its major axis on the hoistway door section A41. Thus, if the edge A51*a* is moved toward the right as viewed in FIGS. 4 and 5, the arms of the bell crank A69 rotate to position the flag A73 to interrupt the beam of radiant energy, thus blocking detection of the beam by the detecting device 61. Consequently, if an object is struck by the hoistway door section A41 during closing movement thereof at any point along the leading edge of the door section, the single beam of radiant energy will be interrupted. The hoistway door section 41 is provided with a similar bell crank and flag mechanism for blocking the beam of radiant energy in a similar manner.

In FIG. 6, the embodiment of the invention illustrated in FIG. 3 is again shown. Additionally, the car door sections 5 and A5 are provided with radiant energy protective means. Thus, a radiant energy beam transmitting device 77 is mounted in the car door section 5, while a beam detecting device 79 is mounted in the car door section A5. The transmitting device 77 projects a beam of radiant energy 81 across the car door opening through apertures 83 and A83 in the car door sections 5 and A5, respectively. Interruption of the beam 81 by an obstructing object may be employed to control movement of the car and hoistway doors in a manner similar to that hereinafter described for interruption of the beam associated with the hoistway door sections.

In order to illustrate suitable operation of the object-detecting device disclosed herein, a simple schematic diagram is illustrated in FIG. 7. In this diagram, the armature 25A and the field winding 25F of the door operating motor 25 (FIG. 1) are illustrated. The car door mechanical safety edge limit switches 39 and A39 are connected in series with the energizing coil of a door safety relay DR across direct current buses L+ and L−. The circuits of FIG. 7 are illustrated with the buses L+ and L− in deenergized condition. Also in series with the energizing coil of the relay DR is a pair of normally closed contacts 85. The contacts 85 are controlled by the radiant energy beam detecting device 61 which is disposed on the hoistway door section A41. The contacts 85 are directly controlled by any suitable translating device associated with the detecting device 61. Such a translating device may take the form of a relay whose coil is not shown. The contacts 85 remain closed as long as the beam of radiant energy is received by the detecting device. Since such operation of contacts by a radiant energy detecting device is well known, it appears unnecessary to describe it further.

Assuming the buses L+ and L− to be energized, as long as the switches 39 and A39 and the contacts 85 remain in closed condition, the relay DR remains energized and picked up to close its make contacts DR1, DR2 and DR3 and to open its break contacts DR4. Under normal conditions, the motor 25 is energized to open or to close the doors by operation of a switch SW. Although this may be a manually operated switch, in a preferred embodiment of the invention this switch represents the contacts of a relay or relays employed in any conventional door-operating system to initiate an opening or a closing operation of the doors.

Assuming that the doors initially are in their fully-open condition, movement of the operating member of the switch SW up results in closure of its contacts SW1 to complete with a limit switch 87 and the contacts DR3 a circuit connecting a door-closing relay CL across the buses L+ and L− for energization. The relay CL closes its make contacts CL1 and CL2 to complete the following energizing circuit:

L+, DR2, CL2, 25F, CL1, DR1, 25A, L−

This circuit energizes the motor for operation in the door-closing direction. As the doors near their fully-closed condition, they open the limit switch 87 to interrupt the energizing circuit for the door-closing relay CL. This relay thereupon drops out to terminate the energization of the motor 25.

If the doors are to be opened, the operating member of the switch SW is operated down to close its contacts SW2. These contacts, together with a limit switch 89, complete an energizing circuit for a door-opening relay OP. Consequently, the relay closes its make contacts OP1 and OP2 to complete the following circuit:

L+, OP1, 25F, OP2, 25A, L−

The motor now is energized in the proper direction to open the doors. As the doors near their fully-open position, the limit switch 89 opens to deenergize the door opening relay OP. This relay opens the make contacts OP1 and OP2 to deenergize the field winding 25F and the armature 25A.

Let it be assumed that during a door-closing operation an object substantially in the closing path of the hoistway door sections 41 and A41 interrupts the beam of radiant energy transmitted across the hoistway opening by the beam transmitting device 53 to open the break contacts 85 (FIG. 7). Opening of the contacts 85 results in deenergization of the door safety relay DR, and this relay thereupon opens its make contacts DR1 and DR2 to deenergize the field windings 25F and the motor armature 25A. Consequently, the doors are brought to a stop. The contacts DR3 also open to interrupt the energizing circuit for the door-closing relay CL. If desired, the deenergization of the door safety relay DR may also be accompanied by reopening of the doors. To this end, break contacts DR4 are provided which are closed when the door safety relay DR is deenergized to complete with the

limit switch 89 an energizing circuit for the door-opening relay OP. It will be observed in FIG. 7 that the door safety edge switches 39 and A39 operate in a manner similar to that described for the contacts 85.

By mounting the transmitting device 53, the detecting device 61 and the reflecting means respectively associated therewith on the door sections as illustrated in the drawings, the length of the beam of radiant energy across the hoistway opening decreases as the doors close to decrease the width of the hoistway and car entranceways. This shortening of the beam makes it unlikely that the detecting device will be affected by reflected infrared radiant energy. In addition, divergence of the beam between the transmitting device and the detecting device will decrease as the door sections approach one another. The foregoing results in increased efficiency of the object detecting system and in optimum sensitivity when it is particularly desirable, i.e., as the door sections approach each other, since the possibility of the striking of an object by the door sections increases as the sections close to decrease the width of the opening.

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

We claim as our invention:

1. In a closure system for an elevator installation, a structure having a hoistway, a hoistway enclosure having a hoistway opening therein and hoistway parts including a hoistway door, means mounting the hoistway door for reciprocation relative to the structure in a substantially straight path to close and to expose the hoistway opening, an elevator car disposed for movement in the hoistway enclosure from a position displaced from the hoistway door to a predetermined position adjacent the hoistway door, said elevator car having an opening and an elevator car door, means mounting the elevator car door for reciprocation in a path substantially parallel to the path of movement of the hoistway door to close and to expose the elevator car opening, the elevator car door being disposed opposite the hoistway door when the elevator car is in the predetermined position, door-operating mechanism for moving the elevator car door and the hoistway door substantially in unison from positions in which both of said doors expose their respective associated openings to positions in which both of said doors close their respective associated openings when the car is in the predetermined position, and object-detecting means responsive to the presence of an object in a space substantially in the path of the hoistway door during a closing movement thereof by the door operating mechanism, said object-detecting means comprising a transmitting device carried by the elevator car for directing a beam of radiant energy into the hoistway toward the hoistway door, first reflecting means mounted on said hoistway parts adjacent said transmitting device for directing said beam of radiant energy across said space in a direction parallel to the closing path of movement of the hoistway door, second reflecting means mounted on said hoistway parts substantially spaced from said first reflecting means for intercepting the beam of radiant energy reflected by said first reflecting means and for redirecting said beam into the hoistway toward the elevator car, said first and second reflecting means having external surfaces disposed in the path of said beam, each of said surfaces lying in a vertical plane, a detecting device carried by the elevator car adjacent said second reflecting means in the path of the beam of radiant energy reflected by said second reflecting means, said detecting device being responsive to interruption of the beam by said object for operating from a first condition to a second condition, means responsive to operation of the detecting device to said second condition during a door-closing operation of the door-operating mechanism for modifying operation of the door-operating mechanism to effect a modification in the closing movement of the hoistway and car doors, and means mounting one of said devices on said car door and its adjacent reflecting means on said hoistway door for movement in unison with one another toward the other of said devices and its adjacent reflecting means during a door-closing operation by said door-operating mechanism, whereby said beam of radiant energy is maintained between said devices during closing movement of the hoistway and car doors by the door-operating mechanism and the length of the path of said beam of radiant energy between said devices decreases as the effective hoistway and elevator car openings decrease.

2. In an elevator system, a structure having a landing, an elevator car for carrying load, means mounting the elevator car for movement relative to the structure from a position displaced from the landing to a predetermined position adjacent the landing, said elevator car having an opening, closure means for controlling access of load to the car through said opening at said landing, closure-operating mechanism for moving said closure means to open and to close said opening when the car is in the predetermined position, object-detecting means responsive to the presence of an object in a space substantially in the path of the closure means during a closing movement thereof by said closure-operating mechanism, said object-detecting means comprising transmitting means for transmitting radiant energy across said space and detecting means in the path of said radiant energy after said energy has crossed said space, said transmitting means and detecting means being carried by the elevator car, said detecting means being responsive to interruption of said energy by said object for controlling the movement of said closure means by said closure-operating mechanism, and means carried by said closure means and responsive to actuation by said object for movement into and out of the path of said radiant energy between said transmitting means and said detecting means for blocking detection of said radiant energy by said detecting means to control movement of said closure means by said closure-operating means when the elevator car is in said predetermined position.

3. In a closure system for an elevator installation, a structure having a hoistway, a hoistway enclosure having a hoistway opening therein and hoistway parts including a hoistway door, means mounting the hoistway door for reciprocation relative to the structure in a substantially straight path to close and to expose the hoistway opening, an elevator car disposed for movement in the hoistway enclosure from a position displaced from the hoistway door to a predetermined position adjacent the hoistway door, said elevator car having an opening and an elevator car door, means mounting the elevator car door for reciprocation in a path substantially parallel to the path of movement of the hoistway door to close and to expose the elevator car opening, the elevator car door being disposed opposite the hoistway door when the elevator car is in the predetermined position, door-operating mechanism for moving the elevator car door and the hoistway door substantially in unison to open and to close their respective associated openings when the car is in the predetermined position, and object-detecting means responsive to the presence of an object in a space substantially in the path of at least one of said doors during a closing movement thereof by the door-operating mechanism, said object-detecting means comprising transmitting means for transmitting radiant energy across said space and detecting means in the path of said radiant energy after said radiant energy has crossed said space, said transmitting means and detecting means being carried by the elevator car, said detecting means being responsive to interruption of said energy by said object for modifying the closing movement of the hoistway and car doors by the door-operating mechanism, and means mounted on said hoistway parts and operable by said

object for movement into and out of the path of said radiant energy between said transmitting means and said detecting means for interrupting said radiant energy to effect said modification in the closing movement of the hoistway and car doors by the door-operating mechanism when the elevator car is in the predetermined position.

4. In a closure system for an elevator installation, a structure having a hoistway, a hoistway enclosure having a hoistway opening therein and hoistway parts including a hoistway door, means mounting the hoistway door for reciprocation relative to the structure in a substantially straight path to close and to expose the hoistway opening, an elevator car disposed for movement in the hoistway enclosure from a position displaced from the hoistway door to a predetermined position adjacent the hoistway door, door-operating mechanism for moving the hoistway door to open and to close the hoistway opening, and object-detecting means responsive to the presence of an object substantially in the path of the hoistway door during a closing movement thereof by the door-operating mechanism, said object-detecting means comprising transmitting means carried by the elevator car for transmitting radiant energy, detecting means carried by the elevator car and responsive to radiant energy, and means mounted on said hoistway parts for directing the first-named radiant energy substantially across the hoistway opening to said detecting means, and blocking means mounted on said hoistway parts and operable by said object for movement into and out of the path of said first-named radiant energy between said transmitting means and said detecting means for interrupting detection of said first-named radiant energy by said detecting means to control movement of the hoistway door by the door operating mechanism when the elevator car is in the predetermined position.

5. In a closure system for an elevator installation, a structure having a hoistway, a hoistway enclosure having a hoistway opening therein and hoistway parts including a hoistway door, means mounting the hoistway door for reciprocation relative to the structure in a substantially straight path to close and to expose the hoistway opening, an elevator car disposed for movement in the hoistway enclosure from a position displaced from the hoistway door to a predetermined position adjacent the hoistway door, door-operating mechanism for moving the hoistway door to open and to close the hoistway opening, and object-detecting means responsive to the presence of an object substantially in the path of the hoistway door during a closing movement thereof by the door-operating mechanism, said object-detecting means comprising transmitting means carried by the elevator car for transmitting radiant energy, detecting means carried by the elevator car and responsive to radiant energy, and means mounted on said hoistway parts for directing the first-named radiant energy substantially across the hoistway opening to said detecting means, the hoistway door having an edge which is a leading edge during a door-closing movement, and blocking means responsive to engagement of said leading edge with said object during a closing movement of the hoistway door by the door-operating mechanism for interrupting detection of said first-named radiant energy by said detecting means, and means responsive to such interruption for modifying such hoistway door movement.

6. In a closure system for an elevator installation, a structure having a hoistway, a hoistway enclosure having a hoistway opening therein and hoistway parts including a hoistway door, means mounting the hoistway door for reciprocation relative to the structure in a substantially straight path to close and to expose the hoistway opening, an elevator car disposed for movement in the hoistway enclosure from a position displaced from the hoistway door to a predetermined position adjacent the hoistway door, door-operating mechanism for moving the hoistway door to open and to close the hoistway opening, and object-detecting means responsive to the presence of an object substantially in the path of the hoistway door during closing movement thereof by the door-operating mechanism, said object-detecting means comprising transmitting means carried by the elevator car for transmitting radiant energy, detecting means carried by the elevator car and responsive to radiant energy, and means mounted on said hoistway parts for directing the first-named radiant energy substantially across the hoistway opening to said detecting means, the hoistway door having an edge which is a leading edge during a door-closing movement, said leading edge being movable relative to the hoistway door in a direction substantially parallel to the closing path of movement thereof, and means responsive to movement by said object of said leading edge relative to the hoistway door during a closing movement of the hoistway door by the door-operating mechanism for interrupting detection of said first-named radiant energy by said detecting means, and means responsive to such interruption for modifying such hoistway door movement.

7. In a closure system for an elevator installation, a structure having a hoistway, a hoistway enclosure having a hoistway opening therein and hoistway parts including a hoistway door, means mounting the hoistway door for horizontal reciprocation relative to the structure in a substantially straight path to close and to expose the hoistway opening, an elevator car disposed for movement in the hoistway enclosure from a position displaced from the hoistway door to a predetermined position adjacent the hoistway door, said elevator car having an opening and an elevator car door, means mounting the elevator car door for reciprocation in a path substantially parallel to the path of movement of the hoistway door to close and to expose the elevator car opening, the elevator car door being disposed opposite the hoistway door when the elevator car is in the predetermined position, door-operating mechanism for moving the elevator car door and the hoistway door substantially in unison to open and to close their respective associated openings when the car is in the predetermined position, and object-detecting means responsive to the presence of an object in a space substantially in the path of the hoistway door during a closing movement thereof by the door-operating mechanism, said object detecting means comprising a transmitting device carried by the elevator car for directing a beam of radiant energy into the hoistway toward the hoistway door, first reflecting means mounted on said hoistway parts for directing said beam of radiant energy across said space in a horizontal direction parallel to the closing path of movement of the hoistway door, second reflecting means mounted on said hoistway parts substantially spaced from said first reflecting means for intercepting the beam of radiant energy reflected by said first reflecting means and for redirecting said beam into the hoistway toward the elevator car, a detecting device carried by the elevator car in the path of the beam of radiant energy reflected by said second reflecting means, said detecting device being responsive to interruption of the beam by said object for operation from a first condition to a second condition, means responsive to operation of the detecting device to said second condition during a door-closing operation of the door-operating mechanism for modifying the closing movement of the hoistway and car doors, and means mounting one of said devices and the reflecting means associated therewith for movement in unison with one another toward the other of said devices and the reflecting means associated therewith during a door-closing operation, whereby the length of the path of said beam of radiant energy between said devices decreases as the effective hoistway and elevator car openings decrease, the hoistway door having an edge which is a leading edge during a door-closing movement, said leading edge being movable relative to the hoistway door in a direction substantially parallel to the closing

path of movement thereof, and means responsive to movement by said object of said leading edge relative to the hoistway door during a closing movement of said hoistway and car doors by the door-operating mechanism for interrupting the detection of said radiant energy by said detecting means, said transmitting device, said two reflecting means and said detecting means all being located on the elevator car side of a vertical plane passing through said hoistway door and parallel to the direction of movement of the doors.

8. In a closure system for an elevator installation, a structure having a hoistway, a hoistway enclosure having a hoistway opening therein and hoistway parts including a hoistway door, means mounting the hoistway door for reciprocation relative to the structure in a substantially straight path to close and to expose the hoistway opening, an elevator car disposed for movement in the hoistway enclosure from a position displaced from the hoistway door to a predetermined position adjacent the hoistway door, said elevator car having an opening and an elevator car door, means mounting the elevator car door for reciprocation in a path substantially parallel to the path of movement of the hoistway door to close and to expose the elevator car opening, the elevator car door being disposed opposite the hoistway door when the elevator car is in the predetermined position, door-operating mechanism for moving the elevator car door and the hoistway door substantially in unison from positions in which both of said doors expose their respective associated openings to positions in which both of said doors close their respective associated openings when the car is in the predetermined position, said hoistway door having an edge which is a leading edge during a closing movement thereof by the door-operating mechanism, and object-detecting means responsive to the presence of an object in a space substantially in the path of the hoistway door during a closing movement thereof by the door-operating mechanism, said object-detecting means comprising a transmitting device carried by the elevator car for directing a beam of radiant energy into the hoistway toward the hoistway door, first reflecting means mounted on said hoistway parts adjacent said transmitting device for directing said beam of radiant energy through said hoistway door leading edge across said space in a direction parallel to the closing path of movement of the hoistway door, second reflecting means mounted on said hoistway parts substantially spaced from said first reflecting means for intercepting the beam of radiant energy reflected by said first reflecting means and for redirecting said beam into the hoistway toward the elevator car, said first and second reflecting means having external surfaces disposed in the path of said beam, each of said surfaces lying in a vertical plane, a detecting device carried by the elevator car adjacent said second reflecting means in the path of the beam of radiant energy reflected by said second reflecting means, said detecting device being responsive to interruption of the beam by said object for operating from a first condition to a second condition, means responsive to operation of the detecting device to said second condition during a door-closing operation of the door-operating mechanism for modifying operation of the door-operating mechanism to effect a modification in the closing movement of the hoistway and car doors, and means mounting one of said devices on said car door and its adjacent reflecting means on said hoistway door for movement in unison with one another toward the other of said devices and its adjacent reflecting means during a door-closing operation by said door-operating mechanism, whereby said beam of radiant energy is maintained between said devices during closing movement of the hoistway and car doors by the door-operating mechanism and the length of the path of said beam of radiant energy between said devices decreases as the effective hoistway and elevator car openings decrease.

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